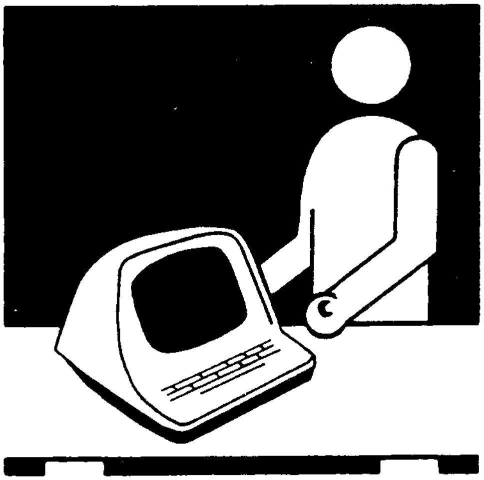
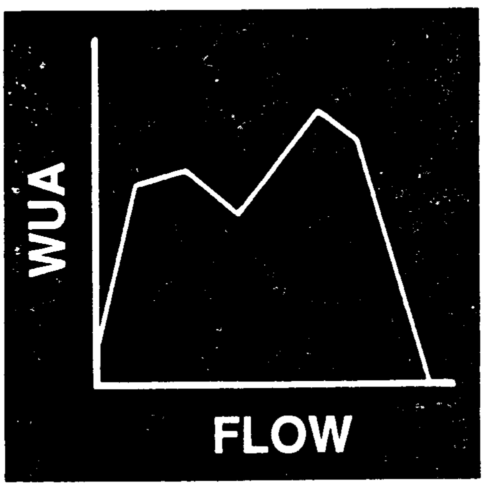


PHYSICAL HABITAT SIMULATION SYSTEM REFERENCE MANUAL – VERSION II

INSTREAM FLOW INFORMATION PAPER NO. 26

BIOLOGICAL REPORT 89(16)
SEPTEMBER 1989



National Ecology Research Center
Fish and Wildlife Service
U.S. Department of the Interior

Biological Report 89(16)
September 1989

PHYSICAL HABITAT SIMULATION SYSTEM REFERENCE MANUAL - VERSION II

Instream Flow Information Paper No. 26

by

Robert T. Milhous
Marlys A. Updike
Diane M. Schneider
National Ecology Research Center
4512 McMurray Avenue
Fort Collins, CO 80525-3400

U.S. Department of the Interior
Fish and Wildlife Service
Research and Development
Washington, DC 20240

Suggested citation:

Milhous, R.T., M.A. Updike, and D.M. Schneider. 1989. Physical Habitat Simulation System Reference Manual - Version II. Instream Flow Information Paper No. 26. U.S. Fish Wild. Serv. Biol. Rep. 89(16). v.p.

PREFACE

The purpose of this manual is to provide information on the programs that comprise the U.S. Fish and Wildlife Service's Physical Habitat Simulation System (PHABSIM)--Version II. In Version I of PHABSIM there were essentially two steps. The first was to do hydraulic simulation and the second was to do habitat simulation. In Version II there are four steps. The first is to simulate water surface elevations, the second to simulate velocities, the third is to simulate the physical habitat versus streamflow relationship, and the fourth is to simulate the physical habitat when combinations of flows are involved. Also in Version II, programs with similar functions were combined. Major PHABSIM programs such as IFG4, WSP, and HABTAT still run the same, but may have enhancements. Other program functions may have been changed in Version II. Therefore, before running a program, review the program documentation, as the program may run differently than in Version I.

Prior to applying the computer models described herein, it is recommended that the user enroll in the short course "Using the Computer Based Physical Habitat Simulation System (PHABSIM)." This course is offered by the Aquatic Systems Branch of the National Ecology Research Center.

This manual has been designed as a computer reference manual to provide users with an overview of the programs that make up PHABSIM and information on running the programs. Detailed information on the use of the programs is not included in this manual.

A PHABSIM user interface program (RPM) has been developed to provide an integrated working environment where the user has a brief on-line description of each PHABSIM program with the capability to run the PHABSIM program while in the user interface. Refer to Appendix F for information on the RPM program.

Chapter I of this reference manual provides a brief introduction to the Instream Flow Incremental Methodology and PHABSIM. Other chapters provide information on the different aspects of using the models. The chapters include:

II. Hydraulic simulation programs used to simulate water surface elevations and velocities.

III. Listing and modification of intermediate files generated by the hydraulic simulation programs.

IV. Curve maintenance programs used to manage the species and recreation criteria.

V. Habitat simulation programs used to simulate the physical habitat relationship in rivers.

VI. Effective habitat analysis programs used when two different flows are important in determining the physical habitat versus flow relationship.

VII. Report generation programs which can be useful for formatting output for reports.

Included in each above section is program documentation for the programs in that section with at least one page of information for each program, including program description, options descriptions, running the program, sample output, and error message descriptions.

The Appendices contain the following sections: (A) File formats for data sets/options files and sample data sets/options files; (B) Descriptions of default filenames; (C) Alphabetical summary of batch/procedure files; (D) Running PHABSIM on a microcomputer; (E) Running PHABSIM on a CDC Cyber computer; (F) PHABSIM user interface program (RPM); and (G) Suitability index curve development program (CURVE).

This manual is the result of several persons' efforts. Dr. Robert T. Milhous developed and implemented most of the computer programs in PHABSIM and contributed portions of the text, Marlys Updike organized and wrote this manual, Diane Schneider provided information on program functions and assisted in testing programs, and John Bartholow contributed information for Appendix D. Appendices F and G, along with the associated software, were developed by Dr. Thomas B. Hardy and Mr. J. Dean Mathias, Department of Civil and Environmental Engineering at Utah State University, Logan, Utah and was funded by research funds from the National Ecology Research Center, Aquatic Systems Branch and by the U.S. Army Corps of Engineers, Waterways Experiment Station, Environmental Impact Research Program, Work Unit No. 32390.

We would like to acknowledge Alan Moos, Tammy Taylor, and Lance David for their work in converting PHABSIM-Version II to the microcomputer. In the process, they updated the batch/procedure files so that program information could be obtained by typing the batch/procedure filename, combined several programs with similar functions, and changed program prompts to be more user-friendly. Trish Gillis and Karen Zalnis assisted in typing and formatting the manuscript. Bob Davis, Debbie Pondelek, and Mary Sanz did the illustrations and flowcharts.

To obtain magnetic tapes or floppy disks containing the PHABSIM programs contact:

TGS Technology
P. O. Box 9076
Fort Collins, CO 80525
(303) 224-4996

For technical assistance with PHABSIM programs, contact the Aquatic Systems Branch at the National Ecology Research Center, (303) 226-9331. Mailing address:

Aquatic Systems Branch
National Ecology Research Center
U.S. Fish and Wildlife Service
4512 McMurray Avenue
Fort Collins, CO 80525-3400

CONTENTS

Page

PREFACE iii
FIGURES ix
TABLES xiii
MEMORANDUM OF UNDERSTANDING xiv

I. INTRODUCTION
Instream Flow Incremental Methodology I.1
Purpose of PHABSIM I.3
Structure of PHABSIM I.5
Outline of the Theory I.9
Hydraulic Simulation in PHABSIM I.10
Calculation of Water Surface Elevations I.11
Calculation of Velocities I.12
The Hydraulic Simulation Programs I.14
Hydraulic Simulation Summary I.21
Habitat Simulation in PHABSIM I.21
Average Parameter Models I.21
Distributed Parameter Models I.22
Effective Habitat Analysis in PHABSIM I.22
Application of Programs I.22
The Use of One Velocity Calibration Data Set with IFG4 ..... I.23
The Use of Two or More Velocity Calibration Data Sets with IFG4 ..... I.25
Summary I.26

II. HYDRAULIC SIMULATION PROGRAMS
Introduction II.1
Data Set Creation, Checking, and Modification
IFG4 Data Set Creation II.8
Checking and Calibrating an IFG4 Data set II.10
IFG4 Data Set Modification II.12
WSP Data Set Creation II.16
Checking a WSP Data Set II.19
WSP Data Set Modification II.19
MANSQ Data Set Creation II.21
Hydraulic Simulation - Calibration II.21
Hydraulic Simulation - Miscellaneous II.22
Program Documentation II.24

III. CROSS SECTION AND HYDRAULIC PROPERTIES (TAPE3 and TAPE4) PROGRAMS
Introduction III.1
Listing Files III.2
Extracting and Combining Data III.4
Modifying Files III.5
Converting Files III.7
Miscellaneous III.8
Program Documentation III.10

CONTENTS (Continued)

Page

IV. CURVE MAINTENANCE PROGRAMS
Introduction IV.1
Data Entry, Review, and Plotting IV.2
Programs used with Formatted (FISHCRV) Curve Files IV.2
Programs used with Unformatted (FISHFIL) Curve Files IV.3
Program Documentation IV.5

V. HABITAT SIMULATION PROGRAMS
Introduction V.1
Options File Creation and Modification V.7
Habitat Simulation - Miscellaneous V.9
Habitat Simulation - Review V.10
Program Documentation V.11

VI. EFFECTIVE HABITAT ANALYSIS PROGRAMS
Introduction VI.1
Listing Information from a ZHCF File VI.2
Miscellaneous ZHCF File Programs VI.3
Manipulating a ZEFTBL File VI.4
Program Documentation VI.5

VII. REPORT GENERATION PROGRAMS
Introduction VII.1
Programs that Reformat a ZHAQF File VII.1
Programs that Reformat a FISHCRV file VII.2
Programs that Reformat a ZEFTBL File VII.2
ZHCF File Listing VII.2
TAPE3 and TAPE4 Listing Programs VII.3
Program Documentation VII.5

VIII. REFERENCES AND OTHER RELATED REPORTS VIII.1

APPENDICES

A. FILE FORMATS AND SAMPLE DATA SETS
AVDEPTH Data Set File Format A.2
Sample AVDEPTH Data Set A.3
FISHCRV File Format A.4
Sample FISHCRV File A.6
HABTAE Options File Format A.7
Sample HABTAE Options File A.18
HABTAM Options File Format A.19
Sample HABTAM Options File A.22
HABTAT Options File Format A.23
Sample HABTAT Options File A.34
Sample Direct Entry HABTAT Input File A.35
HABTAV Options File Format A.36
Sample HABTAV Options File A.39

CONTENTS (Continued)

Page

APPENDIX A (Continued)
HABVD Options File Format A.40
Sample HABVD Options File A.42
Streamflow and Stream Morphology Parameters File Format A.43
IFG4 Data Set File Format A.45
Sample IFG4 Data Set Used to Generate Figure Output A.53
Sample IFG4 Data Set Showing Line Placement A.54
Free-Formatted Input File for ADDCV A.55
Free-Formatted Input File for I4TEXT A.57
MANSQ Data Set File Format A.60
Sample MANSQ Data Set A.61
WSP Data Set File Format A.62
Sample WSP Data Set A.70
Free-Formatted Input File for QCKWSP A.71

B. DESCRIPTIONS OF DEFAULT FILENAMES B.1

C. ALPHABETICAL SUMMARY OF BATCH/PROCEDURE FILES C.1

D. RUNNING PHABSIM ON A MICROCOMPUTER
Hardware and Software Requirements D.1
Making Copies of the PHABSIM Diskettes D.2
Distribution D.3
Configuring Your System D.3
Similarities and Differences with Mainframe PHABSIM D.4
Graphics for the HP Laser Jet Printer D.5
Running PHABSIM and Using Batch Files D.6
Notes on Entering Data D.7
Runtime Error Messages D.7

E. RUNNING PHABSIM ON A CDC CYBER COMPUTER
Logging onto the USBR Computer E.1
Running PHABSIM and Using Procedure Files E.3
Notes on Entering Data E.4
Job Recovery E.4
Logging off of a Cyber Computer E.5
File Information E.5
NOS System Commands E.6
XEDIT Commands E.7

F. PHABSIM USER INTERFACE PROGRAM (RPM)
Introduction F.1
Installing the PHABSIM User Interface F.1
Program Usage and Control F.2
Using the RPM Interface F.3
Use of Function Keys F.6

CONTENTS (Concluded)

Page

G. SUITABILITY INDEX CURVE DEVELOPMENT PROGRAM (CURVE)
Introduction G.1
Program Control G.1
Data Entry G.2
Example Session G.2
Editing Data G.4
Development of Histograms G.5
Curve-Fitting G.7
Saving Data G.12
Edit Axis Labels G.13

GLOSSARY
INDEX

FIGURES

Number		Page
I.1	Basic components and interaction flow for fish population simulation	I.2
I.2	Example of the physical habitat versus streamflow relationship	I.3
I.3	Major linkages for Version I of the Physical Habitat Simulation System	I.7
I.4	Major linkages for Version II of the Physical Habitat Simulation System	I.8
I.5	Comparison of variability resulting from eight models on the physical habitat streamflow relationship	I.10
I.6	Example of the velocity distribution in a typical river	I.13
I.7	Flow of information through PHABSIM-Hydraulic Simulation Programs Group	I.16
I.8	Flow of information through PHABSIM-Curve Maintenance Programs Group	I.17
I.9	Flow of information through PHABSIM-Habitat Simulation Programs Group	I.18
I.10	Flow of information through PHABSIM-Effective Habitat Analysis Programs Group	I.20
II.1	Creating and checking an IFG4 Data Set	II.5
II.2	Creating and checking a WSP Data Set	II.6
II.3	Creating a MANSQ Data Set	II.7
II.4	CALCF4 Output	II.26
II.5	CKI4 Output	II.30
II.6	CKI4TXT Output	II.33
II.7	H2I4 Output	II.39
II.8	HEC2 Output - Sample Summary Table	II.42
II.9	I4VAF Output	II.46
II.10	I4VCE Output	II.50
II.11	IFG4 Output	II.59
II.12	ZVAFF File Generated by IFG4	II.62
II.13	Plot of ZVAFF File Generated by IFG4	II.63
II.14	LPTTHWE Output	II.71
II.15	Calibrating a MANSQ Data Set	II.77
II.16	MANSQ Output	II.79
II.19	REVI4 Output	II.103
II.20	SLOP34 Output	II.114
II.21	STGQS4 Output	II.116
II.22	WSEI4S Output	II.125
II.23	Calibrating a WSP Data Set	II.128
II.24	WSP Output	II.132
II.25	WSPTOHC Output	II.138

FIGURES (Continued)

Number | Page

III.1 Determination of bend weights on a bend (ADDBEND) III.11
III.2 CMPVL4 Output III.14
III.3 CMPWSL Output III.16
III.4 LSTP34 Output III.26
III.5 LSTTP3 Output III.29
III.6 LSTTP4 Output III.31
III.7 LSTVD Output III.34
III.8 LSTWLF Output III.36

IV.1 CRV2LOT Output IV.5
IV.2 LDIR Output IV.11
IV.3 LPTCRV Output IV.13
IV.4 LSTCRV Output IV.17

V.1 The way cells are viewed by the HABTAT and HABTAM/HABTAV programs V.2
V.2 AVDEPTH and AVPERM Calculations V.12
V.3 AVDEPTH Output V.14
V.4 ZHAQF File generated by AVDEPTH V.17
V.5 AVPERM Output V.19
V.6 ZHAQF File generated by AVPERM V.21
V.7 Direct entry HABTAT input file created with HABIN V.25
V.8 HABTAE options file created with HABINE V.28
V.9 HABTAM options file created with HABINM V.30
V.10 HABTAT options file created with HABINS V.32
V.11 HABTAV options file created with HABINV V.34
V.12 HABTAE Output V.43
V.13 ZHAQF file generated by HABTAE V.44
V.14 HABTAM Output V.51
V.15 ZHAQF file generated by HABTAM V.54
V.16 HABTAT Output V.64
V.17 ZHAQF file generated by HABTAT V.68
V.18 HABTAV Output V.74
V.19 ZHAQF file generated by HABTAV V.78
V.20 HABTAT vs. HABVD program results V.81
V.21 HABVD Output V.84
V.22 ZHAQF file generated by HABVD V.87
V.23 HABVD options file created with HBVDIN V.89
V.24 HQF2LT Output V.90
V.25 LPTHQF Output V.91
V.26 LPTHQFN Output V.93
V.27 ZHAQF file generated using Conditional Cover Curves V.102
V.28 ZHAQF file with life stages summed using SUMHQF V.103

FIGURES (Continued)

Number		Page
VI.1	Conceptual illustration of Option 1 in HABEF	VI.10
VI.2	Sample output from HABEF when Option 1 is selected to obtain the union of Brown and Rainbow Trout habitat space	VI.11
VI.3	The EFTBL file written by HABEF when Option 1 is selected	VI.12
VI.4	Conceptual illustration of Option 3 in HABEF	VI.14
VI.5	Sample output from HABEF when Option 3 is selected	VI.15
VI.6	Summary table written to output file by HABEF when Option 3 is selected	VI.16
VI.7	The EFTBL file written by HABEF when Option 3 is selected	VI.17
VI.8	Comparison of the concepts associated with Options 1 and 3 in HABEF	VI.18
VI.9	File comparisons when Options 1, 3, 5, and 6 are selected in HABEF	VI.19
VI.10	Sample output from HABEF when Option 5 is selected	VI.21
VI.11	Sample output from HABEF when Option 6 is selected	VI.22
VI.12	The EFTBL file written by HABEF when Option 6 is selected	VI.23
VI.13	File comparisons when Options 2, 4, 7, and 8 are selected in HABEF	VI.25
VI.14	Sample output from HABEF when Option 2 is selected	VI.26
VI.15	Summary table written to output file by HABEF when Option 2 is selected	VI.27
VI.16	The EFTBL file written by HABEF when Option 2, 4, 7, or 8 is selected	VI.29
VI.17	The concepts on which the effective spawning analysis is based (Option 7 in HABEF)	VI.30
VI.18	Sample output from HABEF when Option 7 is selected	VI.31
VI.19	The concepts on which the stranding index analysis is based (Option 8 in HABEF)	VI.32
VI.20	Sample output from HABEF when Option 8 is selected	VI.33
VI.21	Sample output from the LSTCEL program	VI.35
VI.22	Example of the accumulative distribution of the composite suitability factors (LSTHCF Program)	VI.38
VI.23	Example of a complete listing of cell factors that is written to the ZCEL file (LSTHCF Program)	VI.39
VI.24	Sample output from the MKEHQF program	VI.41
VII.1	EFHTBL Output	VII.5
VII.2	HABAE Output	VII.7
VII.3	HABOUTA Output	VII.10
VII.4	HABOUTS Output	VII.12
VII.5	LSTCP Output	VII.13

FIGURES (Concluded)

Number		Page
F.1	Initial menu for the PHABSIM user interface	F.2
F.2	Example screen showing hierarchical structure of the menu system	F.3
F.3	Example of help screen displayed by using the F1 key	F.4
F.4	Example of dialgoue box and program description	F.5
F.5	Example of using the F8 function key to display a directory	F.5
F.6	Directory window obtained from using the F8 function key	F.6
G.1	Master menu for the CURVE program	G.2
G.2	Edit menu option used to input data from the keyboard	G.3
G.3	Screen after input of data	G.3
G.4	Edit menu option used to modify data	G.4
G.5	Edit menu option used to delete data	G.5
G.6	Histogram-fitting options menu	G.6
G.7	Data input screen for the user-defined histogram option	G.6
G.8	User-defined histogram	G.7
G.9	Curve-fitting menu and available options	G.8
G.10	Exponential-fitting menu and options	G.8
G.11	2nd order polynominal fit to histogram data	G.9
G.12	Screen display with curve scattergram without menus	G.9
G.13	Screen display with curve on histogram without menus	G.10
G.14	Generalized curve-fitting menu	G.10
G.15	Data input screen for the generalized poisson option	G.11
G.16	Data input screen for the generalized exponential option	G.11
G.17	Running filter menu and available options	G.12
G.18	Save data menu and available options	G.13
G.19	Edit axis label menu options	G.13
G.20	Screen showing edited X-axis label	G.14

TABLES

Number		Page
I.1	Example conflict matrix based on optimum flow requirement for angling, river recreation, and trout life stages for the Chattahoochee River	I.6
II.1	HEC-2 Code Numbers to Select on J3 Card	II.41
II.2	IFG4 Program Options	II.53
II.3	MANSQ Program Options	II.75
II.4	WSP Program Options	II.129
V.1	HABTAE Program Options	V.36
V.2	HABTAM Program Options	V.48
V.3	HABTAT Program Options	V.56
V.4	HABTAV Program Options	V.69
V.5	HABVD Program Options	V.82
F.1	Hierarchical Menu Structure of the PHABSIM User Interface	F.8

Memorandum of Understanding
National Ecology Research Center

Received from the
National Ecology Research Center
U.S. Fish and Wildlife Service
Department of the Interior

This agreement, in compliance with the Freedom of Information Act (43 CFR, Part 2), serves as evidence of the mutual understanding governing the transfer and subsequent use of computer software developed by the National Ecology Research Center (NERC). The undersigned, as an independent individual or as the responsible official of the firm, institution, association, government agency, or other such group, agrees that all its members, affiliates, and employees will abide by the conditions listed below. Conditions 1 and 2 specifically apply to non-governmental entities, including corporations, private individuals, and profit-making associations:

1. The computer programs are furnished by NERC and are accepted and used by the recipient individual or group entity with the express understanding that the United States Government makes no warrantees, expressed or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the information or data contained in the programs, or furnished in connection therewith, and the United States shall be under no liability whatsoever to any such individual or group entity by reason of use thereof.

2. There will be no operational support (including technical assistance) of software or documentation transferred from NERC to a government entity unless specifically funded through a current fiscal year agreement, such as Program Advice, interagency or cooperative agreement, or other appropriate arrangement. NERC cannot provide operational support to non-governmental entities.

3. NERC programs were developed by the Federal Government with public funds. Therefore, it is illegal to assert any proprietary rights thereto or to represent the programs to anyone as other than Government programs. The programs should be used only in the public interest and/or the advancement of science. The recipient will not imply proprietary possession of these programs in seeking clients for their application in either the public or private sectors. The recipient may charge clients for the ordinary cost of applying these programs.

4. The recipient also understands that the current programs and all documents related thereto may be discontinued from further support or maintenance by NERC at any time. When NERC supports or maintains an updated version of any program and/or related document, the recipient can request the newest version. NERC may notify recorded users of updates and new products at NERC's initiative, but such notifications are subject to budget and policy constraints. Recipients are not afforded any sort of subscription service.

5. All recipient-modified program source code and documentation should acknowledge the appropriate source of the parent computer program and algorithm. The recipient shall not represent modified NERC programs or documentation or outputs from the programs as original NERC products. Reference shall be made to the NERC software, as modified by the recipient. Recipients who modify or enhance NERC software shall notify NERC of the programs and/or algorithms modified and shall provide NERC with copies of those changes. NERC reserves the right to provide future revisions and enhancements of programs provided under this understanding. Recipients are encouraged not to assert proprietary rights to any enhancements because work at NERC may duplicate or surpass their efforts.

6. If the source code or documentation of NERC programs is transferred to a third party, a copy of this Memorandum of Understanding shall accompany those products, and NERC shall be notified of the transfer. This notification shall include the name, address, and telephone number of the third party. Announcements of updates and releases of new NERC programs may be provided, at NERC's initiative, to all recorded users of NERC software. For purposes of this memorandum, "third party" refers to any physical host computer facility other than at the original recipient's location.

7. All documents and reports conveying information obtained as a result of the use of original NERC programs, by either recipient or third party users, shall acknowledge their origin as being the National Ecology Research Center, United States Department of the Interior. If the programs have been modified and/or are not longer supported or maintained by NERC, this status shall be stated in the acknowledgement.

8. The recipient understands that the acknowledgement of the National Ecology Research Center, U.S. Fish and Wildlife Service, shall not explicitly or implicitly be used to support the specific analysis, interpretations, or other findings of an application or study utilizing these computer programs.

____

NERC Representative - Date

____

Recipient Signature - Date

I. INTRODUCTION

INSTREAM FLOW INCREMENTAL METHODOLOGY

There are four major components of a stream system that determine the productivity of the fishery (Karr and Dudley 1978). These are: (1) flow regime, (2) physical habitat structure (channel form, substrate distribution, and riparian vegetation), (3) water quality (including temperature), and (4) energy inputs from the watershed (sediments, nutrients, and organic matter). The complex interaction of these components determines the primary production, secondary production, and fish population of the stream reach.

The basic components and interactions needed to simulate fish populations as a function of management alternatives are illustrated in Figure I.1. The assessment process utilizes a hierarchical and modular approach combined with computer simulation techniques. The modular components represent the "building blocks" for the simulation. The quality of the physical habitat is a function of flow and, therefore, varies in quality and quantity over the range of the flow regime. The conceptual framework of the Incremental Methodology and guidelines for its application are described in "A Guide to Stream Habitat Analysis Using the Instream Flow Incremental Methodology" (Bovee 1982).

Simulation of physical habitat is accomplished using the physical structure of the stream and streamflow. The modification of physical habitat by temperature and water quality is analyzed separately from physical habitat simulation. Temperature in a stream varies with the seasons, local meteorological conditions, stream network configuration, and the flow regime; thus, the temperature influences on habitat must be analyzed on a stream system basis. Water quality under natural conditions is strongly influenced by climate and the geologic materials, with the result that there is considerable natural variation in water quality. When we add the activities of man, the possible range of water quality possibilities becomes rather large. Consequently, water quality must also be analyzed on a stream system basis. Such analysis is outside the scope of this manual, which concentrates on simulation of physical habitat based on depth, velocity, and a channel index.

The results from PHABSIM can be used alone or by using a series of habitat time series programs that have been developed to generate monthly or daily habitat time series from the Weighted Usable Area versus streamflow table resulting from the habitat simulation programs and streamflow time series data. Monthly and daily streamflow time series may be obtained from USGS gages near the study site or as the output of river system management models.

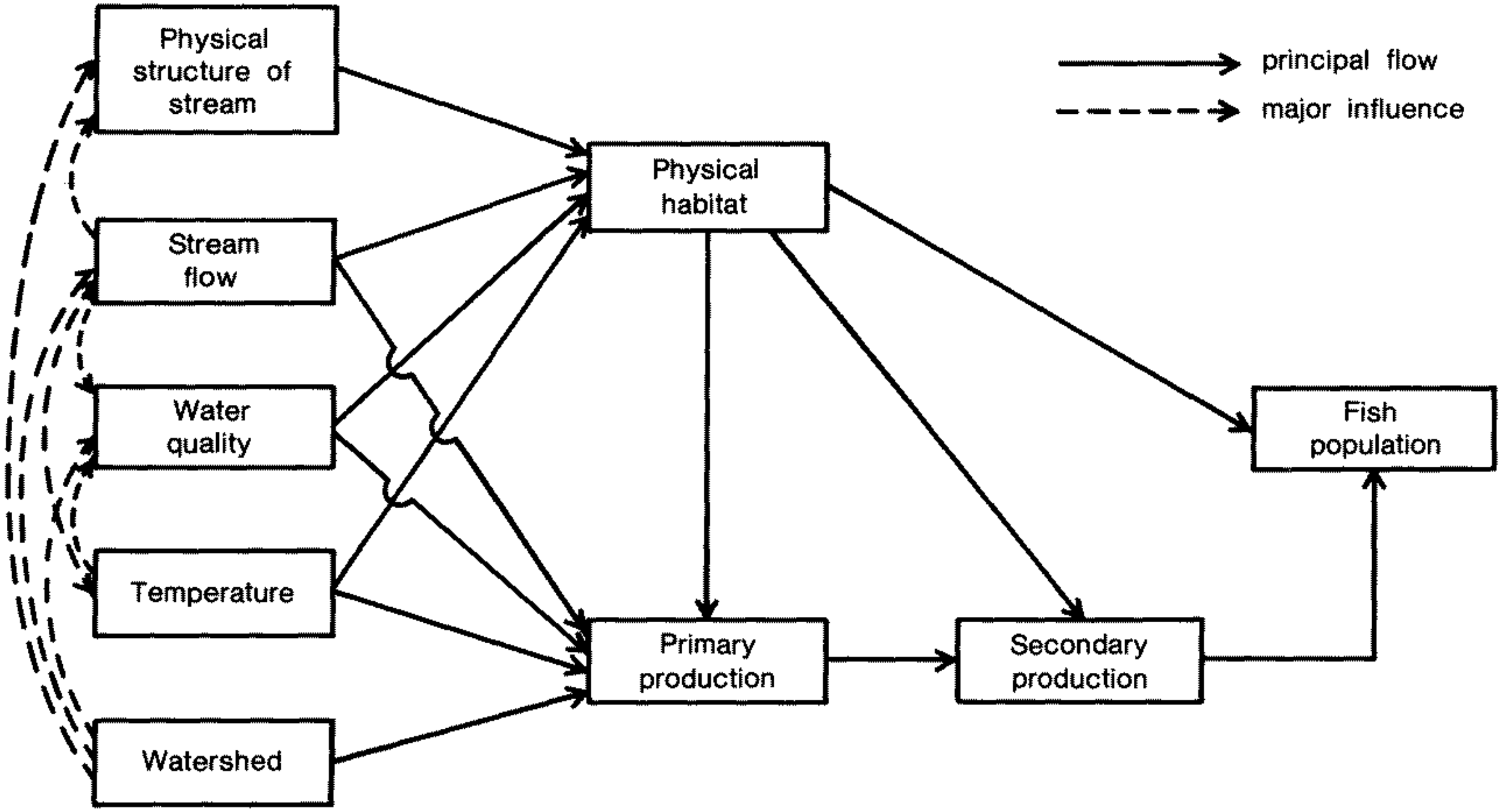


Figure I.1. Basic components and interaction flow for fish population simulation.

PURPOSE OF THE PHYSICAL HABITAT SIMULATION SYSTEM (PHABSIM)

The purpose of the Physical Habitat Simulation System is to simulate a relationship between streamflow and physical habitat for various life stages of a species of fish or a recreational activity. An example of the physical habitat versus streamflow relationship is given in Figure I.2. The basic objective of physical habitat simulation is to obtain a representation of the physical stream so that the stream may be linked, through biological considerations, to the social, political, and economic world.

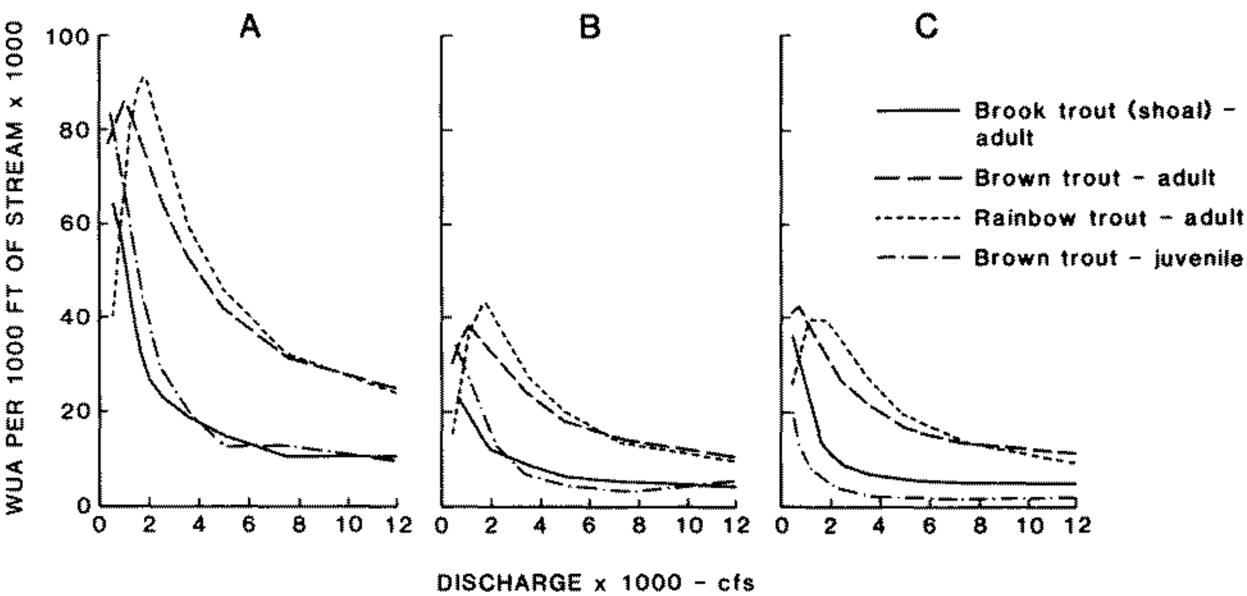


Figure I.2. Example results from an instream flow study on the Chattahoochee River, Georgia. Weighted usable area (WUA) in square feet per 1000 feet of river is presented for four different trout life stages. Each subfigure represents study results for a different river reach. Note that these plots contain information that can be utilized in a water resources conflict. The effects of adding or removing flows can be compared to existing conditions in the river by reading the habitat available to a target organism at each of two or more discharges.

In water allocation decisions, it is desirable to know the relationship between benefits and streamflow for the various uses. In general, the benefit of an out-of-stream use can be quantified in terms of some type of production function that relates the quantity of water used to the benefits produced. Unfortunately, little work has been done to relate the quantity of flow instream to the benefits produced by that flow. Prior to about 1973, instream flow assessments typically arrived at a single streamflow value--a "minimum flow" above which all flows were considered available for out-of-stream use. These flow recommendations were determined from analyses of hydrologic records and/or fish population studies. Because of inherent threshold concepts, these approaches provided only limited opportunity for negotiation and compromise.

In order to improve the ability to make measurable tradeoffs between the various uses, a simulation system called PHABSIM has been developed to analyze and display the relationship between streamflow and physical habitat, or between streamflow and recreational river space. This relationship is a continuous function between the physical habitat and the streamflow. It can be used to examine the tradeoff between the value of water used instream with the water used out-of-stream. Therefore, tradeoffs can be made between alternative uses and mutually acceptable management criteria developed. The decision as to the "best" allocation of the available water is a matter of negotiation among various interest groups.

The use of physical habitat as a substitute for a production function assumes the production of benefits (fish or recreation) is limited by the availability of physical habitat. This assumption is not always true. In some situations the production will be limited by water quality (i.e., acid rain in the Canadian Shield region) or by the activities of man (i.e., over-harvesting of some species). In essentially all situations, physical habitat is a necessary, but not sufficient, factor for the production of benefits. The analyst must never lose sight of the importance of factors other than physical habitat.

Other papers that discuss the application of PHABSIM to water management concerns are "Instream Flow Values as a Factor in Water Management" (Milhous 1983) and "Comparison of Minimum Instream Flow Needs" (Milhous 1986).

As an example of the application of the system, let us first look at an instream flow study of the Chattahoochee River in Georgia. The purpose of the Chattahoochee River instream flow study was to determine the effects of reregulation of releases from a peaking hydropower project on recreational activities and a put-and-take trout fishery (Nestler et al. 1986). Reregulation of the highly fluctuating flows (550 to 8000 cfs on most weekdays) from the peaking project by a smaller reregulation dam would result in steady flows of about 1050 cfs. The steady flow of 1050 cfs from the reregulation dam would provide a more dependable source of water supply for the metropolitan Atlanta area.

The study had most of the elements normally associated with instream flow studies. That is, the flow needs of aquatic biota, recreational activities, and municipal water supply were all in potential conflict. Each of the activities/species had advocates, and a number of vocal interest groups were involved in the controversy. PHABSIM was used to generate relationships between each activity/species and discharge, as shown in Figure I.2. This study was biologically simple because only adult and juvenile life stages needed assessment, since natural reproduction of trout in the tailwater has never been observed.

In contrast to the biological simplicity, the water resources conflict was complex. The habitat requirements of the three life stages peaked at different discharges, and the optimum flow conditions for each of the different recreational activities differed significantly. In other words, "everything seemed to conflict with everything else." The results from the PHABSIM analysis were used to generate a conflict matrix (Table I.1) to allow decisionmakers to crystallize the conflicts in flow requirements for each of the different recreational uses and trout life stages. The results of the instream flow analysis could then be used to optimize as many of the uses of Chattahoochee River water as possible. This and other examples of the use of PHABSIM are given in "Instream Habitat Modeling Techniques" (Nestler, Milhous, and Layzer 1988).

STRUCTURE OF PHABSIM

The two basic components of PHABSIM are the hydraulic and habitat simulations of a stream reach utilizing defined hydraulic parameters and habitat suitability criteria. Hydraulic simulation is used to describe the area of a stream having various combinations of depth, velocity, and channel index as a function of flow. This information is used to calculate the Weighted Usable Area of the stream segment from suitability information based on field sampling of the various species of interest. The objective of this manual is to explain the procedures required to effectively utilize these components.

This manual presents Version II of the Physical Habitat Simulation System. The user's manual for Version I is Milhous, Wagner, and Waddle (1981). The major programs used by PHABSIM Version I are illustrated by Figure I.3. The major programs used in Version II are illustrated in Figure I.4.

In Version I there were essentially two steps. The first was to do hydraulic simulation and the second was to do habitat simulation. The use of Version I was relatively simple and straightforward.

In Version II the system has four steps. The first is to simulate water surface elevations, the second is to simulate velocities, the third is to simulate the physical habitat versus streamflow relationship, and the fourth is to simulate the physical habitat when combinations of flows are involved.

The first step in Version I did the same as the first two steps of Version II but in essentially one step. In Version II the steps are specific and distinct. The use of Version II requires much more understanding of PHABSIM and the application of the results of Version I. The user must select between hydraulic simulation programs and alternatives, select an approach to using the channel index, and select among the habitat simulation models.

Table I.1. Example conflict matrix based on optimum flow requirement for angling, river recreation, and trout life stages for the Chattahoochee River. The effect of increased flows for water supply on each of the competing uses of river water can be seen under the rightmost column.

Life stage/ activity	Trout: Brown trout Juven	Trout: Brown trout Adult	Trout: Adult Brook	Trout: Adult Rainbow	Angling: Wading	Angling: Tubing	Angling: Boat Nopwr	Angling: Boat Power	Rafting: Novice Normal	Rafting: Novice Prefr	Rafting: Midlevel	Rafting: Landing	Canoeing: Novice	Canoeing: Midlevel	Water supply
<u>Trout</u>															
Juvenile brown		0	0	M	0	0	M	X	X	M	XX	0	M	XX	+
Adult brown			0	M	0	0	M-X	X	X	0-M	XX	0	M	XX	+
Adult brook				M-X	0	0-M	X	XX	X	M	XX	0	M	XX	+
Adult rainbow					M	M	0	X	X	0	XX	M	0	XX	+
<u>Angling</u>															
Wading						0	0-M	X	XX	M	XX	0	XX	XX	-
Tubing							0-M	X	XX	M	XX	0	XX	XX	-
Boat-Nopwr								X	XX	0	XX	M-X	0	XX	+
Boat-Power									0	X	XX	XX	X	XX	+
<u>Rafting</u>															
Novice-Normal										XX	XX	XX	XX	XX	+
Novice-Prefr											XX	XX	0	XX	+
Midlevel												XX	XX	0	+
Landing													X	XX	-
<u>Canoeing</u>															
Novice														XX	+
Midlevel															+

0 = No conflict, optima usually within 500 cfs
M = Moderate conflict, optima usually within 500 to 1,000 cfs
X = Extensive conflict, optima usually within 1,000 to 2,000 cfs
XX = Very extensive conflict, optima more than 2,000 cfs apart
+ = Increased flows for water supply beneficial
- = Increased flows for water supply detrimental

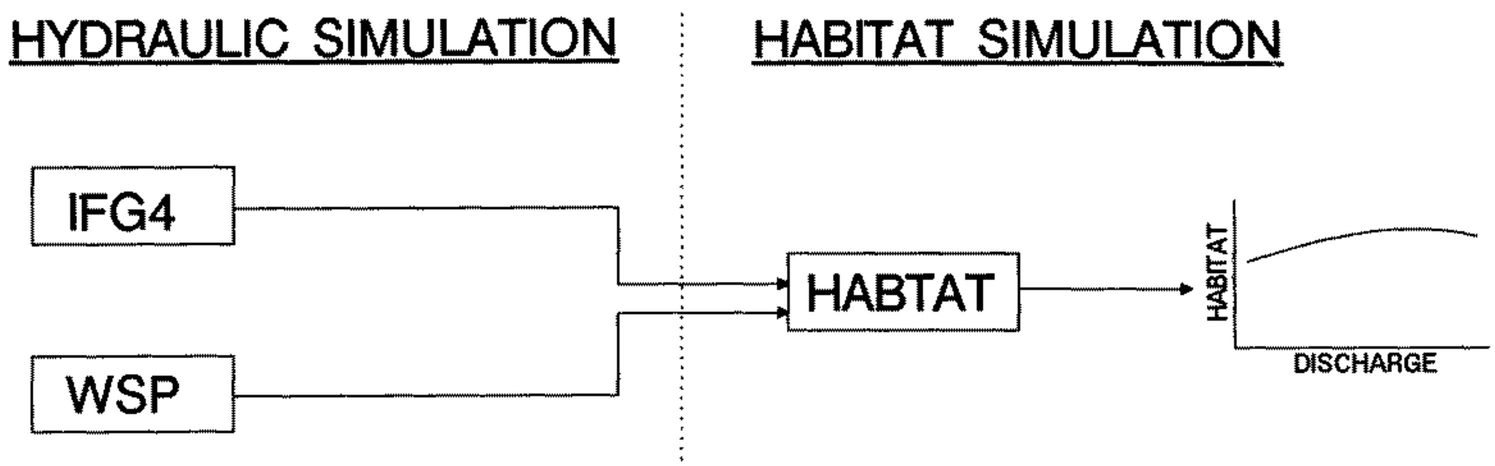


Figure I.3. Major linkages for Version I of the Physical Habitat Simulation System.

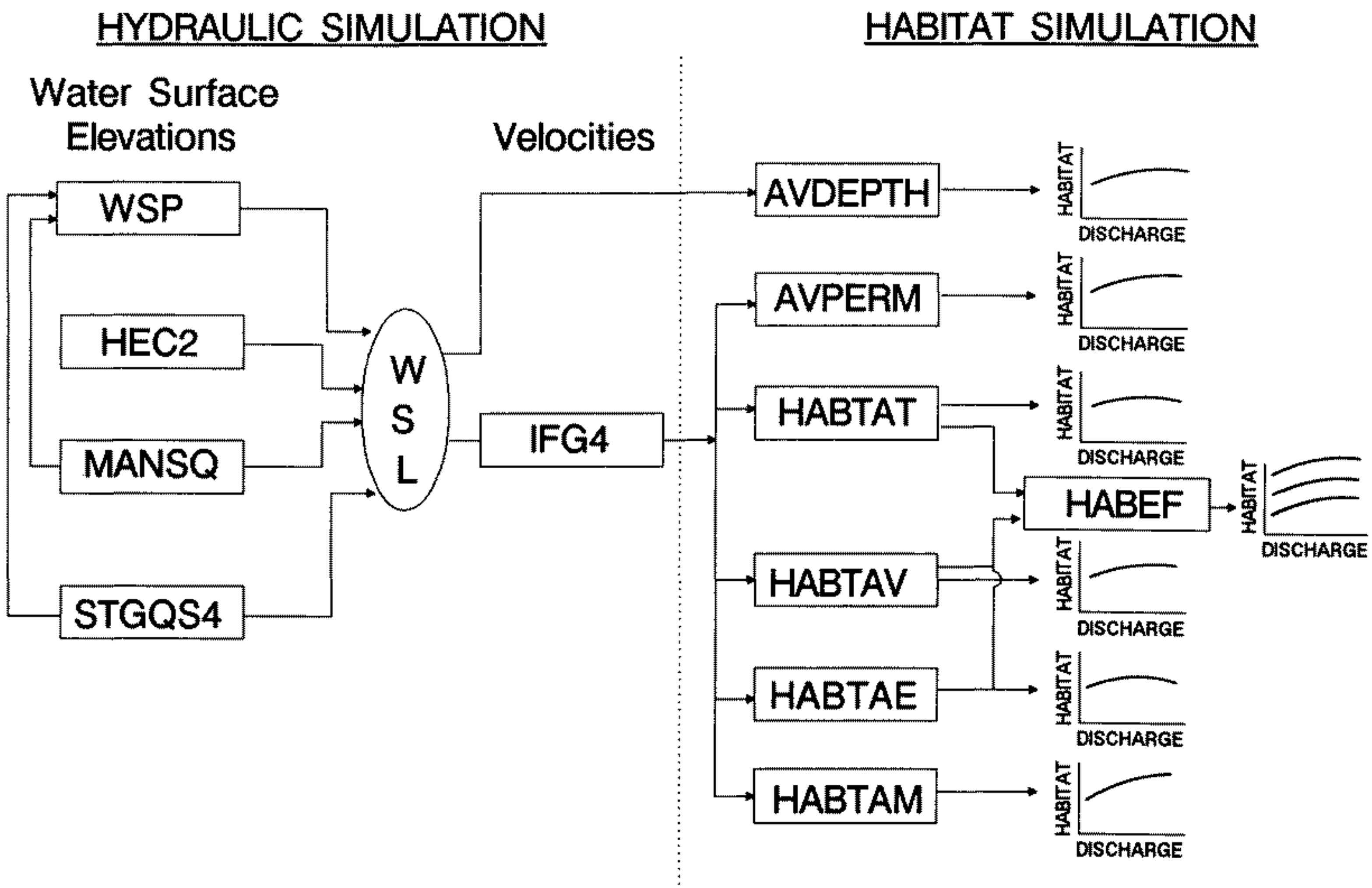


Figure I.4. Major linkages for Version II of the Physical Habitat Simulation System.

OUTLINE OF THE THEORY

The basic equation used in physical habitat simulation is

$$WUA(Q) = \int_A f(v,d,ci)\ dA$$

where WUA(Q) is the physical habitat at the streamflow Q (also called the weighted usable area), dA is an incremental area, A is the total area at the streamflow Q, v is the velocity, d is the depth, ci is an index to the channel characteristics after a combination of a substrate index and a cover index, although other forms of a channel index are possible.

The equation above can also be represented as the sum of areas within a larger reach of stream. In this case the sum is

$$WUA(Q) = \sum_{i=1}^{n} f[v(i) * d(i) * ci(i)]$$

in which the reach has been divided into n cells and v(i), d(i), ci(i) are the average values for the variable within a specific cell (cell i in this case).

Three feasible functions, f( ), are used; these are:

$$f(v,d,ci) = g(v) * h(d) * k(ci)$$

$$= \min g[(v) * h(d) * k(ci)]$$

$$= [g(v) * h(d) * k(ci)]^{1/3}$$

where g( ) is some function of the velocity, h( ) is some function of the depth, and k( ) is some function of the stream channel index, usually substrate and/or cover. The velocity and depth vary as the streamflow changes, but it is assumed the channel index does not. The user may also define any type of function desired so long as it uses combinations of velocity, depth, and a channel index. The first function (simple multiple) assumes each factor has an input on the combined results no matter whether the other factors are high or low; the second (minimum) assumes only one factor, the one that is a minimum, has an input on the combined results; the third (geometric mean) assumes the input on the combined factor to be based on all three, but there are compensatory linkages between the three factors. The user must select between the various forms. See "The Use of Habitat Structure Proterenda for Establishing Flow Regimes Necessary for Maintenance of Fish Habitat" (Stalnaker 1980) for additional information on the nature of the habitat model.

Temperature can also be considered in the physical habitat simulation if the suitability of habitat as a function of temperature is available. The function for temperature is used in the equation below:

$$WUA'(Q) = WUA(Q) \times m(T)$$

where WUA′(Q) is the weighted usable area modified for temperature effect, m( ) is a function of temperature, and T is the temperature. An Instream Flow Information Paper is available that should help in addressing temperature aspects of physical habitat modeling (Bartholow 1989).

HYDRAULIC SIMULATION IN PHABSIM

The techniques used to simulate the hydraulic conditions in a stream can have a significant impact on the habitat versus streamflow relationship determined in the habitat simulation portion of PHABSIM. An example of the variation resulting from alternative approaches to hydraulic simulation is illustrated in Figure I.5. The curve with a peak at about 35 cfs results from an error in the selection of the model used. The other seven relationships are reasonable models based on seven possible assumptions of the "best" hydraulic model. The variation shown is more than is typical.

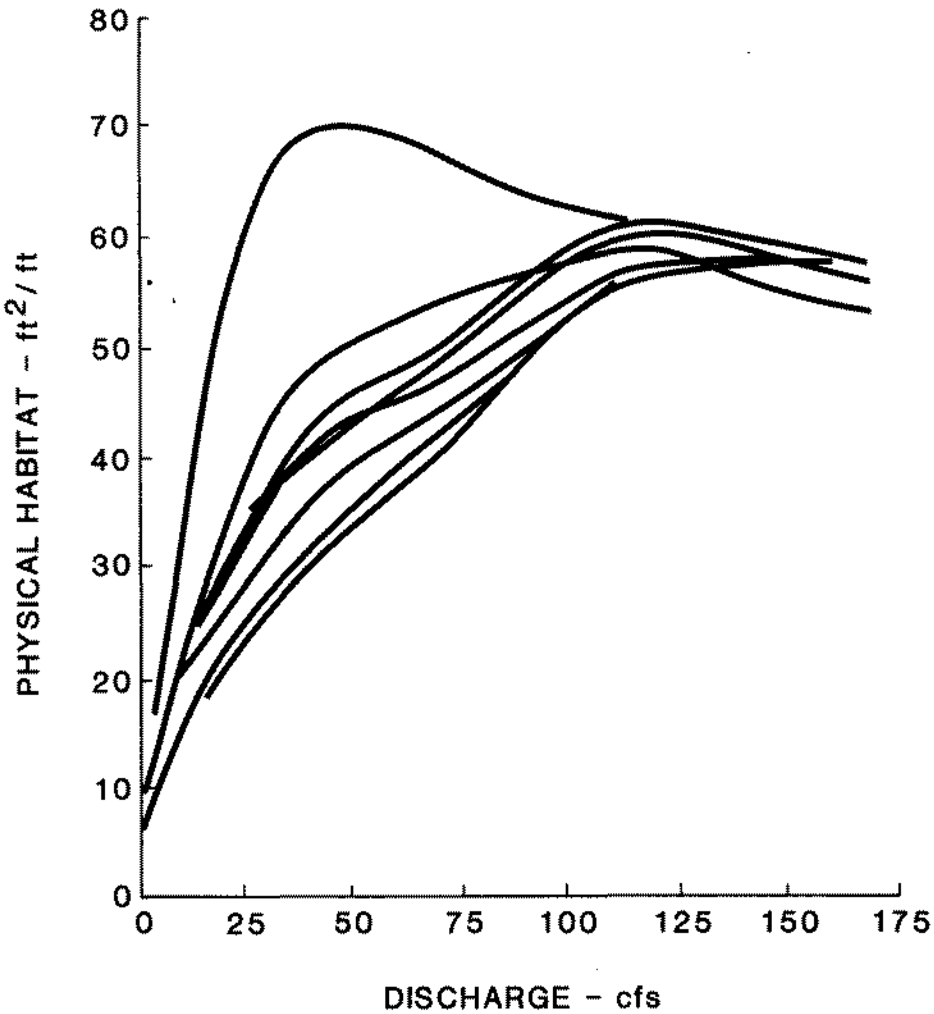


Figure I.5. Comparison of the variability resulting from eight models on the physical habitat versus streamflow relationship.

The hydraulic simulation programs in PHABSIM assume that the shape of the channel does not change with streamflow over the range of flows being simulated. The results of the hydraulic calculations are water surface elevations and velocities. The water surface elevations are one-dimensional in that the same value is used for any point on a cross section. In contrast, the velocity varies from point-to-point across any cross section. The hydraulic models also assume the water surface elevations are effectively independent of the velocity distribution in the channel.

The approaches available for the calculation of the water surface elevations are (1) the stage-discharge relationships, (2) the use of Manning's equation, and (3) the standard step backwater method. The usual application of PHABSIM requires at least one set of water surface elevations to calibrate the model used. It is a rare application that does not have at least one set of water surface elevations available for calibration of the models. In many situations a mixture of models is used to determine the water surface elevations in a river and for a specific flow range. This mixture may vary by cross section or it may vary by flow range.

Calculation of Water Surface Elevations

Three techniques used to simulate water surface elevations are (1) the use of an empirical stage-discharge equation based on measured data, (2) the use of Manning's equation, and (3) the use of the standard step backwater method.

The standard step backwater method starts from a cross section where the water surface elevation is known and determines the water surface elevation at the next upstream cross section by calculating the energy loss between the two cross sections. The energy loss is calculated using the Manning equation. The water surface elevation at the first cross section must be determined in order to start the calculations. This starting water surface elevation may be calculated using either Manning's equation or the stage-discharge relationship, or it may be measured.

The empirical stage-discharge relationship used is

$$Q = \alpha(WSL - STZ)^{\gamma}$$

where Q is the discharge, WSL is the water surface elevation, STZ is the stage of zero flow, and α and γ are empirically derived coefficients. Rantz et al. (1982) reported that the value of γ is commonly between 1.3 and 1.8, and rarely as high as 2.0, for channel control. For section control, the value of γ almost always exceeds 2.0.

The roughness also is a function of the streamflow. An empirical equation relating a discharge and roughness is

$$n = n_0 \left(\frac{Q}{Q_0}\right)^{\beta}$$

where n_0 is the roughness at discharge Q_0 and n is the roughness at discharge Q. β is an empirical coefficient. The value of β is between 0 and -0.35 for gravel and cobble rivers without significant bank roughness (Milhous 1987). For channels with significant bank roughness, the value of β can be positive.

The use of Manning's equation assumes the condition of the channel controls the water surface elevation. In many rivers, the water surface elevation will be controlled by rock ledges, by riffles comprised of boulders and cobbles, by gravel bars, and by constrictions in the width of the channel.

Many rivers have compound control, with section control during low flows and channel control for higher flows. As a result of compound control, the expected stage-discharge relationship calculated in the IFG4 program is used for the lower flows, and water surface elevations determined using MANSQ are used for higher flows.

The standard step backwater calculations are used to determine the water surface elevations at cross sections in which the water surface elevation is controlled by the hydrologic conditions at some downstream section. The calculations use Manning's equation to determine the energy loss between sections.

In some situations, variable backwater occurs, and the WSP program is used to simulate water surface elevations. In relatively steep and rough streams, a mixture of stage-discharge, Manning's equation, and step backwater calculations is needed to determine water surface elevations.

Calculation of Velocities

The velocity distribution across a channel is calculated using the empirical observations on which Manning's equation is based. The channel is divided into cells and the velocity calculated for each of these cells. The physical habitat is calculated on a cell-by-cell basis using these velocities.

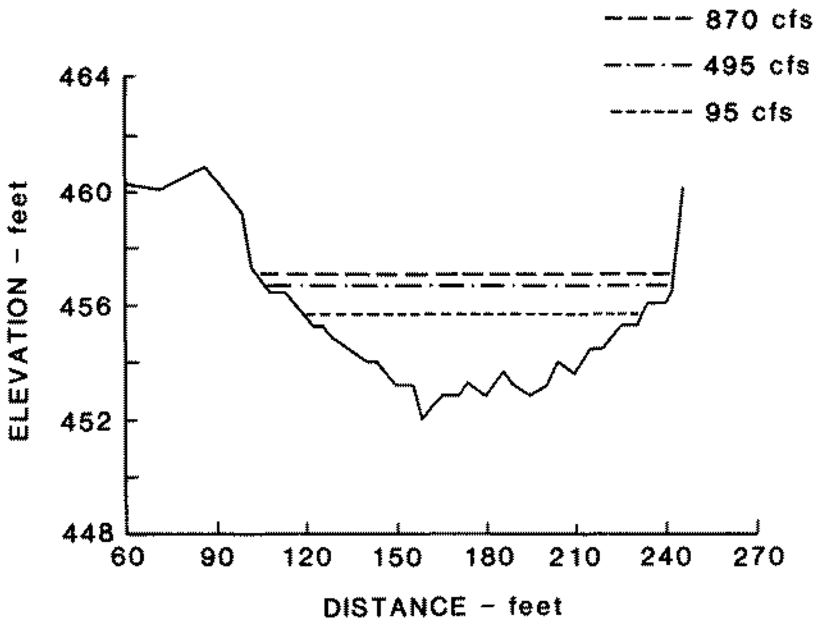
The velocity in the cell k is calculated using the equation

$$v(k) = \frac{[a(k)\ r(k)^{0.667}]/n(k)}{\sum_{j=1}^{nc} [a(j)\ r(j)^{0.0667}]/n(j)}\ QS$$

where a(j) is the area of the cell j, r(j) is the hydraulic radius of the cell j, n(j) is the roughness of the cell j, and nc is the total number of wet cells in a cross section. QS is the streamflow for which the velocity is being calculated.

For one set of velocity measurements, an apparent roughness is calculated for each measured velocity, j, using the equation

$$n(j) = \frac{1.49 * [d(j)^{0.667}]}{v(j)}\ S^{1/2}$$



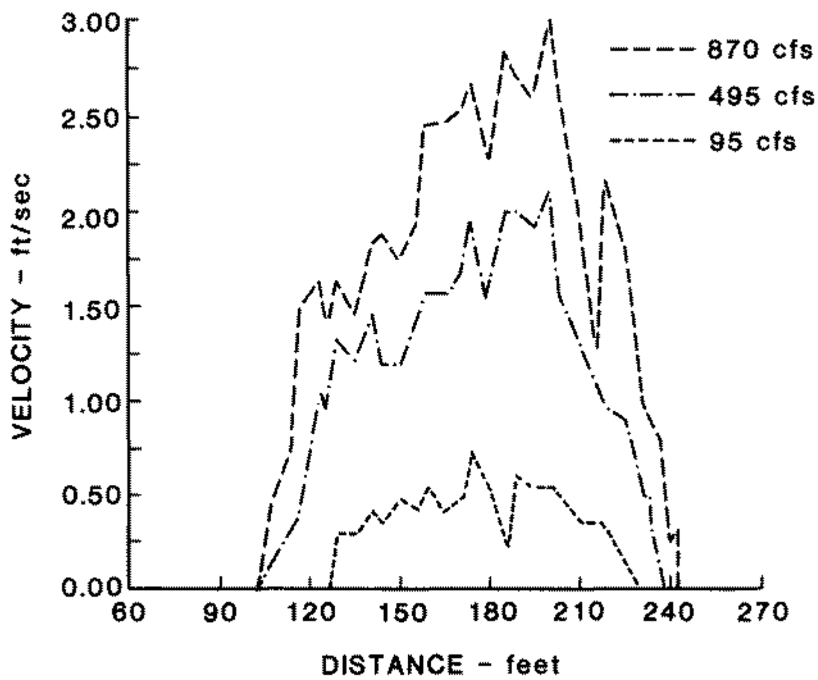


Figure I.6. Cross-sectional shape and velocity distribution in Sportsman's Pool, Salmon River, New York.

where d(j) is the depth at the vertical j, and v(j) is the velocity at vertical j. The roughness n(j) is then used to calculate the velocities for each vertical using the water surface elevation for the discharge for which velocities are being simulated. The slope, S, is either selected by the user or is set to 0.0025 by the program. The water surface elevation is determined using the techniques presented previously.

An example of the velocity distribution in a typical river is given in Figure I.6. Each velocity set would be used to simulate a range of flows, for example, 0 to 250 cfs for the 95 cfs set, 250 to 650 cfs for the 495 cfs set, and above 650 cfs for the 870 cfs set. This means the velocities at the boundary of the range for each set will not be the same. This will have an impact on the simulated physical habitat, but the impact is usually not significant. Nevertheless, the difference in velocity at the boundary should be reviewed before doing the habitat simulation.

One concept that can be used is to determine empirically the parameters α' and β' in the following equation and use this equation to determine the velocities in a vertical

$$v(i) = \alpha' \, Q^{\beta'}$$

Each of the two techniques for simulating the velocities can be used at the option of the user.

The Hydraulic Simulation Programs

The paths through the PHABSIM system that use hydraulic simulation are illustrated in Figure I.7. Figures I.8, I.9, and I.10 illustrate the flow of information through the Curve Maintenance Programs, Habitat Simulation Programs, and the Effective Habitat Analysis Programs.

The principal hydraulic simulation programs in PHABSIM, shown in Figure I.7, are discussed briefly below.

WSP: The Water Surface Profile Program (WSP) uses the standard step backwater method to determine water surface elevations. In the process, velocities are calculated which may be used in habitat simulation if velocity measurements needed to calibrate IFG4 are not available. The model is calibrated to predict water surface elevations by adjusting the Manning's roughness given in the data set.

IFG4: The IFG4 program uses a stage-discharge relationship to determine water surface elevations unless they are supplied in the input data set. When using the stage-discharge relationship, each cross section is treated independently of all others in the data set. The velocities are determined using techniques based on Manning's equation.

The program is calibrated to a set of measured velocities. The usual practice is to use at least one or more sets of velocities although the program can be used when no velocity measurements are available.

HEC2: This program is not part of PHABSIM, but can be used to determine water surface elevations. The HEC2 program uses step backwater calculations to determine water surface elevations. The HEC2 program was developed, and is supported by, the Hydrologic Engineering Center of the U.S. Army Corps of Engineers, Davis, California.

MANSQ: The MANSQ program uses Manning's equation to calculate water surface elevations. The model is calibrated using one set of water surface elevations. Each cross section is simulated independently of all other cross sections in the data set.

Manning's equation is

$$Q = \frac{1.49}{n} R^{2/3} A S^{1/2}$$

where Q is the discharge, n is the roughness, R is the hydraulic radius, A is the cross section area, and S is the energy slope. In most applications of MANSQ there are two unknowns: the roughness and the energy slope. Letting

$$K = \frac{1.49}{n} S^{1/2}$$

and rewriting the Manning's equation given K we have

$$Q = K R^{2/3} A$$

and we now have one unknown (K) which can be determined using one set of water surface elevations to calibrate the model. The value of K can be assumed to be a constant or a power function of the discharge or the hydraulic radius.

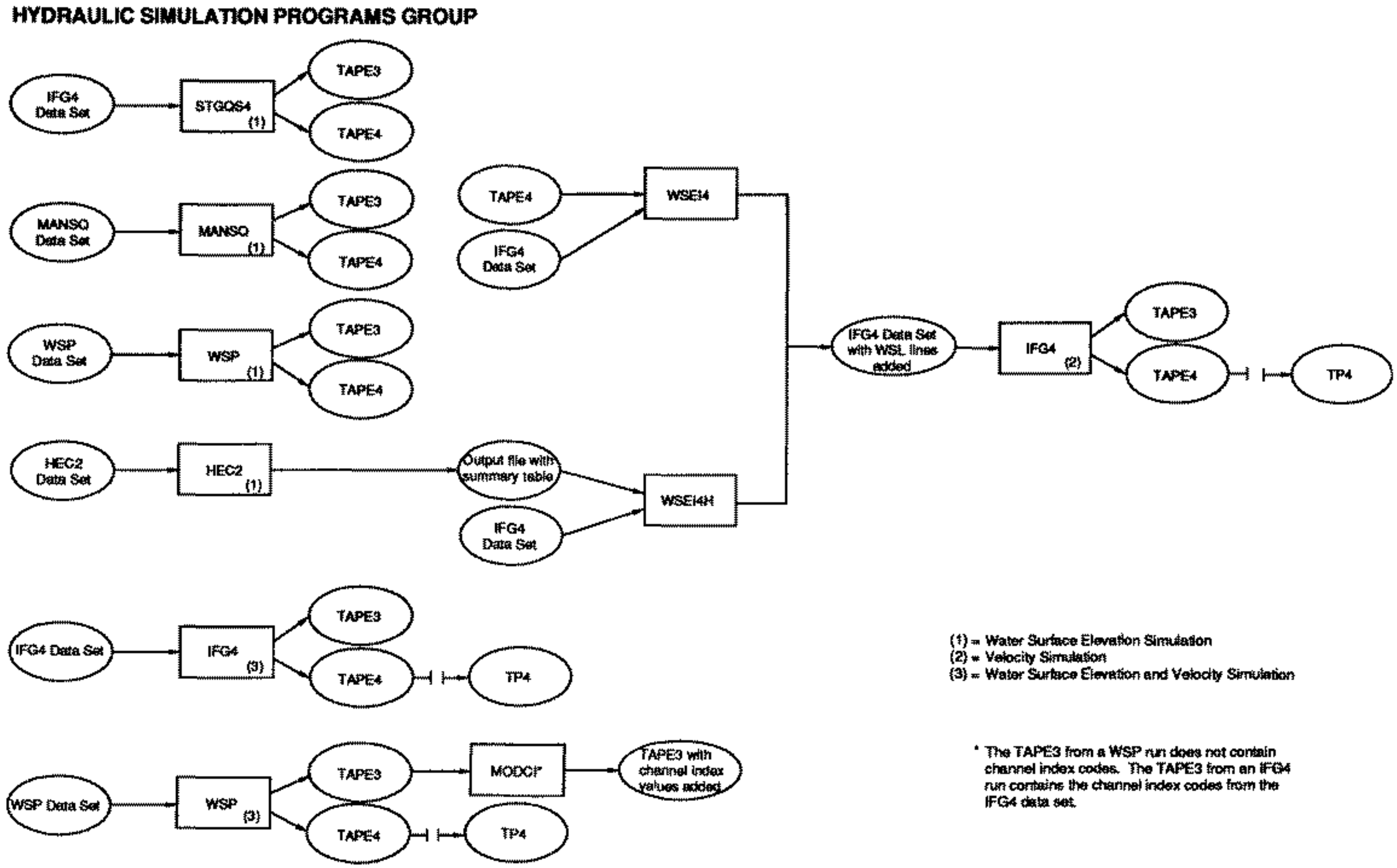


Figure I.7. Flow of information through PHABSIM - Hydraulic Simulation Programs Group.

CURVE MAINTENANCE PROGRAMS GROUP

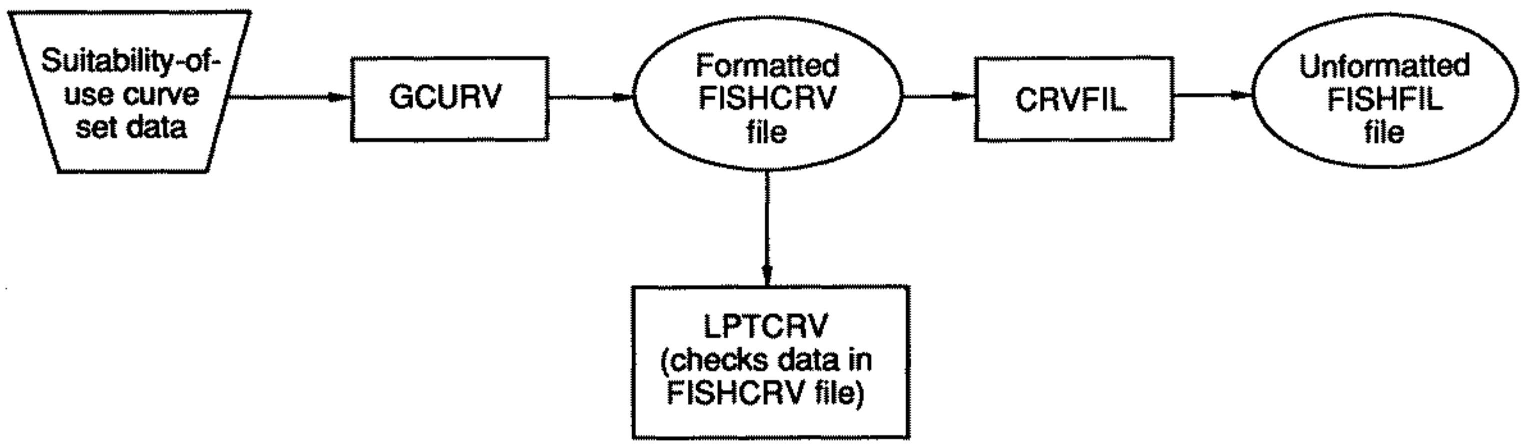


Figure I.8. Flow of information through PHABSIM - Curve Maintenance Programs Group.

HABITAT SIMULATION PROGRAMS GROUP

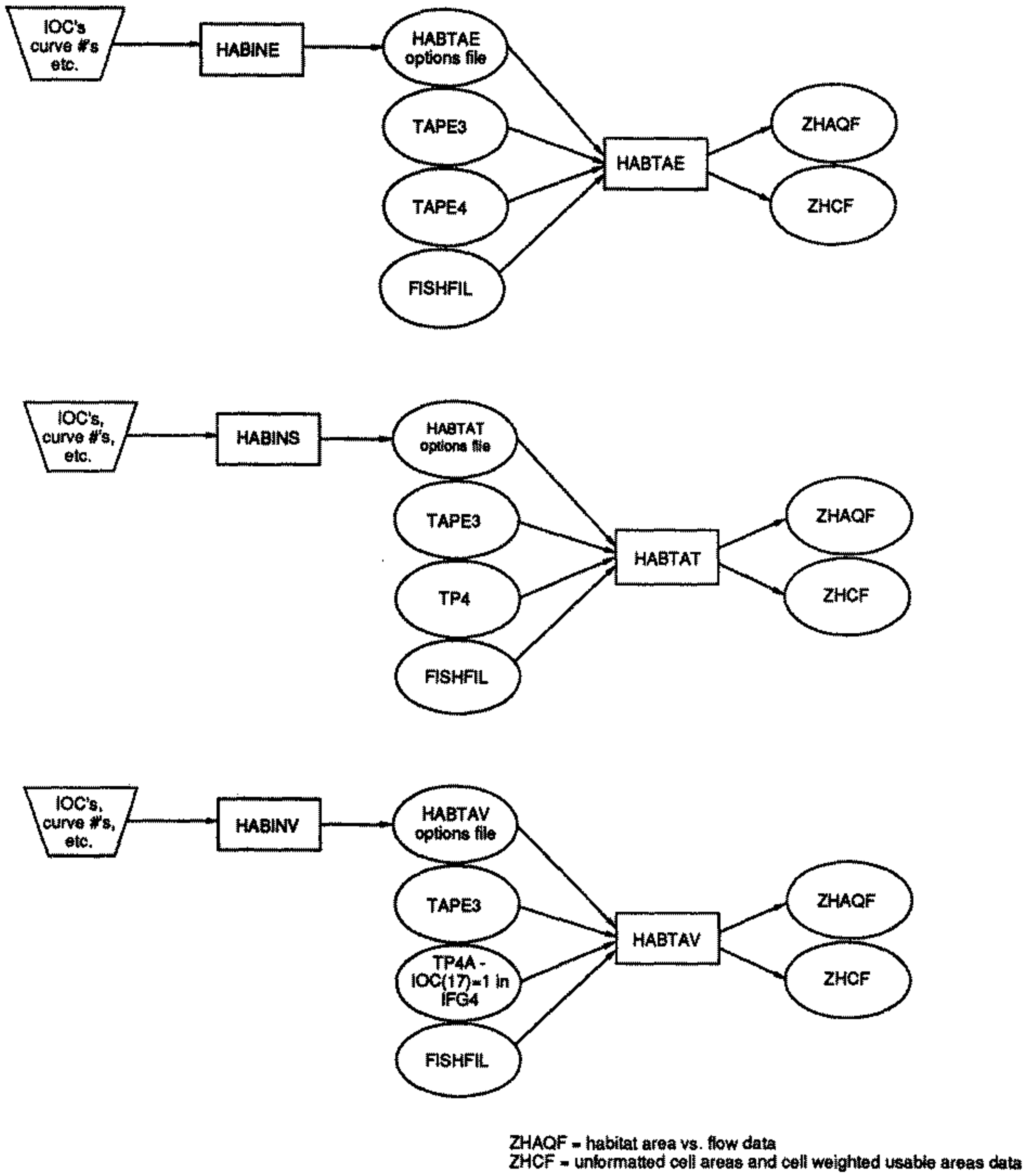
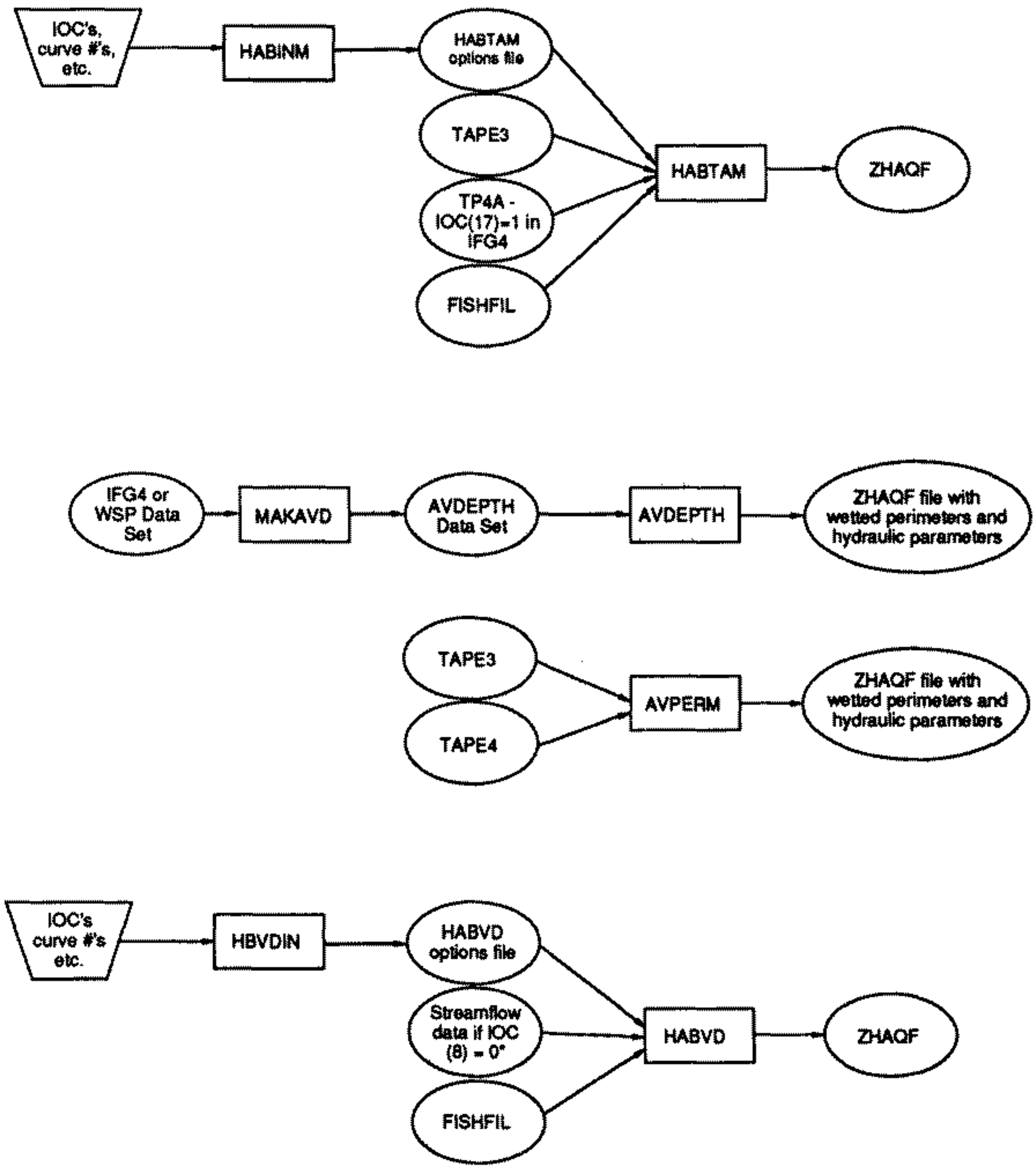


Figure I.9. Flow of information through PHABSIM - Habitat Simulation Programs Group.

HABITAT SIMULATION PROGRAMS GROUP (CONTINUED)

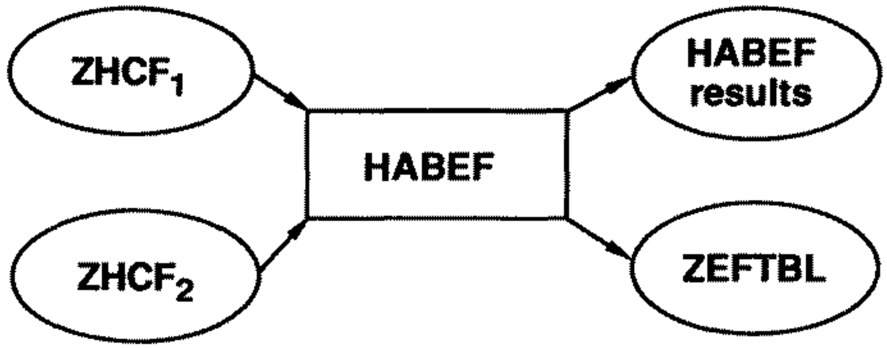


*Stream morphology parameters if IOC(8) = 1

ZHAQF = habitat area vs. flow data
ZHCF = unformatted cell areas and cell weighted usable areas data

Figure I.9. (Concluded)

EFFECTIVE HABITAT ANALYSIS PROGRAMS GROUP



ZHCF = Unformatted file with cell areas and cell weighted usable areas.

ZEFTBL = File similar to a habitat vs. flow (ZHAQF) file when Option 1, 3, 5, or 6 is selected in HABEF; two - flow habitat table when Option 2, 4, 7, or 8 is selected.

Figure I.10. Flow of information through PHABSIM - Effective Habitat Analysis Programs Group.

Hydraulic Simulation Summary

Enough emphasis cannot be placed on the importance of the three basic categories of hydraulic input data: channel characteristics, velocities, and water surface elevations. These are the minimum requirements for simulating depths and velocities as input for habitat simulation, the impetus of hydraulic simulation.

Two important aspects associated with the practice of hydraulic simulation include: (1) the development of a stage-discharge relationship, or rating curve, for the cross section being considered; and (2) accurate simulation of velocities.

The stage-discharge relationship, or rating curve, is the relation between the stage, or water surface elevation, relative to an arbitrary datum, and the discharge that existed at the time and location the water surface elevation was measured. Accuracy of the stage-discharge relationships increases as more measurements or stage-discharge pairs are added to the curve.

In the process of obtaining discharge measurements, dividing the channel into discrete segments and measuring the stage and velocity for each segment, velocities, channel elevations, and water surface elevations are acquired. The depth, calculated as the difference of the water surface elevation and channel elevation, and velocities form the base of information for predicting depth and velocities when simulating flows.

One must be careful, however, to assure that underlying assumptions are not unreasonably violated in order to insure predictive accuracy. A case in point: an assumption that the "structure of the stream channel will not be altered by changes in flow regime" may be invalid on a stream reach particularly subject to processes of scour and deposition. The judgement as to whether geomorphological processes play a significant role in the behavior of the channel must be made.

HABITAT SIMULATION IN PHABSIM

There are two general types of habitat simulation in the Physical Habitat Simulation System: (1) a function based on the average conditions in a stream channel and (2) a function based on the distribution of velocity and depth and the nature of the channel in a stream. Each of these assumes the habitat is related to the nature of the stream and the conditions within the channel. The theory for the distribution parameter models has been presented previously. For the average parameter models, the theory is the same except only the wetted width or surface is considered important.

Average Parameter Models

The average parameter models are AVDEPTH and AVPERM. Each of these calculates the wetted width and wetted surface for flows and water surface elevations supplied by the user. They also determine the width of a stream with water over some depth specified by the user. The average velocity is also calculated.

Distributed Parameter Models

The programs using distribution parameters are the HABTAT, HABTAV, and HABTAE programs. The HABTAT program assumes the condition within a cell establishes the worth of the habitat in the cell. In contrast, the HABTAV program assumes the condition in a cell plus the velocity in other cells or another location in the same cell nearby establishes the worth of the habitat in the cell.

The HABTAE program is similar to the HABTAT program with two important exceptions. The first is that the volume (instead of the surface area) of the habitat may be determined, and habitat conditions at each cross section can also be determined. In addition, the discharge does not have to be constant through the reach. (All the other habitat simulation programs require constant discharge from cross section to cross section in the reach.)

EFFECTIVE HABITAT ANALYSIS IN PHABSIM

The effective habitat analysis (HABEF) in PHABSIM is more a determination of the physical habitat considering two flows, in other words, the HABitat EFfective when two flows are of importance. One example of two flows is spawning flows followed by incubation flows; in this case, the spawning is not effective unless the incubation maintains the habitat in condition for the eggs to hatch. A second case is the rapid change in streamflow between a "base" flow and a "generation" flow below some hydroelectric facilities.

There are two programs available for effective habitat analysis in PHABSIM. The first is the HABEF program, which compares the conditions at two flow conditions in determining the habitat, or the conditions with two life stages, the species cannot move from cell to cell. The second is the HABTAM program in which the species can move from cell to cell.

APPLICATION OF PROGRAMS

There are many paths through PHABSIM; therefore users need to keep sight of the goal, which is to develop a physical habitat versus streamflow function based on the nature of flow in the stream channel.

In this section certain paths are outlined as examples to assist users in developing their own path through the system. These are only examples; users must develop their own paths based on their understanding of the problem.

The PHABSIM model can use a number of programs to determine the water surface elevations and one model to determine the velocity distribution across a channel. The determination of water surface elevations and velocities is discussed further below.

The Use of One Velocity Calibration Data Set with IFG4

The IFG4 program can be used with only one set of velocity data to calibrate the model. The single set of velocities is used to determine the Manning's roughness (n) values which are used to distribute the flows across the cross section. These Manning's n's are effectively velocity distribution terms and not roughness in the usual energy loss sense. The water surface elevations may be determined by the IFG4 program by using the stage-discharge relationship within the program; or they may be determined using other programs such as WSP, WSEI4S, MANSQ, or HEC2. If the stage-discharge relationship is used, it is recommended that at least three reasonable spread-out points be used (i.e., the three points must not be for essentially the same streamflow).

The use of a single velocity calibration data set has proven to be more reliable than the use of three velocity calibration data sets in many cases--provided the water surface elevations are determined using stage-discharge relationships based on three or more points, or by using the WSP model calibrated to water surface elevations with a stage-discharge relationship for the starting water surface elevations. The use of the Water Surface Profile (WSP) program requires the conditions be such that the use of WSP is appropriate. When using the stage-discharge relationship, the same approach is used as with the stage approach within IFG4. The use of Manning's equation requires one set of water surface elevations, and the assumption is made that Manning's equation is valid at each cross section and there is no backwater effect at any cross section.

The use of each approach is outlined below.

When using the WSP program with a single velocity set for calibrating IFG4, the steps to follow are:

1. Collect one set of velocity measurements.

2. Collect water surface elevations at each cross section for at least one streamflow.

3. Prepare and check an IFG4 data set with the single velocity data set.

4. Place the single water surface elevation for the calibration velocity set on the WSL line for each cross section and the corresponding streamflow on a single QARD line and run the IFG4 program. Review the results and select options for the production runs.

5. Convert the IFG4 data set to a WSP data set using the RI4TWSP batch/procedure file; retain the original IFG4 data set.

6. Calibrate the WSP model to water surface elevations with constant roughness for all cells and cross sections.

7. Calibrate the WSP model to essential constant roughness in each cross section, but varying from cross section to cross section if there is a physical reason to do so. The roughness within a section can be varied also if there is a physical reason to do so.

8. Select the streamflows needed to develop the physical habitat versus streamflow relationship.

9. Select roughness multipliers, if appropriate.

10. Run the calibrated WSP model with the streamflows from Step 8.

11. Use the WSEI4 program to read the TAPE4 from Step 10 and place the calculated water surface elevations on the appropriate WSL lines in the IFG4 data set. The streamflows from Step 8 are also written as the streamflows on the QARD lines in the IFG4 data set.

12. Make the production runs with the IFG4 data set.

When using the stage-discharge relationship with a single velocity set for calibrating IFG4, the steps to follow are:

1. Collect one set of velocity measurements.

2. Collect water surface elevations at each cross section for three or more streamflows.

3. Prepare and check an IFG4 data set with the single velocity data set.

4. Place the single water surface elevation for the calibration velocity set on the WSL line for each cross section and the corresponding streamflow on a single QARD line and run the IFG4 program. Review the results and select options for the production runs.

5. Select the streamflows needed to develop the physical habitat versus streamflow relationship.

6. Use the stage-discharge data with the WSEI4S program to create the WSL lines in the IFG4 data set for the production run.

7. Make the production run.

When using Manning's equation (MANSQ) to determine water surface elevations for a single velocity set used to calibrate the IFG4 program, the steps to follow are:

1. Collect one set of velocity measurements and one set of water surface elevations for the cross sections.

2. Prepare and check an IFG4 data set with the single velocity data set.

3. Place the single water surface elevation for the calibration velocity set on the WSL line for each cross section and the corresponding streamflow on a single QARD line and run the IFG4 program. Review the results and select options for the production runs.

4. Select the streamflows needed to develop the physical habitat versus streamflow relationship.

5. Convert the IFG4 data set to a MANSQ data set using the I4TMSQ program; retain the IFG4 data set.

6. Use the single set of water surface elevation-discharge data with the MANSQ program to create a TAPE4 with the water surface elevation and average channel velocities for the flows of interest.

7. Use the WSEI4 program to add the WSL lines to an IFG4 data set.

8. Make the production run.

<u>The Use of Two or More Velocity Calibration Data Sets with IFG4</u>

The use of two or more velocity sets to calibrate the IFG4 model to velocities follows the same steps as presented in the previous section with some exceptions.

The exceptions are the range of the various sets used. If the discharges are arrayed in increasing order and there are n sets, the ranges for each set are for $Q < Q_c(1)$, use the lowest set of velocities to calibrate the IFG4 program. For $Q > Q_c(n)$, use the highest set of velocities to calibrate the IFG4 program. The range between $Q_c(1)$ and $Q_c(n)$ can be handled using two possible approaches. One is to break the internal into pieces and use each calibration velocity set for a specific range. The other approach is to use the data to calibrate the equation

$$v_i = a_i Q^{b_i}$$

for the range $Q_c(1) < Q < Q(n)$.

For the three velocity set case, the steps are presented below as "tasks" in a manner that illustrates a different way of phrasing the work.

Task 1: Collect, check, and enter the data for a study reach into input files.

Task 2: Model the water surface elevations.

Task 3: Model the velocities.

Task 4: Select the streamflows needed for the production runs.

Task 5: Build the IFG4 production data set based on the results from Tasks 2 through 4 above.

Task 6: Develop alternative channel index files as needed for the study.

Task 7: Develop a habitat input file.

Task 8: Calculate the habitat versus streamflow relationship for each velocity data set.

Task 9: Develop the "best" habitat versus streamflow functions.

SUMMARY

In this chapter, a very brief outline of PHABSIM is presented. One of the major tasks of a user is the determination of the programs most appropriate to a given problem.

The first two tasks are the simulation of water surface elevations and velocities using the hydraulic simulation programs. This is followed by the simulation of habitat using one or more of the habitat simulation programs. The fourth task, if appropriate, is the simulation of the effective habitat.

II. HYDRAULIC SIMULATION PROGRAMS

INTRODUCTION

The hydraulic simulation programs in PHABSIM assume that the shape of the channel does not change with streamflow over the range of flows being simulated. The results of the hydraulic calculations are water surface elevations and velocities. The water surface elevations are one-dimensional in that the same value is used for any point on a cross section. In contrast, the velocity varies from point-to-point across any cross section. The hydraulic models also assume the water surface elevation is effectively independent of the velocity distribution in the channel.

The approaches available for the calculation of the water surface elevation are (1) the stage-discharge relationship, (2) the use of Manning's equation, and (3) the standard step backwater method. The usual application of PHABSIM requires at least one set of water surface elevations to calibrate the model used. It is a rare application that does not have at least one set of water surface elevations available for calibration of the models. In many situations a mixture of models is used to determine the water surface elevations.

The velocity distribution is determined using techniques based on Manning's equation. Usually one set of measured velocities is available for calibration of the models.

Refer to the following figures for information on the hydraulic simulation programs:

Figure I.7 - "Flow of Information Through PHABSIM - Hydraulic Simulation Programs Group";
Figure II.1 - "Creating and Checking an IFG4 Data Set";
Figure II.2 - "Creating and Checking a WSP Data Set"; and
Figure II.3 - "Creating a MANSQ Data Set".

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
HEC2		Hydraulic Simulation/ Water Surface Elevation Simulation	This program is not part of PHABSIM, but can be used to determine water surface elevations. The HEC2 program uses step backwater calculations to determine water surface elevations. The HEC2 program was developed, and is supported by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. Refer to "HEC-2 Water Surface Profile Users Manual" for documentation.

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
IFG4 & PHABAR2	RIFG4	Hydraulic Simulation/ Velocity Simulation	Uses a stage-discharge relationship to determine water surface elevations unless they are supplied in the data set. When using the stage-discharge relationship, each cross section is treated independently of all others in the data set. The velocities are determined using techniques based on Manning's equation. **RIFG4,ZIFG4,ZOUT,TAPE3,TAPE4,TP4,ZVAFF, ZVCEF** **ZIFG4**=IFG4 data set (input) **ZOUT**=IFG4 results (output) **TAPE3**=unformatted cross section and reach data (output) **TAPE4**=unformatted flow data (output) **TP4**=rearranged TAPE4 file. Used as input to HABTAT (output) **ZVAFF**=velocity adjustment factor file Created if IOC(13)=1 (output) **ZVCEF**=velocity calibration errors file Created if IOC(10)=1 (output) **NOTE:** If IOC(17)=1, the TAPE4 and TP4 files will be in HABTAM and HABTAV readable format. These files need to be renamed to TAPE4A and TP4A by the user.

HYDRAULIC SIMULATION (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
MANSQ	**RMANSQ**	Hydraulic Simulation/ Water Surface Elevation Simulation	Calculates water surface elevations using Manning's equation. The model is calibrated using one set of water surface elevations. Each cross section is simulated independently of all other cross sections in the data set. **RMANSQ,ZMANSQ,ZOUT,TAPE3,TAPE4** **ZMANSQ**=MANSQ data set (input) **ZOUT**=MANSQ results (output) **TAPE3**=unformatted cross section and reach data (output) **TAPE4**=unformatted flow data (output)
STGQS4	**RSTGQS4**	Hydraulic Simulation/ Water Surface Elevation Simulation	Determines the water surface elevations for an IFG4 data set using the stage-discharge relationship based on flows on the CAL lines. **RSTGQS4,ZIFG4,ZOUT,TAPE3,TAPE4** **ZIFG4**=IFG4 data set (input) **ZOUT**=STGQS4 results (output) **TAPE3**=unformatted cross section and reach data (output) **TAPE4** = unformatted flow data (output)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
WSP, LSTWSL & PHABAR2	**RWSP**	Hydraulic Simulation/ Water Surface Elevation Simulation	Uses the standard step backwater method to determine water surface elevations. In the process, velocities are calculated which may be used in habitat simulation if velocity measurements needed to calibrate IFG4 are not available. The model is calibrated to predict water surface elevations by adjusting the Manning's roughness given in the data set. User has option of listing the simulated water surface elevations to the screen or to an output file to be used in calibration. **RWSP,ZWSP,ZOUT,TAPE3,TAPE4,TP4,ZVOUT** **ZWSP**=WSP data set (input) **ZOUT**=WSP results (output) **TAPE3**=unformatted cross section and reach data (output) **TAPE4**=unformatted flow data (output) **TP4**=rearrranged TAPE4 file. Used as input to HABTAT (output) **ZVOUT**=optional output file formatted for easy review of velocities. Created when Option 5 is on. (output)

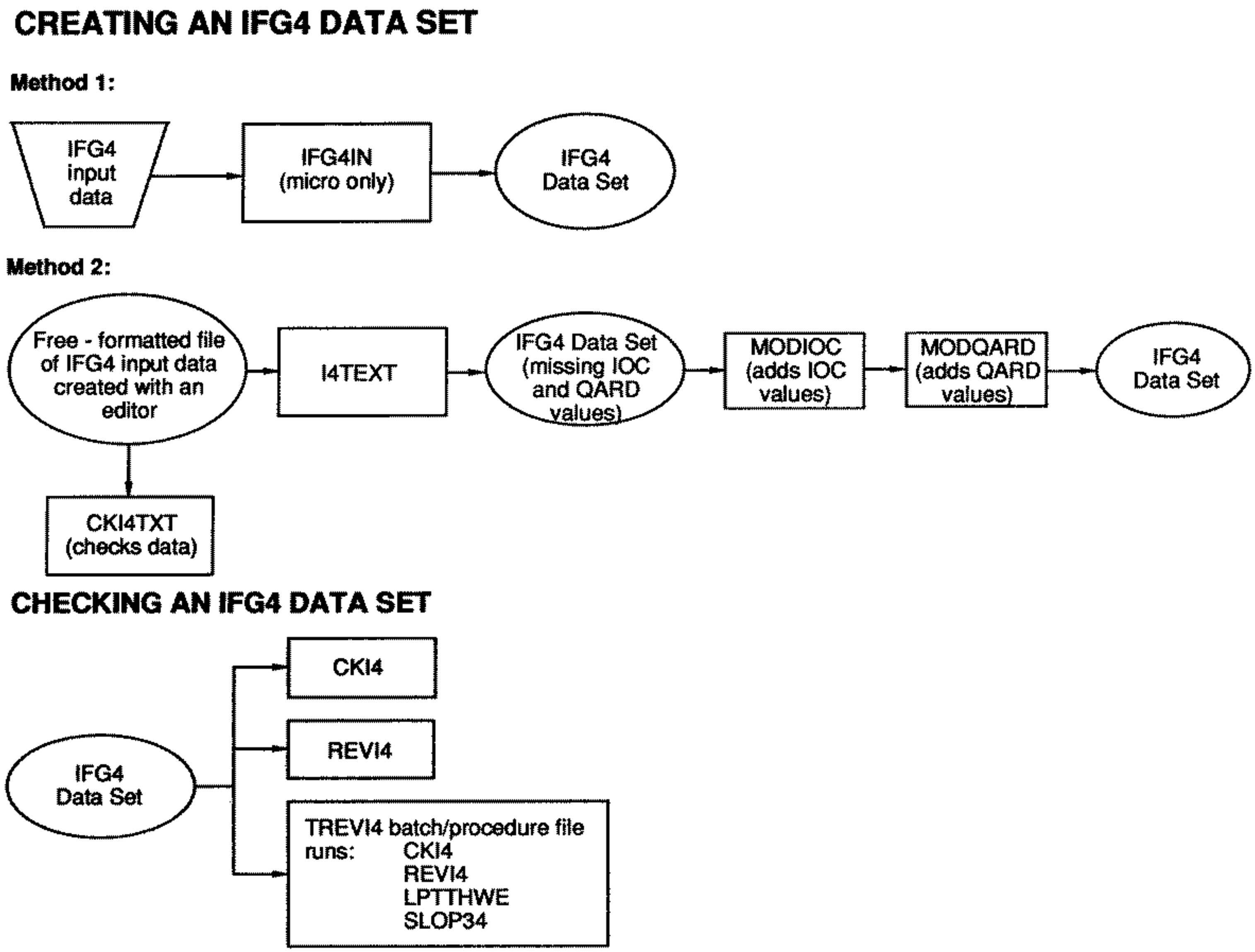


Figure II.1. Creating and checking an IFG4 data set.

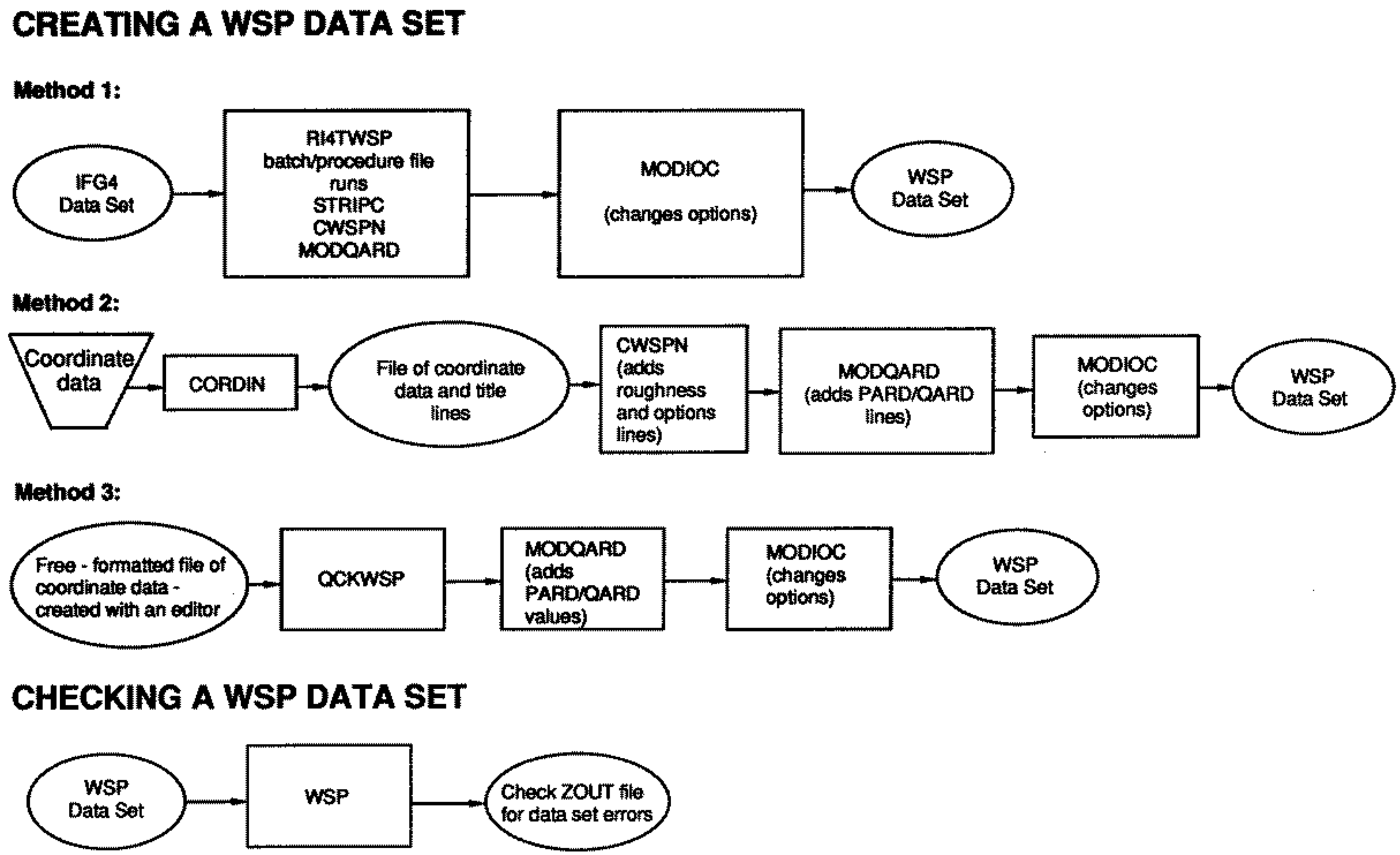


Figure II.2. Creating and checking a WSP data set.

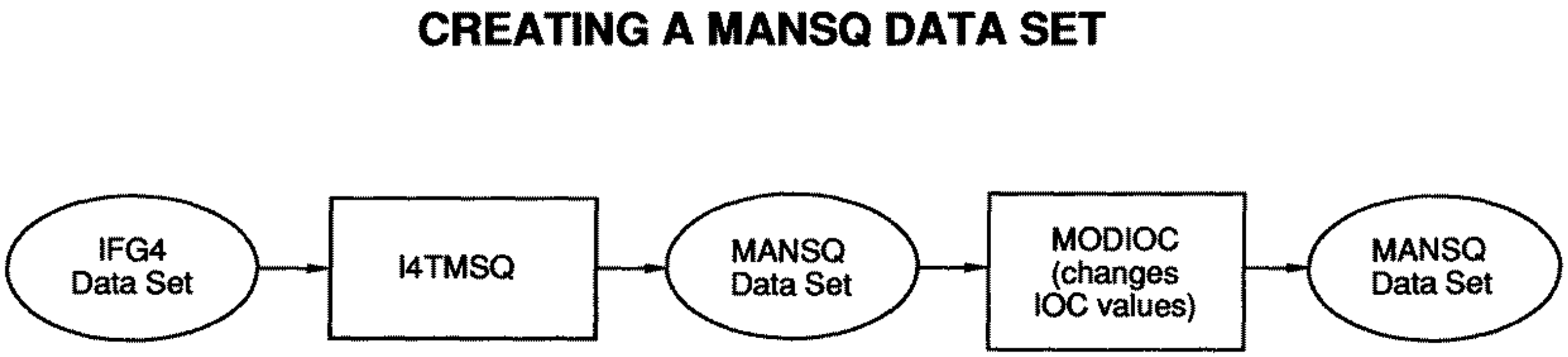


Figure II.3. Creating a MANSQ data set.

IFG4 DATA SET CREATION - Appendix A contains a sample IFG4 data set.

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
Creation Method 1:			
IFG4IN	**RIFG4IN**	IFG4 Data Set Creation	Builds and/or edits an IFG4 data set. Micro only. **RIFG4IN** User is prompted for filename.
Creation Method 2:			
CKI4TXT	**RCKI4TX**	IFG4 Data Set Creation	Reads the free-formatted input file to I4TEXT and writes a detailed listing of the contents in a format that is easy for checking. Type INFOI4T for information on the format of the free-formatted input file. **RCKI4TX,ZIN,ZOUT** **ZIN**=free-formatted file (input) **ZOUT**=CKI4TXT results (output)
I4TEXT	**RI4TEXT**	IFG4 Data Set Creation	Creates an incomplete IFG4 data set (missing IOC and QARD values) with up to nine velocity sets, from a free-formatted file created with an editor. Type INFOI4T for information on the format of the free-formatted input file. **RI4TEXT,ZIN,ZIFG4** **ZIN**=free-formatted file (input) **ZIFG4**=IFG4 data set (output)

IFG4 DATA SET CREATION (Creation Method 2 continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
ADDCV	**RADDCV**	IFG4 Data Set Creation	Adds CAL and VEL lines to an existing IFG4 data set. An IOC and/or a QARD line with no values is also added if they do not exist in the data set. Type INFOACV for information on the format of the free-formatted input file. **RADDCV,ZIN,ZIFG4,ZIFG4N** **ZIN**=free-formatted CAL/VEL data file (input) **ZIFG4**=IFG4 data set in which to add CAL and VEL lines (input) **ZIFG4N**=new IFG4 data set with CAL and VEL lines added (output)
MODIOC	**RMODIOC**	IFG4/WSP/MANSQ/ HABTAT/HABTAM/ HABTAV/HABTAE/ HABVD Data Set Modification	Changes options in the selected data set or options file. **RMODIOC,ZIN,ZOUT** **ZIN**=original data set (input) **ZOUT**=new data set with modified options (output)
MODQARD	**RMODQRD**	IFG4/MANSQ/WSP Data Set Modification	Replaces (or adds if none exist) PARD/QARD lines in an IFG4, MANSQ, or WSP data set **RMODQRD,ZIN,ZMOD,TAPE4,ZOUT** **ZIN**=IFG4, MANSQ, or WSP data set (input) **ZMOD**=modified IFG4, MANSQ, or WSP data set (output) **TAPE4**=unformatted flow data, (optional input). When modifying a WSP data set, user has the option to read data for PARD and QARD lines from a TAPE4 or enter it manually. **ZOUT**=MODQARD results (output). This file is only generated if Option 1 (Stage-Discharge Relationship) is chosen to generate the hydraulic data.

CHECKING AND CALIBRATING AN IFG4 DATA SET

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
CKI4	RCKI4	IFG4 Data Set Checking	Checks a complete IFG4 data set for format errors and writes a summary of each cross section checked. **RCKI4,ZIFG4,CKOUT** **ZIFG4**=IFG4 data set (input) **CKOUT**=CKI4 results (output)
I4VAF	RI4VAF	IFG4 Data Set Calibration	Plots or summarizes and plots the velocity adjustment factors file (ZVAFF) created when IOC(13)=1 in IFG4. **RI4VAF,ZVAFF,ZOUT** **ZVAFF**=velocity adjustment factors file (input) **ZOUT**=I4VAF results (output)
I4VCE	RI4VCE	IFG4 Data Set Calibration	Plots or summarizes and plots the velocity calibration errors file (ZVCEF) created when IOC(10)=1 in IFG4. Graphs are written using character graphics in a 132 characters per line format. **RI4VCE,ZVCEF,ZOUT** **ZVCEF**=velocity calibration errors file (input) **ZOUT**=I4VCE results (output)
REVI4	RREVI4	IFG4 Data Set Calibration	Assists in determining the best approach to hydraulic simulation for a given site using an IFG4 data set. Much of the diagnostic data generated is presented as plots. **RREVI4,ZIFG4,REVOUT,TAPE3,TAPE4** **ZIFG4**=IFG4 data set (input) **REVOUT**=REVI4 results (output) **TAPE3**=unformatted cross section and reach data (output) **TAPE4**=unformatted flow data (output)

CHECKING AND CALIBRATING AN IFG4 DATA SET (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
CKI4, REVI4, LPTTHWE, & SLOP34	TREVI4	IFG4 Data Set Calibration	Generates files for a total review of an IFG4 data set. TAPE3 and TAPE4 files are generated by REVI4 and then are used as input to LPTTHWE and SLOP34. **TREVI4,ZIFG4,CKOUT,REVOUT,LPTOUT, SLPOUT,TAPE3,TAPE4** **ZIFG4**=IFG4 data set (input) **CKOUT**=CKI4 results (output) **REVOUT**=REVI4 results (output) **LPTOUT**=LPTTHWE results (output) **SLPOUT**=SLOP34 results (output) **TAPE3**=unformatted cross section and reach data (output, input) **TAPE4**=unformatted flow data (output, input)

IFG4 DATA SET MODIFICATION

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
CHGVEL	**RCHGVEL**	IFG4 Data Set Modification	Changes all zero velocities to 0.0001 on the VEL lines in an IFG4 data set (blank velocities are not changed). **RCHGVEL,ZIFG4,ZIFG4N** **ZIFG4**=IFG4 data set (input) **ZIFG4N**=new IFG4 data set with zero velocities changed to .0001 (output)
CHSTA	**RCHSTA**	IFG4 Data Set Modification	Changes the cross section ID numbers to stationing in an IFG4 data set. **RCHSTA,ZIFG4,ZIFG4N** **ZIFG4**=IFG4 data set (input) **ZIFG4N**=new IFG4 data set with stationing (output)
DELWSL	**RDELWSL**	IFG4 Data Set Modification	Deletes WSL lines in an IFG4 data set. **RDELWSL,ZIFG4,ZIFG4N** **ZIFG4**=IFG4 data set (input) **ZIFG4N**=new IFG4 data set with WSL lines deleted (output)
MAK1VL	**RMAK1VL**	IFG4 Data Set Modification	Reads an IFG4 data set and writes a new IFG4 data set with one or less velocity sets. **RMAK1VL,ZIFG4,ZIFG4N** **ZIFG4**=IFG4 data set (input) **ZIFG4N**=new IFG4 data set with one or less velocity sets (output)
MODCAL	**RMODCAL**	IFG4 Data Set Modification	Modifies discharges on the CAL lines in an IFG4 data set. **RMODCAL,ZIFG4,ZIFG4N** **ZIFG4**=IFG4 data set (input) **ZIFG4N**=modified IFG4 data set (output)

IFG4 DATA SET MODIFICATION (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
MODIOC	**RMODIOC**	IFG4/WSP/MANSQ/ HABTAT/HABTAM/ HABTAV/HABTAE/ HABVD Data Set Modification	Changes options in the selected data set or options file. **RMODIOC,ZIN,ZOUT** **ZIN**=original data set (input) **ZOUT**=new data set with modified options (output)
MODN	**RMODN**	IFG4/WSP Data Set Modification	Adds or modifies N values for each cross section in an IFG4 or WSP data set. **RMODN,ZIN,ZOUT** **ZIN**=IFG4 or WSP data set (input) **ZOUT**=modified IFG4 or WSP data set (output)
MODQARD	**RMODQRD**	IFG4/MANSQ/WSP Data Set Modification	Replaces (or adds if none exist) PARD/QARD lines in an IFG4, MANSQ, or WSP data set. **RMODQRD,ZIN,ZMOD,TAPE4,ZOUT** **ZIN**=IFG4, MANSQ, or WSP data set (input) **ZMOD**=modified IFG4, MANSQ, or WSP data set (output) **TAPE4**=unformatted flow data, (optional input). When modifying a WSP data set, user has the option to read data for PARD and QARD lines from a TAPE4 or enter it manually. **ZOUT**=MODQARD results (output). This file is only generated if Option 1 (Stage-Discharge Relationship) is chosen to generate the hydraulic data.

IFG4 DATA SET MODIFICATION (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
MODSLP	**RMODSLP**	IFG4/WSP Data Set Modification	Modifies the slope at each cross section in an IFG4 data set OR modifies the water surface elevation or slope for each flow on the QARD lines in a WSP data set. **RMODSLP,ZIN,ZOUT** **ZIN**=IFG4 or WSP data set (input) **ZOUT**=new IFG4 or WSP data set with modified slopes (output)
WSEI4	**RWSEI4**	IFG4 Data Set Modification	Reads water surface elevations and discharges from a TAPE4 or TP4 and adds or replaces the QARD and WSL lines in an IFG4 data set. **RWSEI4,ZIFG4,ZIFG4N,TAPE4** **ZIFG4**=IFG4 data set (input) **ZIFG4N**=new IFG4 data set with added/ replaced water surface elevations and discharges (output) **TAPE4**=unformatted flow data (input)
WSEI4D	**RWSEI4D**	IFG4 Data Set Modification	Adds or replaces the QARD and WSL lines in an IFG4 data set. Data is entered from the keyboard. **RWSEI4D,ZIFG4,ZIFG4N** **ZIFG4**=IFG4 data set (input) **ZIFG4N**=new IFG4 data set with added/ replaced water surface elevations and discharges (output)

IFG4 DATA SET MODIFICATION (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
WSEI4H	**RWSEI4H**	IFG4 Data Set Modification	Reads water surface elevations and discharges from a HEC2 output file and adds or replaces the QARD and WSL lines in an IFG4 data set. **RWSEI4H,ZHECOUT,ZIFG4,ZIFG4N** **ZHECOUT**=HEC2 line printer output file (input) **ZIFG4**=IFG4 data set (input) **ZIFG4N**=new IFG4 data set with added/replaced water surface elevations and discharges from ZHECOUT (output)
WSEI4S	**RWSEI4S**	IFG4 Data Set Modification	Uses a stage-discharge relationship to calculate water surface elevations which are then added to an IFG4 data set. The user enters the stage-Q data needed to determine the stage-discharge relationship. **RWSEI4S,ZIFG4,ZIFG4N,ZOUT** **ZIFG4**=IFG4 data set (input) **ZIFG4N**=new IFG4 data set with WSL lines added (output) **ZOUT**=WSEI4S results, stage-discharge relationships and plots (output)

WSP DATA SET CREATION - Appendix A contains a sample WSP data set.

Creation Method 1:

STRIPC, CWSPN, & MODQARD	**RI4TWSP**	WSP Data Set Creation	Converts an IFG4 data set to a complete WSP data set. Each vertical becomes the right boundary of a cell except the left most vertical. **RI4TWSP,ZIFG4,ZWSP,TAPE4,ZOUT** **ZIFG4**=IFG4 data set (input) **ZWSP**=WSP data set (output) **TAPE4**=unformatted flow data, (optional input). If not supplied, data for the PARD and QARD lines are entered from the keyboard. **ZOUT**=MODQARD results (Option 1 chosen to generate hydraulic data) (output)
MODIOC	**RMODIOC**	IFG4/WSP/MANSQ/ HABTAT/HABTAM/ HABTAV/HABTAE/ HABVD Data Set Modification	Changes options in the selected data set or options file. **RMODIOC,ZIN,ZOUT** **ZIN**=original data set (input) **ZOUT**=new data set with modified options (output)

Creation Method 2:

CORDIN	**RCORDIN**	WSP Data Set Creation	Creates, or adds to, a file of coordinate data and title lines. An ENDJ and an ENDR line are also created. **RCORDIN,ZCORD,ZCORDIN** **ZCORD**=coordinate data file with title lines (output) **ZCORDIN**=coordinate data file to be added to (optional input)

WSP DATA SET CREATION (Creation Method 2 continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
CWSPN	RCWSPN	WSP Data Set Creation	Adds roughness lines to a coordinate data file, one value at each X-Y point except for the left-most point. An options (**) line, with all options off, and an ENDR line are also added if they do not exist. **RCWSPN,ZIN,ZOUT** **ZIN**=coordinate data file (input) **ZOUT**=coordinate data file with roughness, option (**), and ENDR lines added (output)
MODQARD	RMODQRD	IFG4/MANSQ/WSP Data Set Modification	Replaces (or adds if none exist) PARD/QARD lines in an IFG4, MANSQ, or WSP data set. **RMODQRD,ZIN,ZMOD,TAPE4,ZOUT** **ZIN**=IFG4, MANSQ, or WSP data set (input) **ZMOD**=modified IFG4, MANSQ, or WSP data set (output) **TAPE4**=unformatted flow data, (optional input). When modifying a WSP data set, user has the option to read data for PARD and QARD lines from a TAPE4 or enter it manually. **ZOUT**=MODQARD results (output). This file is only generated if Option 1 (Stage-Discharge Relationship) is chosen to generate the hydraulic data.
MODIOC	RMODIOC	IFG4/WSP/MANSQ/ HABTAT/HABTAM/ HABTAV/HABTAE/ HABVD Data Set Modification	Changes options in the selected data set or options file. **RMODIOC,ZIN,ZOUT** **ZIN**=original data set (input) **ZOUT**=new data set with modified options (output)

WSP DATA SET CREATION (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
Creation Method 3:			
QCKWSP	**RQCKWSP**	WSP Data Set Creation	Creates an incomplete WSP data set (missing PARD and QARD values) from a free-formatted file created with an editor. Type INFOQWP for information on the format of the free-formatted input file. **RQCKWSP,ZIN,ZWSP** **ZIN**=free-formatted coordinate data file (input) **ZWSP**=WSP data set (output)
MODQARD	**RMODQRD**	IFG4/MANSQ/WSP Data Set Modification	Replaces (or adds if none exist) PARD/QARD lines in an IFG4, MANSQ, or WSP data set. **RMODQRD,ZIN,ZMOD,TAPE4,ZOUT** **ZIN**=IFG4, MANSQ, or WSP data set (input) **ZMOD**=modified IFG4, MANSQ, or WSP data set (output) **TAPE4**=unformatted flow data, (optional input). When modifying a WSP data set, user has the option to read data for PARD and QARD lines from a TAPE4 or enter it manually. **ZOUT**=MODQARD results (output). This file is only generated if Option 1 (Stage-Discharge Relationship) is chosen to generate the hydraulic data.
MODIOC	**RMODIOC**	IFG4/WSP/MANSQ/ HABTAT/HABTAM/ HABTAV/HABTAE/ HABVD Data Set Modification	Changes options in the selected data set or options file. **RMODIOC,ZIN,ZOUT** **ZIN**=original data set (input) **ZOUT**=new data set with modified options (output)

CHECKING A WSP DATA SET

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
WSP, LSTWSL, & PHABAR2	**RWSP**	Hydraulic Simulation	Data set errors will be listed in the ZOUT file. **RWSP,ZWSP,ZOUT,TAPE3,TAPE4,TP4,ZVOUT** **ZWSP**=WSP data set (input) **ZOUT**=WSP results (output) **TAPE3**=unformatted cross section and reach data (output) **TAPE4**=unformatted flow data (output) **TP4**=rearranged TAPE4 file. Used as input to HABTAT (output). **ZVOUT**=optional output file formatted for easy review of velocities. Created when Option 5 is on. (output)

WSP DATA SET MODIFICATION

MODIOC	**RMODIOC**	IFG4/WSP/MANSQ/HABTAT/HABTAM/HABTAV/HABTAE/HABVD Data Set Modification	Changes options in the selected data set or options file. **RMODIOC,ZIN,ZOUT** **ZIN**=original data set (input) **ZOUT**=new data set with modified options (output)
MODN	**RMODN**	IFG4/WSP Data Set Modification	Adds or modifies N values for each cross section in an IFG4 or WSP data set. **RMODN,ZIN,ZOUT** **ZIN**=IFG4 or WSP data set (input) **ZOUT**=modified IFG4 or WSP data set (output)

WSP DATA SET MODIFICATION (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
MODQARD	**RMODQRD**	IFG4/MANSQ/WSP Data Set Modification	Replaces (or adds if none exist) PARD/QARD lines in an IFG4, MANSQ, or WSP data set. **RMODQRD,ZIN,ZMOD,TAPE4,ZOUT** **ZIN**=IFG4, MANSQ, or WSP data set (input) **ZMOD**=modified IFG4, MANSQ, or WSP data set (output) **TAPE4**=unformatted flow data, (optional input). When modifying a WSP data set, user has the option to read data for PARD and QARD lines from a TAPE4 or enter it manually. **ZOUT**=MODQARD results (output). This file is only generated if Option 1 (Stage-Discharge Relationship) is chosen to generate the hydraulic data.
MODSLP	**RMODSLP**	IFG4/WSP Data Set Modification	Modifies the slope at each cross section in an IFG4 data set OR modifies the water surface elevation or slope for each flow on the QARD lines in a WSP data set. **RMODSLP,ZIN,ZOUT** **ZIN**=IFG4 or WSP data set (input) **ZOUT**=new IFG4 or WSP data set with modified slopes (output)

MANSQ DATA SET CREATION - Appendix A contains a sample MANSQ data set.

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
I4TMSQ	**RI4TMSQ**	MANSQ Data Set Creation	Converts an IFG4 data set to a MANSQ data set with one flow per cross section entered on the CALQ line. **RI4TMSQ,ZIFG4,ZMANSQ** **ZIFG4**=IFG4 data set (input) **ZMANSQ**=MANSQ data set (output)
MODIOC	**RMODIOC**	IFG4/WSP/MANSQ/ HABTAT/HABTAM/ HABTAV/HABTAE/ HABVD Data Set Modification	Changes options in the selected data set or options file. **RMODIOC,ZIN,ZOUT** **ZIN**=original data set (input) **ZOUT**=new data set with modified options (output)

HYDRAULIC SIMULATION - CALIBRATION

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
LPTTHWE	**RLPTHWE**	Hydraulic Simulation Calibration	Plots the Thalweg values and water surface elevations from a TAPE3 and TAPE4. **RLPTHWE,LPTOUT,TAPE3,TAPE4** **LPTOUT**=LPTTHWE results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)
SLOP34	**RSLOP34**	Hydraulic Simulation Calibration	Lists the Thalweg values, water surface elevations, and slopes in the following four tables: water surface elevations, water surface slopes, energy grade line elevations, and energy grade line slopes. **RSLOP34,SLPOUT,TAPE3,TAPE4** **SLPOUT**=SLOP34 results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)

HYDRAULIC SIMULATION - CALIBRATION (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
VWTHWEG	**RVWTHWEG**	Hydraulic Simulation Calibration	Plots Thalweg values and water surface elevations as LPTTHWE; however VWTHWEG allows the user to choose the cross section or discharge to be plotted vs. plotting all of them. VWTHWEG uses screen graphics and is only available on the micro. **RVWTHWEG,ZOUT,TAPE3,TAPE4** **ZOUT**=VWTHWEG results (output) Graphs are displayed on the screen, and the information for each requested graph is written to the output file. **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)

HYDRAULIC SIMULATION - MISCELLANEOUS

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
CALCF4	**RCALCF4**	Hydraulic Simulation -- Miscellaneous	Uses Manning's equation at each cross section to calculate a water transport parameter (WTP) for each water surface elevation in an IFG4 data set. Also develops power relationships between WTP's; area and maximum depth; and discharge and width, velocity, and average depth. **RCALCF4,ZIFG4,ZOUT** **ZIFG4**=IFG4 data set (input) **ZOUT**=CALCF4 results (output)
H2EXT	**RH2EXT**	Hydraulic Simulation -- Miscellaneous	Extracts specified cross section data from the summary table from HEC2 output. **RH2EXT,HECOUT,H2EXOUT** **HECOUT**=output file from HEC2 (input) **H2EXOUT**=cross section data extracted from the HEC2 summary table (output)

HYDRAULIC SIMULATION - MISCELLANEOUS (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
H2I4	**RH2I4**	Hydraulic Simulation -- Miscellaneous	Transfers the first two title lines and the cross section data from a HEC2 input file to a file in IFG4 format. **RH2I4,ZHEC2,ZIFG4** **ZHEC2**=HEC2 input file (input) **ZIFG4**=IFG4 data set with title lines and cross section data (output)
STRIPC	**RSTRIPC**	Hydraulic Simulation -- Miscellaneous	Removes all but the two title lines and the coordinate lines from either an IFG4 or WSP data set. When working with an IFG4 data set, user has option to leave as consecutive cross section ID numbering or convert to stationing (accumulating reach lengths). **RSTRIPC,ZIN,ZOUT** **ZIN**=IFG4 or WSP data set (input) **ZOUT**=coordinate data set (output)
WSPTOHC	**RWSPTHC**	Hydraulic Simulation -- Miscellaneous	Converts a WSP data set to an HEC2 input file. **RWSPTHC,ZWSP,ZHEC2** **ZWSP**=WSP data set (input) **ZHEC2**=HEC2 input file (output)

ADDCV Program

I. INTRODUCTION

The ADDCV program adds CAL and VEL lines to an existing IFG4 data set. An IOC and/or a QARD line with no values, is also added if they do not exist in the data set. The CAL/VEL data is read from a free-formatted file created with an editor. Refer to Appendix A for file format for the free-formatted ADDCV file or type INFOACV for on-line information. Appendix A also contains a sample free-formatted input file to ADDCV.

II. RUNNING ADDCV

RADDCV,ZIN,ZIFG4,ZIFG4N

ZIN=free-formatted CAL/VEL data file (input)
ZIFG4=IFG4 data set in which to add CAL and VEL lines (input)
ZIFG4N=new IFG4 data set with CAL and VEL lines added (output)

CALCF4 Program

I. INTRODUCTION

The CALCF4 program uses Manning's equation at each cross section to calculate a water transport parameter (WTP) for each water surface elevation in an IFG4 data set. It also develops power relationships between WTP's; area and maximum depth; and discharge and width, velocity, and average depth.

II. RUNNING CALCF4

RCALCF4,ZIFG4,ZOUT

ZIFG4=IFG4 data set (input)
ZOUT=CALCF4 results (output)

Figure II.4 contains sample output from the CALCF4 program.

```
88/09/07.              UPPER SALMON RIVER, NEAR STANLEY, IDAHO                    PROGRAM - CALCF4
09.34.20.                      SAMPLE IFG4 DATA SET                                 PAGE -   1

              CROSS SECTION ID IS        0.00

REACH LENGTH DOWNSTREAM IS       0.00     WEIGHT ON SECTION IS  0.30
     STAGE OF ZERO FLOW IS      97.20           GIVEN SLOPE IS 0.02667000

     COORDINATE DATA FLOWS - THERE ARE  30 POINTS

  DISTANCE      0.       2.       4.       4.       5.       8.      12.      14.      16.      16.
 ELEVATION  101.30   100.70    99.80    98.60    97.70    97.30    97.60    97.90    97.60    97.70

  DISTANCE     18.      20.      22.      24.      26.      28.      30.      32.      33.      34.
 ELEVATION   97.50    97.40    97.30    97.20    97.30    97.50    97.40    97.70    97.60    97.60

  DISTANCE     35.      36.      37.      39.      44.      53.      62.      70.      78.      87.
 ELEVATION   97.70    97.70    97.70    97.90    98.10    98.60    99.00    98.50    99.00    99.50

  DISCHARGE       WSL       AREA  VELOCITY        FN  AVE DEPTH  MAX DEPTH      WIDTH       WTP

      21.80     97.86     11.32      1.93      0.58       0.34       0.66      32.90      3.94
      12.60     97.76      8.15      1.55      0.53       0.27       0.56      30.48      3.74
       7.90     97.65      5.09      1.55      0.59       0.21       0.45      24.05      4.38

              REGRESSION OF WTP WITH OTHER VARIABLES

                 XVAR            A             B    STD ERROR   AVE ERROR

              DISCHARGE     0.5170E+01    -0.099       0.039       4.906
                   DMAX     0.3352E+01    -0.301       0.035       4.353
                   DAVE     0.3035E+01    -0.213       0.038       4.816
              HY RADIUS     0.3027E+01    -0.214       0.038       4.816

              WTP = A * (XVAR) ** B

              REGRESSION OF AREA WITH MAXIMUM DEPTH

               MAX DEPTH     0.2711E+02     2.090       0.005       0.627

              AREA = A * (DMAX) ** B

              REGRESSION OF DISCHARGE WITH OTHER VARIABLES

                 YVAR            A             B    STD ERROR   AVE ERROR

                  WIDTH     0.1327E+02     0.304       0.033       4.096
               VELOCITY     0.9528E+00     0.218       0.036       4.608
                   DAVE     0.7912E-01     0.478       0.004       0.441

              YVAR = A * (DISCHARGE) ** B
```

ONLY THE DATA FOR THE FIRST CROSS SECTION HAS BEEN INCLUDED IN THIS SAMPLE OUTPUT.

Figure II.4. Sample output from the CALCF4 program.

CHGVEL Program

I. INTRODUCTION

The CHGVEL program changes all zero velocities to .0001 on the VEL lines in an IFG4 data set (blank velocities are not changed).

II. RUNNING CHGVEL

RCHGVEL,ZIFG4,ZIFG4N

ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set with zero velocities changed to .0001 (output)

```
          PROGRAM CHGVEL IS COMPLETE.

ALL ZERO VELOCITIES HAVE BEEN CONVERTED TO 0.0001,
IF THE NUMBER ON THE VEL LINE WAS ( 0.0), (0.00),
( .00), (  .0), ( 00), OR (  0).  ALL BLANKS
ARE STILL BLANKS.
```

CHSTA Program

I. INTRODUCTION

The CHSTA program changes the cross section ID numbers to stationing in an IFG4 data set. New cross section ID numbers using stationing are written using one decimal point.

II. RUNNING CHSTA

RCHSTA,ZIFG4,ZIFG4N

ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set with stationing (output)

CKI4 Program

I. INTRODUCTION

The CKI4 program checks a complete IFG4 data set for format errors and writes a summary of each cross section checked which includes information on: given discharge for point velocities, given stage for point velocities, low point on cross section, stage of zero flow, weight on cross section, reach length downstream, and given slope.

II. RUNNING CKI4

RCKI4,ZIFG4,CKOUT

ZIFG4=IFG4 data set (input)
CKOUT=CKI4 results (output)

Refer to Figure II.5 for sample output from the CKI4 program. This output was generated from the Sample IFG4 Data set contained in Appendix A.

III. ERROR MESSAGES

Refer to the IFG4 program description for information on error messages.

```
PROGRAM- CKI4              88/06/01.   10.39.45.              PAGE    1

   UPPER SALMON RIVER, NEAR STANLEY, IDAHO
   SAMPLE IFG4 DATA SET

       IOC VALUES ARE - 0 1 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0
                         0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

   OTHER DATA LINES PROCEEDING FIRST SET OF CROSS SECTION DATA ARE=

   QARD   8.0
   QARD  10.0
   QARD  20.0
   QARD  30.0
   QARD  40.0
   QARD  50.0
   QARD  60.0
   QARD  70.0
   QARD  80.0
   QARD  90.0
   QARD 100.0
   QARD 110.0
   QARD 120.0
   QARD 130.0
```

Figure II.5 Sample output from the CKI4 program.

UPPER SALMON RIVER, NEAR STANLEY, IDAHO
SAMPLE IFG4 DATA SET

CALIBRATION DATA FOR CROSS SECTION 0.00

X	Y	CHANNEL INDEX	MANNINGS N	N OBS	POINT VELOCITIES 1	2	3
0.0	101.3	3.0	0.000	0	0.00	0.00	0.00
2.5	100.7	3.0	0.000	0	0.00	0.00	0.00
4.0	99.8	3.0	0.000	0	0.00	0.00	0.00
4.3	98.6	3.0	0.000	0	0.00	0.00	0.00
5.5	97.7	9.2	0.000	1	0.30	0.00	0.00
7.6	97.3	6.0	0.000	0	0.00	0.00	0.00
11.9	97.6	6.0	0.000	0	0.00	0.00	0.00
14.2	97.9	8.2	0.000	0	0.00	0.00	0.00
16.2	97.6	8.2	0.000	0	0.00	0.00	0.00
16.5	97.7	8.2	0.000	1	0.54	0.00	0.00
18.2	97.5	8.2	0.000	1	2.08	0.00	0.00
20.2	97.4	9.0	0.000	1	2.65	0.00	0.00
22.2	97.3	9.0	0.000	1	1.91	0.00	0.00
24.2	97.2	9.0	0.000	1	2.84	0.00	0.00
26.2	97.3	9.0	0.000	1	3.11	0.00	0.00
28.2	97.5	9.0	0.000	1	2.59	0.00	0.00
30.2	97.4	9.0	0.000	1	1.87	0.00	0.00
32.2	97.7	9.0	0.000	1	2.33	0.00	0.00
33.0	97.6	9.0	0.000	1	1.95	0.00	0.00
34.2	97.6	9.2	0.000	1	0.56	0.00	0.00
35.2	97.7	9.2	0.000	1	0.38	0.00	0.00
36.2	97.7	9.2	0.000	1	1.13	0.00	0.00
37.4	97.7	9.2	0.000	0	0.00	0.00	0.00
39.1	97.9	10.0	0.000	0	0.00	0.00	0.00
43.8	98.1	10.0	0.000	0	0.00	0.00	0.00
53.0	98.6	10.0	0.000	0	0.00	0.00	0.00
62.4	99.0	10.0	0.000	0	0.00	0.00	0.00
69.9	98.5	8.2	0.000	0	0.00	0.00	0.00
78.1	99.0	3.0	0.000	0	0.00	0.00	0.00
87.1	99.5	3.0	0.000	0	0.00	0.00	0.00
		GIVEN DISCHARGE			22.	13.	8.
		GIVEN STAGE			97.86	97.76	97.65

LOW POINT ON CROSS SECTION IS - 97.20
STAGE OF ZERO FLOW IS - 97.20
WEIGHT ON SECTION IS - 0.30
REACH LENGTH DOWNSTREAM IS - 0.00

GIVEN SLOPE 0.02667

SECTIONS OF SAMPLE OUTPUT HAVE BEEN DELETED HERE FOR BREVITY.

$$ JOB COMPLETED - DATA FOR 2 SECTIONS WRITTEN

Figure II.5 (Concluded)

CKI4TXT Program

I. INTRODUCTION

The CKI4TXT program reads the free-formatted input file to the I4TEXT program and writes a detailed listing of the contents in a format easy for checking. The I4TEXT program creates an incomplete IFG4 data set (missing IOC and QARD values) with up to nine velocity sets, from a free-formatted file created with an editor.

Refer to Appendix A for the file format required for the free-formatted input file to I4TEXT and CKI4TXT; or type INFOI4T for on-line information. Appendix A also contains a sample free-formatted input file to I4TEXT and CKI4TXT.

II. RUNNING CKI4TXT

RCKI4TX,ZIN,ZOUT

ZIN=free-formatted file (input)
ZOUT=CKI4TXT results (output)

Figure II.6 contains the output from the CKI4TXT program. This output was generated from the sample free-formatted input file to I4TEXT contained in Appendix A.

```
PROGRAM - CKI4TXT          DATE - 88/06/01.          TIME - 08.22.55.          PAGE -   1

        THIS IS TITLE LINE 1:  UPPER SALMON RIVER, NEAR STANLEY, IDAHO

        THIS IS TITLE 2:  FIRST CROSS SECTION OF SAMPLE IFG4 DATA SET CREATED USING I4TEXT


            CROSS SECTION ID NUMBER:     0.0
            NUMBER OF X-Y COORDINATE PAIRS IN CROSS SECTION:  30
            STAGE OF ZERO FLOW:      97.200
            REACH LENGTH DOWNSTREAM:           0.0
            WEIGHT ON CROSS SECTION LOOKING UPSTREAM: 0.30
            SLOPE: 0.02667000
            NUMBER OF CAL SETS:  3
            NUMBER OF VEL SETS TO ADD:  1
            VELOCITY DATA IS FOR VEL SETS  1 THRU  1


            THE CALIBRATION SETS ARE:                 DISCHARGE IN    BEST ESTIMATE
                                                      CFS FOR REACH   FOR XSEC    0.0
                                               WSL        Q1             Q2
                                             97.860      21.80          0.00
                                             97.760      12.60          0.00
                                             97.650       7.90          0.00

                                                 CHANNEL            VELOCITIES
                  DISTANCE (X)  ELEVATION (Y)  INDEX      SET1  SET2  SET3
                      0.0         101.3         3.0     99.99
                      2.5         100.7         3.0     99.99
                      4.0          99.8         3.0     99.99
                      4.3          98.6         3.0     99.99
                      5.5          97.7         9.2      0.30
             ** WARNING ** C I VALUE          9.25000 TRUNCATED TO    9.2
                      7.6          97.3         6.0      0.00
                     11.9          97.6         6.0     99.99
                     14.2          97.9         8.2     99.99
             ** WARNING ** C I VALUE          8.25000 TRUNCATED TO    8.2
                     16.2          97.6         8.2     99.99
             ** WARNING ** C I VALUE          8.25000 TRUNCATED TO    8.2
                     16.5          97.7         8.2      0.54
             ** WARNING ** C I VALUE          8.25000 TRUNCATED TO    8.2
                     18.2          97.5         8.2      2.08
             ** WARNING ** C I VALUE          8.25000 TRUNCATED TO    8.2
                     20.2          97.4         9.0      2.65
                     22.2          97.3         9.0      1.91
                     24.2          97.2         9.0      2.84
                     26.2          97.3         9.0      3.11
                     28.2          97.5         9.0      2.59
                     30.2          97.4         9.0      1.87
                     32.2          97.7         9.0      2.33
                     33.0          97.6         9.0      1.95
                     34.2          97.6         9.2      0.56
             ** WARNING ** C I VALUE          9.25000 TRUNCATED TO    9.2
                     35.2          97.7         9.2      0.38
             ** WARNING ** C I VALUE          9.25000 TRUNCATED TO    9.2
                     36.2          97.7         9.2      1.13
             ** WARNING ** C I VALUE          9.25000 TRUNCATED TO    9.2
```

SAMPLE OUTPUT TERMINATED FOR BREVITY.

Figure II.6. Sample output from the CKI4TXT program.

CORDIN Program

I. INTRODUCTION

The CORDIN program creates, or adds to, a file of coordinate data and title lines. An ENDJ and an ENDR line are also created. The CORDIN program is used in the creation of an WSP data set (it could also be used to create an IFG4 data set - the ENDR line would have to be deleted).

II. RUNNING CORDIN

RCORDIN,ZCORD,ZCORDIN

ZCORD=coordinate data file with title lines (output)
ZCORDIN=coordinate data file to be added to (optional input)

ENTER TWO TITLE LINES:

Two title lines with up to 80 characters per line may be entered to record information such as the name of the river, section of the river involved, conditions of flow, and any other information describing the data.

THIS PROGRAM CAN CALCULATE THE ELEVATION GIVEN A DATUM AND THE DISTANCE FROM THE DATUM TO THE GROUND SURFACE, IF YOU WANT THIS OPTION, ENTER THE DATUM. IF NOT ENTER 0.

ENTER CROSS SECTION ID NUMBER:

ENTER THE NUMBER OF COORDINATE PAIRS FOR CROSS SECTION ---:

ENTER --- COORDINATE PAIRS FOR CROSS SECTION --- (DISTANCE,ELEVATION):
PLEASE PRESS ENTER AFTER EACH PAIR.

When all the coordinate pairs for the cross section are entered -

DO YOU WISH TO ENTER COORDINATE DATA FOR ANOTHER
CROSS SECTION? IF SO, ENTER 1. IF NOT, ENTER 0.

CWSPN Program

I. INTRODUCTION

The CWSPN program adds roughness lines to a coordinate data file, one value at each X-Y point except the left-most point. An options (**) line, with all options off, and an ENDR line are also added if they do not exist. This program is used in the creation of a WSP data set.

II. RUNNING CWSPN

RCWSPN,ZIN,ZOUT

ZIN=coordinate data file (input)
ZOUT=coordinate data file with roughness, options (**), and ENDR lines added (output)

```
ENTER 1 FOR SAME ROUGHNESS FOR ALL SECTIONS
      0 OTHERWISE

CHOICE:
```

If "1" is chosen:

ENTER CONSTANT N:

If "2" is chosen:

ENTER CONSTANT N FOR CROSS SECTION ---:

This prompt will be asked for each cross section in the data set.

DELWSL Program

I. INTRODUCTION

The DELWSL program deletes WSL lines in an IFG4 data set. WSL lines contain the water surface elevations for each flow on the QARD lines for each cross section in an IFG4 data set. WSL lines can be added to an IFG4 data set using the WSEI4, WSEI4D, WSEI4H, or WSEI4S programs; or they can be entered manually following the format for "WSL Lines in an IFG4 Data Set" contained in Appendix A.

II. RUNNING DELWSL

RDELWSL,ZIFG4,ZIFG4N

ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set with WSL lines deleted (output)

H2EXT Program

I. INTRODUCTION

The H2EXT program extracts specified cross section data from the summary table from HEC2 output. Figure II.8 in the HEC2 program section contained in this chapter contains a Sample Summary Table from HEC2 output.

II. RUNNING H2EXT

RH2EXT,HECOUT,H2EXOUT

HECOUT=output file from HEC2 (input)
H2EXOUT=cross section data extracted from the HEC2 summary table (output)

ENTER FIRST AND LAST STATION ID NUMBERS (SECNO) FOR SETS TO EXTRACT

The SECNO from the summary chart for the first cross section and the last cross section to be extracted would be entered. All cross sections between the numbers entered will also be extracted.

H2I4 Program

I. INTRODUCTION

The H2I4 program transfers the first two title lines and the cross section data from a HEC2 input file to a file in IFG4 format. QARD, NS (if the option to enter a constant channel index value was not selected), CAL, and VEL lines must be added to make the resulting file a complete IFG4 data set. These lines can be added using an editor and following the "File Format for an IFG4 Data Set" contained in Appendix A, or by running the following programs:

MODQARD - adds QARD lines
ADDCV - adds CAL and VEL lines
An editor would have to be used to add NS lines.
However, if NS lines were created by H2I4 by selecting option to enter a constant channel index value, the **MODN** program could be used to add or modify the N values. Channel index values would have to be modified with an editor.

II. RUNNING H2I4

RH2I4,ZHEC2,ZIFG4

ZHEC2=HEC2 input file (input)
ZIFG4=IFG4 data set with title lines and cross section data (output)

ENTER 1 FOR NS LINES, 0 OTHERWISE

If "1" was entered:

ENTER CONSTANT CHANNEL INDEX VALUE

The same channel index value would be entered for every cell in the cross section.

Figure II.7 contains the IFG4 data set created from an HEC2 input file using the H2I4 program.

```
TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10
IFG4 DATA SET CREATED FROM AN HEC2 INPUT FILE USING THE H2I4 PROGRAM
IOC        00000000000000000000
XSEC   0.0        0.0 0.5
       0.0  0.0105.9  5.0100.9 10.0 99.6 15.0 98.8 20.0 98.4 21.9 97.5
       0.0 22.0 97.0 22.5 96.8 23.5 96.5 25.0 96.3 30.0 94.9 35.0 94.9
       0.0 40.0 95.5 45.0 95.3 50.0 95.2 55.0 95.7 60.0 95.6 65.0 95.5
       0.0 70.0 95.9 75.0 96.0 80.0 95.9 85.0 95.4 90.0 95.5 95.0 95.3
       0.0100.0 95.7105.0 95.5110.0 95.2115.0 95.0120.0 95.3125.0 95.0
       0.0130.0 94.8135.0 95.9136.0 96.8137.6 96.5140.0 97.3141.5 97.5
       0.0145.0 98.5150.0 99.6155.0100.9160.2103.4
NS     0.0        3.0        3.0        3.0        3.0        3.0        3.0
NS     0.0        3.0        3.0        3.0        3.0        3.0        3.0
NS     0.0        3.0        3.0        3.0        3.0        3.0        3.0
NS     0.0        3.0        3.0        3.0        3.0        3.0        3.0
NS     0.0        3.0        3.0        3.0        3.0        3.0        3.0
NS     0.0        3.0        3.0        3.0        3.0        3.0        3.0
NS     0.0        3.0        3.0        3.0        3.0
XSEC  67.0       67.0 0.5
      67.0  0.0105.4  5.0102.3 10.0100.0 13.0 97.8 13.1 97.5 15.0 97.1
      67.0 15.6 97.1 16.5 96.8 20.0 96.0 25.0 95.9 30.0 96.4 35.0 95.8
      67.0 40.0 95.2 45.0 95.5 50.0 95.5 55.0 96.1 60.0 96.2 65.0 96.4
      67.0 70.0 96.4 75.0 96.5 80.0 96.3 85.0 96.4 90.0 97.0 95.0 95.9
      67.0100.0 95.5105.0 95.0110.0 95.0115.0 95.3120.0 97.1125.0 95.9
      67.0130.0 95.6135.0 95.6138.4 96.5139.5 96.8140.0 97.0142.6 97.5
      67.0145.0 98.4150.0 99.7155.0101.4160.0102.5162.9103.9
NS    67.0        3.0        3.0        3.0        3.0        3.0        3.0
NS    67.0        3.0        3.0        3.0        3.0        3.0        3.0
NS    67.0        3.0        3.0        3.0        3.0        3.0        3.0
NS    67.0        3.0        3.0        3.0        3.0        3.0        3.0
NS    67.0        3.0        3.0        3.0        3.0        3.0        3.0
NS    67.0        3.0        3.0        3.0        3.0        3.0        3.0
NS    67.0        3.0        3.0        3.0        3.0        3.0
XSEC 132.0       65.0 0.5
     132.0  0.0105.2  5.0101.5  9.7 98.1 10.0 97.9 11.6 97.3 13.5 97.0
     132.0 15.0 95.3 20.0 94.7 25.0 95.0 30.0 95.5 35.0 95.3 40.0 95.7
     132.0 45.0 95.8 50.0 96.0 55.0 95.7 60.0 95.9 65.0 95.7 70.0 96.1
     132.0 75.0 95.5 80.0 95.5 85.0 95.5 90.0 95.6 95.0 96.1100.0 95.9
     132.0105.0 95.3110.0 95.0115.0 94.7120.0 95.0125.0 96.1130.0 96.7
     132.0131.9 97.2133.4 97.3135.0 97.6138.2 98.1140.0 99.0145.0 99.7
     132.0150.0100.5155.0101.0160.0103.5161.4104.3
NS   132.0        3.0        3.0        3.0        3.0        3.0        3.0
NS   132.0        3.0        3.0        3.0        3.0        3.0        3.0
NS   132.0        3.0        3.0        3.0        3.0        3.0        3.0
NS   132.0        3.0        3.0        3.0        3.0        3.0        3.0
NS   132.0        3.0        3.0        3.0        3.0        3.0        3.0
NS   132.0        3.0        3.0        3.0        3.0        3.0        3.0
NS   132.0        3.0        3.0        3.0        3.0
ENDJ
```

Figure II.7. IFG4 data set created from a HEC2 input file using the H2I4 program.

HEC2 Program

I. INTRODUCTION

The HEC2 program is not part of PHABSIM, but it can be used to determine water surface elevations. The HEC2 program uses step backwater calculations to determine water surface elevations.

The HEC2 program was developed, and is supported, by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. Refer to the "HEC-2 Water Surface Profile Users Manual" for program documentation.

II. RUNNING HEC2

The Aquatic Systems Branch does not maintain a version of HEC2 for public use. In order to run HEC2, the user must have independent access to the package.

There are both mainframe and microcomputer versions of HEC2 available. The Hydrologic Engineering Center has also developed options not described or used in this manual but are useful when doing instream flow studies.

For information on HEC2, Federal agencies should contact the Hydrologic Engineering Center; others should contact the revelant private group or university.

The following four programs have been developed by the Aquatic Systems Branch for use with HEC2. See the individual program documentation for more information on these programs.

WSPTOHC - Converts a WSP data set to a HEC2 input file.
H2I4 - Transfers the first two title lines and cross section data from a HEC2 input file to a file in IFG4 format.
H2EXT - Extracts specified cross section data from the summary table from HEC2 output.
WSEI4H - Reads water surface elevations and discharges from a HEC2 output file and adds or replaces the QARD and WSL lines in an IFG4 data set.

When running HEC2, the code numbers contained in Table II.1 must be selected on Job Control Parameter Card 3 (J3) in order to generate the "Summary Printout" in the right format to be read by H2EXT and WSEI4H. Figure II.8 contains a Sample Summary Table from HEC2 output.

Table II.1

Code numbers that must be selected on the Job Control Parameter Card 3 (J3) in order to generate the "Summary Printout" in the right format to be read by H2EXT and WSEI4H.

Field	Code Number	Description
1	38	Cross section identification number
2	43	Discharge
3	1	Computed water surface elevation
4	4	Cross section width at calculated water surface elevation
5	5	Slope of the energy grade line for the current section (times 10,000)
6	6	Travel time from the first cross section to the present cross section
7	7	Cumulative volume of water in the stream from the first cross section in acre-feet
8	8	Depth of flow
9	10	Mean velocity head across the entire cross section
10		Blank

87/10/15. 20.54.57.

```
*************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
*************************************************
```

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

ORIGINAL DATA WAS FOR THE WSP PROGRAM

SUMMARY PRINTOUT

SECNO	Q	CWSEL	TOPWID	10K*S	TIME	VOL	DEPTH	HV
.000	10.00	96.10	34.00	104.86	.00	.00	.60	.02
.000	20.00	96.30	48.47	60.22	.00	.00	.80	.02
.000	40.00	96.50	61.60	55.48	.00	.00	1.00	.03
.000	80.00	96.70	77.22	64.53	.00	.00	1.20	.06
.000	200.00	97.10	78.11	64.53	.00	.00	1.60	.12
.000	250.00	97.20	78.33	69.43	.00	.00	1.70	.15
.000	300.00	97.30	78.56	71.32	.00	.00	1.80	.18
.000	400.00	97.50	79.00	69.85	.00	.00	2.00	.23
.000	500.00	97.60	79.15	80.83	.00	.00	2.10	.31
.000	800.00	97.90	79.62	96.59	.00	.00	2.40	.54
.000	1000.00	98.10	79.92	98.13	.00	.00	2.60	.68
* .000	1500.00	98.42	80.42	114.84	.00	.00	2.92	1.11
40.000	10.00	96.23	38.66	12.52	.02	.01	.83	.01
40.000	20.00	96.42	43.08	15.44	.01	.02	1.02	.01
40.000	40.00	96.64	49.30	20.51	.01	.03	1.24	.02
40.000	80.00	96.88	63.37	28.56	.01	.04	1.48	.04
40.000	200.00	97.32	73.10	38.87	.00	.07	1.92	.10
40.000	250.00	97.44	73.69	42.08	.00	.08	2.04	.13
40.000	300.00	97.55	73.73	44.32	.00	.09	2.15	.15
40.000	400.00	97.76	73.80	46.95	.00	.10	2.36	.20
40.000	500.00	97.91	73.86	51.20	.00	.11	2.51	.26
40.000	800.00	98.32	74.00	57.32	.00	.13	2.92	.43
40.000	1000.00	98.55	74.00	59.35	.00	.15	3.15	.54
40.000	1500.00	99.09	74.00	58.19	.00	.18	3.69	.79

Figure II.8. Sample Summary Table from HEC2 output.

I4TEXT Program

I. INTRODUCTION

The I4TEXT program creates an incomplete IFG4 data set (missing IOC and QARD values) with up to nine velocity sets, from a free-formatted file created with an editor. The CKI4TXT program is run to check the free-formatted file before the I4TEXT program is run. CKI4TXT writes a detailed listing of the contents in a format easy for checking.

The MODIOC program could be run on the IFG4 data set created by I4TEXT to add IOC values; and the MODQARD program could be run to add QARD values.

Refer to Appendix A for the file format for the free-formatted input file for I4TEXT and CKI4TXT; or type INFOI4T for on-line information. Appendix A also contains a sample free-formatted input file to I4TEXT.

II. RUNNING I4TEXT

RI4TEXT,ZIN,ZIFG4

ZIN=free-formatted file (input)
ZIFG4=IFG4 data set (output)

I4TMSQ Program

I. INTRODUCTION

The I4TMSQ program converts an IFG4 data set to a MANSQ data set with one flow per cross section entered on the CALQ line.

II. RUNNING I4TMSQ

RI4TMSQ,ZIFG4,ZMANSQ

ZIFG4=IFG4 data set (input)
ZMANSQ=MANSQ data set (output)

The IFG4 data set title lines will be displayed.

DO YOU WANT TO CHANGE THE TITLE? Y/N

FOR CROSS SECTION ---

ENTER THE WATER SURFACE ELEVATION ON CALQ LINE:

ENTER THE FLOW ON CALQ LINE:

ENTER BETA COEFFICIENT:

The above series of prompts will appear for each cross section in the IFG4 data set.

Refer to Appendix A for the "MANSQ Data Set Format" and a sample MANSQ data set.

I4VAF Program

I. INTRODUCTION

The I4VAF program plots or summarizes and plots the velocity adjustment factors file (ZVAFF) created when IOC(13)=1 in IFG4.

II. RUNNING I4VAF

RI4VAF,ZVAFF,ZOUT

ZVAFF=velocity adjustment factor file from IFG4 (input)
ZOUT=I4VAF results (output).

<u>NOTE</u>: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

```
SELECT DESIRED OUTPUT
     1) PLOT ZVAFF FILE
     2) PRINT SUMMARY STATISTICS AND PLOT ZVAFF FILE
CHOICE:
```

Figure II.9 contains sample output from the I4VAF program. This figure contains the summary statistics and the plot generated by selecting Option "2" above. The ZVAFF file was generated by running IFG4 on the Sample IFG4 Data Set in Appendix A with IOC(13)=1.

Velocity Adjustment Factors for flows less than the calibration flows are likely to be less than one. Velocity Adjustment Factors for flows greater than the calibration flows are likely to be greater than one.

```
88/05/09.            UPPER SALMON RIVER, NEAR STANLEY, IDAHO                     PROGRAM - I4VAF
09.55.20.                      SAMPLE IFG4 DATA SET                                PAGE -    1

       ********************************
       *    ANALYSIS OF VAF FACTORS    *
       ********************************

       FLOWS WITH CORRESPONDING VELOCITY ADJUSTMENT FACTORS
       ====================================================

       THE CHANGE FACTOR IS CALCULATED BY THE FOLLOWING EQUATION:

                     CHANGE FACTOR = 1 - VAF


       STATISTICS FOR TOTAL CHANGE FACTOR IN DATA SET
       ======================================

             AVERAGE OF TOTAL NUMBER OF CHANGE FACTOR IS:           -0.070
        AVE. OF ABSOLUTE VALUE OF TOTAL CHANGE FACTOR IS:            0.105
            VARIANCE OF TOTAL NUMBER OF CHANGE FACTOR IS:            0.014
               RANGE FOR TOTAL NUMBER OF CHANGE FACTOR IS:     0.001     -      0.256


       STATISTICS FOR EACH STATION IN DATA SET
       ======================================

       STATISTICS FOR STATION     0.0 ARE-
                                AVERAGE OF CHANGE FACTOR:           -0.035
               AVERAGE OF ABSOLUTE VALUE OF CHANGE FACTOR:            0.037
                              VARIANCE IN THE CHANGE FACTOR:            0.001
                                  RANGE OF CHANGE FACTOR:     0.001     -      0.077

       STATISTICS FOR STATION    14.3 ARE-
                                AVERAGE OF CHANGE FACTOR:           -0.106
               AVERAGE OF ABSOLUTE VALUE OF CHANGE FACTOR:            0.173
                              VARIANCE IN THE CHANGE FACTOR:            0.024
                                  RANGE OF CHANGE FACTOR:     0.028     -      0.256
```

Figure II.9. Sample output from the I4VAF program.

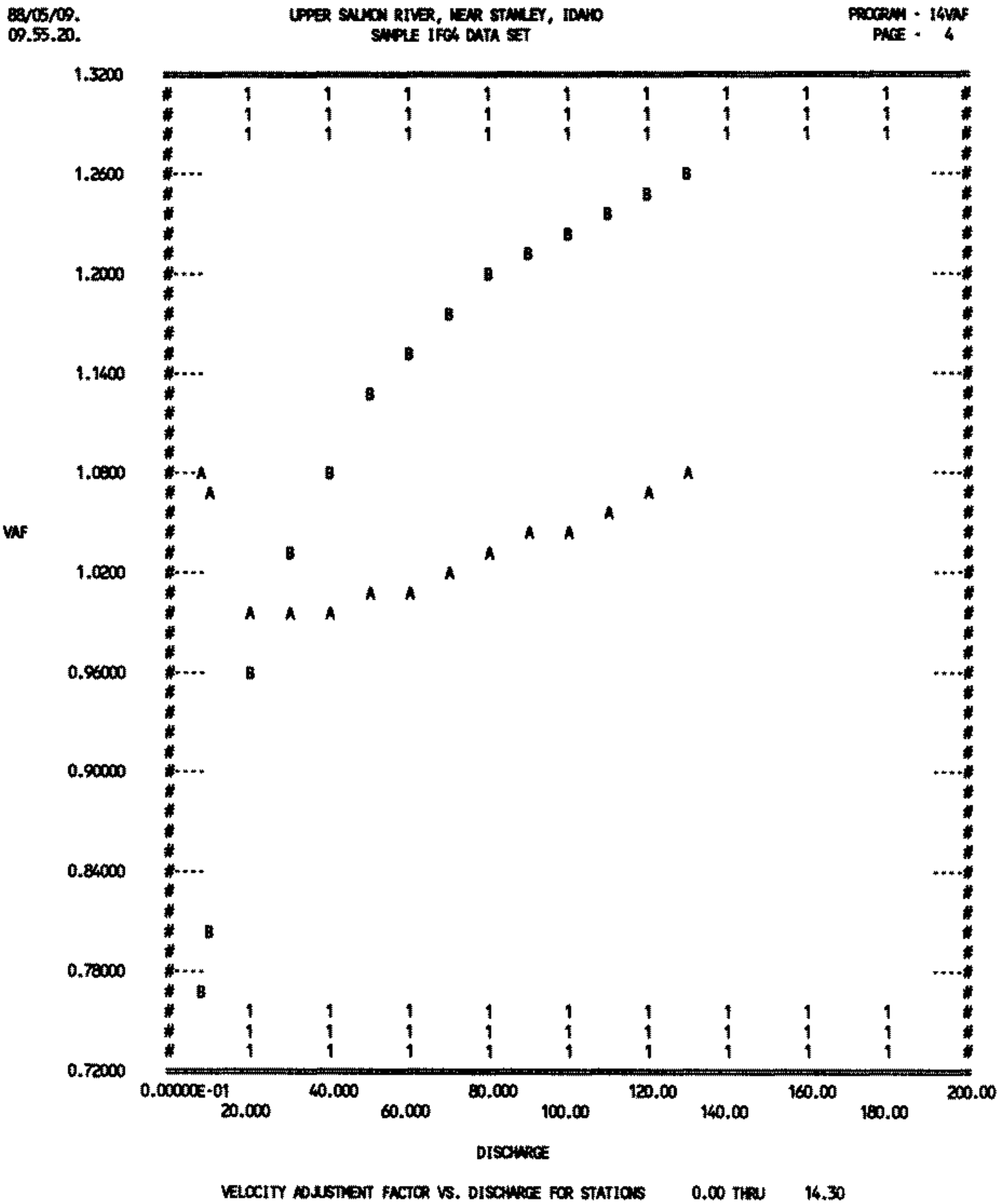


Figure II.9. (Continued)

```
STATISTICS FOR EACH FLOW IN DATA SET
==================================

STATISTICS FOR FLOW    8.000 ARE  -
                   AVERAGE OF CHANGE FACTOR:              0.078
    AVERAGE OF ABSOLUTE  VALUE OF CHANGE FACTOR:          0.155
                  VARIANCE IN CHANGE FACTOR:              0.024
                     RANGE OF CHANGE FACTOR:     0.077     -      0.233

STATISTICS FOR FLOW   10.000 ARE  -
                   AVERAGE OF CHANGE FACTOR:              0.063
    AVERAGE OF ABSOLUTE  VALUE OF CHANGE FACTOR:          0.129
                  VARIANCE IN CHANGE FACTOR:              0.017
                     RANGE OF CHANGE FACTOR:     0.065     -      0.192

STATISTICS FOR FLOW   20.000 ARE  -
                   AVERAGE OF CHANGE FACTOR:              0.023
    AVERAGE OF ABSOLUTE  VALUE OF CHANGE FACTOR:          0.023
                  VARIANCE IN CHANGE FACTOR:              0.001
                     RANGE OF CHANGE FACTOR:     0.001     -      0.046

STATISTICS FOR FLOW   30.000 ARE  -
                   AVERAGE OF CHANGE FACTOR:             -0.009
    AVERAGE OF ABSOLUTE  VALUE OF CHANGE FACTOR:          0.019
                  VARIANCE IN CHANGE FACTOR:              0.000
                     RANGE OF CHANGE FACTOR:     0.009     -      0.028

STATISTICS FOR FLOW   40.000 ARE  -
                   AVERAGE OF CHANGE FACTOR:             -0.038
    AVERAGE OF ABSOLUTE  VALUE OF CHANGE FACTOR:          0.042
                  VARIANCE IN CHANGE FACTOR:              0.002
                     RANGE OF CHANGE FACTOR:     0.004     -      0.081

STATISTICS FOR FLOW   50.000 ARE  -
                   AVERAGE OF CHANGE FACTOR:             -0.063
    AVERAGE OF ABSOLUTE  VALUE OF CHANGE FACTOR:          0.063
                  VARIANCE IN CHANGE FACTOR:              0.004
                     RANGE OF CHANGE FACTOR:     0.004     -      0.123

STATISTICS FOR FLOW   60.000 ARE  -
                   AVERAGE OF CHANGE FACTOR:             -0.083
    AVERAGE OF ABSOLUTE  VALUE OF CHANGE FACTOR:          0.083
                  VARIANCE IN CHANGE FACTOR:              0.005
                     RANGE OF CHANGE FACTOR:     0.012     -      0.154
```

Figure II.9. (Concluded)

I4VCE Program

I. INTRODUCTION

The I4VCE program plots or summarizes and plots the velocity calibration errors file (ZVCEF) created when IOC(10)=1 in IFG4.

II. RUNNING I4VCE

RI4VCE,ZVCEF,ZOUT

ZVCEF=velocity calibration errors file from IFG4 (input)
ZOUT=I4VCE results (output). Graphs are written using character graphics in a 132 characters per line format.

```
SELECT DESIRED OUTPUT
     1) PLOT ZVCEF FILE
     2) PRINT SUMMARY STATISTICS AND PLOT ZVCEF FILE
CHOICE:
```

Figure II.10 contains sample output from the I4VCE program. This figure contains the calibration errors and the plot generated by selecting Option "2" above.

III. ERROR MESSAGES

*****NOTE*****
THERE IS ONLY ONE ERROR VALUE PER STATION IN DATA SET
- THEREFORE STATISTICAL CALCULATIONS ARE OBSOLETE.
****ERROR** EMPTY VCE FILE (OR EOF) - TRY AGAIN**

There must be multiple non-blank velocity sets in the IFG4 data set in order for the program to develop regression lines to calculate the measured flow for each cross section versus the user supplying the measured flow on the CAL line for each cross section. Therefore, a ZVCEF file could not be generated using the Sample IFG4 Data Set in Appendix A, as there is only one non-blank velocity set.

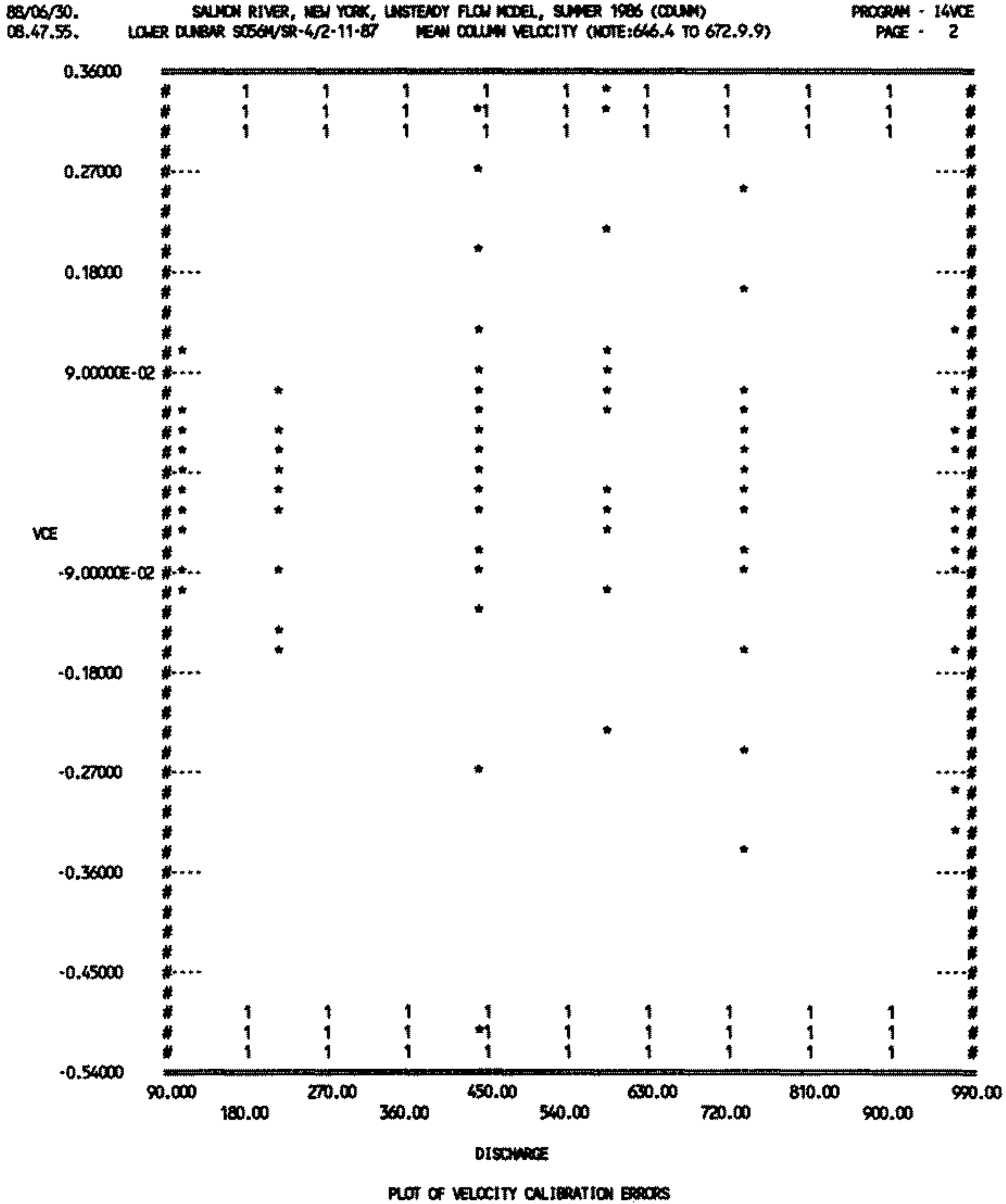


Figure II.10. Sample output from the I4VCE program.

```
     AVERAGE OF TOTAL NUMBER OF ERRORS IS:          -0.007
 AVE. OF ABSOLUTE VALUE OF TOTAL ERRORS IS:          0.079
  STAND. DEV. OF TOTAL NUMBER OF ERRORS IS:          0.122
      RANGE FOR TOTAL NUMBER OF ERRORS IS:    -0.495    -    0.349

STATISTICS FOR STATION   56.0 ARE-
                        AVERAGE OF ERRORS:          -0.007
      AVERAGE OF ABSOLUTE VALUE OF ERRORS:           0.083
                STAND. DEV. IN THE ERRORS:           0.119
                          RANGE OF ERRORS:    -0.328    -    0.349

STATISTICS FOR STATION   58.0 ARE-
                        AVERAGE OF ERRORS:          -0.007
      AVERAGE OF ABSOLUTE VALUE OF ERRORS:           0.076
                STAND. DEV. IN THE ERRORS:           0.124
                          RANGE OF ERRORS:    -0.495    -    0.329
```

Figure II.10. (Concluded)

IFG4 Program

I. INTRODUCTION

The IFG4 program uses a stage-discharge relationship to determine water surface elevations unless they are supplied in the data set. When using the stage-discharge relationship, each cross section is treated independently of all others in the data set. The velocities are determined using techniques based on Manning's equation.

The IFG4 hydraulic simulation model predicts depth of flow and mean column velocities across the stream as a function of discharge. The purpose of the program is to develop the depth and velocity data required by the habitat simulation programs. Given the appropriate streamflow data, it is possible to regress discharge with water surface elevation, and discharge with mean column velocity, using a log-log fit with discharge as the independent variable. The distribution of depth across the stream is obtained implicitly within the program by subtracting the known ground/streambed elevations from the predicted water surface elevation at the cross section.

The IFG4 program is capable of making water surface elevation and velocity predictions for up to 100 flows in a single run. However, when the IFG4 program is used in conjunction with the habitat simulation programs, the limit is 30 flows.

As noted above, the IFG4 model is based on the empirical assumption that water surface elevation and velocity exhibit a log-log linear relationship to flow. For a valid relationship between velocity and flow to be obtained, it is imperative that all sets of velocity measurements for all measured flows be made with respect to a common set of verticals. Generally, closer spacing of verticals is required in the middle of the channel for accurate simulation of low flows.

The IFG4 program defines a cell as the region one-half way between two sets of adjacent verticals. A vertical is a measurement point specified as the X (distance from the head stake) coordinate values. All references to the cell are then made to the vertical. Note that this definition of a cross-sectional cell is different than that used in the HABTAT program. When processing is complete, IFG4 passes simulated velocity and depth information to HABTAT in the form used there.

Refer to Figure II.1 for a flowchart of the various methods available to create an IFG4 data set. Refer to Appendex A for "IFG4 Data Set File Format" for information on what each line contains and instructions for entering data. Appendix A also contains a sample IFG4 data set.

Table II.2 describes the options available in the IFG4 program.

Table II.2. Options in the IFG4 Program.

OPTION	ACTION
1	Prints the numerical details of the computed velocities and water surface elevations for each simulated discharge. Recommend setting to zero (0) for production runs and one (1) for calibration runs. If a record of the velocities and WSL's used in the production runs is desired, use the related options in HABTAT. For calibration runs, the flows on the QARD lines should be the same as on the CAL lines if all the "best estimates" of flows at each cross section are the same, otherwise use a set representative of the measured flows. 0 = Do not print computational details. 1 = Print computational details.
2	Prints the numerical details of the calibration procedure and generates output which helps spot errors and indicates additional parameter adjustments. Recommend setting to one (1). 0 = Do not print calibration details. 1 = Print calibration details.
3	Generates a plot of the cross section coordinate points. An alternative is to run the REVI4 program. Recommend setting to zero (0). 0 = Do not plot cross sections. 1 = Plot cross sections.
4	Generates plots of the points of the stage-discharge rating curve based on log transformation. Recommend running the REVI4 program to look at the stage-discharge relationship prior to running the IFG4 program. If only one set of CAL-VEL data is in the data set, this option must be set to zero (0). 0 = Do not plot rating curve. 1 = Plot rating curve.
5	Controls the discharge used in the calibration (specifies the stage-discharge and velocity-discharge relationships in relation to simulated discharges). Set IOC(5)=0 if IOC(8)=2. Recommend setting to zero "0". 0 = Discharge calculated for each cross section is used in the calibration of $v=aQ^b$ and in the stage-discharge relationship if IOC(8)=0. 1 = Stage-discharge relationship and velocity discharge relationships are determined using the first discharge entered on the CAL lines.
6	Allows a correction in stage if the Velocity Adjustment Factor is beyond specific bounds. Recommend setting to zero (0) as it is more effective to set IOC(8)=1 and input the water surface elevations. 0 = Will adjust velocities only to make the measured discharge equal to the calculated discharge. 1 = Will allow a correction in stage if the Velocity Adjustment Factor is less than 0.90 or greater than 1.10.
7	Allows user to specify the Stage of Zero Flow (SZF) - the limiting elevation in regard to flow. This can be represented by the lowest point in the cross section or the limiting elevation of downstream cross sections. Recommend entering the stage of zero flow on the XSEC line and setting this option to zero (0). 0 = Read stage of zero flow from XSEC line. 1 = Set stage of zero flow to zero.

Table II.2 (Continued)

OPTION	ACTION
8	Defines the computation techniques of the velocity/discharge and stage/discharge relationships. 0 = Use rating curve based on flow selected by IOC(5) to calculate stage for the flows entered on the QARD lines. 1 = Water surface elevation is supplied on WSL lines for each flow entered on the QARD lines. 2 = Stage is calculated using two stage-discharge relationships. The first stage-discharge relationship uses the water surface elevations entered on the CAL lines and the first flow entered on the CAL lines. The second stage-discharge relationship uses the water surface elevations entered on the CAL lines and the discharges calculated using the given velocities or the second flow on the CAL line if the velocities are not given. For each flow entered on the QARD lines, the water surface elevation is calculated using the first relationship. This water surface elevation is used to determine a discharge using the second relationship; this discharge is used in the water (mass) balance calculations. The velocity vs. discharge relationships are based on the discharge calculated using the velocities on the VEL lines. If velocities are all blank (flow calculated based on VEL lines=0), then the second flow on the CAL line is used the same way as the discharges calculated from the velocities on the VEL lines. In this case, the second discharge on the CAL line must be given. Specifically, if IOC(8)=2, there MUST be either non-blank velocity data OR two flows on the CAL lines. NOTE: Option 5 must be off to allow this option to function correctly; the advantages of IOC(8)=2 are lost if IOC(5)=1.
9	Provides for evaluation of negative velocities. When option is off, only the cell with the negative velocity will be evaluated as a semi-log fit. When option is on, one negative velocity will force the entire cross section to be evaluated by a semi-log fit. The relationships developed in the calibration phase are thus forced to be semi-log relationships and the simulation steps are performed using those functions. Recommend setting to zero (0). 0 = When a negative velocity is found, a semi-log equation is used to calibrate that cell ONLY. 1 = When a negative velocity is found, all cells in the cross section are calibrated using a semi-log equation.
10	Writes ZVCEF file containing a summary of the Velocity Calibration Errors which are (V = cQ**B) for each cell and the error factors for velocity. Results are only obtained if the program is using multiple non-blank velocity sets to develop regression lines to calculate the measured flow for each cross section versus the user supplying the measured flow on the CAL line for each cross section. Recommend setting to zero (0) for production runs and until the model has successfully run once. Set to one (1) to check for significance of the V-Q calibration on subsequent calibration runs. 0 = Do not write ZVCEF file. 1 = Write ZVCEF file.

Table II.2 (Continued)

OPTION	ACTION
11	Applies the velocity adjustment factor (VAF). If IOC(11)=1, the velocity adjustment will be bypassed regardless of which combinations of Options 5 and 8 have been selected. Set IOC(11)=0 if IOC(16)=1. Recommend always setting IOC(11)=0. Setting IOC(11)=1 is sometimes referred to as "turning off mass balancing". 0 = Adjust velocities so the discharge calculated using the simulated velocities is the same as a discharge entered on the QARD lines. The adjusting is done using the Velocity Adjustment Factors. 1 = Do not adjust velocities using VAF.
12	Allows user to have the program calculate roughness coefficient if roughness values are not supplied, or to supply the roughness coefficient for each cell with only one measurement. 0 = Uses N on the NS lines, or calculates N if N on NS line is zero. 1 = Uses calculated N for cells with water, N on NS lines for dry cells for which N was supplied, and an estimated N for dry cells where N was not supplied.
13	Writes ZVAFF file containing a summary of the Velocity Adjustment Factors. If IOC(1)=0, recommend setting IOC(13)=1 and checking ZVAFF file for large VAF values. Velocity Adjustment Factors for flows less than the calibration flows are likely to be less than one. Velocity Adjustment Factors for flows greater than the calibration flows are likely to be greater than one. 0 = Do not write ZVAFF file. 1 = Write ZVAFF file.
14	Controls the use of the coefficient (d) in v = cQ**d. 0 = No control of coefficient d. 1 = Uses the average coefficient d of the cells with at least three measured velocities as the coefficient for all cells with at least one measurement. 2 = Uses the average coefficient d with the cells with only one velocity measurement, other cells are unchanged. 3 = Limits the coefficient d to a maximum value specified by the user on the BMAX line. 4 = Uses the average coefficient d for all cells with one or two measured velocities. 5 = Uses the average coefficient d for cells with one measured velocity and applies a limit to d (i.e., 2 and 3 combined).
15	Limits the maximum OR minimum and maximum value of the roughness coefficient (n) used by Manning's Equation in simulating velocities. 0 = No limit on N. 1 = Limit on the maximum OR on the maximum and minimum value of N (values supplied on the NMAX line). 2 = Limit on the maximum value of N and on minimum if N > 0 (values supplied on the NMAX line).

Table II.2 (Concluded)

OPTION	ACTION
16	Allows user to adjust the roughness in a cell as a function of the depth in a cell (variable roughness). This should help in reducing the negative impacts often resulting from too high roughness at the edges in the calibration data set. Use this option with care as more expertise must be obtained in the actual application of this option before a high degree of confidence in its use is appropriate. Judgement is required in choosing a Beta coefficient. The range of values for all but humid tropical channels is from 0.0 to -2.04 with a typical value being in the range of -0.3 to -0.8. The main point here is that the roughness change coefficient (Beta) must be determined by the user. If IOC(16)=1, IOC(11) must be 0 or the results will be irrational. NOTE: n = nc*(d/dc)**B 0 = No variable roughness coefficient. 1 = Use roughness change coefficient (Beta) supplied on the NSLP line.
17	Writes cell velocities to TAPE4 using the criteria below. The normal approach is to average the velocity at the verticals defining the right and left side of a cell to determine that cell's velocity. 0 = Write normal cell velocities (HABTAT format). 1 = Write velocities at wet verticals (HABTAV and HABTAM format). 2 = Write velocities at all verticles (resulting TAPE4 is not for use with PHABSIM programs).
18	In some streams the water surface elevations are significantly different horizontally across a stream which results in the water surface elevations being different on the left and right sides of the stream. Also, in some cases, there may be an island dividing the flow into two channels which results in different water surface elevations in each channel. If this option is used, right and left water surface elevations are entered on the CAL lines. If there are two channels, the location of the "break" in water surface elevations is entered on the XSEC lines. If no "break" is given and IOC(18)=1, the water is assumed to slope evenly from right to left bank. The equivalent of this option has not been implemented in the habitat simulation programs. Therefore, do not use this option when when doing habitat simulation until the option has been implemented there also. 0 = Water surface is horizontal - assumes the water surface elevation is constant to the width of the stream. 1 = Water surface slopes from right to left or there is a break (step) in the water surface elevation.
19	Prints a summary table of the calculated flows. 0 = Do not print a CALQ table. 1 = Print a CALQ table.
20	Multiplies the cross section width by a constant. 0 = Multiplier = 1 (i.e., multiplier = 10**IOC(20) value). 1 = Multiplier = x given * 10**1 (used on large rivers) (i.e., multiplier = 10**IOC(20) value). 2 = Multiplier = x given * 10**2 (used on large rivers) (i.e., multiplier = 10**IOC(20) value). 3 = Multiplier = x given * 10**-1 (used on small rivers) (i.e., multiplier = 10**(2-IOC(20) value)). 4 = Multipler = x given * 10**-2 (used on small rivers) (i.e., multiplier = 10**(2-IOC(20) value)).
21	Not used - set to "0".
22	The IFG4 program aborts if slopes (B) in the equation V = A*Q**B exceeds 3.0 0 = Abort if slopes exceed 3.0. 1 = Do not abort if slopes exceed 3.0.

II. RUNNING IFG4

RIFG4,ZIFG4,ZOUT,TAPE3,TAPE4,TP4,ZVAFF,ZVCEF

ZIFG4=IFG4 data set (input)
ZOUT=IFG4 results (output)
TAPE3=unformatted cross section and reach data (output)
TAPE4=unformatted flow data (output)
TP4=rearranged TAPE4 file. Used as input to HABTAT (output)
ZVAFF=velocity adjustment factor file.
Created if IOC(13)=1 (output)
ZVCEF=velocity calibration errors file.
Created if IOC(10)=1 (output)

NOTE: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

NOTE: If IOC(17)=1, the TAPE4 and TP4 files will be in HABTAM and HABTAV readable format. These files need to be renamed to TAPE4A and TP4A by the user.

```
$$$ JOB COMPLETED NORMAL WITH  9 NOTES

  LINE PRINTER RESULTS ON (output filename specified )
   TAPE3, TAPE4, and TP4 TYPE FILES CREATED

**********************************************************************
***                                                                ***
***  Remember to rename TP4 to TP4A when running HABTAM or HABTAV. ***
***                                                                ***
**********************************************************************
```

Appendix A contains the IFG4 data set that was used to generate the output in Figure II.11. Review the output file for error messages and inconsistancies in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort.

The ZVAFF file created by setting IOC(13)=1 is shown in Figure II.12. The I4VAF program can be run to plot or analyze and plot the Velocity Adjustment Factors (VAF's). Figure II.13.

By looking at the ZVAFF file and the plot, it appears that cross section 0.0 needs additional work as the velocity adjustment factors are in a reverse pattern from what they should be. This indicates that IFG4 is underpredicting water surface elevations at the low flows and overpredicting them at the high flows. Cross section 0.0 is basicaly triangular with numerous irregularities. The three measured points were taken at flows where the water was confined to the thalweg. As a result, the rating curve for this section is too steep to describe the stage-discharge relationship at flows above the high calibration flow.

Recommend running MANSQ and using the predicted water surface elevations to see if better results can be obtained. Refer to MANSQ program documentation for results.

IOC(19)=1

DISCHARGE CALCULATIONS FOR CROSS SECTION 0.00 SET 1

VERTICAL	LEFT	AREA RIGHT	CELL	CELL DISCHARGE
5	0.02	0.76	0.39	0.12
6	0.76	1.76	1.26	0.00
7	1.76	0.26	1.01	0.00
8	0.26	0.23	0.24	0.00
9	0.23	0.06	0.14	0.00
10	0.06	0.44	0.25	0.14
11	0.44	0.82	0.63	1.31
12	0.82	1.02	0.92	2.44
13	1.02	1.22	1.12	2.14
14	1.22	1.22	1.22	3.46
15	1.22	0.92	1.07	3.33
16	0.92	0.82	0.87	2.25
17	0.82	0.62	0.72	1.35
18	0.62	0.17	0.39	0.92
19	0.17	0.31	0.24	0.47
20	0.31	0.21	0.26	0.15
21	0.21	0.16	0.19	0.07
22	0.16	0.19	0.18	0.20
23	0.19	0.11	0.15	0.00
24	0.11	0.00	0.05	0.00
TOTAL			11.31	18.34

SECTIONS OF SAMPLE OUTPUT HAVE BEEN DELETED HERE FOR BREVITY.

ANALYSIS FOR CROSS SECTION 0.00

CALIBRATION OF STAGE - DISCHARGE RELATIONSHIP FOR GIVEN DISCHARGES

DISCHARGE	STAGE	PLOTTING STAGE
21.800	97.860	0.660
12.600	97.760	0.560
7.900	97.650	0.450

STAGE OF ZERO FLOW IS 97.20

STAGE - DISCHARGE RELATIONSHIP

LOG - LOG FUNCTION

Q = 0.621E+02 *(STAGE - 97.20)** 2.623

MEASURED	PREDICTED	RATIO
21.800	20.890	1.044
12.600	13.577	0.928
7.900	7.651	1.033

MEAN ERROR	5.03
VARIANCE	5.84
STD. DEV.	2.42
SAMPLE SIZE	3.

Figure II.11. Sample output from the IFG4 program.

IOC(2)=1

CALIBRATION DETAILS FOR CROSS SECTION 0.00

	X	Y	CHANNEL INDEX VALUE	MANNINGS N	N OBS	CORR COEF	VELOCITIES AT VERTICAL 1	2	3
1	0.0	101.3	3.0	0.000	0	0.00	0.00	0.00	0.00
2	2.5	100.7	3.0	0.000	0	0.00	0.00	0.00	0.00
3	4.0	99.8	3.0	0.000	0	0.00	0.00	0.00	0.00
4	4.3	98.6	3.0	0.000	0	0.00	0.00	0.00	0.00
5	5.5	97.7	9.2	0.238	1	0.00	0.30	0.00	0.00
6	7.6	97.3	6.0	0.000	0	0.00	0.00	0.00	0.00
7	11.9	97.6	6.0	0.000	0	0.00	0.00	0.00	0.00
8	14.2	97.9	8.2	0.000	0	0.00	0.00	0.00	0.00
9	16.2	97.6	8.2	0.000	0	0.00	0.00	0.00	0.00
10	16.5	97.7	8.2	0.132	1	0.00	0.54	0.00	0.00
11	18.2	97.5	8.2	0.059	1	0.00	2.08	0.00	0.00
12	20.2	97.4	9.0	0.055	1	0.00	2.65	0.00	0.00
13	22.2	97.3	9.0	0.086	1	0.00	1.91	0.00	0.00
14	24.2	97.2	9.0	0.065	1	0.00	2.84	0.00	0.00
15	26.2	97.3	9.0	0.053	1	0.00	3.11	0.00	0.00
16	28.2	97.5	9.0	0.047	1	0.00	2.59	0.00	0.00
17	30.2	97.4	9.0	0.077	1	0.00	1.87	0.00	0.00
18	32.2	97.7	9.0	0.031	1	0.00	2.33	0.00	0.00
19	33.0	97.6	9.0	0.051	1	0.00	1.95	0.00	0.00
20	34.2	97.6	9.2	0.176	1	0.00	0.56	0.00	0.00
21	35.2	97.7	9.2	0.188	1	0.00	0.38	0.00	0.00
22	36.2	97.7	9.2	0.063	1	0.00	1.13	0.00	0.00
23	37.4	97.7	9.2	0.000	0	0.00	0.00	0.00	0.00
24	39.1	97.9	10.0	0.000	0	0.00	0.00	0.00	0.00
25	43.8	98.1	10.0	0.000	0	0.00	0.00	0.00	0.00
26	53.0	98.6	10.0	0.000	0	0.00	0.00	0.00	0.00
27	62.4	99.0	10.0	0.000	0	0.00	0.00	0.00	0.00
28	69.9	98.5	8.2	0.000	0	0.00	0.00	0.00	0.00
29	78.1	99.0	3.0	0.000	0	0.00	0.00	0.00	0.00
30	87.1	99.5	3.0	0.000	0	0.00	0.00	0.00	0.00

	1	2	3
CALCULATED DISCHARGE	18.3	0.0	0.0
WATER SURFACE ELEVATIONS	97.86	97.76	97.65
GIVEN DISCHARGE	21.8	12.6	7.9
WATERS EDGE AT LEFT	5.3	5.4	5.8
WATERS EDGE AT RIGHT	38.8	37.9	34.7

THE FUNCTION USED TO FIT S VS. Q IS:

S=A*Q**B+SZF

WHERE:

A= 0.207140E+00
B= 0.381292E+00
SZF= 0.972000E+02

Figure II.11. (Continued)

```
88/04/14.                 UPPER SALMON RIVER, NEAR STANLEY, IDAHO                 PROGRAM-IFG4
15.42.08.                          SAMPLE IFG4 DATA SET                              PAGE   7

  NOTE   1 WHILE PROCESSING CROSS SECTION    0.00 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT   6   0.13200 WAS USED

  NOTE   2 WHILE PROCESSING CROSS SECTION    0.00 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT  23   0.06308 WAS USED

  NOTE   3 WHILE PROCESSING CROSS SECTION    0.00 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT  24   0.06308 WAS USED

  NOTE   4 WHILE PROCESSING CROSS SECTION    0.00 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT  25   0.06308 WAS USED

  NOTE   5 WHILE PROCESSING CROSS SECTION    0.00 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT  28   0.06308 WAS USED
```

SECTIONS OF SAMPLE OUTPUT HAVE BEEN DELETED HERE FOR BREVITY.

```
88/04/14.                 UPPER SALMON RIVER, NEAR STANLEY, IDAHO                 PROGRAM-IFG4
15.42.08.                          SAMPLE IFG4 DATA SET                              PAGE  13

  NOTE   6 WHILE PROCESSING CROSS SECTION   14.30 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT  10   0.13173 WAS USED

  NOTE   7 WHILE PROCESSING CROSS SECTION   14.30 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT  26   0.04081 WAS USED

  NOTE   8 WHILE PROCESSING CROSS SECTION   14.30 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT   8   0.13173 WAS USED

  NOTE   9 WHILE PROCESSING CROSS SECTION   14.30 AN  N  VALUE WAS NEEDED, BUT NOT SUPPLIED
           FOR SEGMENT  29   0.04081 WAS USED
```

IOC(19)=1

SUMMARY OF CALIBRATION FLOWS (CFS)

CROSS SECTION	1	2	3
0.00	21.80	12.60	7.90
14.30	21.80	12.60	7.90
MEANS	21.80	12.60	7.90
STD DEV	0.00	0.00	0.00
COEF OF VARIATION	0.000	0.000	0.000

$$$ JOB COMPLETED NORMALLY WITH 9 NOTES

Figure II.11. (Concluded)

```
UPPER SALMON RIVER, NEAR STANLEY, IDAHO
THIS ZVAFF FILE WAS GENERATED BY RUNNING IFG4 ON THE SAMPLE IFG4 DATA SET.
                              0.00            8.0     1.077
                              0.00           10.0     1.065
                              0.00           20.0     0.999
                              0.00           30.0     0.991
                              0.00           40.0     0.996
                              0.00           50.0     1.004
                              0.00           60.0     1.012
                              0.00           70.0     1.022
                              0.00           80.0     1.031
                              0.00           90.0     1.041
                              0.00          100.0     1.050
                              0.00          110.0     1.059
                              0.00          120.0     1.068
                              0.00          130.0     1.077
                             14.30            8.0     0.767
                             14.30           10.0     0.808
                             14.30           20.0     0.954
                             14.30           30.0     1.028
                             14.30           40.0     1.081
                             14.30           50.0     1.123
                             14.30           60.0     1.154
                             14.30           70.0     1.178
                             14.30           80.0     1.197
                             14.30           90.0     1.214
                             14.30          100.0     1.228
                             14.30          110.0     1.240
                             14.30          120.0     1.251
                             14.30          130.0     1.256
```

Figure II.12. ZVAFF file generated by IFG4.

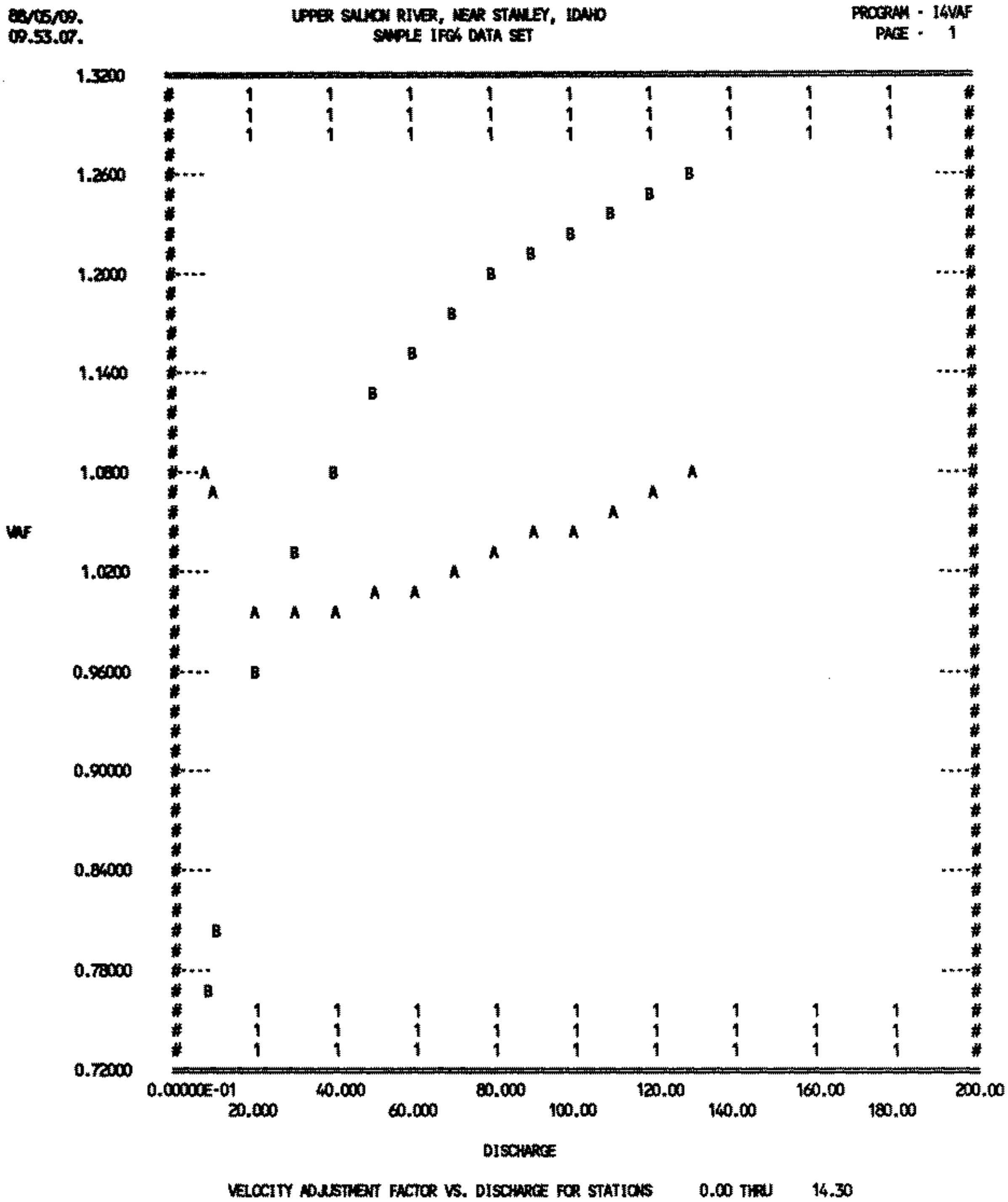


Figure II.13. Plot of ZVAFF file generated by IFG4.

III. IFG4 ERROR MESSAGES - Refer to Appendix A for information on "IFG4 Data Set Format".

1. **MORE THAN 100 TRIALS WERE REQUIRED TO DETERMINE THE PROPER WSL.**
   The program has a limit of 100 iterative trials to obtain the water surface elevation. Check your data for accuracy.

2. **WATER SURFACE ELEVATION LINES EXPECTED BUT NOT PRESENT.**
   WSL lines are needed when IOC(8)=1.

3. **A PROBLEM HAS BEEN ENCOUNTERED FINDING A GROUND POINT ABOVE THE WATER SURFACE. THIS PROBLEM OCCURRED AT SECTION --- WHILE PROCESSING Q=---.**
   This message indicates that you did not include enough of the channel in your initial survey. The program will extend a straight line up from the last known coordinate.

4. **THE WATER SURFACE ELEVATION --- IS ---- FEET ABOVE THE RIGHT (LEFT) END POINT OF THE CROSS SECTION.**
   This problem is similar to the preceeding one because the discharge simulated is above the last coordinate defining the channel. The program will continue to process flows unless the difference is over 10 feet.

5. **NO MORE THAN 100 Q'S MAY BE PROCESSED IN ONE RUN.**
   The program has a predetermined limit of 100 discharges that can be processed during one run. The maximum discharges that the habitat simulation programs can accept is 30.

6. **NO MORE THAN 5 DEPTHS MAY BE PROCESSED IN ONE RUN.**
   Up to five depths may be specified on the DEPTH lines to determine the width of the channel which is at least as deep as the depths specified.

7. **INPUT LINES APPEAR TO BE OUT OF ORDER. THE --- LINE WAS EXPECTED, BUT --- WAS OBTAINED INSTEAD.**
   Improper sequence or format of lines, or lines called for by a particular option were not supplied. Correct data set and rerun.

8. **WHILE READING FORMAT --- LINES FOR STATION ---, LINES FOR STATION --- WERE OBTAINED.**
   Indicates that incomplete information was given. Check data set.

9. **WHILE READING FORMAT --- LINES FOR STATION --- THE SET NUMBER --- DOES NOT MATCH THE SET NUMBER ON THE CALIBRATION LINE ---.**
   The information given for a particular calibration discharge set is not complete. Check data set.

10. **ERROR ON CROSS SECTION ---. NO MORE THAN 100 COORD. MAY BE USED TO DEFINE A CROSS SECTION.**
    The program is dimensioned for 100 coordinate pairs.

11. **NO MORE THAN 9 CALIBRATION SETS MAY BE USED.**
    The program is dimensioned for 9 possible sets.

12. **OPTION FOR STAGE-Q RELATIONSHIP SELECTED WITHOUT Q'S BEING PROVIDED.**
You must supply stage data if IOC(8)=2. The program will abort.

13. **HAVING TROUBLE FINDING A NON-ZERO CALIBRATION VELOCITY WHEN COMPUTING MANNING'S N, WHILE PROCESSING SECTION --- POINT ---.**
The program will abort. This indicates that standing water is being analyzed.

14. **THERE IS A PROBLEM ON CROSS SECTION --- WITH THE VELOCITIES AND THE COORDINATES AT VERTICAL ---. A VELOCITY HAS BEEN GIVEN (---) BUT THE DEPTH (---) BASED ON THE WSL (---) IS NEGATIVE.**
Program may not abort; message will be in output file indicating that there may be an error in data; or, the water surface elevation based on a flat surface is different from the actual water surface elevation at the vertical.

15. **FOR THE CROSS SECTION --- THERE ARE -- CELLS WITH THE SLOPE IN THE VELOCITY VS. Q RELATIONSHIP GREATER THAN 3, SUGGEST USING ANOTHER APPROACH TO HYDRAULIC SIMULATION.**
This will cause run to abort. To override the abort, set IOC(22)=1.

16. **ZERO DISCHARGE COMPUTED AT CROSS SECTION --- AND SET ---.**
Program run continues. Message is in output file.

17. **WHEN IOC(8)=2 AND THE VELOCITIES ARE NOT SUPPLIED, THE CALCULATED Q MUST BE ON THE CAL LINE.**
This will cause run to abort.

18. **THE WATER SURFACE ELEVATION --- FOR Q --- IS BELOW THE LOWEST POINT ON THIS CROSS SECTION ---. THIS PROBLEM IS BEING CORRECTED BY SETTING THE WSL TO 0.1 FEET ABOVE THE LOW POINT ON THE XSEC.**
Program run continues; message is in output file.

19. **FOR CROSS SECTION --- AND CALIBRATION SET --- FOUND A ZERO FLOW WHEN A NON-ZERO FLOW WAS NEEDED FOR LEFT AND RIGHT STAGE ANALYSIS.**
IOC(18)=1 and the calibration flow for this set is equal to zero. Set IOC(18)=0 as this option has not yet been implemented in any of the programs in PHABSIM other than IFG4.

20. **ZERO OR NEGATIVE DISCHARGE NOT ALLOWED, DISCHARGE=---.**
Program will abort.

21. **ENDJ LINE NOT FOUND.**
The last line of an IFG4 data set must contain "ENDJ" in columns 1-4.

22. **IOC(8) NOT EQUAL TO 1 AND TOTAL NUMBER OF CALIBRATION SETS=1. UNABLE TO CREATE A RATING CURVE WITH ONLY ONE POINT.**
Program will abort.

23. **OPTION TO READ CALCULATED FLOW SELECTED. FLOW READ WAS ZERO. RUN TERMINATING.**
IOC(5) was set to "1" and the calculated flow was zero.

24. **PROBLEM AT CELL -- SLOPE IN VELOCITY REGRESSION IS IRRATIONAL. NOT A GOOD SIMULATION OF VELOCITIES, USE ANOTHER APPROACH. ALL VELOCITIES AT CELL --- ARE SET TO 0.0. SLOPE IS ---.**
Recommend running a different hydraulic simulation program to determine water surface elevations; add these WSL's to the IFG4 data set, and run IFG4 again to see if better results are obtained.

25. **WHEN NO VELOCITY IS SUPPLIED AND CALCULATED Q IS NOT GIVEN, IOC(5) MUST BE 1.**
Program will abort.

26. **DEPENDENT VARIABLE IS LESS THAN OR EQUAL TO ZERO. NOW SET EQUAL TO 0.01, REVIEW YOUR DATA.**
Regression analysis for the stage-discharge relationship cannot be done using zero values for discharge. A zero discharge was found and made 0.01. Most likely there is a data problem.

27. **BAD DATA-CHECK YOUR DATA, LOG OF COEFFICIENT A SET EQUAL TO -299.0.**
For some reason an unrealistic stage-discharge relationship was determined. The relationship was modified so that the program would not abort. A data problem exists and should be fixed.

28. **WITH LESS THAN 3 SETS OF VELOCITY MEASUREMENTS IOC(14) MUST BE SET TO ZERO.**
Program will abort.

29. **THE WIDTH IS A NEGATIVE NUMBER -- (XL,XR=--) IN SUBROUTINE-SLICE WHILE PROCESSING SECTION -- FOR Q=---.**
Suggests error in coordinate data.

30. **STAGE - STAGE OF ZERO FLOW IS LESS THAN OR EQUAL TO ZERO FOR SET #.**
Probably an error in recording water surface elevations. At a certain flow (set #), the stage of zero flow is greater than the water surface elevation.

31. **WHILE PROCESSING CROSS SECTION --- AN N VALUE WAS NEEDED, BUT NOT SUPPLIED FOR SEGMENT ---. ------- WAS USED**
The will appear as a note in the IFG4 output file. This message occurs when a vertical was dry for the calibration data set and a N value was not assigned. In the simulation process the program searches adjacent cells until a N value is found; this value of N is used. If no N values are found, a value of 0.06 is used. The user should review the results to see if the N's actually used are reasonable.

IFG4IN Program

I. INTRODUCTION

The IFG4IN program is available on the microcomputer to enter and/or edit an IFG4 data set. It also performs several checks on the data as it is being entered. The TREVI4, RCKI4, or REVI4 batch/procedure files could also be run to check the complete data set prior to running the IFG4 program.

The IFG4IN program has the following limitations and assumptions:

ACCURACY

- The option which calculates the discharge given X,Y coordinates and the cell velocities is based on a method that is more elaborate than is typicaly used when one does this with a hand calculator. Specifically, the cell is defined as being vertically centered. The width of each cell is calculated as being from the half-way points to the neighboring verticals. The depth is calculated as being the average of that vertical and each of the neighboring verticals. These average widths and depths are then multiplied times the given vertical's velocity and summed across the channel for the total flow (Q). Results should be comparable with other popular methods under most circumstances, but do not expect exact comparison. If there is a large difference, you have probably done something wrong, and that is what this part of the program is for.

- The screen graphics resolution may not be capable of displaying all points on a graph.

KNOWN DEFICIENCIES

- The program does not check for every possible combination of IOC parameters which may cause mathematical "blowup" in the IFG4 program.

- Once a line has been added, it cannot be deleted. An external editor must be used to delete the line.

- CAL lines must be numbered sequentially starting with 1. The IFG4 program will accept almost any sequence of numbers such as 2, 4, 6.

- The program does not contain the ability to incorporate the instrument height into bed elevation data.

- Additional cross sections cannot be added to an existing data set. An external editor may be used to merge cross section data.

ASSUMPTIONS

- Assumes that the input files are "legally" formatted (syntactically correct) when read into memory. At least the two title lines, IOC line, and one cross section (coordinates plus NS lines) must be present. If a formatting error is present, the user will be informed of a probable error, but the program may ignore the error and continue on. If this should occur, "Ctrl-Break" out of the program and use an external editor to correct the problem.

- Each parameter has built-in upper and lower bounds to attempt to prevent outlandish user input errors. An external editor can be used to change the data values if needed.

- Assumes that stationing is used as cross section identification numbering.

- Will not allow VEL lines to be added unless there is a corresponding CAL line.

- Assumes that QARD flows should be entered from low to high.

II. RUNNING IFG4IN

RIFG4IN

User will be prompted for filename. If an existing data set is being edited, the unedited version of the file will be saved with a .BAK extension.

This program is not available on the CDC.

The program is organized in a hierarachical menu system. By following the menus, one may step forward and backward through the system as the need dictates.

An introductory screen will appear showing the version of the program and then the following "main" menu will appear.

IFG4 DATA ENTRY AND EDITING

0. Exit this program

1. Get an existing IFG4 data set from disk
2. Enter a new data set for IFG4
3. Select New Transect Data
4. Edit IFG4 data set
5. Scrutinize an IFG4 data set
6. List IFG4 data set
7. Set program defaults (not implemented yet)

You must first either ENTER or GET a data set. When "getting" an existing data set, the filename must have ".IN4" as the MS/DOS extension; the version before editing will be saved with a ".BAK" extension. Data sets being "entered" are automatically assigned the ".IN4" extension.

One cross section (transect) is worked on at a time when entering or editing a data set.

At various times, error or warning messages may be printed to the screen. These will be preceeded by a beeping sound to alert the user to a probable error.

Almost all prompts are accompanied by a "default" answer which is activated by pressing the ENTER (or RETURN) key. The defaults for some prompts, usually yes or no questions, may be displayed in brackets [ ]. The defaults for most other prompts will be shown on the screen.

EDITING KEYS

- The ENTER key stores new values.
- The ESC key gets you out of most editing areas.
- New data points may be inserted by pressing the INS key or deleted by pressing the DEL key.
- The up and down arrows are operable; the left and right arrows are not. The up and down arrows will not store a value, thus, the only way to leave a field blank is to press the down arrow "over" the field. It is unwise to leave blank fields on any lines except VEL's and Manning's N.
- Two data entry/editing areas use the TAB key to get from one data type to another and back again. These are (X and Y) and (N and S).
- A "Ctrl-Break" will exit the program completely. No changes will be stored.

Refer to Appendix A for a sample IFG4 data set.

LPTTHWE Program

I. INTRODUCTION

The LPTTHWE program plots the Thalweg values and water surface elevations for given discharges from a TAPE3 and TAPE4 generated by the hydraulic simulation programs. A graph of the coordinate points for each cross section is also generated along with a table containing the water surface elevations in relation to given distances, Thalwegs, and discharges.

II. RUNNING LPTTHWE

RLPTHWE,LPTOUT,TAPE3,TAPE4

LPTOUT=LPTTHWE results (output)
TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)

NOTE: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

Figure II.14 contains sample output from the LPTTHWE program.

III. ERROR MESSAGES

STATION ON FLOW FILE --- NOT FOUND ON C/S FILE

The TAPE3 and TAPE4 have different Cross Section ID Numbers in them. They were probably created using different data sets or CHSTA4 was run on the TAPE4 to change cross section ID numbering; the TAPE3 cross section numbering was not changed.

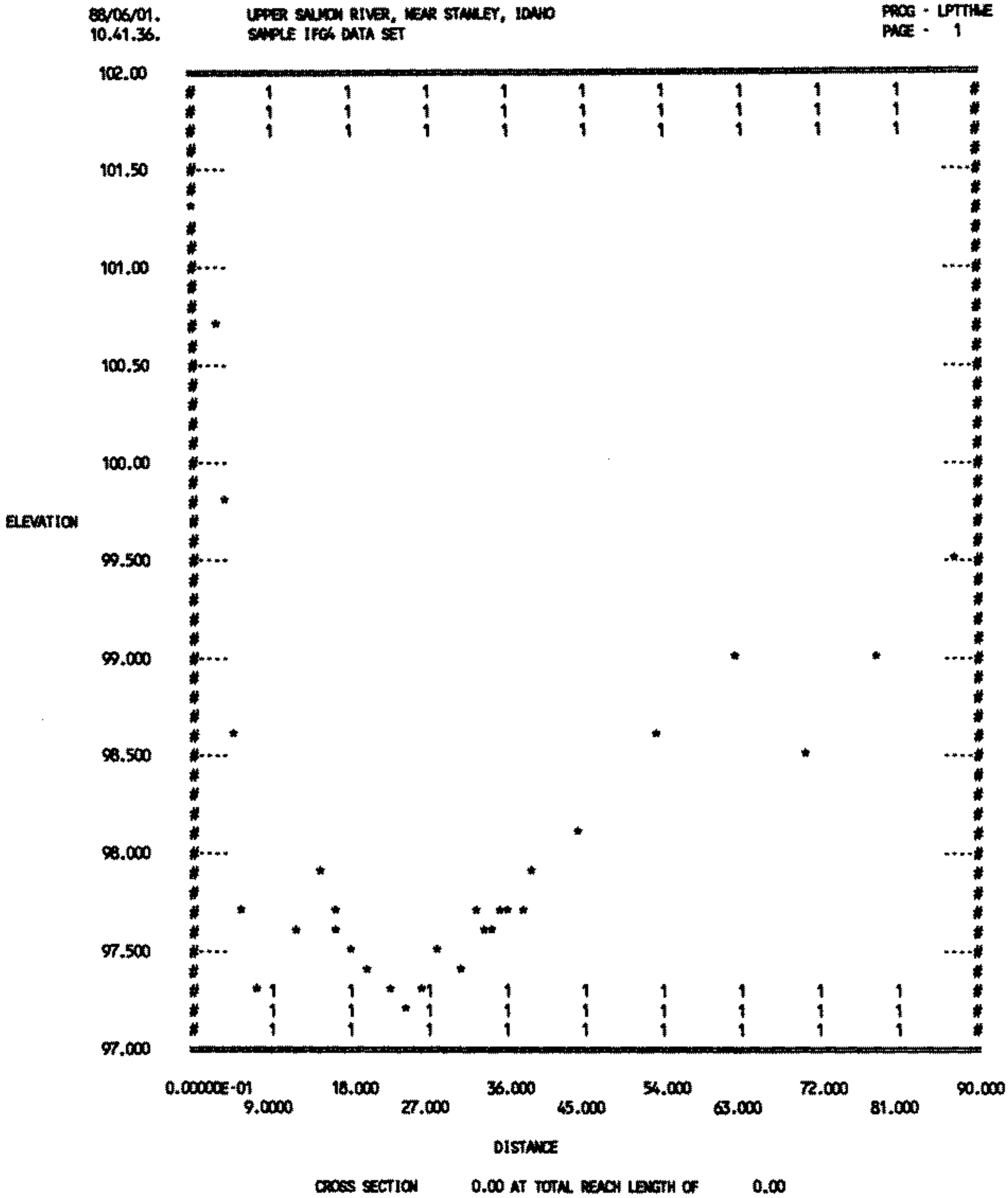


Figure II.14. Sample output from the LPTTHWE program.

DISTANCE	THALWEG	130.00	120.00	110.00	100.00	90.00	80.00	70.00
0.0	97.20	98.53	98.49	98.44	98.40	98.35	98.30	98.25
14.2	97.60	98.83	98.80	98.76	98.72	98.68	98.63	98.58

DISTANCE	THALWEG	60.00	50.00	40.00	30.00	20.00	10.00	8.00
0.0	97.20	98.19	98.12	98.05	97.96	97.85	97.70	97.66
14.2	97.60	98.53	98.47	98.40	98.32	98.22	98.08	98.04

ONLY THE DATA GENERATED FOR THE FIRST CROSS SECTION AND ONE FLOW HAVE BEEN INCLUDED IN THIS SAMPLE OUTPUT.

Figure II.14. (Continued)

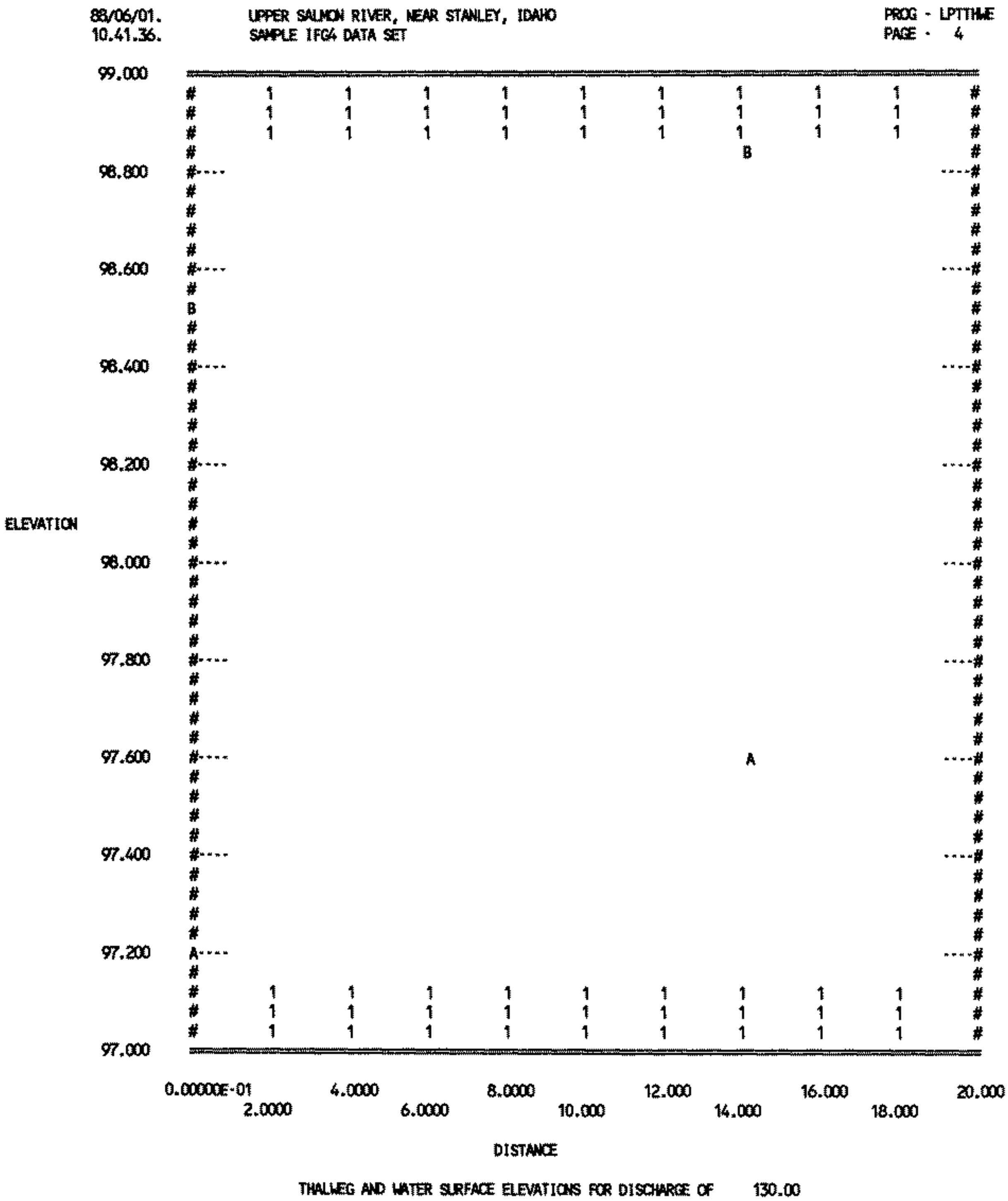


Figure II.14. (Concluded)

MAK1VL Program

I. INTRODUCTION

The MAK1VL program reads an IFG4 data set and writes a new IFG4 data set with one or less velocity sets.

II. RUNNING MAK1VL

RMAK1VL,ZIFG4,ZIFG4N

ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set with one or less velocity sets (output)

User will be prompted to

ENTER SET NUMBER FOR VELOCITY SET TO BE RETAINED:

The velocity set specified will be kept; all other velocity sets will be blank. If a "0" or a number that is not a set in the data set is specified, all velocity sets will be blank.

MANSQ Program

I. INTRODUCTION

The MANSQ program can be used to simulate the water surface elevations using Manning's equation calibrated to one set of water surface elevations. Each cross section is simulated independently of all other cross sections in the data set. Figure II.15 flowcharts calibrating a MANSQ data set.

The basic assumption made when using the MANSQ program to simulate water surface elevations is that each cross section is at normal depth and no backwater effect occurs between the various cross sections. MANSQ generally fails in pools.

The I4TMSQ program is used to convert an IFG4 data set to a MANSQ data set. Refer to Appendex A for "MANSQ Data Set Format" for more information and for the format of a MANSQ data set if an IFG4 data set is not available for conversion. Appendix A also contains a sample MANSQ data set.

Table II.3 describes the options available in the MANSQ program.

Table II.3. Options in the MANSQ Program.

OPTION	ACTION
1	Prints water surface elevation calculations using Manning's equation. Recommend setting to "0". 0 = Do not print WSL calculations using Manning's equation. 1 = Print WSL calculations using Manning's equation.
2	Allows user to adjust conveyance in a river. If B is not supplied, no adjustment in conveyance is made. When "2" is selected, the Beta coefficient on the CALQ line is the median size of the bed material (D50). 0 = Use (Q/QC)**B to adjust conveyance. 1 = Use (RH/RHC)**B to adjust conveyance. 2 = Use ((RHC/RH)**0.167) * (log(2.42(RH/D50)) / log(2.42(RHC/D50)))
3	Prints initial discharge-elevation table. 0 = Do not print initial discharge-elevation table. 1 = Print initial discharge-elevation table.
4	Prints critical water surface elevation calculations. Recommend setting to "0". 0 = Do not print critical WSL calculations. 1 = Print critical WSL calculations.
5	Plots cross section parameters for each cross section (velocity vs. discharge; area vs. discharge; hydraulic radius vs. discharge; average depth vs. discharge; maximum depth vs. discharge; width vs. discharge; and wetted perimeter vs. discharge). 0 = Do not plot cross section parameters. 1 = Plot cross section parameters.

Table II.3 (Concluded)

OPTION	ACTION
6	Allows the hydraulic radius for a cell to be weighted by the area in a cell which results in an area weighted hydraulic radius. Recommend setting to one "1". 0 = Use normal hydraulic radius (R=AREA/(WETTED PERIMETER)) 1 = Use area weighted hydraulic radius.
7	Plots the Stage-Q Relationship determined using Manning's equation and the critical water surface elevation calculations. 0 = Log-log plot. 1 = Arithmatic and log-log plots. 2 = No plots.
8	Generates a plot of the cross section coordinate points. 0 = Do not plot cross sections. 1 = Plot cross sections.
9	Determines selection of velocity equation. 0 = Use Manning's equation. 1 = Use Chezy's equation.
10	Provides for modification of the hydraulic radius. 0 = Do not modify hydraulic radius. 1 = Hydraulic radius is reduced by the hydraulic radius at the stage of zero flow.
11	Writes velocities to TAPE4 using the criteria below. The normal approach is to average the velocity at the verticals defining the right and left side of a cell to determine that cell's velocity. 0 = Write mean velocity for the whole cross section. 1 = Write normal cell velocities (HABTAT format). 2 = Write velocities at wet verticals (HABTAV and HABTAM format). 3 = Write velocities at all verticles (resulting TAPE4 is not for use with PHABSIM programs).
12-19	Reserved for future options.
20	Multiplies the cross section width by a constant. 0 = Multiplier = 1 (i.e., multiplier = 10**IOC(20) value). 1 = Multiplier = x given * 10**1 (used on large rivers) (i.e., multiplier = 10**IOC(20) value). 2 = Multiplier = x given * 10**2 (used on large rivers) (i.e., multiplier = 10**IOC(20) value). 3 = Multiplier = x given * 10**-1 (used on small rivers) (i.e., multiplier = 10**(2-IOC(20) value)). 4 = Multipler = x given * 10**-2 (used on small rivers) (i.e., multiplier = 10**(2-IOC(20) value)).

CALIBRATING A MANSQ DATA SET

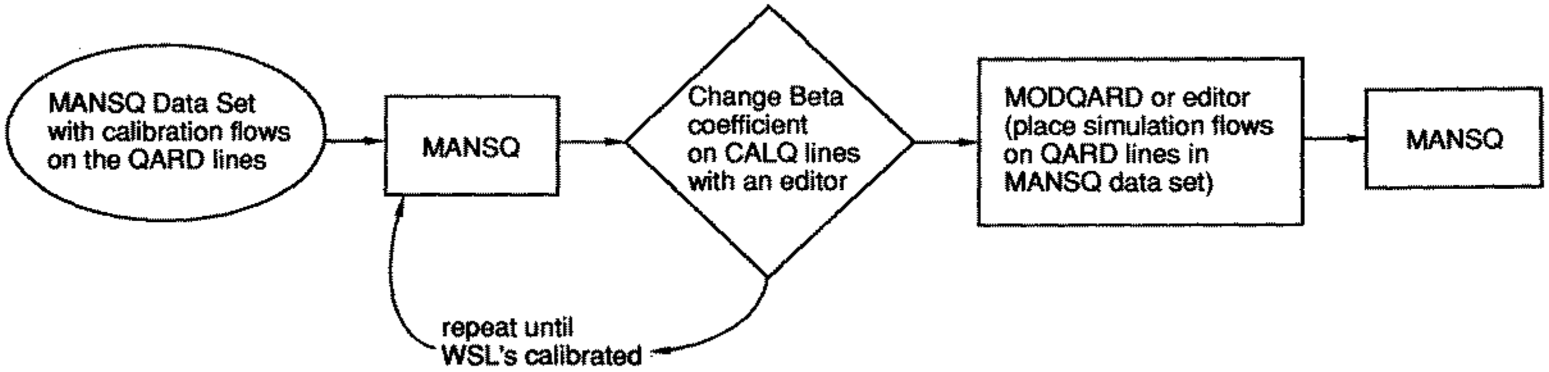


Figure II.15. Calibrating a MANSQ Data Set.

II. RUNNING MANSQ

RMANSQ,ZMANSQ,ZOUT,TAPE3,TAPE4

ZMANSQ=MANSQ data set (input)
ZOUT=MANSQ results (output)
TAPE3=unformatted cross section and reach data (output)
TAPE4=unformatted flow data (output)

NOTE: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

Appendix A contains the MANSQ data set that was used to generate the output in Figure II.16. Review the output file for error messages and inconsistancies in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort.

When IFG4 was run on the sample IFG4 data set, it was determined that the rating curve for the first cross section was too steep to describe the stage-discharge relationship at flows above the high calibration flow. Therefore, it was recommended that MANSQ be run to determine water surface elevations as it incorporates the expansion of cross sectional area as flows increase and does a better job of predicting the correct stages.

In this case, MANSQ significantly improves the results for the first cross section, but does not improve the results of the second cross section appreciably. The second cross section is a parabolic section, so the slope of the rating curve will be nearly constant from low to high flow.

III. ERROR MESSAGES

Most of the errors in MANSQ are due to data set format errors. Refer to Appendix A for "MANSQ Data Set Format". Also refer to error message section in the IFG4 program documentation, as several of the errors messages are the same.

1. **ERROR AT SECTION ---, CALQ EXPECTED BUT NOT FOUND.**
   Check data set. Make sure that there is a CALQ (not CAL) line for each cross section.

2. **NO MORE THAN ONE CALIBRATION SET MAY BE USED WHILE PROCESSING CROSS SECTION ---.**
   The program is dimensioned for one CALQ line per cross section.

3. **USING A NEGATIVE BETA COEFFICIENT. MOST OFTEN BETA IS POSITIVE IN MANSQ.**
   This is a warning; the program will not abort. At one time the beta coefficient had to be entered as a negative value. This is no longer the case.

WHEN THE FLOW IS SUPER CRITICAL (FROUDE NO. IS GREATER THAN 1.0) THE
CRITICAL WATER SURFACE ELEVATION IS WRITTEN ON THE HYDRAULICS PROPERTIES
FILE (TAPE4).

```
IOC =  0 0 1 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0
       0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

ONLY THE OUTPUT FOR CROSS SECTION 0.0 HAS BEEN INCLUDED IN THIS SAMPLE OUTPUT.

```
              CROSS SECTION ID NUMBER:        0.00

   REACH LENGTH DOWNSTREAM:        0.00    WEIGHT ON SECTION:  0.30
        STAGE OF ZERO FLOW:       97.20         GIVEN SLOPE: 0.02667000

            CF = CFC*((Q/QC)**       0.10)

        COORDINATE DATA PAIRS - THERE ARE  30 POINTS
```

DISTANCE	0.0	2.5	4.0	4.3	5.5	7.6	11.9	14.2	16.2	16.5
ELEVATION	101.3	100.7	99.8	98.6	97.7	97.3	97.6	97.9	97.6	97.7
CHANNEL INDEX	3.0	3.0	3.0	3.0	9.2	6.0	6.0	8.2	8.2	8.2
DISTANCE	18.2	20.2	22.2	24.2	26.2	28.2	30.2	32.2	33.0	34.2
ELEVATION	97.5	97.4	97.3	97.2	97.3	97.5	97.4	97.7	97.6	97.6
CHANNEL INDEX	8.2	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.2
DISTANCE	35.2	36.2	37.4	39.1	43.8	53.0	62.4	69.9	78.1	87.1
ELEVATION	97.7	97.7	97.7	97.9	98.1	98.6	99.0	98.5	99.0	99.5
CHANNEL INDEX	9.2	9.2	9.2	10.0	10.0	10.0	10.0	8.2	3.0	3.0

```
         CALIBRATION STAGE IS     97.860    CALIBRATION DISCHARGE IS      21.80
      CROSS SECTIONAL AREA IS     11.32          HYDRAULIC RADIUS IS       0.41
            AVERAGE DEPTH IS       0.34             MAXIMUM DEPTH IS       0.66
 LOW POINT ON CROSS SECTION IS    97.20              STREAM WIDTH IS      32.90
          WETTED PERIMETER IS     33.13

     WATER TRANSPORT PARAMETER (1.49*(S**.5)/N) IS       3.52
```

Figure II.16. Sample output from the MANSQ program.

88/06/28. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM - MANSQ
16.03.15. SAMPLE MANSQ DATA SET-CREATED FROM IFG4 DATA SET USING THE I4TMSQ PROGRAM PAGE - 3

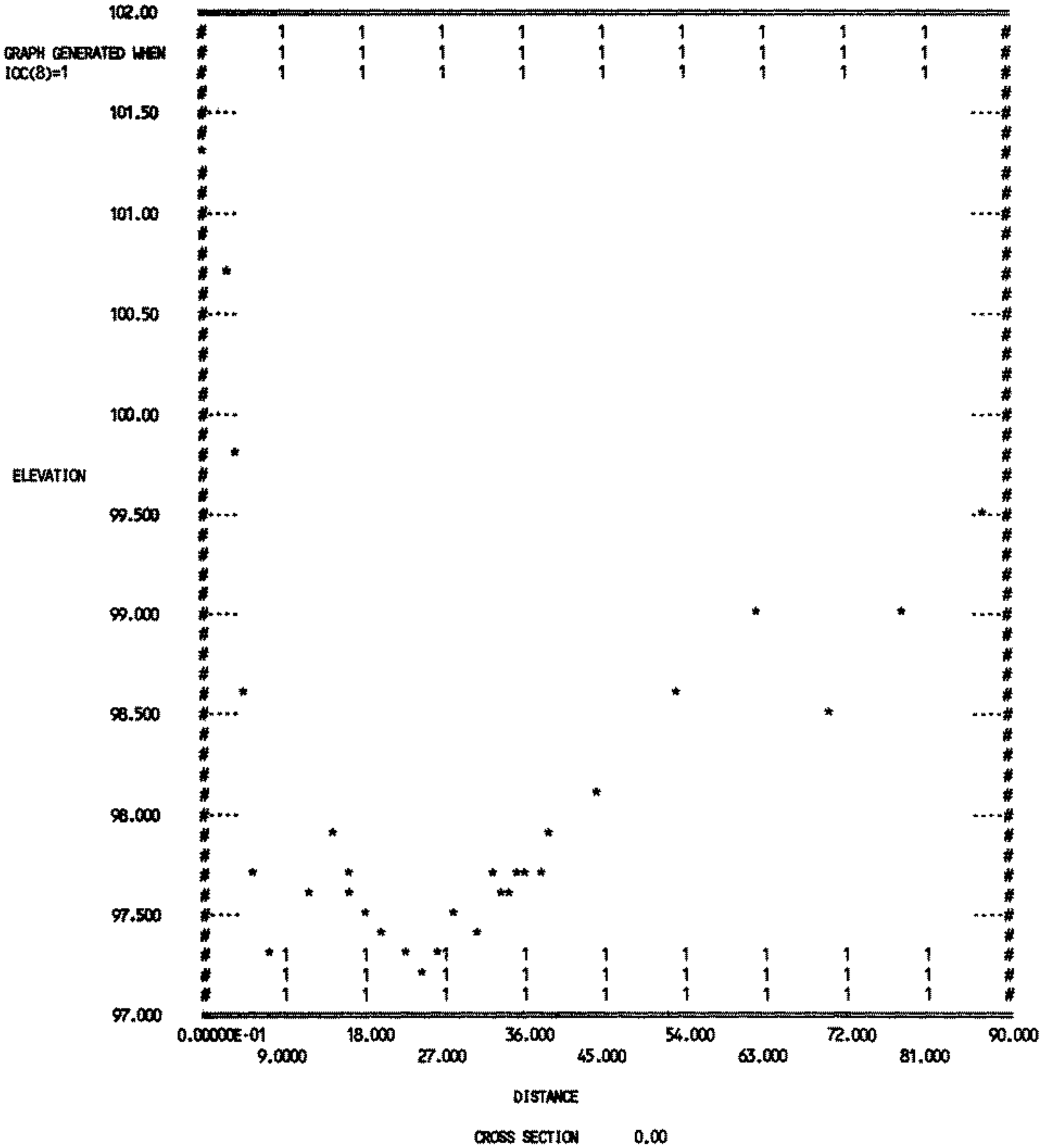


Figure II.16. (Continued)

TABLE GENERATED WHEN
IOC(3)=1

INITIAL DISCHARGE ELEVATION TABLE (Q,WSL)-

0.1	97.300	0.5	97.400	1.7	97.500	4.4	97.600
9.0	97.700	16.2	97.800	21.8	97.860	26.0	97.900
38.7	98.000	54.3	98.100	73.0	98.200	94.9	98.300
120.0	98.400	148.4	98.500	180.4	98.600	217.1	98.700
258.5	98.800	304.8	98.900	356.6	99.000	415.8	99.100
480.9	99.200	552.0	99.300	629.1	99.400	712.2	99.500
802.1	99.600	898.1	99.700	999.9	99.800	1107.6	99.900
1221.1	100.000	1340.3	100.100	1465.2	100.200	1595.7	100.300
1731.9	100.400	1873.6	100.500	2020.9	100.600	2173.7	100.700
2332.2	100.800	2496.2	100.900	2665.8	101.000	2840.9	101.100
3021.6	101.200	3207.9	101.300				

CROSS SECTION ID NUMBER: 0.00

DISCHARGE	W.S. ELEV.	VELOCITY	AREA	HY RADIUS	AVE DEPTH	MAX DEPTH	WIDTH	WP	WTP
8.00	97.68	1.36	5.86	0.28	0.23	0.48	25.78	25.91	3.18
10.00	97.72	1.47	6.82	0.30	0.23	0.52	29.41	29.57	3.25
20.00	97.84	1.86	10.74	0.39	0.33	0.64	32.48	32.70	3.49
30.00	97.93	2.17	13.81	0.46	0.40	0.73	34.71	34.97	3.63
40.00	98.01	2.42	16.51	0.52	0.45	0.81	36.59	36.88	3.74
50.00	98.08	2.63	18.98	0.58	0.50	0.88	38.23	38.54	3.82
60.00	98.13	2.82	21.24	0.62	0.54	0.93	39.50	39.83	3.89
70.00	98.19	3.00	23.32	0.66	0.58	0.99	40.52	40.88	3.95
80.00	98.23	3.16	25.34	0.70	0.61	1.03	41.49	41.87	4.01
90.00	98.28	3.31	27.22	0.74	0.64	1.08	42.38	42.77	4.05
100.00	98.32	3.44	29.04	0.77	0.67	1.12	43.22	43.62	4.10
110.00	98.36	3.57	30.81	0.81	0.70	1.16	44.02	44.44	4.14
120.00	98.40	3.70	32.46	0.83	0.73	1.20	44.75	45.18	4.17
130.00	98.44	3.81	34.16	0.86	0.75	1.24	45.50	45.94	4.21

DISCHARGE	MANNING	CRITICAL	FROUDE NUMBER	WSL's WRITTEN TO HYD. PROPERTIES FILE (TAPE4)
8.00	97.68	97.57	0.50	97.68
10.00	97.72	97.60	0.54	97.72
20.00	97.84	97.73	0.57	97.84
30.00	97.93	97.81	0.61	97.93
40.00	98.01	97.88	0.64	98.01
50.00	98.08	97.94	0.66	98.08
60.00	98.13	97.99	0.68	98.13
70.00	98.19	98.05	0.70	98.19
80.00	98.23	98.10	0.71	98.23
90.00	98.28	98.14	0.73	98.28
100.00	98.32	98.18	0.74	98.32
110.00	98.36	98.23	0.75	98.36
120.00	98.40	98.27	0.76	98.40
130.00	98.44	98.30	0.77	98.44

NOTE - AREA WEIGHTED HYDRAULIC RADIUS USED

Figure II.16. (Continued)

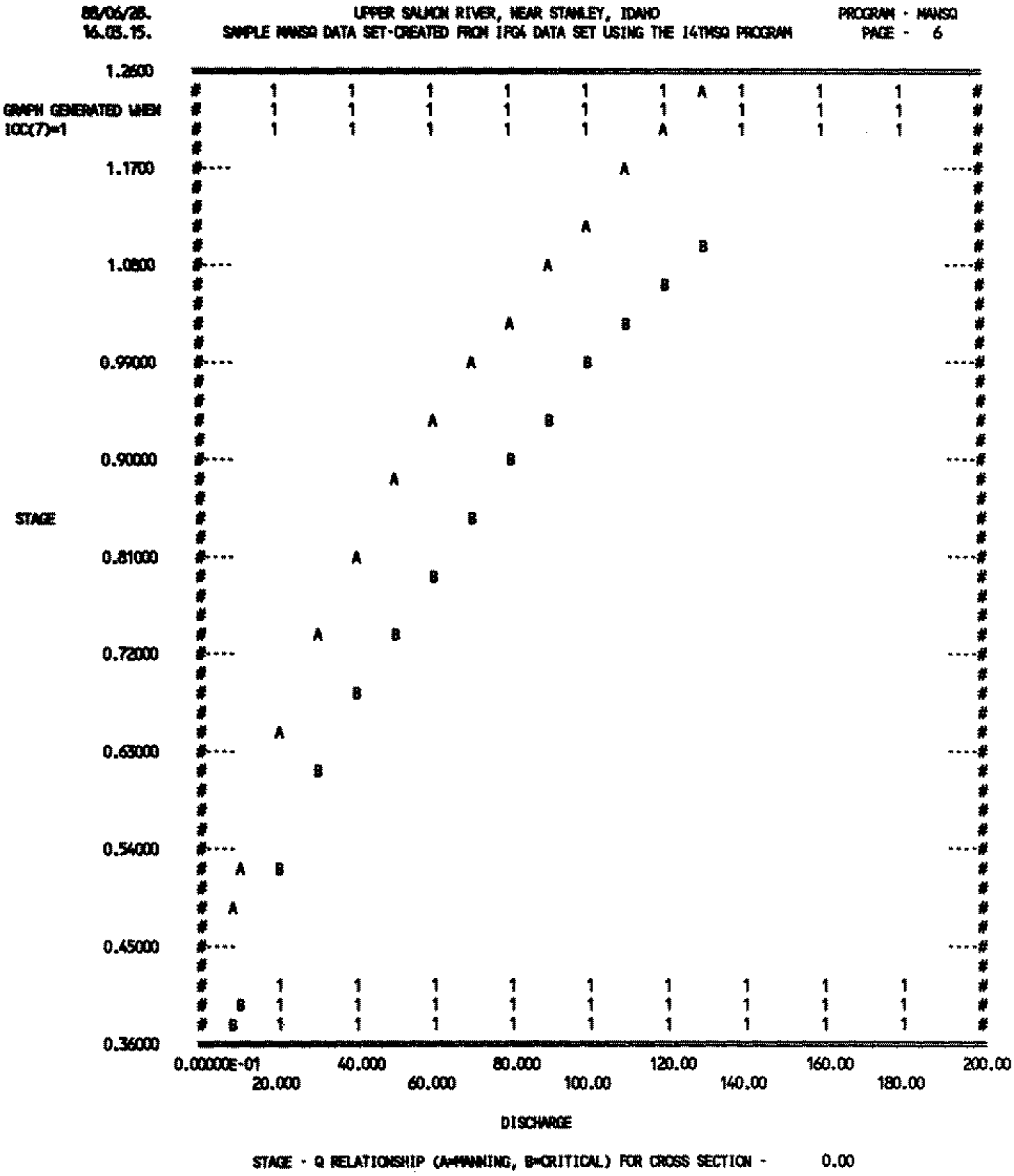


Figure II.16. (Continued)

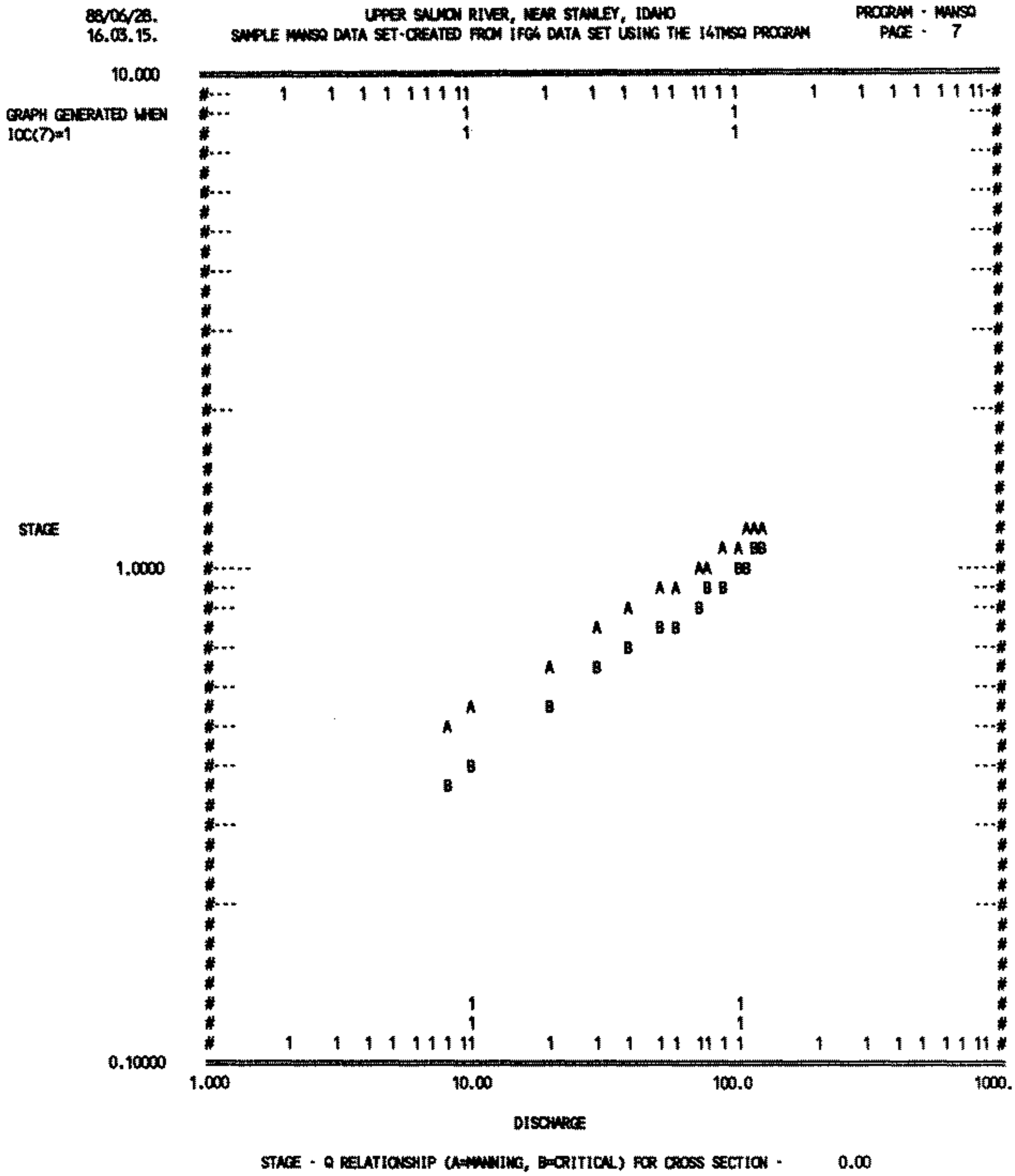


Figure II.16. (Continued)

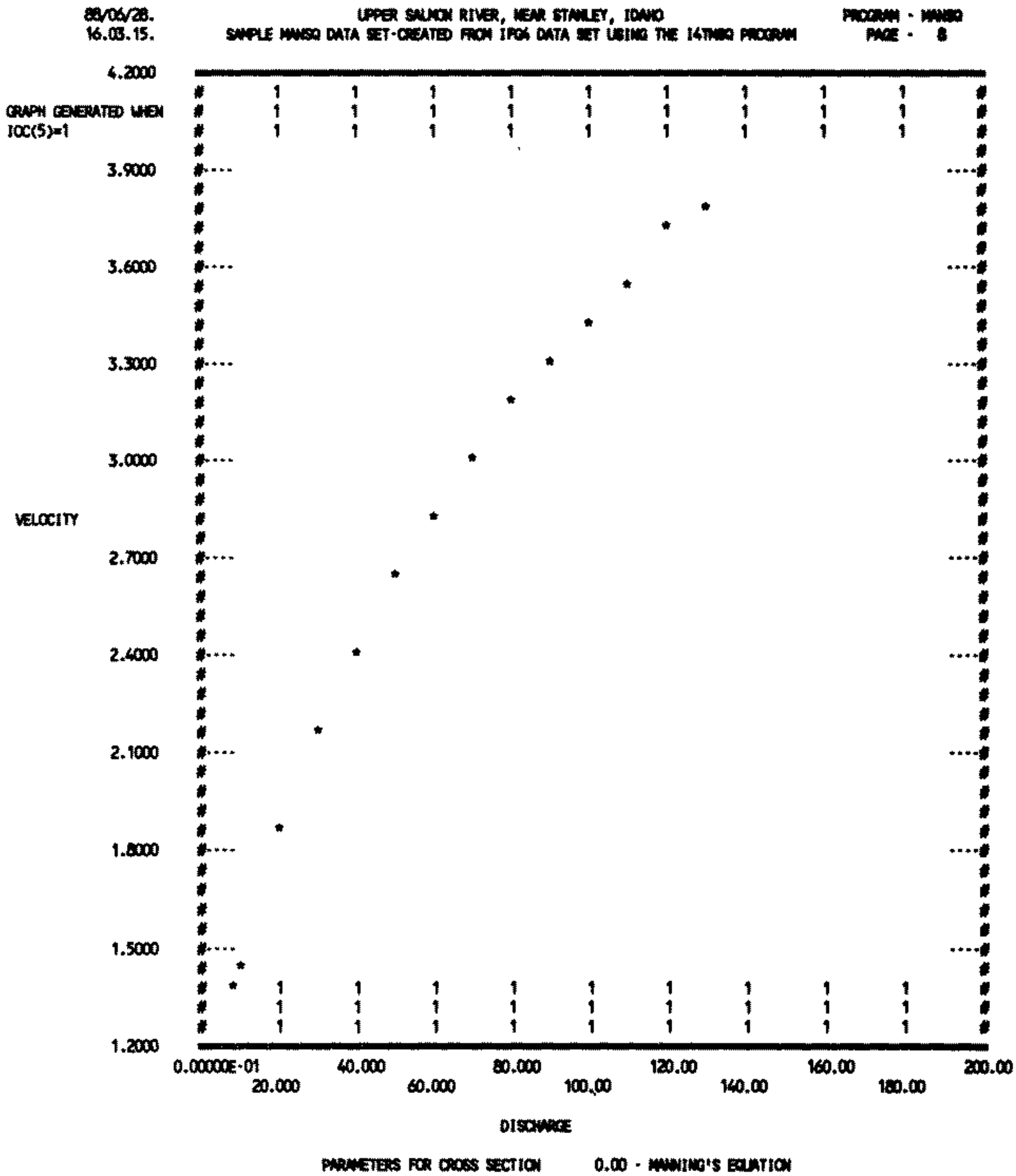


Figure II.16. (Continued)

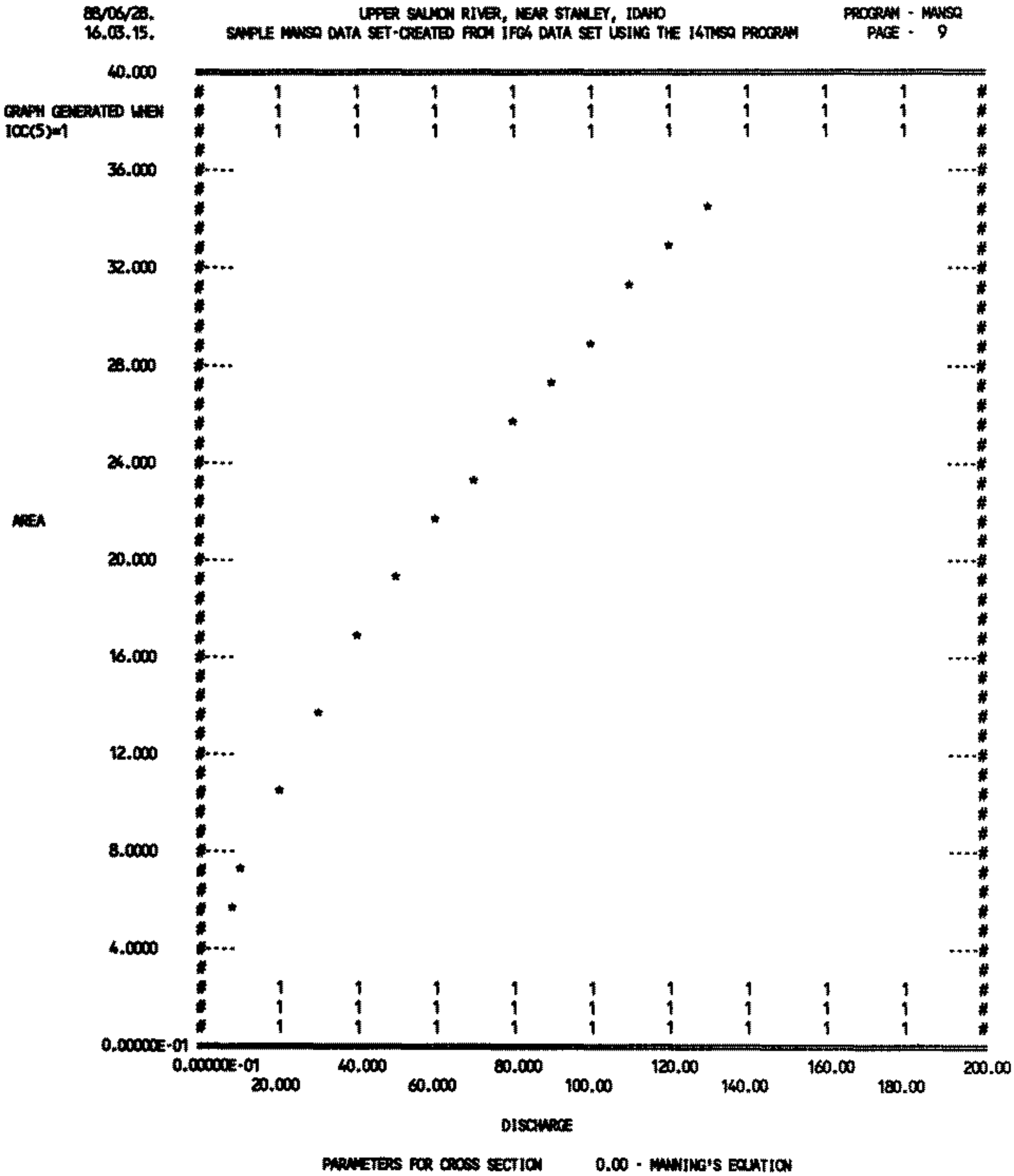


Figure II.16. (Continued)

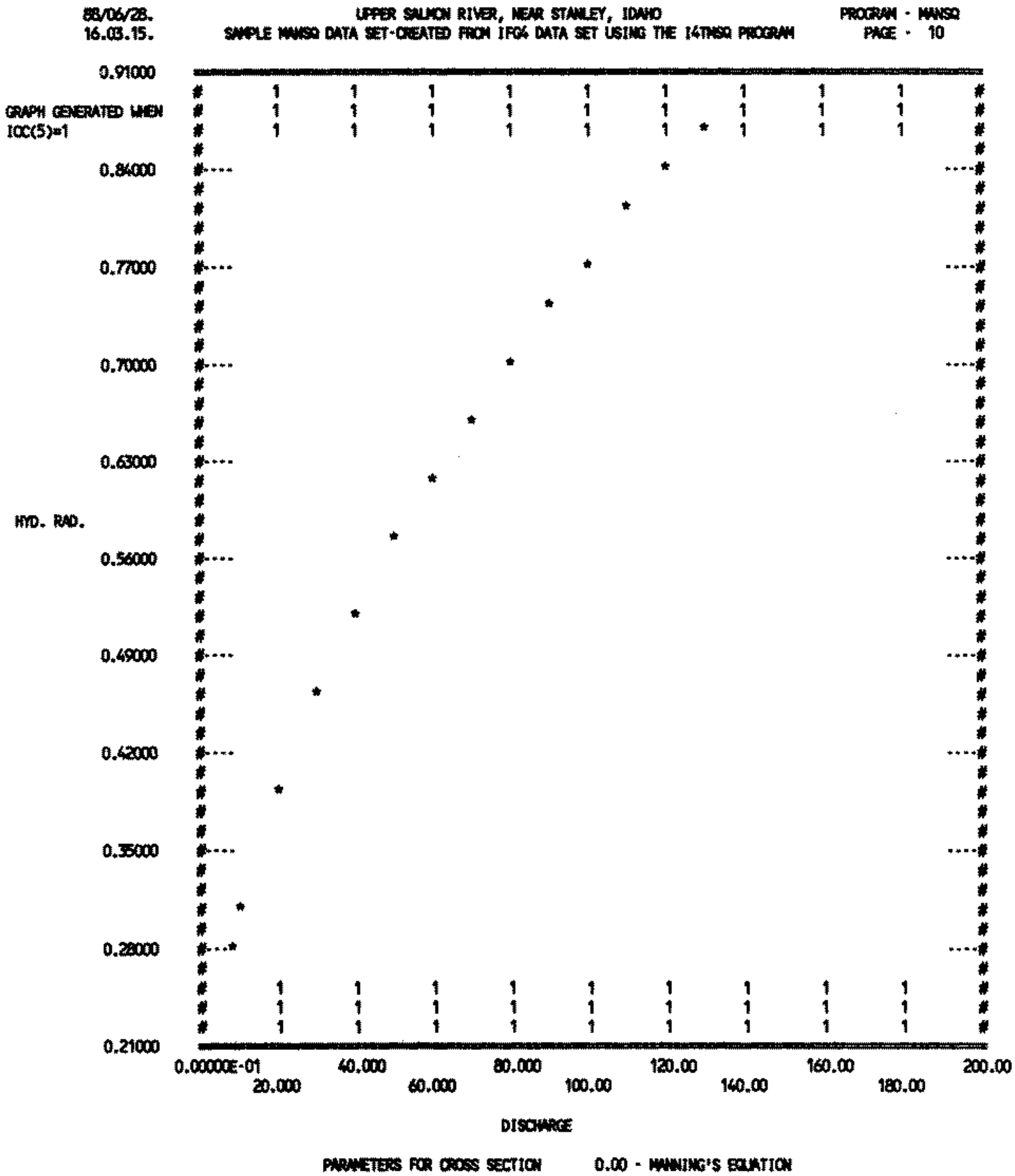


Figure II.16. (Continued)

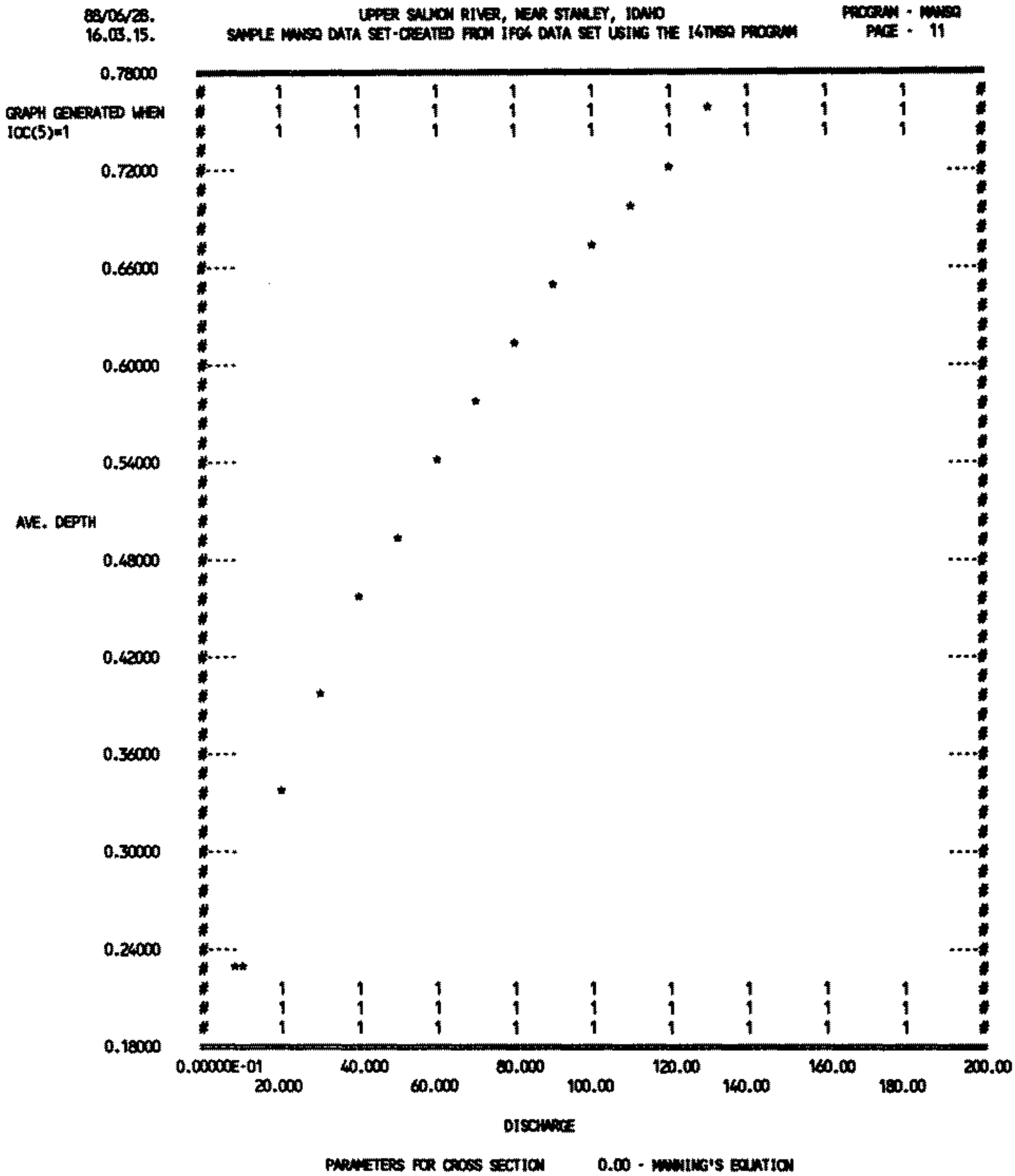
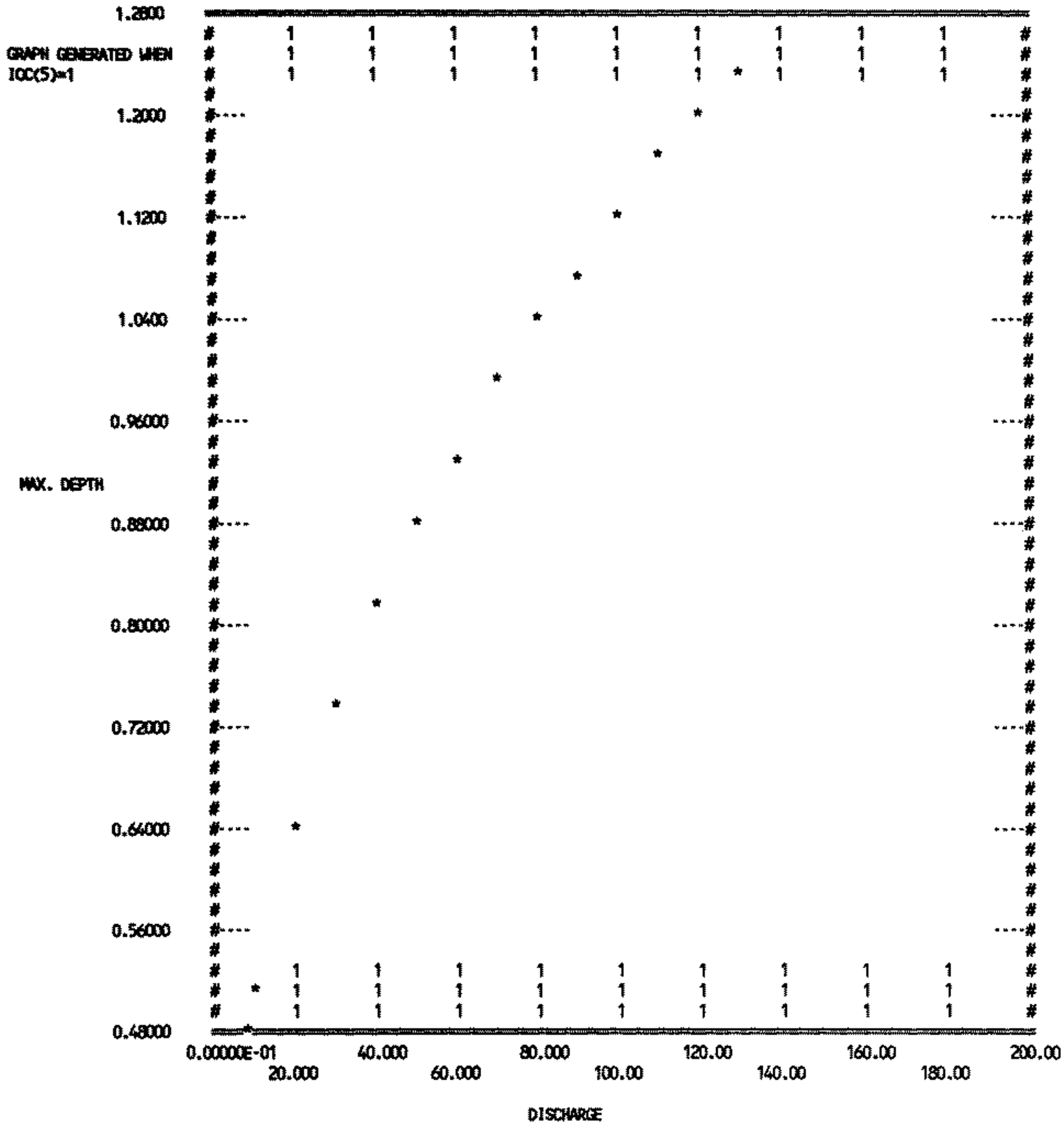


Figure II.16. (Continued)

88/06/28. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM - MANSQ
16.03.15. SAMPLE MANSQ DATA SET-CREATED FROM IFG4 DATA SET USING THE I4TMSQ PROGRAM PAGE - 12



PARAMETERS FOR CROSS SECTION 0.00 - MANNING'S EQUATION

Figure II.16. (Continued)

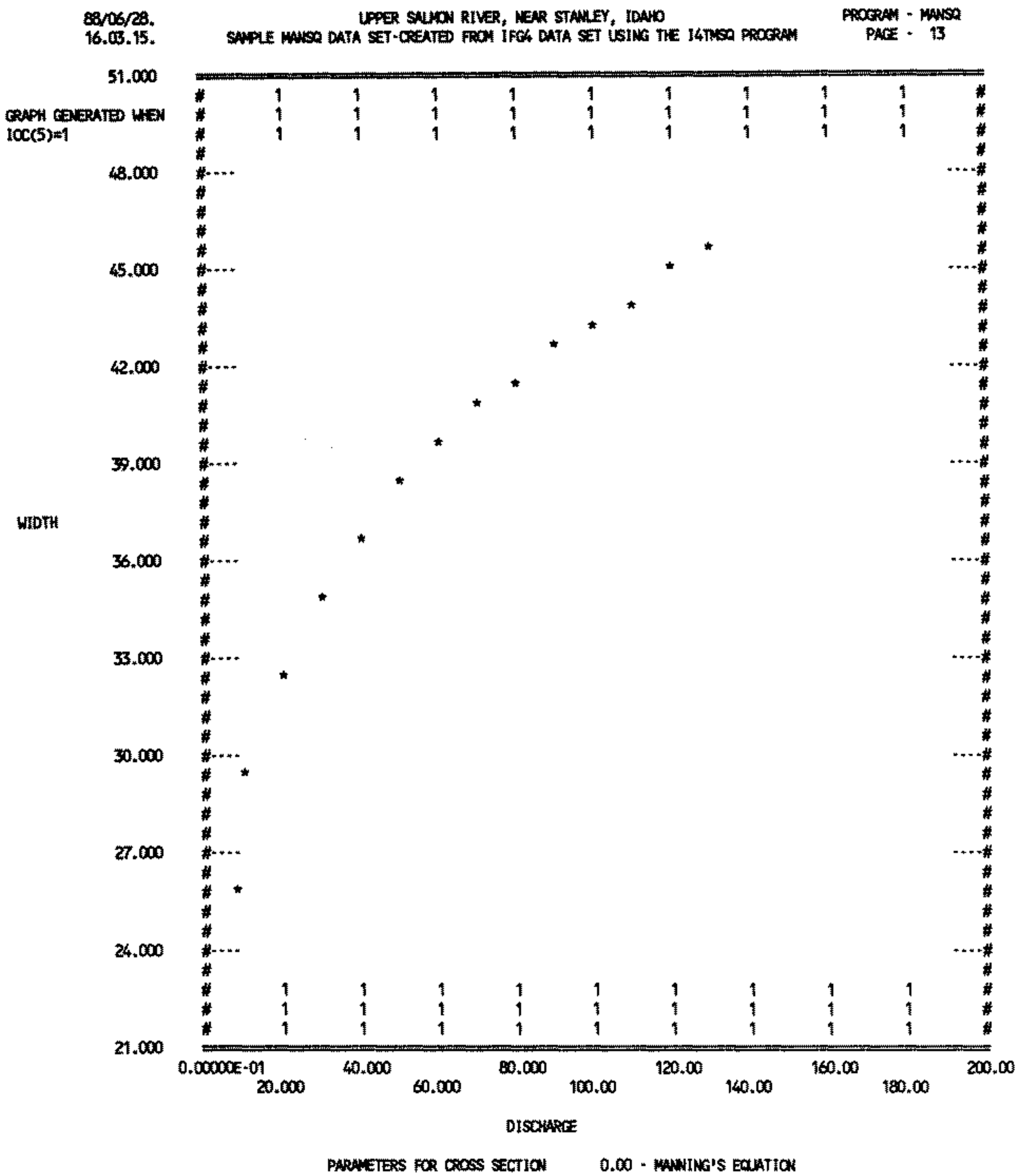


Figure II.16. (Continued)

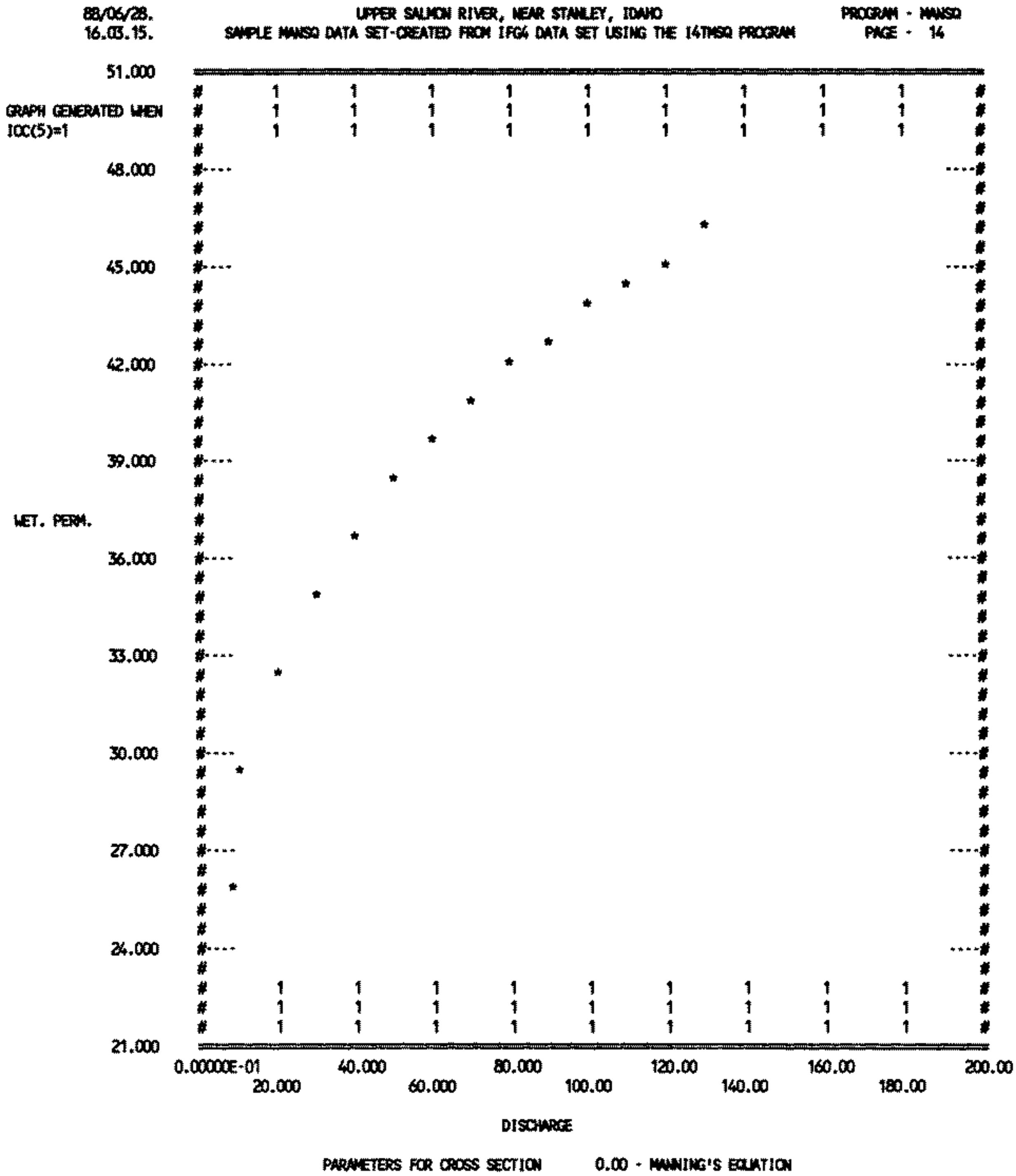


Figure II.16. (Concluded)

MODCAL Program

I. INTRODUCTION

The MODCAL program modifies the discharges on the CAL lines in an IFG4 data set.

The first discharge on a CAL line is the best estimate of the discharge for the cross section (if flow is constant, it is also the best estimate of the discharge for the reach).

The second discharge on a CAL line is the discharge for the cross section if IFG4 with velocities supplied calculated the discharge. It is entered when IOC(8)=2 in IFG4 and WSL lines are not supplied in the data set. If velocities are present, the discharge calculated based on them takes precedence over this supplied discharge.

II. RUNNING MODCAL

RMODCAL,ZIFG4,ZIFG4N

ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set with modified discharges on the CAL lines (output)

```
SELECT AN OPTION TO MODIFY DISCHARGES ON THE CAL LINES

  0 = MODIFY DISCHARGE FOR REACH FOR EACH CAL SET (Q1)
  1 = MODIFY SECOND CAL DISCHARGE FOR EACH CROSS
      SECTION FOR EACH CAL SET (Q2)
  2 = MODIFY BOTH AS DESCRIBED ABOVE (Q1 & Q2)

SELECTION:


THE CURRENT VALUES FOR CAL SET 1 AT CROSS SECTION --- ARE:
      REACH DISCHARGE (Q1):  -----
 SECOND CAL DISCHARGE (Q2):  -----
```

<u>If Option "0" is selected</u>:

```
ENTER REACH DISCHARGE (Q1) FOR CAL SET ---
(OR -1 IF THE CURRENT DISCHARGE IS CORRECT.)
```

This prompt will be asked for each CAL set in the first cross section in the data set. The reach discharges entered for the first cross section will be entered on the corresponding CAL sets for each cross section in the data set.

If Option "1" is selected:

```
ENTER SECOND CAL DISCHARGE (Q2) FOR CAL SET -- AT CROSS SECTION ---
(OR -1 IF THE CURRENT DISCHARGE IS CORRECT)
```

If Option "2" is selected:

The above two prompts will appear for the first cross section; for subsequent cross sections in the data set, only the prompt for best estimate of discharge will be asked.

MODIOC Program

I. INTRODUCTION

The MODIOC program changes the IOC options in the following data sets (IFG4,WSP,MANSQ) and options files (HABTAT,HABTAM,HABTAV,HABVD,HABTAE).

JUST the option numbers are modified with the MODIOC program; not the associated lines (i.e., NOSE Line, CELL Line, etc.). For example, if MODIOC is used to set IOC(14)=2 in HABTAT, the user will not be prompted to enter the associated NOSE line. Likewise, if IOC(14) is changed from "2" to "0", the NOSE line is not removed. Also, ALL options must be re-entered when changing options using the MODIOC program. With the above considerations in mind, it may be easier to use an editor to change the appropriate option(s) and lines.

II. RUNNING MODIOC

RMODIOC,ZIN,ZOUT

ZIN=original data set (input)
ZOUT=new data set with modified options (output)

ID	DATA SET TYPE
1	HABTAT
2	HABTAV
3	HABTAM
4	IFG4
5	WSP
6	HABVD
7	MANSQ
8	HABTAE

ENTER DATA SET ID:

For example, if you wish to modify options in a WSP data set, enter "5" here. See note below for additional information on WSP options.

The options are displayed for the data set specified by the user. The user is asked to enter the IOC values.

NOTE: This is the only program where the user is prompted for the additional lines required when Options 1 or 7 are "on" in WSP (CTR1 and CTRF lines). Options 2,3, and 4 also require additional lines, but the user is not prompted for the required information, as these options are not normally used in instream flow studies. Refer to "Guide to the Application of the Water Surface Profile Computer Program" (U.S. Bureau of Reclamation 1968) for more information on the options.

OPTION 1=T IN WSP:

HOW MANY STATIONS FOR INCREMENTAL DISCHARGE (100 MAX):

ENTER THE --- PAIRS OF STATION SEQUENCE NUMBERS AND INCREMENTAL DISCHARGES:

The Station Sequence Number is the position of the cross section in the data set, i.e., 1=first station, 2=second station, etc.

OPTION 7=T IN WSP:

HOW IS THE ENERGY BALANCE TO BE CALCULATED?
1 - HARMONIC/ARITHMETIC COMBINATION (DEFAULT)
2 - GEOMETRIC MEAN
3 - HARMONIC MEAN
4 - HEC FRICTION LOSS FUNCTION
5 - ELLIPTICAL MEAN
6 - ARITHMETIC MEAN

ENTER CHOICE:

ENTER EXPANSION LOSS COEFFICIENT (MIN 0.0; MAX 1.0):

ENTER CONTRACTION LOSS COEFFICIENT (MIN 0.0; MAX 0.5):

MODN Program

I. INTRODUCTION

The MODN program adds or modifies N values for each cross section in an IFG4 or WSP data set.

In an IFG4 data set, N values are supplied on the NS lines for each surveyed point on the cross section, in the same order as the points were given on the coordinate lines. Although Manning's N values may be supplied for all verticals, they need only be supplied at points on the cross section which are above all measured flows and thus had no measured velocities. When N values are not supplied, the program calculates them for all cells with two or more measured velocities. In the simulation phase when N values are needed, but not supplied, the program takes the N values from the nearest cell where they were supplied or calculated. It will also print a message in the IFG4 output file indicating the need for N values and count this as a "note". If the user does not agree with internally generated N values, he may supply his own values for subsequent runs.

In a WSP data set, N values for each cell in the cross section are entered on the Roughness lines. A maximum of 100 N values may be used per cross section. The Thalweg must be indicated with a negative sign. The N values are determined at the right hand boundary of the cell. These boundaries should be established at all significant breaks in the channel and floodplain geometry and at significant changes in microhabitat.

II. RUNNING MODN

RMODN,ZIN,ZOUT

ZIN=IFG4 or WSP data set (input)
ZOUT=modified IFG4 or WSP data set (output)

```
HOW ARE THE ROUGHNESS (N) VALUES TO BE MODIFIED?
    1 - CONSTANT REPLACEMENT
    2 - CONSTANT MULTIPLIER
    3 - DIRECT INDIVIDUAL REPLACEMENT

ENTER CHOICE:
```

<u>Constant Replacement</u> = All cells in a cross section are assigned the Roughness (N) value supplied.

<u>Constant Multiplier</u> = All the Roughness (N) values for the cells in a cross section are multiplied by the number supplied. The resulting values replace the values currently on the lines.

<u>Direct Individual Replacement</u> = Roughness (N) values can be changed for individual cells in a cross section.

<u>The following prompt will be asked for a WSP Data Set</u>:

ENTER 1 FOR VARIABLE REACH LENGTH, 0 FOR BLANK REACH LENGTH:

If stationing was used as cross section ID numbering, enter "0".
If station indexing was used, enter "1".

Refer to Appendix A "WSP Data Set Format - Coordinate Lines and Roughness Lines" for discussion of stationing vs. station indexing.

The Roughness (N) Values for each cross section are displayed and the user is prompted to enter N values according to what choice was entered above.

NOTE: In a WSP data set, the N value displayed may not be the actual N value that is read if the Main Channel and Overbank Roughness Multipliers are set to a value other than "1" on the QARD line.

MODQARD Program

I. INTRODUCTION

The MODQARD program replaces (or adds if none exist) PARD/QARD lines in an IFG4, MANSQ, or WSP data set.

In an IFG4 and MANSQ data set, the QARD line contains the simulation flows to be routed through the cross sections in the reach. The IFG4 and MANSQ programs will accept up to 100 QARD lines; however, when they are used in conjunction with the habitat simulation programs, the number of flows is limited to 30. Flows may be entered in any order; however, it is recommended that they be entered low to high. Flows will be processed in the order entered.

In a WSP data set, the PARD line indicates the total number of flows to be processed and the units being used (English or Metric). The WSP program will process up to 50 flows; however, when WSP is used on conjuction with the habitat simulation programs, the number of flows is limited to 30. The QARD lines in a WSP data set indicate the flows for which a water suface profile is desired, the water surface elevation or slope for the most downstream cross section for the given discharge, and the main channel and overbank roughness modifiers.

II. RUNNING MODQARD

RMODQRD,ZIN,ZMOD,TAPE4,ZOUT

ZIN=IFG4, MANSQ, or WSP data set (input)
ZMOD=modified IFG4, MANSQ, or WSP data set (output)
TAPE4=unformatted flow data (optional input). When modifying a WSP data set, user has option to read PARD and QARD line data from a TAPE4 or enter it manually.
ZOUT=MODQARD results (output). This file is only generated when option 1 (Stage-Discharge Relationship) is chosen to generate the hydraulic data.

<u>If the input data set is an IFG4 or MANSQ data set</u>, the user will only be prompted for the number of flows for the QARD lines and the flows.

<u>If the input data set is a WSP data set</u>, the following prompts will be asked:

```
WHAT IS THE UNIT OF MEASUREMENT?
  0 - ENGLISH
  1 - METRIC
ENTER 0 OR 1:
```

If the Metric system of units is used, elevation and distance are expressed in meters, area in square meters, volume in meters cubed, and velocity in meters per second. The roughness coefficient in the Metric system of units is identical to the roughness coefficient in the English system of units. If input data is metric, output data will also be metric.

HOW WILL THE HYDRAULIC DATA BE GENERATED?

0 - CONSTANT SLOPE IS TO BE USED
1 - STAGE-DISCHARGE RELATIONSHIP IS TO BE USED
2 - WSL AND DISCHARGE DATA WILL BE ENTERED BY USER
3 - WSL AND DISCHARGE DATA IS ON A TAPE4 TYPE FILE

ENTER CHOICE:

Options 0 or 2 are usually used.

HOW MANY FLOWS FOR QARD LINES (MAX 30):

ENTER THE -- STREAM FLOWS:

ENTER A CROSS SECTION WIDTH AND A REACH LENGTH DISTANCE MULTIPLIER:

These are the multipliers entered on the PARD line when working with very large rivers (those over two miles wide or if the flood plain is included). The maximum number allowed in a data set is 9999.; by using a multiplier the actual length and width can be specified. This multiplier applies to the X coordinates entered on the Coordinate Lines and the reach length on the Roughness Lines.

If multipliers are not being used, enter "1" for both multipliers.

If "0" was entered above to use constant slope:

ENTER CONSTANT SLOPE:

If "2" was entered above to enter WSL and discharge data:

ENTER THE -- WATER SURFACE ELEVATIONS:

HOW WILL THE ROUGHNESS MULTIPLIER BE DETERMINED?
0 = DIRECT ENTRY
1 = CALCULATED USING RM=(Q/QC**B)

Usually when converting an IFG4 data set to a WSP data set using the RI4TWSP procedure, "0" is entered and then "1"'s are entered as the multipliers. These are the multipliers that are entered on the QARD lines. These roughness modifiers are changed when calibrating a WSP data set. In the calibration phase, it may be easier to use an editor to change the roughness multipliers rather than use the MODQARD program.

ENTER THE MAIN CHANNEL AND THE OVERBANK ROUGHNESS MULTIPLIERS
FOR THE -- DISCHARGES.

ENTER A MAIN CHANNEL AND AN OVERBANK MULTIPLIER FOR DISCHARGE --:

This prompt will appear for each discharge specified above.

For instream flow analysis, the main channel and overbank roughness modifier should be set to the same value. The main channel roughness modifier is a factor applied to the main channel roughness coefficient to give it a desired modification. The overbank modifier is applied in the same manner as the main channel modifier. Roughness modifiers are useful when a uniform adjustment is desired for all roughness coefficients within a certain channel reach. This is a carry-over from a previous version of WSP. As currently used, the main channel would only equal the Thalweg cell, everything else is "overbank"; this is the reason both multipliers are equal.

MODSLP Program

I. INTRODUCTION

The MODSLP program modifies the slope at each cross section in an IFG4 data set OR modifies the water surface elevation or slope for each flow on the QARD lines in a WSP data set. In a WSP data set, either the slope or water surface elevation is entered on the QARD lines. If the value entered is greater than 0.1, it is the water surface elevation; if the value entered is less than 0.1, it is the estimated starting water surface slope.

II. RUNNING MODSLP

RMODSLP,ZIN,ZOUT

ZIN=IFG4 or WSP data set (input)
ZOUT=new IFG4 or WSP data set with modified slopes (output)

The two title lines from the data set will appear.

<u>If you are modifing an IFG4 data set</u>:

```
PRESENT SLOPE FOR CROSS SECTION --- IS: -----
ENTER NEW SLOPE OR 0 TO LEAVE AS IS:
```

The above prompt will be asked for each cross section in the data set.

<u>If you are modifying a WSP data set</u>:

```
PRESENT SLOPE/W.S ELEVATION FOR FLOW OF --- IS: -----
ENTER NEW SLOPE/W.S. ELEVATION OR 0 TO LEAVE AS IS:
```

The above prompt will be asked for each flow on the QARD lines in the data set.

QCKWSP Program

I. INTRODUCTION

The QCKWSP program creates an incomplete WSP data set (missing PARD and QARD values) from a free-formatted file created with an editor. Type INFOQWP for information on the format of the free-formatted input file.

The roughness is assumed to be 0.035; which is described as earth channels that are considerably covered with small growth and cleared, but not continuously maintained floodways.

The following programs could be run to modify the WSP data set created by QCKWSP:

MODN	- change the roughness (N) values.
MODIOC	- change Option values.
MODQARD	- add PARD and QARD values.

Refer to Appendix A for the file format for the free-formatted input file for QCKWSP; or type INFOQWP for on-line information. Appendix A also contains a sample free-formatted input file to QCKWSP.

II. RUNNING QCKWSP

RQCKWSP,ZIN,ZWSP

ZIN=free-formatted coordinate data file (input)
ZWSP=WSP data set (output)

REVI4 Program

I. INTRODUCTION

The REVI4 program assists in determining the best approach to hydraulic simulation for a given site using a complete IFG4 data set. Much of the diagnostic data generated are presented as plots. The TAPE3 and TAPE4 files generated can be used as input to the SLOP34 and LPTTHWE programs for further review of an IFG4 data set. They are automatically used as input to these programs when the TREVI4 batch/procedure file is run for a "total review" of an IFG4 data set.

Relationships between variables are determined using a log-log and semi-log relationship. Roughness is calculated and displayed. The stage-discharge relationship is determined and the water surface elevations determined for the streamflow on the QARD lines. If the first QARD has a zero flow value, then the water surface elevation is determined at the calibration flows, 0.4 and 0.2 times the lowest calibrated discharge and 2.5 and 5.0 times the largest calibration discharge. These water surface elevations are written to the TAPE4 file along with the average velocity. The cross section data (i.e., distances, elevations, and channel indexes) are written to TAPE3.

II. RUNNING REVI4

RREVI4,ZIFG4,REVOUT,TAPE3,TAPE4

ZIFG4=IFG4 data set (input)
REVOUT=REVI4 results (output)
TAPE3=unformatted cross section and reach data (output)
TAPE4=unformatted flow data (output)

<u>NOTE</u>: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

Figure II.19 contains sample output from the REVI4 program.

III. ERROR MESSAGES

Refer to the IFG4 program description for information on error messages.

```
IOC'S ARE  0 1 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0
            0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

METRIC INDEX IS.................. 0

NUMBER OF STREAMFLOWS SIMULATED IS 14

THE SIMULATED FLOWS ARE -

       8.00      10.00      20.00      30.00      40.00      50.00
      60.00      70.00      80.00      90.00     100.00     110.00
     120.00     130.00
```

ONLY THE DATA GENERATED FOR THE FIRST CROSS SECTION IS INCLUDED IN THIS SAMPLE OUTPUT.

```
CROSS STATION ID NUMBER:        0.00

WEIGHT ON SECTION WORKING UPSTREAM:   0.30

REACH LENGTH TO DOWNSTREAM CROSS SECTION:     0.00000

STAGE OF ZERO FLOW:       97.20

GIVEN SLOPE: 0.02667000

NUMBER OF COORDINATE POINTS:    30

                 COORDINATE DATA FOLLOWS
                 ***********************
```

DISTANCE	0.0	2.5	4.0	4.3	5.5	7.6	11.9	14.2	16.2	16.5
ELEVATION	101.3	100.7	99.8	98.6	97.7	97.3	97.6	97.9	97.6	97.7
CHANNEL INDEX	3.0	3.0	3.0	3.0	9.2	6.0	6.0	8.2	8.2	8.2
DISTANCE	18.2	20.2	22.2	24.2	26.2	28.2	30.2	32.2	33.0	34.2
ELEVATION	97.5	97.4	97.3	97.2	97.3	97.5	97.4	97.7	97.6	97.6
CHANNEL INDEX	8.2	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.2
DISTANCE	35.2	36.2	37.4	39.1	43.8	53.0	62.4	69.9	78.1	87.1
ELEVATION	97.7	97.7	97.7	97.9	98.1	98.6	99.0	98.5	99.0	99.5
CHANNEL INDEX	9.2	9.2	9.2	10.0	10.0	10.0	10.0	8.2	3.0	3.0

```
CROSS SECTION       0.00

     GIVEN FLOW   21.80  12.60   7.90
CALCULATED FLOW   18.34   0.00   0.00
          STAGE   97.86  97.76  97.65

                VELOCITY CALIBRATION DATA
************************************************
  LOCATION                  VELOCITIES

       0.0   0.00   0.00   0.00
       2.5   0.00   0.00   0.00
       4.0   0.00   0.00   0.00
       4.3   0.00   0.00   0.00
       5.5   0.30   0.00   0.00
       7.6   0.00   0.00   0.00
```

SAMPLE VELOCITY DATA TERMINATED HERE FOR BREVITY.

Figure II.19. Sample output from the REVI4 program.

AVERAGE CHANNEL PARAMETERS FOR CROSS SECTION 0.00

STREAM FLOW	WATER SURFACE ELEVATION	WIDTH	CROSS SEC. AREA	WETTED PERIMETER	AVERAGE DEPTH	MAX DEPTH	PLOTTING STAGE	HYDRAULIC RADIUS	CONVEYANCE FACTOR
21.8	97.86	32.9	11.3	33.1	0.34	0.66	0.66	0.342	3.94
12.6	97.76	30.5	8.1	30.7	0.27	0.56	0.56	0.266	3.74
7.9	97.65	24.0	5.1	24.2	0.21	0.45	0.45	0.211	4.38

REGRESSION EQUATION IS -

CFAC = 0.5170E+01 * Q ** -0.099

STANDARD ERROR OF ESTIMATE IS - 0.039

AVERAGE ERROR IS - 4.906 PERCENT

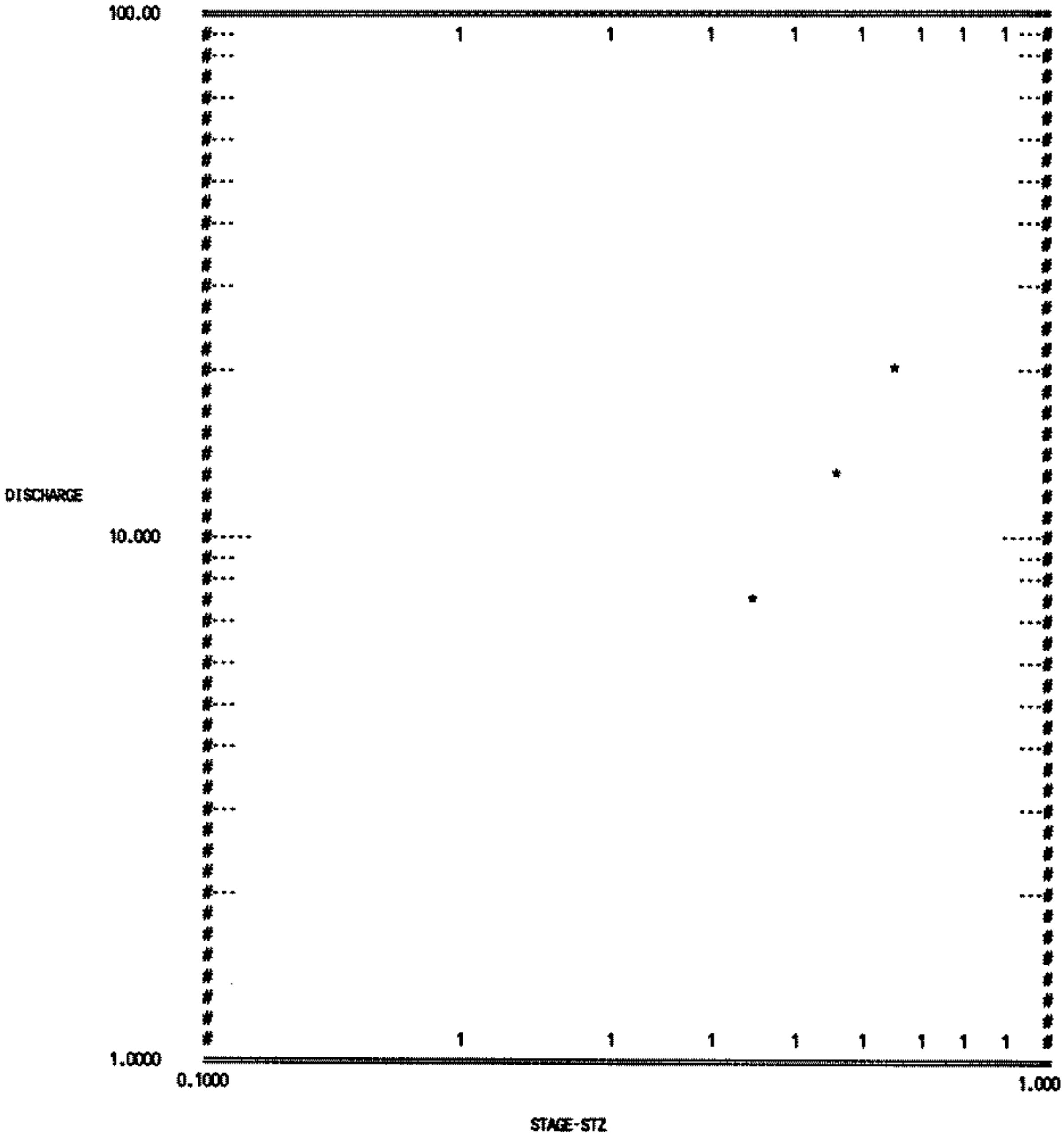
WIDTH = 0.1327E+02 * Q ** 0.304

DEPTH = 0.7912E-01 * Q ** 0.478

VELOCITY = 0.9528E+00 * Q ** 0.218

Figure II.19. (Continued)

88/07/05. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM - REVI4
09.13.30. SAMPLE IFG4 DATA SET PAGE - 5



STAGE - DISCHARGE DATA FOR CROSS SECTION 0.00 STZ = 97.20

Figure II.19. (Continued)

CALIBRATION OF STAGE-DISCHARGE RELATIONSHIP

DISCHARGE	STAGE	PLOTTING STAGE
21.800	97.860	0.660
12.600	97.760	0.560
7.900	97.650	0.450

STAGE OF ZERO FLOW IS 97.20

STAGE - DISCHARGE RELATIONSHIP

LOG - LOG FUNCTION

Q = 0.621E+02 *(STAGE - 97.20)** 2.623

MEASURED	PREDICTED	RATIO
21.800	20.890	1.044
12.600	13.577	0.928
7.900	7.651	1.033

MEAN ERROR	5.03
VARIANCE	5.84
STD. DEV.	2.42
SAMPLE SIZE	3.

DISCHARGE	WSL	VELOCITY	FROUDE NUMBER
130.00	98.53	3.40	0.67
120.00	98.49	3.30	0.66
110.00	98.44	3.20	0.65
100.00	98.40	3.08	0.64
90.00	98.35	2.97	0.63
80.00	98.30	2.84	0.62
70.00	98.25	2.71	0.61
60.00	98.19	2.57	0.60
50.00	98.12	2.41	0.58
40.00	98.05	2.24	0.57
30.00	97.96	2.05	0.56
20.00	97.85	1.82	0.55
10.00	97.70	1.58	0.57
8.00	97.66	1.52	0.58

Figure II.19. (Continued)

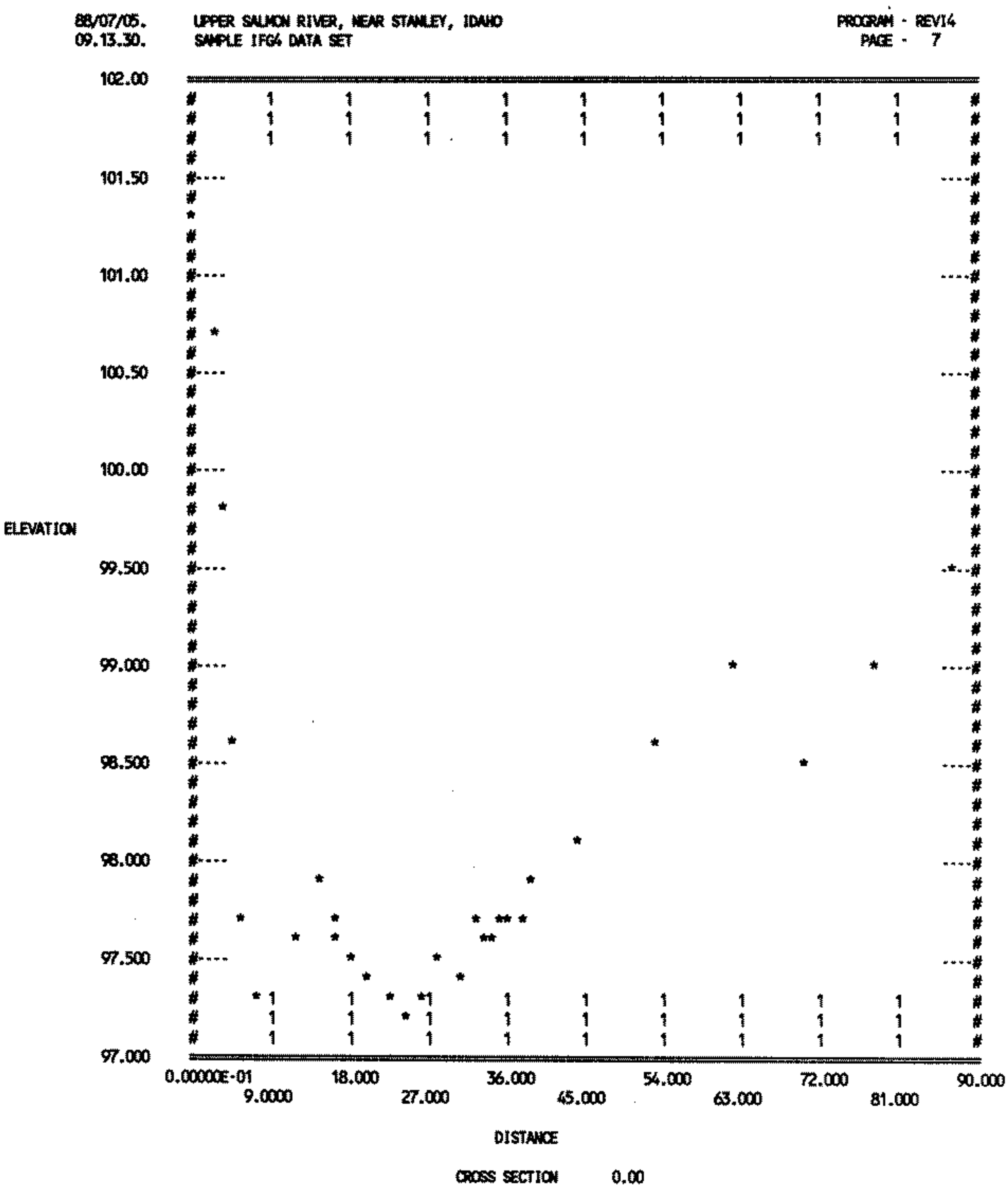


Figure II.19. (Continued)

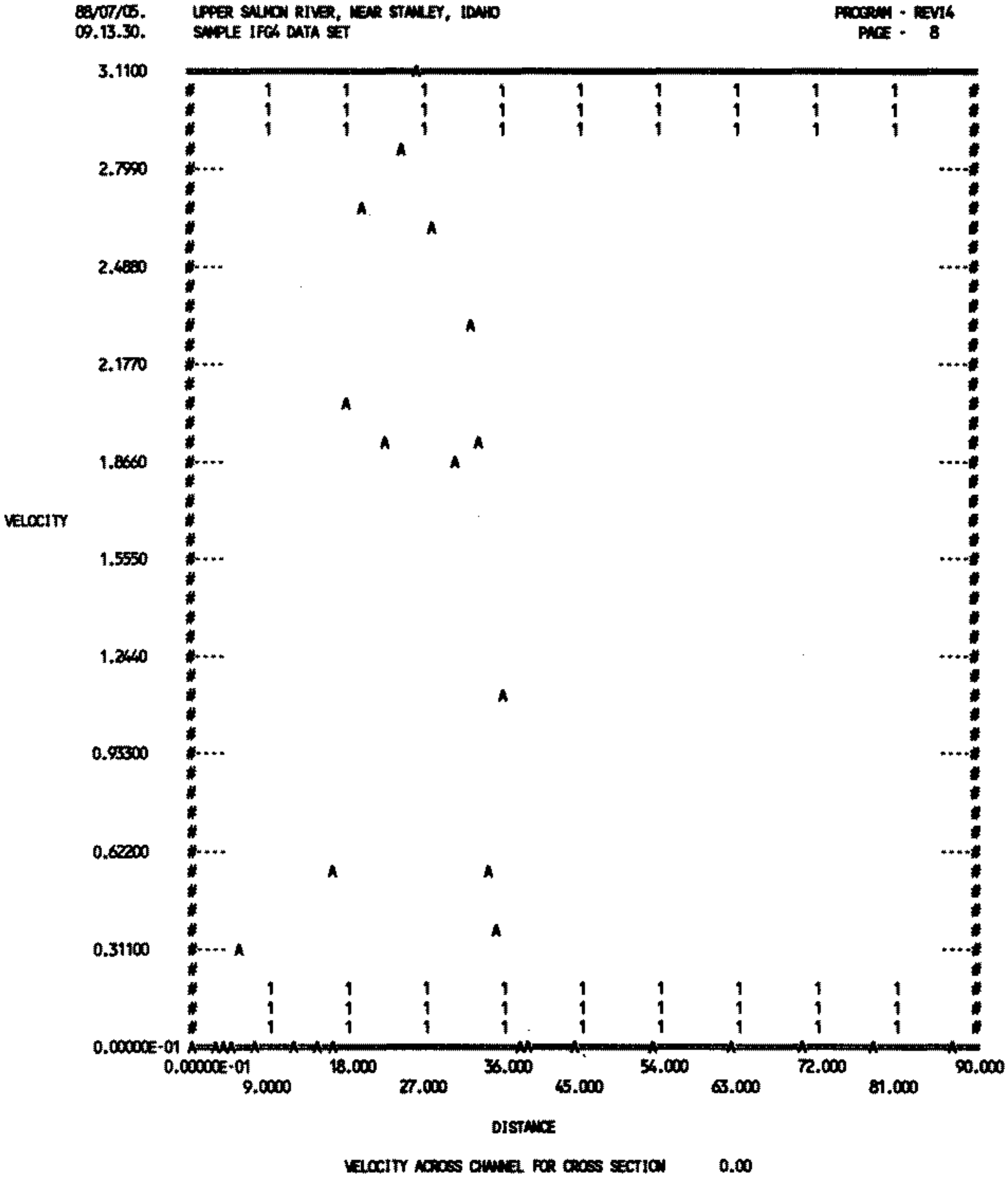


Figure II.19. (Continued)

CROSS SECTION 0.00

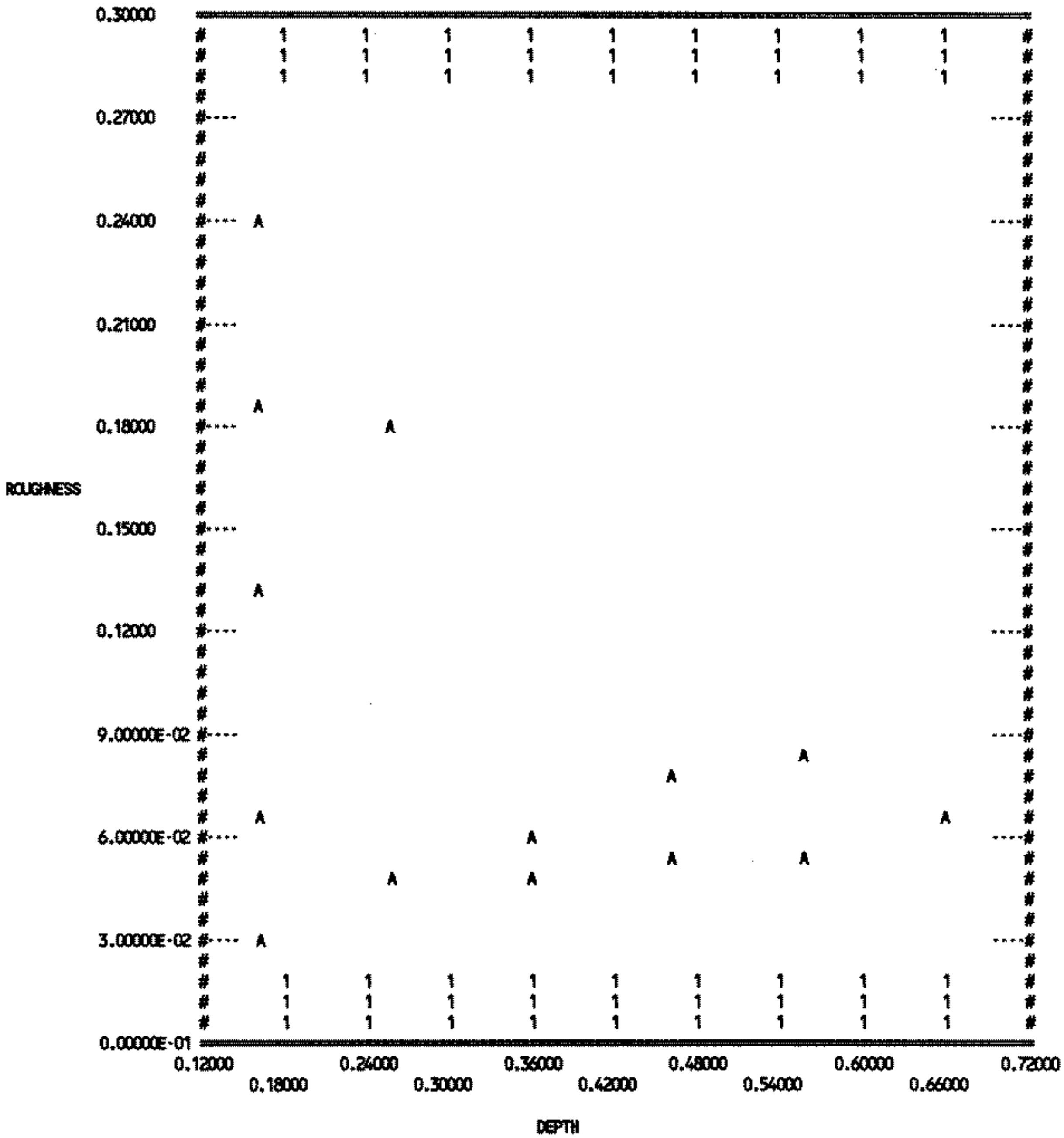
GIVEN FLOW	21.80	12.60	7.90
STAGE	97.86	97.76	97.65

CALCULATED ROUGHNESS

LOCATION	ROUGHNESS		
0.0	0.000	0.000	0.000
2.5	0.000	0.000	0.000
4.0	0.000	0.000	0.000
4.3	0.000	0.000	0.000
5.5	0.239	0.000	0.000
7.6	0.000	0.000	0.000
11.9	0.000	0.000	0.000
14.2	0.000	0.000	0.000
16.2	0.000	0.000	0.000
16.5	0.133	0.000	0.000
18.2	0.059	0.000	0.000
20.2	0.055	0.000	0.000
22.2	0.087	0.000	0.000
24.2	0.065	0.000	0.000
26.2	0.053	0.000	0.000
28.2	0.048	0.000	0.000
30.2	0.078	0.000	0.000
32.2	0.031	0.000	0.000
33.0	0.051	0.000	0.000
34.2	0.177	0.000	0.000
35.2	0.189	0.000	0.000
36.2	0.063	0.000	0.000
37.4	0.000	0.000	0.000
39.1	0.000	0.000	0.000
43.8	0.000	0.000	0.000
53.0	0.000	0.000	0.000
62.4	0.000	0.000	0.000
69.9	0.000	0.000	0.000
78.1	0.000	0.000	0.000
87.1	0.000	0.000	0.000

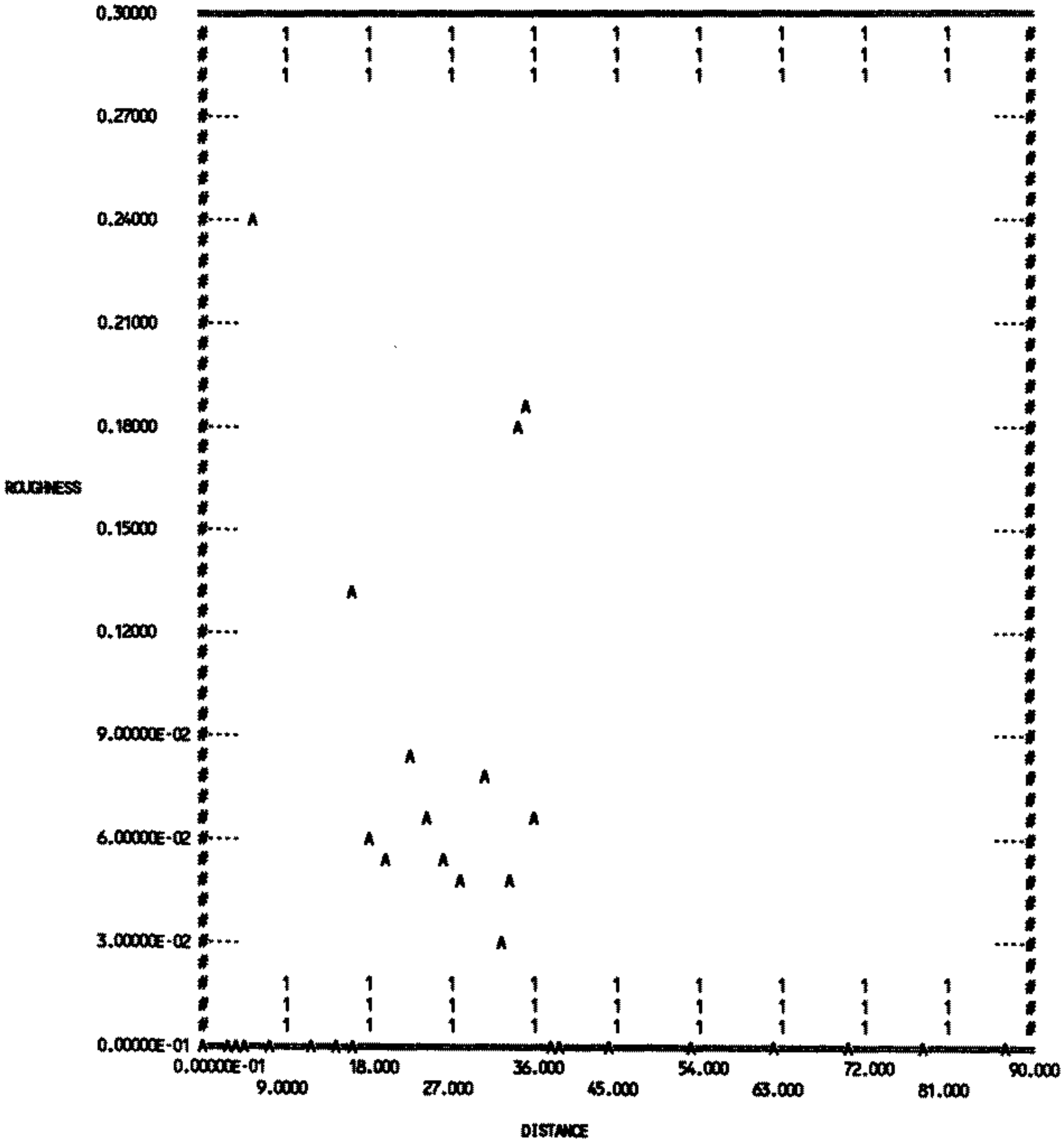
Figure II.19. (Continued)

88/07/05. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM - REVI4
09.13.30. SAMPLE IFG4 DATA SET PAGE - 10



DEPTH VS ROUGHNESS FOR EACH CAL SET, CROSS SECTION 0.00

Figure II.19. (Continued)



ROUGHNESS ACROSS CHANNEL FOR CROSS SECTION 0.00

Figure II.19. (Continued)

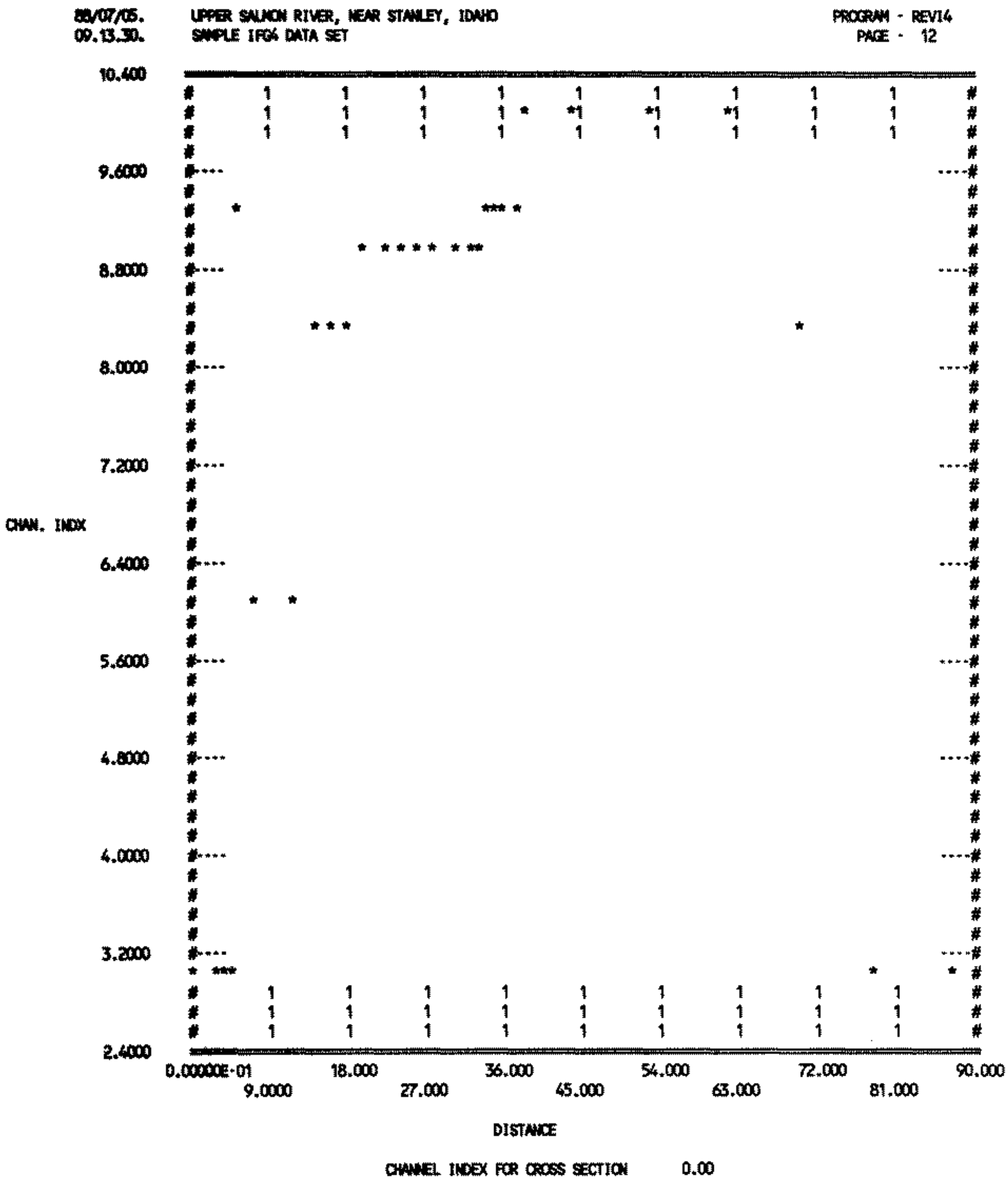


Figure II.19. (Concluded)

RI4TWSP Batch/Procedure File

I. INTRODUCTION

The RI4TWSP batch/procedure file converts an IFG4 data set to a complete WSP data set by running the following three programs: STRIPC, CWSPN, and MODQARD. Each vertical becomes the right boundary of a cell, except the left-most vertical.

II. RUNNING THE RI4TWSP BATCH/PROCEDURE FILE

RI4TWSP,ZIFG4,ZWSP,TAPE4,ZOUT

ZIFG4=IFG4 data set (input)
ZWSP=WSP data set (output)
TAPE4=unformatted flow data (optional input)
If not supplied, data for the PARD and QARD lines are entered from the keyboard.
ZOUT=MODQARD results (output). This file is only generated when Option 1 (Stage-Discharge Relationship) is chosen to generate the hydraulic data.

Refer to the individual program documentation for STRIPC, CWSPN, and MODQARD for more information.

SLOP34 Program

I. INTRODUCTION

The SLOP34 program reads a TAPE3 and TAPE4 and determines the water surface and energy slopes between the cross sections. The slope between two cross sections is the difference in elevation divided by the distance between them. If there is a cross section both upstream and downstream, the slope reported is the average of the slope to the upstream cross section and the slope to the downstream cross section. The slope for the two end cross sections is calculated by difference in elevations between the section and adjacent section.

Four tables are included in the output file generated by the SLOP34 program:

- water surface elevations
- water surface slopes
- energy grade line elevations
- energy grade line slopes

II. RUNNING SLOP34

RSLOP34,SLPOUT,TAPE3,TAPE4

SLPOUT=SLOP34 results (output)
TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)

Figure II.20 contains sample output from the SLOP34 program.

```
         88/06/01.          UPPER SALMON RIVER, NEAR STANLEY, IDAHO                             PROG - SLOP34
         10.43.28.          SAMPLE IFG4 DATA SET                                                    PAGE -   1

           WATER SURFACE ELEVATIONS

DISTANCE    THALWEG      130.00      120.00      110.00      100.00       90.00       80.00       70.00

     0.0      97.20       98.53       98.49       98.44       98.40       98.35       98.30       98.25
    14.2      97.60       98.83       98.80       98.76       98.72       98.68       98.63       98.58

DISTANCE    THALWEG       60.00       50.00       40.00       30.00       20.00       10.00        8.00

     0.0      97.20       98.19       98.12       98.05       97.96       97.85       97.70       97.66
    14.2      97.60       98.53       98.47       98.40       98.32       98.22       98.08       98.04
```

Figure II.20. Sample output from the SLOP34 program.

WATER SURFACE SLOPES

DISTANCE	THALWEG	130.00	120.00	110.00	100.00	90.00	80.00	70.00
0.0	97.20	0.02172263	0.02200264	0.02229496	0.02260014	0.02292084	0.02326028	0.02362114
14.2	97.60	0.02172263	0.02200264	0.02229496	0.02260014	0.02292084	0.02326028	0.02362114

DISTANCE	THALWEG	60.00	50.00	40.00	30.00	20.00	10.00	8.00
0.0	97.20	0.02400770	0.02442798	0.02489056	0.02541311	0.02602668	0.02680942	0.02700431
14.2	97.60	0.02400770	0.02442798	0.02489056	0.02541311	0.02602668	0.02680942	0.02700431

SLOPES CALCULATED USING AVERAGE OF ADJACENT SLOPES

ENERGY GRADE LINE ELEVATIONS

DISTANCE	THALWEG	130.00	120.00	110.00	100.00	90.00	80.00	70.00
0.0	97.20	98.72	98.67	98.62	98.56	98.50	98.44	98.37
14.2	97.60	99.05	99.00	98.95	98.90	98.85	98.79	98.73

DISTANCE	THALWEG	60.00	50.00	40.00	30.00	20.00	10.00	8.00
0.0	97.20	98.30	98.22	98.13	98.03	97.91	97.74	97.70
14.2	97.60	98.66	98.59	98.50	98.40	98.28	98.11	98.07

SLOPE OF ENERGY GRADE LINE

DISTANCE	THALWEG	130.00	120.00	110.00	100.00	90.00	80.00	70.00
0.0	97.20	0.02276344	0.02314089	0.02351031	0.02388241	0.02425880	0.02463946	0.02502495
14.2	97.60	0.02276344	0.02314089	0.02351031	0.02388241	0.02425880	0.02463946	0.02502495

DISTANCE	THALWEG	60.00	50.00	40.00	30.00	20.00	10.00	8.00
0.0	97.20	0.02541525	0.02578146	0.02591478	0.02591424	0.02596992	0.02582483	0.02587141
14.2	97.60	0.02541525	0.02578146	0.02591478	0.02591424	0.02596992	0.02582483	0.02587141

SLOPES CALCULATED USING AVERAGE OF ADJACENT SLOPES

Figure II.20. (Concluded)

STGQS4 Program

I. INTRODUCTION

The STGQS4 program determines water surface elevations for an IFG4 data set using the stage-discharge relationship based on flows on the CAL lines. The output is shorter and easier to read than IFG4 output when you are only interested in the predicted water surface elevations.

Only two of the IOC values in IFG4 are used in STGQS4; they are IOC(5) and IOC(20). IOC(20) indicates that the cross section width is to multiplied by a constant and works exactly as in IFG4. IOC(5) works a little different in STGQS4 than in IFG4. If IOC(5)=0 in STGQS4, the second discharge on the CAL line is used in developing a stage-discharge relationship. If the second discharge is blank or zero, the first discharge will be used. STGQS4 does not calculate discharges from the velocities on the VEL lines (use the values from REVI4). If IOC(5)=1 in STGQS4, the first discharge on the CAL line is used and must be supplied.

II. RUNNING STGSQ4

RSTGQS4,ZIFG4,ZOUT,TAPE3,TAPE4

ZIFG4=IFG4 data set (input)
ZOUT=STGQS4 results (output)
TAPE3=unformatted cross section and reach data (output)
TAPE4=unformatted flow data (output)

Appendix A contains the IFG4 data set that was used to generate the output in Figure II.21. Review the output file for error messages and inconsistancies in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort.

```
 88/04/26.     UPPER SALMON RIVER, NEAR STANLEY, IDAHO                                  PROGRAM - STGQS4
15.16.40.     SAMPLE IFG4 DATA SET                                                              PAGE -   2

               STATION ID IS        0.00

 REACH LENGTH DOWNSTREAM IS        0.00     WEIGHT ON SECTION IS  0.30
      STAGE OF ZERO FLOW IS       97.20            GIVEN SLOPE IS 0.02667000

      COORDINATE DATA FLOWS - THERE ARE  30 POINTS

  DISTANCE        0.       2.       4.       4.       5.       8.      12.      14.      16.      16.
 ELEVATION   101.30   100.70    99.80    98.60    97.70    97.30    97.60    97.90    97.60    97.70

  DISTANCE       18.      20.      22.      24.      26.      28.      30.      32.      33.      34.
 ELEVATION    97.50    97.40    97.30    97.20    97.30    97.50    97.40    97.70    97.60    97.60

  DISTANCE       35.      36.      37.      39.      44.      53.      62.      70.      78.      87.
 ELEVATION    97.70    97.70    97.70    97.90    98.10    98.60    99.00    98.50    99.00    99.50
```

Figure II.21. Sample output from the STGQS4 program.

CALIBRATION OF STAGE - DISCHARGE RELATIONSHIP

DISCHARGE	STAGE	PLOTTING STAGE
21.800	97.860	0.660
12.600	97.760	0.560
7.900	97.650	0.450

STAGE OF ZERO FLOW IS 97.20

STAGE - DISCHARGE RELATIONSHIP

LOG - LOG FUNCTION

Q = 0.621E+02 *(STAGE - 97.20)** 2.623

MEASURED	PREDICTED	RATIO
21.800	20.890	1.044
12.600	13.577	0.928
7.900	7.651	1.033

MEAN ERROR	5.03
VARIANCE	5.84
STD. DEV.	2.42
SAMPLE SIZE	3.

DISCHARGE	WSL	VELOCITY	FROUDE NUMBER
8.00	97.66	1.52	0.58
10.00	97.70	1.58	0.57
20.00	97.85	1.82	0.55
30.00	97.96	2.05	0.56
40.00	98.05	2.24	0.57
50.00	98.12	2.41	0.58
60.00	98.19	2.57	0.60
70.00	98.25	2.71	0.61
80.00	98.30	2.84	0.62
90.00	98.35	2.97	0.63
100.00	98.40	3.08	0.64
110.00	98.44	3.20	0.65
120.00	98.49	3.30	0.66
130.00	98.53	3.40	0.67

ONLY THE OUTPUT FROM CROSS SECTION 0.0 IS INCLUDED IN THIS SAMPLE OUTPUT.

Figure II.21. (Concluded)

STRIPC Program

I. INTRODUCTION

The STRIPC program removes all but the two title lines and the coordinate lines from either an IFG4 or WSP data set. It is used when converting a data set from either IFG4 format to WSP format or WSP format to IFG4 format.

II. RUNNING STRIPC

RSTRIPC,ZIN,ZOUT

ZIN=IFG4 or WSP data set (input)
ZOUT=coordinate data set (output)

When stripping an IFG4 data set, the following prompt appears to allow the user to change the cross section ID numbering from consecutive numbering to stationing. A WSP data set uses stationing as cross section ID numbering.

```
DO YOU WISH COLUMNS 2-10 OF THE COORDINATE SET TO
CONTAIN THE ACCUMULATIVE REACH LENGTH, OR LEAVE IT
UNCHANGED?

   0 - ACCUMULATIVE REACH LENGTH (STATIONING)
   1 - LEAVE UNCHANGED

ENTER 0 OR 1:
```

TREVI4 Batch/Procedure File

I. INTRODUCTION

The TREVI4 batch/procedure file generates files for a total review of an IFG4 data set by running the CKI4, REVI4, LPTTHWE, and SLOP34 programs. The TAPE3 and TAPE4 files are generated by the REVI4 program and are then used as input to the LPTTHWE and the SLOP34 programs.

II. RUNNING THE TREVI4 BATCH/PROCEDURE FILE

TREVI4,ZIFG4,CKOUT,REVOUT,LPTOUT,SLPOUT,TAPE3,TAPE4

ZIFG4=IFG4 data set (input)
CKOUT=CKI4 results (output)
REVOUT=REVI4 results (output)
LPTOUT=LPTTHWE results (output)
TAPE3=unformatted cross section and reach data (output, input)
TAPE4=unformatted flow data (output, input)

Refer to the individual program documentation for the CKI4, REVI4, LPTTHWE, and SLOP34 programs for sample output.

VWTHWEG Program

I. INTRODUCTION

The VWTHWEG program plots Thalweg values and water surface elevations from a TAPE3 and TAPE4 as LPTTHWE does; however VWTHWEG allows the user to choose the cross section or discharge to be plotted vs. plotting all of them.

VWTHWEG uses screen graphics and is only available on the micro. The computer must have a Color Graphics Adaptor (CGA) or compatible graphics card.

II. RUNNING VWTHWEG

RVWTHWEG,ZOUT,TAPE3,TAPE4

ZOUT=VWTHWEG results (output)
Graphs are displayed on the screen, and the information for each requested graph is written to the output file.
TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)

```
ENTER 0 TO PLOT WSL VS. LONGITUDINAL DISTANCE FOR A CROSS
        SECTION, OR
      1 TO PLOT THALWEG VS. WSL VALUES FOR A DISCHARGE, OR
      2 TO EXIT PROGRAM:
```

<u>If "0" is entered to plot WSL vs. longitudinal distance for a cross section</u>:

THE CROSS SECTIONS ARE:

1: (first Cross Section ID No.) 2: (second Cross Section ID No.)

Each Cross Section ID No. on the TAPE3 will be listed preceeded with a consecutive Index number.

ENTER INDEX NUMBER OF CROSS SECTION ID FOR GRAPH:

The index number, NOT the Cross Section ID No. is entered, i.e., "1" would be entered to plot the first cross section listed.

<u>If "1" is entered to plot Thalweg vs. WSL values for a discharge</u>:

The discharges will be listed along with an index number as explained above. The user will be prompted to enter the Index Number of the discharge to be graphed.

WSEI4 Program

I. INTRODUCTION

The WSEI4 program reads water surface elevations and discharges from a TAPE4 or TP4 and adds or replaces the QARD and WSL lines in an IFG4 data set. The original IFG4 data set must contain NS lines, as the WSEI4 program searches for the NS lines and inserts the WSL lines after them.

II. RUNNING WSEI4

RWSEI4,ZIFG4,ZIFG4N,TAPE4

ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set with added or replaced water surface elevations and discharges (output)
TAPE4=unformatted flow data (input)

REVIEW IOC VALUES - IOC(8) MUST BE 1 OR 3

IOC(8)=1 in an IFG4 data set instructs the IFG4 program to read the water surface elevations supplied on the WSL lines for each flow entered on the QARD lines.

IOC(8)=3 in an IFG4 data set instructs the IFG4 program to read the water surface elevations supplied on the WSL lines for each flow entered on the QARD lines. The flow used to adjust the velocities is multiplied by the ratio of the discharge calculated from the velocities on the VEL lines to the discharge on the CAL line. If more than one set of VEL lines is present, the ratio based on the last set is used.

WSEI4D Program

I. INTRODUCTION

The WSEI4D program adds or replaces QARD and WSL lines in an IFG4 data set. Data is entered from the keyboard. It can be used when water surface elevations determined from one model are being used for some cross sections, and other models are used for other cross sections, or when water surface elevations from different models for individual cells in a cross section are being added to the IFG4 data set.

The original IFG4 data set must contain NS lines, as the WSEI4D program searches for the NS lines and inserts the WSL lines after them.

II. RUNNING WSEI4D

RWSEI4D,ZIFG4,ZIFG4N

ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set wth added or replaced water surface elevations and discharges (output)

HOW MANY QARD FLOWS (MAX 30)
(FOR NO CHANGE IN THE QARD FLOWS ENTER A 0)

If "0" is entered, the new data set with WSL lines added will contain the same flows on the QARD lines as the original data set.

ENTER WATER SURFACE ELEVATIONS FOR THE FOLLOWING FLOWS:

If "0" was entered above for no change in the QARD flows, the existing QARD flows will be listed here.

ENTER --- WSL('s) FOR CROSS SECTION ---:

A water surface elevation is entered for each cell in the cross section.

REVIEW IOC VALUES - IOC(8) MUST BE 1 OR 3

IOC(8)=1 in an IFG4 data set instructs the IFG4 program to read the water surface elevations supplied on the WSL lines for each flow entered on the QARD lines.

IOC(8)=3 in an IFG4 data set instructs the IFG4 program to read the water surface elevations supplied on the WSL lines for each flow entered on the QARD lines. The flow used to adjust the velocities is multiplied by the ratio of the discharge calculated from the velocities on the VEL lines to the discharge on the CAL line. If more than one set of VEL lines is present, the ratio based on the last set is used.

WSEI4H Program

I. INTRODUCTION

The WSEI4H program reads water surface elevations and discharges from a HEC2 output file and adds or replaces the QARD and WSL lines in an IFG4 data set. The original IFG4 data set must contain NS lines, as the WSEI4H program searches for the NS lines and inserts the WSL lines after them.

The water surface elevations and discharges are read from the "Summary Printout" in the HEC2 output file. The following code numbers must be selected on Job Control Parameter Card 3 (J3) when running HEC-2 in order to generate the "Summary Printout" in the right format.

Field	Code Number	Description
1	38	Cross section identificationn number
2	43	Discharge
3	1	Computed water surface elevation
4	4	Cross section width at calculated water surface elevation
5	5	Slope of the energy grade line for the current section (time 10,000)
6	6	Travel time from the first cross section to the present cross section
7	7	Cumulative volume of water in the stream from the first cross section in acre-feet
8	8	Depth of flow
9	10	Mean velocity head across the entire cross section
10		Blank

II. RUNNING WSEI4H

RWSEI4H,ZHECOUT,ZIFG4,ZIFG4N

ZHECOUT=HEC2 line printer output file (input)
ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set with added or replaced water surface elevations and discharges from ZHECOUT (output)

REVIEW IOC VALUES - IOC(8) MUST BE 1 OR 3

IOC(8)=1 in an IFG4 data set instructs the IFG4 program to read the water surface elevations supplied on the WSL lines for each flow entered on the QARD lines.

IOC(8)=3 in an IFG4 data set instructs the IFG4 program to read the water surface elevations supplied on the WSL lines for each flow entered on the QARD lines. The flow used to adjust the velocities is multiplied by the ratio of the discharge calculated from the velocities on the VEL lines to the discharge on the CAL line. If more than one set of VEL lines is present, the ratio based on the last set is used.

WSEI4S Program

I. INTRODUCTION

The WSEI4S program uses a stage-discharge relationship to calculate water surface elevations which are then added to an IFG4 data set. The user enters the stage-Q data needed to determine the stage-discharge relationship. The original IFG4 data set must contain NS lines, as the WSEI4S program searches for the NS lines and inserts the WSL lines after them.

Running STGQS4 or IFG4 on a single velocity data set produces the same same results as WSEI4S.

II. RUNNING WSEI4S

RWSEI4S,ZIFG4,ZIFG4N,ZOUT

ZIFG4=IFG4 data set (input)
ZIFG4N=new IFG4 data set with WSL lines added (output)
ZOUT=WSIE4S results, stage-discharge relationship, and plots (output)

NOTE: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

HOW MANY SIMULATION (QARD) FLOWS:

ENTER THE --- FLOWS:

The following sequence of prompts will be asked for each cross section in the IFG4 data set.

ENTER FIRST CROSS SECTION ID NUMBER:

HOW MANY STAGE - DISCHARGE PAIRS:

ENTER THE STAGE, DISCHARGE PAIRS (STQ,Q):

ENTER STAGE OF ZERO FLOW:

STAGE Q EQUATION IS -

ENTER WSL AND STAGE PAIR:

This is when the datum for the water surface elevations is not the same as the datum used for the rest of the measurements. If the same datum was used, enter two (2) equal numbers here.

- - - CALCULATING, PLEASE WAIT ---

REVIEW IOC VALUES - IOC(8) MUST BE 1 OR 3

IOC(8)=1 in an IFG4 data set instructs the IFG4 program to read the water surface elevations supplied on the WSL lines for each flow entered on the QARD lines.

IOC(8)=3 in an IFG4 data set instructs the IFG4 program to read the water surface elevations supplied on the WSL lines for each flow entered on the QARD lines. The flow used to adjust the velocities is multiplied by the ratio of the discharge calculated from the velocities on the VEL lines to the discharge on the CAL line. If more than one set of VEL lines is present, the ratio based on the last set is used.

Figure II.22 contains sample output from the WSEI4S program. Only the stage-discharge data and plot for cross section 0.0 has been included in this figure.

```
88/05/31.     UPPER SALMON RIVER, NEAR STANLEY, IDAHO                          PROGRAM - WSEI4S
12.58.57.     SAMPLE IFG4 DATA SET                                                  PAGE -   2

                   DISCHARGE          STAGE           PLOTTING STAGE

                      21.800          97.860              0.660
                      12.600          97.760              0.560
                       7.900          97.650              0.450

              STAGE OF ZERO FLOW IS   97.20

                      STAGE - DISCHARGE RELATIONSHIP

                      LOG - LOG FUNCTION

                                Q = 0.621E+02 *(STAGE -    97.20 )**    2.623

                      MEASURED    PREDICTED     RATIO
                        21.800       20.890     1.044
                        12.600       13.577     0.928
                         7.900        7.651     1.033

                           MEAN ERROR        5.03
                             VARIANCE        5.84
                            STD. DEV.        2.42
                          SAMPLE SIZE          3.

                    DISCHARGE     STAGE       WSL

                          8.0     97.658     97.658
                         20.0     97.849     97.849
                         40.0     98.046     98.046
                         60.0     98.187     98.187
                         80.0     98.301     98.301
```

Figure II.22. Sample output from the WSEI4S program.

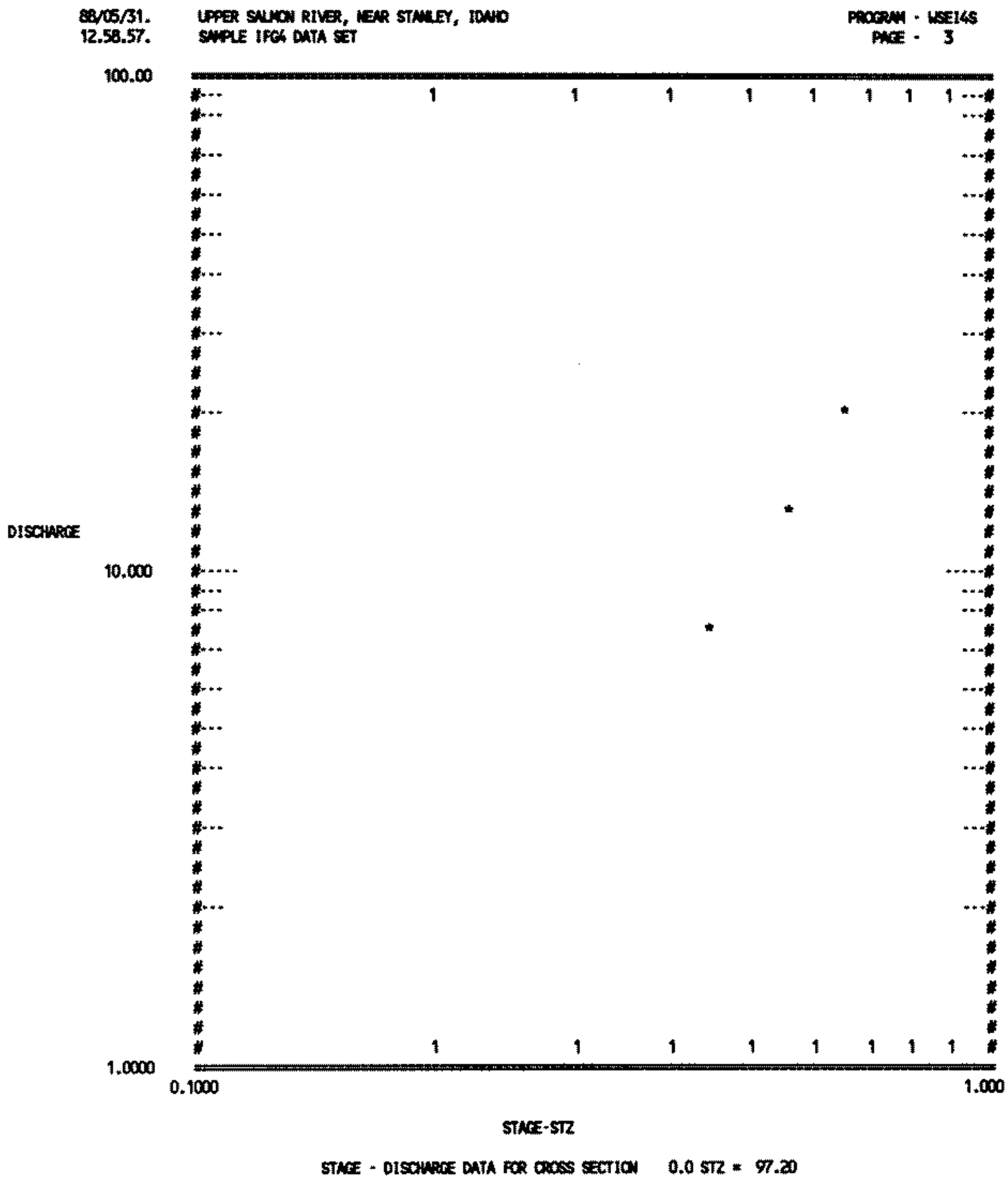


Figure II.22. (Concluded)

WSP Program

I. INTRODUCTION

The Water Surface Profile (WSP; also referred to as IFG2) program is a U.S. Bureau of Reclamation (USBR) program modified to calculate the velocities and water surface elevations required as input to the habitat simulation programs. WSP provides very detailed depth and transverse velocity information. The model can be used to predict the horizontal distribution of depth and mean column velocity over a range of streamflows with one set of field data.

The objective of this type of hydraulic simulation is to be able to predict how the depth, velocity, and widths vary for each cross section over a range of simulated discharges. Specific hydraulic relationships between the physical channel and discharge must be met to evaluate these changes in reference to a stream reach.

Several basic assumptions are made in the development of the water surface profile. Included are the assumptions that steady flow conditions existed during the period the field measurements were made and that the boundary conditions remained rigid.

WSP requires a minimum of one (more are desirable) cross section measurement, with one water surface elevation for each cross section measured at that flow. The program was originally intended to yield the water surface profile as the end result; however, in the PHABSIM system, the end result is a set of velocities for each cross section and the water surface profiles. Application of the WSP program requires calibration of the data set for a particular site. Care must be taken to ensure an accurate calibration because the results affect the calculation of habitat. Figure II.23 flowcharts the steps in calibrating a WSP data set.

Typically, the weighted usable area predicted by the habitat simulation programs is much more sensitive to errors in the velocities than errors in the water surface elevations.

Refer to Figure II.2 for a flowchart of the various methods available to create a WSP data set. For information on what each line in the data set contains, instructions for entering data, and a sample WSP data set, refer to Appendix A - "WSP Data Set Format".

There are several hydraulic options available in the WSP program; however, most of them have a limited usefulness with PHABSIM. The options are summarized below in Table II.4. For a detailed explanation of the options, refer to "Guide to the Application of the Water Surface Profile Computer Program" (U.S. Bureau of Reclamation 1968).

CALIBRATING A WSP DATA SET

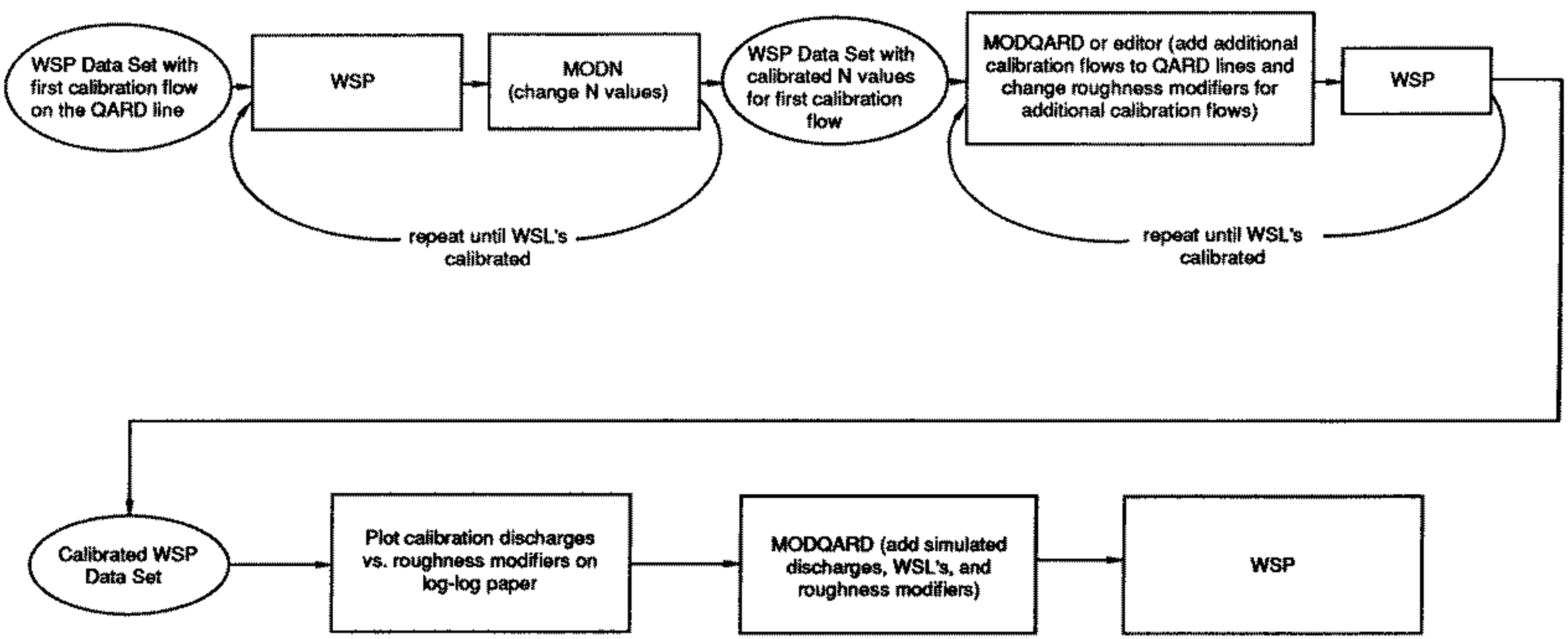


Figure II.23. Calibrating a WSP Data Set.

Table II.4. Options in the WSP Program.

OPTION	ACTION
1	Provides for a step change in discharge between cross sections. If option is turned on, a "CTR1" line is required. Refer to Appendix A for format. F = Do not provide for a step change in discharge. T = Provide for a step change in discharge.
2	Uses an observed water surface profile to evaluate channel roughness. The best fit between the computed and observed profile is obtained by varying the roughness coefficient (N). The maximum change in the roughness coefficient is plus or minus 0.038. Caution is suggested when using this option in instream flow studies due to the sensitivity of WUA to velocities. If option is turned on, a "CTR2" line is required and only one discharge can be run. See the U.S. Bureau of Reclamation (1968) manual for details concerning this option. Recommend setting to "F". F = Do not vary roughness coefficient. T = Vary roughness coefficient.
3	Allows for the accounting of sediment accumulation in the channel. Its main intent was for describing sediment buildup behind reservoirs, therefore it is not directly applicable to instream flow studies as other methods are more appropriate. If option is turned on, a "CTR3" line is required. See the U.S. Bureau of Reclamation (1968) manual for details concerning this option. Recommend setting to "F". F = Do not allow for elevation of sediment accumulation in channel. T = Allow for elevation of sediment accumulation in channel.
4	Produces output of hydraulic property tables for selected cross sections. The present output of WSP is considered more than sufficient for most instream flow studies. If option is turned on, a "CTR4" line is required. See the U.S. Bureau of Reclamation (1968) manual for details concerning this option. Recommend setting to "F". F = Do not produce hydraulic property tables. T = Produce hydraulic property tables.
5	Writes ZVOUT file containing formatted output of velocity calibration cells. Recommend setting to "F". F = Do not write ZVOUT file. T = Write ZVOUT file.
6	Determines what is written to TAPE3 (cross section and reach data). F = Write channel index value of 0.0 for each cell. T = Write roughness (Manning's N) in place of the channel index. The roughness will be the value given on the roughness lines.
7	Selects energy balance calculations, parameters, and equations. Consult a hydraulic engineer familiar with open channel flow when using the non-default options. If option is turned on, a "CTRF" line is required. Refer to Appendix A for format. F = Use standard averaging function. T = Allows user to select type of averaging function (i.e., Geometric mean, Harmonic mean, HEC friction loss function, Elliptical mean, Arithmetic mean).

Table II.4. (Concluded)

OPTION	ACTION
8	Overrides certain error processing by allowing a limit on the allowable change in energy loss between two sections to be overriden. WSP will not calculate the upstream water surface elevation if the change in elevation is larger than a specified amount and will not proceed further. Sometimes it is useful to review the results with a large change in water surface elevation between two cross sections. F = Do not override error processing. Production runs should be done with this option off as the underlying problem should be dealt with first. T = Overrides limit on allowable change in energy loss between two sections.
9	Writes the calculated slope to TAPE4 as an additional variable. If this option is selected, do not use the TAPE4 file as input to the habitat simulation programs. F = Do not write calculated slope to TAPE4. T = Write calculated slope to TAPE4.
10	Prints out cell details in the WSP output. Recommend setting to "F" for calibration runs and "T" for production runs. F = Print cell details. T = Do not print cell details.

NOTE: Refer to Appendix A - "WSP Data Set Format - PARD Line" for information on the critical constraint option.

II. RUNNING WSP

RWSP,ZWSP,ZOUT,TAPE3,TAPE4,TP4,ZVOUT

ZWSP=WSP data set (input)
ZOUT=WSP results (output)
TAPE3=unformatted cross section and reach data (output)
TAPE4=unformatted flow data (output)
TP4=rearranged TAPE4 file. Used as input to HABTAT (output)
ZVOUT=optional output file formatted for easy review of velocities. Created when option 5 is on. (output)

DO YOU WANT A SUMMARY OF STATISTICS FOR CALIBRATION? (YES OR NO):

Entering YES will run the LSTWSL program which lists the simulated water surface elevations from the generated output file to the screen or to an output file to be used in the calibration process.

The TAPE3 resulting from a WSP run does not contain channel index values.

Channel index values are not included in a WSP data set; thus they are not passed onto the TAPE3. Therefore, if the TAPE3 is going to be used as input to the habitat simulation programs, then channel index data must be added using the MODCI program.

Channel index values are used in the calculation of Weighted Usable Area (WUA) in habitat simulation. If all the channel index values are set to zero (0), the user can set an option in the habitat simulation programs that will either use a value of channel index value of zero in the calculation of WUA for that cell, or not use a channel index value of zero in the calculation of WUA for that cell (i.e., only use velocity times depth).

WSP does not write a TAPE4A or TP4A which can be used as input to HABTAM or HABTAV.

Appendix A contains the WSP data set that was used to generate the output in Figure II.24. Review the output file for error messages and inconsistancies in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort.

Below is a definition of the variables that may be written to WSP output. Not all of these variables are in the output for each cross section, but are usually located somewhere in the output from a WSP run.

HF1 =	Head loss for downstream section.
HF2 =	Head loss for upstream section.
HV1 =	Velocity head for downstream section.
HV2 =	Velocity head for upstream section.
HSF =	Slope of the energy grade line at the section.
Total Head =	Total head loss between sections.

```
              WSP - - INPUT CONTROL LINE AND ERROR LISTING

    PARD     7        1.      0        1.
    QARD   25.     95.6200             1.4700      1.4700
    QARD   50.     95.8600             1.3500      1.3500
    QARD  100.     96.1800             1.2400      1.2400
    QARD  250.     96.7500             1.1000      1.1000
    QARD  500.     97.3200             1.0100      1.0100
    QARD  750.     97.7400             0.9600      0.9600
    QARD 1000.     98.0800             0.9300      0.9300
    FFFFFFFFF                                                                       **
             0.   0.0    105.9   5.0   100.9  10.0    99.6  15.0  98.8  20.0  98.4  21.9  97.5     0.0
             0.  22.0     97.0  22.5    96.8  23.5    96.5  25.0  96.3  30.0  94.9  35.0  94.9     0.0
             0.  40.0     95.5  45.0    95.3  50.0    95.2  55.0  95.7  60.0  95.6  65.0  95.5     0.0
             0.  70.0     95.9  75.0    96.0  80.0    95.9  85.0  95.4  90.0  95.5  95.0  95.3     0.0
             0. 100.0     95.7 105.0    95.5 110.0    95.2 115.0  95.0  120.0 95.3 125.0  95.0     0.0
             0. 130.0     94.8 135.0    95.9 136.0    96.8 137.6  96.5  140.0 97.3 141.5  97.5     0.0
             0. 145.0     98.5 150.0    99.6 155.0   100.9 160.2 103.4   0.0   0.0   0.0   0.0     0.0
             0. 0.064      5.0   0.0   0.064  10.0     0.0 0.064  15.0   0.0 0.064  20.0   0.0     0.0 *
             0. 0.064     21.9   0.0   0.064  22.0     0.0 0.064  22.5   0.0 0.064  23.5   0.0     0.0 *
             0. 0.064     25.0   0.0   0.064  30.0     0.0 0.064  35.0   0.0 0.064  40.0   0.0     0.0 *
             0. 0.064     45.0   0.0   0.064  50.0     0.0 0.064  55.0   0.0 0.064  60.0   0.0     0.0 *
             0. 0.064     65.0   0.0   0.064  70.0     0.0 0.064  75.0   0.0 0.064  80.0   0.0     0.0 *
             0. 0.064     85.0   0.0   0.064  90.0     0.0 0.064  95.0   0.0 0.064 100.0   0.      0.0 *
             0. 0.064    105.0   0.0   0.064 110.0     0.0 0.064 115.0   0.0 0.064 120.0   0.0     0.0 *
             0. 0.064    125.0   0.0  -0.064 130.0     0.0 0.064 135.0   0.0 0.064 136.0   0.0     0.0 *
             0. 0.064    137.6   0.0   0.064 140.0     0.0 0.064 141.5   0.0 0.064 145.0   0.0     0.0 *
             0. 0.064    150.0   0.0   0.064 155.0     0.0 0.064 160.2   0.0 0.000   0.0   0.0     0.0 *
            67.   0.0    105.4   5.0   102.3  10.0   100.0  13.0  97.8  13.1  97.5  15.0  97.1     0.0
            67.  15.6     97.1  16.5    96.8  20.0    96.0  25.0  95.9  30.0  96.4  35.0  95.8     0.0
            67.  40.0     95.2  45.0    95.5  50.0    95.5  55.0  96.1  60.0  96.2  65.0  96.4     0.0
            67.  70.0     96.4  75.0    96.5  80.0    96.3  85.0  96.4  90.0  97.0  95.0  95.9     0.0
            67. 100.0     95.5 105.0    95.0 110.0    95.0 115.0  95.3 120.0  97.1 125.0  95.9     0.0
            67. 130.0     95.6 135.0    95.6 138.4    96.5 139.5  96.8 140.0  97.0 142.6  97.5     0.0
            67. 145.0     98.4 150.0    99.7 155.0   101.4 160.0 102.5 162.9 103.9   0.0   0.0     0.0
            67. 0.064      5.0   0.0   0.064  10.0     0.0 0.064  13.0   0.0 0.064  13.1   0.0     0.0 *
            67. 0.064     15.0   0.0   0.064  15.6     0.0 0.064  16.5   0.0 0.064  20.0   0.0     0.0 *
            67. 0.064     25.0   0.0   0.064  30.0     0.0 0.064  35.0   0.0 0.064  40.0   0.0     0.0 *
            67. 0.064     45.0   0.0   0.064  50.0     0.0 0.064  55.0   0.0 0.064  60.0   0.0     0.0 *
            67. 0.064     65.0   0.0   0.064  70.0     0.0 0.064  75.0   0.0 0.064  80.0   0.0     0.0 *
            67. 0.064     85.0   0.0   0.064  90.0     0.0 0.064  95.0   0.0 0.064 100.0   0.0     0.0 *
            67.-0.064    105.0   0.0   0.064 110.0     0.0 0.064 115.0   0.0 0.064 120.0   0.0     0.0 *
            67. 0.064    125.0   0.0   0.064 130.0     0.0 0.064 135.0   0.0 0.064 138.4   0.0     0.0 *
            67. 0.064    139.5   0.0   0.064 140.0     0.0 0.064 142.6   0.0 0.064 145.0   0.0     0.0 *
            67. 0.064    150.0   0.0   0.064 155.0     0.0 0.064 160.0   0.0 0.064 162.9   0.0     0.0 *
           132.   0.0    105.2   5.0   101.5   9.7    98.1  10.0  97.9  11.6  97.3  13.5  97.0     0.0
           132.  15.0     95.3  20.0    94.7  25.0    95.0  30.0  95.5  35.0  95.3  40.0  95.7     0.0
           132.  45.0     95.8  50.0    96.0  55.0    95.7  60.0  95.9  65.0  95.7  70.0  96.1     0.0
           132.  75.0     95.5  80.0    95.5  85.0    95.5  90.0  95.6  95.0  96.1 100.0  95.9     0.0
           132. 105.0     95.3 110.0    95.0 115.0    94.7 120.0  95.0 125.0  96.1 130.0  96.7     0.0
           132. 131.9     97.2 133.4    97.3 135.0    97.6 138.2  98.  140.0  99.0 145.0  99.7     0.0
           132. 150.0    100.5 155.0   101.0 160.0   103.5 161.4 104.3   0.0   0.0   0.0   0.0     0.0
           132. 0.064      5.0   0.0   0.064   9.7     0.0 0.064  10.0   0.0 0.064  11.6   0.0     0.0 *
           132. 0.064     13.5   0.0   0.064  15.0     0.0-0.064  20.0   0.0 0.064  25.0   0.0     0.0 *
           132. 0.064     30.0   0.0   0.064  35.0     0.0 0.064  40.0   0.0 0.064  45.0   0.0     0.0 *
           132. 0.064     50.0   0.0   0.064  55.0     0.0 0.064  60.0   0.0 0.064  65.0   0.0     0.0 *
           132. 0.064     70.0   0.0   0.064  75.0     0.0 0.064  80.0   0.0 0.064  85.0   0.0     0.0 *
           132. 0.064     90.0   0.0   0.064  95.0     0.0 0.064 100.0   0.0 0.064 105.0   0.0     0.0 *
           132. 0.064    110.0   0.0   0.064 115.0     0.0 0.064 120.0   0.0 0.064 125.0   0.0     0.0 *
           132. 0.064    130.0   0.0   0.064 131.9     0.0 0.064 133.4   0.0 0.064 135.0   0.0     0.0 *
           132. 0.064    138.2   0.0   0.064 140.0     0.0 0.064 145.0   0.0 0.064 150.0   0.0     0.0 *
           132. 0.064    155.0   0.0   0.064 160.0     0.0 0.064 161.4   0.0 0.000   0.0   0.0     0.0 *
    ENDJ
```

Figure II.24. Sample output from the WSP program.

SUMMARY OF PROFILE DATA

DISCHARGE	BEGINNING ELEVATION	ROUGHNESS MODIFIERS FOR, OVERBANK	MAIN CHANNEL	ESTIMATED BEGINNING HYDRAULIC GRADIENT
25.	95.62	1.47	1.47	REDUNDANT
50.	95.86	1.35	1.35	REDUNDANT
100.	96.18	1.24	1.24	REDUNDANT
250.	96.75	1.10	1.10	REDUNDANT
500.	97.32	1.01	1.01	REDUNDANT
750.	97.74	0.96	0.96	REDUNDANT
1000.	98.08	0.93	0.93	REDUNDANT

SUMMARY OF OPTIONS AND COORDINATE DATA

STATION	NUMBER OF ROUGHNESS SEGMENTS IN SECTION	ELEVATION OF SEDIMENT DELTA	ELEVATION OF OBSERVED PROFILE	INCREMENTAL DISCHARGE
0.	39	0.0	0.0	0.

NUMBER OF COORDINATE PAIRS = 40
OPTION PARAMETERS OF ZERO INDICATE A REDUNDANCY

ROUGHNESS CELL BOUNDARIES

RIGHT COORD.	5.0	10.0	15.0	20.0	21.9	22.0	22.5	23.5	25.0	30.0
ROUGHNESS	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
REACH LENGTH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIGHT COORD.	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0
ROUGHNESS	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
REACH LENGTH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIGHT COORD.	85.0	90.0	95.0	100.0	105.0	110.0	115.0	120.0	125.0	130.0
ROUGHNESS	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	-0.064
REACH LENGTH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIGHT COORD.	135.0	136.0	137.6	140.0	141.5	145.0	150.0	155.0	160.2	
ROUGHNESS	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	
REACH LENGTH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

COORDINATE DATA

X COORDINATES	0.00	5.00	10.00	15.00	20.00	21.90	22.00	22.50	23.50	25.00
Y COORDINATES	105.90	100.90	99.60	98.80	98.40	97.50	97.00	96.80	96.50	96.30
X COORDINATES	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00
Y COORDINATES	94.90	94.90	95.50	95.30	95.20	95.70	95.60	95.50	95.90	96.00
X COORDINATES	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	120.00	125.00
Y COORDINATES	95.90	95.40	95.50	95.30	95.70	95.50	95.20	95.00	95.30	95.00
X COORDINATES	130.00	135.00	136.00	137.60	140.00	141.50	145.00	150.00	155.00	160.20
Y COORDINATES	94.80	95.90	96.80	96.50	97.30	97.50	98.50	99.60	100.90	103.40

Figure II.24. (Continued)

```
89/01/09.      TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10   PROGRAM-WSP(IFG2)
16.54.18.                          SAMPLE CALIBRATED WSP DATA SET                                  PAGE    5

 STATION    0 +  0  ENGLISH SYSTEM      ASSUMED ELEV.    0.00    THALWEG ELEV.    94.8   THALWEG SLOPE  0.0000

 THIS IS A CONTROL SECTION -COMPUTATION LINE NOT REQD
```

LENGTH OF CENTROID	CONVEYANCE AREAS	TOP WIDTHS	HYDRAULIC RADII	ROUGHNESS COEFFICIENTS	CONVEYANCE FACTORS	VELOCITIES	DISCHARGES

NOTE: The following 20 lines of information WOULD NOT be printed if Option 10 was set to "T".

0.0	0.9	2.6	0.3	0.09408	7.	0.77	1
0.0	3.6	5.0	0.7	0.09408	46.	1.26	5
0.0	2.1	5.0	0.4	0.09408	19.	0.87	2
0.0	1.1	5.0	0.2	0.09408	6.	0.57	1
0.0	1.9	5.0	0.4	0.09408	15.	0.81	1
0.0	0.9	4.2	0.2	0.09408	5.	0.55	0
0.0	0.0	1.0	0.0	0.09408	0.	0.07	0
0.0	0.4	5.0	0.1	0.09408	1.	0.27	0
0.0	0.1	1.5	0.1	0.09408	0.	0.24	0
0.0	0.2	2.2	0.1	0.09408	1.	0.36	0
0.0	0.9	5.0	0.2	0.09408	4.	0.48	0
0.0	1.1	5.0	0.2	0.09408	6.	0.57	1
0.0	0.6	4.0	0.2	0.09408	3.	0.46	0
0.0	0.2	3.0	0.1	0.09408	0.	0.24	0
0.0	1.4	5.0	0.3	0.09408	9.	0.65	1
0.0	2.6	5.0	0.5	0.09408	27.	1.01	3
0.0	2.4	5.0	0.5	0.09408	22.	0.94	2
0.0	2.4	5.0	0.5	0.09408	22.	0.94	2
0.0	3.6	5.0	0.7	-0.09408	46.	1.25	5
0.0	1.5	3.7	0.4	0.09408	13.	0.85	1
SUM OR AVG	28.	82.	0.4	0.09408	253.	1.01	25

```
 THIS SECTION HAS 39 ROUGHNESS SEGMENT(S). 20 SEGMENT(S) WERE USED FOR THIS DISCHARGE.
 THIS SECTION IS AN INITIAL CONTROL - FLOW IS SUB-CRITICAL - COMPUTED SLOPE =  0.00979    W.S. ELEV. =  95.62
```

SECTIONS OF SAMPLE OUTPUT HAVE BEEN DELETED HERE FOR BREVITY.

NOTE: This type of output is generated for each flow for each cross section.

```
ENDR
```

Figure II.24. (Concluded)

III. WSP ERROR MESSAGES

Refer to Appendix A for "WSP Data Set File Format".

1. **NO PARD LINE FOUND IN WSP DATA SET.**
   Either the PARD line is missing or only one title line was used and the PARD line was read as the second title line.

2. **INVALID TYPE -- NOT METERS OR BLANK.**
   Field on the PARD line indicating units of measurement used was something other than Blank for English or METERS for Metric.

3. **CRITICAL DISCHARGE CONSTANT INVALID.**
   Field on the PARD line indicating critical discharge constant contains something other than "0" or "1".

4. **MAXIMUM OF --- DISCHARGES EXCEEDED.**
   There are more QARD lines than indicated on the PARD line.

5. **NO DISCHARGES SPECIFIED.**
   Either there are no QARD lines or the field on the PARD line indicating the number of flows to be run was left blank.

6. **NO QARD LINE FOUND IN WSP DATA SET.**
   Either there are no QARD lines or the field on the PARD line indicating the number of flows to be run is greater than the number of QARD lines.

7. **EXPECTED LINE NOT RECEIVED -- CHECK DATA SET STRUCTURE.**
   Either lines are out of order, a line is missing, or there is a blank line in the data set.

8. **INVALID CHARACTER IN OPTION SELECTION.**
   Valid option values on the Option Contol Line are F, T, or blank (blank=F). Something other than these values has been entered.

9. **INVALID OPTION SPECIFIED.**
   Option has been turned on, but the appropriate CTR Line has not been supplied for that option.

10. **OPTION LINE RECEIVED FOR UNSELECTED OPTION.**
    CTR lines have been supplied for an option, but the related option has not been turned on.

11. **MORE THAN THE SPECIFIED NO. OF OPTIONS -- RECEIVED.**
    Either this error or error 10 above will appear if CTR lines were supplied for an option, but the related option was not turned on.

12. **NUMBER OF OPTIONS RECEIVED DOES NOT EQUAL NUMBER SPECIFIED NUM. REC= --- NUM. SPEC.=---.**
    This error is somewhat redundant. If error 8, 9, 10, or 11 is listed, this will probably be listed also.

13. **MAXIMUM OF --- CROSS SECTIONS EXCEEDED.**
On some CTR lines you are asked to enter the number for cross sections that the option applies to. This error appears if data is not supplied for the number of cross sections specified, or if data is missing, or if the number specified is greater than 100.

14. **STATIONS ARE NOT IN ASCENDING ORDER FROM LOWEST TO HIGHEST ON INPUT LINE.**
The coordinate and roughness line stationing must increase from low to high on the input line. If this message appears, the cross section stationing does not consistently increase as you move away from the zero point. Check the X coordinates on both the Coordinate and Roughness lines. This message may also appear if an asterisk (*) is missing from the last Roughness line in a series.

15. **MAXIMUM OF 99 SEGMENTS EXCEEDED.**
The program is dimensioned to handle up to 99 roughness segments per cross section. These roughness segments are entered on the Roughness lines.

16. **NO ROUGHNESS SEGMENTS PROVIDED.**
There are no Roughness lines in the data set; or there is not an asterisk (*) in Column 80 on a Roughness line; or there is not a minus sign on the roughness coefficient indicating the thalweg or main channel.

17. **YTRAN CANNOT BE EQUAL TO ZERO.**
Zero is not a valid value for the elevation increment or slope for elevation transposition which was entered in Columns 71-75 on the Roughness lines.

18. **FIRST ROUGHNESS SEGMENT OUTSIDE COORDINATE BOUNDS.**
Usually refers to the left side coordinates on the Roughness lines. The first right boundary of the first roughness segment has been entered as being before the first coordinate station (i.e., outside the coordinate data set). For example, the first station on the Roughness line is at 10 feet, but the first station on the Coordinate line is 20.

19. **NO POINT TO LEFT OF FIRST POINT.**
Similar to #18. Usually occurs when the first roughness segment coordinate is given as zero.

20. **RIGHT HAND ROUGHNESS SEGMENT ESTABLISHED AT RIGHT HAND COORDINATE POINT.**
The right-most roughness segment boundary is less than the right-most coordinate. The program adds a roughness segment to be a cell between the last right-hand roughness segment and the right-most coordinate.

21. **NO THALWEG VALUE PROVIDED FOR THIS CROSS SECTION.**
No minus sign has been entered to mark the thalweg or main channel roughness segment.

22. **OVERBANK RULE VIOLATED.**
If an overbank (no minus sign) roughness segment is assigned to one side of the main channel or thalweg, an overbank roughness segment must be assigned to the other side. Also, if one cross section has overbank roughness segments, all other cross sections must have them as well. This could also happen if the thalweg is squeezed over to one side of the channel and it is the first roughness segment.

23. **STATION SPACING OR CRITICAL CONSTRAINT IS PROJECTED TOO FAR.**
This error usually occurs when there is a large elevation change between two cross sections. This could imply that your stations are too far apart. However, when the elevation change is extreme, distance between stations could be quite small and still produce this problem. Remedy this by establishing an intermediate cross section to reduce the step change in elevation.

24. **UNEXPECTED END OF FILE.**
The ENDJ or ENDR lines are missing from the data set, or you are trying to run an empty input file.

25. **NO COORDINATE DATA PROVIDED FOR DOWNSTREAM CROSS SECTION.**
No coordinate data was entered and there was not an elevation increment or slope entered into Columns 71-75 on a Roughness line.

26. **ZERO-ENERGY BALANCE VOIDED W.S. ELEV= ---**
This is a warning that the slope of the stream is so small that it is almost level. The program cannot detect an energy loss. Since it cannot be negative, that would indicate water was running uphill, the program set the value to "0".

27. **WARNING - ONLY ONE CROSS SECTION IN THIS DATA SET.**
Since WSP uses the step-backwater method to predict water surface elevations, it uses the water surface elevations at the first cross section, which are given. Therefore, if only one cross section is in the data set, no water surface elevations are being predicted.

WSPTOHC Program

I. INTRODUCTION

The WSPTOHC program converts a WSP data set to an HEC2 input file.

The HEC2 program is not part of PHABSIM, but it can be used to determine water surface elevations. The HEC2 program uses step backwater calculations to determine water surface elevations.

The HEC2 program was developed, and is supported, by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. Refer to the "HEC-2 Water Surface Profile Users Manual" for program documentation.

II. RUNNING WSPTOHC

RWSPTHC,ZWSP,ZHEC2

ZWSP=WSP data set (input)
ZHEC2=HEC2 input file (output)

Figure II.25 contains an HEC2 input file resulting from running WSPTOHC on the Sample WSP Data Set in Appendix A.

```
T1TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10
T2SAMPLE CALIBRATED WSP DATA SET
T3 ORIGINAL DATA WAS FOR THE WSP PROGRAM  88/06/30.
J1             2                0.000000       0     0.5      0.    95.6
J2     1       1       0       0       0  1.4700     2.5       6              00
J3    38      43       1       4       5       6       7       8      10
QT     7     25.     50.    100.    250.    500.    750.   1000.
NC 0.064 0.06400 0.06400 0.10000 0.50000
X1     0      40   125.0   130.0     0.0     0.0     0.0             0.0      00
GR 105.9     0.0   100.9     5.0    99.6    10.0    98.8    15.0    98.4    20.0
GR  97.5    21.9    97.0    22.0    96.8    22.5    96.5    23.5    96.3    25.0
GR  94.9    30.0    94.9    35.0    95.5    40.0    95.3    45.0    95.2    50.0
GR  95.7    55.0    95.6    60.0    95.5    65.0    95.9    70.0    96.0    75.0
GR  95.9    80.0    95.4    85.0    95.5    90.0    95.3    95.0    95.7   100.0
GR  95.5   105.0    95.2   110.0    95.0   115.0    95.3   120.0    95.0   125.0
GR  94.8   130.0    95.9   135.0    96.8   136.0    96.5   137.6    97.3   140.0
GR  97.5   141.5    98.5   145.0    99.6   150.0   100.9   155.0   103.4   160.2
NC 0.064 0.06400 0.06400 0.10000 0.50000
X1    67      41   100.0   105.0    67.0    67.0    67.0             0.0      00
GR 105.4     0.0   102.3     5.0   100.0    10.0    97.8    13.0    97.5    13.1
GR  97.1    15.0    97.1    15.6    96.8    16.5    96.0    20.0    95.9    25.0
GR  96.4    30.0    95.8    35.0    95.2    40.0    95.5    45.0    95.5    50.0
GR  96.1    55.0    96.2    60.0    96.4    65.0    96.4    70.0    96.5    75.0
GR  96.3    80.0    96.4    85.0    97.0    90.0    95.9    95.0    95.5   100.0
GR  95.0   105.0    95.0   110.0    95.3   115.0    97.1   120.0    95.9   125.0
GR  95.6   130.0    95.6   135.0    96.5   138.4    96.8   139.5    97.0   140.0
GR  97.5   142.6    98.4   145.0    99.7   150.0   101.4   155.0   102.5   160.0
GR 103.9   162.9
```

Figure II.25. Sample HEC2 input file resulting from running WSPTOHC on a WSP data set.

```
NC 0.064 0.06400 0.06400 0.10000 0.50000
X1   132       40    15.0    20.0    65.0    65.0    65.0             0.0      00
GR 105.2      0.0   101.5     5.0    98.1     9.7    97.9    10.0    97.3    11.6
GR  97.0     13.5    95.3    15.0    94.7    20.0    95.0    25.0    95.5    30.0
GR  95.3     35.0    95.7    40.0    95.8    45.0    96.0    50.0    95.7    55.0
GR  95.9     60.0    95.7    65.0    96.1    70.0    95.5    75.0    95.5    80.0
GR  95.5     85.0    95.6    90.0    96.1    95.0    95.9   100.0    95.3   105.0
GR  95.0    110.0    94.7   115.0    95.0   120.0    96.1   125.0    96.7   130.0
GR  97.2    131.9    97.3   133.4    97.6   135.0    98.1   138.2    99.0   140.0
GR  99.7    145.0   100.5   150.0   101.0   155.0   103.5   160.0   104.3   161.4
EJ
T1TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10
T2SAMPLE CALIBRATED WSP DATA SET
T3 ORIGINAL DATA WAS FOR THE WSP PROGRAM  88/06/30.
J1             3                0.000000       0     0.5      0.    95.9
J2     2       0        0       0       0 1.3500     2.5       6               00
T1TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10
T2SAMPLE CALIBRATED WSP DATA SET
T3 ORIGINAL DATA WAS FOR THE WSP PROGRAM  88/06/30.
J1             4                0.000000       0     0.5      0.    96.2
J2     3       0        0       0       0 1.2400     2.5       6               00
T1TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10
T2SAMPLE CALIBRATED WSP DATA SET
T3 ORIGINAL DATA WAS FOR THE WSP PROGRAM  88/06/30.
J1             5                0.000000       0     0.5      0.    96.7
J2     4       0        0       0       0 1.1000     2.5       6               00
T1TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10
T2SAMPLE CALIBRATED WSP DATA SET
T3 ORIGINAL DATA WAS FOR THE WSP PROGRAM  88/06/30.
J1             6                0.000000       0     0.5      0.    97.3
J2     5       0        0       0       0 1.0100     2.5       6               00
T1TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10
T2SAMPLE CALIBRATED WSP DATA SET
T3 ORIGINAL DATA WAS FOR THE WSP PROGRAM  88/06/30.
J1             7                0.000000       0     0.5      0.    97.7
J2     6       0        0       0       0 0.9600     2.5       6               00
T1TAYLOR RIVER IFG4, 3 FLOWS OF 162,254,AND 591 CFS   HIGH FLOW SET,NMAX0.10
T2SAMPLE CALIBRATED WSP DATA SET
T3 ORIGINAL DATA WAS FOR THE WSP PROGRAM  88/06/30.
J1             8                0.000000       0     0.5      0.    98.1
J2    15       0        0       0       0 -0.9300    2.5       6               00


ER
```

Figure II.25. (Concluded)

III. CROSS SECTION AND HYDRAULIC PROPERTIES FILE PROGRAMS (TAPE3 AND TAPE4/TP4 OR TAPE4A/TP4A)

INTRODUCTION

The TAPE3 and TAPE4/TP4 (TAPE4A/TP4A) files are unformatted files generated from the hydraulic simulation programs; where TAPE3 contains cross section and reach data, TAPE4 contains flow data, and TP4 is a rearranged TAPE4 in a format acceptable by the habitat simulation programs.

TP4 can be used in place of TAPE4 in any of the programs in this group. Also TAPE4A can be used in place of TAPE4, and TP4A can be used in place of TP4. TAPE4A and TP4A contain the cell velocities calculated at the verticals when IOC(17)=1 in the IFG4 program, IOC(11)=2 in the MANSQ program, or Option 1 is selected in the DIRI4 program. TAPE4A and TP4A are used as input to the HABTAM or HABTAV habitat simulation programs.

When the cell velocities are calculated at the verticals to be used with HABTAM or HABTAV, the TAPE4 and TP4 resulting from the hydraulic simulation program must be renamed to TAPE4A and TP4A by the user, or TAPE4A and TP4A should be substituted in place of the default output filenames for TAPE4 and TP4.

The programs presented in this chapter allow the user to list, modify, extract, or combine information from various TAPE3 or TAPE4/TP4 files. Programs are also available to convert the files from unformatted to formatted files and vice versa to allow them to be transferred from computer to computer.

The selection of partial data from the TAPE3 or TAPE4/TP4 files may be desired in some instream flow studies to analyze the physical habitat versus streamflow relationship for an individual cross section or for a series of cross sections less than the total series for a study reach. Also, detailed analysis sometimes needs to be done for one streamflow but not for all of the flows simulated in the hydraulic simulation program.

LISTING INFORMATION FROM TAPE3 AND TAPE4(TP4) FILES

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
LSTTP3	**RLSTTP3**	TAPE3 Listing	Lists the contents of a TAPE3 file. **RLSTTP3,ZOUT,TAPE3** **ZOUT**=LSTTP3 results (output) **TAPE3**=unformatted cross section and reach data (input)
LSTTP4	**RLSTTP4**	TAPE4 Listing	Lists the contents of a TAPE4 file. **RLSTTP4,ZOUT,TAPE4** **ZOUT**=LSTTP4 results (output) **TAPE4**=unformatted flow data (input)
LSTP34	**RLSTP34**	TAPE3/4 Listing	Lists the contents of a TAPE3 and TAPE4 file. **RLSTP34,ZOUT,TAPE3,TAPE4** **ZOUT**=LSTP34 results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)
CMPWSL	**RCMPWSL**	TAPE4 Listing	Compares the water surface elevations in two TAPE4 files. **RCMPWSL,TAPE4A,TAPE4B,ZOUT,TAPE3** **TAPE4A**=TAPE4 file (input) **TAPE4B**=TAPE4 file (input) **ZOUT**=WSL comparison listing of the two TAPE4's (output) **TAPE3**=title lines read from the TAPE3, if supplied. If not supplied, user is prompted to enter two title lines (input)

LISTING INFORMATION FROM TAPE3 AND TAPE4(TP4) FILES (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
CMPVL4	**RCMPVL4**	TAPE4 Listing	Compares the velocities from up to six TAPE4's. The TAPE4's being compared are usually created using alternative approaches to velocity calculations for the same water surface elevations and discharges. **RCMPVL4,ZOUT,TAPE3,TAPE4A,TAPE4B, TAPE4C,TAPE4D,TAPE4E,TAPE4F** **ZOUT**=CMPVL4 results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4A...TAPE4F**=up to six unformatted flow data files. TAPE4A and TAPE4B are required (input)
LSTVD	**RLSTVD**	TAPE3/4 Listing	Lists the velocities and depths of the cells, and cross section data that are found on a TAPE3 and TAPE4. **RLSTVD,ZOUT,TAPE3,TAPE4** **ZOUT**=LSTVD results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)

EXTRACTING AND COMBINING DATA FROM TAPE3 AND TAPE4(TP4) FILES

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
EXT3C1	**REXT3C1**	TAPE3 Manipulation	Transfers two title lines and one set of cross section data from one TAPE3 to a new TAPE3. **REXT3C1,TAPE3,TAPE3N** **TAPE3**=unformatted cross section and reach data (input) **TAPE3N**=new TAPE3 with one set of cross section and reach data (output)
EXT4C1	**REXT4C1**	TAPE4 Manipulation	Transfers flow data for one cross section from one TAPE4 to a new TAPE4. **REXT4C1,TAPE4,TAPE4N** **TAPE4**=unformatted flow data (input) **TAPE4N**=new TAPE4 with flow data for one cross section (output)
EXTQT4	**REXTQT4**	TAPE4 Manipulation	Transfers one set of flow data for all cross sections from one TAPE4 to a new TAPE4. **REXTQT4,TAPE4,TAPE4N** **TAPE4**=unformatted flow data (input) **TAPE4N**=new TAPE4 with flow data for one discharge (output)
EXT3T4	**REXT3T4**	TAPE3/4 Manipulation	Transfers one or more sets of cross section data for one or more flows from one TAPE3/TAPE4 set to a new TAPE3/TAPE4 set. **REXT3T4,TAPE3,TAPE4,TAPE3N,TAPE4N** **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input) **TAPE3N**=new TAPE3 with one or more sets of unformatted cross section and reach data (output) **TAPE4N**=new TAPE4 with one or more sets of unformatted flow data (output)

EXTRACTING AND COMBINING DATA FROM TAPE3 AND TAPE4(TP4) FILES (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
COMTP3	**RCOMTP3**	TAPE3 Manipulation	Combines two TAPE3 files. **RCOMTP3,TAPE3A,TAPE3B,TAPE3N** **TAPE3A**=unformatted cross section and reach data (input) **TAPE3B**=unformatted cross section and reach data (input) **TAPE3N**=combined TAPE3 files (output)
COMTP4	**RCOMTP4**	TAPE4 Manipulation	Combines two TAPE4 files. User can select option to specify a division flow where flows less than or equal to the division flow are transferred from the first TAPE4 and combined with flows greater than the division flow from the second TAPE4. **RCOMTP4,TAPE4A,TAPE4B,TAPE4N** **TAPE4A**=unformatted flow data (input) **TAPE4B**=unformatted flow data (input) **TAPE4N**=combined TAPE4 files (output)

MODIFYING TAPE3 AND TAPE4(TP4) FILES

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
ADDBEND	**RADBEND**	TAPE3 Modification	Adds left and right bend weights to a TAPE3. **RADBEND,TAPE3,TAPE3N** **TAPE3**=unformatted cross section and reach data (input) **TAPE3N**=modified TAPE3 with left and right bend weights added (output)
MODRLW	**RMODRLW**	TAPE3 Modification	Changes cross section weights and reach lengths on a TAPE3 file. **RMODRLW,TAPE3,TAPE3N** **TAPE3**=unformatted cross section and reach data (input) **TAPE3N**=modified TAPE3 file (output)

MODIFYING TAPE3 AND TAPE4(TP4) FILES (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
ENTCI	**RENTCI**	TAPE3 Modification	Interactive program to create a file containing channel index data, reach lengths, and weighting factors to be run through MODCI to modify a TAPE3 (generally used with WSP). **RENTCI,ZCHANF** **ZCHANF**=file containing channel index data (output)
MODCI	**RMODCI**	TAPE3 Modification	Adds or modifies channel index data, reach lengths, and weighting factors in a TAPE3. Option of entering data from the keyboard or reading data from a file created by ENTCI. **RMODCI,TAPE3,TAPE3N,ZCHANF** **TAPE3**=unformatted cross section and reach data (input) **TAPE3N**=modified TAPE3 file with channel index data added (output) **ZCHANF**=file containing channel index data (input)
CHSTA4	**RCHSTA4**	TAPE4 Modification	Changes station (cross section) ID numbers on a TAPE4. **RCHSTA4,TAPE4,TAPE4N** **TAPE4**=unformatted flow data (input) **TAPE4N**=modified TAPE4 with new station (cross-section) ID numbers (output)

CONVERTING TAPE3 AND TAPE4(TP4) FILES

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
UTP34F	**RUTP34F**	TAPE3/4 Conversion	Converts an unformatted TAPE3 or TAPE4 to a formatted TAPE3F or TAPE4F. **RUTP34F,TAPE3,TAPE3F,TAPE4,TAPE4F** (if only a TAPE4 is to be converted, use: RUTP34F,TAPE4,TAPE4F) **TAPE3**=unformatted cross section and reach data (input) **TAPE3F**=formatted cross section and reach data (output) **TAPE4**=unformatted flow data (input) **TAPE4F**=formatted flow data (output)
FTP34U	**RFTP34U**	TAPE3/4 Conversion	Converts a formatted TAPE3F or TAPE4F to an unformatted TAPE3 or TAPE4. **RFTP34U,TAPE3F,TAPE3,TAPE4F,TAPE4** (if only a TAPE4 is to be converted, use: RFTP34U,TAPE4F,TAPE4) **TAPE3F**=formatted cross section and reach data (input) **TAPE3**=unformatted cross section and reach data (output) **TAPE4F**=formatted flow data (input) **TAPE4**=unformatted flow data (output)

MISCELLANEOUS TAPE3 AND TAPE4(TP4) PROGRAMS

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
DIRI4 & PHABAR2	**RDIRI4**	TAPE3/4 -- Miscellaneous	Creates a TAPE3 and TAPE4 based on the data contained in the IFG4 data set. Used when simulation of additional velocities is not desired. **RDIRI4,ZIFG4,TAPE3,TAPE4,TP4** **ZIFG4**=IFG4 data set (input) **TAPE3**=unformatted cross section and reach data (output) **TAPE4**=unformatted flow data (output) **TP4**=rearranged TAPE4 file. Used as input to HABTAT (output). If Option 1 is selected in DIRI4, the TAPE4 and TP4 files will be in HABTAM and HABTAV readable format. These files need to be renamed to TAPE4A and TP4A by the user.
LSTWLF	**RLSTWLF**	TAPE3/4 -- Miscellaneous	Lists water surface elevations on a TAPE4, and calculates and lists the Froude number and mean channel velocities for each cross section and each flow. **RLSTWLF,ZOUT,TAPE3,TAPE4** **ZOUT**=LSTWLF results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)

MISCELLANEOUS TAPE3 AND TAPE4(TP4) PROGRAMS (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
PHABAR2 & PHABARR	RPHABAR	TAPE4 -- Miscellaneous	Rearranges a TAPE4 and writes a TP4. **RPHABAR,TAPE4,TP4,POS** **TAPE4**=unformatted flow data (input) **TP4**=rearranged TAPE4 file (output) **POS**= -1 Leaves negative velocities as negative numbers. (PHABARR) **POS**= 1 Converts negative velocities to positive numbers. (PHABAR2) (default is POS = 1) (PHABAR2) Run by the RIFG4, RWSP, and RDIRI4 batch/procedure files.
PHABRTN	RPHBRTN	TAPE4 -- Miscellaneous	Converts a TP4 file back to a TAPE4 file. **RPHBRTN,TP4,TAPE4** **TP4**=rearranged TAPE4 file of unformatted flow data (input) **TAPE4**=unformatted flow data (output)

ADDBEND Program

I. INTRODUCTION

The ADDBEND program adds left and right bend weights to a TAPE3. The normal use of the habitat simulation programs assumes the reach length is the same for all cells in a cross section. This is the same as assuming the stream is straight.

The assumption of a straight stream usually does not lead to any significant loss in the accuracy of the calculated weighted usable area, but there are cases where the bends are significant.

For a bend such as shown in Figure III.1, the reach length is assumed to be proportional to the fraction of the stream width the cell lies from the stream's edge. The cell's length can be calculated from the average reach length (RL), the multiplier for the bend on the left side (WL), and the multiplier for the bend on the right side (WR).

If ADDBEND has been run on a TAPE3, IOC(12) must be set to "1" in the habitat simulation programs. If IOC(12) is set to "1", and left and right bend weights have NOT been added with ADDBEND, the program will abort and the output file will contain a message "List Exceeds Data - Filename TAPE3".

II. RUNNING ADDBEND

RADBEND,TAPE3,TAPE3N

TAPE3=unformatted cross section and reach data (input)
TAPE3N=modified TAPE3 with left and right bend weights added (output)

<u>The following prompt will be asked for each cross section on the TAPE3</u>:

ENTER WEIGHT FOR BEND ON LEFT AND RIGHT SIDE
OF CROSS SECTION --- (WL,WR):

Figure III.1. is a diagram of how to determine left and right bend weights.

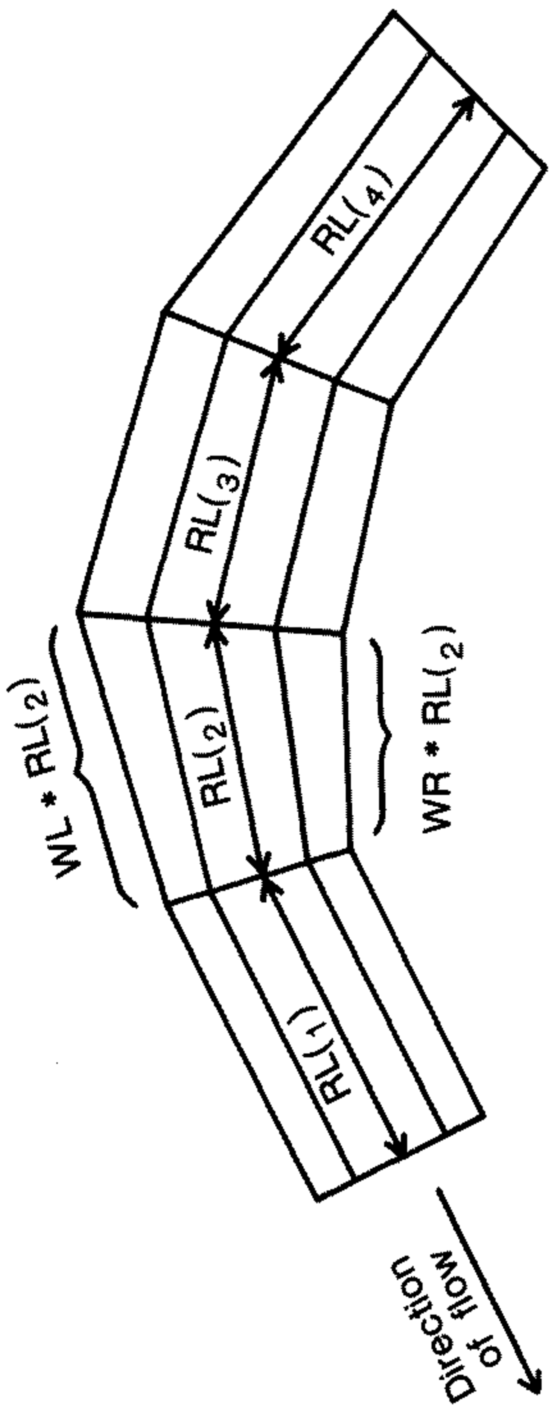


Figure III.1 Determination of bend weights on a bend.

CHSTA4 Program

I. INTRODUCTION

The CHSTA4 program changes station (cross section) ID numbers on a TAPE4. It is most often used when an IFG4 data set using consecutive ID numbering is converted to a WSP data set using stationing as cross section ID numbering. If WSP is run on the WSP data set and the water surface elevations written to the TAPE4 are to be read back into the IFG4 data set using WSEI4, the cross section ID numbering will be different on the TAPE4 than in the IFG4 data set. Therefore, CHSTA4 must be run to change the cross section ID numbering to match the IFG4 data set.

II. RUNNING CHSTA4

RCHSTA4,TAPE4,TAPE4N

TAPE4=unformatted flow data (input)
TAPE4N=modified TAPE4 with new station (cross section) ID numbers (output)

STATION = --- ENTER NEW STATION ID:

This prompt will appear for each cross section on the TAPE4.

NUMBER OF FLOWS SIMULATED = ---

CMPVL4 Program

I. INTRODUCTION

The CMPVL4 program compares the velocities from up to six TAPE4's (TP4's, TAPE4A's, or TP4A's). The TAPE4's being compared are usually created using alternative approaches to velocity calculations for the same water surface elevations and discharges.

For example, you may wish to compare the velocities calculated by running IFG4 using one velocity set vs. using no velocity sets; or compare the results of the velocities calculated by IFG4 vs. MANSQ, etc.

II. RUNNING CMPVL4

RCMPVL4,ZOUT,TAPE3,TAPE4A,TAPE4B,TAPE4C,TAPE4D,TAPE4E,TAPE4F

ZOUT=CMPVL4 results (output)
TAPE3=unformatted cross section and reach data (input)
TAPE4A...TAPE4F=up to six unformatted flow data files.
TAPE4A and TAPE4B are required (input)

The two title lines from the TAPE3 used as input will be listed.

ENTER 1 TO LIST ONE SET OF VELOCITIES TO SCREEN
0 TO LIST ALL VELOCITIES TO AN ALTERNATIVE FILE

<u>If "1" is selected</u>, the following prompts appear and the information will appear on the screen; no output file is created.

DISCHARGES FOUND ON FIRST TAPE4 ARE-

Discharges will be listed here

ENTER THE DISCHARGE YOU WANT TO LIST:

ENTER LABELS FOR EACH FLOW DATA SET, MAX 10 CHARS - (ONE LABEL PER LINE)

Figure III.2 contains sample output from the CMPVL4 program.

```
88/09/06.     UPPER SALMON RIVER, NEAR STANLEY,                                            PROGRAM - CMPVL4
09.07.46.     IFG4 DATA SET WITH WSL LINES ADDED FROM MANSQ AND ZERO VELOCITY SETS           PAGE -    2

        SECTION -        0.00          DISCHARGE -       8.00          WATER SURFACE ELEVATION -    97.680

                                                  VELOCITIES

                                            0 VEL Sets  1 VEL Set

                                     1          0.86        0.46
                                     2          1.17        0.62
                                     3          0.30        0.16
                                     4          0.30        0.16
                                     5          0.30        0.16
                                     6          0.52        0.62
                                     7          1.23        1.51
                                     8          1.57        1.59
                                     9          1.88        1.78
                                    10          1.88        2.22
                                    11          1.39        1.90
                                    12          1.23        1.40
                                    13          0.70        0.63
                                    14          0.30        0.42
                                    15          0.61        0.54
                                    16          0.30        0.12
```

ONLY THE COMPARISON FOR THE FIRST CROSS SECTION AND THE FIRST FLOW ARE INCLUDED IN THIS SAMPLE OUTPUT.

Figure III.2 Sample output from the CMPVL4 program.

CMPWSL Program

I. INTRODUCTION

The CMPWSL program compares the water surface elevations in two TAPE4's (TP4's, TAPE4A's, or TP4A's). The cross section ID number, discharge, water surface elevation from the first TAPE4, water surface elevation from the second TAPE4, and the difference between the two are written to the output file.

II. RUNNING CMPWSL

RCMPWSL,TAPE4A,TAPE4B,ZOUT,TAPE3

TAPE4A=TAPE4 file (input)
TAPE4B=TAPE4 file (input)
ZOUT=WSL comparison listing of the two TAPE4's (output)
TAPE3=title lines read from the TAPE3, if supplied.
If not supplied, user is prompted to enter two title lines (optional, input)

```
ENTER TITLE FOR THE FIRST SET (60 CHAR MAX):

ENTER TITLE FOR THE SECOND SET (60 CHAR MAX):
```

The output in Figure III.3 is a comparison of the results of running IFG4 and MANSQ on the same data.

```
DATE - 88/06/16.      TIME - 15.35.15.      PROGRAM - CMPWSL     PAGE -  1

    UPPER SALMON RIVER, NEAR STANLEY, IDAHO
    CROSS SECTIONS 0 AND 14.3

         FIRST SET - PREDICTED WSL'S FROM IFG4

        SECOND SET - PREDICTED WSL'S FROM MANSQ
```

C/S ID	DISCHARGE	FIRST SET	SECOND SET	DIFFERENCE
0.00	8.00	97.66	97.68	-0.02
0.00	10.00	97.70	97.72	-0.02
0.00	20.00	97.85	97.84	0.01
0.00	30.00	97.96	97.93	0.02
0.00	40.00	98.05	98.01	0.04
0.00	50.00	98.12	98.08	0.04
0.00	60.00	98.19	98.13	0.05
0.00	70.00	98.25	98.19	0.06
0.00	80.00	98.30	98.23	0.07
0.00	90.00	98.35	98.28	0.07
0.00	100.00	98.40	98.32	0.08
0.00	110.00	98.44	98.36	0.08
0.00	120.00	98.49	98.40	0.09
0.00	130.00	98.53	98.44	0.09
14.30	8.00	98.04	98.04	0.01
14.30	10.00	98.08	98.08	0.01
14.30	20.00	98.22	98.22	0.00
14.30	30.00	98.32	98.32	0.00
14.30	40.00	98.40	98.40	0.00
14.30	50.00	98.47	98.47	0.00
14.30	60.00	98.53	98.53	0.00
14.30	70.00	98.58	98.58	0.01
14.30	80.00	98.63	98.62	0.01
14.30	90.00	98.68	98.66	0.02
14.30	100.00	98.72	98.70	0.02
14.30	110.00	98.76	98.73	0.03
14.30	120.00	98.80	98.77	0.03
14.30	130.00	98.83	98.80	0.04

```
   NORMAL END OF JOB
```

Figure III.3 Sample output from the CMPWSL program.

COMTP3 Program

I. INTRODUCTION

The COMTP3 program combines two TAPE3 files.

II. RUNNING COMTP3

RCOMTP3,TAPE3A,TAPE3B,TAPE3N

TAPE3A=unformatted cross section and reach data (input)
TAPE3B=unformatted cross section and reach data (input)
TAPE3N=combined TAPE3's (output)

The title lines from the two TAPE3 files will be listed.

ENTER TWO LINE TITLE FOR NEW TAPE3N:

THE REACH LENGTH FOR THE FIRST CROSS SECTION
ON THE SECOND TAPE3 FILE IS:
ENTER A NEW REACH LENGTH OR -1 TO LEAVE AS IS:

The COMTP3 program adds the second TAPE3 onto the end of the first TAPE3. Most often, the reach length on the first cross section on a TAPE3 is zero. This is not the desired reach length when it becomes a mid-section. This prompt allows the user to change the reach length on the first cross section of the second TAPE3 file when two TAPE3 files are being combined.

COMTP4 Program

I. INTRODUCTION

The COMTP4 program combines two TAPE4 files. User can select option to specify a division flow where flows less than or equal to the division flow are transferred from the first TAPE4 and combined with flows greater than the division flow from the second TAPE4.

II. RUNNING COMTP4

RCOMTP4,TAPE4A,TAPE4B,TAPE4N

TAPE4A=unformatted flow data (input)
TAPE4B=unformatted flow data (input)
TAPE4N=combined TAPE4's (output)

```
ENTER:
   0 : TO COMBINE TWO TAPE4'S
       ADDING SECOND FILE AFTER END OF FIRST
   1 : TO MERGE TWO TAPE4'S, SORTING BY FLOW
   2 : TO MERGE TWO TAPE4'S, USING SPECIFIED
       DIVISION FLOW
 CHOICE:
```

If Option 2 is selected,

ENTER FLOW DIVIDING FIRST SET FROM SECOND:

Flows less than or equal to the division flow are transferred from the first TAPE4 and combined with flows greater than the division flow from the second TAPE4.

DIRI4 Program

I. INTRODUCTION

The DIRI4 program creates a TAPE3 and TAPE4 based on the data contained in the IFG4 data set. It is used when simulation of additional velocities is not desired.

II. RUNNING DIRI4

RDIRI4,ZIFG4,TAPE3,TAPE4,TP4

ZIFG4=IFG4 data set (input)
TAPE3=unformatted cross section and reach data (output)
TAPE4=unformatted flow data (output)
TP4=rearranged TAPE4 file. Used as input to HABTAT (output).

NOTE: If Option 1 is selected in DIRI4, the TAPE4 and TP4 files will be in HABTAM and HABTAV readable format. These files need to be renamed to TAPE4A and TP4A by the user.

```
ENTER 0 IF FLOW PROPERTIES FILE (TAPE4)
        IS FOR HABTAT
      1 IF FOR HABTAV OR HABTAM
```

ENTCI Program

I. INTRODUCTION

The ENTCI program is an interactive program to create a file containing channel index data, reach lengths, and weighting factors to be run through MODCI to modify a TAPE3. This program is generally run when the TAPE3 resulting from a WSP run is to be used as input to the habitat simulation programs. Channel index values are not included in a WSP data set; (channel index values of "0" are written to the TAPE3 by WSP) thus they are not passed onto the TAPE3. Channel index values are used in the calculation of Weighted Usable Area (WUA) in habitat simulation.

II. RUNNING ENTCI

RENTCI,ZCHANF

ZCHANF=file containing channel index data (output)

WHAT IS THE TITLE FOR THIS FILE (MAX 80 CHAR)-

WHAT IS THE CROSS SECTION ID NUMBER-

WHAT IS THE REACH LENGTH-
(FOR NO CHANGE IN THE REACH LENGTH ON THE CROSS SECTION ENTER -1)

WHAT IS THE WEIGHT ON THE CROSS SECTION-
(FOR NO CHANGE IN THE WEIGHT ON THE CROSS SECTION ENTER -1)

HOW MANY CHANNEL INDEX VALUES ARE TO BE ENTERED FOR THIS CROSS SECTION
(FOR NO CHANGE IN THE CHANNEL INDEX VALUES ON THE CROSS SECTION ENTER A 0)

If channel index values are being entered, the user will be prompted to enter the channel index values.

The above series of prompts will appear for each cross section data to be modified. The resulting file will be used as input to MODCI to add or modify the channel index values, reach lengths, and weights on a TAPE3.

Sample ZCHANF file.

```
CHANNEL INDEX DATA TO BE ADDED TO A TAPE3
XSEC              0.0      -1.00-1.0   30
NS       0.0     3.00      3.00      3.00      3.00     9.25      6.00
NS       0.0     6.00      8.25      8.25      8.25     8.25      9.00
NS       0.0     9.00      9.00      9.00      9.00     9.00      9.00
NS       0.0     9.00      9.25      9.25      9.25     9.25     10.00
NS       0.00   10.00     10.00     10.00      8.25     3.00      3.00
```

EXT3C1 Program

I. INTRODUCTION

The EXT3C1 program transfers two title lines and one set of cross section data from one TAPE3 to a new TAPE3.

The selection of partial data from a TAPE3 file may be desired in some instream flow studies to analyze the physical habitat versus streamflow relationship for an individual cross section or for a series of cross sections less than the total series for a study reach.

II. RUNNING EXT3C1

REXT3C1,TAPE3,TAPE3N

TAPE3=unformatted cross section and reach data (input)
TAPE3N=new TAPE3 with one set of cross section and reach data (output)

CROSS SECTION ID NUMBERS ARE -

ENTER CROSS SECTION ID NUMBER OF SECTION TO BE TRANSFERRED:

EXT3T4 Program

I. INTRODUCTION

The EXT3T4 program transfers one or more sets of cross section data for one or more flows from one TAPE3/TAPE4 set to a new TAPE3/TAPE4 set.

The selection of partial data from a TAPE3 and TAPE4 file may be desired in some instream flow studies to analyze the physical habitat versus streamflow relationship for an individual cross section or for a series of cross sections less than the total series for a study reach; or for certain flows rather than for all the flows simulated.

II. RUNNING EXT3T4

REXT3T4,TAPE3,TAPE4,TAPE3N,TAPE4N

TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)
TAPE3N=new TAPE3 with one or more sets of unformatted cross section and reach data (output)
TAPE4N=new TAPE4 with one or more sets of unformatted flow data (output)

DATA SET TITLE IS -

The two title lines from the TAPE3 will be displayed.

ENTER 1 TO CHANGE SECOND LINE OF TITLE, 0 OTHERWISE:

If "1" is selected:

ENTER NEW SECOND LINE

CROSS SECTION ID NUMBERS ARE -

Cross section ID numbers will be listed here.

HOW MANY SECTIONS ARE TO BE TRANSFERRED?

ENTER THE -- CROSS SECTION ID NUMBER(S) TO BE TRANSFERRED:

DISCHARGES FOUND ON TAPE4 ARE -

Discharges will be listed here.

HOW MANY DISCHARGES ARE TO BE TRANSFERRED?
(ENTER 0 TO TRANSFER ALL DISCHARGES):

ENTER DISCHARGE(S) TO BE TRANSFERRED:

EXT4C1 Program

I. INTRODUCTION

The EXT4C1 program transfers flow data for one cross section from one TAPE4 to a new TAPE4.

The selection of partial data from a TAPE4 file may be desired in some instream flow studies to analyze the physical habitat versus streamflow relationship for an individual cross section or for a series of cross sections less than the total series for a study reach.

II. RUNNING EXT4C1

REXT4C1,TAPE4,TAPE4N

TAPE4=unformatted flow data (input)
TAPE4N=new TAPE4 with flow data for one cross section (output)

CROSS SECTION ID NUMBERS ON FLOW FILE ARE-

ENTER CROSS SECTION ID OF SECTION TO BE TRANSFERRED:

Discharge information on the new TAPE4 will include the water surface elevation and velocities for all flows on the TAPE4 for the cross section specified.

EXTQT4 Program

I. INTRODUCTION

The EXTQT4 program transfers one set of flow data for all cross sections from one TAPE4 to a new TAPE4.

The selection of partial data from a TAPE4 file may be desired in some instream flow studies to analyze the physical habitat versus streamflow relationship for one flow rather than for all the flows simulated for a study reach.

II. RUNNING EXTQT4

REXTQT4,TAPE4,TAPE4N

TAPE4=unformatted flow data (input)
TAPE4N=new TAPE4 with flow data for one discharge (output)

DISCHARGES FOUND ON TAPE4 ARE -

Discharges will be listed here.

ENTER DISCHARGE TO BE TRANSFERRED

Enter the discharge to be transferred to the new TAPE4. Discharge information on the new TAPE4 will include the water surface elevation and velocities for each cross section for the flow transferred.

FTP34U Program

I. INTRODUCTION

The FTP34U program converts a formatted TAPE3F or TAPE4F to an unformatted TAPE3 or TAPE4.

The formatted versions of these files were created by the UTP34F program. Unformatted files are likely to be incompatible between a microcomputer and the CDC mainframe, and between different microcomputers. The formatted version of the files should be used when transferring from computer to computer.

II. RUNNING FTP34U

RFTP34U,TAPE3F,TAPE3,TAPE4F,TAPE4

(if only a TAPE4 is to be converted,
use: RFTP34U,TAPE4F,TAPE4)

TAPE3F=formatted cross section and reach data (input)
TAPE3=unformatted cross section and reach data (output)
TAPE4F=formatted flow data (input)
TAPE4=unformatted flow data (output)

LSTP34 Program

I. INTRODUCTION

The LSTP34 program lists the contents of a TAPE3 and a TAPE4 file (a TP4, TAPE4A, or TP4A can be used in place of a TAPE4). A TAPE3 file is an unformatted file containing cross section and reach data; and a TAPE4 (TP4, TAPE4A, or TP4A) is an unformatted file containing flow data. These files are generated by the hydraulic simulation programs and are used as input to the habitat simulation programs.

II. RUNNING LSTP34

RLSTP34,ZOUT,TAPE3,TAPE4

ZOUT=LSTP34 results (output)
TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)

Figure III.4 contains sample output from the LSTP34 program.

```
88/08/25.                UPPER SALMON RIVER, NEAR STANLEY, IDAHO                          PROGRAM-LSTP34
11.55.49.              IFG4 DATA SET WITH WSL LINES ADDED FROM MANSQ                               PAGE   2

 CROSS SECTION COORDINATES FOR      0.00     REACH LENGTH=      0.00     WEIGHT ON REACH=  0.30
 NUMBER OF CROSS SECTION POINTS=  30

     0.00   101.30     3.00     2.50   100.70     3.00     4.00    99.80     3.00     4.30    98.60     3.00
     5.50    97.70     9.25     7.60    97.30     6.00    11.90    97.60     6.00    14.20    97.90     8.25
    16.20    97.60     8.25    16.50    97.70     8.25    18.20    97.50     8.25    20.20    97.40     9.00
    22.20    97.30     9.00    24.20    97.20     9.00    26.20    97.30     9.00    28.20    97.50     9.00
    30.20    97.40     9.00    32.20    97.70     9.00    33.00    97.60     9.00    34.20    97.60     9.25
    35.20    97.70     9.25    36.20    97.70     9.25    37.40    97.70     9.25    39.10    97.90    10.00
    43.80    98.10    10.00    53.00    98.60    10.00    62.40    99.00    10.00    69.90    98.50     8.25
    78.10    99.00     3.00    87.10    99.50     3.00

 CROSS SECTION COORDINATES FOR     14.30     REACH LENGTH=     14.25     WEIGHT ON REACH=  0.50
 NUMBER OF CROSS SECTION POINTS=  32

     0.00   101.90     3.00     3.00   101.30     3.00     4.70   101.00     3.00     5.30   100.00     3.00
    15.00   100.00     3.00    19.10    99.60     3.00    29.30    99.20     3.00    33.10    98.40     3.00
    41.00    98.50     7.50    46.10    98.20     8.25    48.10    98.00     8.50    48.50    97.90     8.50
    49.30    97.80     8.50    50.30    97.80     9.25    52.30    97.70     9.00    54.30    97.60     9.00
    56.30    97.80     9.00    58.30    97.60     9.00    60.30    97.60    10.00    62.30    97.60    10.00
    64.30    97.70     9.00    65.00    97.80     9.00    66.30    97.70    10.00    68.30    97.90    10.00
    70.30    98.20    10.00    73.80    98.20    10.00    77.70    98.80    10.00    86.80    99.00    10.25
    94.30    98.50     9.50    99.10    98.90     7.75   103.60   100.30     3.00   108.40   101.30     3.00

            REACH LENGTH IS TO NEXT DOWNSTREAM SECTION
```

ONE LINE OF INFORMATION COULD HAVE BEEN ENTERED HERE IF DESIRED.

Figure III.4 Sample output from the LSTP34 program.

```
Q RELATED DATA FOR THE CROSS SECTION       0.00
    DISCHARGE =       8.00    NUMBER OF VELOCITIES =    16     WSL =      97.68

VELOCITIES      0.46      0.62      0.16      0.16      0.16      0.62      1.51      1.59      1.78      2.22
                1.90      1.40      0.63      0.42      0.54      0.12

Q RELATED DATA FOR THE CROSS SECTION       0.00
    DISCHARGE =      10.00    NUMBER OF VELOCITIES =    20     WSL =      97.72

VELOCITIES      0.03      0.52      0.69      0.21      0.21      0.27      0.76      1.67      1.71      1.87
                2.33      2.07      1.56      0.96      0.81      0.70      0.20      0.18      0.26      0.13

Q RELATED DATA FOR THE CROSS SECTION       0.00
    DISCHARGE =      20.00    NUMBER OF VELOCITIES =    20     WSL =      97.84

VELOCITIES      0.14      0.78      1.00      0.37      0.37      0.62      1.30      2.37      2.30      2.41
                3.02      2.87      2.24      2.05      2.06      1.23      0.46      0.72      1.07      0.54

Q RELATED DATA FOR THE CROSS SECTION       0.00
    DISCHARGE =      30.00    NUMBER OF VELOCITIES =    21     WSL =      97.93

VELOCITIES      0.21      0.95      1.22      0.58      0.58      0.86      1.66      2.87      2.72      2.79
                3.50      3.44      2.72      2.75      2.88      1.61      0.62      1.05      1.58      0.99
                0.20
```

SECTIONS OF SAMPLE OUTPUT HAVE BEEN DELETED HERE FOR BREVITY.

SUMMARY OF WEIGHTS ON SECTIONS

CROSS SEC	EFFECTIVE REACH LENGTH	WEIGHT	PERCENT
0.0	4.28	0.30	30.00
14.3	9.97	0.50	70.00

TOTAL LENGTH OF STUDY REACH IS 14.25

ONE LINE OF INFORMATION COULD HAVE BEEN ENTERED HERE IF DESIRED.

NORMAL END OF JOB

Figure III.4 (Concluded)

LSTTP3 Program

I. INTRODUCTION

The LSTTP3 program lists the contents of a TAPE3 file. A TAPE3 file is an unformatted file containing cross section and reach data generated by the hydraulic simulation programs and used as input to the habitat simulation programs.

II. RUNNING LSTTP3

RLSTTP3,ZOUT,TAPE3

ZOUT=LSTTP3 results (output)
TAPE3=unformatted cross section and reach data (input)

```
LIST TAPE3 OPTIONS:
  1) FULL LISTING
  2) PARTIAL LISTING
ENTER CHOICE:
```

FULL LISTING = Cross section ID number, reach length, weight on reach, number of cross section points, left and right reach length weights (if added with ADDBEND), and the X,Y coordinate pairs with their associated channel index/roughness values.

PARTIAL LISTING = The X,Y coodinate pairs with their associated channel index/roughness values are not listed as in the full listing.

Figure III.5 contains sample output from the LSTTP3 program.

RESULTS WHEN A "PARTIAL LISTING" IS SELECTED WITH THE LSTTP3 PROGRAM

```
88/08/22.     UPPER SALMON RIVER, NEAR STANLEY, IDAHO                            PROGRAM - LSTTP3
16.15.27.     IFG4 DATA SET WITH WSL LINES ADDED FROM MANSQ                        PAGE -    2

    CROSS SECTION =       0.0    REACH LENGTH =        0.00     WEIGHT ON REACH =  0.30
    NUMBER OF CROSS SECTION POINTS =  30


    CROSS SECTION =      14.3    REACH LENGTH =       14.25     WEIGHT ON REACH =  0.50
    NUMBER OF CROSS SECTION POINTS =  32


                                                    FOR TOTAL REACH
            CROSS SEC   REACH LENGTH   C/S WEIGHT   LENGTH    PERCENT

                0.0          0.00          0.30       4.28     30.00
               14.3         14.25          0.50       9.97     70.00
```

LSTTP3 RESULTS WHEN THE TAPE3 CONTAINS WEIGHTS FOR BENDS WHICH WERE ADDED USING THE ADDBEND PROGRAM

```
88/08/22.     SALMON RIVER, NEW YORK, UNSTEADY FLOW MODEL, SUMMER 1986 (CPINM)             PROGRAM - LSTTP3
16.18.17.     PINEVILLE  S118M/SR-4/2-10-87 MEAN VELOCITY(SZF=471.5-GUESS)                    PAGE -    2

    CROSS SECTION =      118.0    REACH LENGTH =        0.00     WEIGHT ON REACH =  1.00
    NUMBER OF CROSS SECTION POINTS =  49
    WEIGHT FOR BEND ON LEFT SIDE =   1.60        WEIGHT FOR BEND ON RIGHT SIDE =   0.40


    CROSS SECTION =      121.0    REACH LENGTH =     1388.00     WEIGHT ON REACH =  0.50
    NUMBER OF CROSS SECTION POINTS =  31
    WEIGHT FOR BEND ON LEFT SIDE =   1.22        WEIGHT FOR BEND ON RIGHT SIDE =   0.78


    CROSS SECTION =      129.0    REACH LENGTH =     4500.00     WEIGHT ON REACH =  0.50
    NUMBER OF CROSS SECTION POINTS =  29
    WEIGHT FOR BEND ON LEFT SIDE =   0.70        WEIGHT FOR BEND ON RIGHT SIDE =   1.30


                                                    FOR TOTAL REACH
            CROSS SEC   REACH LENGTH   C/S WEIGHT   LENGTH    PERCENT

              118.0          0.00          1.00     1388.00    23.57
              121.0       1388.00          0.50     2250.00    38.21
              129.0       4500.00          0.50     2250.00    38.21
```

Figure III.5 Sample output from the LSTTP3 program.

RESULTS WHEN A "FULL LISTING" IS SELECTED WITH THE LSTTP3 PROGRAM

```
88/08/22.      UPPER SALMON RIVER, NEAR STANLEY, IDAHO                          PROGRAM - LSTTP3
16.14.09.      IFG4 DATA SET WITH WSL LINES ADDED FROM MANSQ                      PAGE -    2

   CROSS SECTION =        0.0    REACH LENGTH =        0.00    WEIGHT ON REACH =  0.30
   NUMBER OF CROSS SECTION POINTS =  30
```

X	Y	CHANNEL INDEX / ROUGHNESS
0.0	101.30	3.00000
2.5	100.70	3.00000
4.0	99.80	3.00000
4.3	98.60	3.00000
5.5	97.70	9.25000
7.6	97.30	6.00000
11.9	97.60	6.00000
14.2	97.90	8.25000
16.2	97.60	8.25000
16.5	97.70	8.25000
18.2	97.50	8.25000
20.2	97.40	9.00000
22.2	97.30	9.00000
24.2	97.20	9.00000
26.2	97.30	9.00000
28.2	97.50	9.00000
30.2	97.40	9.00000
32.2	97.70	9.00000
33.0	97.60	9.00000
34.2	97.60	9.25000
35.2	97.70	9.25000
36.2	97.70	9.25000
37.4	97.70	9.25000
39.1	97.90	10.00000
43.8	98.10	10.00000
53.0	98.60	10.00000
62.4	99.00	10.00000
69.9	98.50	8.25000
78.1	99.00	3.00000
87.1	99.50	3.00000

ONLY THE DATA FOR THE FIRST CROSS SECTION HAS BEEN INCLUDED IN THIS SAMPLE OUTPUT.

			FOR TOTAL REACH	
CROSS SEC	REACH LENGTH	C/S WEIGHT	LENGTH	PERCENT
0.0	0.00	0.30	4.28	30.00
14.3	14.25	0.50	9.97	70.00

Figure III.5 (Concluded)

LSTTP4 Program

I. INTRODUCTION

The LSTTP4 program lists the contents of a TAPE4 file. The program also will list the contents of a TP4, TAPE4A, or TP4A file. These files are unformatted files containing flow data generated by the hydraulic simulation programs and used as input to the habitat simulation programs.

LSTTP4 output contains the predicted water surface elevation for each flow in a cross section. The slope is also listed if Option 9=T in the WSP program (writes the calculated slope to the TAPE4 as an additional variable). If Option 9=T in WSP, the resulting TAPE4 cannot be used as input to the habitat simulation programs.

II. RUNNING LSTTP4

RLSTTP4,ZOUT,TAPE4

ZOUT=LSTTP4 results (output)
TAPE4=unformatted flow data (input)

DO YOU WANT VELOCITIES TO BE LISTED? Y/N

If "Y" is selected to list velocities, the velocity for each cell in a cross section is also listed.

Figure III.6 contains sample output from the LSTTP4 program.

RESULTS OF THE LSTTP4 PROGRAM WHEN VELOCITIES ARE NOT LISTED

CROSS SECTION =	0.0	Q =	8.00	WSL =	97.680
CROSS SECTION =	0.0	Q =	10.00	WSL =	97.720
CROSS SECTION =	0.0	Q =	20.00	WSL =	97.840
CROSS SECTION =	0.0	Q =	30.00	WSL =	97.930
CROSS SECTION =	0.0	Q =	40.00	WSL =	98.010
CROSS SECTION =	0.0	Q =	50.00	WSL =	98.080
CROSS SECTION =	0.0	Q =	60.00	WSL =	98.130

ONLY PART OF THE DATA FOR THE FIRST CROSS SECTION HAS BEEN INCLUDED IN THIS SAMPLE OUTPUT.

Figure III.6. Sample output from the LSTTP4 program.

RESULTS OF THE LSTTP4 PROGRAM WHEN SLOPES WERE WRITTEN TO THE TAPE4 BY SETTING OPTION 9=T IN THE WSP PROGRAM

```
CROSS SECTION =      0.0     Q =      30.00     WSL =     98.900
SLOPE =   0.000687


CROSS SECTION =     18.3     Q =      30.00     WSL =     98.917
SLOPE =   0.000055


CROSS SECTION =     25.5     Q =      30.00     WSL =     98.917
SLOPE =   0.000105


CROSS SECTION =     34.8     Q =      30.00     WSL =     98.925
SLOPE =   0.000011
```

RESULTS OF THE LSTTP4 PROGRAM WHEN VELOCITIES ARE LISTED

```
  CROSS SECTION =      0.0     Q =       8.00     NUMBER OF VELOCITIES =  16
  WSL =      97.680
THE VELOCITIES ARE -
     0.46      0.62     0.16      0.16      0.16      0.62      1.51
     1.59      1.78     2.22      1.90      1.40      0.63      0.42
     0.54      0.12

  CROSS SECTION =      0.0     Q =      10.00     NUMBER OF VELOCITIES =  20
  WSL =      97.720
THE VELOCITIES ARE -
     0.03      0.52     0.69      0.21      0.21      0.27      0.76
     1.67      1.71     1.87      2.33      2.07      1.56      0.96
     0.81      0.70     0.20      0.18      0.26      0.13

  CROSS SECTION =      0.0     Q =      20.00     NUMBER OF VELOCITIES =  20
  WSL =      97.840
THE VELOCITIES ARE -
     0.14      0.78     1.00      0.37      0.37      0.62      1.30
     2.37      2.30     2.41      3.02      2.87      2.24      2.05
     2.06      1.23     0.46      0.72      1.07      0.54

  CROSS SECTION =      0.0     Q =      30.00     NUMBER OF VELOCITIES =  21
  WSL =      97.930
THE VELOCITIES ARE -
     0.21      0.95     1.22      0.58      0.58      0.86      1.66
     2.87      2.72     2.79      3.50      3.44      2.72      2.75
     2.88      1.61     0.62      1.05      1.58      0.99      0.20
```

ONLY PART OF THE DATA FOR THE FIRST CROSS SECTION HAS BEEN INCLUDED IN THIS SAMPLE OUTPUT.

Figure III.6. (Concluded)

LSTVD Program

I. INTRODUCTION

The LSTVD program lists the velocities and depths of the cells, and cross section data that are found on a TAPE3 and TAPE4 (a TP4, TAPE4A, or TP4A can be used in place of a TAPE4). A TAPE3 file is an unformatted file containing cross section and reach data; and a TAPE4 (TP4, TAPE4A, or TP4A) is an unformatted file containing flow data. These files are generated by the hydraulic simulation programs and are used as input to the habitat simulation programs.

II. RUNNING LSTVD

RLSTVD,ZOUT,TAPE3,TAPE4

ZOUT=LSTVD results (output)
TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)

```
ENTER HOW VELOCITIES WERE WRITTEN ON TAPE4:
  1) AVERAGE OF THE VELOCITIES FOR A CELL DEFINED BY ADJACENT
     VERTICALS (HABTAT)
  2) VELOCITIES FOR A CELL CENTERED ON A VERTICAL (HABTAM, HABTAV)
```

Option 2 would be entered if the TAPE4 (which should have been renamed TAPE4A by the user) was created by setting IOC(17)=1 in IFG4; setting IOC(11)=2 in MANSQ; or created by the DIRI4 program using Option 1.

Figure III.7 contains sample output from the LSTVD program.

COORDINATE DATA FOR CROSS SECTION - 0.00 SECTION NO. - 1

X	0.0	2.5	4.0	4.3	5.5	7.6	11.9	14.2	16.2	16.5	18.2	20.2
Y	101.3	100.7	99.8	98.6	97.7	97.3	97.6	97.9	97.6	97.7	97.5	97.4
S	3.0	3.0	3.0	3.0	9.2	6.0	6.0	8.2	8.2	8.2	8.2	9.0
X	22.2	24.2	26.2	28.2	30.2	32.2	33.0	34.2	35.2	36.2	37.4	39.1
Y	97.3	97.2	97.3	97.5	97.4	97.7	97.6	97.6	97.7	97.7	97.7	97.9
S	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.2	9.2	9.2	9.2	10.0
X	43.8	53.0	62.4	69.9	78.1	87.1						
Y	98.1	98.6	99.0	98.5	99.0	99.5						
S	10.0	10.0	10.0	8.2	3.0	3.0						

STREAM DISCHARGE IS 8.0 CUSECS WSL IS 97.68 FEET

D	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1	0.2	0.3
V	0.00	0.00	0.00	0.00	0.46	0.62	0.16	0.16	0.16	0.62	1.51	1.59
D	0.4	0.4	0.3	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
V	1.78	2.22	1.90	1.40	0.63	0.42	0.54	0.12	0.00	0.00	0.00	0.00
D	0.0	0.0	0.0	0.0	0.0							
V	0.00	0.00	0.00	0.00	0.00							

STREAM DISCHARGE IS 10.0 CUSECS WSL IS 97.72 FEET

D	0.0	0.0	0.0	0.0	0.2	0.3	0.1	0.1	0.1	0.1	0.3	0.4
V	0.00	0.00	0.00	0.03	0.52	0.69	0.21	0.21	0.27	0.76	1.67	1.71
D	0.5	0.5	0.3	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0
V	1.87	2.33	2.07	1.56	0.96	0.81	0.70	0.20	0.18	0.26	0.13	0.00
D	0.0	0.0	0.0	0.0	0.0							
V	0.00	0.00	0.00	0.00	0.00							

REMAINING OUTPUT WAS TERMINTATED HERE FOR BREVITY.

Figure III.7. Sample output from the LSTVD program.

LSTWLF Program

I. INTRODUCTION

The LSTWLF program lists water surface elevations on a TAPE4, and calculates and lists the Froude number and mean channel velocities for each cross section and each flow. A TAPE3 file is an unformatted file containing cross section and reach data; and a TAPE4 (TP4, TAPE4A, or TP4A) is an unformatted file containing flow data. These files are generated by the hydraulic simulation programs and are used as input to the habitat simulation programs.

II. RUNNING LSTWLF

RLSTWLF,ZOUT,TAPE3,TAPE4

ZOUT=LSTWLF results (output)
TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)

The definitions of the terms given on the output from LSTWLF are given below:

DISTANCE: The distance from the most downstream cross section to the next upstream cross section.

THALWEG: The elevation of the low point in the cross section.

VEL (Mean Channel Velocity): The velocity calculated by dividing the discharge by the cross-sectional area.

CVEL (Celerity): The velocity of a gravity wave in the channel at the given water surface elevation. The celerity is given by the equation

$$CVEL = \sqrt{gd}$$

where g is the acceleration of gravity and d is the depth calculated by the equation

$$d = Q/W$$

where Q is the discharge and W is the surface width at the given water surface elevation. The celerity then becomes

$$CVEL = \sqrt{gQ/W}$$

FROUDE NUMBER: The ratio of the mean channel velocity to the celerity. If the Froude number is <1.0, the flow is sub-critical (slow); and if it is >1.0, the flow is super-critical (fast). A Froude number of 1.0 is critical flow.

Figure III.8 contains sample output from the LSTWLF program.

```
88/08/27.     UPPER SALMON RIVER, NEAR STANLEY, IDAHO                PROGRAM - LSTWLF
09.15.13.     IFG4 DATA SET WITH WSL LINES ADDED FROM MANSQ             PAGE -    2
```

WATER SURFACE ELEVATIONS

DISTANCE	THALWEG	8.00	10.00	20.00	30.00	40.00	50.00	60.00
0.0	97.20	97.68	97.72	97.84	97.93	98.01	98.08	98.13
14.2	97.60	98.04	98.08	98.22	98.32	98.40	98.47	98.53

DISTANCE	THALWEG	70.00	80.00	90.00	100.00	110.00	120.00	130.00
0.0	97.20	98.19	98.23	98.28	98.32	98.36	98.40	98.44
14.2	97.60	98.58	98.62	98.66	98.70	98.73	98.77	98.80

FROUDE NUMBERS (VEL/CVEL)

DISTANCE	THALWEG	8.00	10.00	20.00	30.00	40.00	50.00	60.00
0.0	97.20	0.51	0.52	0.58	0.61	0.63	0.65	0.69
14.2	97.60	0.37	0.39	0.51	0.56	0.60	0.67	0.70

DISTANCE	THALWEG	70.00	80.00	90.00	100.00	110.00	120.00	130.00
0.0	97.20	0.69	0.72	0.73	0.74	0.76	0.76	0.77
14.2	97.60	0.72	0.75	0.77	0.78	0.80	0.80	0.82

MEAN CHANNEL VELOCITIES

DISTANCE	THALWEG	8.00	10.00	20.00	30.00	40.00	50.00	60.00
0.0	97.20	1.37	1.44	1.88	2.19	2.42	2.61	2.84
14.2	97.60	1.17	1.30	1.81	2.15	2.43	2.63	2.78

DISTANCE	THALWEG	70.00	80.00	90.00	100.00	110.00	120.00	130.00
0.0	97.20	2.98	3.18	3.31	3.46	3.58	3.70	3.79
14.2	97.60	2.94	3.11	3.25	3.37	3.53	3.60	3.72

Figure III.8 Sample output from the LSTWLF program.

MODCI Program

I. INTRODUCTION

The MODCI program adds or modifies channel index data, reach lengths, and weighting factors in a TAPE3. Option of entering data from the keyboard or reading data from a file created by ENTCI.

This program is generally run when the TAPE3 resulting from a WSP run is to be used as input to the habitat simulation programs. Channel index values are not included in a WSP data set; thus they are not passed onto the TAPE3 (channel index values of "0" are written to the TAPE3 by WSP). Channel index values are used in the calculation of Weighted Usable Area (WUA) in habitat simulation.

II. RUNNING MODCI

RMODCI,TAPE3,TAPE3N,ZCHANF

TAPE3=unformatted cross section and reach data (input)
TAPE3N=modified TAPE3 file with channel index data added (output)
ZCHANF=file containing channel index data (input).
This file was created by the ENTCI program.

ENTER 0 TO READ DATA FROM FILE CREATED BY ENTCI,
ENTER 1 TO INPUT DATA FROM KEYBOARD:

The following series of prompts will appear if data is being entered from the keyboard:

THE CROSS SECTION ID NUMBER IS ---:
WEIGHT FOR CROSS SECTION IS ---:
(ENTER NEW WEIGHT OR -1 TO LEAVE AS IS):

REACH LENGTH FOR CROSS SECTION --- IS ---:
(ENTER NEW REACH LENGTH OR -1 TO LEAVE AS IS):

NUMBER OF CHANNEL INDEX VALUES FOR CROSS SECTION --- IS ---:
ENTER -- NEW CHANNEL INDEX VALUES,
OR 0 FOR NO CHANGE IN THE CHANNEL INDEX VALUES FOR THE CROSS SECTION:

MODRLW Program

I. INTRODUCTION

The MODRLW program changes cross section weights and reach lengths on a TAPE3 file.

A TAPE3 file is an unformatted file containing cross section and reach data. It is generated by the hydraulic simulation programs and is used as input to the habitat simulation programs.

II. RUNNING MODRLW

RMODRLW,TAPE3,TAPE3N

TAPE3=unformatted cross section and reach data (input)
TAPE3N=modified TAPE3 file (output)

ENTER 0 TO CHANGE ONLY WEIGHTS
1 TO CHANGE BOTH WEIGHTS AND REACH LENGTHS:

If "0" is entered:

ENTER WEIGHT ON DISTANCE TO UPSTREAM CROSS SECTION
FOR CROSS SECTION --:

PHABSIM programs assume that the hydraulic variables measured at a cross section extend halfway to adjacent cross sections upstream and downstream. If this is not the case, upstream weighting factors should be applied. Weighting factors are used by the habitat simulation programs, not the hydraulic simulation programs.

If "1" is entered:

ENTER REACH LENGTH AND WEIGHT FOR CROSS SECTION --- (RL,W):

The Reach Length is the distance to the adjacent downstream cross section. The first cross section is assumed to be the one farthest downstream; thus its distance is 0.

RPHABAR Batch/Procedure File

I. INTRODUCTION

The RPHABAR batch/procedure file runs either the PHABAR2 or PHABARR programs to rearrange a TAPE4 and writes a TP4. The user will not normally run this procedure as the RIFG4, RWSP, and RDIRI4 batch/procedure files automatically run the PHABAR2 program for you.

The hydraulic simulation program output for all flows is arranged by cross section. The computational procedure develops the water surface elevations and velocities for one cross section, writes those data for all flows at that section to TAPE4, then moves to the next cross section, and so forth through the reach. In contrast, the habitat simulation programs require that the hydraulic data for all the cross sections in the reach be available one flow at a time. The PHABARR and PHABAR2 programs rearrange the TAPE4 output from the hydraulic programs into the format required by the habitat simulation programs and write it on TP4.

II. RUNNING THE RPHABAR BATCH/PROCEDURE FILE

RPHABAR,TAPE4,TP4,POS

TAPE4=unformatted flow data (input)
TP4=rearranged TAPE4 file (output)
POS= -1 Leaves negative velocities as negative numbers (PHABARR)
POS= 1 Converts negative velocities to positive numbers (PHABAR2)

Default is POS=1 (PHABAR2).
Run by the RIFG4, RWSP, and RDIRI4 batch/procedures files.

PHABRTN Program

I. INTRODUCTION

The PHABRTN program converts a TP4 file back to a TAPE4 file. TP4 is a rearranged TAPE4 file created by the PHABAR2 program when the RIFG4, RWSP, or RDIRI4 batch/procedures files are run. TAPE4 and TP4 contain unformatted flow data. TP4A can also be converted back to TAPE4A.

The hydraulic simulation program output for all flows is arranged by cross section. The computational procedure develops the water surface elevations and velocities for one cross section, writes those data for all flows at that section to TAPE4, then moves to the next cross section, and so forth through the reach. In contrast, the habitat simulation programs require that the hydraulic data for all the cross sections in the reach be available one flow at a time. The PHABARR and PHABAR2 programs rearrange the TAPE4 output from the hydraulic programs into the format required by the habitat simulation programs and write it on TP4.

II. RUNNING PHABRTN

RPHBRTN,TP4,TAPE4

TP4=rearranged TAPE4 file of unformatted flow data (input)
TAPE4=unformatted flow data (output)

UTP34F Program

I. INTRODUCTION

The UTP34F program converts an unformatted TAPE3 or TAPE4 to a formatted TAPE3F or TAPE4F.

A TAPE3 file is an unformatted file containing cross section and reach data, and a TAPE4 (TP4, TAPE4A, or TP4A) is an unformatted file containing flow data. These files are generated by the hydraulic simulation programs and are used as input to the habitat simulation programs.

Unformatted files are likely to be incompatible between a microcomputer and the CDC mainframe, and between different microcomputers. The formatted version of the files should be used when transferring from computer to computer.

II. RUNNING UTP34F

RUTP34F,TAPE3,TAPE3F,TAPE4,TAPE4F

(if only a TAPE4 is to be converted,
use: RUTP34F,TAPE4,TAPE4F)

TAPE3=unformatted cross section and reach data (input)
TAPE3F=formatted cross section and reach data (output)
TAPE4=unformatted flow data (input)
TAPE4F=formatted flow data (output)

IV. CRITERIA CURVE MAINTENANCE PROGRAMS

INTRODUCTION

In order to evaluate the magnitude of impacts caused by changes in stream hydraulics, it is necessary to develop an information base for each species or group of species of interest. The information base is in the form of criteria curves of aquatic species or recreational activities.

Biological criteria are primarily aimed at those parameters affecting fish distribution which are directly related to streamflow and channel morphology; specifically depth, velocity, temperature, and channel index. Cover, a habitat parameter of paramount importance to many species, is also indirectly related to streamflow. Cover may be incorporated into an assessment by evaluating the usability of available cover objects in reference to the flow parameters around them.

The expressed assumption is that the distribution and abundance of any species is not primarily influenced by any single parameter of streamflow, but is related by varying degrees to all streamflow hydraulic parameters. Furthermore, these criteria are based on the assumption that individuals of a species tend to select the most favorable conditions in a stream, but will also use less favorable conditions, with the preference for use decreasing where conditions are less favorable.

A group of curve maintenance programs has been developed to manage a file of criteria curves of aquatic species or recreational activities. Figure I.7 contains information on the "Flow of Information Through PHABSIM - Curve Maintenance Programs Group".

In this documentation, the term FISHCRV refers to the formatted (card image) version of the file containing the curve sets created by the GCURV program or by using an editor. The term FISHFIL refers to the unformatted (binary) version of the file created by the CRVFIL program. The unformatted version of the file is used as an input to the habitat simulation programs.

The formatted version of the curves file can be thought of as a library where curves are filed by identification number. This file should be saved and may be added to as new curves are entered.

CRITERIA CURVE DATA ENTRY, REVIEW, AND PLOTTING PROGRAMS

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
GCURV	**RGCURV**	Criteria Curve Data Entry	Builds a formatted FISHCRV file from keyboard input. **RGCURV,FISHCRV** **FISHCRV**=formatted curves file (output)
LPTCRV	**RLPTCRV**	Criteria Curve Review and Plotting	Checks data contained in a formatted FISHCRV file with option to generate graphs from the curve data. **RLPTCRV,FISHCRV,ZOUT** **FISHCRV**=formatted curves file (input) **ZOUT**=LPTCRV results (output)

PROGRAMS USED WITH FORMATTED (FISHCRV) CURVES FILES

CRVFIL	**RCRVFIL**	Criteria Curve Conversion	Converts a formatted FISHCRV file to an unformatted FISHFIL file. **RCRVFIL,FISHCRV,FISHFIL** **FISHCRV**=formatted curves file (input) **FISHFIL**=unformatted curves file (output)
CRV2LOT	**RCRV2LT**	Criteria Curve Conversion	Converts a formatted FISHCRV file to a file that is readable by LOTUS. **RCRV2LT,FISHCRV,ZOUT** **FISHCRV**=formatted curves file (input) **ZOUT**=LOTUS readable curves file (output)

PROGRAMS USED WITH FORMATTED (FISHCRV) CURVES FILES (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
EXCRVS	REXCRVS	Criteria Curve Manipulation	Extracts specified curve sets from a formatted FISHCRV file and writes the extracted curves to a new file in FISHCRV format. **REXCRVS,FISHCRV,NEWFCRV** **FISHCRV**=formatted curves file (input) **NEWFCRV**=new formatted curves file (output)
LSTH	RLSTH	Criteria Curve Listing	Lists the header lines in a formatted FISHCRV file. **RLSTH,FISHCRV,ZOUT** **FISHCRV**=formatted curves file (input) **ZOUT**=LSTH results (output) (if filename is not specified, output will go to the screen)

PROGRAMS USED WITH UNFORMATTED (FISHFIL) CURVES FILES

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
CRVWRT	RCRVWRT	Criteria Curve Conversion	Converts an unformatted FISHFIL file to a formatted FISHCRV file. **RCRVWRT,FISHFIL,FISHCRV** **FISHFIL**=unformatted curves file (input) **FISHCRV**=formatted curves file (output)
LDIR	RLDIR	Criteria Curve Listing	Writes a complete or partial directory listing of an unformatted FISHFIL. **RLDIR,FISHFIL,ZOUT** **FISHFIL**=unformatted curves file (input) **ZOUT**=LDIR results (output) (if filename not specified, output will go to the screen)

PROGRAMS USED WITH UNFORMATTED (FISHFIL) CURVES FILES (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
LSTCNUM	**RLSTCNM**	Criteria Curve Listing	Lists the curve set ID numbers in an unformatted FISHFIL file. **RLSTCNM,FISHFIL,ZOUT** **FISHFIL**=unformatted curves file (input) **ZOUT**=LSTCNUM results (output) (if filename is not specified, output will go to the screen)
LSTCRV	**RLSTCRV**	Criteria Curve Listing	Lists the coordinates of the curves in a FISHFIL file for up to 40 life stages. **RLSTCRV,FISHFIL,ZOUT,ZHABIN** **FISHFIL**=unformatted curves file (input) **ZOUT**=curve coordinates from FISHFIL (output) **ZHABIN**=HABTAT, HABTAV, HABTAM, HABTAE, or HABVD options file, optional (input). If specified, the curve set ID numbers on the CURVES line in the options file will be displayed; the user will be prompted to enter how many of these curve sets to process and the curve set ID numbers.

CRV2LOT Program

I. INTRODUCTION

The CRV2LOT program converts a formatted FISHCRV file to a file that is readable by LOTUS. Since the number of coordinate pairs may vary, all columns are as long as the longest record with zero fills in the columns not filled with curve data. If temperature suitability is not present, temperature columns are zero filled.

II. RUNNING CRV2LOT

RCRV2LT,FISHCRV,ZOUT

FISHCRV=formatted curves file (input)
ZOUT=LOTUS readable curves file (output)

CONVERTING ASCII TEXT CURVES FILE TO LOTUS READABLE FORMAT:

END OF INFORMATION FOUND, ALL CURVES HAVE BEEN WRITTEN TO FILE.

Figure IV.1 contains sample output from the CRV2LOT program.

```
"H 11119  9  9  7  0 WINTER TROUT                         ADULT    88/04/25

" ","VELOCITY"," ","DEPTH"," CHANNEL""DESCRPT."," TEMPERATURE"
     0.00     1.00     0.00     0.00     0.00     0.00     0.00     0.00
     0.20     1.00     0.50     0.05     3.90     0.00     0.00     0.00
     0.30     0.80     0.75     0.10     4.00     1.00     0.00     0.00
     0.50     0.50     1.00     0.25     7.00     1.00     0.00     0.00
     0.75     0.20     1.25     0.50     8.00     0.50     0.00     0.00
     1.00     0.15     1.50     0.75     9.00     0.00     0.00     0.00
     1.50     0.10     1.75     1.00   100.00     0.00     0.00     0.00
     2.00     0.00     4.00     1.00     0.00     0.00     0.00     0.00
   100.00     0.00   100.00     1.00     0.00     0.00     0.00     0.00

"H 11112  4  7  8  0 BROWN TROUT                            FRY

" ","VELOCITY"," ","DEPTH"," CHANNEL""DESCRPT."," TEMPERATURE"
     0.00     1.00     0.00     0.00     0.00     1.00     0.00     0.00
     0.10     1.00     0.10     0.10     1.00     1.00     0.00     0.00
     0.50     0.00     0.20     1.00     2.00     1.00     0.00     0.00
   100.00     0.00     0.50     1.00     4.00     1.00     0.00     0.00
     0.00     0.00     1.25     0.30     6.00     1.00     0.00     0.00
     0.00     0.00     3.00     0.00     8.00     1.00     0.00     0.00
     0.00     0.00   100.00     0.00     9.00     1.00     0.00     0.00
     0.00     0.00     0.00     0.00   100.00     1.00     0.00     0.00
```

Figure IV.1. Sample output from the CRV2LOT program.

CRVFIL Program

I. INTRODUCTION

The CRVFIL program converts a formatted FISHCRV file to an unformatted FISHFIL file. The FISHFIL is used as input to the habitat simulation programs.

Unformatted files, such as FISHFIL, are likely to be incompatible between a microcomputer and the CDC mainframe, and between different microcomputers. The formatted version (FISHCRV) of the files should be used when transferring from computer to computer.

II. RUNNING CRVFIL

RCRVFIL,FISHCRV,FISHFIL

FISHCRV=formatted curves file (input)
FISHFIL=unformatted curves file (output)

A directory of the FISHFIL will print out on the screen.

CRVWRT Program

I. INTRODUCTION

The CRVWRT program converts an unformatted FISHFIL file to a formatted FISHCRV file. This program is not normally used, as it is recommended that the formatted (card image) version of the file be saved and added to as new curves are entered.

Unformatted files, such as FISHFIL, are likely to be incompatible between a microcomputer and the CDC mainframe, and between different microcomputers. The formatted version (FISHCRV) of the files should be used when transferring from computer to computer.

II. RUNNING CRVWRT

RCRVWRT,FISHFIL,FISHCRV

FISHFIL=unformatted curves file (input)
FISHCRV=formatted curves file (output)

EXCRVS Program

I. INTRODUCTION

The EXCRVS program extracts specified curve sets from a FISHCRV file and writes the extracted curves to a new file in FISHCRV format.

II. RUNNING EXCRVS

REXCRVS,FISHCRV,NEWFCRV

FISHCRV=formatted curves file (input)
NEWFCRV=new formatted curves file (output)

```
ENTER NUMBER OF CURVE SETS TO EXTRACT:

ENTER THE CURVE SET ID NUMBER(S):

ENTER TITLE LINE FOR NEW FISHCRV FILE (70 CHARS MAX)
?
```

A listing of the header lines in the new FISHCRV file will print out on the screen.

GCURV Program

I. INTRODUCTION

The GCURV program builds a FISHCRV file containing criteria curves of aquatic species or recreational activities. This file can be edited with an editor to correct errors or for modifications. The LPTCRV program checks the data contained in a FISHCRV file for errors. After correcting errors identified by running LPTCRV, convert the FISHCRV file to an unformatted FISHFIL by using the CRVFIL program. The unformatted FISHFIL is used as input to the habitat simulation programs.

Appendix A contains the file format for a FISHCRV file and a sample FISHCRV file.

II. RUNNING GCURV

RGCURV,FISHCRV

FISHCRV=formatted curves file (output)

ENTER THE TITLE FOR THE FILE (70 CHARS MAX):

NUMBER OF CURVE SETS TO BE ENTERED (60 MAX):

ENTER CURVE SET ID NUMBERS:

Six-digit identification numbers for family, species, and lifestage.

NUMBER OF POINTS FOR VELOCITY CURVE:

When entering curve coordinate data for velocity, depth, and channel index, each curve must begin with a minimum X value of 0 and should end with a maximum X value of 100.

NUMBER OF POINTS FOR DEPTH CURVE:

NUMBER OF POINTS FOR CHANNEL INDEX CURVE:

NUMBER OF POINTS FOR TEMPERATURE CURVE:

SPECIES DESCRIPTOR (40 CHARS MAX):

LIFE STAGE DESCRIPTOR (8 CHARS MAX):

ENTER -- VELOCITY COORDINATE PAIRS (V,SI):

ENTER -- DEPTH COORDINATE PAIRS (D,SI):

ENTER -- CHANNEL INDEX COORDINATE PAIRS (S,SI):

LDIR Program

I. INTRODUCTION

The LDIR program writes a complete or partial directory listing of an unformatted FISHFIL.

II. RUNNING LDIR

RLDIR,FISHFIL,ZOUT

FISHFIL=unformatted curves file (input)
ZOUT=LDIR results (output) (if filename is not specified, output will go to the screen)

```
FOR A COMPLETE LISTING OF THE CURVE DIRECTORY ENTER 1.
FOR A PARTIAL LISTING ENTER 0.
```

Figure IV.2 contains sample output from the LDIR program. A partial directory listing and a complete directory listing is included.

PARTIAL DIRECTORY LISTING FROM THE LDIR PROGRAM

CURVE FILE TITLE -
SAMPLE FISHCRV FILE CREATED WITH THE GCURV PROGRAM

NUMBER OF CURVES- 11
DATE AND TIME LAST MODIFIED OR CREATED- 88/07/14. 11.28.32.

	ID NUMBER	SPECIES	LIFE STAGE	DATE
1	11119	WINTER TROUT	ADULT	88/07/14.
2	11112	BROWN TROUT	FRY	88/07/14.
3	11114	BROWN TROUT	JUVENILE	88/07/14.
4	11115	BROWN TROUT	ADULT	88/07/14.
5	11120	BROWN TROUT	SPAWNING	88/07/14.
6	11126	BROWN/RAINBOW COLD WEATHER	EGGS	88/07/14.
7	11127	BROWN/RAINBOW TROUT MILD WINTER	EGG	88/07/14.
8	21110	RAINBOW TROUT	SPAWNING	88/07/14.
9	21112	RAINBOW TROUT	FRY	88/07/14.
10	21114	RAINBOW TROUT	JUVENILE	88/07/14.
11	21115	RAINBOW TROUT	ADULT	88/07/14.

11 CURVES IN FILE.

COMPLETE DIRECTORY LISTING FROM THE LDIR PROGRAM

CURVE FILE TITLE -
SAMPLE FISHCRV FILE CREATED WITH THE GCURV PROGRAM

NUMBER OF CURVES- 11
DATE AND TIME LAST MODIFIED OR CREATED- 88/07/14. 11.28.32.

DIRECTORY FOR THE HABITAT PREFERENCE CURVE FILE 88/07/14. 11.28.32. PAGE 1

	ID NUMBER	SPECIES	LIFE STAGE	NO. OF POINTS USED VEL	DEP	SUBS	TEMP	INSTALLATION DATE	TOTAL POINTS
1.	11119	WINTER TROUT	ADULT	9	9	7	0	88/07/14.	25.00
2.	11112	BROWN TROUT	FRY	4	7	8	0	88/07/14.	19.00
3.	11114	BROWN TROUT	JUVENILE	6	3	8	0	88/07/14.	17.00
4.	11115	BROWN TROUT	ADULT	5	3	7	0	88/07/14.	15.00
5.	11120	BROWN TROUT	SPAWNING	6	4	11	0	88/07/14.	21.00
6.	11126	BROWN/RAINBOW COLD WEATHER	EGGS	5	6	8	0	88/07/14.	19.00
7.	11127	BROWN/RAINBOW TROUT MILD WINTER	EGG	4	4	8	0	88/07/14.	16.00
8.	21110	RAINBOW TROUT	SPAWNING	7	6	11	0	88/07/14.	24.00
9.	21112	RAINBOW TROUT	FRY	4	8	8	0	88/07/14.	20.00
10.	21114	RAINBOW TROUT	JUVENILE	5	4	8	0	88/07/14.	17.00
11.	21115	RAINBOW TROUT	ADULT	4	4	8	0	88/07/14.	16.00

Figure IV.2. Sample output from the LDIR program.

LPTCRV Program

I. INTRODUCTION

The LPTCRV program checks data contained in a formatted FISHCRV file with the option to generate graphs from the curve data. The file may have been generated by the GCURV program or created with an editor.

II. RUNNING LPTCRV

RLPTCRV,FISHCRV,ZOUT

FISHCRV=formatted curves file (input)
ZOUT=LPTCRV results (output)

<u>NOTE</u>: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

ENTER 1 TO PLOT CRITERIA, 0 OTHERWISE:

Entering "1" generates the same output as "0" plus the plots.

SEARCH (output filename) FOR $$$ TO LOCATE ERROR MESSAGES.

Notice the errors that are identified on the first page of the sample LPTCRV output contained in Figure IV.3.

The following FISHCRV file was used as input to the LPTCRV program which resulted in the sample output.

```
    FISHCRV FILE WITH ERRORS
H  10102  5  7  4  0 BROWN TROUT - COVER                    JUVENILE  88/06/16.
V  10102  0.00  1.00  0.50  1.00  2.00  0.30  3.25  0.00100.00  0.00
D  10102  0.00  0.00  0.10  0.00  5.00  1.00  2.50  1.00  3.00  0.80  4.00  0.00
D  10102100.00  0.00
S  10102  1.00  0.00  2.00  0.80  3.00  0.80  4.00  1.00
```

```
 PROG - LPTCRV  88/06/16.  08.53.17.    FISHCRV FILE WITH ERRORS                          PAGE    1

   SET NO.   1   BROWN TROUT - COVER                          JUVENILE      CURVE NO.   10102

         VELOCITY   DATA

      VELOCITY        0.00       0.50       2.00       3.25      100.00
   SUITABILITY      1.00       1.00       0.30       0.00       0.00

         DEPTH      DATA

         DEPTH        0.00       0.10       5.00       2.50       3.00       4.00      100.00
   SUITABILITY      0.00       0.00       1.00       1.00       0.80       0.00       0.00

$$$ ERROR (  1) X COORD. DONT ASCEND (  5.00  2.50) ON THE DEPTH      CURVE

         CHANNEL INDEX DATA

 CHANNEL INDEX        1.00       2.00       3.00       4.00
   SUITABILITY      0.00       0.80       0.80       1.00
     $$$ FIRST POINT MUST BE ZERO
          1.00 WAS FOUND

     $$$ LAST POINT MUST BE 100.0
          4.00 WAS FOUND
```

ONLY THE PLOT OF THE DEPTH CURVE IS INCLUDED IN THIS SAMPLE OUTPUT; NOTICE THAT THE ERRORS ARE NOT IDENTIFIED IN THIS PLOT.

Figure IV.3. Sample output from the LPTCRV program.

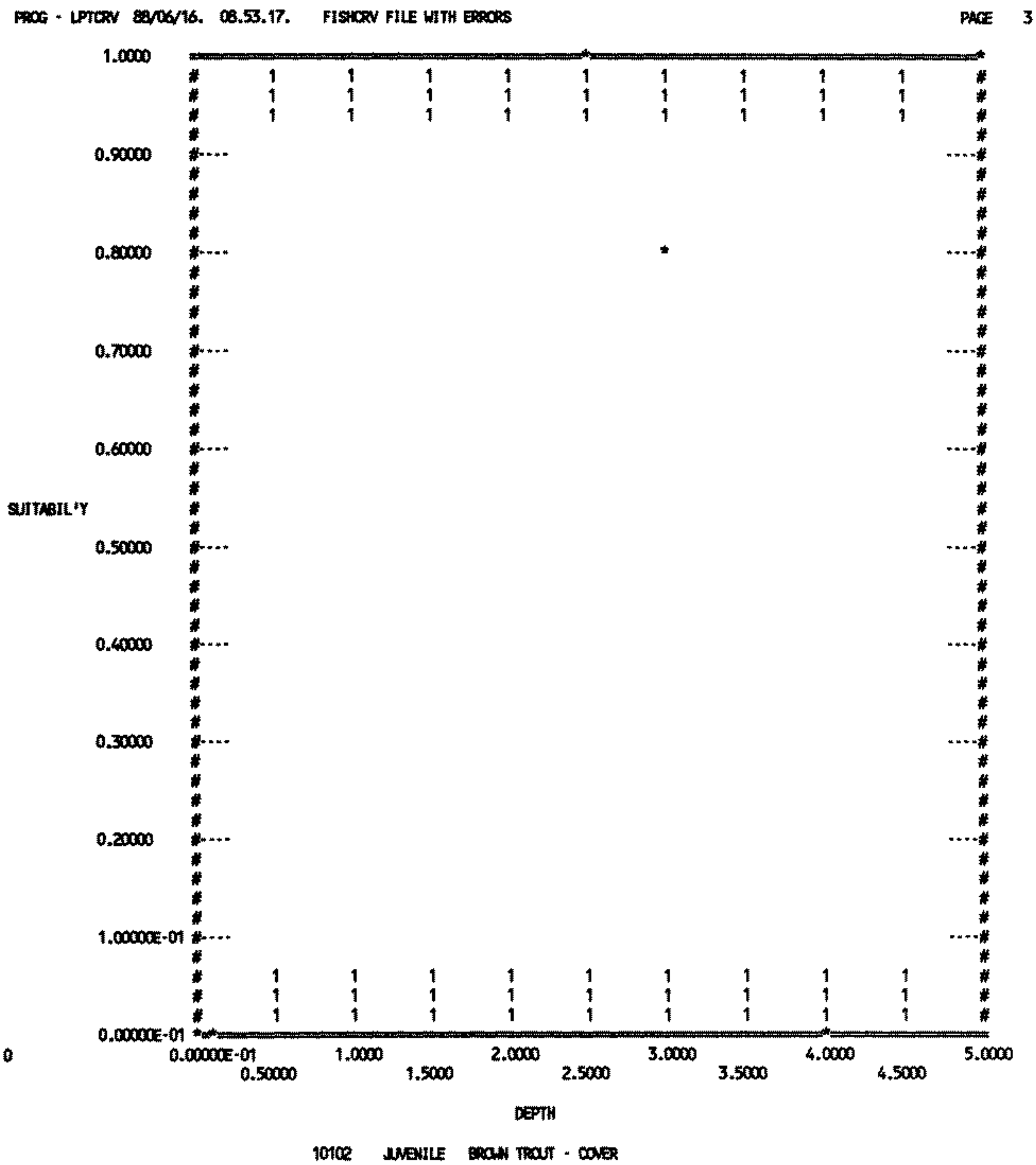


Figure IV.3. (Concluded)

LSTCNUM Program

I. INTRODUCTION

The LSTCNUM program lists the curve set ID numbers in an unformatted FISHFIL.

II. RUNNING LSTCNUM

RLSTCNM,FISHFIL,ZOUT

FISHFIL=unformatted curves file (input)
ZOUT=LSTCNUM results (output) (if filename is not specified, output will go to the screen)

The following type of output will appear on the screen or in the output file if specified.

```
THERE ARE   11 CURVES IN THE FILE, THEY ARE-
     11119    11112    11114    11115    11120    11126    11127
     21110    21112    21114    21115
```

LSTCRV Program

I. INTRODUCTION

The LSTCRV program lists the coordinates of the curves in a FISHFIL file for up to 40 life stages.

II. RUNNING LSTCRV

RLSTCRV,FISHFIL,ZOUT,ZHABIN

FISHFIL=unformatted curves file (input)
ZOUT=curve coordinates from FISHFIL (output)
ZHABIN=HABTAT, HABTAV, HABTAM, HABTAE, or HABVD options file, optional (input). If specified, the curve set ID numbers on the CURVES line in the options file will be displayed; the user will be prompted to enter how many of these curve sets to process and the curve set ID numbers.

Prompts when ZHABIN is specified as an input file:

CURVE SET ID NUMBERS IN THE FILE ARE-

Curve set ID numbers from the curves entered on the CURVES line in the options file will be listed.

HOW MANY OF THESE CURVE SETS DO YOU WISH TO PROCESS?

PLEASE LIST THE ID NUMBERS FOR THE CURVE SETS:

Figure IV.4 contains sample output from the LSTCRV program.

```
CURVES ON THE FILE ARE-
         11119     21110

 CURVE SET DEFINITION DATA WAS OBTAINED FROM THE FISHFIL FILE WHOSE TITLE LINE IS -

         SAMPLE FISHCRV FILE CREATED WITH THE GCURV PROGRAM

           LAST UPDATED ON 88/08/01. 09.41.21.


    WINTER TROUT                               ADULT        11119

         VELOCITY     DATA

    VELOCITY           0.00     0.20     0.30     0.50     0.75     1.00     1.50     2.00   100.00
    SUITABILITY        1.00     1.00     0.80     0.50     0.20     0.15     0.10     0.00     0.00

         DEPTH        DATA

    DEPTH              0.00     0.50     0.75     1.00     1.25     1.50     1.75     4.00   100.00
    SUITABILITY        0.00     0.05     0.10     0.25     0.50     0.75     1.00     1.00     1.00

         CHANNEL INDEX DATA

    CHANNEL INDEX      0.00     3.90     4.00     7.00     8.00     9.00   100.00
    SUITABILITY        0.00     0.00     1.00     1.00     0.50     0.00     0.00

    RAINBOW TROUT                              SPAWNING     21110

         VELOCITY     DATA

    VELOCITY           0.00     0.50     1.30     1.40     2.00     3.20   100.00
    SUITABILITY        0.00     0.00     0.95     1.00     1.00     0.00     0.00

         DEPTH        DATA

    DEPTH              0.00     0.30     0.70     2.00     8.00   100.00
    SUITABILITY        0.00     0.00     1.00     1.00     0.00     0.00

         CHANNEL INDEX DATA

    CHANNEL INDEX      0.00     1.00     2.00     3.00     4.00     5.00     6.00     7.00     8.00
   9.00
    SUITABILITY        0.00     0.00     1.00     1.00     1.00     0.10     0.00     0.00     0.00
   0.00
    CHANNEL INDEX    100.00
    SUITABILITY        0.00

 NORMAL END OF JOB
```

Figure IV.4. Sample output from the LSTCRV program.

LSTH Program

I. INTRODUCTION

The LSTH program lists the header lines in a formatted FISHCRV file.

II. RUNNING LSTH

RLSTH,FISHCRV,ZOUT

FISHCRV=formatted curves file (input)
ZOUT=LSTH results (output) (if filename is not specified, output will go to the screen)

The following output will appear on the screen or in the output file if an output filename is specified.

```
       TITLE OF FILE IS -

  SAMPLE FISHCRV FILE CREATED WITH THE GCURV PROGRAM

         NO. OF POINTS                                LIFE
    ID  VEL DEP CI TEMP SPECIES                       STAGE      DATE

  11119   9   9   7   0 WINTER TROUT                  ADULT     88/04/25
  11112   4   7   8   0 BROWN TROUT                   FRY
  11114   6   3   8   0 BROWN TROUT                   JUVENILE
  11115   5   3   7   0 BROWN TROUT                   ADULT
  11120   6   4  11   0 BROWN TROUT                   SPAWNING
  11126   5   6   8   0 BROWN/RAINBOW COLD WEATHER    EGGS
  11127   4   4   8   0 BROWN/RAINBOW MILD WINTER     EGG
  21110   7   6  11   0 RAINBOW TROUT                 SPAWNING
  21112   4   8   8   0 RAINBOW TROUT                 FRY
  21114   5   4   8   0 RAINBOW TROUT                 JUVENILE
  21115   4   4   8   0 RAINBOW TROUT                 ADULT

         11 CURVE SETS IN FILE
```

V. HABITAT SIMULATION PROGRAMS

INTRODUCTION

The following programs are microhabitat simulation models that simulate the physical habitat for an aquatic species or the recreational space available for specific types of recreational activities. The data used are the habitat suitability curves, stream channel geometry, water surface elevations, and mean cell velocities of the stream.

The stream is broken down into a series of rectangular cells, the length and width of which are determined by the reach length stationing and the cross-sectional stationing, respectively, as entered in the hydraulic simulation. Each cell is then evaluated for its habitat suitability to various life stages and species, based on fixed characteristics of the cell (such as channel index) and variable characteristics of the cell (such as depth, velocity, and width). Refer to Figure V.1 for information on how the HABTAT, HABTAM, and HABTAV programs view a cell's boundaries. The HABTAE program has the option of viewing cell boundaries either way.

The theory of the habitat simulation programs is based on the assumption that aquatic species will react to changes in the hydraulic environment. These changes are simulated for each cell in a defined stream reach. The stream reach simulation takes the form of a multi-dimensional matrix of the calculated surface areas of a stream having different combinations of hydraulic parameters (i.e., depth, velocity, and channel index). Depth and velocity vary with changes in discharge causing changes in the amount of available habitat. The end product of the habitat simulation is a description of habitat area as a function of discharge.

This habitat-discharge relationship is the basis of further analysis from which fishery and recreation management decisions are developed. By linking the habitat-discharge relationship with flow data, a habitat-flow relationship can be developed. This information can assist in identifying critical time periods for a given life stage, limiting habitat availability for each life stage (i.e., physical carrying capacity), and limiting habitat availability for different species. This method is particularly useful in evaluating potential changes in species composition because changes in hydraulic characteristics will initiate differential species reactions.

Refer to Figure I.8 for information on the "Flow of Information Through PHABSIM-Version II -- Habitat Simulation Programs Group".

NOTE: The TAPE3 and TP4 files used as input to the HABTAT program are output from an IFG4 or WSP run. The TAPE3 and TAPE4 files resulting from a MANSQ or STGQS4 run could be used, but they use a constant velocity for all cells.

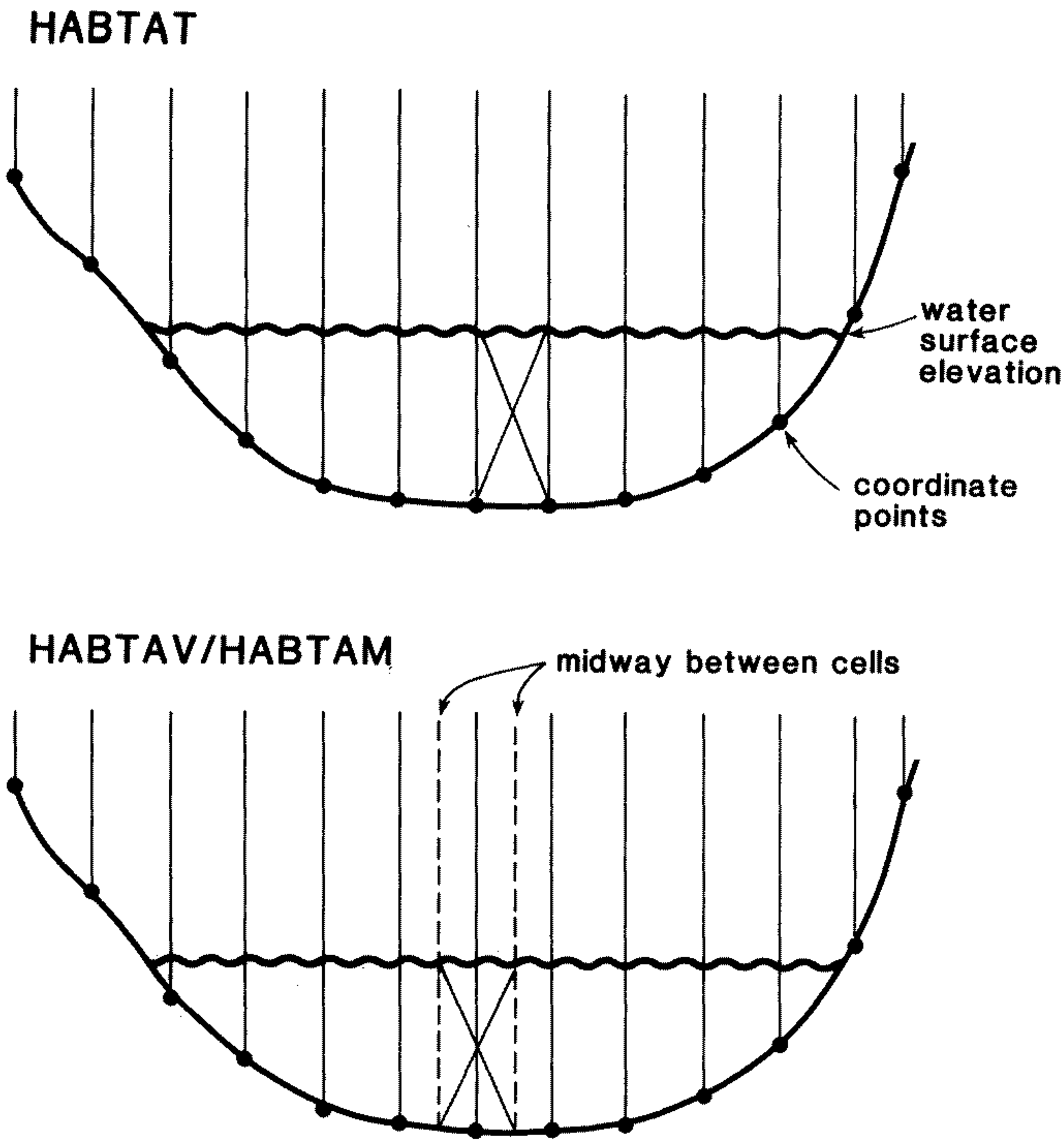


Figure V.1. The way cells are viewed by the HABTAT and HABTAM/HABTAV programs.

HABITAT SIMULATION PROGRAMS

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
AVDEPTH	**RAVDPTH**	Habitat Simulation	Calculates average cross section (hydraulic) parameters associated with flow in a river. **RAVDPTH,ZAVIN,ZOUT,ZHAQF** **ZAVIN**=AVDEPTH data set (WSP type data set with control line and water surface elevations added to the top) (input) **ZOUT**=AVDEPTH results (output) **ZHAQF**=habitat vs. flow file (output)
AVPERM	**RAVPERM**	Habitat Simulation	Calculates average parameters for each cross section and for a weighted reach of river. Basically it is an average parameter habitat model and can be used for analysis similar to AVDEPTH. **RAVPERM,ZOUT,TAPE3,TAPE4,ZHAQF** **ZOUT**=AVPERM results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input) **ZHAQF**=habitat vs. flow file (output)

HABITAT SIMULATION PROGRAMS (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
HABTAE	**RHABTAE**	Habitat Simulation	Calculates weighted usable area (surface or bed) or weighted usable volume (WUV) for each cross section. Weighted usable area may be calculated one of two ways depending on the options selected; (1) weighted usable surface area (WUA) (same as HABTAT, HABTAV, and HABTAM) and (2) weighted usable bed area (WUBA) which can be thought of as the weighted wetted perimeter times a length to calculate an area. The program writes a file containing the cross section weighted usable area (surface or bed) or weighted usable volume (dependent sections), OR the weighted usable area (surface or bed) or weighted usable volume for a reach (independent cross sections) depending on the option selected. For surface area and dependent cross sections, the HABTAE program will give the same results as the HABTAT program provided the same simulation options are selected. **RHABTAE,ZHABIN,ZOUT,FISHFIL,TAPE3, TAPE4,ZHAQF,ZHCF** **ZHABIN**=HABINE file (input) **ZOUT**=HABTAE results (output) **FISHFIL**=unformatted curves file (input) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input) **ZHAQF**=habitat vs. flow file (output) **ZHCF**=unformatted cell areas and cell weighted usable area (output). Created if IOC(13)=1.

HABITAT SIMULATION PROGRAMS (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
HABTAM	**RHABTAM**	Habitat Simulation	Simulates situations in which fish can migrate laterally within a cross section in order to make use of the available weighted usable area (WUA) when there is a change in velocity. **RHABTAM,ZHABIN,ZOUT,FISHFIL,TAPE3,TP4A, ZHAQF** **ZHABIN**=HABINM file (input) **ZOUT**=HABTAM results (output) **FISHFIL**=unformatted curves file (input) **TAPE3**=unformatted cross section and reach data (input) **TP4A**=rearranged TAPE4A file (TP4 was created in HABTAM and HABTAV format by setting IOC(17)=1 in IFG4 and was renamed TP4A by the user) (input) **ZHAQF**=habitat vs. flow file (output)
HABTAT	**RHABTAT**	Habitat Simulation	Computes the available habitat area in a reach of a stream. **RHABTAT,ZHABIN,ZOUT,FISHFIL,TAPE3,TP4, ZHAQF,ZHCF** **ZHABIN**=HABINS or HABIN file (input) **ZOUT**=HABTAT results (output) **FISHFIL**=unformatted curves file (input) **TAPE3**=unformatted cross section and reach data (input) **TP4**=rearranged TAPE4 file (input) **ZHAQF**=habitat vs. flow file (output) **ZHCF**=unformatted cell areas and cell weighted usable area (output). Created if IOC(13)=1.

HABITAT SIMULATION PROGRAMS (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
HABTAV	**RHABTAV**	Habitat Simulation	Simulates situations where fish habitat is determined by hydraulic parameters at the fish's location, as well as by velocities near the fish. **RHABTAV,ZHABIN,ZOUT,FISHFIL,TAPE3,TP4A, ZHAQF,ZHCF** **ZHABIN**=HABINV file (input) **ZOUT**=HABTAV results (output) **FISHFIL**=unformatted curves file (input) **TAPE3**=unformatted cross section and reach data (input) **TP4A**=rearranged TAPE4A file (TP4 was created in HABTAM and HABTAV format by setting IOC(17)=1 in IFG4 and was renamed TP4A by the user) (input) **ZHAQF**=habitat vs. flow file (output) **ZHCF**=unformatted cell areas and cell weighted usable area (output). Created if IOC(13)=1.
HABVD	**RHABVD**	Habitat Simulation	Calculates weighted usable area using flow-related data from the U.S. Geological Survey. **RHABVD,ZHABIN,ZIN,FISHFIL,ZOUT,ZHAQF** **ZHABIN**=HBVDIN file (input) **ZIN**=streamflow data or stream morphology parameters (input) **FISHFIL**=unformatted curves file (input) **ZOUT**=HABVD results (output) **ZHAQF**=habitat vs. flow file (output)

NOTE: Refer to individual program documentation for more information on the above habitat simulation programs. Also, refer to Figure V.1 for a diagram of how the different habitat simulation programs view a cell.

HABITAT SIMULATION - OPTIONS FILE CREATION AND MODIFICATION

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
HABIN	**RHABIN**	HABTAT Options File Creation	Builds a HABTAT options file which may contain hydraulic data, cross section data, or formatted FISHCRV type data. **RHABIN,ZHABIN** **ZHABIN**=HABTAT options file (output)
HABINE	**RHABINE**	HABTAE Options File Creation	Builds a HABTAE options file. **RHABINE,ZHABIN** **ZHABIN**=HABTAE options file (output)
HABINM	**RHABINM**	HABTAM Options File Creation	Builds a HABTAM options file. **RHABINM,ZHABIN** **ZHABIN**=HABTAM options file (output)
HABINS	**RHABINS**	HABTAT Options File Creation	Builds a HABTAT options file. **RHABINS,ZHABIN** **ZHABIN**=HABTAT options file (output)
HABINV	**RHABINV**	HABTAV Options File Creation	Builds a HABTAV options file. **RHABINV,ZHABIN** **ZHABIN**=HABTAV options file (output)
HBVDIN	**RHBVDIN**	HABVD Options File Creation	Builds a HABVD options file. **RHBVDIN,ZHABIN** **ZHABIN**=HABVD options file (output)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
MAKAVD	**RMAKAVD**	AVDEPTH Input File Creation	Creates an input file for the AVDEPTH program from a WSP or IFG4 data set; water surface elevations are read from a TAPE4 (generated from the input data set) or entered interactively. **RMAKAVD,ZIN,ZAVIN,TAPE4** **ZIN**=IFG4 or WSP data set (input) **ZAVIN**=AVDEPTH data set (output) **TAPE4**=unformatted flow data (optional input)
MODIOC	**RMODIOC**	IFG4/WSP/MANSQ/ HABTAT/HABTAM/ HABTAV/HABTAE/ HABVD Data Set Modification	Changes options in the selected data set or options file. **RMODIOC,ZIN,ZOUT** **ZIN**=original data set (input) **ZOUT**=new data set with modified options (output)

HABITAT SIMULATION - MISCELLANEOUS

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
COMHQF	**RCOMHQF**	Habitat Simulation -- Miscellaneous	Averages or combines habitat area data from two habitat vs. streamflow files based on weighting factors supplied by the user. The weight for the first file must be less than or equal to "1". The weight for the second file is assumed to be "1" minus the first file weight. Any number of ZHAQF files may be combined by adjusting the weight factors and running COMHQF on two ZHAQF files at a time. **RCOMHQF,ZHAQFN,ZHAQF,ZHAQF2,ZOUT** **ZHAQFN**=averaged or combined habitat area versus streamflow file (output) **ZHAQF**=habitat area vs. streamflow file (input) **ZHAQF2**=habitat area vs. streamflow file (input) **ZOUT**=averaged or combined habitat area in tables for each individual life stage (output)
HQF2LT	**RHQF2LT**	Habitat Simulation -- Miscellaneous	Converts a habitat vs. streamflow file to a file that is readable by LOTUS. **RHQF2LT,ZHAQF,ZOUT** **ZHAQF**=habitat vs. flow file (input) **ZOUT**=LOTUS readable ZHAQF file (output)
SUMHQF	**RSUMHQF**	Habitat Simulation -- Miscellaneous	Sums conditional cover columns in a ZHAQF file into one habitat vs. flow figure for each life stage. Run when conditional cover curves were used as input to the habitat simulation programs. Allows up to 5 life stages to be grouped in each record. **RSUMHQF,ZHAQF,ZHAQFN** **ZHAQF**=habitat vs. streamflow file (input) **ZHAQFN**=modified ZHAQF file with columns summed (output)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
LPTHQF	**RLPTHQF**	Habitat Simulation -- Review	Plots the habitat vs. flow functions - one species per page; 1-5 life stages. **RLPTHQF,ZHAQF,ZOUT** **ZHAQF**=habitat vs. flow file (input) **ZOUT**=LPTHQF results (output)
LPTHQFN	**RLPTHQN**	Habitat Simulation -- Review	Plots the habitat vs. flow functions - one life stage per page. When more than one ZHAQF input file is specified, one curve from each file will be plotted on the same page. **RLPTHQN,ZOUT,ZHAQF1,ZHAQF2,ZHAQF3, ZHAQF4,ZHAQF5** **ZOUT**=LPTHQFN results (output) **ZHAQF(1-5)**=1 to 5 habitat vs. flow files (input)

AVDEPTH and AVPERM Programs

I. INTRODUCTION

Wetted perimeter, wetted width, and average velocity have long been used as indexes to the physical habitat in a stream. In using the wetted width or wetted perimeter, the assumption is made that all the area of the stream is of equal value to the instream flow activity of interest. The wetted perimeter and wetted width will always either stay the same or increase with depth. If these, and the above, assumptions can be made, then the use of the AVDEPTH and AVPERM programs is appropriate.

The major difference between the AVDEPTH and the AVPERM programs is input to the programs. The AVDEPTH program uses a WSP-type data set with at least two additional lines added to the top. The first line contains controls for the calculation and output for the AVDEPTH program; the other additional lines contain water surface elevations for the cross sections. The AVPERM program uses a TAPE3 which contains unformatted cross section and reach data, and a TAPE4 which contains unformatted flow data. These two files are generated by the hydraulic simulation programs. In AVDEPTH, the weight on a cross section is always 0.5; in AVPERM, the weight is written to the TAPE3 resulting from the hydraulic simulation process. PHABSIM programs assume that the hydraulic variables measured at a cross section extend halfway to adjacent cross sections upstream and downstream. If this is not the case, upstream weighting factors should be applied.

The output resulting from AVDEPTH and AVPERM gives information for each cross section and a summary of the average parameters for a whole reach of stream including discharge, depth, cross-sectional data, and velocity. In addition, for each of the specified depths (maximum of five), AVDEPTH and AVPERM calculate the total width of the stream that is as least as deep as the specified depth (Figure V.2).

The advantage of using the wetted width or wetted perimeter approach for developing indexes to physical habitat in a stream is that the development requires much less field and office work than the use of the weighted usable area approach used in PHABSIM. This savings in effort results from:

1. Species criteria not having to be developed or obtained;
2. If using AVDEPTH, velocities need not be measured for the purpose of calibrating a hydraulic simulation model to velocities, although the discharge must be known; and
3. The interpretation of the results requires the use of only one factor (i.e., wetted perimeter or wetted width) in contrast to the many possible life stages (factors) which may need to be considered when using weighted usable areas.

The use of wetted width is a special case of weighted usable area in which the weights are 1.0 for all velocities, depths, and channel indexes. Because the wetted perimeter is nearly the same as the wetted width, the same can be said for the wetted perimeter as well.

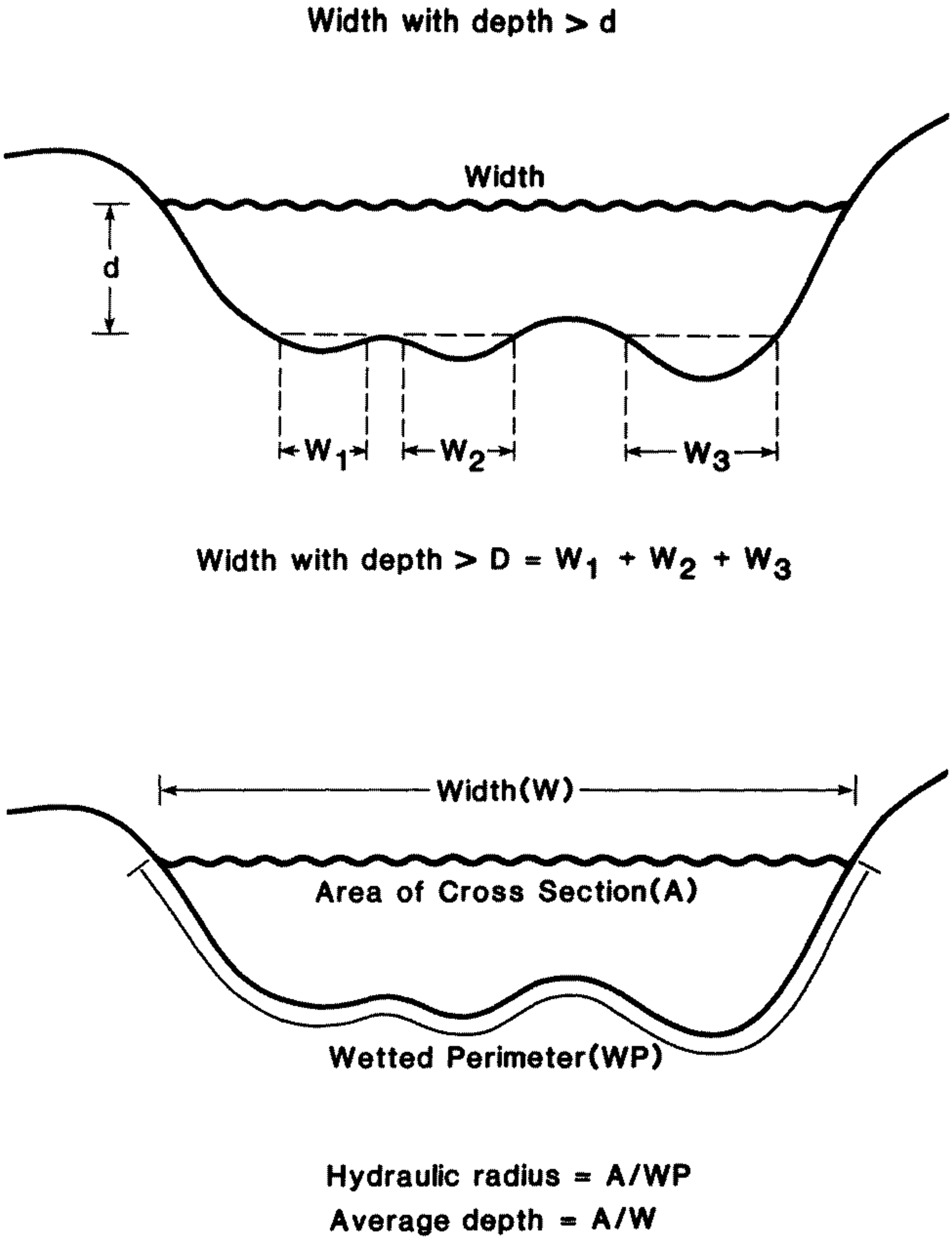


Figure V.2. AVDEPTH and AVPERM calculations.

II. RUNNING AVDEPTH

The MAKAVD program is used to convert a WSP or IFG4 data set to an AVDEPTH data set. Refer to Appendix A for "AVDEPTH Data Set Format" and information on what each line contains. Appendix A also contains a sample AVDEPTH data set.

RAVDPTH,ZAVIN,ZOUT,ZHAQF

ZAVIN=AVDEPTH data set (WSP type data set with control line and water surface elevations added to the top) (input)
ZOUT=AVDEPTH results (output)
ZHAQF=habitat vs. flow file (output)

NOTE: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

Appendix A contains the AVDEPTH data set that was used to generate the output in Figure V.3. Figure V.4 contains the ZHAQF file created by AVDEPTH.

III. AVDEPTH ERROR MESSAGES

Most of the error messages result from data set format errors. Refer to Appendix A for "AVDEPTH Data Set Format" and "WSP Data Set Format".

1. **THERE IS A PROBLEM IN STATIONING OF TRANSECT NO. --- OR TRANSECT NO. --- THE TWO NUMBERS APPEAR ON LINES THAT ARE RIGHT NEXT TO EACH OTHER IN THE DATA FILE.**

   The program will use the first station number and continue to run.

ONLY THE DATA FOR CROSS SECTION 0.00 HAS BEEN INCLUDED IN THIS SAMPLE OUTPUT.

COORDINATE DATA FOR CROSS SECTION 0.00

DISTANCE	0.00	2.50	4.00	4.30	5.50	7.60	11.90	14.20	16.20	16.50
ELEVATION	101.30	100.70	99.80	98.60	97.70	97.30	97.60	97.90	97.60	97.70
DISTANCE	18.20	20.20	22.20	24.20	26.20	28.20	30.20	32.20	33.00	34.20
ELEVATION	97.50	97.40	97.30	97.20	97.30	97.50	97.40	97.70	97.60	97.60
DISTANCE	35.20	36.20	37.40	39.10	43.80	53.00	62.40	69.90	78.10	87.10
ELEVATION	97.70	97.70	97.70	97.90	98.10	98.60	99.00	98.50	99.00	99.50

ESTIMATE OF PARAMETERS FOR CROSS SECTION 0.00

WATER ELEVATION	CHANNEL AREA	SURFACE WIDTH	AVERAGE DEPTH	WETTED PERIMETER	HYDRAULIC RADIUS	FLOW FACTOR	SURFACE WIDTH WITH DEPTH OF AT LEAST 0.25 FT	0.50 FT	1.00 FT	1.50 FT	2.00 FT	FLOW	VELOCITY
97.68	5.84	25.72	0.23	25.85	0.23	3.6972	11.25	0.00	0.00	0.00	0.00	8.00	1.37
97.72	6.95	29.52	0.24	29.67	0.23	3.7893	14.30	0.80	0.00	0.00	0.00	10.00	1.44
97.84	10.66	32.42	0.33	32.64	0.33	3.9540	19.71	5.98	0.00	0.00	0.00	20.00	1.88
97.93	13.68	34.61	0.40	34.87	0.39	4.0930	25.72	11.25	0.00	0.00	0.00	30.00	2.19
98.01	16.53	36.60	0.45	36.89	0.45	4.1336	30.48	16.93	0.00	0.00	0.00	40.00	2.42
98.08	19.15	38.34	0.50	38.65	0.50	4.1701	32.18	19.36	0.00	0.00	0.00	50.00	2.61
98.13	21.10	39.43	0.54	39.76	0.53	4.3398	33.38	22.93	0.00	0.00	0.00	60.00	2.84
98.19	23.50	40.61	0.58	40.97	0.57	4.3155	34.86	26.28	0.00	0.00	0.00	70.00	2.98
98.23	25.14	41.40	0.61	41.77	0.60	4.4649	35.85	29.76	1.20	0.00	0.00	80.00	3.18
98.28	27.23	42.39	0.64	42.77	0.64	4.4659	37.09	30.97	3.20	0.00	0.00	90.00	3.31
98.32	28.94	43.17	0.67	43.58	0.66	4.5389	38.09	31.93	4.99	0.00	0.00	100.00	3.46
98.36	30.69	43.96	0.70	44.38	0.69	4.5847	39.03	32.90	6.97	0.00	0.00	110.00	3.58
98.40	32.46	44.75	0.73	45.18	0.72	4.6090	39.82	33.87	8.96	0.00	0.00	120.00	3.70
98.44	34.27	45.54	0.75	45.99	0.75	4.6161	40.61	4.86	12.01	0.00	0.00	130.00	3.79

Figure V.3. Sample output from the AVDEPTH program.

88/07/26. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM-AVDEPTH
11.52.46. AVDEPTH DATA SET CREATED FROM AN IFG4 DATA SET WITH THE MAKAVD PROGRAM PAGE- 3

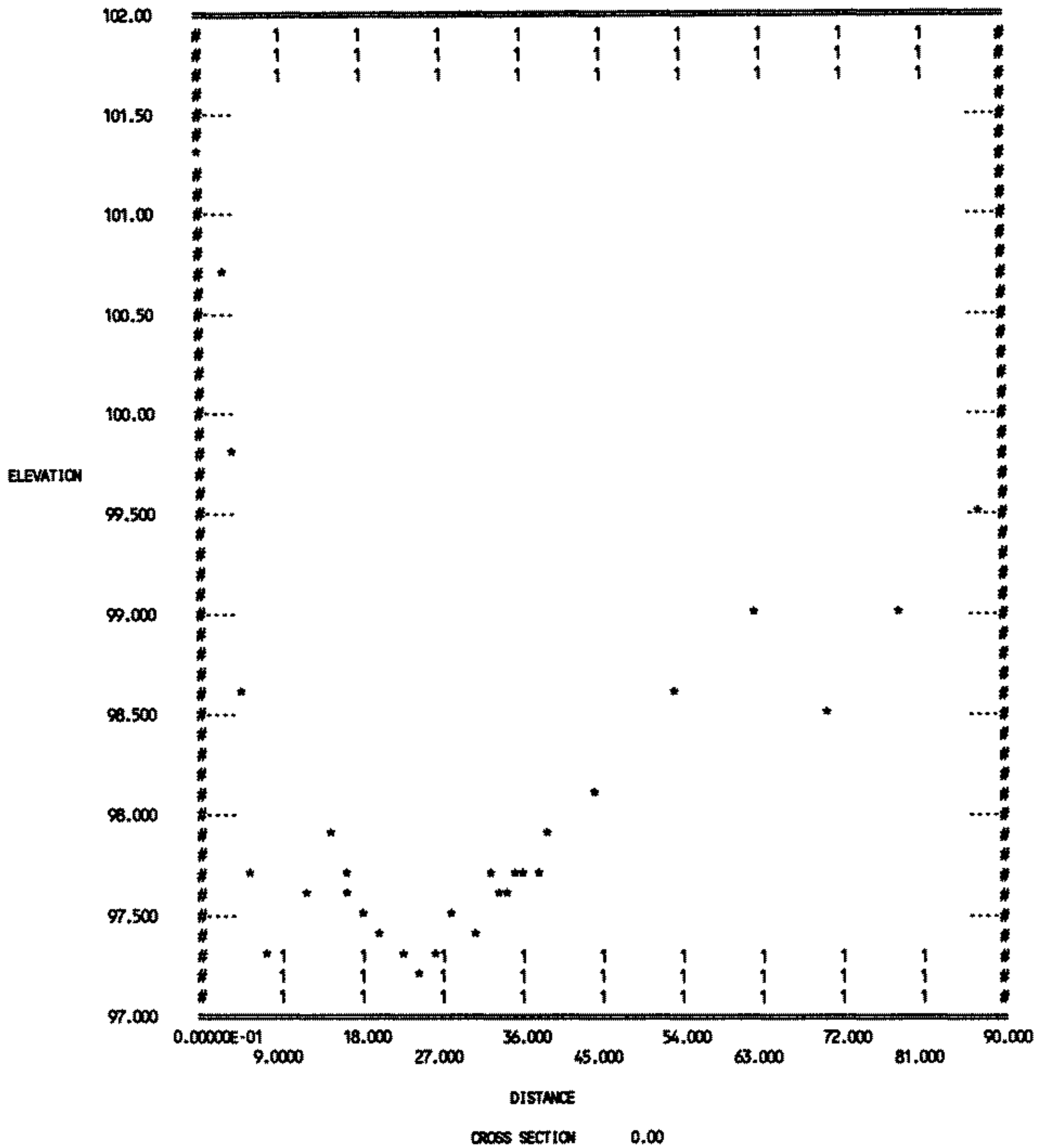


Figure V.3. (Continued)

SUMMARY OF AVERAGE PARAMETERS FOR WHOLE REACH

	WETTED		WIDTH WITH DEPTH GREATER THAN							
DISCHARGE	PERIMETER	WIDTH	0.25	0.50	1.00	1.50	2.00	DEPTH	C/S AREA	VELOCITY
8.00	23.73	23.63	13.77	0.00	0.00	0.00	0.00	0.27	6.3	1.26
10.00	25.98	25.86	16.42	0.40	0.00	0.00	0.00	0.28	7.3	1.37
20.00	30.45	30.29	20.13	8.69	0.00	0.00	0.00	0.36	10.9	1.84
30.00	32.75	32.57	23.88	14.80	0.00	0.00	0.00	0.42	13.8	2.17
40.00	34.71	34.50	26.93	18.37	0.00	0.00	0.00	0.48	16.5	2.42
50.00	39.35	39.12	30.17	19.96	0.00	0.00	0.00	0.49	19.1	2.62
60.00	42.09	41.85	31.48	22.15	0.00	0.00	0.00	0.51	21.3	2.81
70.00	43.66	43.40	32.81	24.24	0.00	0.00	0.00	0.55	23.7	2.96
80.00	44.83	44.56	33.77	26.31	3.20	0.00	0.00	0.57	25.4	3.15
90.00	46.10	45.82	35.28	27.25	5.40	0.00	0.00	0.60	27.4	3.28
100.00	47.27	46.97	37.93	28.07	7.50	0.00	0.00	0.62	29.3	3.41
110.00	48.25	47.94	40.01	30.65	9.54	0.00	0.00	0.65	30.9	3.56
120.00	49.42	49.10	41.85	31.61	11.93	0.00	0.00	0.67	32.9	3.65
130.00	50.40	50.07	42.82	32.46	14.50	0.00	0.00	0.69	34.6	3.76

NORMAL END OF JOB

Figure V.3. (Concluded)

UPPER SALMON RIVER, NEAR STANLEY, IDAHO
ZHAQF FILE GENERATED BY THE AVDEPTH PROGRAM

WIDTH AND WETTED PERIMETER

	DISCHARGE	WIDTH	WETTED P
* 1	8.00	23.63	23.73
* 2	10.00	25.86	25.98
* 3	20.00	30.29	30.45
* 4	30.00	32.57	32.75
* 5	40.00	34.50	34.71
* 6	50.00	39.12	39.35
* 7	60.00	41.85	42.09
* 8	70.00	43.40	43.66
* 9	80.00	44.56	44.83
*10	90.00	45.82	46.10
*11	100.00	46.97	47.27
*12	110.00	47.94	48.25

****

WIDTH WITH DEPTH GREATER THAN X

	DISCHARGE	X= 0.25	X= 0.50	X= 1.00	X= 1.50	X= 2.00
* 1	8.00	13.77	0.00	0.00	0.00	0.00
* 2	10.00	16.42	0.40	0.00	0.00	0.00
* 3	20.00	20.13	8.69	0.00	0.00	0.00
* 4	30.00	23.88	14.80	0.00	0.00	0.00
* 5	40.00	26.93	18.37	0.00	0.00	0.00
* 6	50.00	30.17	19.96	0.00	0.00	0.00
* 7	60.00	31.48	22.15	0.00	0.00	0.00
* 8	70.00	32.81	24.24	0.00	0.00	0.00
* 9	80.00	33.77	26.31	3.20	0.00	0.00
*10	90.00	35.28	27.25	5.40	0.00	0.00
*11	100.00	37.93	28.07	7.50	0.00	0.00
*12	110.00	40.01	30.65	9.54	0.00	0.00

****

CROSS SECTIONAL AREA

	DISCHARGE	C/S AREA
* 1	8.00	6.33
* 2	10.00	7.32
* 3	20.00	10.85
* 4	30.00	13.83
* 5	40.00	16.51
* 6	50.00	19.09
* 7	60.00	21.34
* 8	70.00	23.67
* 9	80.00	25.43
*10	90.00	27.44
*11	100.00	29.30
*12	110.00	30.94

****

MEAN CHANNEL VELOCITY

	DISCHARGE	VELOCITY
* 1	8.00	1.26
* 2	10.00	1.37
* 3	20.00	1.84
* 4	30.00	2.17
* 5	40.00	2.42
* 6	50.00	2.62
* 7	60.00	2.81
* 8	70.00	2.96
* 9	80.00	3.15
*10	90.00	3.28
*11	100.00	3.41
*12	110.00	3.56

****

Figure V.4. ZHAQF file generated by AVDEPTH.

IV. RUNNING AVPERM

RAVPERM,ZOUT,TAPE3,TAPE4,ZHAQF

ZOUT=AVPERM results (output)
TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)
ZHAQF=habitat vs. flow file (output)

ENTER NUMBER OF DEPTHS (5 MAX):

If depths are specified, the AVPERM program will calculate the total width of the stream that is as least as deep as the depth(s) specified.

ENTER THE --- DEPTHS:

Figure V.5 contains sample output from the ZOUT file created by AVPERM. Figure V.6 contains the ZHAQF file generated by AVPERM.

DATE - 88/10/04.   UPPER SALMON RIVER, NEAR STANLEY, IDAHO   PROGRAM - AVPERM
TIME - 13.12.34.   IFG4 DATA SET WITH WSL LINES ADDED FROM MANSQ   PAGE - 1

AVERAGE PARAMETERS FOR CROSS SECTION   0.00

DISCHARGE	W.S. ELEV	AVERAGE VELOCITY	HYDRAULIC DEPTH	HYDRAULIC RADIUS	WETTED WIDTH	WETTED PERIMETER	FROUDE NUMBER	DRAG PARAMETER	WADING PARAMETER	C/S AREA
8.0	97.68	1.37	0.23	0.23	25.7	25.9	0.51	0.43	0.31	5.8
10.0	97.72	1.44	0.24	0.23	29.5	29.7	0.52	0.49	0.34	6.9
20.0	97.84	1.88	0.33	0.33	32.4	32.6	0.58	1.16	0.62	10.7
30.0	97.93	2.19	0.40	0.39	34.6	34.9	0.61	1.90	0.87	13.7
40.0	98.01	2.42	0.45	0.45	36.6	36.9	0.63	2.65	1.09	16.5
50.0	98.08	2.61	0.50	0.50	38.3	38.7	0.65	3.41	1.30	19.2
60.0	98.13	2.84	0.54	0.53	39.4	39.8	0.69	4.33	1.52	21.1
70.0	98.19	2.98	0.58	0.57	40.6	41.0	0.69	5.14	1.72	23.5
80.0	98.23	3.18	0.61	0.60	41.4	41.8	0.72	6.15	1.93	25.1
90.0	98.28	3.31	0.64	0.64	42.4	42.8	0.73	7.02	2.12	27.2
100.0	98.32	3.46	0.67	0.66	43.2	43.6	0.74	8.00	2.32	28.9
110.0	98.36	3.58	0.70	0.69	44.0	44.4	0.76	8.97	2.50	30.7
120.0	98.40	3.70	0.73	0.72	44.8	45.2	0.76	9.91	2.68	32.5
130.0	98.44	3.79	0.75	0.75	45.5	46.0	0.77	10.83	2.85	34.3

DRAG PARAMETER = (VELOCITY ** 2.0) * DEPTH
WADING PARAMETER = VELOCITY * DEPTH

DEPTH PARAMETERS FOR CROSS SECTION   0.00

DISCHARGE	TOTAL WIDTH	WIDTH WITH DEPTH GREATER THAN 0.25		0.50		1.00		1.50		2.00	
		SUM	CONT. W	SUM	CONT. W	SUM	CONT. W	SUM	CONT. W	SUM	CONT. W
8.0	26.	11.	8.	0.	0.	0.	0.	0.	0.	0.	0.
10.0	30.	14.	9.	1.	1.	0.	0.	0.	0.	0.	0.
20.0	32.	20.	14.	6.	5.	0.	0.	0.	0.	0.	0.
30.0	35.	26.	15.	11.	8.	0.	0.	0.	0.	0.	0.
40.0	37.	30.	23.	17.	13.	0.	0.	0.	0.	0.	0.
50.0	38.	32.	24.	19.	14.	0.	0.	0.	0.	0.	0.
60.0	39.	33.	25.	23.	15.	0.	0.	0.	0.	0.	0.
70.0	41.	35.	35.	26.	16.	0.	0.	0.	0.	0.	0.
80.0	41.	36.	36.	30.	22.	1.	1.	0.	0.	0.	0.
90.0	42.	37.	37.	31.	23.	3.	3.	0.	0.	0.	0.
100.0	43.	38.	38.	32.	24.	5.	5.	0.	0.	0.	0.
110.0	44.	39.	39.	33.	24.	7.	6.	0.	0.	0.	0.
120.0	45.	40.	40.	34.	34.	9.	7.	0.	0.	0.	0.
130.0	46.	41.	41.	35.	35.	12.	8.	0.	0.	0.	0.

"CONT. W" IS MAXIMUM CONTIGUOUS WIDTH

ONLY THE INFORMATION FOR THE FIRST CROSS SECTION IS INCLUDED IN THIS SAMPLE OUTPUT.

Figure V.5. Sample output from the AVPERM program.

DATE - 88/10/04. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM - AVPERM
TIME - 13.12.34. IFG4 DATA SET WITH WSL LINES ADDED FROM MANSQ PAGE - 3

SUMMARY OF AVERAGE PARAMETERS FOR WHOLE REACH

DISCHARGE	WETTED PERIMETER	WIDTH	WIDTH WITH DEPTH GREATER THAN 0.25	0.50	1.00	1.50	2.00	DEPTH	C/S AREA	VELOCITY
8.00	22.88	22.79	14.78	0.00	0.00	0.00	0.00	0.29	6.5	1.23
10.00	24.50	24.40	17.27	0.24	0.00	0.00	0.00	0.31	7.5	1.34
20.00	29.58	29.44	20.30	9.78	0.00	0.00	0.00	0.37	10.9	1.83
30.00	31.90	31.75	23.14	16.23	0.00	0.00	0.00	0.44	13.9	2.16
40.00	33.83	33.66	25.50	18.94	0.00	0.00	0.00	0.49	16.5	2.42
50.00	39.63	39.44	29.37	20.19	0.00	0.00	0.00	0.48	19.1	2.62
60.00	43.02	42.82	30.72	21.84	0.00	0.00	0.00	0.50	21.4	2.80
70.00	44.73	44.51	31.99	23.42	0.00	0.00	0.00	0.53	23.7	2.95
80.00	46.05	45.82	32.94	24.93	4.00	0.00	0.00	0.56	25.5	3.13
90.00	47.43	47.19	34.56	25.76	6.28	0.00	0.00	0.58	27.5	3.27
100.00	48.75	48.49	37.86	26.52	8.50	0.00	0.00	0.61	29.4	3.40
110.00	49.80	49.54	40.40	29.75	10.56	0.00	0.00	0.63	31.0	3.54
120.00	51.12	50.84	42.67	30.70	13.12	0.00	0.00	0.65	33.1	3.63
130.00	52.17	51.88	43.71	31.49	15.50	0.00	0.00	0.67	34.7	3.74

Figure V.5. (Concluded)

```
UPPER SALMON RIVER, NEAR STANLEY, IDAHO
ZHAQF FILE CREATED BY THE AVPERM PROGRAM
WIDTH AND WETTED PERIMETER
      DISCHARGE    WIDTH       WETTED P
* 1       8.00       22.79       22.88
* 2      10.00       24.40       24.50
* 3      20.00       29.44       29.58
* 4      30.00       31.75       31.90
* 5      40.00       33.66       33.83
* 6      50.00       39.44       39.63
* 7      60.00       42.82       43.02
* 8      70.00       44.51       44.73
* 9      80.00       45.82       46.05
*10      90.00       47.19       47.43
*11     100.00       48.49       48.75
*12     110.00       49.54       49.80
***************
WIDTH WITH DEPTH GREATER THAN X
      DISCHARGE    X= 0.25     X= 0.50     X= 1.00     X= 1.50     X= 2.00
* 1       8.00       14.78        0.00        0.00        0.00        0.00
* 2      10.00       17.27        0.24        0.00        0.00        0.00
* 3      20.00       20.30        9.78        0.00        0.00        0.00
* 4      30.00       23.14       16.23        0.00        0.00        0.00
* 5      40.00       25.50       18.94        0.00        0.00        0.00
* 6      50.00       29.37       20.19        0.00        0.00        0.00
* 7      60.00       30.72       21.84        0.00        0.00        0.00
* 8      70.00       31.99       23.42        0.00        0.00        0.00
* 9      80.00       32.94       24.93        4.00        0.00        0.00
*10      90.00       34.56       25.76        6.28        0.00        0.00
*11     100.00       37.86       26.52        8.50        0.00        0.00
*12     110.00       40.40       29.75       10.56        0.00        0.00
***************
CROSS SECTIONAL AREA
      DISCHARGE    C/S AREA
* 1       8.00        6.53
* 2      10.00        7.47
* 3      20.00       10.93
* 4      30.00       13.88
* 5      40.00       16.50
* 6      50.00       19.06
* 7      60.00       21.43
* 8      70.00       23.74
* 9      80.00       25.54
*10      90.00       27.53
*11     100.00       29.44
*12     110.00       31.04
***************
MEAN CHANNEL VELOCITY
     DISCHARGE    VELOCITY
* 1       8.00        1.23
* 2      10.00        1.34
* 3      20.00        1.83
* 4      30.00        2.16
* 5      40.00        2.42
* 6      50.00        2.62
* 7      60.00        2.80
* 8      70.00        2.95
* 9      80.00        3.13
*10      90.00        3.27
*11     100.00        3.40
*12     110.00        3.54
***************
```

Figure V.6. ZHAQF file generated by AVPERM.

COMHQF Program

I. INTRODUCTION

The COMHQF program averages or combines habitat area data from two habitat vs. streamflow files based on weighting factors supplied by the user. The weight for the first file must be less than or equal to "1". The weight for the second file is assumed to be "1" minus the first file weight. Any number of ZHAQF files may be combined by adjusting the weight factors and running COMHQF with each set of two files.

The equation used when combining two files with weights is:

$$HAC = (HA1 \times W1) + (HA2 \times W2)$$
$$W2 = 1.0 - W1$$
$$W1 \leq 1.0$$
$$Q1 = Q2$$

where
HA1 = habitat area from the first ZHAQF file
HA2 = habitat area from the second ZHAQF file
HAC = combined habitat area
W1 = weight on first ZHAQF file
W2 = weight on second ZHAQF file
Q1 = streamflow from first ZHAQF file, and
Q2 = streamflow from second ZHAQF file

II. RUNNING COMHQF

RCOMHQF,ZHAQFN,ZHAQF,ZHAQF2,ZOUT

ZHAQFN=averaged or combined habitat vs. flow file (output)
ZHAQF=habitat vs. flow file (input)
ZHAQF2=habitat vs. flow file (input)
ZOUT=averaged or combined habitat area in tables
for each individual life stage (output)

The two title lines from the two input files are displayed.

ENTER TWO LINE TITLE

These two title lines will be in the averaged or combined output file.

If the "Life Stage Lines" are not the same on both ZHAQF files specified as input, the following message will appear, but the program will not abort:

```
WARNING - LIFE STAGE TITLES DO NOT MATCH.
      WILL USE LIFE STAGE TITLE FROM FIRST
      HAQF FILE
```

Input files need to be in the same format and contain the same type of information to be logically combined, i.e., combining different habitat simulation figures for the same discharges, species, and life stages of fish would be logical.

ENTER 0 TO AVERAGE HAQF FILES,
1 TO COMBINE WITH WEIGHTS:

If "1" is entered to combine with weights:

ENTER WEIGHT FOR FLOWS ON SET 1 -

ENTER WEIGHT FOR WUA ON SET 1 -

The weights for the first file must be less than or equal to "1". The weight for the second file is assumed to be "1" minus the first file weight.

HABIN Program

I. INTRODUCTION

The HABIN program builds the long form of a HABTAT options file which may contain hydraulic data, cross section data, or formatted FISHCRV type data. This file is used as input to the HABTAT program.

It is recommended that the HABINS program be used to create the HABTAT options file versus using the HABIN program.

Refer to Appendix A, HABTAT Options File Format, for file format for a HABIN file.

II. RUNNING HABIN

RHABIN,ZHABIN

ZHABIN=HABTAT options file (output)

DO YOU WISH TO:
(1) GENERATE A COMPLETE DATA SET,
(2) GENERATE DATA UP TO CURVE SETS,
(3) GENERATE JUST FLOW DATA,
(4) GENERATE JUST CURVE SETS, OR
(5) GENERATE IOC, HEADER, AND CURVES LINES ONLY.

1 = The IOC, TITLE, HEADER, and CURVES lines are entered into the options file along with the criteria curves data, cross section data, and hydraulic data. No previously created files are utilized as input to HABTAT.

2 = The IOC, TITLE, HEADER, and CURVES lines are entered into the options file along with the cross section and hydraulic data. A previously created FISHFIL is also used as input to HABTAT.

3 = The file resulting from this option cannot be used as input to HABTAT in place of a TP4. In order to read flow data from the options file, the cross section data must also be read from the options file (IOC(8)=0). Therefore, if flow data is to be entered into the options file, select Option 1 or 2 above.

4 = Just the H line and POINT lines of the criteria curve data are written to a file. In order to utilize this file, it would have to be appended to the end of the file created by selecting Option 5 in HABIN, or appended to the bottom of the HABTAT options file created by the HABINS program. It is recommended that the criteria curve data be entered using the GCURV program to create a FISHCRV file. This file could either be converted to a FISHFIL and used as input to HABTAT or, it could be appended to the bottom of the HABTAT options file created by HABINS (remove the title line).

5 = This option is the same as running the HABINS program.

Figure V.7 contains a sample direct entry HABTAT input file created by the HABIN program.

```
IOC        1110010001000000000000000000000000000000
EXAMPLE OF A DIRECT ENTRY HABTAT INPUT FILE CREATED BY HABIN
DATA FROM THE SAMPLE IFG4 DATA SET IS INCLUDED IN THIS FILE
HEADER      1
CURVES     -21112
XHEAD           0.0   30      14.25      0.30
COORD           0.0      0.00    101.30      2.50    100.70      4.00     99.80
COORD           0.0      4.30     98.60      5.50     97.70      7.60     97.30
COORD           0.0     11.90     97.60     14.20     97.90     16.20     97.60
COORD           0.0     16.50     97.70     18.20     97.50     20.20     97.40
COORD           0.0     22.20     97.30     24.20     97.20     26.20     97.30
COORD           0.0     28.20     97.50     30.20     97.40     32.20     97.70
COORD           0.0     33.00     97.60     34.20     97.60     35.20     97.70
COORD           0.0     36.20     97.70     37.40     97.70     39.10     97.90
COORD           0.0     43.80     98.10     53.00     98.60     62.40     99.00
COORD           0.0     69.90     98.50     78.10     99.00     87.10     99.50
SUBSTR          0.0  3.0  3.0  3.0  3.0  9.2  6.0  6.0  8.2  8.2  8.2  8.2  9.0
SUBSTR          0.0  9.0  9.0  9.0  9.0  9.0  9.0  9.0  9.2  9.2  9.2  9.2 10.0
SUBSTR          0.0 10.0 10.0 10.0  8.2  3.0  3.0
XHEAD          14.3   32       0.00      0.50
COORD          14.3      0.00    101.90      3.00    101.30      4.70    101.00
COORD          14.3      5.30    100.00     15.00    100.00     19.10     99.60
COORD          14.3     29.30     99.20     33.10     98.40     41.00     98.50
COORD          14.3     46.10     98.20     48.10     98.00     48.50     97.90
COORD          14.3     49.30     97.80     50.30     97.80     52.30     97.70
COORD          14.3     54.20     97.60     56.30     97.80     58.30     97.60
COORD          14.3     60.30     97.60     62.30     97.60     64.30     97.70
COORD          14.3     65.00     97.80     66.30     97.70     68.30     97.90
COORD          14.3     70.30     98.20     73.80     98.20     77.70     98.80
COORD          14.3     86.80     99.00     94.30     98.50     99.10     98.90
COORD          14.3    103.60    100.30    108.40    101.30
SUBSTR         14.3  3.0  3.0  3.0  3.0  3.0  3.0  3.0  3.0  7.4  8.2  8.5  8.5
SUBSTR         14.3  8.0  0.5  9.2  9.0  9.0  9.0  9.0 10.0 10.0  9.0  9.0 10.0
SUBSTR         14.3 10.0 10.0 10.0 10.0 10.2  9.5  7.7  3.0
ENDXSEC
QHEAD           0.0     21.80     1   29     97.86
VELOCI          0.0  0.0  0.0  0.0  0.2  0.2  0.0  0.0  0.0  0.3  1.3  2.4  2.3
VELOCI          0.0  2.4  3.0  2.8  2.2  2.1  2.1  1.3  0.5  0.8  0.6  0.0  0.0
VELOCI          0.0  0.0  0.0  0.0  0.0  0.0
QHEAD          14.3     21.80     1   31     98.24
VELOCI         14.3  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.4  0.9  1.5
VELOCI         14.3  2.0  2.0  2.0  2.2  2.3  2.3  2.5  2.5  2.3  1.3  0.7  0.8
VELOCI         14.3  0.3  0.0  0.0  0.0  0.0  0.0  0.0
ENDQ
H  21112  4  8  8  0 RAINBOW TROUT                    FRY
V  21112  0.00  1.00  0.10  1.00  0.50  0.00100.00  0.00
D  21112  0.00  0.00  0.10  0.10  0.20  1.00  0.50  1.00  1.00  0.50  1.25  0.30
D  21112  3.00  0.00100.00  0.00
S  21112  0.00  1.00  1.00  1.00  2.00  1.00  4.00  1.00  6.00  1.00  8.00  1.00
S  21112  9.00  1.00100.00  0.00
```

Figure V.7. Sample direct entry HABTAT input file created with HABIN.

HABINE Program

I. INTRODUCTION

The HABINE program builds a HABTAE options file. The following files are used along with the HABINE options file as input to HABTAE: (1) a FISHFIL containing criteria curves of aquatic species or recreational activities created by the curve maintenance programs, (2) TAPE3 containing cross section data which is output from IFG4 or WSP, and (3) TAPE4 containing hydraulic data which is output from IFG4 or WSP. **Note** that HABTAE uses a TAPE4 as input versus a TP4 as the other habitat simulation programs use. Also, the TAPE4 may have the cell velocities calculated (as per HABTAT) or have velocities calculated at the coordinate points (as per HABTAV and HABTAM).

Refer to Appendix A, HABTAE Options File Format, for file format for a HABINE file. Figure V.8 contains a sample HABTAE input file created by the HABINE program.

II. RUNNING HABINE

RHABINE,ZHABIN

ZHABIN=HABTAE options file (output)

The options are displayed and the user is asked to enter the IOC values. Typical settings for IOC values are 0=OFF and 1=ON. HABTAE options are described in Table V.1 in the HABTAE program documentation.

The following prompts will appear in the following circumstances:

If IOC(14)=1

```
ENTER NOSE DEPTH:
ENTER A AND B IN VNOSE = A*VMEAN**B:
```

If IOC(14)=2

```
ENTER NOSE DEPTH:
```

If IOC(14)=3

```
ENTER NOSE DEPTH:
ENTER D65 OF BED MATERIAL:
```

If IOC(14)=4

```
ENTER NOSE DEPTH:
ENTER MANNING'S ROUGHNESS:
```

```
If IOC(14)=5

  ENTER NOSE DEPTH:
  ENTER A AND B IN VNOSE = A*VMEAN**B:

If IOC(14)=6

  ENTER NOSE DEPTH:
  ENTER MANNING'S ROUGHNESS:

If IOC(14)=7

  ENTER MANNING'S ROUGHNESS:

If IOC(17)=3

  ENTER D65 OF BED MATERIAL:
  ENTER SPECIFIC GRAVITY:

If IOC(16)=2 or 3

  ENTER DEPTH OF CELL AT TOP OF WATER COLUMN:
```

```
HOW MANY CURVE SETS (MAX 40):

ENTER THE -- CURVE SET ID NUMBERS (USUALLY 6 DIGIT):
WHERE --
  NEGATIVE NUMBERS INDICATE CURVE SETS ARE INCLUDED IN THIS FILE.
  POSITIVE NUMBERS INDICATE CURVE SETS WILL BE READ FROM A FISHFIL.
```

```
If IOC(11)=1

  ENTER MINIMUM CONTIGUOUS WIDTH FOR --- CURVES:

If IOC(19)=1

  ENTER MINIMUM COMPOSITE SUITABILITY FACTOR:

If IOC(19)=2

  ENTER MINIMUM COMPOSITE SUITABILITY FACTORS FOR --- CURVES:
```

If IOC(21)=1

ENTER VALUE OF IOC14 FOR --- CURVES:

If the IOC14 value entered here is greater than zero, then the Curve ID number will be displayed and then the following prompt:

CURVE ID: ---
ENTER ICF PARAMETER:

The appropriate prompts for IOC14, IOC16, and IOC17 will be asked depending on what the ICF parameter is set to.

If IOC(21)=2

ENTER VALUE OF IOC14 FOR ALL CURVES:
ENTER ICF PARAMETER FOR ALL CURVES:

The appropriate prompts for IOC14, IOC16, and IOC17 will be asked depending on what the ICF parameter is set to.

```
IOC       0110000000100000000001
HEADER    18
CURVES    -721001  720701  720702  720704  720601  720602  720603  720501  720502
CURVES     720503  720202  720401  720403  720300  720302  720303  720904  720905
WMIN          .00     .00     .00     .00     .00     .00     .00   10.00   15.00
WMIN          .00     .00   20.00   10.00   15.00   15.00   10.00    5.00    5.00
INOSE     6099000000000000099
DNOSE     0   721001       .00      .035       .00
DNOSE     4   720702       .00       .00       .00
DNOSE     4   720704       .00       .00       .00
DNOSE     7   720904       .00       .00       .00
DNOSE     7   720905       .00       .00       .00
H 721001  6  4  4  0 FISHING - BANK                      FLOAT-LURE
V 721001   .00   .00  2.00  1.00  6.00  1.00  9.00   .00 10.00   .00100.00   .00
D 721001   .00  1.00  4.00  1.00 10.00  1.00100.00  1.00
S 721001   .00  1.00  2.00  1.00  8.00  1.00100.00  1.00
```

Figure V.8. Sample HABTAE options file created with HABINE.

Criteria curves have been added to the end of this file. They can either be added with an editor or created with GCURV and appended to the end of this file (if GCURV is used, delete the TITLE line). These curve sets are then accessed by entering curve set ID numbers as negative numbers on the Curves line. Be sure to update the number of curves on the Header line if additional curve set ID numbers are added to the Curves line. Refer to Appendix A - "File Format for HABTAE Options File - CURVES Line" for more information.

The program adds zeros to the end of the IOC line to allow for future options in the HABTAE program.

HABINM Program

I. INTRODUCTION

The HABINM program builds a HABTAM options file. The following files are used along with the HABINM options file as input to HABTAM: (1) a FISHFIL containing criteria curves of aquatic species or recreational activities created by the curve maintenance programs, (2) TAPE3 containing cross section data which is output from IFG4, and (3) TP4A containing hydraulic data which is output from IFG4. TP4A is a TP4 created with IOC(17)=1 in the IFG4 program and then renamed TP4A by the user. This version of TP4 is in HABTAM and HABTAV readable format rather than HABTAT readable format.

Refer to Appendix A, HABTAM Options File Format, for file format for creating a HABINM file. Figure V.9 contains a sample HABTAM input file created by the HABINM program.

II. RUNNING HABINM

RHABINM,ZHABIN

ZHABIN=HABTAM options file (output)

The options are displayed and the user is asked to enter the IOC values. Typical settings for IOC values are 0=OFF and 1=ON. HABTAM options are described in Table V.2 in the HABTAM program documentation.

<u>The following prompts will appear in the following circumstances</u>:

If IOC(6)=1 or IOC(14)=1

```
ENTER NOSE DEPTH:
ENTER A AND B IN VNOSE = A*VMEAN**B:
```

If IOC(6)=2 or IOC(14)=2

```
ENTER NOSE DEPTH:
```

If IOC(6)=3 or IOC(14)=3

```
ENTER NOSE DEPTH:
ENTER D65 OF BED MATERIAL:
```

```
HOW MANY CURVE SETS (MAX 40):

ENTER NUMBER OF FLOW PAIRS FOR MIGRATION CALCULATION:

ENTER NUMBER OF ADDITIONAL MIGRATION (ADMG) LINES:
```

ENTER THE -- CURVE SET ID NUMBERS (USUALLY 6 DIGIT):
WHERE --
  NEGATIVE NUMBERS INDICATE CURVE SETS ARE INCLUDED IN THIS FILE.
  POSITIVE NUMBERS INDICATE CURVE SETS WILL BE READ FROM A FISHFIL.

ENTER THE -- MAXIMUM MIGRATION DISTANCES FOR THE -- CURVE SETS:

If the number of additional migration (ADMG) lines was not "0", then the following prompt would appear:

ENTER THE -- PAIRS OF ADDITIONAL MIGRATION (ADMG) VALUES
(CURVE SET ID#, DISTANCE)

ENTER THE -- FLOW PAIRS (QARD) FOR MIGRATION CALCULATION (START,END)

HABTAM OPTIONS FILE CREATED.

```
IOC        0000000001000000000000000000000000000
HEADER       3   6   1
CURVES     21112   21114   21115
MIGR        0.00    5.00   10.00
ADMG       21115     15.00
QARD        10.00   130.00
QARD        30.00   130.00
QARD        50.00   130.00
QARD        70.00   130.00
QARD        90.00   130.00
QARD       110.00   130.00
```

Figure V.9. Sample HABTAM options file created with HABINM.

Criteria curves could be added to the end of this file with an editor or created with GCURV and appended to the end of this file (if GCURV is used, delete the TITLE line). These curve sets are then accessed by entering curve set ID numbers as negative numbers on the Curves line. Be sure to update the number of curves sets on the Header line if additional curve set ID numbers are added to the Curves line. Refer to Appendix A - "File Format for HABTAT Options File CURVES Line" for more information.

The program adds zeros to the end of the IOC line to allow for future options in the HABTAM program.

HABINS Program

I. INTRODUCTION

The HABINS program builds a HABTAT options file. This is the recommended program (vs. HABIN) for creating a HABTAT options file. The following files are used along with this version of the HABTAT options file as input to HABTAT: (1) a FISHFIL containing criteria curves of aquatic species or recreational activities created by the curve maintenance programs, (2) TAPE3 containing cross section data which is output from IFG4 or WSP, and (3) TP4 containing hydraulic data which is output from IFG4 or WSP.

Refer to Appendix A, HABTAT Options File Format, for file format for a HABINS file. Figure V.10 contains a sample HABTAT input file created by the HABINS program.

II. RUNNING HABINS

RHABINS,ZHABIN

ZHABIN=HABTAT options file (output)

The options are displayed and the user is asked to enter the IOC values. Typical settings for IOC values are 0=OFF and 1=ON. HABTAT options are described in Table V.3 in the HABTAT program documentation.

<u>The following prompts will appear in the following circumstances</u>:

If IOC(14)=1

```
ENTER NOSE DEPTH:
ENTER A AND B IN VNOSE = A*VMEAN**B:
```

If IOC(14)=2

```
ENTER NOSE DEPTH:
```

If IOC(14)=3

```
ENTER NOSE DEPTH:
ENTER D65 OF BED MATERIAL:
```

If IOC(14)=4

```
ENTER MANNINGS ROUGHNESS:
```

If IOC(14)=5

```
ENTER D65, MANNINGS N, AND SPECIFIC GRAVITY:
```

If IOC(16)=2 or 3

ENTER DEPTH OF TOP CELL:

If IOC(5)=1-7

ENTER MIN AND MAX FOR VELOCITY ON MATRICES:
ENTER MIN AND MAX FOR DEPTH ON MATRICES:
ENTER MIN AND MAX FOR CHANNEL INDEX ON MATRICES:

If IOC(13)=1

The prompt "How Many Curve Sets" will not be asked, as only one curve set can be processed at a time.

HOW MANY CURVE SETS (MAX 40):

ENTER THE -- CURVE SET ID NUMBERS (USUALLY 6 DIGIT):
WHERE --
  NEGATIVE NUMBERS INDICATE CURVE SETS ARE INCLUDED IN THIS FILE.
  POSITIVE NUMBERS INDICATE CURVE SETS WILL BE READ FROM A FISHFIL.

HABTAT OPTIONS FILE CREATED.

```
IOC        1110010101000200000000000000000000000000
NOSE            0.200
HEADER      3
CURVES      21112    21114    21115
```

Figure V.10. Sample HABTAT options file created with HABINS.

Criteria curves could be added to the end of this file with an editor or created with GCURV and appended to the end of this file (if GCURV is used, delete the TITLE line). These curve sets are then accessed by entering curve set ID numbers as negative numbers on the Curves line. Be sure to update the number of curves on the Header line if additional curve set ID numbers are added to the Curves line. Refer to Appendix A - "File Format for HABTAT Options File - CURVES Line" for more information.

The program adds zeros to the end of the IOC line to allow for future options in the HABTAT program.

HABINV Program

I. INTRODUCTION

The HABINV program builds a HABTAV options file. The following files are used along with the HABINV options file as input to HABTAV: (1) a FISHFIL containing criteria curves of aquatic species or recreational activities created by the curve maintenance programs, (2) TAPE3 containing cross section data which is output from IFG4, and (3) TP4A containing hydraulic data which is output from IFG4. TP4A is a TP4 created with IOC(17)=1 in the IFG4 program and then renamed TP4A by the user. This version of TP4 is in HABTAM and HABTAV readable format rather than HABTAT readable format.

Refer to Appendix A, HABTAV Options File Format, for file format for creating a HABINV file. Figure V.11 contains a sample HABTAV input file created by the HABINV program.

II. RUNNING HABINV

RHABINV,ZHABIN

ZHABIN=HABTAV options file (output)

The options are displayed and the user is asked to enter the IOC values. Typical settings for IOC values are 0=OFF and 1=ON. HABTAV options are described in Table V.4 in the HABTAV program documentation.

<u>The following prompts will appear in the following circumstances</u>:

If IOC(6)=1 or IOC(14)=1

ENTER NOSE DEPTH:
ENTER CALIBRATION PARAMETER "A":
ENTER CALIBRATION PARAMETER "B":

If IOC(6)=2 or IOC(14)=2

ENTER NOSE DEPTH:

If IOC(6)=3 or IOC(14)=3

ENTER NOSE DEPTH:
ENTER D65 OF BED MATERIAL:

If IOC(13)=1

The prompt "How Many Curve Sets" will not be asked as only one curve set can be processsed at a time.

HOW MANY CURVE SETS (MAX 40):

ENTER THE -- CURVE SET ID NUMBERS (USUALLY 6 DIGIT):
WHERE --
NEGATIVE NUMBERS INDICATE CURVE SETS ARE INCLUDED IN THIS FILE.
POSITIVE NUMBERS INDICATE CURVE SETS WILL BE READ FROM A FISHFIL.

If IOC(1)=1 or 2

ENTER THE -- MIGRATION DISTANCES (DIST) FOR THE -- CURVE SETS.

ENTER THE -- MIGRATION VELOCITIES (VLIM) TO BE SEARCHED FOR, FOR THE -- CURVE SETS.

If IOC(5)=1

ENTER THE -- VELOCITIES (VO) WHERE FISH HABITAT BECOMES WORTHLESS (0), FOR THE -- CURVE SETS.

```
IOC        1000000001000000000000000000000000000000
HEADER       3
CURVES      21112   21114   21115
DIST        20.00   10.00   15.00
VLIM         1.00    2.00    3.00
```

Figure V.10. Sample HABTAV options file created with HABINV.

Criteria curves could be added to the end of this file with an editor or created with GCURV and appended to the end of this file (if GCURV is used, delete the TITLE line). These curve sets are then accessed by entering curve set ID numbers as negative numbers on the Curves line. Be sure to update the number of curves on the Header line if additional curve set ID numbers are added to the Curves line. Refer to Appendix A - "File Format for HABTAT Options File - CURVES Line" for more information.

The program adds zeros to the end of the IOC line to allow for future options in the HABTAV program.

HABTAE Program

I. INTRODUCTION

The HABTAE program calculates weighted usable area (surface or bed) or weighted usable volume (WUV) for each cross section. Weighted usable area may be calculated one of two ways depending on the options selected; (1) weighted usable surface area (WUA) (same as HABTAT, HABTAV and HABTAM) and (2) weighted usable bed area (WUBA) which can be thought of as the weighted wetted perimeter times a length to calculate an area. The program writes a file containing the cross section weighted usable area (surface or bed) or weighted usable volume (dependent sections), OR the weighted usable area (surface or bed) or weighted usable volume for a reach (independent cross sections) depending on the option selected. When using the HABTAE program, WUA will refer to the weighted usable surface area; WUBA - weighted usable bed area; and WUV - weighted usable volume.

For surface area and dependent cross sections, the HABTAE program will give the same results as the HABTAT program provided the same simulation options are selected.

Input to the HABTAE program is the options file created by the HABINE program and these previously created files: (1) a FISHFIL containing criteria curves of aquatic species and/or recreational activities created by the curve maintenance programs, (2) TAPE3 containing cross section data which is output from IFG4 or WSP, and (3) TAPE4 containing hydraulic data which is output from IFG4 or WSP. **Note** that HABTAE uses a TAPE4 as input versus a TP4 as the other habitat simulation programs use. Also, the TAPE4 may have the cell velocities calculated (as per HABTAT) or have velocities calculated at the coordinate points (as per HABTAV and HABTAM).

Table V.1 describes the options available in the HABTAE program. These options are selected in the HABTAE options file created by HABINE.

Table V.1. Options in the HABTAE Program.

OPTION	ACTION
1	Determines if the weighted usable area (WUA), weighted usable volume (WUV), or weighted usable bed area (WUBA), is to be calculated, and if the WUA, WUV, or WUBA is to be calculated for an independent cross section or for a reach. If the option to calculate WUV for an independent cross section is selected, then the flows for that cross section do not have to be the same as for the other cross sections. If the WUA, WUV, or WUBA for a reach is being calculated, then the flows must be the same from section to section. 0 = Calculate WUA for a reach. 1 = Calculate WUA for independent cross sections. 2 = Calculate WUV for a reach. 3 = Calculate WUV for independent cross sections. 4 = Calculate WUBA for a reach. 5 = Calculate WUBA for independent cross sections.
2	Prints out cross section data (from TAPE3). Recommend setting to one (1). 0 = Do not print cross section data. 1 = Print cross section data.
3	Prints out the flow related data (from TAPE4) for each cross section evaluated at each discharge. It also lists the velocity for each cell that has water in it. The data are a rehash of the WSP or IFG4 output. Recommend setting to one (1). 0 = Do not print flow related data. 1 = Print flow related data.
4	Prints out all the computational details used in determining the Weighted Usable Area, Weighted Usable Bed Area, or Weighted Usable Volume. Recommend setting to zero (0) except when details are needed to evaluate the simulation. Strongly recommend using only a few life stages and discharges when using this option. On the micro, the size of the output file may be a constraint. 0 = Do not print computational details. 1 = Print computational details.
5	Prints WUA, WUBA, or WUV data for individual cross sections. Values are automatically printed if IOC(1)=1,3, or 5; but will not be printed if IOC(1)=0,2, or 4, unless IOC(5)=1. 0 = Do not print WUA/WUBA/WUV for each cross section. 1 = Print WUA/WUBA/WUV for each cross section.
6	Prints out the coordinates defining the criteria curves. Recommend setting to one (1). 0 = Do not print criteria curve coordinates. 1 = Print criteria curve coordinates.
7	Prints out a table of the distribution of composite suitability factors (CF). If IOC(7)=1, then IOC(1) should not be set to 1,3, or 5. IOC(7) is automatically set to zero regardless of what is entered here if IOC(1)=1,3, or 5. 0 = Do not print composite suitability factors table. 1 = Print composite suitability factors table.
8	Defines where velocities were calculated on the TAPE4. 0 = TAPE4 contains cell velocities (as per HABTAT). 1 = TAPE4 contains velocities at the coordinate points (as per HABTAV and HABTAM).

OPTION	ACTION
9	Controls how the calculation of habitat area will be made. 0 = Standard calculation -- Combined Suitability Factor (CF)=f(v)*g(d)*h(ci) where f(v)*g(d)*h(ci)) = variable preferences for velocity, depth and channel index. This is a simple multiplication of the velocity, depth, and channel index weights and implies synergistic action. Optimum habitat only exists if all variables are optimum. 1 = Geometric Mean -- CF=(f(v)*g(d)*h(ci))**0.333 This technique implies compensation effects; if two of the three variables are in the optimum range, the value of the third variable has less effect unless it is zero. 2 = Lowest Limiting Parameter -- CF=MIN(f(v)*g(d)*h(ci)) This control determines the Composite Suitability Factor as the value of the most restrictive variable. This implies a limiting factor concept (i.e., the habitat is no better than its worst component), but is limited <u>only</u> by its worst element. 3 = User defined calculation using WFTEST subroutine. (Not available on the micro). This control allows the user to specify his own preference function. A subroutine is written with the name WFTEST and the first statement is of the form: SUBROUTINE WFTEST (CF,V,DEPTH,CI) where CF=the suitability of the habitat in a specific cell, V=velocity, DEPTH=depth, and CI=channel index. The remaining statements may be of any form the user desires. Because of the experimental nature of this option, only one curve set may be analyzed at a time.
10	Determines selection of habitat area. The weighted usable area can be surface or bed. The usable area is all areas with a composite suitability factor greater than 0.001. 0 = Write weighted usable area or volume to ZHAQF file. 1 = Write usable area or volume to ZHAQF file.
11	Allows use of a minumum contiguous width of composite suitability factors greater than 0. 0 = Do not use a minumim contiguous width. 1 = Use a minimum contiguous width. WMIN lines are required with this option. The minimum width must be given for each curve set ID Number (life stage) - (can be zero).
12	Allows the reach length to vary from cell to cell (Variable Reach Length) across the stream (i.e., a bend). 0 = Use reach as rectangles in plane view. 1 = Use reach as trapezoids (describes bends - implies that ADDBEND was run on the TAPE3).
13	Writes a ZHCF file (unformatted file used for effective habitat analysis) with station ID, flow, cell area, cell WUA, and cell weighting factor. Recommend setting to zero (0) unless there is a specific need for the ZHCF file. 0 = Do not write ZHCF file. 1 = Write ZHCF file.

Table V.1. (Continued)

OPTION	ACTION
14	Controls how the velocity for the cell is calculated. **NOTE: IOC(14) in HABTAE is different than IOC(14) in HABTAT.**

If IOC(16) is not set to 0, then IOC(14) should not be set to 0.

0 = Mean column velocity.

1 = Nose velocity - Empirical equation based on the 1/7 power law and user defined coefficients. User supplies the nose depth for which a velocity is to be calculated, and the calibration parameters A and B. These values are entered on the NOSE line.

$$\frac{Vn}{\bar{V}} = A \left(\frac{DN}{D}\right)^B$$

where:
N = nose velocity of the cell
A and B = user defined calibration parameters
$\bar{V}$ = mean velocity of the cell
DN = nose depth for species in question
D = total depth of the cell

2 = Nose velocity - 1/7th power law equation. User supplies nose depth on NOSE line.

3 = Nose velocity - logarithmic velocity distribution equation. The nose depth and the D65 of the bed material are supplied by the user on the NOSE line.

4 = Nose velocity - 1/mth power law equation. The nose velocity equation used is

$$\frac{Vn}{\bar{V}} = (1 + m) \left(\frac{Dn}{D}\right)^{1/m}$$

and m is calculated using the equation

$$m = \frac{c}{n} D^{0.1667}$$

where $\bar{V}$ is the mean column velocity, Vn the nose velocity, Dn the nose depth, D the total depth, n the Manning's roughness coefficient, and c is 0.105 for traditional units and 0.128 for metric units. The value of m is determined for each cell. The value of n and the nose depth are given on the NOSE line.

5 = Nose velocity - 1/mth power law equation. Same as IOC(14)=4 except m is calculated using the equation

$$m = aD^b$$

Values for a and b are supplied on the NOSE line. The nose depth is also entered on the NOSE line.

6 = Nose velocity - 1/mth power law equation. Same as IOC(14)=4 except the nose depth (Dn) is measured from the surface. The values for nose depth and n are entered on the NOSE line.

Table V.1. (Continued)

OPTION ACTION

7 = Nose velocity - Shear velocity.
In order to calculate the shear stress (τ), the Manning's roughness must be known. This value is entered on the NOSE line.

$$u_* = \sqrt{\tau / \rho}$$

where: u_* = shear velocity
τ = shear stress on the bed
ρ = density of the water

15 Limits the velocities allowed in the habitat simulation calculations. Strongly recommend setting to "0" or "1". If "2" is selected, there probably was an error in the hydraulic simulation process.

0 = Abort if velocities are less than 0 or greater than 15.
1 = Convert negative velocities to positive velocities; aborts if velocities are greater than 15.
2 = No restriction on velocities.

16 Determines if given velocities (from TAPE4) or nose velocities are used in habitat simulation and determines how those nose velocities are calculated.

If IOC(16) is not set to 0, then IOC(14) should not be set to 0.

If IOC(16) is 1, 2, or 3, set IOC(17) to 0.

0 = Given velocities, or nose velocities, (depending on what IOC(14) was set to) are used for habitat simulation.

1 = Optimum velocities are used for habitat simulation with equal depth from top as from bottom.

A "top and bottom cell" are removed from the water column. Within the remaining water column, the velocities in the habitat simulation calculations are optimized, i.e., it is assumed that the fish can move vertically to find the "best velocity" in the remaining water column. This "best velocity" is used with the nose velocity calculated by the selection of IOC(14). If IOC(14)=0, and IOC(16)=1 or 2, the program will calculate nose velocities as if IOC(14)=2.

The "optimum (best) velocity" is defined as the velocity that is found within the range of nose depth down from the surface (top) and nose depth up from the bottom.

Nose depth is set by one of two methods,
a) if a NOSE line is present, nose depth = the data supplied on the NOSE line
b) if a NOSE line is not present, nose depth = .1.

Table V.1. (Continued)

OPTION	ACTION
	2 = Optimum velocities are used for habitat simulation with unequal depth from top as from bottom.

A "top and bottom of a cell" are removed from the water column. Within the remaining water column, the velocities in the habitat simulation calculations are optimized, i.e., it is assumed that the fish can move vertically to find the "best velocity" in the remaining water column. This "best velocity" is used with the nose velocity calculated by the selection of IOC(14). If IOC(14)=0, and IOC(16)=1 or 2, the program will calculate nose velocities as if IOC(14)=2.

The "bottom of the cell" is defined as the nose depth from the bottom of the water column. The nose depth is set on the NOSE line. If a NOSE line is not present, nose depth = .1.

The "top of the cell" is defined as the distance from the surface of the water column to the depth specified on the CELL line.
bottom = as defined by the CELL line

3 = Mean velocity in a top cell is used in habitat simulation.

The velocities used are the mean velocity found in a cell defined as existing between the surface of the water column and the depth specified on a CELL line.

17 Defines what to use as velocity as a replacement for velocity. These replacements should be treated as velocities and be entered on the "V" lines when entering the Curve Set Data.

If IOC(17) is not 0, then IOC(16) must be 0.
If IOC(17) is 1 or 2, then IOC(14) must be 0.
If IOC(17) is 3, then IOC(14) must be set to 7 and Manning's N, D65 of bed material, and the specific gravity must be entered on the NOSE line. If specific gravity is not specified, 2.65 is used.

0 = Use given velocity.
1 = Use velocity * depth as velocity.
2 = Use (velocity**2) * depth as velocity
3 = Use Shield's Parameter as velocity.

$$K_s = \frac{\tau}{D_{65}\,(S_s - 1)\gamma}$$

where:
K_s = Shield's parameter
τ = shear stress on a bed
D_{65} = size of bed surface material at which 65% are smaller
S_s = specific gravity of the bed material
γ = unit weight of water

4 = Use Froude Number as velocity.

$$FN = \frac{V}{\sqrt{gd}}$$

where: V = Velocity
g = Acceleration of gravity
d = Depth

Table V.1. (Concluded)

OPTION	ACTION

18 Defines how channel index values of zero (0) are used.

0 = Do not use a channel index value of zero in the calculation of WUA for that cell.
1 = Use a channel index value of zero in the calculation of WUA for that cell.

19 Allows the user to specify a minimum value for the composite suitability factor (CF). These minimum values are entered on the CFMIN line.

0 = No minimum composite suitability factor specified.
1 = Same minimum composite suitability factor specified for all life stages.
2 = Different minimum composite suitability factor specified for each life stage.

20 Determines what units (traditional or metric) to write the output.

0 = Write output in traditional (English) units.
1 = Write output in metric units.

21 Allows different location of velocities or velocity replacements to be used for each life stage. This option is basically the same as allowing IOC(14), IOC(16), and IOC(17) to be selected for each life stage. **NOTE:** In this section IOC14, IOC16, and IOC17 (without parenthesis) refer to the values set on the INOSE and DNOSE lines, versus IOC(14), IOC(16), and IOC(17) which refers to the actual option number.

If IOC(21) is not equal to zero, then IOC(14), IOC(16) and IOC(17) should be set to zero. If they are not set to 0, the values entered on the INOSE and DNOSE lines will override the values set by IOC(14), (16), and (17) and on the NOSE and CELL lines.

0 = Use velocities that were selected by IOC(14), IOC(16), and IOC(17). Same velocity for all life stages.

1 = Allows using combinations of IOC16 and IOC17 for each life stage and specification as to whether mean or nose velocities (IOC14) are to be used. When using this option, IOC16 and IOC17 are mutually exclusive and are represented by the ICF parameter on the DNOSE line. The IOC14 value is set on the INOSE line.

ICF PARAMETER	IOC16 VALUE	IOC17 VALUE	Permissible IOC14 Values	Action
0 =	0	0	0,1,2,3,4,5,6,7	Use mean or nose velocity
1 =	1	0	1,2,3,4	Optimize velocity
2 =	2	0	1,2,3,4	Optimize velocity
3 =	3	0	0	Velocity = Mean velocity in top cell
4 =	0	1	0	Vel. Replacement = velocity * depth
5 =	0	2	0	Vel. Replacement = (velocity**2) * depth
6 =	0	3	7	Vel. Replacement = Shield's Parameter
7 =	0	4	0	Vel. Replacement = Froude Number

The DNOSE line contains the ICF parameter and the same information as on the NOSE and CELL lines.

One INOSE line is required and a DNOSE line is required for each life stage where the IOC14 value on the INOSE line is not zero.

See discussion of INOSE and DNOSE line in Appendix A - HABTAE format for more information.

2 = Allows selecting between a nose velocity and mean column velocity. One DNOSE line and one INOSE line are required.

II. RUNNING HABTAE

RHABTAE,ZHABIN,ZOUT,FISHFIL,TAPE3,TAPE4,ZHAQF,ZHCF

ZHABIN=HABINE file (input)
ZOUT=HABTAE results (output)
FISHFIL=unformatted curves file (input)
TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)
ZHAQF=habitat vs. flow file (output)
ZHCF=unformatted cell areas and cell weighted usable areas
Created if IOC(13)=1. (output)

Figure V.12 contains sample output from the ZOUT file created by HABTAE. Review the output file for error messages and inconsistancies in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort.

Figure V.13 contains a sample ZHAQF file. The ZHCF file created when IOC(13)=1 in HABTAE, HABTAT, or HABTAV is an unformatted file.

III. HABTAE ERROR MESSAGES

Refer to error messages section in HABTAT program documentation section as most of the error messages are the same. Most of the errors specific to HABTAE are due to illogical combinations of IOC options. When using the HABINE program to create the HABTAE options file, users are prompted when illogical combinations are entered and are instructed to enter different option values.

```
89/08/17.          SAMPLE OUTPUT FROM THE                                    PROGRAM - HABTAE
12.05.38.             HABTAE PROGRAM                                             PAGE -   1


        IOC     0 1 1 0 0   0 0 0 0 0   1 0 0 0 0   0 0 0 0 0
                1

        SURFACE AREA ANALYSIS SELECTED

        EFFECTIVE SECTION REACH LENGTHS AND WEIGHTS ARE-

                         C/S         RL       PERCENT

                         1.00       77.50      50.00
                         2.00       77.50      50.00

                        REACH      155.00     100.00


        SPECIES - KAYAKING  (FROUDE NUMBER)            LIFE STAGE - CLASS 2       CURVE ID -   720905
```

DISCHARGE	MEAN VELOCITY	SURFACE AREA	USABLE AREA	WEIGHTED AREA	TOTAL VOLUME	PERCENT USABLE	PERCENT WUA
100.0	1.29	56791.	53200.	22312.	77755.	93.68	39.29
125.0	1.47	57023.	55650.	25320.	85214.	97.59	44.40
150.0	1.63	57179.	55650.	27408.	91757.	97.33	47.93
200.0	1.94	57447.	56900.	30568.	102973.	99.05	53.21
250.0	2.22	57698.	56900.	32588.	112494.	98.62	56.48
300.0	2.48	58165.	56900.	33826.	120875.	97.82	58.15
400.0	2.95	59209.	57550.	34888.	135379.	97.20	58.92
500.0	3.38	60917.	58000.	35056.	147924.	95.21	57.55
750.0	4.28	68478.	60000.	35443.	175170.	87.62	51.76
1000.0	5.03	71042.	66000.	36437.	198793.	92.90	51.29

```
      UNITS: TRADITIONAL     VELOCITY TERM - FROUDE            WMIN =      5.000     CFMIN =  0.00
```

Figure V.12. Sample output from the HABTAE program.

```
SAMPLE ZHAQF FILE GENERATED BY
THE HABTAE PROGRAM
TOTAL AREA
      DISCHARGE  AREA
* 1      100.00    56791.19
* 2      125.00    57022.75
* 3      150.00    57179.33
* 4      200.00    57446.72
* 5      250.00    57697.89
* 6      300.00    58165.12
* 7      400.00    59209.31
* 8      500.00    60917.47
* 9      750.00    68478.39
*10     1000.00    71041.52
***************
FISHING - BANK
      DISCHARGE  FLOAT-LURE
* 1      100.00    45107.75
* 2      125.00    46561.90
* 3      150.00    47552.36
* 4      200.00    48972.34
* 5      250.00    49896.31
* 6      300.00    50684.26
* 7      400.00    51817.25
* 8      500.00    52860.50
* 9      750.00    55925.41
*10     1000.00    57631.53
***************
FISHING - WATER CONTACT
      DISCHARGE  WADING       WADE-KORK    WADE-V*D
* 1      100.00    29165.19     39954.56     25854.62
* 2      125.00    28653.00     40117.92     23719.41
* 3      150.00    28013.04     39938.50     21605.89
* 4      200.00    26505.54     38799.50     17737.57
* 5      250.00    25006.17     37005.40     14688.06
* 6      300.00    23695.84     34728.06     12724.32
* 7      400.00    21534.98     28565.71     10461.66
* 8      500.00    19947.66     22933.43      9662.55
* 9      750.00    18523.26     19252.12     11804.91
*10     1000.00    15954.90     17248.26     12481.90
***************
FISHING - SNAGGING/LIFTING (MOD SRT)
      DISCHARGE  SNAG-SIGHT   SNAG-BLIND   LIFTING
* 1      100.00    48983.66     49711.19      9648.71
* 2      125.00    48757.13     49942.75      9249.81
* 3      150.00    48437.84     50099.33      8768.08
* 4      200.00    47580.91     50246.90      7816.86
* 5      250.00    46280.89     50202.99      6901.26
* 6      300.00    45147.44     50408.88      6005.77
* 7      400.00    43227.57     50948.05      4483.95
* 8      500.00    41962.53     52124.05      3560.19
* 9      750.00    43017.25     58564.71      2856.93
*10     1000.00    40358.05     60140.45      5055.82
***************
```

Figure V.13. ZHAQF file generated by HABTAE.

FISHING - DRIFT BOAT (SRT)

	DISCHARGE	PASSAGE	OPERATION	FLOT-PLG
* 1	100.00	44579.45	17198.51	0.00
* 2	125.00	48369.38	21225.37	0.00
* 3	150.00	51011.25	24148.67	0.00
* 4	200.00	54278.50	28748.37	0.00
* 5	250.00	55254.78	32586.65	0.00
* 6	300.00	55693.93	35413.55	0.00
* 7	400.00	56236.12	39423.41	31.58
* 8	500.00	56712.09	41007.40	343.30
* 9	750.00	58183.49	40675.64	4620.30
*10	1000.00	60932.57	38224.34	14946.34

****

WATER CONTACT

	DISCHARGE	WADING
* 1	100.00	54370.47
* 2	125.00	53265.14
* 3	150.00	51951.37
* 4	200.00	48892.76
* 5	250.00	45856.93
* 6	300.00	43158.59
* 7	400.00	38627.79
* 8	500.00	35642.95
* 9	750.00	32934.14
*10	1000.00	27577.09

****

RAFTING

	DISCHARGE	NOVICE	MID-LEVEL
* 1	100.00	29165.29	512.02
* 2	125.00	31533.78	1298.87
* 3	150.00	33277.30	1988.69
* 4	200.00	40380.22	3964.57
* 5	250.00	43055.14	5963.26
* 6	300.00	44977.50	8488.64
* 7	400.00	47640.47	12567.70
* 8	500.00	47978.02	16356.92
* 9	750.00	43793.64	23949.95
*10	1000.00	32306.55	28602.77

****

CANOEING

	DISCHARGE	GENERAL	NOVICE-OR	MID-LEVEL
* 1	100.00	33504.90	32060.22	8396.75
* 2	125.00	37215.68	34432.16	11114.16
* 3	150.00	40088.06	35586.72	13768.19
* 4	200.00	44422.55	37136.16	17231.61
* 5	250.00	47339.84	38401.65	19881.69
* 6	300.00	49420.43	38603.48	25215.63
* 7	400.00	52533.12	38119.27	29113.19
* 8	500.00	54391.30	37537.97	31173.46
* 9	750.00	57174.91	34638.66	34494.19
*10	1000.00	59426.93	33303.10	36997.50

****

KAYAKING (FROUDE NUMBER)

	DISCHARGE	CLASS 1	CLASS 2
* 1	100.00	21342.01	22312.18
* 2	125.00	22022.78	25319.59
* 3	150.00	22551.61	27408.12
* 4	200.00	23447.79	30568.13
* 5	250.00	23838.40	32588.50
* 6	300.00	23909.39	33825.55
* 7	400.00	23804.55	34888.26
* 8	500.00	23630.30	35056.50
* 9	750.00	23263.56	35442.88
*10	1000.00	24186.75	36436.71

****

Figure V.13. (Concluded)

HABTAM Program

I. INTRODUCTION

The HABTAM program simulates situations in which fish can migrate laterally within a cross section in order to make use of the available weighted usable area (WUA) when there is a change in velocity.

The logic of HABTAM is similar to that of HABTAT with two major exceptions, cell definition and migration calculation. See Figure V.1 for a diagram of how the HABTAM and HABTAV programs view a cell location in contrast to how the HABTAT program views the cell location relative to verticals. In HABTAM, cells are defined by one measured vertical located at the center of the cell. The values of stream characteristics (depth, velocity, and channel index) for each cell are the values of the velocity, depth, and channel index at the measured vertical.

The second major difference between HABTAT and HABTAM is the migration calculation performed by HABTAM between the user-designated starting flow and user-designated ending flow. As in HABTAT, HABTAM calculates WUA at each designated flow using functions of velocity, depth, and channel index. HABTAM assumes that the available WUA at the user-designated starting flow is fully utilized. Considering the user-designated maximum allowable migration distance for each life stage of each species, the program calculates how much of the available WUA at the user-designated ending flow can be utilized. Fish are permitted to migrate only laterally from cell to cell within a cross section.

The user designates a starting flow, ending flow, and a maximum allowable migration distance for each life stage of each species. The program looks only at the user-designated starting and ending flows for the migration calculations, and it processes each cross section as a separate entity, that is, fish cannot migrate from one cross section to another. Assuming that the stream is saturated with fish at the starting flow (all WUA is occupied) and that the flow is then changed to the ending flow, the program permits the fish to migrate in either direction within the cross section up to the maximum allowable migration distance for the particular life stage. The program then calculates how much (the maximum amount) of the WUA available at the ending flow can be utilized by the fish presently existing in the stream. The results will show that either all the available WUA at the ending flow can be utilized, or there is an excess of WUA available at the ending flow which cannot be used because there are no fish to use it.

The following assumptions are made in doing the migration calculations:

1. Fish migration is assumed to begin at the cell boundaries. Thus, when a fish is given a maximum allowable migration distance greater than zero, it is automatically permitted to migrate to adjacent cells. Any distance it might have to travel within its cell of origin is negated.

2. In situations where the maximum allowable migration distance places a fish on the border of two cells the fish is NOT permitted access to the further cell.

3. Since HABTAM calculates a cell width for each new flow it processes, the width calculated at the flow designated as the ending flow is used as the cell width for the migration calculation.

4. When a portion of a cell becomes dry at the user-designated ending flow, the fish are not permitted to migrate beyond that dry boundary point.

5. When a given life stage does not migrate at all, a value of 0.0 should be entered as the maximum allowable migration distance for that life stage. When this occurs, the program will select for the WUA with migration, the minimum of the WUA at the starting flow, and WUA at the ending flow.

Input to the HABTAM program is the options file created by the HABINM program and the previously created files: (1) a FISHFIL containing criteria curves of aquatic species or recreational activities created by the curve maintenance programs, (2) TAPE3 containing cross section data which is output from IFG4, and (3) TP4A containing hydraulic data which is output from IFG4. TP4A is a TP4 created with IOC(17)=1 in the IFG4 program and then renamed TP4A by the user. This version of TP4 is in HABTAM and HABTAV readable format rather than HABTAT readable format.

Table V.2 describes the options available in the HABTAM program. These options are selected in the HABTAM options file created by HABINM.

Table V.2. Options in the HABTAM Program.

OPTION	ACTION
1	Prints out details of migration calculations. Recommend setting to zero (0). 0 = Do not print migration calculation details. 1 = Print migration calculation details.
2	Prints out cross section data (from TAPE3). Recommend setting to one (1). 0 = Do not print cross section data. 1 = Print cross section data.
3	Prints out the flow related data (from TP4A) for each cross section evaluated at each discharge. It also lists the velocity for each cell that has water in it. The data are a rehash of the IFG4 output. Recommend setting to one (1). 0 = Do not print flow related data. 1 = Print flow related data.
4	Prints out all the computational details used in determining the Weighted Usable Area. Recommend setting to zero (0) except when details are needed to evaluate the simulation. Strongly recommend using only a few life stages and discharges when using this option. On the micro, the size of the output file may be a constraint. 0 = Do not print computational details. 1 = Print computational details.
5	Not used - set to "0".
6	Scans adjacent cells for: If neither IOC(6) nor IOC(14) equals 0, then they must be set to the same number. 0 = Mean column velocity. 1 = Nose velocity - Use Empirical equation based on the 1/7th power law and user defined coefficients. 2 = Nose velocity - Use 1/7th power law equation. 3 = Nose velocity - use logarithmic velocity distribution equation.
7	Defines how channel index values of zero (0) are used. 0 = Do not use a channel index value of zero in the calculation of WUA for that cell. 1 = Use a channel index value of zero in the calculation of WUA for that cell.
8	Prints out the coordinates defining the criteria curves. Recommend setting to one (1). 0 = Do not print criteria curve coordinates. 1 = Print criteria curve coordinates.
9	Controls how the calculation of habitat area will be made. 0 = Standard calculation -- Combined Suitability Factor (CF)=f(v)*g(d)*h(ci) where f(v)*g(d)*h(ci)) = variable preferences for velocity, depth and channel index. This is a simple multiplication of the velocity, depth, and channel index weights and implies synergistic action. Optimum habitat only exists if all variables are optimum. 1 = Geometric Mean -- CF=(f(v)*g(d)*h(ci))**0.333 This technique implies compensation effects; if two of the three variables are in the optimum range, the value of the third variable has less effect unless it is zero.

Table V.2 (Concluded)

OPTION	ACTION
	2 = Lowest Limiting Parameter -- CF=MIN(f(v)*g(d)*h(ci))

This control determines the Composite Suitability Factor as the value of the most restrictive variable. This implies a limiting factor concept (i.e., the habitat is no better than its worst component), but is limited only by its worst element.

3 = User defined calculation using WFTEST subroutine.
(Not available on the micro).

This control allows the user to specify his own preference function. A subroutine is written with the name WFTEST and the first statement is of the form:

```
SUBROUTINE WFTEST (CF,V,DEPTH,CI)
```

where CF=the suitability of the habitat in a specific cell, V=velocity, DEPTH=depth, and CI=channel index. The remaining statements may be of any form the user desires. Because of the experimental nature of this option, only one curve set may be analyzed at a time.

10 Prints the habitat area as a percent of total area. Recommend setting to one (1).

0 = Do not print habitat area as a percent of total area.
1 = Print habitat area as a percent of total area.

11 Not used - set to "0".

12 Allows the reach length to vary from cell to cell (Variable Reach Length) across the stream (i.e., a bend).

0 = Use reach as rectangles in plane view.
1 = Use reach as trapezoids (describes bends - implies that ADDBEND was run on the TAPE3).

13 Not used - set to "0".

14 Controls how the velocity for the cell is calculated. If neither IOC(6) nor IOC(14) equals 0, then they must be set to the same number.

0 = Mean column velocity.

1 = Nose velocity - Empirical equation based on the 1/7 power law and user defined coefficients. User supplies the nose depth for which a velocity is to be calculated, and the calibration parameters A and B. These values are entered on the NOSE line.

$$\frac{Vn}{\bar{V}} = A\left(\frac{DN}{D}\right)^{B}$$

where:
N = nose velocity of the cell
A and B = user defined calibration parameters
$\bar{V}$ = mean velocity of the cell
DN = nose depth for species in question
D = total depth of the cell

2 = Nose velocity - 1/7th power law equation.
User supplies nose depth on NOSE line.

3 = Nose velocity - logarithmic velocity distribution equation.
The nose depth and the D65 of the bed material are supplied by the user on the NOSE line.

II. RUNNING HABTAM

RHABTAM,ZHABIN,ZOUT,FISHFIL,TAPE3,TP4A,ZHAQF

ZHABIN=HABINM file (input)
ZOUT=HABTAM results (output)
FISHFIL=unformatted curves file (input)
TAPE3=unformatted cross section and reach data (input)
TP4A=rearranged TAPE4A file (TP4 was created in HABTAM/HABTAV format by setting IOC(17)=1 in IFG4 and was renamed TP4A by the user) (input)
ZHAQF=habitat vs. flow file (output)

Figure V.14 contains sample output from the ZOUT file created by HABTAM. Review the output file for error messages and inconsistancies in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort. Figure V.15 contains the ZHAQF file created by HABTAM.

III. HABTAM ERROR MESSAGES

Refer to error messages section in HABTAT program documentation section as several of the error messages are the same. Error messages specific to HABTAM are described below.

1. **INPUT LINE OF THE FORM --- WAS EXPECTED BUT --- WAS READ.**
   Check data set. Refer to Appendix A for "HABTAM Options File Format".

2. **OPTION 6 VALUE --- AND OPTION 14 VALUE --- TO CALCULATE NOSE VELOCITY ARE NOT THE SAME.**
   If neither IOC(6) nor IOC(14)=0, then they must be set to the same number.

3. **THE VALUE OF OPTION 14 IS ---, SINCE IT SHOULD NOT BE >3, IT HAS BEEN CHANGED TO A VALUE OF 2.**
   Values 4, 5, and 6 for IOC(14) are only available in HABTAT, not HABTAM or HABTAV.

4. **ON SECTION --- DID NOT FIND ENOUGH VELOCITIES. DID YOU USE CORRECT OPTION (IOC(17)=1) IN IFG4?**
   IOC(17)=1 in IFG4 writes velocities to TP4 in HABTAM and HABTAV format. TP4 must be renamed to TP4A by the user before being used as input to HABTAM or HABTAV.

5. **THE STARTING FLOW --- IS NOT A VALID FLOW. THE ENDING FLOW --- IS NOT A VALID FLOW. MIGRATION CALCULATIONS FOR THE FLOW PAIR --- ARE NOT BEING DONE.**
   The starting and ending flows entered on the QARD lines must have been included in the IFG4 data set that was used to create the TAPE3 and TP4 being used as input to HABTAM.

6. **CROSS SECTION DATA --- IS OUT OF SYNCH WITH Q RELATED DATA ---.**
   Used TAPE4 or TP4 instead of TAPE4A or TP4A; or TAPE3 or TP4A are bad; or the TAPE3 and TP4A were not created using the same data set.

```
88/04/26.              UPPER SALMON RIVER, NEAR STANLEY, IDAHO                          PROGRAM-HABTAM
11.05.51.   IFG4 DATA SET WITH WSL LINES ADDED FOR BOTH CROSS SECTIONS FROM MANSQ            PAGE 1

                        IOC       0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

                        HEADER        3   6   1

                        CURVE ID NUMBERS          21112   21114   21115

                        MAX MIGRATION DIST         0.00    5.00   10.00

                        ADDITIONAL MAX MIGRATION DIST        21115       15.00

                        MIGRATION FLOW PAIRS        10.00      130.00

                        MIGRATION FLOW PAIRS        30.00      130.00

                        MIGRATION FLOW PAIRS        50.00      130.00

                        MIGRATION FLOW PAIRS        70.00      130.00

                        MIGRATION FLOW PAIRS        90.00      130.00

                        MIGRATION FLOW PAIRS       110.00      130.00



         CURVE SET DEFINITION DATA WAS OBTAINED FROM THE FISHFIL FILE WHOSE TITLE LINE IS -

                       SAMPLE FISHCRV FILE CREATED WITH THE GCURV PROGRAM

                              LAST UPDATED ON 88/04/25. 15.03.07.
```

Figure V.14. Sample output from the HABTAM program.

Q .VS. AVAILABLE WUA PER 1000 FEET OF STREAM FOR RAINBOW TROUT

Q	FRY	JUVENILE	ADULT
8.00	1040.43	0.00	93.85
10.00	893.72	0.00	117.06
20.00	556.54	81.64	193.24
30.00	181.59	139.76	259.32
40.00	61.33	168.90	316.73
50.00	169.38	342.71	398.32
60.00	263.99	428.30	504.76
70.00	367.02	435.08	611.91
80.00	33.68	340.37	675.69
90.00	60.98	492.12	748.31
100.00	95.78	587.23	813.00
110.00	259.47	551.62	847.07
120.00	566.17	560.97	910.33
130.00	878.16	527.63	955.84

Q .VS. AVAILABLE WUA AS A PERCENTAGE OF THE GROSS AREA FOR RAINBOW TROUT

Q	GROSS	FRY	JUVENILE	ADULT
8.00	22789.	4.57	0.00	0.41
10.00	24395.	3.66	0.00	0.48
20.00	29444.	1.89	0.28	0.66
30.00	31748.	0.57	0.44	0.82
40.00	33660.	0.18	0.50	0.94
50.00	39436.	0.43	0.87	1.01
60.00	42818.	0.62	1.00	1.18
70.00	44512.	0.82	0.98	1.37
80.00	45820.	0.07	0.74	1.47
90.00	47187.	0.13	1.04	1.59
100.00	48495.	0.20	1.21	1.68
110.00	49535.	0.52	1.11	1.71
120.00	50843.	1.11	1.10	1.79
130.00	51883.	1.69	1.02	1.84

Figure V.14. (Continued)

PERMITTING FISH MIGRATION USING A BEGINNING FLOW OF 10.00
UTILIZED HABITAT AREA FOR RAINBOW TROUT
AT AN ENDING FLOW OF 130.00 BECOMES:

LIFESTAGE	MAX ALLOWABLE MIGRATION	UTILIZED HABITAT AREA PER 1000 FEET OF STREAM	GROSS AREA USED PER 1000 FT	PERCENT OF GROSS AREA USED	PERCENT OF LIMIT
FRY	0.00	0.00	2322.	0.00	0.00
JUVENILE	5.00	0.00	6565.	0.00	0.00
ADULT	10.00	116.49	16587.	0.22	99.51
ADULT	15.00	116.49	16587.	0.22	99.51

PERMITTING FISH MIGRATION USING A BEGINNING FLOW OF 30.00
UTILIZED HABITAT AREA FOR RAINBOW TROUT
AT AN ENDING FLOW OF 130.00 BECOMES:

LIFESTAGE	MAX ALLOWABLE MIGRATION	UTILIZED HABITAT AREA PER 1000 FEET OF STREAM	GROSS AREA USED PER 1000 FT	PERCENT OF GROSS AREA USED	PERCENT OF LIMIT
FRY	0.00	0.00	2322.	0.00	0.00
JUVENILE	5.00	138.95	6565.	0.27	99.42
ADULT	10.00	260.35	16587.	0.50	100.40
ADULT	15.00	260.35	16587.	0.50	100.40

PERMITTING FISH MIGRATION USING A BEGINNING FLOW OF 50.00
UTILIZED HABITAT AREA FOR RAINBOW TROUT
AT AN ENDING FLOW OF 130.00 BECOMES:

LIFESTAGE	MAX ALLOWABLE MIGRATION	UTILIZED HABITAT AREA PER 1000 FEET OF STREAM	GROSS AREA USED PER 1000 FT	PERCENT OF GROSS AREA USED	PERCENT OF LIMIT
FRY	0.00	0.00	2322.	0.00	0.00
JUVENILE	5.00	341.75	6565.	0.66	99.72
ADULT	10.00	397.89	16587.	0.77	99.89
ADULT	15.00	397.89	16587.	0.77	99.89

SECTIONS OF SAMPLE OUTPUT DELETED HERE FOR BREVITY.

Figure V.14. (Concluded)

```
UPPER SALMON RIVER, NEAR STANLEY, IDAHO
ZHAQF FILE GENERATED BY HABTAM
TOTAL AREA
      DISCHARGE  AREA
*          8.00    22788.89
*         10.00    24395.06
*         20.00    29444.04
*         30.00    31747.52
*         40.00    33659.56
*         50.00    39436.34
*         60.00    42818.31
*         70.00    44512.37
*         80.00    45820.20
*         90.00    47187.19
*        100.00    48494.82
*        110.00    49535.04
*        120.00    50842.66
*        130.00    51882.87
***************
RAINBOW TROUT
      DISCHARGE  FRY          JUVENILE     ADULT
*          8.00     1040.43        0.00        93.85
*         10.00      893.72        0.00       117.06
*         20.00      556.54       81.64       193.24
*         30.00      181.59      139.76       259.32
*         40.00       61.33      168.90       316.73
*         50.00      169.38      342.71       398.32
*         60.00      263.99      428.30       504.76
*         70.00      367.02      435.08       611.91
*         80.00       33.68      340.37       675.69
*         90.00       60.98      492.12       748.31
*        100.00       95.78      587.23       813.00
*        110.00      259.47      551.62       847.07
*        120.00      566.17      560.97       910.33
*        130.00      878.16      527.63       955.84
***************
```

Figure V.15. ZHAQF file generated by the HABTAM program.

HABTAT Program

I. INTRODUCTION

The theory of the habitat simulation utilized by the HABTAT program is based on the assumption that aquatic species will react to changes in the hydraulic environment. These changes are simulated for each cell in a defined stream reach. The stream reach simulation takes the form of a multi-dimensional matrix of the calculated surface areas of a stream having different combinations of hydraulic parameters (i.e., depth, velocity, and channel index). Velocity and depth vary with changes in discharge causing changes in the amount of available habitat. The end product of the habitat simulation is a description of habitat area as a function of discharge.

There are four methods available to run the HABTAT program.

1. The recommended method is using the short form of the HABTAT options file created by the HABINS program and then utilizing these previously created files: (1) a FISHFIL containing criteria curves of aquatic species or recreational activities created by the curve maintenance programs, (2) TAPE3 containing cross section data resulting from an IFG4 or WSP run, and (3) TP4 containing hydraulic data resulting from an IFG4 or WSP run.

The following three methods require that the HABIN program be used to create the long form of the HABTAT options file with the following alternatives:

2. Utilizing a previously created FISHFIL and entering the cross section and hydraulic data into the options file (no TAPE3 or TP4 used as input).

3. Entering the criteria curves data into the options file and utilizing the TAPE3 and TP4 files resulting from an IFG4 or WSP run.

4. Entering the criteria curves data, cross section data, and hydraulic data into the options file. No previously created files are utilized.

Table V.3 describes the options available in the HABTAT program. These options are selected in the HABTAT options file created by HABINS or HABIN.

Table V.3. Options in the HABTAT Program.

OPTION	ACTION
1	Prints out the minimum and maximum matrix values for Option 5. 0 = Do not print minimum and maximum matrix values. 1 = Print minimum and maximum matrix values.
2	Prints out cross section data (from TAPE3). Recommend setting to one (1). 0 = Do not print cross section data. 1 = Print cross section data.
3	Prints out the flow related data (from TP4) for each cross section evaluated at each discharge. It also lists the velocity for each cell that has water in it. The data are a rehash of the WSP or IFG4 output. Recommend setting to one (1). 0 = Do not print flow related data. 1 = Print flow related data.
4	Prints out all the computational details used in determining the Weighted Usable Area. Recommend setting to zero (0) except when details are needed to evaluate the simulation. Strongly recommend using only a few life stages and discharges when using this option. On the micro, the size of the output file may be a constraint. 0 = Do not print computational details. 1 = Print computational details.
5	Prints the matrices as described below. If chosen, this option prompts the user for minimum and maximum values for the matrices. These values are entered on the HEADER line of the habitat options file. Using this option will substantially increase the cost of running the HABTAT program on the Cyber (cpu time requirements will double). Recommend setting to zero (0). 0 = Do not print matrices. 1 = Print velocity-depth matrix. 2 = Print velocity-channel index matrix. 3 = Print both velocity-depth and velocity-channel index matrices. 4 = Print depth-channel index matrix. 5 = Print both velocity-depth and depth-channel index matrices. 6 = Print both velocity-channel index and depth-channel index matrices. 7 = Print all three matrices.
6	Prints out the coordinates defining the criteria curves. Recommend setting to one (1). 0 = Do not print criteria curve coordinates. 1 = Print criteria curve coordinates.
7	Writes habitat results on TAPE7 (unformatted file). This option is seldom used. Recommend setting to zero (0). 0 = Do not write results on TAPE7. 1 = Write results on TAPE7.
8	Instructs the HABTAT program where the hydraulic (cross section, reach, and flow) data is located. Usually set to one (1). 0 = Hydraulic data in HABTAT options file. 1 = Hydraulic data in TAPE3 and TP4 files resulting from an IFG4 or WSP run.

Table V.3 (Continued)

OPTION	ACTION
9	Controls how the calculation of habitat area will be made.

0 = Standard calculation -- Combined Suitability Factor (CF)=f(v)*g(d)*h(ci)

where f(v)*g(d)*h(ci)) = variable preferences for velocity, depth and channel index. This is a simple multiplication of the velocity, depth, and channel index weights and implies synergistic action. Optimum habitat only exists if all variables are optimum.

1 = Geometric Mean -- CF=(f(v)*g(d)*h(ci))**0.333

This technique implies compensation effects; if two of the three variables are in the optimum range, the value of the third variable has less effect unless it is zero.

2 = Lowest Limiting Parameter -- CF=MIN(f(v)*g(d)*h(ci))

This control determines the Composite Suitability Factor as the value of the most restrictive variable. This implies a limiting factor concept (i.e., the habitat is no better than its worst component), but is limited <u>only</u> by its worst element.

3 = User defined calculation using WFTEST subroutine.
(Not available on the micro).

This control allows the user to specify his own preference function. A subroutine is written with the name WFTEST and the first statement is of the form:

```
SUBROUTINE WFTEST (CF,V,DEPTH,CI)
```

where CF=the suitability of the habitat in a specific cell, V=velocity, DEPTH=depth, and CI=channel index. The remaining statements may be of any form the user desires. Because of the experimental nature of this option, only one curve set may be analyzed at a time.

10 Prints the habitat area as a percent of total area. Recommend setting to one (1).

0 = Do not print habitat area as a percent of total area.
1 = Print habitat area as a percent of total area.

11 Selects the time base of the WUA output. This option is used when IOC(7)=1. Recommend setting to zero (0).

0 = Flow data is not ordered chronologically.
1 = Flow data is ordered by months starting with October.
2 = Flow data is ordered by months starting with January.

12 Allows the reach length to vary from cell to cell (Variable Reach Length) across the stream (i.e., a bend). If IOC(12)=1, set IOC(15)=1.

0 = Use reach as rectangles in plane view.
1 = Use reach as trapezoids (describes bends - implies that ADDBEND was run on the TAPE3).

13 Writes a ZHCF file (unformatted file used for effective habitat analysis) with station ID, flow, cell area, cell WUA, and cell weighting factor. Only one curve set at a time can be used with this option. Recommend setting to zero (0), unless there is a specific need for the ZHCF file.

0 = Do not write ZHCF file.
1 = Write ZHCF file.

Table V.3 (Continued)

OPTION ACTION

14 Controls how the velocity for the cell is calculated. If IOC(14)=4, 5, or 6, set IOC(16)=0.

0 = Mean column velocity.

1 = Nose velocity - Empirical equation based on the 1/7 power law and user defined coefficients. User supplies the nose depth for which a velocity is to be calculated, and the calibration parameters A and B. These values are entered on the NOSE line.

$$\frac{Vn}{\bar{V}} = A \left(\frac{DN}{D}\right)^B$$

where: N = nose velocity of the cell
A and B = user defined calibration parameters
$\bar{V}$ = mean velocity of the cell
DN = nose depth for species in question
D = total depth of the cell

2 = Nose velocity - 1/7th power law equation. User supplies nose depth on NOSE line.

3 = Nose velocity - logarithmic velocity distribution equation. The nose depth and the D65 of the bed material are supplied by the user on the NOSE line.

4 = Nose velocity - Shear velocity. In order to calculate the shear stress (τ), the Manning's roughness must be known. This value is entered on the NOSE line.

$$u_* = \sqrt{\tau/\rho}$$

where: u_* = shear velocity
τ = shear stress on the bed
ρ = density of the water

5 = Nose velocity - Shield's parameter. When using this option, Manning's roughness, D65 of the bed material, and the specific gravity must be entered in the NOSE line. If specific gravity is not specified, 2.65 is used.

$$K_s = \frac{\tau}{D_{65}\ (S_s - 1)\gamma}$$

where: K_s = Shield's parameter
τ = shear stress on a bed
D_{65} = size of bed surface material at which 65% are smaller
S_s = specific gravity of the bed material
γ = unit weight of water

6 = Nose velocity - Froude number. Used in recreational analysis to give an index to turbulence.

$$FN = \frac{V}{\sqrt{gd}}$$

where: V = Velocity
g = Acceleration of gravity
d = Depth

Table V.3 (Continued)

OPTION	ACTION
15	Increases the calculations by about 40% by not combining the total reach length assigned to a section early in the calculation. When IOC(12)=1, set IOC(15)=1. 0 = Combine reach lengths prior to calculations. 1 = Do not combine reach lengths prior to calculations.
16	Determines if given velocities (from TP4 or direct entry) or nose velocities are used in habitat simulation and determines how those nose velocities are calculated. Set IOC(16)=0, if IOC(14)=4, 5, or 6. 0 = Given velocities, or nose velocities, (depending on what IOC(14) was set to) are used for habitat simulation. 1 = Optimum velocities are used for habitat simulation with equal depth from top as from bottom. A "top and bottom cell" are removed from the water column. Within the remaining water column, the velocities in the habitat simulation calculations are optimized, i.e., it is assumed that the fish can move vertically to find the "best velocity" in the remaining water column. This "best velocity" is used with the nose velocity calculated by the selection of IOC(14). If IOC(14)=0, and IOC(16)=1 or 2, the program will calculate nose velocities as if IOC(14)=2. The "optimum (best) velocity" is defined as the velocity that is found within the range of nose depth down from the surface (top) and nose depth up from the bottom. Nose depth is set by one of two methods (a) if a NOSE line is present, nose depth = the data supplied on the NOSE line, (b) if a NOSE line is not present, nose depth = .1. 2 = Optimum velocities are used for habitat simulation with unequal depth from top as from bottom. A "top and bottom of a cell" are removed from the water column. Within the remaining water column, the velocities in the habitat simulation calculations are optimized, i.e., it is assumed that the fish can move vertically to find the "best velocity" in the remaining water column. This "best velocity" is used with the nose velocity calculated by the selection of IOC(14). If IOC(14)=0, and IOC(16)=1 or 2, the program will calculate nose velocities as if IOC(14)=2. The "bottom of the cell" is defined as the nose depth from the bottom of the water column. The nose depth is set on the NOSE line. If a NOSE line is not present, nose depth = .1. The "top of the cell" is defined as the distance from the surface of the water column to the depth specified on the CELL line. bottom = as defined by the CELL line 3 = Mean velocity in a top cell used for habitat simulation. The velocities used are the mean velocity found in a cell defined as existing between the surface of the water column and the depth specified on a CELL line.

Table V.3 (Concluded)

OPTION	ACTION
17	Defines what to use as velocity. IOC(17)=1 or 2 is for use with some recreation criteria such as wading. 0 = Use given velocity. 1 = Use velocity * depth as velocity. 2 = Use (velocity**2) * depth as velocity
18	Defines how channel index values of zero (0) are used. 0 = Do not use a channel index value of zero in the calculation of WUA for that cell. 1 = Use a channel index value of zero in the calculation of WUA for that cell.
19	Defines how cross section weights of zero (0) are used. 0 = Change weights of zero (0) to 0.5. 1 = Do not change zero (0) weights.

II. RUNNING HABTAT

RHABTAT,ZHABIN,ZOUT,FISHFIL,TAPE3,TP4,ZHAQF,ZHCF

ZHABIN=HABINS or HABIN file (input)
ZOUT=HABTAT results (output)
FISHFIL=unformatted curves file (input)
TAPE3=unformatted cross section and reach data (input)
TP4=rearranged TAPE4 file (input)
ZHAQF=habitat vs. flow file (output)
ZHCF=unformatted cell areas and cell weighted usable areas
Created if IOC(13)=1. (output)

Figure V.16 contains sample output from the ZOUT file created by HABTAT. Review the output file for error messages and inconsistancies in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort.

Figure V.17 contains a sample ZHAQF File. The ZHCF file created when IOC(13)=1 in HABTAT, HABTAV, or HABTAE is an unformatted file.

III. HABTAT ERROR MESSAGES

1. **LINES OUT OF ORDER, FORMAT --- WAS EXPECTED BUT --- WAS OBTAINED PROCESSING CROSS SECTION ---.**
Check options file. Improper sequence of format or lines, or lines called for by a particular option were not supplied. Refer to Appendix A for "HABTAT Options File Format".

2. **THE NUMBER OF VELOCITIES SUPPLIED --- FOR CROSS SECTION --- WHILE WORKING ON Q=--- WAS NOT ADEQUATE TO SATISFY NEEDS. TEN MORE ITEMS WILL BE ADDED, MERELY DUPLICAING ITEM GIVEN.**
The velocity cells probably do not match between the TAPE3 and TP4. Reproduce TAPE3 and TP4 and re-run HABTAT.

3. **IOC(13) CAN BE ONE ONLY WHEN NUMBER OF LIFE STAGES IS ONE.**
When generating a ZHCF file (IOC(13)=1), only one curve set may be used at a time.

4. **CROSS SECTION DATA --- IS OUT OF SYNCH WITH Q RELATED DATA ---.**
Used TAPE4 instead of TP4; or TAPE3 or TP4 are bad; or the TAPE3 and TP4 were not created using the same data set.

5. **THE WATER SURFACE ELEVATION --- IS --- FEET ABOVE THE LEFT (RIGHT) ENDPOINT OF XSEC ---.Q=---. HOWEVER, SINCE THERE IS LESS THAN 10.0 FEET INVOLVED THE RUN IS ALLOWED TO CONTINUE.**
Message is in ZOUT file. The discharge simulated is above the last coordinate defining the channel. The program will continue to process Q's unless the difference is over 10 feet.

6. **"HABTAT aborts and the DAYFILE on the Cyber contains an arithmatic indefinite."**
All curves must start with an X value = 0 and end with an X value = 100.

7. **"HABTAT aborts and ZOUT file contains the message "LIST EXCEEDS DATA - Filename TAPE3"**
IOC(12)=1, therefore program expects that ADDBEND has been run to add information to the TAPE3. Set IOC(12)=0 or run ADDBEND.

8. **CURVE SET ID NO. INDICATED TO BE ON THE FILE --- WAS NOT FOUND IN THE DIRECTORY FOR THE FILE.**
Check CURVES line in the options file to see if the correct curve set ID number was entered; remember curve set ID numbers are entered as positive numbers when they are to be read from a FISHFIL and as negative numbers when they are to be read from the options file; or one curve set ID number is entered on the CURVES line, but a number other than one is entered on the HEADER line; or the FISHFIL may be bad.

9. **CURVE SPECIFIED --- WAS NOT OBTAINED FROM THE FILE ---.**
See #8 above.

10. **THE ID NO. FOR A CURVE SET FURNISHED AS INPUT --- WAS NOT ON THE LIST OF CURVES TO BE USED.**
See #8 above.

11. **TOO MANY CURVE SETS SPECIFIED TO BE PROCESSED ---. ONLY 40 SETS MAY BE PROCESSED IN ONE RUN.**
Program aborts.

12. **LINES APPEAR TO BE OUT OF ORDER WHILE READING THE CURVE SET LINES FOR --, ID NUMBER -- WAS OBTAINED.**
When using curve sets contained in the options file, the curve set information must be entered in the same order as the ID numbers entered on the CURVES line(s).

13. **MORE THAN 100 POINTS SPECIFIED FOR THE GROUND PROFILE --- AT SECTION ---.**
Program is dimensioned for 100 coordinate pairs to define a cross section.

14. **MORE THAN 99 VELOCITIES HAVE BEEN SPECIFIED FOR SECTION ---.**
The maximum number of coordinate points in HABTAT is 100. This means that the maximum number of cells is 99. Therefore, the maximum number of velocities per cross section is 99.

15. **THE VELOCITY (DEPTH, CHANNEL INDEX) --- COULDN'T BE LOCATED IN THE LIST OF BRACKETS FOR THE MATRIX.**
IOC(5)=1-7 and the minimum and maximum values specified on the HEADER line in the options file could not be found.

16. **INTERPOLATION NOT POSSIBLE BECAUSE THE INDEP. VARIABLE (---) EXCEEDS (IS LESS THAN) THE LARGEST (SMALLEST) VALUE IN THE TABLE (---).**
A value calculated is outside the range defined by the curves in the FISHFIL. This usually indicates that the minimum and maximum X values defining a curve were not 0.0 and 100.0.

17. **WEIGHT ON SECTION -- IS GREATER THAN 1.0.**
Weights cannot be greater than one on a TAPE3.

18. **VELOCITY EXCEEDS MAX. VEL. IN SPECIES CRITERIA TABLE or VELOCITY LESS THAN MIN. VEL. IN SPECIES CRITERIA TABLE.**
The program only interpolates between given points. This error occurs when all possible values are not bounded by the criteria.

19. **DEPTH LESS THAN ZERO.**
Depths below ground (less than zero) are not permitted.

20. **CROSS SECTION IDS DON'T MATCH WITHIN DATA FOR THE SECTION EXPECTED --, OBTAINED --.**
Check TAPE3 and TP4 to make sure they both have the same cross section ID numbers. If hydraulic data was entered into the HABTAT options file, check to make sure consistant cross section ID numbering was used.

```
************************************************
*     PHYSICAL HABITAT SIMULATION SYSTEM      *
*     INSTREAM FLOW GROUP, USFWS              *
*     VERSION OF APRIL, 1988                  *
*     RUN DATE 88/04/26.  TIME 12.54.32.      *
************************************************


                          H     H   AAAAA    BBBBBB   TTTTTTT   AAAAA   TTTTTTT
                          H     H  A     A   B     B     T     A     A     T
                          H     H  A     A   B     B     T     A     A     T
                          HHHHHHH  AAAAAAA   BBBBBB      T     AAAAAAA     T
                          H     H  A     A   B     B     T     A     A     T
                          H     H  A     A   B     B     T     A     A     T
                          H     H  A     A   BBBBBB      T     A     A     T


        HABTAT PROGRAM VERSION NUMBER 4.2
       LAST MODIFIED ON  26 APRIL 1988.
 IOC     11100      10101      00020      00000
```

IOC(1)=1

```
 NUMBER OF CURVES    3

 VELOCITY BRACKETS SUPPLIED      0.00      0.00
 SUBDIVIDED INTO RANGES     0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00

 DEPTH BRACKETS SUPPLIED      0.00      0.00
 SUBDIVIDED INTO RANGES     0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00

 CHANNEL INDEX BRACKETS SUPPLIED     0.00    0.00
 SUBDIVIDED INTO RANGES     0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00
0.00

 CURVE ID NUMBERS    21112    21114    21115

 VELOCITIES MOVED TO NOSE DEPTH OF     0.20 USING THE PARAMETERS        0.000        0.000        0.000
0.200
                                                      (D65,AN,BN,DTOP)

              STAID  REACH LENGTH  WEIGHT  PERCENT
                0.0        14.25     0.30    30.00
               14.3         9.97     0.50    70.00
```

Figure V.16. Sample output from the HABTAT program.

88/04/26. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM-HABTAT
12.54.32. IFG4 DATA SET WITH WSL LINES ADDED FOR BOTH CROSS SECTIONS FROM MANSQ PAGE 2

IOC(2)=1

CROSS SECTION COORD. FOR 0.00 NP= 30 NL= 14 RL= 14.25 W= 0.30

0.00	101.30	3.00	2.50	100.70	3.00	4.00	99.80	3.00	4.30	98.60	3.00
5.50	97.70	9.25	7.60	97.30	6.00	11.90	97.60	6.00	14.20	97.90	8.25
16.20	97.60	8.25	16.50	97.70	8.25	18.20	97.50	8.25	20.20	97.40	9.00
22.20	97.30	9.00	24.20	97.20	9.00	26.20	97.30	9.00	28.20	97.50	9.00
30.20	97.40	9.00	32.20	97.70	9.00	33.00	97.60	9.00	34.20	97.60	9.25
35.20	97.70	9.25	36.20	97.70	9.25	37.40	97.70	9.25	39.10	97.90	10.00
43.80	98.10	10.00	53.00	98.60	10.00	62.40	99.00	10.00	69.90	98.50	8.25
78.10	99.00	3.00	87.10	99.50	3.00						

CROSS SECTION COORD. FOR 14.30 NP= 32 NL= 20 RL= 9.97 W= 0.50

0.00	101.90	3.00	3.00	101.30	3.00	4.70	101.00	3.00	5.30	100.00	3.00
15.00	100.00	3.00	19.10	99.60	3.00	29.30	99.20	3.00	33.10	98.40	3.00
41.00	98.50	7.50	46.10	98.20	8.25	48.10	98.00	8.50	48.50	97.90	8.50
49.30	97.80	8.50	50.30	97.80	9.25	52.30	97.70	9.00	54.30	97.60	9.00
56.30	97.80	9.00	58.30	97.60	9.00	60.30	97.60	10.00	62.30	97.60	10.00
64.30	97.70	9.00	65.00	97.80	9.00	66.30	97.70	10.00	68.30	97.90	10.00
70.30	98.20	10.00	73.80	98.20	10.00	77.70	98.80	10.00	86.80	99.00	10.25
94.30	98.50	9.50	99.10	98.90	7.75	103.60	100.30	3.00	108.40	101.30	3.00

88/04/26. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM-HABTAT
12.54.32. IFG4 DATA SET WITH WSL LINES ADDED FOR BOTH CROSS SECTIONS FROM MANSQ PAGE 3

Q RELATED DATA FOR THE CROSS SECTION 0.00
DISCHARGE = 8.00 IVS = 16 WSEL = 97.68

VELOCITIES	0.46	0.62	0.16	0.16	0.16	0.62	1.51	1.59	1.78	2.22
	1.90	1.40	0.63	0.42	0.54	0.12				

Q RELATED DATA FOR THE CROSS SECTION 14.30
DISCHARGE = 8.00 IVS = 15 WSEL = 98.04

VELOCITIES	0.08	0.33	0.73	1.02	1.07	1.18	1.25	1.28	1.38	1.50
	1.47	1.25	0.71	0.33	0.20					

Q RELATED DATA FOR THE CROSS SECTION 0.00
DISCHARGE = 10.00 IVS = 20 WSEL = 97.72

VELOCITIES	0.03	0.52	0.69	0.21	0.21	0.27	0.76	1.67	1.71	1.87
	2.33	2.07	1.56	0.96	0.81	0.70	0.20	0.18	0.26	0.13

SECTIONS OF SAMPLE OUTPUT DELETED HERE FOR BREVITY.

Figure V.16. (Continued)

CURVE SET DEFINITION DATA WAS OBTAINED FROM THE FISHFIL FILE WHOSE TITLE LINE IS -
SAMPLE FISHCRV FILE CREATED WITH THE GCURV PROGRAM
LAST UPDATED ON 88/04/25. 15.03.07.

IOC(6)=1

VELOCITY WEIGHTING FOR RAINBOW TROUT FRY

VELOCITY	WEIGHT
0.00	1.00
0.10	1.00
0.50	0.00
100.00	0.00

DEPTH WEIGHTING FOR RAINBOW TROUT FRY

DEPTH	WEIGHT
0.00	0.00
0.10	0.10
0.20	1.00
0.50	1.00
1.00	0.50
1.25	0.30
3.00	0.00
100.00	0.00

CHANNEL INDEX WEIGHTING FOR RAINBOW TROUT FRY

CHANNEL INDEX	WEIGHT
0.00	1.00
1.00	1.00
2.00	1.00
4.00	1.00
6.00	1.00
8.00	1.00
9.00	1.00
100.00	0.00

SECTIONS OF SAMPLE OUTPUT DELETED HERE FOR BREVITY.

Figure V.16. (Continued)

88/04/26. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM-HABTAT
12.54.32. IFG4 DATA SET WITH WSL LINES ADDED FOR BOTH CROSS SECTIONS FROM MANSQ PAGE 9

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR RAINBOW TROUT

	Q	FRY	JUVENILE	ADULT
1	8.00	593.92	0.00	79.87
2	10.00	385.61	0.00	101.70
3	20.00	256.72	0.00	185.36
4	30.00	76.00	207.60	259.73
5	40.00	140.67	395.44	332.98
6	50.00	418.61	495.20	432.46
7	60.00	211.13	491.81	547.08
8	70.00	65.73	691.26	660.58
9	80.00	58.67	689.96	740.38
10	90.00	38.96	675.61	830.34
11	100.00	3.88	596.44	911.59
12	110.00	0.00	512.90	970.48
13	120.00	0.00	621.43	1054.90
14	130.00	0.00	728.64	1113.86

88/04/26. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM-HABTAT
12.54.32. IFG4 DATA SET WITH WSL LINES ADDED FOR BOTH CROSS SECTIONS FROM MANSQ PAGE 10

IOC(10)=1

Q VS. AVAILABLE HABITAT AREA AS A PERCENTAGE OF THE GROSS AREA FOR RAINBOW TROUT

	Q	GROSS	FRY	JUVENILE	ADULT
1	8.	22789.	2.61	0.00	0.35
2	10.	24395.	1.58	0.00	0.42
3	20.	29444.	0.87	0.00	0.63
4	30.	31748.	0.24	0.65	0.82
5	40.	33660.	0.42	1.17	0.99
6	50.	39436.	1.06	1.26	1.10
7	60.	42818.	0.49	1.15	1.28
8	70.	44512.	0.15	1.55	1.48
9	80.	45820.	0.13	1.51	1.62
10	90.	47187.	0.08	1.43	1.76
11	100.	48495.	0.01	1.23	1.88
12	110.	49535.	0.00	1.04	1.96
13	120.	50843.	0.00	1.22	2.07
14	130.	51883.	0.00	1.40	2.15

$$$ NORMAL COMPLETION OF JOB

Figure V.16. (Concluded)

```
UPPER SALMON RIVER, NEAR STANLEY, IDAHO
ZHAQF FILE GENERATED BY HABTAT
TOTAL AREA
      DISCHARGE  AREA
* 1        8.00    22788.90
* 2       10.00    24395.06
* 3       20.00    29444.04
* 4       30.00    31747.52
* 5       40.00    33659.56
* 6       50.00    39436.34
* 7       60.00    42818.31
* 8       70.00    44512.37
* 9       80.00    45820.20
*10       90.00    47187.19
*11      100.00    48494.81
*12      110.00    49535.04
*13      120.00    50842.66
*14      130.00    51882.89
***************
RAINBOW TROUT
      DISCHARGE  FRY          JUVENILE     ADULT
* 1        8.00      593.92        0.00        79.87
* 2       10.00      385.61        0.00       101.70
* 3       20.00      256.72        0.00       185.36
* 4       30.00       76.00      207.60       259.73
* 5       40.00      140.67      395.44       332.98
* 6       50.00      418.61      495.20       432.46
* 7       60.00      211.13      491.81       547.08
* 8       70.00       65.73      691.26       660.58
* 9       80.00       58.67      689.96       740.38
*10       90.00       38.96      675.61       830.34
*11      100.00        3.88      596.44       911.59
*12      110.00        0.00      512.90       970.48
*13      120.00        0.00      621.43      1054.90
*14      130.00        0.00      728.64      1113.86
***************
```

Figure V.17. ZHAQF file generated by HABTAT.

HABTAV Program

I. INTRODUCTION

The HABTAV program simulates situations where fish habitat is determined by hydraulic parameters at the fish's location, as well as by velocities near the fish.

In HABTAV, cells are defined by one measured vertical located at the center of the cell. See Figure V.1 for diagram of how the HABTAV and HABTAM programs view a cell location in contrast to how the HABTAT program views the cell location relative to verticals. The values of stream characteristics (depth, velocity, and channel index) for each cell are the values of the velocity, depth, and channel index at the measured vertical.

Option 1 in HABTAV scans the cross section a user-specified distance out from the cell for which the habitat is being simulated for a user-specified velocity in adjacent cells. If the velocity is found within the distance, the WUA calculated for the cell is multiplied by one. If the user-specified velocity is not found, HABTAV (with option 5 on) scans the cross section a second time for an initial velocity. This initial velocity is the first velocity where fish habitat is worth more than zero. HABTAV searches for a velocity between the initial velocity and the user-specified velocity closest to the user-specified velocity and then interpolates a worth for this velocity between zero and one. This worth is multiplied by WUA for a new value. If option 5 is off and the user-specified velocity is not found, WUA is multiplied by zero.

Input to the HABTAV program is the options file created by the HABINV program and these previously created files: (1) a FISHFIL containing criteria curves of aquatic species or recreational activities created by the curve maintenance programs, (2) TAPE3 containing cross section data which is output from IFG4, and (3) TP4A containing hydraulic data which is output from IFG4. TP4A is a TP4 created with IOC(17)=1 in the IFG4 program and then renamed TP4A by the user. This version of TP4 is in HABTAM and HABTAV readable format rather than HABTAT readable format.

Table V.4 describes the options available in the HABTAV program. These options are selected in the HABTAV options file created by HABINV.

Table V.4. Options in the HABTAV Program.

OPTION	ACTION
1	Scans for velocity in adjacent cells. 0 = Do not scan adjacent cells for velocity. 1 = Scans adjacent cells within a user-defined distance (DIST) for velocity greater than or equal to a user-defined velocity (VLIM). If found, WUA for current cell = WUA * 1. 2 = Scans adjacent cells within a user-defined distance (DIST) for velocity less than or equal to a user-defined velocity (VLIM). If found, WUA for current cell = WUA * 1.
2	Prints out the cross section data (from TAPE3). Recommend setting to one (1). 0 = Do not print cross section data. 1 = Print cross section data.
3	Prints out the flow related data (from TP4A) for each cross section evaluated at each discharge. It also lists the velocity for each cell that has water in it. The data are a rehash of the IFG4 output. Recommend setting to one (1). 0 = Do not print flow related data. 1 = Print flow related data.
4	Prints out all the computational details used in determining the Weighted Usable Area. Recommend setting to zero (0) except when details are needed to evaluate the simulation. Strongly recommend using only a few life stages and discharges when using this option. On the micro, the size of the output file may be a constraint. 0 = Do not print computational details. 1 = Print computational details.
5	When scanning has been turned on by setting IOC(1)=to 1 or 2, this option controls how to calculate WUA in the current cell when VLIM is not found within the DIST. 0 = If VLIM is not found in adjacent cells, multiply WUA * 0. 1 = If VLIM is not found in adjacent cells, scans a second time for an initial velocity, VO, which is the first velocity where fish habitat is greater than 0. Then searches for a velocity between VO and VLIM which is closest to VLIM and interpolates a multiplier for the WUA for the current cell between 0 and 1 based on the found velocity.

NOTES: Explanation of the different combinations of IOC(1), IOC(5), and VO.

If IOC(1)=1, IOC(5)=1, and VO > VLIM, it is illogical to supply a VO. Likewise, if IOC(1)=2, IOC(5)=1, and VO < VLIM, it is illogical to supply a VO.

<u>Reason</u>: In the following cases, although a VO is supplied, it is not used.

- setting IOC(1)=1, IOC(5)=1, and VO > VLIM defaults to the same results as setting IOC(1)=1 and IOC(5)=0 (no VO); and

- setting IOC(1)=2, IOC(5)=1, and VO < VLIM defaults to the same results as setting IOC(1)=2 and IOC(5)=0 (no VO).

Table V.4. (Continued)

OPTION	ACTION

6 Scans adjacent cells for:

If neither IOC(6) nor IOC(14) equals 0, then they must be set to the same number.

0 = Mean column velocity.
1 = Nose velocity - Empirical equation based on the 1/7 power law and user defined coefficients. User supplies the nose depth for which a velocity is to be calculated, and the calibration parameters A and B. These values are entered on the NOSE line.

$$\frac{Vn}{\bar{V}} = A \left(\frac{DN}{D}\right)^B$$

where:
N = nose velocity of the cell
A and B = user defined calibration parameters
$\bar{V}$ = mean velocity of the cell
DN = nose depth for species in question
D = total depth of the cell

2 = Nose velocity - 1/7th power law equation. User supplies nose depth on NOSE line.

3 = Nose velocity - logarithmic velocity distribution equation. The nose depth and the D65 of the bed material are supplied by the user on the NOSE line.

7 Defines how channel index values of zero (0) are used.

0 = Do not use a channel index value of zero in the calculation of WUA for that cell.
1 = Use a channel index value of zero in the calculation of WUA for that cell.

8 Not used - set to "0".

9 Controls how the calculation of habitat area will be made.

0 = Standard calculation -- Combined Suitability Factor (CF)=f(v)*g(d)*h(ci)

where f(v)*g(d)*h(ci)) = variable preferences for velocity, depth and channel index. This is a simple multiplication of the velocity, depth, and channel index weights and implies synergistic action. Optimum habitat only exists if all variables are optimum.

1 = Geometric Mean -- CF=(f(v)*g(d)*h(ci))**0.333

This technique implies compensation effects; if two of the three variables are in the optimum range, the value of the third variable has less effect unless it is zero.

2 = Lowest Limiting Parameter -- CF=MIN(f(v)*g(d)*h(ci))

This control determines the Composite Suitability Factor as the value of the most restrictive variable. This implies a limiting factor concept (i.e., the habitat is no better than its worst component), but is limited <u>only</u> by its worst element.

3 = User defined calculation using WFTEST subroutine. (Not available on the micro).

This control allows the user to specify his own preference function. A subroutine is written with the name WFTEST and the first statement is of the form:

```
SUBROUTINE WFTEST (CF,V,DEPTH,CI)
```

where CF=the suitability of the habitat in a specific cell, V=velocity, DEPTH=depth, and CI=channel index. The remaining statements may be of any form the user desires. Because of the experimental nature of this option, only one curve set may be analyzed at a time.

Table V.4. (Concluded)

OPTION	ACTION
10	Prints the habitat area as a percent of total area. Recommend setting to one (1). 0 = Do not print habitat area as a percent of total area. 1 = Print habitat area as a percent of total area.
11	Not used - set to "0".
12	Allows the reach length to vary from cell to cell (Variable Reach Length) across the stream (i.e., a bend). 0 = Use reach as rectangles in plane view. 1 = Use reach as trapezoids (describes bends - implies that ADDBEND was run on the TAPE3).
13	Writes a ZHCF file (unformatted file used for effective habitat analysis) with station ID, flow, cell area, cell WUA, and cell weighting factor. Only one curve set at a time can be used with this option. Recommend setting to zero (0) unless there is a specific need for the ZHCF file. 0 = Do not write ZHCF file. 1 = Write ZHCF file.
14	Controls how the velocity for the cell is calculated. Refer to IOC(6) for description of these options. If neither IOC(6) nor IOC(14) equals 0, then they must be set to the same number. 0 = Mean column velocity. 1 = Nose velocity - Empirical equation based on the 1/7 power law and user defined coefficients. 2 = Nose velocity - 1/7th power law equation. 3 = Nose velocity - logarithmic velocity distribution equation.

II. RUNNING HABTAV

RHABTAV,ZHABIN,ZOUT,FISHFIL,TAPE3,TP4A,ZHAQF,ZHCF

ZHABIN=HABINV file (input)
ZOUT=HABTAV results (output)
FISHFIL=unformatted curves file (input)
TAPE3=unformatted cross section and reach data (input)
TP4A=rearranged TAPE4A file (TP4 was created in HABTAM/HABTAV format by setting IOC(17)=1 in IFG4 and was renamed TP4A by the user) (input)
ZHAQF=habitat vs. flow file (output)
ZHCF=unformatted cell areas and cell weighted usable areas. Created if IOC(13)=1. (output)

Figure V.18 contains sample output from the ZOUT file created by HABTAV. Review the output file for error messages and inconsistances in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort.

The ZHAQF and ZHCF files are in the same format as when created by HABTAT. Figure V.19 contains the ZHAQF file created by HABTAV.

III. HABTAV ERROR MESSAGES

Refer to error messages section in HABTAT program documentation section as several of the error messages are the same. Error messages specific to HABTAV are described below.

1. **INPUT LINE OF THE FORM --- WAS EXPECTED BUT --- WAS READ.**
   Check data set. Refer to Appendix A for "HABTAV Options File Format".

2. **IOC(1) WAS SET TO --, IOC(1) MUST BE:**
   0 - DO NOTHING
   1 - SEARCH FOR V GREATER THAN OR EQUAL TO VLIM
   2 - SEARCH FOR V LESS THAN OR EQUAL TO VLIM
   Values 0, 1, and 2 are the only valid values for IOC(1) in HABTAV. Refer to Table V.4 "Options in the HABTAV Program" for more information on available options.

3. **IOC(13) CAN BE ONE ONLY WHEN NUMBER OF LIFE STAGES IS ONE.**
   When generating a ZHCF file (IOC(13)=1), only one curve set may be used at a time.

4. **CROSS SECTION DATA --- IS OUT OF SYNCH WITH Q RELATED DATA ---.**
   Used TAPE4 or TP4 instead of TAPE4A or TP4A; or TAPE3 or TP4A is bad; or the TAPE3 and TP4A were not created using the same data set.

```
88/04/25.                    UPPER SALMON RIVER, NEAR STANLEY, IDAHO                                    PROGRAM-HABTAV
15.04.33.    IFG4 DATA SET WITH WSL LINES ADDED FOR BOTH CROSS SECTIONS FROM MANSQ                          PAGE   1

**************************************************
*       PHYSICAL HABITAT SIMULATION SYSTEM       *
*       INSTREAM FLOW GROUP, USFWS               *
*       VERSION OF APRIL, 1988                   *
*       RUN DATE 88/04/25.  TIME 15.04.33.       *
**************************************************


                                    H     H    AAAAA    BBBBBB   TTTTTTT   AAAAA   V     V
                                    H     H   A     A   B     B     T     A     A  V     V
                                    H     H   A     A   B     B     T     A     A  V     V
                                    HHHHHHH   AAAAAAA   BBBBBB      T     AAAAAAA  V     V
                                    H     H   A     A   B     B     T     A     A   V   V
                                    H     H   A     A   B     B     T     A     A    V V
                                    H     H   A     A   BBBBBB      T     A     A     V


          HABTAV PROGRAM VERSION 2.0
         LAST MODIFIED ON 11 APRIL 1988.

 IOC      1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

 HEADER       3

             CURVE ID  DIST   VLIM                  CURVE ID  DIST   VLIM                  CURVE ID  DIST
VLIM
               21112  20.00   1.00                    21114  10.00   2.00                    21115  15.00
3.00
```

Figure V.18. Sample output from the HABTAV program.

CURVE SET DEFINITION DATA WAS OBTAINED FROM THE FISHFIL FILE WHOSE TITLE LINE IS -

SAMPLE FISHCRV FILE CREATED WITH THE GCURV PROGRAM

LAST UPDATED ON 88/04/25. 15.03.07.

RAINBOW TROUT FRY 21112

VELOCITY DATA

VELOCITY	0.00	0.10	0.50	100.00
INDEX	1.00	1.00	0.00	0.00

DEPTH DATA

DEPTH	0.00	0.10	0.20	0.50	1.00	1.25	3.00	100.00
INDEX	0.00	0.10	1.00	1.00	0.50	0.30	0.00	0.00

CHAN.INDEX DATA

CHAN.INDEX	0.00	1.00	2.00	4.00	6.00	8.00	9.00	100.00
INDEX	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00

RAINBOW TROUT JUVENILE 21114

VELOCITY DATA

VELOCITY	0.00	1.20	1.60	2.60	100.00
INDEX	1.00	1.00	0.25	0.00	0.00

DEPTH DATA

DEPTH	0.00	0.40	0.70	100.00
INDEX	0.00	0.00	1.00	1.00

CHAN.INDEX DATA

CHAN.INDEX	0.00	1.00	2.00	6.00	7.00	8.00	9.00	100.00
INDEX	1.00	1.00	0.50	0.50	1.00	1.00	0.00	0.00

Figure V.18. (Continued)

RAINBOW TROUT ADULT 21115

VELOCITY DATA

VELOCITY	0.00	1.50	3.00	100.00
INDEX	1.00	1.00	0.00	0.00

DEPTH DATA

DEPTH	0.00	1.00	1.60	100.00
INDEX	0.00	0.20	1.00	1.00

CHAN.INDEX DATA

CHAN.INDEX	0.00	1.00	2.00	6.00	7.00	8.00	9.00	100.00
INDEX	0.00	1.00	0.70	0.70	1.00	1.00	0.00	0.00

Figure V.18. (Continued)

Q .VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR RAINBOW TROUT

Q	FRY	JUVENILE	ADULT
8.00	1040.43	0.00	0.00
10.00	893.72	0.00	0.00
20.00	556.54	2.03	134.60
30.00	181.59	27.84	168.72
40.00	61.33	80.79	316.73
50.00	169.38	242.65	398.32
60.00	263.99	345.68	460.18
70.00	367.02	435.08	544.37
80.00	33.68	340.37	588.94
90.00	60.98	492.12	641.61
100.00	95.78	587.23	685.60
110.00	259.47	551.62	702.90
120.00	566.17	560.97	744.92
130.00	878.16	527.63	773.44

NOTE: AVAILABLE HABITAT AREA FOR FRY WAS CALCULATED BY SCANNING THE XSEC 20.00 FT. FOR VELOCITIES GREATER THAN 1.00

NOTE: AVAILABLE HABITAT AREA FOR JUVENILE WAS CALCULATED BY SCANNING THE XSEC 10.00 FT. FOR VELOCITIES GREATER THAN 2.00

NOTE: AVAILABLE HABITAT AREA FOR ADULT WAS CALCULATED BY SCANNING THE XSEC 15.00 FT. FOR VELOCITIES GREATER THAN 3.00

Q .VS. AVAILABLE HABITAT AREA AS A PERCENTAGE OF THE GROSS AREA FOR RAINBOW TROUT

Q	GROSS	FRY	JUVENILE	ADULT
8.00	22789.	4.57	0.00	0.00
10.00	24395.	3.66	0.00	0.00
20.00	29444.	1.89	0.01	0.46
30.00	31748.	0.57	0.09	0.53
40.00	33660.	0.18	0.24	0.94
50.00	39436.	0.43	0.62	1.01
60.00	42818.	0.62	0.81	1.07
70.00	44512.	0.82	0.98	1.22
80.00	45820.	0.07	0.74	1.29
90.00	47187.	0.13	1.04	1.36
100.00	48495.	0.20	1.21	1.41
110.00	49535.	0.52	1.11	1.42
120.00	50843.	1.11	1.10	1.47
130.00	51883.	1.69	1.02	1.49

$$$ NORMAL COMPLETION OF HABTAV $$$

Figure V.18. (Concluded)

```
UPPER SALMON RIVER, NEAR STANLEY, IDAHO
ZHAQF FILE GENERATED BY HABTAV
TOTAL AREA
      DISCHARGE  AREA
 *         8.00     22788.89
 *        10.00     24395.06
 *        20.00     29444.04
 *        30.00     31747.52
 *        40.00     33659.56
 *        50.00     39436.34
 *        60.00     42818.31
 *        70.00     44512.37
 *        80.00     45820.20
 *        90.00     47187.19
 *       100.00     48494.82
 *       110.00     49535.04
 *       120.00     50842.66
 *       130.00     51882.87
 ***************
 RAINBOW TROUT
       DISCHARGE  FRY          JUVENILE     ADULT
 *         8.00     1040.43        0.00         0.00
 *        10.00      893.72        0.00         0.00
 *        20.00      556.54        2.03       134.60
 *        30.00      181.59       27.84       168.72
 *        40.00       61.33       80.79       316.73
 *        50.00      169.38      242.65       398.32
 *        60.00      263.99      345.68       460.18
 *        70.00      367.02      435.08       544.37
 *        80.00       33.68      340.37       588.94
 *        90.00       60.98      492.12       641.61
 *       100.00       95.78      587.23       685.60
 *       110.00      259.47      551.62       702.90
 *       120.00      566.17      560.97       744.92
 *       130.00      878.16      527.63       773.44
 ***************
```

Figure V.19. ZHAQF file generated by the HABTAV program.

HABVD Program

I. INTRODUCTION

The HABVD program is a "short cut" method of habitat simulation that uses data readily available from the U.S. Geological Survey and the logic and concepts of the HABTAT program. The resulting physical habitat versus streamflow relationship is not as valuable as the standard HABTAT output, but the results cost a lot less.

The logic of the program is basically the same as HABTAT except only one velocity and one depth are used to represent the habitat in the stream. Specifically, the weighted usable area for a streamflow Q is:

$$WUA(Q) = A * f(v) * g(d) * h(s)$$

where Q = streamflow
WUA = weighted usable area at the discharge Q
A = surface area per unit length (same as stream width) at streamflow Q
v = velocity at streamflow Q
d = depth at streamflow Q
s = channel index

f ( ), g ( ), h ( ) are functions dependent on the species and life stage of interest (or recreational activity if recreation is of concern)

The summary of discharge measurements available for numerous gauging stations can be used to determine the velocity, average depth, and surface width. Not all USGS data are useful for this purpose because some of the data is collected at man-made controls such as weirs and bridges. Only data from reasonable natural measurement points should be used with the HABVD program.

In some cases, stream morphology relationships have been developed for a specific location - these can be used directly. Channel index information is not available as part of the discharge measurement summaries and will have to be obtained from some other source. One channel index value may be assigned for the whole section of the stream being analyzed.

The stream morphology relationships are of the form:

$$v = k\ Q^m$$

$$d = c\ Q^f$$

$$w = a\ Q^b$$

where v = velocity at streamflow Q
d = depth at streamflow Q
w = stream width
Q = streamflow
k,m,c,f,a,b = coefficients (the sum of the coefficients m,f,and b must equal "1".)

If IOC(8)=0, the program calculates the coefficients from the data supplied. If IOC(8)=1, the program is supplied the coefficients in the format described in Appendix A (HABVD Streamflow or Stream Morphology Parameters File).

The results from the HABVD program are different from the results from the HABTAT program. Examples of the different results from HABTAT and HABVD are shown in in Figure V.20. Our experience indicates the differences shown are typical.

The HABVD program was written to solve some missing data problems and has been used to determine if one set of HABTAT results could be transferred downstream. Both cases were an appropriate use of the program. The HABVD program should be considered as a supplemental program to HABTAT, not as a replacement.

Table V.5 describes the options available in the HABVD program. These options are selected in the HABVD options file created by HBVDIN.

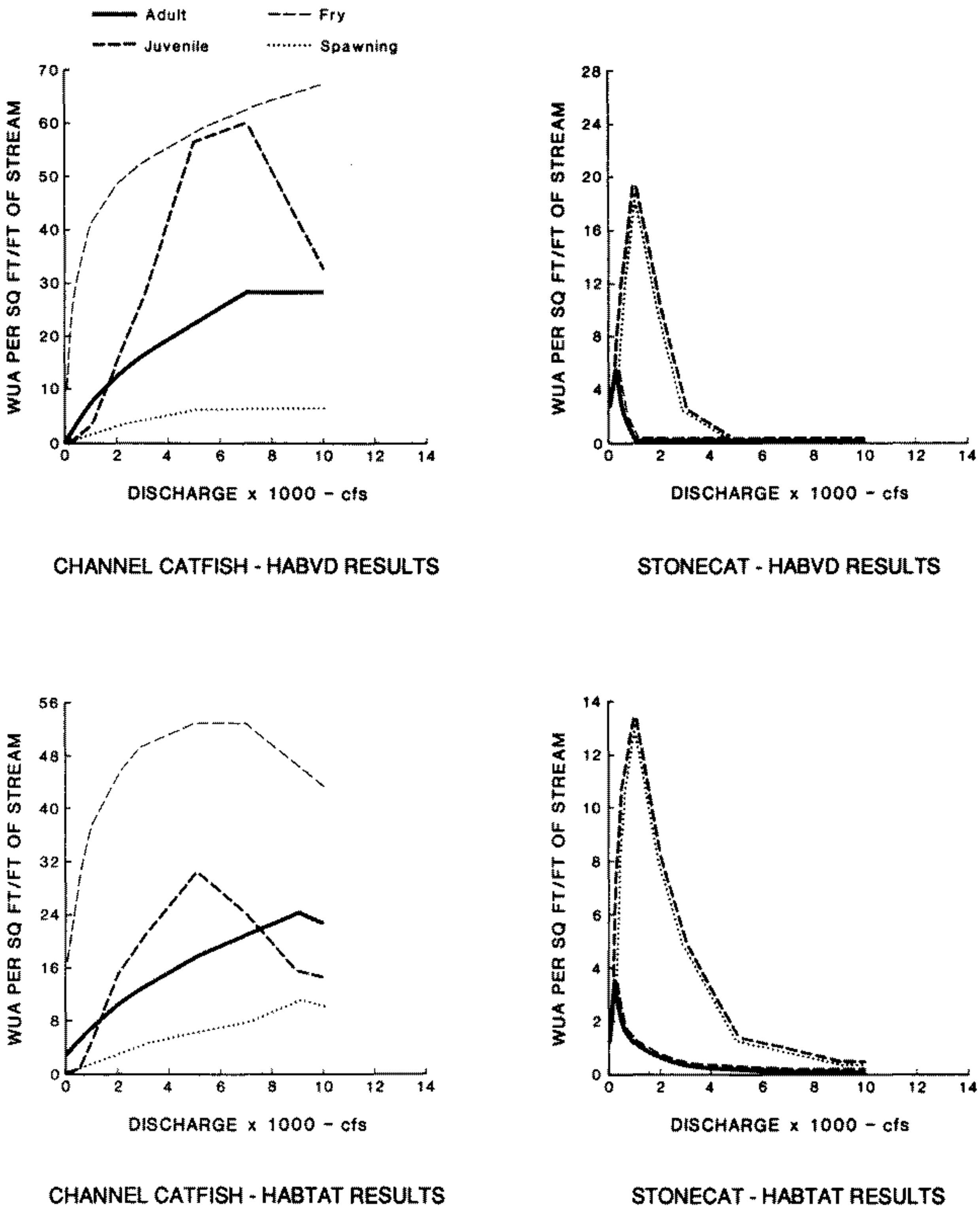


Figure V.20. HABTAT vs. HABVD program results.

Table V.5. Options in the HABVD Program.

OPTION	ACTION
1	Not used - set to "0".
2	Print new velocities, depths, and discharges resulting from IOC(5)=0 or 1. 0 = Do not print new velocities, depths, and discharges. 1 = Print new velocities, depths, and discharges.
3	Print stream morphology relationships. 0 = Do not print stream morphology relationships. 1 = Print stream morphology relationships.
4	Prints out all the computational details used in determining the Weighted Usable Area. Recommend setting to zero (0) except when details are needed to evaluate the simulation. Strongly recommend using only a few life stages and discharges when using this option. On the micro, the size of the output file may be a constraint. 0 = Do not print computational details. 1 = Print computational details.
5	Instructs the HABVD program where the discharge or streamflow data is located. 0 = Read discharges from the input file. 1 = Derive streamflows from the ranges of discharges on flow file. 2 = Use streamflow from data points.
6	Prints out the coordinates defining the criteria curves. Recommend setting to one (1). 0 = Do not print criteria curve coordinates. 1 = Print criteria curve coordinates.
7	Writes habitat results on TAPE7 (unformatted file). This option is seldom used. Recommend setting to zero (0). 0 = Do not write results on TAPE7. 1 = Write results on TAPE7 (seldom used).
8	Instructs the HABVD program what data is contained in the input file. 0 = Read stream width, cross-sectional area, and discharge from flow file. 1 = Read stream morphology parameters from flow file.

Table V.5. (Concluded)

OPTION	ACTION
9	Controls how the calculation of habitat area will be made. 0 = Standard calculation -- Combined Suitability Factor (CF)=f(v)*g(d)*h(ci) where f(v)*g(d)*h(ci)) = variable preferences for velocity, depth and channel index. This is a simple multiplication of the velocity, depth, and channel index weights and implies synergistic action. Optimum habitat only exists if all variables are optimum. 1 = Geometric Mean -- CF=(f(v)*g(d)*h(ci))**0.333 This technique implies compensation effects; if two of the three variables are in the optimum range, the value of the third variable has less effect unless it is zero. 2 = Lowest Limiting Parameter -- CF=MIN(f(v)*g(d)*h(ci)) This control determines the Composite Suitability Factor as the value of the most restrictive variable. This implies a limiting factor concept (i.e., the habitat is no better than its worst component), but is limited only by its worst element. 3 = User defined calculation using WFTEST subroutine. (Not available on the micro). This control allows the user to specify his own preference function. A subroutine is written with the name WFTEST and the first statement is of the form: SUBROUTINE WFTEST (CF,V,DEPTH,CI) where CF=the suitability of the habitat in a specific cell, V=velocity, DEPTH=depth, and CI=channel index. The remaining statements may be of any form the user desires. Because of the experimental nature of this option, only one curve set may be analyzed at a time.
10	Prints the habitat area as a percent of total area. Recommend setting to one (1). 0 = Do not print habitat area as a percent of total area. 1 = Print habitat area as a percent of total area.

II. RUNNING HABVD

RHABVD,ZHABIN,ZIN,FISHFIL,ZOUT,ZHAQF

ZHABIN=HBVDIN file (input)
ZIN=streamflow data or stream morphology parameters (input)
FISHFIL=unformatted curves file (input)
ZOUT=HABVD results (output)
ZHAQF=habitat vs. flow file (output)

Refer to Appendix A for the file format for the streamflow data or stream morphology parameters file (ZIN) which is used as input to HABVD. If IOC(8)=0, USGS streamflow data is entered; if IOC(8)=1, stream morphology parameters are entered.

Figure V.21 contains sample output from the ZOUT file created by HABVD. Review the output file for error messages and inconsistancies in data. Error messages in the form of notes or other statements may be written that did not appear on the screen or cause the program to abort.

Figure V.22 contains the ZHAQF file created by HABVD.

IV. HABVD ERROR MESSAGES

Most of the error messages are related to incorrect format of input files. Refer to Appendix A (HABVD Options File Format and HABVD Streamflow and Stream Morphology Parameters File Format).

ERROR IN STREAM MORPHOLOGY SET UP OR WRONG OPTION SELECTED.
If IOC(8)=0, USGS streamflow data should be contained in the ZIN input file; if IOC(8)=1, stream morphology parameters should be contained in the ZIN input file.

```
TITLE OF STREAM DATA SET IS -

SOLOMON RIVER NEAR GLEN ELDER, KANSAS
DATA FROM USGS DISCHARGE SUMMARY SHEETS (WY79-81)

IOC = 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
      0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

CURVES TO BE USED ARE-

      21112     21114     21115

CURVE SET DEFINITION DATA WAS OBTAINED FROM THE FISHFIL FILE WHOSE TITLE LINE IS -

SAMPLE FISHCRV FILE CREATED WITH THE GCURV PROGRAM

LAST UPDATED ON 88/07/28. 10.47.04.
```

Figure V.21. Sample output from the HABVD program.

DATA FOR STREAM MORPHOLOGY ANALYSIS

DISCHARGE	VELOCITY	DEPTH	WIDTH
31.00	0.90	0.78	44.00
122.00	1.59	2.29	33.50
515.00	2.00	3.95	65.00
17.40	1.09	0.58	27.50
17.80	1.28	0.38	36.50
13.70	0.59	1.05	22.00

RELATIONSHIP BETWEEN VELOCITY AND DISCHARGE

VELOCITY = 0.454 * DISCHARGE ** 0.245

RELATIONSHIP BETWEEN DEPTH AND DISCHARGE

DEPTH = 0.135 * DISCHARGE ** 0.548

RELATIONSHIP BETWEEN WIDTH AND DISCHARGE

WIDTH = 16.295 * DISCHARGE ** 0.207

RELATIONSHIP BETWEEN DISCHARGE AND DEPTH

DISCHARGE = 39.772 * DEPTH ** 1.468

Figure V.21. (Continued)

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR RAINBOW TROUT

MONTH	Q	FRY	JUVENILE	ADULT
1	7.00	0.00	0.00	1912.85
2	25.00	0.00	31729.83	5001.36
3	50.00	0.00	36625.78	14761.26
4	100.00	0.00	26104.32	42277.18
5	200.00	0.00	11420.88	43469.17
6	300.00	0.00	10115.39	41127.37
7	500.00	0.00	7630.73	36080.32
8	700.00	0.00	5351.74	31137.87
9	900.00	0.00	3245.42	26421.77
10	1000.00	0.00	2246.37	24149.43

Q VS. AVAILABLE HABITAT AREA AS A PERCENTAGE OF THE GROSS AREA FOR RAINBOW TROUT

MONTH	Q	GROSS	FRY	JUVENILE	ADULT
1	7.	24379.	0.00	0.00	7.85
2	25.	31730.	0.00	100.00	15.76
3	50.	36626.	0.00	100.00	40.30
4	100.	42277.	0.00	61.75	100.00
5	200.	48801.	0.00	23.40	89.08
6	300.	53074.	0.00	19.06	77.49
7	500.	58994.	0.00	12.93	61.16
8	700.	63250.	0.00	8.46	49.23
9	900.	66627.	0.00	4.87	39.66
10	1000.	68097.	0.00	3.30	35.46

Figure V.21. (Concluded)

```
SOLOMON RIVER BELOW GLEN ELDER DAM
ZHAQF FILE GENERATED BY THE HABVD PROGRAM
TOTAL AREA OF STREAM
       DISCHARGE  TOTAL AREA
* 1         7.00    24379.15
* 2        25.00    31729.83
* 3        50.00    36625.78
* 4       100.00    42277.18
* 5       200.00    48800.61
* 6       300.00    53073.72
* 7       500.00    58993.84
* 8       700.00    63249.64
* 9       900.00    66627.44
*10      1000.00    68096.66
***************
RAINBOW TROUT
       DISCHARGE  FRY         JUVENILE     ADULT
* 1         7.00        0.00        0.00     1912.85
* 2        25.00        0.00    31729.83     5001.36
* 3        50.00        0.00    36625.78    14761.26
* 4       100.00        0.00    26104.32    42277.18
* 5       200.00        0.00    11420.88    43469.17
* 6       300.00        0.00    10115.39    41127.37
* 7       500.00        0.00     7630.73    36080.32
* 8       700.00        0.00     5351.74    31137.87
* 9       900.00        0.00     3245.42    26421.77
*10      1000.00        0.00     2246.37    24149.43
***************
```

Figure V.22. ZHAQF file generated by HABVD.

HBVDIN Program

I. INTRODUCTION

The HBVDIN program builds a HABVD options file. The following files are used along with the HBVDIN options file as input to HABVD: (1) a free-formatted file containing streamflow data or stream morphology parameters and, (2) a FISHFIL containing criteria curves of aquatic species or recreational activities created by the curve maintenance programs.

Refer to Appendix A (HABVD Options File Format) for file format for a HBVDIN file and for the format of the "Free-Formatted HABVD Streamflow or Stream Morphology Parameters File".

Figure V.23 contains a sample HABVD options file created by the HBVDIN program.

II. RUNNING HBVDIN

RHBVDIN,ZHABIN

ZHABIN=HABVD options file (output)

ENTER TWO TITLE LINES (80 CHARS. MAX PER LINE):

ENTER CHANNEL INDEX (0 IF NOT USED):

One channel index value may be assigned for the whole stream.

THE FOLLOWING IOC OPTIONS ARE FOR A HABVD DATA SET

The options are displayed and the user is asked to enter the IOC values. Typical settings for IOC values are 0=OFF and 1=ON. HABVD options are described in Table V.5 in the HABVD program documentation.

HOW MANY CURVE SETS (MAX 40):

ENTER THE -- CURVE SET ID NUMBERS (USUALLY 6 DIGIT):
WHERE --
NEGATIVE NUMBERS INDICATE CURVE SETS ARE INCLUDED IN THIS FILE.
POSITIVE NUMBERS INDICATE CURVE SETS WILL BE READ FROM A FISHFIL.

HOW MANY FLOWS OF INTEREST?

ENTER THE -- STREAMFLOWS OF INTEREST:

HABVD OPTIONS FILE CREATED.

```
SOLOMON RIVER BELOW GLEN ELDER DAM
STREAMFLOW DATA FROM USGS DISCHARGE MEASUREMENTS
IOC        0000000001000000000000000000000000
HEADER     3
CURVES     21112   21114   21115
QARD          7.00
QARD         25.00
QARD         50.00
QARD        100.00
QARD        200.00
QARD        300.00
QARD        500.00
QARD        700.00
QARD        900.00
QARD       1000.00
```

Figure V.23. Sample HABVD options file created with HBVDIN.

Criteria curves could be added to this file with an editor or created with GCURV and appended to this file between the CURVES and QARD lines (if GCURV is used, delete the TITLE line). These curve sets are then accessed by entering curve set ID numbers as negative numbers on the Curves line. Be sure to update the number of curves on the Header line if additional curve set ID numbers are added to the Curves line. Refer to Appendix A - "File Format for HABTAT Options File - CURVES Line" for more information.

The program adds zeros to the end of the IOC line to allow for future options in the HABVD program.

HQF2LT Program

I. INTRODUCTION

The HQF2LT program converts a habitat versus streamflow file to a file that is readable by LOTUS.

II. RUNNING HQF2LT

RHQF2LT,ZHAQF,ZOUT

ZHAQF=habitat vs. flow file (input)
ZOUT=LOTUS readable ZHAQF file (output)

Figure V.24 contains sample output from the HQF2LT program.

```
"UPPER SALMON RIVER, NEAR STANLEY, IDAHO
"ZHAQF FILE GENERATED BY HABTAT
"TOTAL AREA
"      DISCHARGE  AREA
* 1        8.00    22788.90
* 2       10.00    24395.06
* 3       20.00    29444.04
* 4       30.00    31747.52
* 5       40.00    33659.56
* 6       50.00    39436.34
* 7       60.00    42818.31
* 8       70.00    44512.37
* 9       80.00    45820.20
*10       90.00    47187.19
*11      100.00    48494.81
*12      110.00    49535.04
*13      120.00    50842.66
*14      130.00    51882.89
```

Figure V.24. Sample output from the HQF2LT Program.

LPTHQF Program

I. INTRODUCTION

The LPTHQF program is a habitat simulation review program to plot the habitat vs. flow functions - one species per page; 1-5 life stages.

The LPTHQFN program can be used to plot the habitat. vs. flow functions - one life stage per page (up to five ZHAQF files can be used as input to the LPTHQFN program).

II. RUNNING LPTHQF

RLPTHQF,ZHAQF,ZOUT

ZHAQF=habitat vs. flow file (input)
ZOUT=LPTHQF results (output)

__NOTE__: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

Figure V.25 contains sample output from the LPTHQF program.

```
DATE - 88/08/16.   UPPER SALMON RIVER, NEAR STANLEY, IDAHO                PROGRAM - LPTHQF
TIME - 09.22.02.   ZHAQF FILE GENERATED BY HABTAT                            PAGE -   3

PLOTTING EACH LIFE STAGE OF -

RAINBOW TROUT
    A    FRY
    B    JUVENILE
    C    ADULT
    D
    E
```

	Q	A	B	C	D	E
* 1	8.00	593.92	0.00	79.87		
* 2	10.00	385.61	0.00	101.70		
* 3	20.00	256.72	0.00	185.36		
* 4	30.00	76.00	207.60	259.73		
* 5	40.00	140.67	395.44	332.98		
* 6	50.00	418.61	495.20	432.46		
* 7	60.00	211.13	491.81	547.08		
* 8	70.00	65.73	691.26	660.58		
* 9	80.00	58.67	689.96	740.38		
*10	90.00	38.96	675.61	830.34		
*11	100.00	3.88	596.44	911.59		
*12	110.00	0.00	512.90	970.48		
*13	120.00	0.00	621.43	1054.90		
*14	130.00	0.00	728.64	1113.86		

Figure V.25. Sample output from the LPTHQF program.

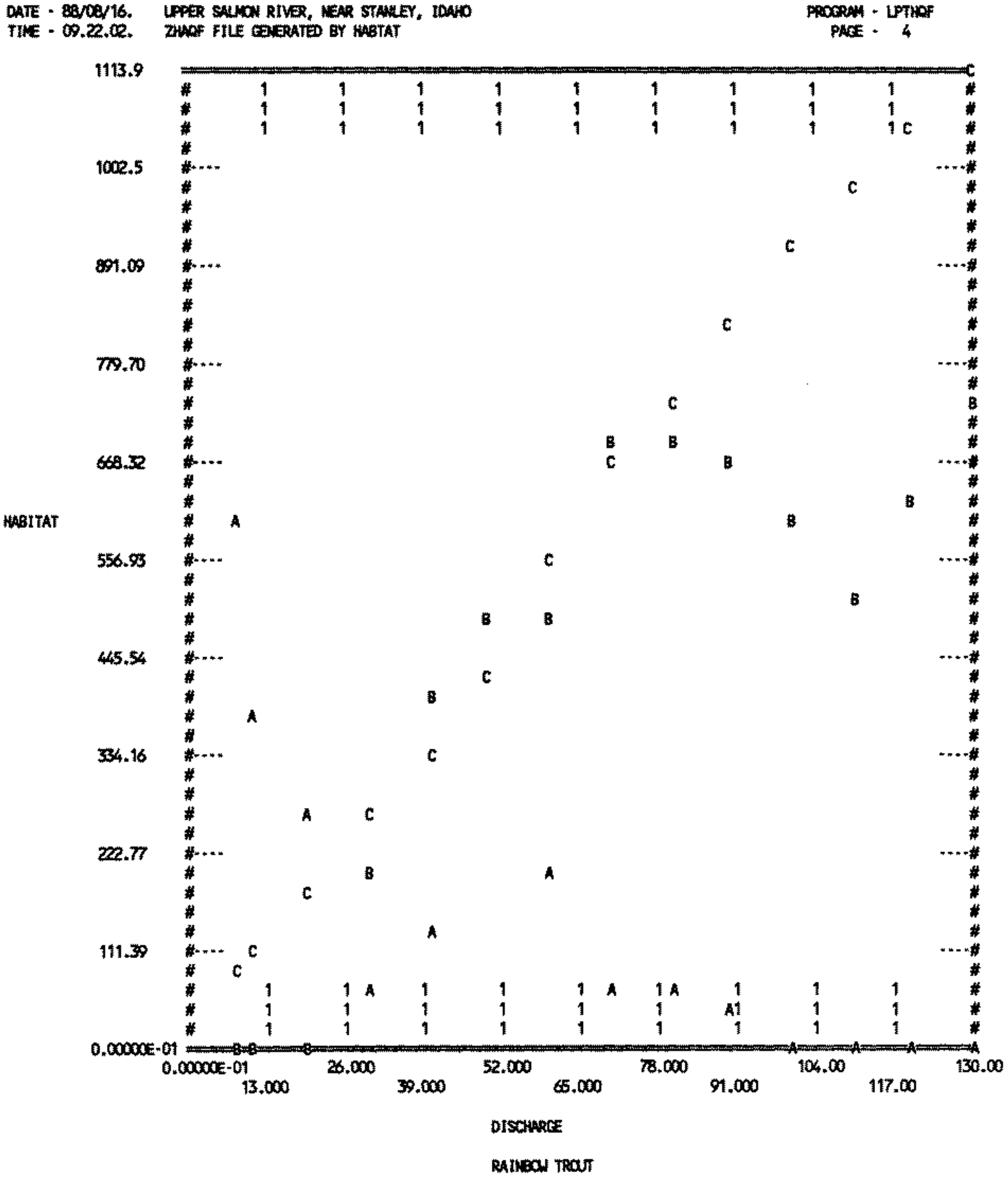


Figure V.25. (Concluded)

LPTHQFN Program

I. INTRODUCTION

The LPTHQFN program is a habitat simulation review program to plot the habitat vs. flow functions - one life stage per page (up to five ZHAQF files can be used as input). When more than one ZHAQF input file is specified, one curve from each file will be plotted on the same page.

The LPTHQF program can be used to plot the habitat. vs. flow functions - one species per page; 1-5 life stages (only one ZHAQF file is used as input to the LPTHQF program).

II. RUNNING LPTHQFN

RLPTHQN,ZOUT,ZHAQF1,ZHAQF2,ZHAQF3,ZHAQF4,ZHAQF5

ZOUT=LPTHQFN results (output)
ZHAQF(1-5)=one to five habitat vs. flow files (input)

<u>NOTE</u>: On the microcomputer, graphs may be printed to the screen or to the output file using character graphics (132 characters per line format). In order to use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

Figure V.26 contains sample output from the LPTHQFN program.

```
DATE - 88/08/16.   GRAPH OF HABITAT VS. FLOW (ZHAQF) FILES GENERATED          PROGRAM - LPTHQFN
TIME - 09.30.32.    BY HABTAT, HABTAM, AND HABTAV                                    PAGE - 1


                                  DATA SET A IS

                               UPPER SALMON RIVER, NEAR STANLEY, IDAHO
                               ZHAQF FILE GENERATED BY HABTAT


                                  DATA SET B IS

                               UPPER SALMON RIVER, NEAR STANLEY, IDAHO
                               ZHAQF FILE GENERATED BY HABTAM


                                  DATA SET C IS

                               UPPER SALMON RIVER, NEAR STANLEY, IDAHO
                               ZHAQF FILE GENERATED BY HABTAV
```

Figure V.26. Sample output from the LPTHQFN program.

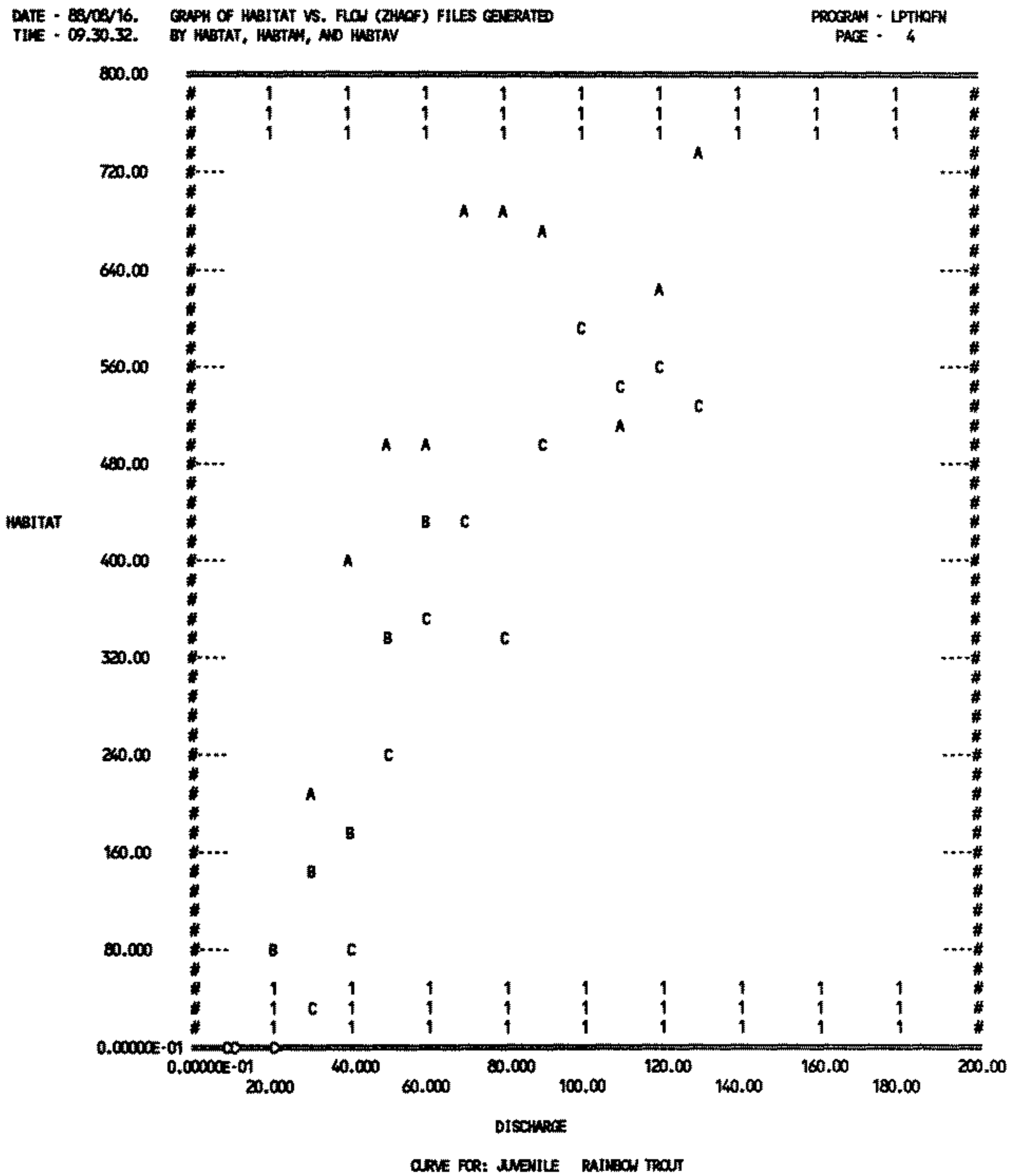


Figure V.26. (Concluded)

MAKAVD Program

I. INTRODUCTION

The MAKAVD program creates an input file for the AVDEPTH program from a WSP or IFG4 data set; water surface elevations are read from a TAPE4 (generated from the input data set) or entered interactively. When an IFG4 data set is converted to an AVDEPTH data set, each cross section is divided into five cells of equal width.

An AVDEPTH data set is a WSP type data set with at least two additional lines added to the top. The first line contains controls for the calculation and output when the AVDEPTH program is run; the other additional lines contain water surface elevations for the cross sections. Refer to Appendix A for the file format for an AVDEPTH data set and a sample AVDEPTH data set. This data set was created using an IFG4 data set and the TAPE4 generated from it.

II. RUNNING MAKAVD

RMAKAVD,ZIN,ZAVIN,TAPE4

ZIN=IFG4 or WSP data set (input)
ZAVIN=AVDEPTH data set (output)
TAPE4=unformatted flow data (optional input)

```
INPUT FILE FOR THE AVDEPTH PROGRAM BEING CREATED
WITH WITH THE TITLE OF-
```

The two title lines from the input data set will be displayed here.

```
WATER SURFACE ELEVATIONS WILL BE OBTAINED FROM:
   (1) A TAPE4 FILE
   (2) DIRECT ENTRY
CHOICE:
```

<u>If Option 1 is selected to read water surface elevations from a TAPE4 file</u>:

The TAPE4 must have been generated by the data set being used as input to MAKAVD.

```
ENTER PLOTTING CONTROL OPTION
   (0) NO PLOTTING
   (1) TO PLOT THE CROSS SECTIONS
CHOICE:
```

Entering "1" will generate a plot of the elevation vs. distance for each cross section.

ENTER NUMBER OF DEPTHS (5 MAX):

If depths are specified, the AVDEPTH program will calculate the total width of the stream that is as least as deep as the depth(s) specified.

ENTER THE --- DEPTHS:

The Velocity Calculation Control Option is automatically set to "1" when the water surface elevations are read from the TAPE4 generated from the input data set. This option generates data for the "Flow Factor" and "Velocity" columns in the AVDEPTH output for each cross section. A table of the "Summary of Average Parameters for Whole Reach" is also generated by AVDEPTH when the Velocity Control Option is on.

<u>If Option 2 is selected to directly enter water surface elevations</u>:

```
ENTER PLOTTING CONTROL OPTION
   (0) NO PLOTTING
   (1) TO PLOT THE CROSS SECTIONS
CHOICE:
```

Entering "1" will generate a plot of the elevation vs. distance for each cross section.

```
ENTER VELOCITY CALCULATION CONTROL OPTION
   (0) DO NOT CALCULATE VELOCITIES
   (1) CALCULATE VELOCITIES (DISCHARGES ON THE QARD LINES MUST MATCH
       WATER SURFACE ELEVATIONS ENTERED ON THE WSL LINES)
CHOICE:
```

This option generates data for the "Flow Factor" and "Velocity" columns in the AVDEPTH output for each cross section. A table of the "Summary of Average Parameters for Whole Reach" is also generated by AVDEPTH when the Velocity Control Option is on.

<u>If "0" is selected</u>:

ENTER NUMBER OF WATER SURFACE ELEVATIONS PER CROSS SECTION:

<u>If "1" is selected</u>:

The flows on the QARD lines are displayed and the following prompt appears:

```
DO YOU WANT TO
    (1) ENTER NEW QARD LINES
    (2) USE EXISTING
CHOICE:
```

If "1" is selected:

ENTER NUMBER OF QARD LINES:
ENTER --- FLOWS FOR THE QARD LINES:

ENTER NUMBER OF DEPTHS (5 MAX):

If depths are specified, the AVDEPTH program will calculate the total width of the stream that is as least as deep as the depth(s) specified.

ENTER THE --- DEPTHS:

ENTER THE --- ELEVATIONS FOR CROSS SECTION ---:

MODIOC Program

I. INTRODUCTION

The MODIOC program changes the IOC options in the following data sets (IFG4,WSP,MANSQ) and options files (HABTAT,HABTAM,HABTAV,HABVD,HABTAE).

JUST the option numbers are modified with the MODIOC program; not the associated lines (i.e., NOSE Line, CELL Line, etc.). For example, if MODIOC is used to set IOC(14)=2 in HABTAT, the user will not be prompted to enter the associated NOSE line. Likewise, if IOC(14) is changed from "2" to "0", the NOSE line is not removed. Also, ALL options must be re-entered when changing options using the MODIOC program. With the above considerations in mind, it may be easier to use an editor to change the appropriate option(s) and lines.

II. RUNNING MODIOC

RMODIOC,ZIN,ZOUT

ZIN=original data set (input)
ZOUT=new data set with modified options (output)

ID	DATA SET TYPE
1	HABTAT
2	HABTAV
3	HABTAM
4	IFG4
5	WSP
6	HABVD
7	MANSQ
8	HABTAE

ENTER DATA SET ID:

For example, if you wish to modify options in a WSP data set, enter "5" here. See note below for additional information on WSP options.

The options are displayed for the data set specified by the user. The user is asked to enter the IOC values.

NOTE: This is the only program where the user is prompted for the additional lines required when Options 1 or 7 are "on" in WSP (CTR1 and CTRF lines). Options 2,3, and 4 also require additional lines, but the user is not prompted for the required information, as these options are not normally used in instream flow studies. Refer to "Guide to the Application of the Water Surface Profile Computer Program" (U.S. Bureau of Reclamation 1968) for more information on the options.

OPTION 1=T IN WSP:

HOW MANY STATIONS FOR INCREMENTAL DISCHARGE (100 MAX):

ENTER THE --- PAIRS OF STATION SEQUENCE NUMBERS AND INCREMENTAL DISCHARGES:

The Station Sequence Number is the position of the cross section in the data set, i.e., 1=first station, 2=second station, etc.

OPTION 7=T IN WSP:

HOW IS THE ENERGY BALANCE TO BE CALCULATED?
1 - HARMONIC/ARITHMETIC COMBINATION (DEFAULT)
2 - GEOMETRIC MEAN
3 - HARMONIC MEAN
4 - HEC FRICTION LOSS FUNCTION
5 - ELLIPTICAL MEAN
6 - ARITHMETIC MEAN

ENTER CHOICE:

ENTER EXPANSION LOSS COEFFICIENT (MIN 0.0; MAX 1.0):

ENTER CONTRACTION LOSS COEFFICIENT (MIN 0.0; MAX 0.5):

SUMHQF Program

I. INTRODUCTION

The SUMHQF program sums conditional cover columns in a ZHAQF file into one habitat vs. flow figure for each life stage. SUMHQF is run when conditional cover curves were used as input to the habitat simulation programs. Up to five life stages can be grouped in each record (section).

II. RUNNING SUMHQF

RSUMHQF,ZHAQF,ZHAQFN

ZHAQF=habitat vs. flow file (input)
ZHAQFN=modified habitat vs. flow file with columns summed (output)

Figure V.27 contains a habitat vs. flow (ZHAQF) file that was generated by a habitat simulation program using conditional cover curves as input.

The results of running SUMHQF on this file and summing the life stages and grouping the life stages together is shown in Figure V.28.

The Species Line and Life Stage Line for the first record in the ZHAQF file is printed out. If the first record in the file contains "Total Area" information, that record is skipped as there is nothing to sum and no other information should be grouped with it.

EXAMPLE:

```
================================================================================
SPECIES NAME IS:  WINTER STEELHEAD - FRY
LIFE STAGE NAME IS:    NO COV      OHC        SM OBJ     LG OBJ       COMBO
================================================================================

DO YOU WANT TO SUM THESE LIFE STAGES?
     0)  TO SUM LIFE STAGES
     1)  TO LEAVE UNCHANGED
CHOICE:
```

If "0" is entered to "Sum Life Stages" -

ENTER NEW SPECIES NAME OR '*' TO LEAVE UNCHANGED (MAX 40 CHAR):

In this case, you would probably want to change the species name to "Winter Steelhead" versus "Winter Steelhead - Fry".

ENTER NEW LIFE STAGE NAME OR '*' TO USE ----- (MAX 10 CHAR):

The blank would contain the first life stage name from the record (NO COV in example above). In this example, you would probably want to change the life stage name to "Fry".

The following prompt would appear _after_ the first species record, BUT before the series of prompts for that record. Records are separated by a line of at least 10 astericks (**********).

DO YOU WANT THIS LIFE STAGE TO BE GROUPED
WITH THE PREVIOUS LIFE STAGE? (Y/N):

This allows grouping up to five life stages for one species into one record versus having separate records for each life stage of a species.

ALTMAR REACH OF SALMON RIVER, NEW YORK
COMPOSITE OF VELOCITIES AND SECTIONS AS ISLANDS
TOTAL AREA

	DISCHARGE	AREA
* 1	25.00	155830.02
* 2	50.00	177486.70
* 3	100.00	196136.69
* 4	200.00	216444.92
* 5	350.00	255153.21
* 6	500.00	275933.49
* 7	750.00	290595.31
* 8	1000.00	299066.76
* 9	1500.00	314227.33
*10	2000.00	324867.37
*11	3000.00	336215.01
*12	4000.00	342061.39
*13	6000.00	353205.87

****

WINTER STEELHEAD - FRY

	DISCHARGE	NO COV	OHC	SM OBJ	LG OBJ	COMBO
* 1	25.00	36804.74	16306.65	.00	21789.52	25244.11
* 2	50.00	42488.03	29452.52	77.77	27011.82	30049.86
* 3	100.00	49470.16	52286.84	497.36	36938.97	38996.91
* 4	200.00	57006.86	75435.19	1679.59	54869.38	55732.63
* 5	350.00	53623.63	72839.97	11397.30	72371.30	73694.66
* 6	500.00	57625.58	80676.66	13611.55	86036.53	85775.26
* 7	750.00	42776.20	76005.57	17616.62	97044.67	88448.59
* 8	1000.00	44224.03	66899.98	17214.27	99281.85	87951.39
* 9	1500.00	33173.15	51386.66	11574.54	93601.19	84916.85
*10	2000.00	30239.80	45081.72	9715.15	89563.80	78886.59
*11	3000.00	41442.36	52683.58	8968.61	99457.46	85294.71
*12	4000.00	40432.90	52567.05	9091.70	91380.50	74053.72
*13	6000.00	38948.23	52587.85	9177.92	75138.07	53160.54

****

WINTER STEELHEAD - JUVENILE

	DISCHARGE	NO COV	OHC	SM OBJ	LG OBJ
* 1	25.00	8571.75	8400.63	8299.07	15146.13
* 2	50.00	9510.26	9713.29	10403.51	15011.19
* 3	100.00	10862.79	12096.84	12639.01	13434.02
* 4	200.00	11115.56	17193.59	13461.92	9264.43
* 5	350.00	8391.54	20679.94	13209.33	7143.46
* 6	500.00	7582.15	22703.33	15003.20	5988.42
* 7	750.00	10476.25	33439.54	17078.55	5783.53
* 8	1000.00	16027.40	43305.33	18235.65	5270.12
* 9	1500.00	19676.19	47712.90	16389.55	5490.25
*10	2000.00	17830.52	47498.62	14661.03	4733.12
*11	3000.00	367.64	27747.65	10016.22	1064.70
*12	4000.00	314.97	23107.39	9086.60	481.36
*13	6000.00	312.27	19566.01	7995.55	183.39

****

WINTER STEELHEAD - ADULT

	DISCHARGE	NO COV	OHC	SM OBJ	LG OBJ	COMBO
* 1	25.00	43608.82	6196.79	25572.92	68915.12	56589.43
* 2	50.00	52224.68	10751.89	30262.63	73718.21	60120.13
* 3	100.00	61181.60	16278.15	34279.03	72336.25	59780.00
* 4	200.00	66805.23	20009.82	35725.55	64934.86	52818.65
* 5	350.00	70469.46	18052.48	39403.82	64219.78	54584.10
* 6	500.00	72489.76	17356.70	42966.28	64386.38	55091.62
* 7	750.00	70860.33	18509.72	47208.83	50221.78	45213.51
* 8	1000.00	64313.60	15762.86	48012.24	39843.04	38723.45
* 9	1500.00	56186.58	11580.82	48662.42	30564.08	34261.80
*10	2000.00	53859.44	11422.69	47223.98	29356.40	33701.92
*11	3000.00	51531.37	9654.18	42808.11	34230.58	30885.99
*12	4000.00	50553.59	9889.69	41964.97	33305.82	30155.11
*13	6000.00	49788.69	9994.45	43444.38	32462.49	29209.57

****

Figure V.27. ZHAQF file generated using Conditional Cover Curves.

ALTMAR REACH OF SALMON RIVER, NEW YORK
COMPOSITE OF VELOCITIES AND SECTIONS AS ISLANDS
TOTAL AREA

	DISCHARGE	AREA
* 1	25.00	155830.02
* 2	50.00	177486.70
* 3	100.00	196136.69
* 4	200.00	216444.92
* 5	350.00	255153.21
* 6	500.00	275933.49
* 7	750.00	290595.31
* 8	1000.00	299066.76
* 9	1500.00	314227.33
*10	2000.00	324867.37
*11	3000.00	336215.01
*12	4000.00	342061.39
*13	6000.00	353205.87

****

WINTER STEELHEAD

	DISCHARGE	FRY	JUVENILE	ADULT
* 1	25.00	100145.02	40417.58	200883.09
* 2	50.00	129080.00	44638.25	227077.53
* 3	100.00	178190.23	49032.66	243855.03
* 4	200.00	244723.64	51035.50	240294.09
* 5	350.00	283926.84	49424.27	246729.62
* 6	500.00	323725.56	51277.10	252290.73
* 7	750.00	321891.66	66777.87	232014.17
* 8	1000.00	315571.50	82838.49	206655.20
* 9	1500.00	274652.37	89268.89	181255.70
*10	2000.00	253487.06	84723.29	175564.44
*11	3000.00	287846.72	39196.21	169110.22
*12	4000.00	267525.87	32990.32	165869.17
*13	6000.00	229012.59	28057.22	164899.56

****

Figure V.28. ZHAQF file with life stages summed using SUMHQF.

VI. EFFECTIVE HABITAT ANALYSIS PROGRAMS

INTRODUCTION

The effective habitat analysis programs allow the user to compare the conditions in a specific cell at either alternative flows or for alternative species/life stages. The program to perform this analysis is HABEF which stands for effective habitat given a range of streamflows.

The HABEF program has the following options:

- perform an analysis combining the habitat for two life stages or species,
- determine the competition between two species or life stages,
- determine the minimum habitat available for a life stage subjected to two flows,
- determine the maximum habitat available for a life stage subjected to two flows,
- do an effective spawning analysis, and
- do a stranding index analysis.

The HABEF program should be not confused with the effective habitat programs that are part of the times series library of programs (TSLIB). Refer to the HABEF program documentation for more information on this program.

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
HABEF	**RHABEF**	Effective Habitat Analysis	Compares two ZHCF files created when IOC(13)=1 in HABTAT, HABTAV, or HABTAE. Comparisons available are: 1) Union of life stage 2) Minimum WUA 3) Competition analysis 4) Maximum WUA 5) Minimum life stage 6) Maximum life stage 7) Effective spawning analysis 8) Stranding index analysis **RHABEF,ZHCF1,ZHCF2,ZOUT,ZEFTBL** **ZHCF1**=unformatted cell areas and cell weighted usable areas (input) **ZHCF2**=unformatted cell areas and cell weighted usable areas (input) **ZOUT**=HABEF results (output) **ZEFTBL**=file similar to a ZHAQF file when Options 1,3,5, or 6 are selected; two-flow habitat table when Option 2,4,7, or 8 is selected. (output)

LISTING INFORMATION FROM A ZHCF FILE

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
LSTHCF	RLSTHCF	ZHCF File Listing	Lists the contents of a ZHCF file with various options. These options include: listing the title and species name, creating a file with the habitat vs. flow relationship (ZHAQF), determining the accumulative distribution of the composite suitability of use factors, and the listing of all cell factors. **RLSTHCF,ZHCF,ZOUT,ZCEL,ZHAQF** **ZHCF**=unformatted cell areas and cell weighted usable areas (input) **ZOUT**=accumulative distribution of composite suitability of use factors (output) **ZCEL**=cell factors file (output) **ZHAQF**=habitat vs. flow file (output)
LSTCEL	RLSTCEL	ZHCF File Listing	Lists the suitability of use factors for each cell in a pattern resembling a map. This allows for the comparison of factors in adjacent cells and how the factors for a cell vary with discharge. A "map" for each cross section is generated. **RLSTCEL,ZHCF,TAPE3,ZOUT** **ZHCF**=unformatted cell areas and cell weighted usable areas (input) **TAPE3**=unformatted cross section and reach data (input) **ZOUT**=LSTCEL results (output)

MISCELLANEOUS ZHCF FILE PROGRAMS

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
EXTCF	**REXTCF**	ZHCF File -- Miscellaneous	Creates an input file for the PLOTCF program which plots composite suitability weighting factors. **REXTCF,TAPE3,TAPE4,ZHCF,ZCF** **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input) **ZHCF**=unformatted file with cell areas and cell weighted usable areas (input) **ZCF**=composite suitability weighting factors data (output)
PLOTCF	**RPLOTCF**	ZHCF File -- Miscellaneous	Plots the composite suitability weighting factors file (ZCF) created by the EXTCF program. This program is only available on the micro. The microcomputer must have the capability to display CGA (640 x 200) graphics. **RPLOTCF,ZCF** **ZCF**=composite suitability weighting factors data (input)
TRNHCF	**RTRNHCF**	ZHCF File -- Miscellaneous	Converts an unformatted ZHCF file to a formatted ZHCF file; or converts a formatted ZHCF file to an unformatted ZHCF file. **RTRNHCF,ZHCF,ZHCFN** **ZHCF**=unformatted or formatted file of cell areas and cell weighted usable areas (input) **ZHCFN**=new ZHCF file that is either formatted or unformatted depending on whether the input file was formatted or unformatted (output)

MANIPULATING A ZEFTBL FILE

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
MKEHQF	**RMKEHQF**	ZEFTBL File Manipuation	Creates two habitat vs. flow (ZHAQF) files from the two-flow habitat table (ZEFTBL file) created by HABEF when Option 2,4,7, or 8 is selected. **RMKEHQF,ZEFTBL,ZHAQF1,ZHAQF2** **ZEFTBL**=two-flow habitat table (input) **ZHAQF1**=habitat vs. flow file with up to five columns per "species equivalent" section (output) **ZHAQF2**=habitat vs. flow file with one column per "species equivalent" section (output)
MRGEFT	**RMRGEFT**	ZEFTBL File Manipulation	Merges two two-flow habitat tables (ZEFTBL files), created by HABEF when Option 2,4,7, or 8 is selected. **RMRGEFT,ZEFTBL1,ZEFTBL2,ZEFTBLN,ZOUT** **ZEFTBL1**=two-flow habitat table (input) **ZEFTBL2**=two-flow habitat table (input) **ZEFTBLN**=new ZEFTBL file (output) **ZOUT**=matrix table of the combined ZEFTBL files (output)

EXTCF Program

I. INTRODUCTION

The EXTCF program creates an input file for the PLOTCF program which plots composite suitability weighting factors. This allows one to examine the composite habitat suitability index for each cell of each cross section at each simulated flow for a single life stage.

The PLOTCF program is only available on the microcomputer. In order to run PLOTCF, the microcomputer must have the capability to display CGA (640 x 200 graphics).

Input to EXTCF is a TAPE3 containing cross section and reach data and a TAPE4 containing flow data; these two files are output from the hydraulic simulation process and were used as input to the habitat simulation programs HABTAT, HABTAV, or HABTAE. The ZHCF file is created by setting IOC(13)=1 in HABTAT, HABTAV, or HABTAE.

II. RUNNING EXTCF

REXTCF,TAPE3,TAPE4,ZHCF,ZCF

TAPE3=unformatted cross section and reach data (input)
TAPE4=unformatted flow data (input)
ZHCF=unformatted cell areas and cell weighted usable areas (input)
ZCF=composite suitability weighting factors data (output)

HABEF Program

I. INTRODUCTION

The HABEF program calculates the physical habitat considering the conditions at two streamflows and/or for two life stages or species of fish. The program uses two ZHCF files created by the HABTAT, HABTAV, or HABTAE programs, when IOC(13)=1, as input. In some cases, the second ZHCF file is a copy of the first. In other cases the files are for different life stages for the same species or, they may be for different species.

The information in each ZHCF file consists of information for each cell. The basic equation used in HABTAT, HABTAV, and HABTAE is that the usability of a cell, i, is given by the equation

$$WUA(i) = A(i) * CF(i)$$

where CF is some function of the velocity, depth, and the channel index for the cell. The information written to the ZHCF file consists of A(i) and CF(i) for each cell used in the physical habitat simulation.

The Weighted Usable Area (WUA) term as used in HABEF is defined by the equation

$$WUA = \sum_{i=1}^{ncell} CF_i \quad A_i$$

where CF is the suitability factor based on velocity, depth, and a channel index, and A is the area of a wet cell. The usable area (UA) is

$$UA = \sum_{i=1}^{ncell} \begin{matrix} IF(CF \geq 0.001)\ UA_i = A_i \\ IF(CF < 0.001)\ UA_i = 0.0 \end{matrix}$$

Options in the HABEF program are:

1. UNION OF LIFE STAGE 1 WITH LIFE STAGE 2
2. STREAMFLOW VARIATION ANALYSIS (MINIMUM WUA)
3. COMPETITION ANALYSIS
4. STREAMFLOW VARIATION ANALYSIS (MAXIMUM WUA)
5. MINIMUM OF LIFE STAGE 1 AND LIFE STAGE 2
6. MAXIMUM OF LIFE STAGE 2 AND LIFE STAGE 2
7. EFFECTIVE SPAWNING ANALYSIS
8. STRANDING INDEX ANALYSIS

OPTION	ANALYSIS
1	Union of two life stages or species--useful when one is interested in the total habitat for a combination of species (i.e., brown and rainbow trout). In contrast, Option 3 (the competition analysis) would show where brown and rainbow trout "compete" for space.
2	Streamflow variation analysis where the minimum weighted usable area for each cell is a comparison of the cell WUA's in each ZHCF file. Every flow in the first ZHCF file is matched with every flow in the second ZHCF file. Option 2 is useful when there are rapid changes in streamflow, i.e., hydropeaking. Option 5 is similar to Option 2 except for the matching of streamflows.
3	Competition between species or life stages, i.e., would show where brown and rainbow trout "compete" for space.
4	Streamflow variation analysis where the maximum weighted usable area for each cell is a comparison of the cell WUA's in each ZHCF file. Every flow in the first ZHCF file is compared to every flow in the second ZHCF file. Option 4 is useful when there are slow changes in streamflow, i.e., normal changes due to dry vs. rainy season such as is typical for fall spawning in the northwestern U.S.
5	Minimum WUA analysis which is similar to Option 2 except that the first flow in the first ZHCF file is compared only to the first flow in the second ZHCF file, the second to the second, and so forth through both files.
6	Maximum WUA analysis which is similar to Option 4 except that the first flow in the first ZHCF file is compared to the first flow in the second ZHCF file, the second to the second, and so forth through both files.
7	Effective spawning analysis is functionally similar to Option 2 except that if the cell WUA in the second file is greater then zero, then the WUA on the first is considered "effective"; but if the area in the second is zero, then the area on the first is considered "ineffective" and made equal to zero.
8	Stranding index analysis is functionally similar to Option 7 except the results on the second ZHCF file must indicate where stranding would not occur. In other words, the species criteria used in HABTAT to generate the second ZHCF file should be for non-stranding. One possibility is that the suitability index for velocity and channel index would be 1.0 for all velocities and channel indexes. For depth, the index might be 0.0 for depths less than some minimum, and 1.0 for depths greater than the minimum. The user may have other approaches.

II. RUNNING HABEF

RHABEF,ZHCF1,ZHCF2,ZOUT,ZEFTBL

ZHCF1=unformatted cell areas and cell weighted usable areas (input)
ZHCF2=unformatted cell areas and cell weighted usable areas (input)
ZOUT=HABEF results (output)
ZEFTBL=file similar to a ZHAQF file when Option 1,3,5, or 6 is selected; two-flow habitat table when Option 2, 4, 7, or 8 is selected (output)

The same TAPE3 (containing stream geometry data) must have been used as input to the HABTAT, HABTAV, or HABTAE programs when generating the ZHCF files. However, the TP4 (containing flow data) used as input to HABTAT or HABTAV (TAPE4 for HABTAE) does not have to be the same. This allows for the different analysis available in the HABEF program.

The title lines and the name of the species and life stages in the files are displayed.

JOB TITLE WILL BE SAME AS FOR SET 1, ENTER 1 TO CHANGE
ENTER 0 FOR NO CHANGE IN TITLE:

If "1" is entered to change the title:

ENTER TWO LINE TITLE FOR JOB

The HABEF options will be displayed and the user is asked to enter the number for the option desired.

ENTER TOTAL REACH LENGTH (USE 1000 IF UNKNOWN)
(MUST NOT BE ZERO):

Reach length information is not contained in ZHCF files, as they contain information on individual "cells"; consequently, the total reach length must be supplied by the user.

UNION ANALYSIS - Option 1

The first option in HABEF is the union of two life stages or species. The option is illustrated in Figure VI.1. The union may be the union of two life stages of the same species (i.e., fry and juveniles) or it may be the union of two species (i.e., rainbow and brown trout).

An example of the results obtained for brown and rainbow trout is given in Figure VI.2. A ZEFTBL file (Figure VI.3) which is similar to a ZHAQF file is also produced.

A union analysis will result in a physical habitat value for a given streamflow greater than the highest of the two independent areas, but less than the sum of the two.

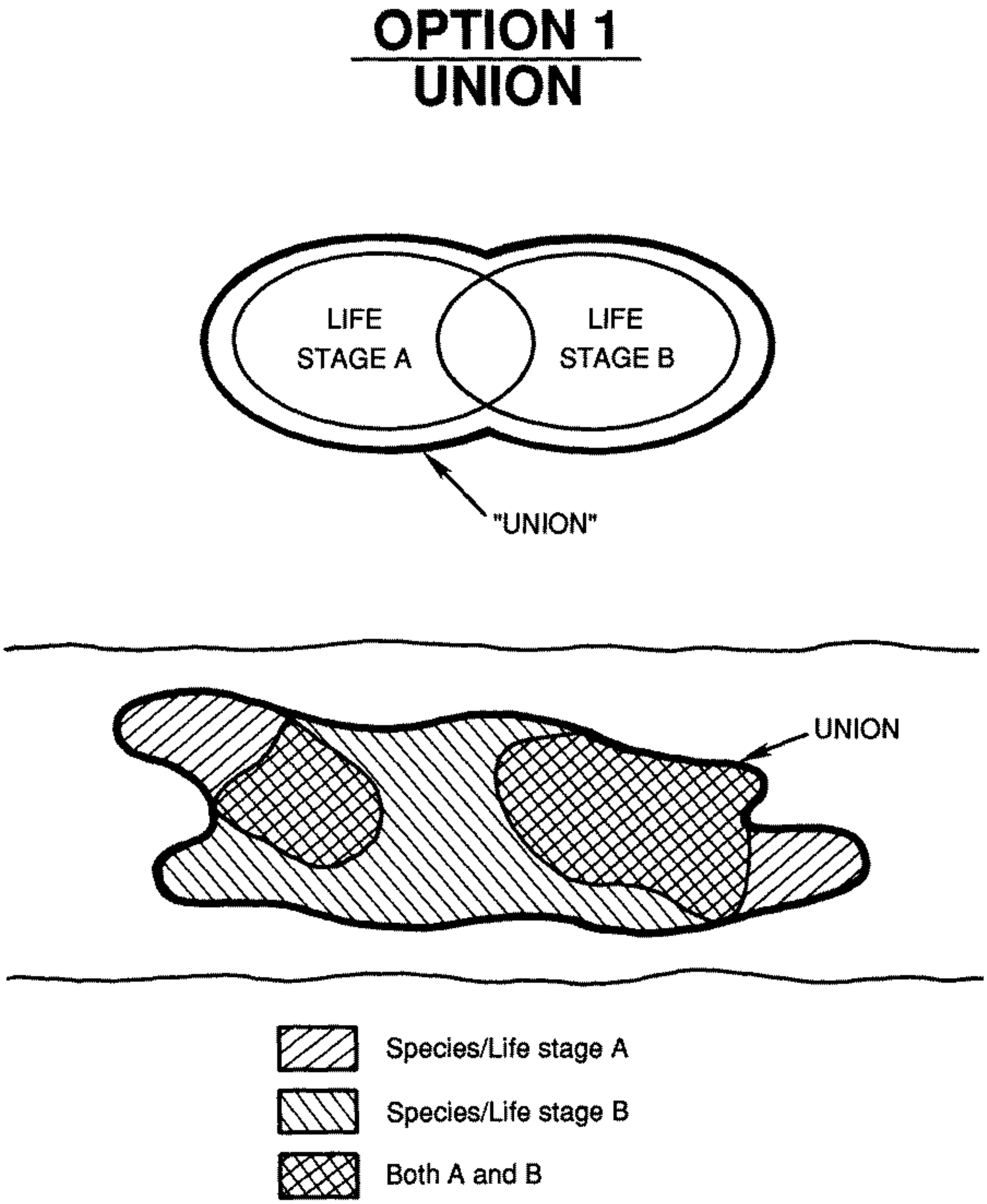


Figure VI.1. Conceptual illustration of Option 1 in HABEF.

WILLIAMS FORK RIVER BELOW LEAH, COLORADO
UNION ANALYSIS OF ADULT BROWN AND RAINBOW TROUT

DATA SET 1 IS
CURVE NUMBER = 11102
SPECIES = RAINBOW TROUT

LIFE STAGE = ADULT

DATA SET 2 IS
CURVE NUMBER = 11302
SPECIES = BROWN TROUT

LIFE STAGE = ADULT

DISCHARGE	TOTAL AREA	RAINBOWS SET USABLE AREA USED	RAINBOWS SET USABLE AREA WEIGHTED	BROWNS SET USABLE AREA USED	BROWNS SET USABLE AREA WEIGHTED	UNION WUA
8.00	7653.09	6849.35	606.95	2177.00	912.28	1246.55
15.00	8738.55	7937.63	960.78	2848.00	1338.09	1800.91
25.00	10142.23	9258.57	1375.67	3736.55	1620.19	2238.97
40.00	11578.09	10717.16	1911.45	4826.55	1674.29	2616.40
60.00	13963.16	13038.93	2184.67	6538.35	1700.95	2764.80
80.00	15386.44	14486.64	2277.22	7474.05	1761.84	2919.50
100.00	16289.14	15338.07	2182.08	8016.60	1713.09	2862.27
125.00	17096.79	15368.47	1906.92	9394.60	1620.83	2645.85
150.00	18035.44	14273.86	1631.74	10183.40	1606.24	2491.62
175.00	18837.84	13524.95	1499.27	10811.40	1633.98	2477.96
200.00	19036.68	12700.68	1387.59	11466.70	1601.41	2412.67
250.00	19334.14	10764.13	1183.26	13459.45	1559.76	2199.45
300.00	19376.58	8259.38	1050.24	14618.20	1582.36	2101.06
400.00	19450.99	5020.93	957.88	17385.15	1530.64	1937.77
500.00	19512.23	4029.19	872.24	17953.70	1425.52	1768.46
750.00	19692.03	2649.52	624.39	13767.52	1074.92	1329.74
1000.00	19808.23	1448.25	420.80	10081.05	842.80	1023.65

END OF JOB

Figure VI.2. Sample output from HABEF when Option 1 is selected to obtain the union of Brown and Rainbow Trout habitat space.

```
WILLIAMS FORK RIVER BELOW LEAH, COLORADO
UNION ANALYSIS OF ADULT BROWN AND RAINBOW TROUT
UNION OF ADULT BROWN AND RAINBOW TROUT
      DISCHARGE  RAINBOWS    BROWNS       UNION
* 1       8.00     606.95     912.28     1246.55
* 2      15.00     960.78    1338.09     1800.91
* 3      25.00    1375.67    1620.19     2238.97
* 4      40.00    1911.45    1674.29     2616.40
* 5      60.00    2184.67    1700.95     2764.80
* 6      80.00    2277.22    1761.84     2919.50
* 7     100.00    2182.08    1713.09     2862.27
* 8     125.00    1906.92    1620.83     2645.85
* 9     150.00    1631.74    1606.24     2491.62
*10     175.00    1499.27    1633.98     2477.96
*11     200.00    1387.59    1601.41     2412.67
*12     250.00    1183.26    1559.76     2199.45
*13     300.00    1050.24    1582.36     2101.06
*14     400.00     957.88    1530.64     1937.77
*15     500.00     872.24    1425.52     1768.46
*16     750.00     624.39    1074.92     1329.74
*17    1000.00     420.80     842.80     1023.65
***************
```

Figure VI.3. The EFTBL file written by HABEF when Option 1 is selected.

COMPETITION ANALYSIS - Option 3

Of considerable interest is the competition of two life stages or two species for the same space. An analysis of habitat competition can be done using Option 3 in HABEF.

The concept associated with competition analysis using Option 3 is shown in Figure VI.4. Most likely, two species will compete for some of the habitat, and in other places have the habitat all to themselves (assuming two species are in the stream). In the competition habitat areas, there are places where one species/life stage is better suited than the other; and other places where the converse is true. Option 3 gives information on both of these possibilities as is illustrated in Figure VI.5.

Figure VI.6 contains the summary matrix table written to the HABEF output file when Option 3 is selected. The total Weighted Usable Area (WUA) is the same as the WUA produced by HABTAT; the dominant WUA is the WUA which is used by one species only, plus the area subject to competition in which this species is dominant over the other. The summary results are also written to an EFTBL file in a format similar to a ZHAQF file (Figure VI.7).

A comparison of the concepts of Option 1 and Option 3 is shown in Figure VI.8. These two options use the same information but do very different analyses. The two options compare the results from a HABTAT analysis for the same streamflow. The file comparisons are shown in Figure VI.9.

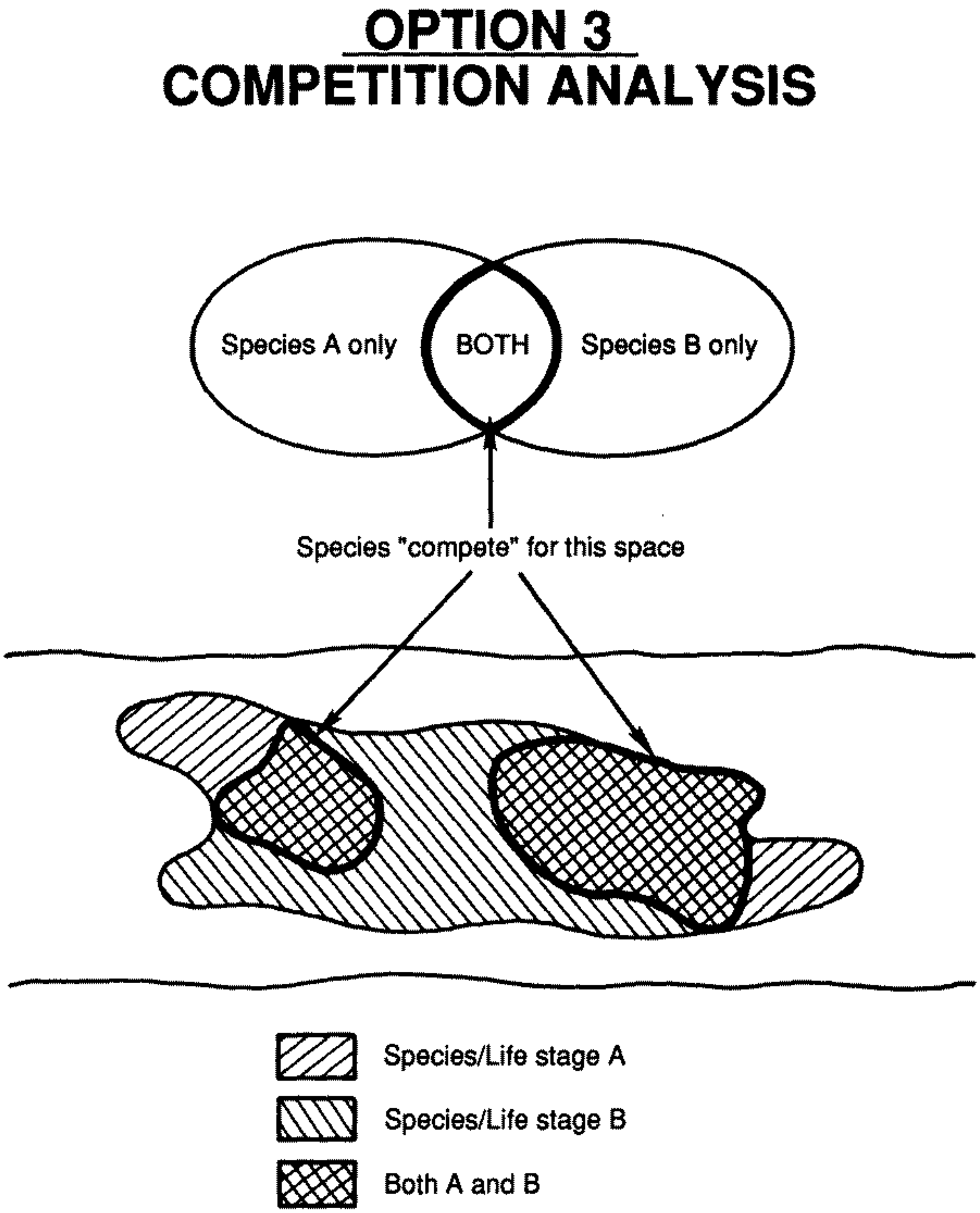


Figure VI.4. Conceptual illustration of Option 3 in HABEF.

```
DATE - 88/10/11.          WILLIAMS FORK RIVER BELOW LEAH, COLORADO                      PROGRAM - HABEF
TIME - 09.17.53.        COMPETITION ANALYSIS OF BROWN TROUT WITH RAINBOW TROUT                PAGE -   2

   DATA SET 1 IS                                                            DATA SET 2 IS
    CURVE NUMBER =   11102                                               CURVE NUMBER =   11302
         SPECIES = RAINBOW TROUT                                              SPECIES = BROWN TROUT

              LIFE STAGE = ADULT                                                 LIFE STAGE = ADULT

        DISCHARGE =       8.00  TOTAL AREA =      7653.1
       SPECIES 1 ONLY- USABLE =      5267.4  WT. USABLE =        328.6
       SPECIES 2 ONLY- USABLE =       595.0  WT. USABLE =        284.1
         BOTH SPECIES- USABLE  =      1582.0
       WT. USABLE FOR 1 WITH BOTH-      278.3     WORTH FOR 1 GREATER THAN 2-       17.0
       WT. USABLE FOR 2 WITH BOTH-      628.2     WORTH FOR 2 GREATER THAN 1-      616.8
       SPECIES 1 OR 2 USABLE =      7444.4                  EQUAL WORTH-         0.0

        DISCHARGE =      15.00  TOTAL AREA =      8738.6
       SPECIES 1 ONLY- USABLE =      5747.6  WT. USABLE =        442.5
       SPECIES 2 ONLY- USABLE =       658.0  WT. USABLE =        331.1
         BOTH SPECIES- USABLE  =      2190.0
       WT. USABLE FOR 1 WITH BOTH-      518.3     WORTH FOR 1 GREATER THAN 2-       47.9
       WT. USABLE FOR 2 WITH BOTH-     1007.0     WORTH FOR 2 GREATER THAN 1-      979.4
       SPECIES 1 OR 2 USABLE =      8595.6                  EQUAL WORTH-         0.0

        DISCHARGE =      25.00  TOTAL AREA =     10142.2
       SPECIES 1 ONLY- USABLE =      6243.0  WT. USABLE =        499.6
       SPECIES 2 ONLY- USABLE =       721.0  WT. USABLE =        377.7
         BOTH SPECIES- USABLE  =      3015.6
       WT. USABLE FOR 1 WITH BOTH-      876.0     WORTH FOR 1 GREATER THAN 2-      430.3
       WT. USABLE FOR 2 WITH BOTH-     1242.5     WORTH FOR 2 GREATER THAN 1-      931.4
       SPECIES 1 OR 2 USABLE =      9979.6                  EQUAL WORTH-         0.0

        DISCHARGE =      40.00  TOTAL AREA =     11578.1
       SPECIES 1 ONLY- USABLE =      6611.6  WT. USABLE =        515.7
       SPECIES 2 ONLY- USABLE =       721.0  WT. USABLE =        430.7
         BOTH SPECIES- USABLE  =      4105.5
       WT. USABLE FOR 1 WITH BOTH-     1395.8     WORTH FOR 1 GREATER THAN 2-      882.7
       WT. USABLE FOR 2 WITH BOTH-     1243.5     WORTH FOR 2 GREATER THAN 1-      787.4
       SPECIES 1 OR 2 USABLE =     11438.2                  EQUAL WORTH-         0.0

        DISCHARGE =      60.00  TOTAL AREA =     13963.2
       SPECIES 1 ONLY- USABLE =      7282.4  WT. USABLE =        484.5
       SPECIES 2 ONLY- USABLE =       781.8  WT. USABLE =        444.8
         BOTH SPECIES- USABLE  =      5756.5
       WT. USABLE FOR 1 WITH BOTH-     1700.1     WORTH FOR 1 GREATER THAN 2-     1241.0
       WT. USABLE FOR 2 WITH BOTH-     1256.2     WORTH FOR 2 GREATER THAN 1-      594.5
       SPECIES 1 OR 2 USABLE =     13820.7                  EQUAL WORTH-         0.0
```

Figure VI.5. Sample output from HABEF when Option 3 is selected.

DATE - 88/10/11. WILLIAMS FORK RIVER BELOW LEAH, COLORADO PROGRAM - HABEF
TIME - 09.17.53. COMPETITION ANALYSIS OF BROWN TROUT WITH RAINBOW TROUT PAGE - 5

SUMMARY OF COMPETITION ANALYSIS -

DISCHARGE	TOTAL WUA RAINBOWS	TOTAL WUA BROWNS	DOMINATE WUA RAINBOWS	DOMINATE WUA BROWNS
8.00	606.93	912.28	345.65	900.87
15.00	960.78	1338.09	490.45	1310.45
25.00	1375.63	1620.19	929.87	1309.06
40.00	1911.45	1674.20	1398.37	1218.03
60.00	2184.64	1700.95	1725.51	1039.26
80.00	2277.22	1761.84	1819.29	1100.21
100.00	2182.08	1713.09	1767.78	1094.49
125.00	1906.92	1620.82	1582.11	1063.74
150.00	1631.60	1606.24	1332.75	1158.84
175.00	1499.22	1633.98	1149.22	1328.71
200.00	1387.59	1601.41	1061.31	1351.35
250.00	1183.26	1559.76	889.54	1309.90
300.00	1050.22	1582.36	756.87	1344.19
400.00	957.88	1530.60	675.06	1262.67
500.00	872.18	1425.52	614.70	1153.76
750.00	624.39	1074.86	441.77	887.90
1000.00	420.80	842.73	299.26	724.32

END OF JOB

Figure VI.6. Summary table written to output file by HABEF when Option 3 is selected.

WILLIAMS FORK RIVER BELOW LEAH, COLORADO
COMPETITION ANALYSIS OF BROWN TROUT WITH RAINBOW TROUT
COMPETITION ANALYSIS - TOTAL THEN DOMINATE

	DISCHARGE	RAINBOWS	BROWNS	RAINBOWS	BROWNS
* 1	8.00	606.93	912.28	345.65	900.87
* 2	15.00	960.78	1338.09	490.45	1310.45
* 3	25.00	1375.63	1620.19	929.87	1309.06
* 4	40.00	1911.45	1674.20	1398.37	1218.03
* 5	60.00	2184.64	1700.95	1725.51	1039.26
* 6	80.00	2277.22	1761.84	1819.29	1100.21
* 7	100.00	2182.08	1713.09	1767.78	1094.49
* 8	125.00	1906.92	1620.82	1582.11	1063.74
* 9	150.00	1631.60	1606.24	1332.75	1158.84
*10	175.00	1499.22	1633.98	1149.22	1328.71
*11	200.00	1387.59	1601.41	1061.31	1351.35
*12	250.00	1183.26	1559.76	889.54	1309.90
*13	300.00	1050.22	1582.36	756.87	1344.19
*14	400.00	957.88	1530.60	675.06	1262.67
*15	500.00	872.18	1425.52	614.70	1153.76
*16	750.00	624.39	1074.86	441.77	887.90
*17	1000.00	420.80	842.73	299.26	724.32

****

Figure VI.7. The EFTBL file written by HABEF when Option 3 is selected.

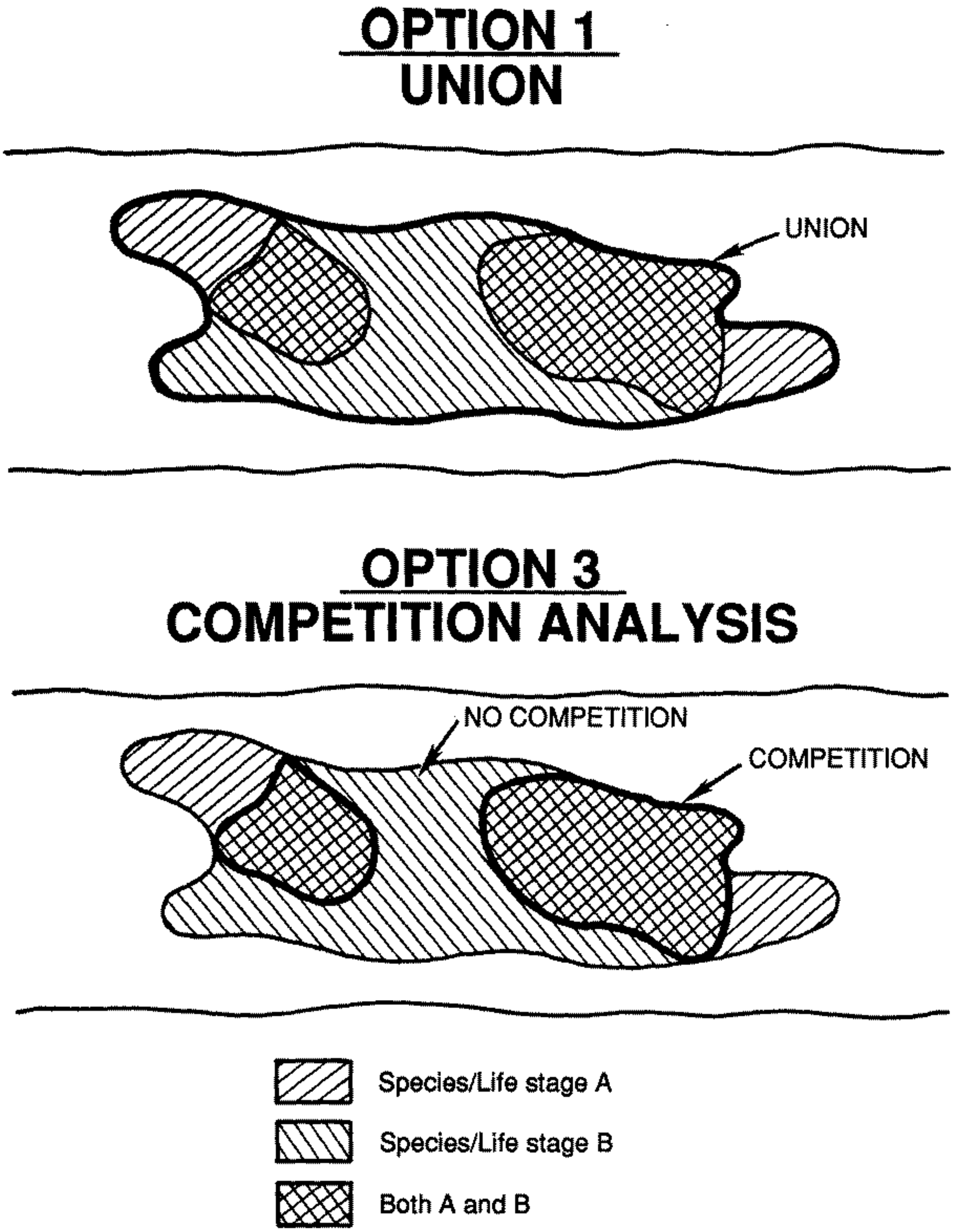


Figure VI.8. Comparison of the concepts associated with Options 1 and 3 in HABEF.

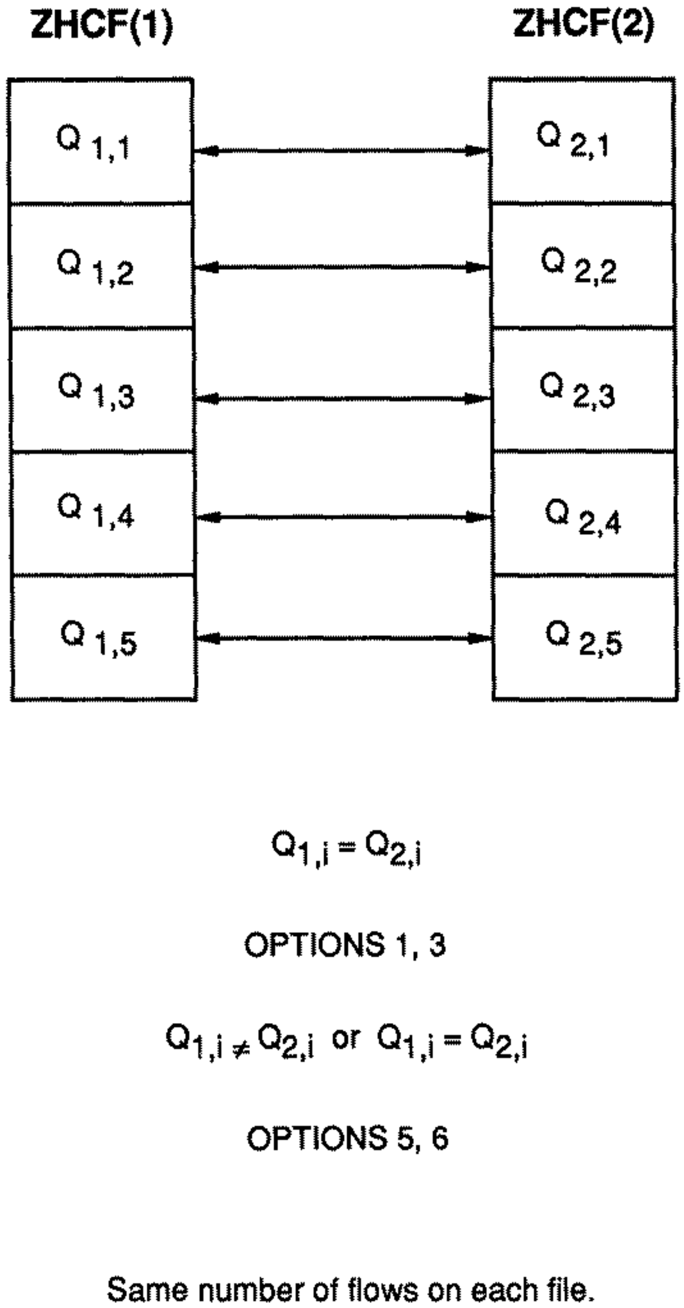


Figure VI.9. File comparisons when Option 1, 3, 5, or 6 is selected in HABEF.

MAXIMUM/MINIMUM ANALYSES - Options 5 and 6

The purpose of Options 5 and 6 is to compare the state under one condition (flow, species, etc.) for a specific cell to the state with a second condition in the same cell. This file comparison process is illustrated in Figure VI.9.

There are two logics used in the comparison.

The logic for Option 5 is:

$$WUA = MIN(WUA(1),WUA(2))$$

where WUA(1) is the composite suitability factor from the first file, and WUA(2) is the composite suitability factor from the second file.

The logic for Option 6 is:

$$WUA = MAX(WUA(1),WUA(2))$$

Figure VI.10 contains the results for Option 5. Figure VI.11 contains the results for Option 6.

An EFTBL file which is similar to a ZHAQF file is also produced (Figure VI.12). The first column contains the WUA for the first file, the second column contains the WUA for the second file, and the third column contains the minimum or maximum WUA depending on the option selected. The discharge written is from the first file; if the discharge on the second file is different from the first, it is written in the fifth column.

DATE - 88/10/11. WILLIAMS FORK RIVER BELOW LEAH, COLORADO PROGRAM - HABEF
TIME - 09.28.55. MINIMUM HABITAT ANALYSIS WITH BASE FLOW OF 8 CFS PAGE - 2

DATA SET 1 IS
CURVE NUMBER = 11102
SPECIES = RAINBOW TROUT

LIFE STAGE = ADULT

DATA SET 2 IS
CURVE NUMBER = 11102
SPECIES = RAINBOW TROUT

LIFE STAGE = ADULT

	MINIMUM Q SET TOTAL	USABLE AREA			BASE Q SET TOTAL	USABLE AREA		
MINIMUM DISCHARGE	AREA	USED	WEIGHTED	DISCHARGE	AREA	USED	WEIGHTED	WUA
8.0	7653.1	6849.4	606.9	8.0	7653.1	6849.4	606.9	606.9
15.0	8738.6	7937.6	960.8	15.0	8738.6	7937.6	960.8	960.8
25.0	10142.2	9258.6	1375.7	25.0	10142.2	9258.6	1375.7	1375.7
40.0	11578.1	10717.2	1911.4	40.0	11578.1	10717.2	1911.4	1911.4
60.0	13963.2	13038.9	2184.7	60.0	13963.2	13038.9	2184.7	2184.7
80.0	15386.4	14486.6	2277.2	80.0	15386.4	14486.6	2277.2	2277.2
100.0	16289.1	15338.1	2182.1	100.0	16289.1	15338.1	2182.1	2182.1
125.0	17096.8	15368.5	1906.9	125.0	17096.8	15368.5	1906.9	1906.9
150.0	18035.4	14273.9	1631.7	150.0	18035.4	14273.9	1631.7	1631.7
175.0	18837.8	13525.0	1499.3	175.0	18837.8	13525.0	1499.3	1499.3
200.0	19036.7	12700.7	1387.6	200.0	19036.7	12700.7	1387.6	1387.6
250.0	19334.1	10764.1	1183.3	250.0	19334.1	10764.1	1183.3	1183.3
300.0	19376.6	8259.4	1050.2	300.0	19376.6	8259.4	1050.2	1050.2
400.0	19451.0	5020.9	957.9	400.0	19451.0	5020.9	957.9	957.9
500.0	19512.2	4029.2	872.2	500.0	19512.2	4029.2	872.2	872.2
750.0	19692.0	2649.5	624.4	750.0	19692.0	2649.5	624.4	624.4
1000.0	19808.2	1448.2	420.8	1000.0	19808.2	1448.2	420.8	420.8

END OF JOB

Figure VI.10 Sample output from HABEF when Option 5 is selected.

DATE - 88/10/11. WILLIAMS FORK RIVER BELOW LEAH, COLORADO PROGRAM - HABEF
TIME - 09.33.12. MAXIMUM HABITAT ANALYSIS PAGE - 2

DATA SET 1 IS
CURVE NUMBER = 11102
SPECIES = RAINBOW TROUT

LIFE STAGE = ADULT

DATA SET 2 IS
CURVE NUMBER = 11102
SPECIES = RAINBOW TROUT

LIFE STAGE = ADULT

MAXIMUM Q SET				BASE Q SET				
MAXIMUM DISCHARGE	TOTAL AREA	USABLE AREA USED	WEIGHTED	DISCHARGE	TOTAL AREA	USABLE AREA USED	WEIGHTED	WUA
8.0	7653.1	6849.4	606.9	8.0	7653.1	6849.4	606.9	606.9
15.0	8738.6	7937.6	960.8	15.0	8738.6	7937.6	960.8	960.8
25.0	10142.2	9258.6	1375.7	25.0	10142.2	9258.6	1375.7	1375.7
40.0	11578.1	10717.2	1911.4	40.0	11578.1	10717.2	1911.4	1911.4
60.0	13963.2	13038.9	2184.7	60.0	13963.2	13038.9	2184.7	2184.7
80.0	15386.4	14486.6	2277.2	80.0	15386.4	14486.6	2277.2	2277.2
100.0	16289.1	15338.1	2182.1	100.0	16289.1	15338.1	2182.1	2182.1
125.0	17096.8	15368.5	1906.9	125.0	17096.8	15368.5	1906.9	1906.9
150.0	18035.4	14273.9	1631.7	150.0	18035.4	14273.9	1631.7	1631.7
175.0	18837.8	13525.0	1499.3	175.0	18837.8	13525.0	1499.3	1499.3
200.0	19036.7	12700.7	1387.6	200.0	19036.7	12700.7	1387.6	1387.6
250.0	19334.1	10764.1	1183.3	250.0	19334.1	10764.1	1183.3	1183.3
300.0	19376.6	8259.4	1050.2	300.0	19376.6	8259.4	1050.2	1050.2
400.0	19451.0	5020.9	957.9	400.0	19451.0	5020.9	957.9	957.9
500.0	19512.2	4029.2	872.2	500.0	19512.2	4029.2	872.2	872.2
750.0	19692.0	2649.5	624.4	750.0	19692.0	2649.5	624.4	624.4
1000.0	19808.2	1448.2	420.8	1000.0	19808.2	1448.2	420.8	420.8

END OF JOB

Figure VI.11. Sample output from HABEF when Option 6 is selected.

```
WILLIAMS FORK RIVER BELOW LEAH, COLORADO
MAXIMUM HABITAT ANALYSIS
ADULT RAINBOW TROUT WITH BASE Q OF 8 CFS
      DISCHARGE  MAXIMUM Q   BASE Q        MAXIMUM   2ND DISCH.
* 1        8.00     606.95     606.95      606.95
* 2       15.00     960.78     960.78      960.78
* 3       25.00    1375.67    1375.67     1375.67
* 4       40.00    1911.45    1911.45     1911.45
* 5       60.00    2184.67    2184.67     2184.67
* 6       80.00    2277.22    2277.22     2277.22
* 7      100.00    2182.08    2182.08     2182.08
* 8      125.00    1906.92    1906.92     1906.92
* 9      150.00    1631.74    1631.74     1631.74
*10      175.00    1499.27    1499.27     1499.27
*11      200.00    1387.59    1387.59     1387.59
*12      250.00    1183.26    1183.26     1183.26
*13      300.00    1050.24    1050.24     1050.24
*14      400.00     957.88     957.88      957.88
*15      500.00     872.24     872.24      872.24
*16      750.00     624.39     624.39      624.39
*17     1000.00     420.80     420.80      420.80
***************
```

Figure VI.12. The EFTBL file written by HABEF when Option 6 is selected.

STREAMFLOW VARIATION ANALYSIS - Option 2, 4, 7, or 8

The purpose of the streamflow variation analysis is to look at the habitat from two flows with both flows varying over a range. The analysis is similar to the maximum/minimum analysis with the difference being that all flow sets on one file are compared to all flow sets on another file. Effective spawning logic can also be done. In effective spawning analysis, an area available for spawning habitat is available only if the incubation is satisfactory during the following incubation period.

This type of comparison of flows is demonstrated in Figure VI.13.

Option 2 is where WUA = MIN(WUA(1,i),WUA(2,k))

Option 4 is where WUA = MAX(WUA(1,i),WUA(2,k))

Option 7 is IF(WUA(2) > 0 WUAE = WUA(1)

IF(WUA(2) = 0 WUAE = 0.0

Option 8 is IF(WUA(2) > 0 WUAE = WUA(1)

IF(WUA(2) = 0 WUAE = 0.0

$$SI = \left(1.0 - \frac{\Sigma WUAE}{\Sigma WUA(1)} \right) * 100.0$$

The output resulting from Option 2 is illustrated in Figure VI.14. The results from Option 4 will look the same, except that the last column will be the maximum value of the combined habitat instead of the minimum.

The last page of the output is a matrix table of the results of the analysis as shown in Figure VI.15. The summary output is also written to the EFTBL file (two-flow habitat file when Option 2, 4, 7 or 8 is selected) in a form that can be used in Time Series analysis. A portion of this file is presented in Figure VI.16.

Effective spawning analysis is done if Option 7 is selected. The logic behind effective spawning is illustrated in Figure VI.17. The results obtained when Option 7 is used are shown in Figure VI.18.

Stranding index analysis is done if Option 8 is selected. The logic behind stranding index analysis is illustrated in Figure VI.19. The results obtaining when Option 8 is used are shown in Figure VI.20.

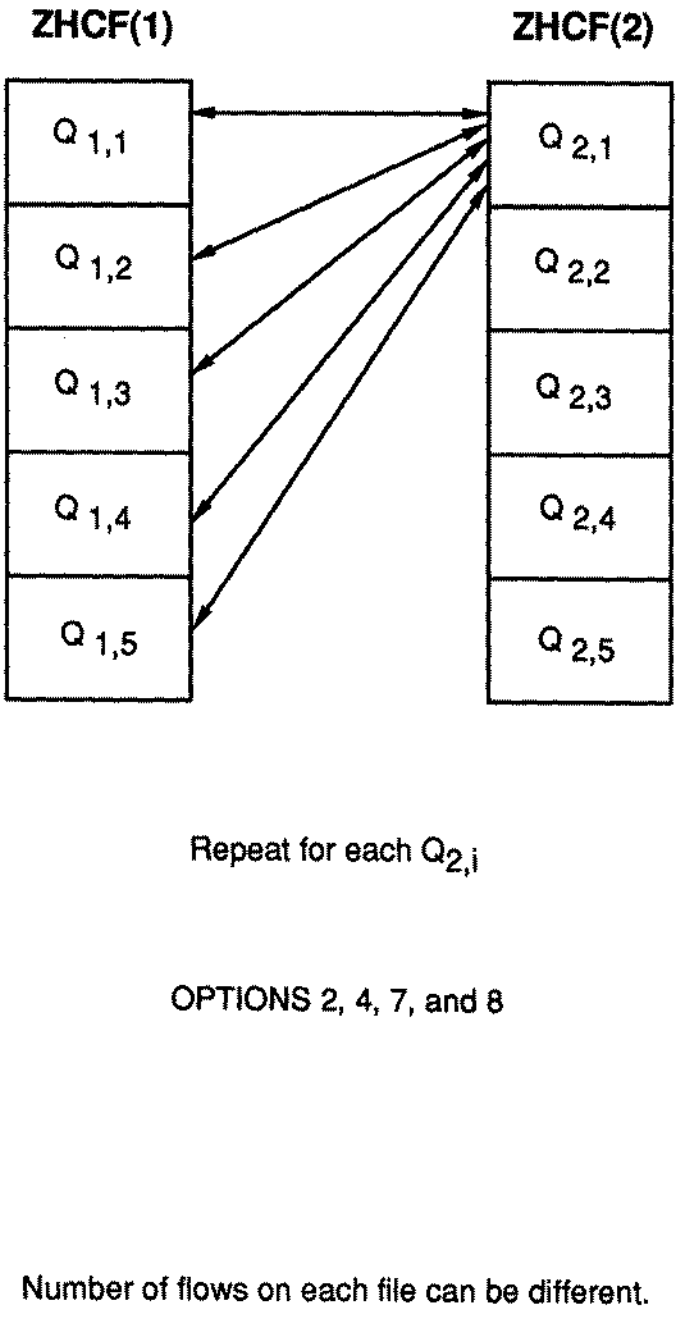


Figure VI.13. File comparisons when Option 2, 4, 7, or 8 is selected in HABEF.

DATE - 88/10/11.
TIME - 11.53.12.

WILLIAMS FORK RIVER BELOW LEAH, COLORADO
MINIMUM VARIATION ANALYSIS

PROGRAM - HABEF
PAGE - 2

FIRST DATA SET IS
CURVE NUMBER = 11102
SPECIES = RAINBOW TROUT

LIFE STAGE = ADULT

SECOND DATA SET IS
CURVE NUMBER = 11102
SPECIES = RAINBOW TROUT

LIFE STAGE = ADULT

MINIMUM DISCHARGE	FIRST SET TOTAL AREA	FIRST SET USABLE AREA USED	FIRST SET USABLE AREA WEIGHTED	DISCHARGE	SECOND SET TOTAL AREA	SECOND SET USABLE AREA USED	SECOND SET USABLE AREA WEIGHTED	WUA
8.0	7653.1	6849.4	606.9	8.0	7653.1	6849.4	606.9	606.9
15.0	8738.6	7937.6	960.8	8.0	7653.1	6849.4	606.9	605.6
25.0	10142.2	9258.6	1375.7	8.0	7653.1	6849.4	606.9	599.9
40.0	11578.1	10717.2	1911.4	8.0	7653.1	6849.4	606.9	584.5
60.0	13963.2	13038.9	2184.7	8.0	7653.1	6849.4	606.9	554.0
80.0	15386.4	14486.6	2277.2	8.0	7653.1	6849.4	606.9	530.6
100.0	16289.1	15338.1	2182.1	8.0	7653.1	6849.4	606.9	470.3
125.0	17096.8	15368.5	1906.9	8.0	7653.1	6849.4	606.9	371.7
150.0	18035.4	14273.9	1631.7	8.0	7653.1	6849.4	606.9	251.5
175.0	18837.8	13525.0	1499.3	8.0	7653.1	6849.4	606.9	172.8
200.0	19036.7	12700.7	1387.6	8.0	7653.1	6849.4	606.9	112.8
250.0	19334.1	10764.1	1183.3	8.0	7653.1	6849.4	606.9	67.0
300.0	19376.6	8259.4	1050.2	8.0	7653.1	6849.4	606.9	59.9
400.0	19451.0	5020.9	957.9	8.0	7653.1	6849.4	606.9	52.3
500.0	19512.2	4029.2	872.2	8.0	7653.1	6849.4	606.9	33.1
750.0	19692.0	2649.5	624.4	8.0	7653.1	6849.4	606.9	12.8
1000.0	19808.2	1448.2	420.8	8.0	7653.1	6849.4	606.9	06.2
8.0	7653.1	6849.4	606.9	15.0	8738.6	7937.6	960.8	605.6
15.0	8738.6	7937.6	960.8	15.0	8738.6	7937.6	960.8	960.8
25.0	10142.2	9258.6	1375.7	15.0	8738.6	7937.6	960.8	946.5
40.0	11578.1	10717.2	1911.4	15.0	8738.6	7937.6	960.8	924.0
60.0	13963.2	13038.9	2184.7	15.0	8738.6	7937.6	960.8	880.1
80.0	15386.4	14486.6	2277.2	15.0	8738.6	7937.6	960.8	807.8
100.0	16289.1	15338.1	2182.1	15.0	8738.6	7937.6	960.8	699.8
125.0	17096.8	15368.5	1906.9	15.0	8738.6	7937.6	960.8	538.6
150.0	18035.4	14273.9	1631.7	15.0	8738.6	7937.6	960.8	369.2
175.0	18837.8	13525.0	1499.3	15.0	8738.6	7937.6	960.8	253.0
200.0	19036.7	12700.7	1387.6	15.0	8738.6	7937.6	960.8	169.2
250.0	19334.1	10764.1	1183.3	15.0	8738.6	7937.6	960.8	113.4
300.0	19376.6	8259.4	1050.2	15.0	8738.6	7937.6	960.8	94.0
400.0	19451.0	5020.9	957.9	15.0	8738.6	7937.6	960.8	76.9
500.0	19512.2	4029.2	872.2	15.0	8738.6	7937.6	960.8	48.6
750.0	19692.0	2649.5	624.4	15.0	8738.6	7937.6	960.8	15.2
1000.0	19808.2	1448.2	420.8	15.0	8738.6	7937.6	960.8	08.6

Figure VI.14. Sample output from HABEF when Option 2 is selected.

DATE - 88/10/11. WILLIAMS FORK RIVER BELOW LEAH, COLORADO PROGRAM - HABEF
TIME - 11.53.12. MINIMUM VARIATION ANALYSIS PAGE - 11

MINIMUM VARIATION ANALYSIS - ADULT RAINBOW TROUT

FIRST FLOWS	SECOND FLOWS										
	8.0	15.0	25.0	40.0	60.0	80.0	100.0	125.0	150.0	175.0	200.0
8.0	606.9	605.6	599.9	584.5	554.0	530.6	470.3	371.7	251.5	172.8	112.8
15.0	605.6	960.8	946.5	924.0	880.1	807.8	699.8	538.6	369.2	253.0	169.2
25.0	599.9	946.5	1375.7	1343.5	1260.0	1129.5	959.1	750.2	494.7	351.6	247.9
40.0	584.5	924.0	1343.5	1911.4	1750.0	1558.0	1326.2	991.5	669.0	472.0	354.6
60.0	554.0	880.1	1260.0	1750.0	2184.7	1953.0	1695.2	1285.9	903.1	671.2	525.2
80.0	530.6	807.8	1129.5	1558.0	1953.0	2277.2	1977.2	1517.0	1109.5	854.7	678.5
100.0	470.3	699.8	959.1	1326.2	1695.2	1977.2	2182.1	1707.0	1282.3	1013.1	824.3
125.0	371.7	538.6	750.2	991.5	1285.9	1517.0	1707.0	1906.9	1463.9	1182.1	977.3
150.0	251.5	369.2	494.7	669.0	903.1	1109.5	1282.3	1463.9	1631.7	1341.7	1124.1
175.0	172.8	253.0	351.6	472.0	671.2	854.7	1013.1	1182.1	1341.7	1499.3	1278.3
200.0	112.8	169.2	247.9	354.6	525.2	678.5	824.3	977.3	1124.1	1278.3	1387.6
250.0	67.0	113.4	176.0	257.9	388.9	499.7	606.1	728.2	841.8	968.7	1058.0
300.0	59.9	94.0	143.2	209.3	304.1	390.8	471.2	561.6	652.1	744.2	808.3
400.0	52.3	76.9	113.7	155.1	214.4	274.8	323.7	380.2	436.4	483.9	536.2
500.0	33.1	48.6	69.3	102.6	155.3	197.4	234.5	276.8	320.9	362.8	406.8
750.0	12.8	15.2	23.4	47.4	92.9	126.9	148.8	175.7	202.4	227.9	255.4
1000.0	6.2	8.6	15.7	33.9	68.0	81.3	90.7	100.7	113.2	125.8	137.8

Figure VI.15. Summary table written to output file by HABEF when Option 2 is selected.

MINIMUM VARIATION ANALYSIS - ADULT RAINBOW TROUT

FIRST FLOWS	SECOND FLOWS 250.0	300.0	400.0	500.0	750.0	1000.0
8.0	67.0	59.9	52.3	33.1	12.8	6.2
15.0	113.4	94.0	76.9	48.6	15.2	8.6
25.0	176.0	143.2	113.7	69.3	23.4	15.7
40.0	257.9	209.3	155.1	102.6	47.4	33.9
60.0	388.9	304.1	214.4	155.3	92.9	68.0
80.0	499.7	390.8	274.8	197.4	126.9	81.3
100.0	606.1	471.2	323.7	234.5	148.8	90.7
125.0	728.2	561.6	380.2	276.8	175.7	100.7
150.0	841.8	652.1	436.4	320.9	202.4	113.2
175.0	968.7	744.2	483.9	362.8	227.9	125.8
200.0	1058.0	808.3	536.2	406.8	255.4	137.8
250.0	1183.3	926.5	640.2	503.2	305.3	160.4
300.0	926.5	1050.2	755.9	611.3	352.4	188.2
400.0	640.2	755.9	957.9	777.2	442.6	252.7
500.0	503.2	611.3	777.2	872.2	495.5	293.1
750.0	305.3	352.4	442.6	495.5	624.4	382.1
1000.0	160.4	188.2	252.7	293.1	382.1	420.8

Figure VI.15. (Concluded)

```
WILLIAMS FORK RIVER BELOW LEAH, COLORADO
MINIMUM VARIATION ANALYSIS
FIRST      - SECOND     TABLE
MINIMUM VARIATION ANALYSIS - ADULT RAINBOW TROUT
        17   17
                    8.00
                   15.00
                   25.00
                   40.00
                   60.00
                   80.00
                  100.00
                  125.00
                  150.00
                  175.00
                  200.00
                  250.00
                  300.00
                  400.00
                  500.00
                  750.00
                 1000.00
                    8.00
                   15.00
                   25.00
                   40.00
                   60.00
                   80.00
                  100.00
                  125.00
                  150.00
                  175.00
                  200.00
                  250.00
                  300.00
                  400.00
                  500.00
                  750.00
                 1000.00
                  606.95
                  605.56
                  599.89
                  584.51
                  554.04
                  530.56
```

SAMPLE OUTPUT TERMINATED FOR BREVITY.

Figure VI.16. The EFTBL file written by HABEF when Option 2, 4, 7, or 8 is selected.

OPTION 7
EFFECTIVE SPAWNING

IF (WUA (2) > 0) WUAE = WUA (1)

IF (WUA (2) = 0) WUAE = 0.0

CELL-BY-CELL

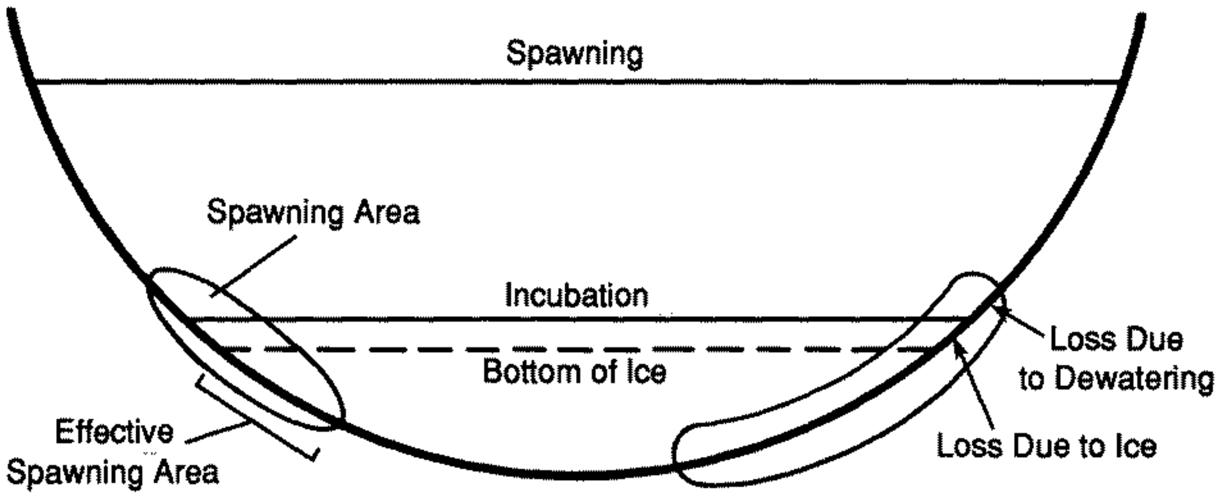


Figure VI.17. The concepts on which the effective spawning analysis is based (Option 7 in HABEF).

DATE - 88/10/11. WILLIAMS FORK RIVER BELOW LEAH, COLORADO PROGRAM - HABEF
TIME - 10.01.35. EFFECTIVE SPAWNING ANALYSIS PAGE - 2

SPAWNING DATA SET IS
CURVE NUMBER = 11110
SPECIES = RAINBOW TROUT

INCUBATION DATA SET IS
CURVE NUMBER = 30001
SPECIES = SALMONIDAE (SALMON/TROUT)

LIFE STAGE =

LIFE STAGE =

SPAWNING DISCHARGE	INCUBATION DISCHARGE	TOTAL AREA	ORIGINAL SPAWNING AREA	EFFECTIVE SPAWNING AREA
8.00	8.00	7653.09	96.53	0.00
15.00	8.00	8738.55	321.85	6.40
25.00	8.00	10142.23	817.26	23.96
40.00	8.00	11578.09	1442.16	29.56
60.00	8.00	13963.16	1830.33	23.96
80.00	8.00	15386.44	1912.02	15.81
100.00	8.00	16289.14	1887.84	8.68
125.00	8.00	17096.79	1839.61	3.75
150.00	8.00	18035.44	1895.99	1.29
175.00	8.00	18837.84	1892.33	0.11
200.00	8.00	19036.68	1856.24	0.00
250.00	8.00	19334.14	1680.04	0.00
300.00	8.00	19376.58	1407.48	0.00
400.00	8.00	19450.99	1040.64	0.00
500.00	8.00	19512.23	935.29	0.00
750.00	8.00	19692.03	281.93	0.00
1000.00	8.00	19808.23	49.81	0.00
8.00	15.00	7653.09	96.53	0.00
15.00	15.00	8738.55	321.85	6.40
25.00	15.00	10142.23	817.26	37.35
40.00	15.00	11578.09	1442.16	49.76
60.00	15.00	13963.16	1830.33	48.69
80.00	15.00	15386.44	1912.02	35.11
100.00	15.00	16289.14	1887.84	23.71
125.00	15.00	17096.79	1839.61	12.24
150.00	15.00	18035.44	1895.99	6.38
175.00	15.00	18837.84	1892.33	2.93
200.00	15.00	19036.68	1856.24	1.00
250.00	15.00	19334.14	1680.04	0.09
300.00	15.00	19376.58	1407.48	0.00
400.00	15.00	19450.99	1040.64	0.00
500.00	15.00	19512.23	935.29	0.00
750.00	15.00	19692.03	281.93	0.00
1000.00	15.00	19808.23	49.81	0.00

Figure VI.18. Sample output from HABEF when Option 7 is selected.

OPTION 8
STRANDING INDEX

IF (WUA (2) > 0)   WUAE = WUA (1)

IF (WUA (2) = 0)   WUAE = 0.0

CELL-BY-CELL

$$SI = \left(1.0 - \frac{\Sigma WUAE}{\Sigma WUA(1)}\right) * 100.0$$

Figure VI.19. The concepts on which the stranding index analysis is based (Option 8 in HABEF).

DATE - 88/10/11. PINEVILLE REACH OF SALMON RIVER, NEW YORK (SUMMER 1986) PROGRAM - HABEF
TIME - 10.13.14. STRANDING INDEX ANALYSIS PAGE - 2

ADULTS DATA SET IS
CURVE NUMBER = 11003
SPECIES = WINTER STEELHEAD

LIFE STAGE = ADULT-COOL

STRANDING DATA SET IS
CURVE NUMBER = 11013
SPECIES = WINTER STEELHEAD

LIFE STAGE = STRANDING

ADULTS DISCHARGE	STRANDING DISCHARGE	TOTAL AREA	ORIGINAL ADULTS AREA	EFFECTIVE ADULTS AREA	STRANDING INDEX
25.00	25.00	567128.50	177083.61	177083.61	0.00
50.00	25.00	627357.50	246647.41	246647.42	0.00
100.00	25.00	667031.87	314153.56	311644.75	0.80
200.00	25.00	757710.00	391841.00	354400.59	9.55
350.00	25.00	834780.00	469914.69	368880.47	21.50
500.00	25.00	868239.12	480064.53	331897.87	30.86
750.00	25.00	894366.87	434384.28	280658.62	35.39
1000.00	25.00	930011.81	408880.84	256018.89	37.39
1500.00	25.00	994084.00	300902.09	169730.27	43.59
2000.00	25.00	1055822.00	276710.06	141433.31	48.89
3000.00	25.00	1127412.00	233167.84	125653.55	46.11
4000.00	25.00	1140795.00	128571.41	46487.59	63.84
6000.00	25.00	1153615.00	33223.86	6403.54	80.73
25.00	50.00	567128.50	177083.61	177083.61	0.00
50.00	50.00	627357.50	246647.41	246647.42	0.00
100.00	50.00	667031.87	314153.56	314153.56	0.00
200.00	50.00	757710.00	391841.00	381051.87	2.75
350.00	50.00	834780.00	469914.69	417611.59	11.13
500.00	50.00	868239.12	480064.53	386830.59	19.42
750.00	50.00	894366.87	434384.28	325683.06	25.02
1000.00	50.00	930011.81	408880.84	294769.19	27.91
1500.00	50.00	994084.00	300902.09	187997.14	37.52
2000.00	50.00	1055822.00	276710.06	157459.36	43.10
3000.00	50.00	1127412.00	233167.84	141337.97	39.38
4000.00	50.00	1140795.00	128571.41	60049.39	53.29
6000.00	50.00	1153615.00	33223.86	8325.57	74.94
25.00	100.00	567128.50	177083.61	177083.61	0.00
50.00	100.00	627357.50	246647.41	246647.42	0.00
100.00	100.00	667031.87	314153.56	314153.56	0.00
200.00	100.00	757710.00	391841.00	391687.62	0.04
350.00	100.00	834780.00	469914.69	465834.69	0.87
500.00	100.00	868239.12	480064.53	456082.16	5.00
750.00	100.00	894366.87	434384.28	375021.94	13.67
1000.00	100.00	930011.81	408880.84	324946.12	20.53
1500.00	100.00	994084.00	300902.09	210994.34	29.88
2000.00	100.00	1055822.00	276710.06	180456.56	34.78
3000.00	100.00	1127412.00	233167.84	157855.17	32.30
4000.00	100.00	1140795.00	128571.41	76440.98	40.55
6000.00	100.00	1153615.00	33223.86	10762.55	67.61

Figure VI.20. Sample output from HABEF when Option 8 is selected.

LSTCEL Program

I. INTRODUCTION

The LSTCEL program lists the contents of a ZHCF file and uses a TAPE3 file containing unformatted cross section and reach data that was generated by the hydraulic simulation programs.

The output from LSTCEL is a listing of the composite suitability of use factors in a format that makes it easy to see how the composite suitability of use terms vary across the stream channel and as a function of discharge. The output resembles a "map" if the cell widths are nearly the same across a cross section.

II. RUNNING LSTCEL

LSTCEL,ZHCF,TAPE3,ZOUT

ZHCF=unformatted cell areas and cell weighted usable areas (input)
TAPE3=unformatted cross section and reach data (input)
ZOUT=LSTCEL results (output)

Figure VI.21 contains sample output from the LSTCEL program.

88/10/11. WILLIAMS FORK RIVER SECTION 1 ** COLORADO/NEHRING ** PROGRAM - LSTCEL
10.24.04. ONE MILE BELOW KINNEY CREEK CONFLUENCE IFG4 DATA PAGE - 2

RAINBOW TROUT LIFE STAGE - ADULT NUMBER - 11102 STATION - 0.00

				DISCHARGE											
	X	Y	S	8.0	15.0	25.0	40.0	60.0	80.0	100.0	125.0	150.0	175.0	200.0	250.0
1	1.0	96.60	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	2.0	96.50	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	4.0	96.30	4.00	0.00	0.00	0.01	0.02	0.04	0.05	0.06	0.07	0.07	0.08	0.09	0.11
4	6.0	96.20	5.50	0.00	0.01	0.04	0.07	0.10	0.14	0.16	0.16	0.16	0.15	0.15	0.15
5	8.0	96.10	5.50	0.00	0.02	0.07	0.12	0.12	0.11	0.10	0.07	0.05	0.03	0.00	0.00
6	10.0	96.10	5.50	0.01	0.05	0.10	0.13	0.12	0.12	0.10	0.07	0.05	0.03	0.00	0.00
7	12.0	95.90	5.50	0.03	0.07	0.12	0.14	0.12	0.12	0.10	0.07	0.05	0.03	0.00	0.00
8	14.0	96.00	5.50	0.04	0.09	0.13	0.14	0.12	0.11	0.09	0.06	0.04	0.01	0.00	0.00
9	16.0	95.80	5.50	0.07	0.12	0.15	0.14	0.12	0.11	0.09	0.06	0.04	0.01	0.00	0.00
10	18.0	95.80	5.50	0.08	0.13	0.14	0.12	0.11	0.08	0.06	0.03	0.00	0.00	0.00	0.00
11	20.0	95.80	5.50	0.08	0.13	0.13	0.12	0.10	0.06	0.04	0.01	0.00	0.00	0.00	0.00
12	22.0	95.80	5.50	0.09	0.14	0.14	0.12	0.11	0.08	0.06	0.03	0.00	0.00	0.00	0.00
13	24.0	95.70	5.50	0.12	0.14	0.13	0.12	0.09	0.06	0.04	0.00	0.00	0.00	0.00	0.00
14	26.0	95.70	5.50	0.12	0.13	0.12	0.09	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00
15	28.0	95.70	5.50	0.11	0.13	0.12	0.11	0.07	0.04	0.01	0.00	0.00	0.00	0.00	0.00
16	30.0	95.80	5.50	0.11	0.14	0.13	0.11	0.08	0.05	0.03	0.00	0.00	0.00	0.00	0.00
17	32.0	95.70	5.50	0.14	0.15	0.13	0.12	0.08	0.06	0.03	0.00	0.00	0.00	0.00	0.00
18	34.0	95.50	5.50	0.10	0.14	0.15	0.13	0.13	0.10	0.08	0.05	0.02	0.00	0.00	0.00
19	36.0	95.90	5.50	0.03	0.08	0.12	0.12	0.11	0.08	0.05	0.03	0.00	0.00	0.00	0.00
20	38.0	96.00	5.50	0.01	0.04	0.11	0.11	0.09	0.06	0.04	0.01	0.00	0.00	0.00	0.00
21	40.0	96.10	5.50	0.00	0.01	0.05	0.11	0.10	0.10	0.07	0.04	0.02	0.00	0.00	0.00
22	42.0	96.20	5.50	0.00	0.00	0.01	0.04	0.11	0.11	0.10	0.08	0.05	0.03	0.01	0.00
23	44.0	96.40	5.50	0.00	0.00	0.00	0.00	0.04	0.09	0.10	0.09	0.07	0.04	0.02	0.00
24	46.0	96.50	5.50	0.00	0.00	0.00	0.00	0.02	0.07	0.10	0.10	0.09	0.07	0.05	0.01
25	48.0	96.50	5.50	0.00	0.00	0.00	0.00	0.02	0.07	0.10	0.09	0.09	0.07	0.04	0.00
26	50.0	96.50	5.50	0.00	0.00	0.00	0.00	0.04	0.09	0.10	0.09	0.08	0.05	0.03	0.00
27	52.0	96.40	5.50	0.00	0.01	0.02	0.05	0.11	0.13	0.12	0.11	0.10	0.07	0.05	0.01
28	54.0	96.10	5.50	0.00	0.01	0.03	0.08	0.12	0.12	0.11	0.10	0.07	0.05	0.03	0.00
29	56.0	96.30	5.50	0.00	0.00	0.00	0.01	0.06	0.11	0.10	0.09	0.07	0.04	0.02	0.00
30	58.0	96.50	5.50	0.00	0.00	0.00	0.00	0.01	0.04	0.09	0.09	0.09	0.07	0.04	0.00
31	60.0	96.60	5.50	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.10	0.10	0.09	0.09	0.04
32	62.0	96.60	5.50	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.10	0.11	0.10	0.09	0.06
33	64.0	96.60	5.50	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.08	0.09	0.08	0.06	0.02
34	66.0	96.70	5.50	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.09	0.08	0.06	0.04	0.00
35	68.0	96.50	5.50	0.00	0.00	0.00	0.00	0.04	0.09	0.11	0.09	0.08	0.06	0.04	0.00
36	70.0	96.40	5.50	0.00	0.01	0.02	0.05	0.10	0.13	0.13	0.12	0.11	0.10	0.08	0.04
37	72.0	96.10	5.50	0.00	0.03	0.06	0.09	0.14	0.16	0.16	0.16	0.15	0.15	0.15	0.13
38	74.0	96.00	5.50	0.00	0.03	0.06	0.09	0.13	0.16	0.17	0.17	0.17	0.16	0.17	0.17
39	76.0	96.10	5.50	0.00	0.01	0.02	0.03	0.04	0.06	0.08	0.09	0.11	0.13	0.15	0.18
40	78.0	96.60	5.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
41	80.0	97.50	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	82.0	98.80	4.00												

Figure VI.21. Sample output from the LSTCEL program.

LSTHCF Program

I. INTRODUCTION

The LSTHCF program lists the contents of a ZHCF file with various options. These options include: listing the title and species name, creating a file with the habitat vs. flow relationship (ZHAQF), determining the accumulative distribution of the composite suitability of use factors, and the listing of all cell factors.

II. RUNNING LSTHCF

RLSTHCF,ZHCF,ZOUT,ZCEL,ZHAQF

ZHCF=unformatted cell areas and cell weighted usable areas (input)
ZOUT=accumulative distribution of composite suitability of use factors (output)
ZCEL=cell factors file (output)
ZHAQF=habitat vs. flow file (output)

ENTER 0 FOR TITLE LINES AND SPECIES NAME ONLY,
1 FOR FURTHER REPORTS:

If "0" is entered:

The two title lines and the curve set ID number, species name, and life stage contained in the ZHCF file will be displayed on the screen. No output file is created.

If "1" is entered:

ENTER TOTAL REACH LENGTH (USE 1000 IF UNKNOWN)
(ZERO REACH LENGTH MEANS A HAQF FILE WILL NOT BE WRITTEN)
(ALSO DISTRIBUTION ANALYSIS WILL NOT BE DONE):

Reach length information is not contained in ZHCF files as they contain information on individual "cells"; consequently, the total reach length must be supplied by the user.

If "0" is entered for the reach length:

ENTER 0 FOR COMPLETE LISTING OF CELL FACTORS
1 FOR NO COMPLETE LIST:

Cell factors are the composite factors resulting from the use of velocity, depth, and channel index to develop a "worth" for the cell.

If a reach length is entered:

```
ENTER 1 TO WRITE WUA VS. Q FILE (HAQF)
0 OTHERWISE:

ENTER 1 TO DO ACCUMULATIVE DISTRIBUTION OF THE COMPOSITE
        SUITABILITY OF USE FACTORS
      0 OTHERWISE
```

Accumulative distribution is the percent greater than some specific value of cell factors.

```
ENTER 0 FOR COMPLETE LISTING OF CELL FACTORS
      1 FOR NO COMPLETE LIST:
```

Figure VI.22 is an example of the accumulative distribution of the composite suitability factors. Figure VI.23 is an example of a complete listing of cell factors that is written to the ZCEL file.

RAINBOW TROUT ADULT
11102

STAID	DISCHARGE	AREA	TUA	WUA	CF
0.0	8.0	672.9	672.9	46.3	0.069
40.0	8.0	1772.3	1771.3	95.1	0.054
91.0	8.0	2210.6	1638.6	246.2	0.150
192.0	8.0	1489.2	1489.2	142.8	0.096
226.0	8.0	992.6	790.7	48.7	0.062
255.0	8.0	515.5	514.8	27.8	0.054

DISCHARGE = 8.00 TOTAL AREA = 7653.1 USABLE AREA = 606.9

	ACCUM. WEIGHTED USABLE AREA		ACCUM. TOTAL AREA USED	
WEIGHT	AREA	PERCENT	AREA	PERCENT
0.0001	606.9	100.0	6877.4	89.9
0.1000	352.5	58.1	1831.0	23.9
0.2000	163.3	26.9	456.0	6.0
0.3000	163.3	26.9	456.0	6.0
0.4000	0.0	0.0	0.0	0.0
0.5000	0.0	0.0	0.0	0.0
0.6000	0.0	0.0	0.0	0.0
0.7000	0.0	0.0	0.0	0.0
0.8000	0.0	0.0	0.0	0.0
0.9000	0.0	0.0	0.0	0.0
1.0000	0.0	0.0	0.0	0.0

Figure VI.22. Example of the accumulative distribution of the composite suitability factors.

DATE - 88/10/11.   WILLIAMS FORK RIVER   SECTION 1 ** COLORADO/NEHRING **   PROGRAM - LSTHCF
TIME - 10.39.25.   HIGH SET OF VELOCITES USED FOR CALIBRATION   PAGE - 1

CURVE NUMBER- 11102   SPECIES- RAINBOW TROUT
LIFE STAGE- ADULT

CROSS SECTION IS 0.00   DISCHARGE IS 8.0 AREA = 672.9   TUA = 672.9   WUA = 46.3

CELL	1	2	3	4	5	6	7	8	9	10
AREA	0.0	0.0	0.0	0.0	0.0	39.0	40.0	40.0	40.0	40.0
UAREA	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.6	2.9	3.2
QM	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.04	0.07	0.08

CELL	11	12	13	14	15	16	17	18	19	20
AREA	40.0	40.0	40.0	0.0	40.0	40.0	40.0	40.0	40.0	38.0
UAREA	3.4	3.8	4.8	5.0	4.5	4.3	5.6	3.9	1.2	0.2
QM	0.08	0.09	0.12	0.12	0.11	0.11	0.14	0.10	0.03	0.01

CELL	21	22	23	24	25	26	27	28	29	30
AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UAREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CELL	31	32	33	34	35	36	37	38	39	40
AREA	0.0	0.0	0.0	0.0	0.0	0.0	38.0	38.0	0.0	0.0
UAREA	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0
QM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CELL	41
AREA	0.0
UAREA	0.0
QM	0.00

Figure VI.23. Example of a complete listing of cell factors that is written to the ZCEL file.

MKEHQF Program

I. INTRODUCTION

The MKEHQF program creates two habitat vs. flow (ZHAQF) files from the two-flow habitat table (ZEFTBL file) created by HABEF when Option 2,4, 7, or 8 is selected.

II. RUNNING MKEHQF

RMKEHQF,ZEFTBL,ZHAQF1,ZHAQF2

ZEFTBL=two-flow habitat table (input)
ZHAQF1=habitat vs. flow file with up to five columns per "species equivalent" section (output)
ZHAQF2=habitat vs. flow file with one column per "species equivalent" section (output)

Figure VI.24 contains sample output from the MKEHQF program.

ZHAQF1 File with up to five columns per "species equivalent" section.

```
PINEVILLE REACH OF SALMON RIVER, NEW YORK  (SUMMER 1986)
COMPOSITE OF VELOCITY SIMULATIONS
BROWN TROUT SPAWNING W/ FLUSHING
      DISCHARGE  Q2=   25.0  Q2=   50.0  Q2=  100.0  Q2=  200.0  Q2=  350.0
* 1       25.00         0.00         0.00         0.00         0.00         0.00
* 2       50.00         0.00         0.00         0.00         0.00         0.00
* 3      100.00         0.00         0.00         0.00         0.00         0.00
* 4      200.00         0.00         0.00         0.00         0.00         0.00
* 5      350.00         0.00         0.00         0.00         0.00         0.00
* 6      500.00         0.00         0.00         0.00         0.00         0.00
* 7      750.00         0.00         0.00         0.00         0.00         0.00
* 8     1000.00         0.00         0.00         0.00         0.00         0.00
* 9     1500.00         0.00         0.00         0.00         0.00         0.00
*10     2000.00         0.00         0.00         0.00         0.00         0.00
*11     3000.00         0.00         0.00         0.00         0.00         0.00
*12     4000.00         0.00         0.00         0.00         0.00         0.00
*13     6000.00         0.00         0.00         0.00         0.00         0.00
***************
BROWN TROUT SPAWNING W/ FLUSHING
      DISCHARGE  Q2=  500.0  Q2=  750.0  Q2= 1000.0  Q2= 1500.0  Q2= 2000.0
* 1       25.00         0.00       135.57       135.57       135.57       135.57
* 2       50.00         0.00       283.56       283.56       353.97       353.97
* 3      100.00         0.00       567.62       604.03      1431.18      1431.18
* 4      200.00         0.00       938.77      1274.88      4474.80      4632.10
* 5      350.00         0.00       460.40      1511.27      7430.40      7962.14
* 6      500.00         0.00        97.07       881.15      6407.63      7286.69
* 7      750.00         0.00        16.73       439.16      4287.73      6242.26
* 8     1000.00         0.00         0.00       113.05      1431.46      3261.72
* 9     1500.00         0.00         0.00         0.00       125.39       811.07
*10     2000.00         0.00         0.00         0.00         8.24       164.03
*11     3000.00         0.00         0.00         0.00         0.00         3.35
*12     4000.00         0.00         0.00         0.00         0.00         0.00
*13     6000.00         0.00         0.00         0.00         0.00         0.00
***************
BROWN TROUT SPAWNING W/ FLUSHING
      DISCHARGE  Q2= 3000.0  Q2= 4000.0  Q2= 6000.0
* 1       25.00       135.57       135.57       135.57
* 2       50.00       353.97       353.97       353.97
* 3      100.00      1431.18      1431.18      1431.18
* 4      200.00      4632.10      4632.10      4632.10
* 5      350.00      7962.14      7962.14      7962.14
* 6      500.00      7341.67      7341.67      7341.67
* 7      750.00      7007.82      7007.82      7007.82
* 8     1000.00      5226.51      5226.51      5226.51
* 9     1500.00      3825.00      3825.00      3825.00
*10     2000.00      2341.89      2341.89      2341.89
*11     3000.00       225.26       225.26       225.26
*12     4000.00         6.71         6.71         6.71
*13     6000.00         0.00         0.00         0.00
***************
```

Figure VI.24. Sample output from the MKEHQF Program.

ZHAQF2 File with one column per "species equivalent" section.

```
PINEVILLE REACH OF SALMON RIVER, NEW YORK  (SUMMER 1986)
COMPOSITE OF VELOCITY SIMULATIONS
        BROWN TROUT      SPAWNING W/ FLUSHING
              DISCHARGE  Q2=   25.0
        * 1       25.00          0.00
        * 2       50.00          0.00
        * 3      100.00          0.00
        * 4      200.00          0.00
        * 5      350.00          0.00
        * 6      500.00          0.00
        * 7      750.00          0.00
        * 8     1000.00          0.00
        * 9     1500.00          0.00
        *10     2000.00          0.00
        *11     3000.00          0.00
        *12     4000.00          0.00
        *13     6000.00          0.00
        ***************
        BROWN TROUT SPAWNING W/ FLUSHING
              DISCHARGE  Q2=   50.0
        * 1       25.00          0.00
        * 2       50.00          0.00
        * 3      100.00          0.00
        * 4      200.00          0.00
        * 5      350.00          0.00
        * 6      500.00          0.00
        * 7      750.00          0.00
        * 8     1000.00          0.00
        * 9     1500.00          0.00
        *10     2000.00          0.00
        *11     3000.00          0.00
        *12     4000.00          0.00
        *13     6000.00          0.00
        ***************
        BROWN TROUT SPAWNING W/ FLUSHING
              DISCHARGE  Q2=  100.0
        * 1       25.00          0.00
        * 2       50.00          0.00
        * 3      100.00          0.00
        * 4      200.00          0.00
        * 5      350.00          0.00
        * 6      500.00          0.00
        * 7      750.00          0.00
        * 8     1000.00          0.00
        * 9     1500.00          0.00
        *10     2000.00          0.00
        *11     3000.00          0.00
        *12     4000.00          0.00
        *13     6000.00          0.00
        ***************
```

REMAINER OF THIS SAMPLE OUTPUT HAS BEEN DELETED FOR BREVITY.

Figure VI.24. (Concluded)

MRGEFT Program

I. INTRODUCTION

The MRGEFT program merges two two-flow habitat tables (ZEFTBL files) created by HABEF when Option 2,4, 7, or 8 is selected and creates a new EFTBL file.

II. RUNNING MRGEFT

RMRGEFT,ZEFTBL1,ZEFTBL2,ZEFTBLN,ZOUT

ZEFTBL1=two-flow habitat table (input)
ZEFTBL2=two-flow habitat table (input)
ZEFTBLN=new ZEFTBL file (output)
ZOUT=matrix table of the combined ZEFTBL files (output)

The Title Lines from the two ZEFTBL files being merged will be diplayed on the screen. The user is prompted to retain the title of the first set or enter a new two-line title.

The two Labels (assigned when the file was created using HABEF) from each of the files will be displayed. The user is prompted to enter new labels.

The two Life Stages (assigned when the file was created using HABEF) from each of the files will be displayed. The user is prompted to enter a new life stage name.

ENTER 1 TO SUM WEIGHTED USABLE AREAS
2 TO DO WEIGHTED SUM OF WEIGHTED USABLE AREAS:

1 = the total area is the sum of two areas, i.e., two channels around an island.

2 = the total area is on each file and each is a sample of the total, i.e., two study areas in the same reach.

<u>If "2" is entered</u>:

ENTER WEIGHT ON FIRST DATA SET:

The weight for the first file must be less than or equal to "1". The weight for the second file is assumed to be "1" minus the first file weight.

PLOTCF Program

I. INTRODUCTION

The PLOTCF program plots the composite suitability weighting factors file (ZCF) created by the EXTCF program. This allows one to examine the composite habitat suitability index for each cell of each cross section at each simulated flow for a single life stage.

The PLOTCF program is only available on the microcomputer. The micro must have the capability to display CGA (640 x 200) graphics or EGA (640 x 350) graphics. If graphics printouts are desired, a graphics printer must be available. The program will also support Hercules and VGA graphics; however, the user is responsible for providing software to print the results.

II. RUNNING PLOTCF

RPLOTCF,ZCF

ZCF=composite suitability weighting factors data (input)
(created by the EXTCF program)

```
ENTER 1 FOR COLOR GRAPHICS ADAPTOR, OR
      2 FOR COLOR ENHANCED GRAPHICS ADAPTOR, OR
      3 FOR MONO  ENHANCED GRAPHICS ADAPTOR, OR
      4 FOR HERCULES DISPLAY, OR
      5 FOR MONO  VGA DISPLAY ADAPTOR, OR
      6 FOR COLOR VGA DISPLAY ADAPTOR.
        (ENTER to Quit)?
```

If a HERCULES display is being used, the QBHERC program must be run prior to running PLOTCF.

The PLOTCF program allows hierarchial movement within it by just typing <CR>.

```
ENTER 1 FOR PLAN VIEW, OR
      2 FOR CROSS SECTIONAL VIEW
        (ENTER for new Data File)
```

<u>If "1" is entered for Plan View</u>:

DO YOU WANT THALWEG TO BE IN A STRAIGHT LINE (Y/N)?

<u>Y</u>es = aligns the Thalwegs for all cross sections.
<u>N</u>o = aligns the left headpins of all cross sections.

<u>If "2" was entered above for Cross Sectional View</u>:

The program will ask for the cross section number for the cross section to plot.

In both cases, a list of flows will be displayed on the screen, and the user will be asked to enter a flow number for the flow to plot.

NOTES:

1. The cross sectional view fails to shade cells that are not completely submerged at the chosen flow. These edge cells often are prime habitat. Comparing the cross sectional plot with the plan view will show omissions.

2. The plan view display fails to show the water's edge. Comparison of the plan view plot with the cross sectional plot will show the water's edge.

3. Distinction between shading types, and division boundaries between the cells themselves, is difficult if cells are quite narrow.

TRNHCF Program

I. INTRODUCTION

The TRNHCF program converts an unformatted ZHCF file to a formatted ZHCF file, or it converts a formatted ZHCF file to an unformatted ZHCF file. A ZHCF file is created by setting IOC(13)=1 in the HABTAT, HABTAV, or HABTAE programs.

Unformatted files are likely to be incompatible between a microcomputer and the CDC mainframe, and between different microcomputers. The formatted version of the files should be used when transferring from computer to computer.

II. RUNNING TRNHCF

RTRNHCF,ZHCF,ZHCFN

ZHCF=unformatted or formatted file of cell areas and cell weighted usable areas (input)
ZHCFN=new ZHCF file that is either formatted or unformatted depending on whether the input file was formatted or unformatted (output)

```
ENTER 1 FOR UNFORMATTED TO FORMATTED
      2 FOR FORMATTED TO UNFORMATTED
```

VII. REPORT GENERATION PROGRAMS

INTRODUCTION

The standard output from the PHABSIM programs is not always in a format most useful for report purposes. The following programs have been developed to allow the user to format output to better meet his needs when writing reports.

PROGRAMS THAT REFORMAT A ZHAQF FILE

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
HABOUTA	**RHBOUTA**	Report Generation	Writes the data from a habitat versus streamflow file into a format that may be useful for report purposes. **RHBOUTA,ZHAQF,ZOUT** **ZHAQF**=habitat vs. flow file (input) **ZOUT**=HABOUTA results (output)
HABOUTS	**RHBOUTS**	Report Generation	Writes the data from a habitat versus streamflow file into a format that may be useful for report purposes, and sums the life stage values into one habitat versus streamflow figure for each life stage for each flow. The ZHAQF file being used as input is assumed to have been generated using conditional cover curves as input to the habitat simulation program. **RHBOUTS,ZHAQF,ZOUT** **ZHAQF**=habitat vs. flow file (input) **ZOUT**=HABOUTS results (output)
HABAE	**RHABAE**	Report Generation	Writes the data from a ZHAQF file into a format that may be useful for report purposes, and calculates the minimum adult equivalent habitat area for each life stage for each flow. **RHABAE,ZHAQF,ZOUT,ZHAQFN** **ZHAQF**=habitat vs. flow file (input) **ZOUT**=HABAE results (output) **ZHAQFN**=new ZHAQF file with equivalent habitat area (output)

PROGRAMS THAT REFORMAT A FISHCRV FILE

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
LSTCP	RLSTCP	Report Generation	Reads a FISHCRV file and creates a file with one species set per page. **RLSTCP,FISHCRV,ZOUT** **FISHCRV**=formatted curves file (input) **ZOUT**=LSTCP results (output)

PROGRAMS THAT REFORMAT A ZEFTBL FILE

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
EFHTBL	REFHTBL	Report Generation	Writes the data from a two-flow habitat table (ZEFTBL file), created by selecting Option 2, 4, 7, or 8 in HABEF, into a format that may be useful for report purposes. **REFHTBL,ZEFTBL,ZOUT** **ZEFTBL**=two-flow habitat table (input) **ZOUT**=EFHTBL results (output)

ZHCF FILE LISTING

The following program lists information from the unformatted cell areas and cell weighted usable areas file (ZHCF) and may be useful for report generation. Individual documentation for this program is located in Chapter VI.

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
LSTCEL	RLSTCEL	ZHCF File Listing	Lists the suitability of use factors for each cell in a pattern resembling a map. This allows for the comparison of factors in adjacent cells and how the factors for a cell vary with discharge. A "map" for each cross section is generated. **RLSTCEL,ZHCF,TAPE3,ZOUT** **ZHCF**=unformatted cell areas and cell weighted usable areas (input) **TAPE3**=unformatted cross section and reach data (input) **ZOUT**=LSTCEL results (output)

TAPE3 AND TAPE4 LISTING PROGRAMS

The following programs list information from the Cross Section and Hydraulic Properties files (TAPE3 and TAPE4) and may be useful for report generation. Individual documentation for these programs is located in Chapter III.

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
CMPWSL	**RCMPWSL**	TAPE4 Listing	Compares the water surface elevations in two TAPE4 files. **RCMPWSL,TAPE4A,TAPE4B,ZOUT,TAPE3** **TAPE4A**=TAPE4 file (input) **TAPE4B**=TAPE4 file (input) **ZOUT**=WSL comparison listing of the two TAPE4's (output) **TAPE3**=title lines read from the TAPE3, if supplied. If not supplied, user is prompted to enter two title lines (input)
LSTP34	**RLSTP34**	TAPE3/4 Listing	Lists the contents of a TAPE3 and TAPE4 file. **RLSTP34,ZOUT,TAPE3,TAPE4** **ZOUT**=LSTP34 results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)
LSTVD	**RLSTVD**	TAPE3/4 Listing	Lists the velocities and depths of the cells, and cross section data that are found on a TAPE3 and TAPE4. **RLSTVD,ZOUT,TAPE3,TAPE4** **ZOUT**=LSTVD results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)

TAPE3 AND TAPE4 LISTING PROGRAMS (Continued)

PROGRAM NAME	BATCH/PROCEDURE FILENAME	FUNCTION	PROGRAM DESCRIPTION
LSTWLF	**RLSTWLF**	TAPE3/4 -- Miscellaneous	Lists water surface elevations on a TAPE4, and calculates and lists the Froude number and mean channel velocities for each cross section and each flow. **RLSTWLF,ZOUT,TAPE3,TAPE4** **ZOUT**=LSTWLF results (output) **TAPE3**=unformatted cross section and reach data (input) **TAPE4**=unformatted flow data (input)

EFHTBL Program

I. INTRODUCTION

The EFHTBL program writes the data from a two-flow habitat table (ZEFTBL file), created by selecting Option 2, 4, 7 or 8 in HABEF, into a format that may be useful for report purposes.

II. RUNNING EFHTBL

REFHTBL,ZEFTBL,ZOUT

ZEFTBL=two-flow habitat table (input)
ZOUT=EFHTBL results (output)

Figure VII.1 contains sample output from the EFHTBL program.

```
DATE - 88/09/29.         PINEVILLE REACH OF SALMON RIVER, NEW YORK  (SUMMER 1986)          PROGRAM - EFHTBL
TIME - 08/36/51.          COMPOSITE OF VELOCITY SIMULATIONS                                       PAGE -   1
                          BROWN TROUT SPAWNING W/ FLUSHING
```

SPAWNING FLOWS	INCUBATION FLOWS 25.0	50.0	100.0	200.0	350.0	500.0	750.0	1000.0	1500.0	2000.0	3000.0
25.0	0.0	0.0	0.0	0.0	0.0	0.0	135.6	135.6	135.6	135.6	135.6
50.0	0.0	0.0	0.0	0.0	0.0	0.0	283.6	283.6	354.0	354.0	354.0
100.0	0.0	0.0	0.0	0.0	0.0	0.0	567.6	604.0	1431.2	1431.2	1431.2
200.0	0.0	0.0	0.0	0.0	0.0	0.0	938.8	1274.9	4474.8	4632.1	4632.1
350.0	0.0	0.0	0.0	0.0	0.0	0.0	460.4	1511.3	7430.4	7962.1	7962.1
500.0	0.0	0.0	0.0	0.0	0.0	0.0	97.1	881.2	6407.6	7286.7	7341.7
750.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	439.2	4287.7	6242.3	7007.8
1000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.1	1431.5	3261.7	5226.5
1500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	125.4	811.1	3825.0
2000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	164.0	2341.9
3000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	225.3

Figure VII.1 Sample output from the EFHTBL program.

HABAE Program

I. INTRODUCTION

The HABAE program writes the data from a habitat versus streamflow (ZHAQF) file into a format that may be useful for report purposes, and it calculates the minimum adult equivalent habitat area for each life stage for each flow.

II. RUNNING HABAE

RHABAE,ZHAQF,ZOUT,ZHAQFN

ZHAQF=habitat vs. flow file (input)
ZOUT=HABAE results (output)
ZHAQFN=new ZHAQF file with equivalent habitat area (output)

ENTER 1 TO CONVERT FROM ENGLISH TO METRIC, 2 FOR NO CONVERSION

Enter "1" if you want the output printed in Metric units instead of English (meters versus feet).

ENTER 1 FOR WUA PRINTED XX.XX, 2 FOR WUA PRINTED XX

Weighted usable area (WUA) and flow (Q) can be printed in the output with or without a decimal point.

ENTER 1 FOR Q PRINTED XX.XX, 2 FOR Q PRINTED XX

ENTER 1 FOR A BINDING EDGE, 2 FOR NO BINDING EDGE

The binding edge is on the top of the paper.

If "1" is entered for a Binding Edge:

HOW MANY LINES FOR BINDING EDGE

At this point the user will be prompted to enter an Adult Equivalent Area for each life stage for each species in the ZHAQF file.

If prompted to enter a weight for the Total Area, enter "1" as the Total Area does not need a weight. Total Area is usually the first heading in a ZHAQF file.

ENTER 1 TO PRINT UNITS BELOW TABLE, 2 FOR NO PRINT OF UNITS

If "1" is entered, the following will be printed below each table depending on if the units are in English or Metric:

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET
Q IN CUBIC METERS PER SECOND, WUA IN SQUARE METERS PER 1000 METERS

Figure VII.2 contains sample output from the HABAE program.

Output contained in ZOUT file.

```
88/08/27.          UPPER SALMON RIVER, NEAR STANLEY, IDAHO          PROGRAM - HABAE
07.50.57.              ZHAQF FILE GENERATED BY HABTAT                   PAGE    1
```

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR TOTAL AREA

Q	AREA	EQUIVALENT
8	22789	22789
10	24395	24395
20	29444	29444
30	31748	31748
40	33660	33660
50	39436	39436
60	42818	42818
70	44512	44512
80	45820	45820
90	47187	47187
100	48495	48495
110	49535	49535
120	50843	50843
130	51883	51883
WEIGHT ON LIFE STAGE	1.00	

DISCHARGE IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

```
88/08/27.          UPPER SALMON RIVER, NEAR STANLEY, IDAHO          PROGRAM - HABAE
07.50.57.              ZHAQF FILE GENERATED BY HABTAT                   PAGE    2
```

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR RAINBOW TROUT

Q	FRY	JUVENILE	ADULT	EQUIVALENT
8	594	0	80	0
10	386	0	102	0
20	257	0	185	0
30	76	208	260	260
40	141	395	333	333
50	419	495	432	432
60	211	492	547	547
70	66	691	661	329
80	59	690	740	293
90	39	676	830	195
100	4	596	912	19
110	0	513	970	0
120	0	621	1055	0
130	0	729	1114	0
WEIGHT ON LIFE STAGE	5.00	1.50	1.00	

DISCHARGE IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

Figure VII.2 Sample output from the HABAE program.

Output contained in ZHAQFN file.

```
UPPER SALMON RIVER, NEAR STANLEY, IDAHO
NEW ZHAQF FILE GENERATED BY HABAE
      DISCHARGE   EQUIVALENT
  1*        8.00    22788.90
  2*       10.00    24395.06
  3*       20.00    29444.04
  4*       30.00    31747.52
  5*       40.00    33659.56
  6*       50.00    39436.34
  7*       60.00    42818.31
  8*       70.00    44512.37
  9*       80.00    45820.20
 10*       90.00    47187.19
 11*      100.00    48494.81
 12*      110.00    49535.04
 13*      120.00    50842.66
 14*      130.00    51882.89
***************
DISCHARGE   EQUIVALENT
  1*        8.00        0.00
  2*       10.00        0.00
  3*       20.00        0.00
  4*       30.00      259.73
  5*       40.00      332.98
  6*       50.00      432.46
  7*       60.00      547.08
  8*       70.00      328.65
  9*       80.00      293.35
 10*       90.00      194.80
 11*      100.00       19.40
 12*      110.00        0.00
 13*      120.00        0.00
 14*      130.00        0.00
***************
```

Figure VII.2 (Concluded)

HABOUTA Program

I. INTRODUCTION

The HABOUTA program writes the data from a habitat versus streamflow (ZHAQF) file into a format that may be useful for report purposes.

II. RUNNING HABOUTA

RHBOUTA,ZHAQF,ZOUT

ZHAQF=habitat vs. flow file (input)
ZOUT=HABOUTA results (output)

ENTER 1 TO CONVERT FROM ENGLISH TO METRIC, 2 FOR NO CONVERSION

Enter "1" if you want the output printed in Metric units instead of English (meters versus feet).

ENTER 1 FOR WUA PRINTED XX.XX, 2 FOR WUA PRINTED XX

Weighted usable area (WUA) and flow (Q) can be printed in the output with or without a decimal point.

ENTER 1 FOR Q PRINTED XX.XX, 2 FOR Q PRINTED XX

ENTER 1 FOR A BINDING EDGE, 2 FOR NO BINDING EDGE

The binding edge is on the top of the paper.

If "1" is entered for a Binding Edge:

HOW MANY LINES FOR BINDING EDGE

ENTER 1 TO PRINT UNITS BELOW TABLE, 2 FOR NO PRINT OF UNITS

If "1" is entered, the following will be printed below each table depending on if the units are in English or Metric.

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

Q IN CUBIC METERS PER SECOND, WUA IN SQUARE METERS PER 1000 METERS

Figure VII.3 contains sample output from the HABOUTA program.

88/08/27. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM - HABOUTA
07.41.22. ZHAQF FILE GENERATED BY HABTAT PAGE 2

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR TOTAL AREA

	Q	AREA
1	8.00	22788.90
2	10.00	24395.06
3	20.00	29444.04
4	30.00	31747.52
5	40.00	33659.56
6	50.00	39436.34
7	60.00	42818.31
8	70.00	44512.37
9	80.00	45820.20
10	90.00	47187.19
11	100.00	48494.81
12	110.00	49535.04
13	120.00	50842.66
14	130.00	51882.89

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

88/08/27. UPPER SALMON RIVER, NEAR STANLEY, IDAHO PROGRAM - HABOUTA
07.41.22. ZHAQF FILE GENERATED BY HABTAT PAGE 3

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR RAINBOW TROUT

	Q	FRY	JUVENILE	ADULT
1	8.00	593.92	0.00	79.87
2	10.00	385.61	0.00	101.70
3	20.00	256.72	0.00	185.36
4	30.00	76.00	207.60	259.73
5	40.00	140.67	395.44	332.98
6	50.00	418.61	495.20	432.46
7	60.00	211.13	491.81	547.08
8	70.00	65.73	691.26	660.58
9	80.00	58.67	689.96	740.38
10	90.00	38.96	675.61	830.34
11	100.00	3.88	596.44	911.59
12	110.00	0.00	512.90	970.48
13	120.00	0.00	621.43	1054.90
14	130.00	0.00	728.64	1113.86

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

Figure VII.3 Sample output from the HABOUTA program.

HABOUTS Program

I. INTRODUCTION

The HABOUTS program writes the data from a habitat versus streamflow (ZHAQF) file into a format that may be useful for report purposes, and it sums the life stage values into one habitat vs. flow figure for each life stage for each flow. The ZHAQF file being used as input is assumed to have been generated using conditional cover curves as input to the habitat simulation program.

II. RUNNING HABOUTS

RHBOUTS,ZHAQF,ZOUT

ZHAQF=habitat vs. flow file (input)
ZOUT=HABOUTS results (output)

ENTER 1 TO CONVERT FROM ENGLISH TO METRIC, 2 FOR NO CONVERSION

Enter "1" if you want the output printed in Metric units instead of English (meters versus feet).

ENTER 1 FOR WUA PRINTED XX.XX, 2 FOR WUA PRINTED XX

Weighted usable area (WUA) and flow (Q) can be printed in the output with or without a decimal point.

ENTER 1 FOR Q PRINTED XX.XX, 2 FOR Q PRINTED XX

ENTER 1 FOR A BINDING EDGE, 2 FOR NO BINDING EDGE

The binding edge is on the top of the paper.

If "1" is entered for a Binding Edge:

HOW MANY LINES FOR BINDING EDGE

ENTER 1 TO PRINT UNITS BELOW TABLE, 2 FOR NO PRINT OF UNITS

If "1" is entered, the following will be printed below each table depending on if the units are in English or Metric:

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

Q IN CUBIC METERS PER SECOND, WUA IN SQUARE METERS PER 1000 METERS

Figure VII.4 contains sample output from the HABOUTS program. The ZHAQF file used as input to the SUMHQF program (Figure V.27) was used as input to the HABOUTS program to generate these results.

88/08/27. ALTMAR REACH OF SALMON RIVER, NEW YORK PROGRAM - HABOUTS
07.45.14. COMPOSITE OF VELOCITIES AND SECTIONS AS ISLANDS PAGE 1

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR TOTAL AREA

	Q	AREA	SUM
1	25	155830	155830
2	50	177487	177487
3	100	196137	196137
4	200	216445	216445
5	350	255153	255153
6	500	275933	275933
7	750	290595	290595
8	1000	299067	299067
9	1500	314227	314227
10	2000	324867	324867
11	3000	336215	336215
12	4000	342061	342061
13	6000	353206	353206

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

88/08/27. ALTMAR REACH OF SALMON RIVER, NEW YORK PROGRAM - HABOUTS
07.45.14. COMPOSITE OF VELOCITIES AND SECTIONS AS ISLANDS PAGE 2

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR WINTER STEELHEAD - FRY

	Q	NO COV	OHC	SM OBJ	LG OBJ	COMBO	SUM
1	25	36805	16307	0	21790	25244	100145
2	50	42488	29453	78	27012	30050	129080
3	100	49470	52287	497	36939	38997	178190
4	200	57007	75435	1680	54869	55733	244724
5	350	53624	72840	11397	72371	73695	283927
6	500	57626	80677	13612	86037	85775	323726
7	750	42776	76006	17617	97045	88449	321892
8	1000	44224	66900	17214	99282	87951	315571
9	1500	33173	51387	11575	93601	84917	274652
10	2000	30240	45082	9715	89564	78887	253487
11	3000	41442	52684	8969	99457	85295	287847
12	4000	40433	52567	9092	91380	74054	267526
13	6000	38948	52588	9178	75138	53161	229013

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

SAMPLE OUTPUT TERMINATED HERE FOR BREVITY.

Figure VII.4 Sample output from the HABOUTS program.

LSTCP Program

I. INTRODUCTION

The LSTCP program reads a FISHCRV file and writes a file with one species set per page. The species indicator is the first four numbers assigned as the curve set ID number (family and species); the last two numbers indicate life stage. Therefore, all curve sets using the same first four numbers as a curve set ID number will be listed on the same page.

II. RUNNING LSTCP

RLSTCP,FISHCRV,ZOUT

FISHCRV=formatted curves file (input)
ZOUT=LSTCP results (output)

ENTER 1 FOR A BINDING EDGE, 2 FOR NO BINDING EDGE

The binding edge is on the top of the paper.

If "1" is entered for a Binding Edge:

HOW MANY LINES FOR BINDING EDGE

```
DATE - 88/01/28      TIME - 22.31.48.                          PAGE -  1

RECREATION SUITABILITY OF USE CRITERIA - SALMON RIVER STUDY
H 720101 10  6  5  0 BOATING                             TUBING
V 720101  0.00  0.52  1.00  1.00  2.00  1.00  4.00  1.00  5.00  1.00  6.00  0.80
V 720101  8.00  0.50  9.00  0.00 10.00  0.00100.00  0.00
D 7?0101  0.00  0.00  0.50  0.00  1.00  0.00  2.00  1.00 10.00  1.00100.00  1.00
S 720101  0.00  1.00  5.00  1.00 10.00  1.00 15.00  1.00100.00  1.00
H 720102 10 11  5  0 BOATING                             CANOEING
V 720102  0.00  0.60  0.40  1.00  2.00  1.00  4.00  1.00  6.00  1.00  7.00  1.00
V 720102  8.00  0.80  9.00  0.52 10.00  0.00100.00  0.00
D 720102  2.50  1.00  3.00  1.00  4.00  1.00 10.00  1.00100.00  1.00
S 720102  0.00  1.00  5.00  1.00 10.00  1.00 15.00  1.00100.00  1.00
```

The following would appear on the second page.

```
DATE - 88/01/28      TIME - 22.31.48.                          PAGE -  2

RECREATION SUITABILITY OF USE CRITERIA - SALMON RIVER STUDY
H 720201  9  9  5  0 WATER CONTACT                        SWIMMING
V 720201  0.00  0.56  0.30  1.00  0.80  1.00  1.00  0.94  2.00  0.50  3.00  0.00
V 720201  4.00  0.00 10.00  0.00100.00  0.00
D 720201  0.00  0.00  1.00  0.00  2.00  0.00  2.50  0.00  3.00  0.50  3.50  0.80
D 720201  4.00  1.00 10.00  1.00100.00  1.00
S 720201  0.00  1.00  5.00  1.00 10.00  1.00 15.00  1.00100.00  1.00
```

Figure VII.5. Sample output from the LSTCP program.

VIII. REFERENCES AND OTHER RELATED REPORTS

Anonymous. 1981. Instream flow field techniques manual. Cooperative Instream Flow Group. Revised.

Bartholow, J.M. 1989. Stream temperature investigations: field and analytic methods. Instream Flow Information Paper No. 13. U.S. Fish Wildl. Serv. Biol. Rep. 89(17). 139 pp.

Bartholow, J.M., and T.J. Waddle. 1986. Introduction to stream network habitat analysis. Instream Flow Information Paper No. 22. U.S. Fish Wildl. Serv. Biol. Rep. 86(8). 242 pp.

Bovee, K.D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Methodology. Instream Flow Information Paper No. 12. U.S. Fish Wildl. Serv. FWS/OBS-82/26. 248 pp.

Bovee, K.D. 1986. Development and evaluation of habitat suitability criteria for use in the Instream Flow Incremental Methodology. Instream Flow Information Paper No. 21. U.S. Fish Wild. Serv. Biol. Rep. 86(7). 235 pp.

Control Data Corporation. NOS Reference Manual, Vol. 1. CDC Manual No. 60435-400.

Control Data Corporation. NOS Reference Manual, Vol. 2. CDC Manual No. 60445-300.

Control Data Corporation. NOS Time-sharing user's guide. CDC Manual No. 60436-400.

Control Data Corporation. NOS Time-sharing user's reference. CDC Manual No. 60435500.

Control Data Corporation. XEDIT Reference Manual. CDC Manual No. 60455730.

Cooperative Instream Flow Service Group. 1979. IFG incremental methodology overview. U.S. Fish Wild. Serv. W/IFG-80/31. 20 minute slide-tape program on the incremental methodology.

Cooperative Instream Flow Service Group. 1980. IFG incremental methodology - site selection. U.S. Fish Wildl. Serv. W/IFG-83/W09. 15 minute slide-tape program on the incremental methodology.

Crance, J.H., and J. Shoemaker. 1986. 18-minute slide-tape on development and use of suitability index curves for use in instream flow studies. U.S. Fish Wildl. Serv. NEC-86/21. 27 pp.

Milhous, R.T. 1978. A computer program for the determination of average hydraulic and shape parameters of a stream cross section (IFG1A). U.S. Fish Wildl. Serv., National Ecology Research Center, Fort Collins, Colorado. 71 pp.

Milhous, R.T. 1983. Instream flow values as a factor in water management. Pages 231-237 in R.J. Charbeneau and B.P. Popkin, eds. Regional and State water resources planning and management. American Water Resources Association, Bethesda, MD.

Milhous, R.T. 1986. Comparison of minimum instream flow needs. Pages 2089-2097 in M. Karamouz, G.R. Baumli, and W.J. Brick, eds. Water from '86: world water issues in evolution. ASCE, New York.

Milhous, R.T. 1987. Discussion of hydraulics of high-gradient streams. Journal of Hydraulic Engineering, Vol. 113, No. 7, American Society of Civil Engineers, New York. pp. 921-923.

Milhous, R.T. [1989.] Hydraulics in the Physical Habitat Simulation System. Instream Flow Information Paper No. 19. In preparation.

Milhous, R.T., D.L. Wegner, and T. Waddle. 1981. User's guide to the Physical Habitat Simulation System (PHABSIM). Instream Flow Information Paper No. 11. U.S. Fish Wildl. Serv. FWS/OBS-81/43 (revised). 475 pp.

Nestler, J.M., J. Fritschen, R.T. Milhous, and J. Troxel. 1986. Effects of flow alterations on trout, angling, and recreation in the Chattahoochee River between Buford Dam and Peachtree Creek. Technical Report E-86-10, Water Experiment Station, U.S. Army Corps of Engineers, Vicksburg, MS. 73 pp.

Nestler, J.M., R.T. Milhous, and J.B. Layzer. [1989.] Instream habitat modeling techniques. In J. Gore, ed. Alternatives in regulated river management. CRC Publishing Co., Boca Raton, Florida. In preparation.

Rantz, S.E., and others. 1982. Measurement and computation of streamflow. U.S. Geological Survey Water Supply Paper 2175. Washington, DC.

Stalnaker, C.B. 1980. The use of habitat structure proterenda for establishing flow regimes necessary for maintenance of fish habitat. Pages 321-337 in J.F. Ward and J.A. Stanford, eds. The ecology of regulated streams. Plenum Publishing Corporation, New York, NY.

Theurer, F.T., K.A. Voos, and W.J. Miller. 1984. Instream water temperature model. Instream Flow Information Paper No. 16. U.S. Fish Wildl. Serv. FWS/OBS-84/15. 372 pp.

U.S. Army Corps of Engineers. 1985. HEC-2 water surface profiles user's manual. Hydrologic Engineering Center, U.S. Army Corps of Engineers, 609 Second St., Davis, California.

U.S. Bureau of Reclamation. 1968. Guide for application of the water surface profile computer program. Hydrology Branch, Denver, CO. 36 pp.