Draft

WinTR-20 User Guide

Revision Date: July 23, 2004

Preface

The WinTR-20 Computer Program for Project Formulation Hydrology version 1.00 has been revised to operate with Windows Interface. This user guide will assist the new or occasional users prepare and run the program

This version of WinTR-20 is improved over the old version of TR-20 February 1992 version with the following features:

- Inclusion of Windows interface
- Updated computational coding
- Muskingum-Cunge reach routing for channel reaches
- Transforms old TR-20 input data to new WinTR-20 format
- HEC-RAS Reformatter that transforms HEC-RAS output profile data to WinTR-20 stream cross section data

Please report any problems you find to the WinTR-20 development team at tr20team@wcc.nrcs.usda.gov or the hydraulic engineer in your state.

Acknowledgments

One of the great pleasures of wrinting this User Guide is acknowleding the efforts of many people whose names may not appear on this cover, but whose hard work, cooperation, friendship and understanding were crucial to the production of this User Guide.

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Chapter 1 Introduction

1.1 Program Description

The WinTR-20 model is a storm event surface water hydrologic model applied at a watershed scale. The model assists in the hydrologic evaluation of flood events for use in the analysis of water resource projects. It can be used to analyze current watershed conditions as well as assess the impact of proposed changes (alternates) made within the watershed. Multiple storms (or rainfall frequencies) can be analyzed within one model run. A summary table for all alternates and storms within the run can be produced. Direct runoff is computed from watershed land areas resulting from synthetic or natural rain events. The runoff is routed through channels and/or impoundments to the watershed outlet.

1.2 Brief History

Natural Resource Conservation Service (NRCS) hydrology techniques are based upon unit hydrograph theory and the runoff curve number method of calculating direct runoff from the rainfall occurring over specified areas (National Engineering Handbook, Part 630, Hydrology, NEH-630.10 and 630.16). The Soil Conservation Service (SCS) and the Agricultural Research Service (ARS) developed the background theory and verification studies for these in the 1940's and 1950's. In the beginning, all necessary computations were done by hand or by calculators and an analysis of a sizeable watershed typically took weeks or months. In the 1960's, the agencies cooperated to hire C-E-I-R, Inc. to write a computer program in FORTRAN for the IBM 360 mainframe computer system (1964). This reduced calculation time enormously and allowed analysis of complex subwatershed systems to proceed much more rapidly even though the engineer still had to collect the data, code it onto punch cards and get it to the mainframe location system for processing. In the early 1980's, the program code was updated to FORTRAN 77 for use on the personal computers that were becoming a standard office fixture. The document describing this program was released as an SCS technical release TR-20 "Computer Program for Project Formulation Hydrology" in 1982 (SCS, 1982). Engineers then were able to run the program (version 83(.9) dated 1986) at their own desk. Numerous minor modifications and additions were made to TR-20 for the next 12 years and several draft versions with improvements had a limited distribution. In late 1998, a WinTR-20 work group was organized to develop the next generation of the program, suitable for triumphant entry into the new millennium and utilizing the expanded capabilities of the latest new computer technologies (windows format).

1.3 Model Overview

The major components of the WinTR-20 System are shown in Figure 1. The program components (rectangular boxes) are 1) the Controller/Editor which allows the running of the other program components and the entry/editing of data for the WinTR-20 model, 2) the WinTR-20 model which is the heart of the system and performs the rainfall-runoff and watershed routing calculations, 3) the Data Converter which transforms old TR-20 input data to the new input format accepted by the WinTR-20 model, and 4) the HEC-RAS Reformatter which transforms HEC-RAS output profile data to WinTR-20 stream cross section data. The remaining rectangles (WinTR-20 GIS Input Generator and FLOOD ECONOMICS) represent programs for which direct links with the WinTR-20 system do not exist at this time and which are not covered in this manual.

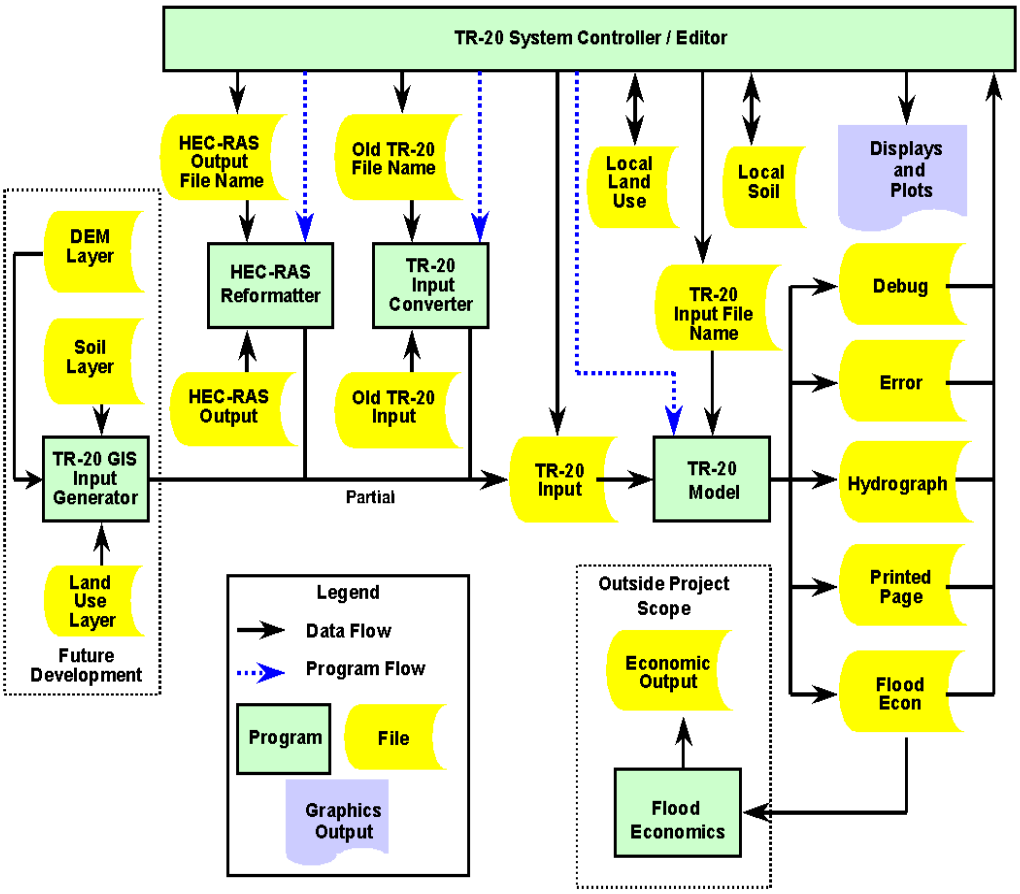


Figure 1.1: WinTR-20 System Diagram

1.4 Capabilities and Limitations

WinTR-20 model is a storm event surface water hydrologic model applied at a watershed scale that meets these criteria:

Table 1.1: WinTR-20 Capabilities and Limitations

Variable	Limits
Types of reaches	Channel or Structure
Channel Manning "n"	.005 – 1.00
Reach Routing	Muskingum-Cunge
Sheet Flow Maximum Length	100 feet
Sheet Flow Manning "n"	.005 –1.00
Hydrograph Distribution Increment	>= .01 cfs
Runoff Curve Number	30-100
Weighted Curve Number	30-100

Features of old program that is no longer supported:

1. **Capabilities associated with IPEAKS and PEAKS. IPEAKS was used in conjunction with the modified Att-Kin channel routing where reach lengths were made as long as possible – not available with the present WinTR-20 model. PEAKS was used to obtain peak discharge values at intermediate points between cross sections and/or structures. Reach length is less important with the Muskingum-Cunge reach routing used in the present model and thus the need to determine peak flow at points within a reach is no longer necessary.**

2. **The use of a rain table as a runoff table can be handled by changing affected sub-area CN to 100, which converts all rainfall to runoff.**

3. **A separate Data Check program is no longer needed as data checking is done within the WinTR-20 Controller/Editor model.**

1.5 Minimum Data Requirements

WinTR-20 can handle complex as well as very simple problems such as determining the peak flow for one watershed. Analysis of a simple problem can be set up with a few records. These data include: **WinTR-20 Identifier**-Input Units Code, Output Units Code, Minimum Hydrograph Value, and Watershed Description; **Sub-Area**-Sub-Area Identifier, Sub-Area Reach Identifier, Sub-Area Drainage Area, Sub-Area Weighted Curve Number, Time of Concentration (Tc Details), Select Sub-Area (Peak Output Code, Hydrograph Output Code, Time Analysis Code, and Hydrograph File Code); and **Storm Analysis**-Storm Identifier, Gage Rain Table Identifier(Type I, Type I(48), Type IA, Type II, Type

II(48), Type III, and Type NM (60-75), Gage Antecedent Runoff Condition (1, 2 or 3), 2-Yr 24-Hr Rainfall. (See Example #1 in Chapter 4)

1.6 User Responsibility

Results from the model can be sensitive to the input data. It is the user's responsibility to ensure that all the input data (whether it is actually entered or imploded through default values for blank data fields) is appropriate for the watershed and watershed conditions being analyzed.

1.7 Overview of This Manual

This user's manual is the primary piece of documentation on how to use the WinTR-20 system. The manual is organized as follows:

- Chapters1-2 provide an introduction and overview of WinTR-20 System, and instructions on how to install and uninstall the software.
- Chapter 3 provides a quick overview of the WinTR-20 System.
- Chapter 4 describes the input and output parameters in detail, and describes how to developed user-defined tables.
- Chapter 5 describes the TR-20 Converter and gives a comparison of Old TR-20 and present WinTR-20.
- Chapter 6 describes how the HEC-RAS REformatter operates
- Chapter 7 describes how the HEC-RAS Reformatter operates.
- Appendix A contains a list of references.
- Appendix B contains a list of Errors and Warning Messages.

Chapter 2 Installing of TR-20 System

2.1 Computer Requirements

The Controller/Editor is the one part of the WinTR-20 system that is Windows® based (Windows® 95/98, NT, 2000 or XP when tested) and therefore is sensitive to the computer display environment. For best viewing set the monitor resolution to 1024 x 768 and the number of colors to greater than 256. If your computer monitor will not support these requirements, the software will also run with a resolution of 800 x 600 with 256 colors. The viewing quality may be diminished with this color selection as the background color around variable names and other labels may not appear the same as shown in the figures in this manual.

2.2 Installation Procedure

To install the software onto your hard disk does the following:

- Insert the WinTR-20 CD into the CD drive.
- The setup program should run automatically when the user clicks on the WinTR-20 CD.
- If the setup program does not run, use the window explorer to start the **setup.exe** program from the CD.
- Follow the setup instructions on the screen.

The setup program will automatically create a program group called WinTR-20. The WinTR-20 program will be listed under the **Programs** menu, which is located on the **Start** menu.

2.3 Uninstall Procedure

To uninstall the software, do the following:

- From the **Start Menu** select **Settings** and then **Control Panel**.
- From the **Control Panel** folder select **Add/Remove Programs**.
- From the Tab marked as **Install/Uninstall** select the WinTR-20 program, and then press the **Add/Remove** button.
- Follow the uninstall direction on the screen and the software will be removed from your hard drive.

Chapter 3 Users Overview

The WinTR-20 Watershed Hydrology Model is an NRCS computer program developed to predict the runoff resulting from rainfall over a watershed. The WinTR-20 model is the heart of the system and computes the runoff hydrographs, and performs channel and structure routings for the watershed.

This chapter provides a quick overview of how a project is performed with the WinTR-20 software. Special topics on how the WinTR-20 Converter, and how to use on-line help are also covered.

Contents

- Starting WinTR-20
- Steps in Using the WinTR-20 System Controller / Editor
  1. Starting a New Project
  2. Using Data Section Name List on the Main Window to Enter Data
  3. Saving Input Data
  4. Performing WinTR-20 Calculations
  5. Viewing and Printing Results
- WinTR-20 Converter
- HEC-RAS Reformatter

3.1 Starting WinTR-20

When you run the WinTR-20 Setup program, you will get a new group of programs called **WinTR-20** and a program icon called **WinTR-20**. The WinTR-20 should appear in the start menu under **Programs**. A shortcut can be created, and the icon for WinTR-20 will look like the following:

Figure 3.1: The WinTR-20 Icon for Windows

To Start WinTR-20 from Windows:

- Go to **Start** menu and select Programs, then select **WinTR-20**. Double click on the WinTR-20 Icon

When you start up the WinTR-20 program, the WinTR-20 System Controller / Editor Main Window appears as shown in Figure 3.2 (with the **Disclaimer Statement** and **New User? Click Here).**

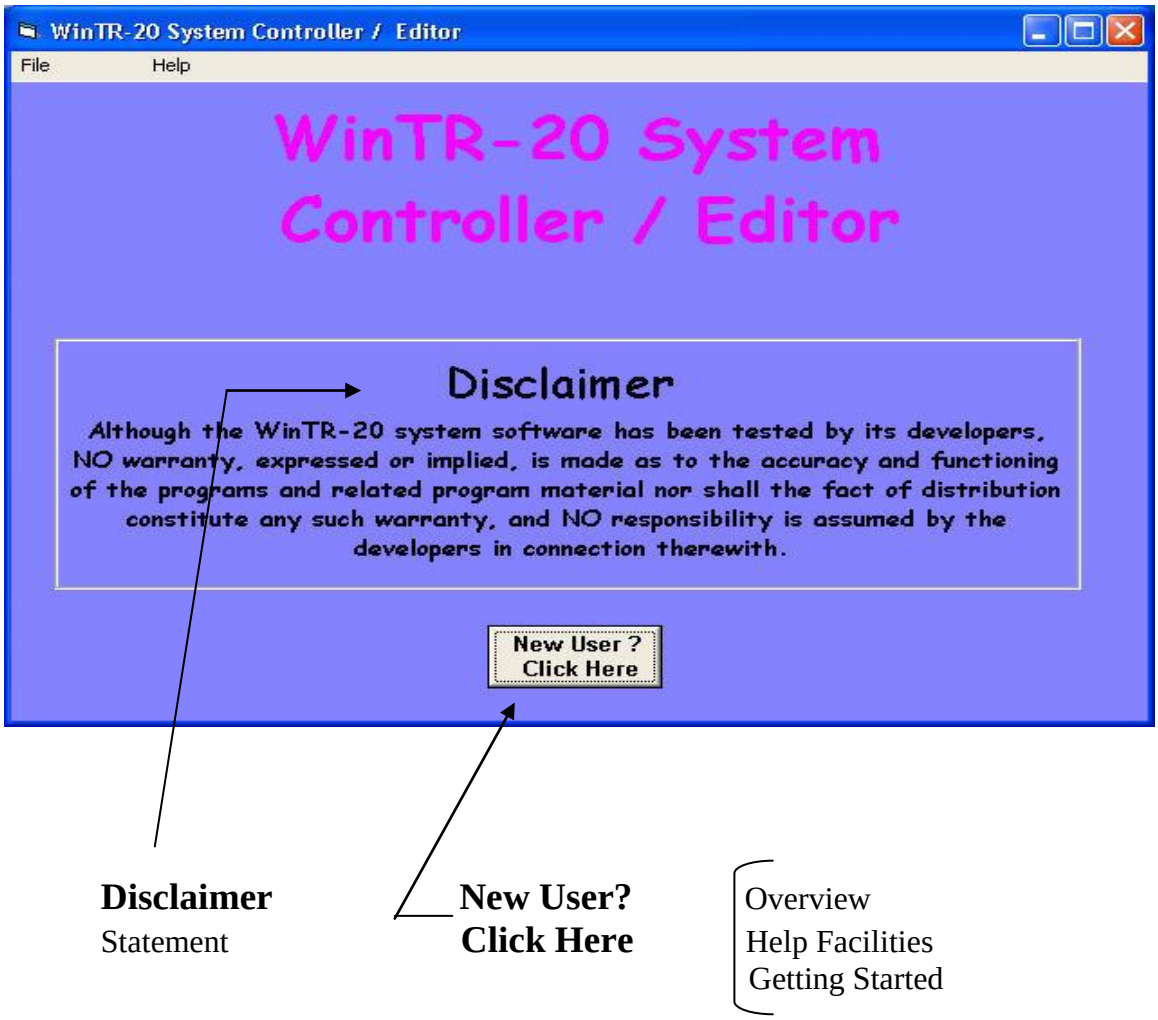


Figure 3.2: The WinTR-20 System Controller / Editor Main Window

Clicking on the **New User? Click Here** button or the **Help** button in the menu bar will make the Overviews, Help Facilities and Getting Started Help Windows (Figure 3.3 – 3.5) available.

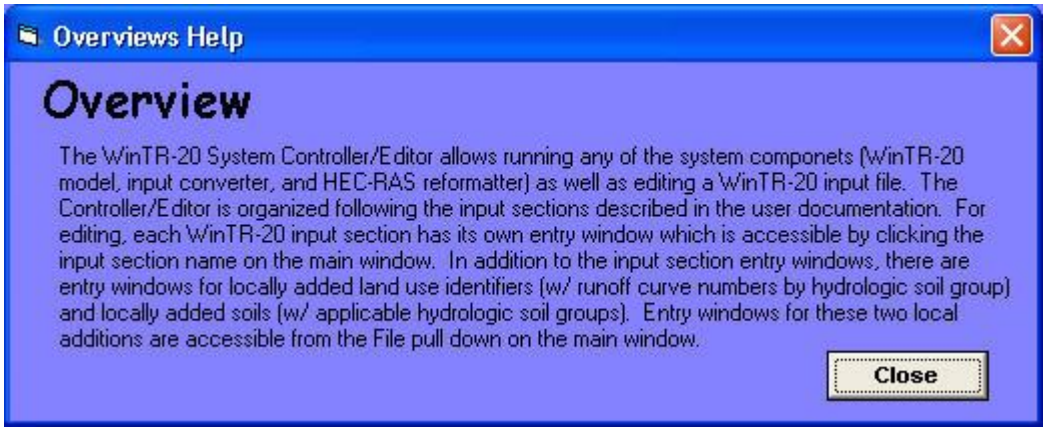


Figure 3.3: Overview Help Screen

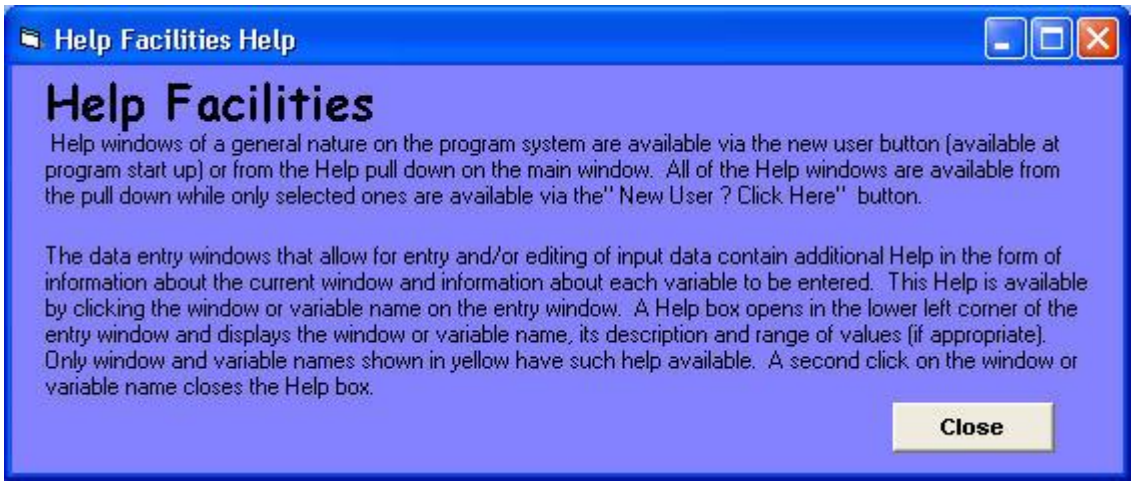


Figure 3.4: Help Facilities Window Screen

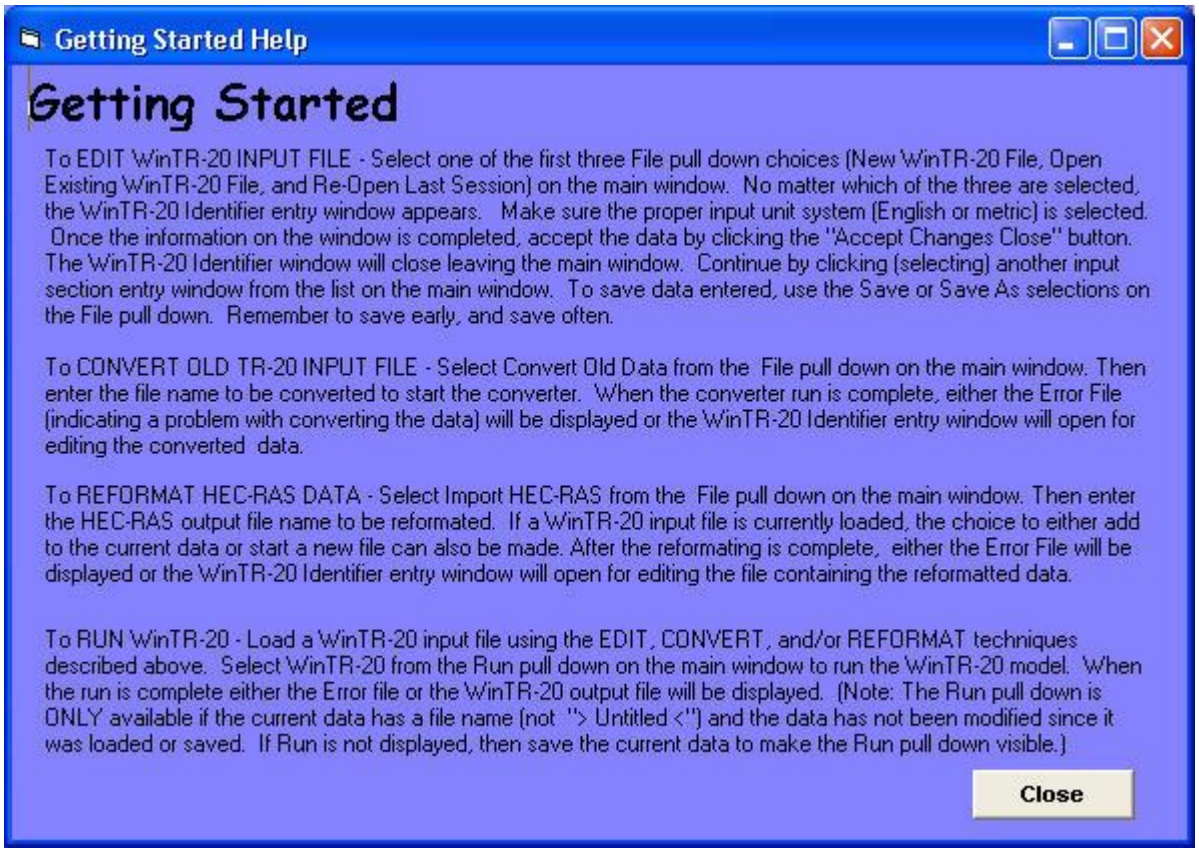


Figure 3.5: Getting Started Window Screen

Clicking on the File button on the Main Window opens a menu that will allow the user to start developing a dataset (see Figure 3.6). After initiating the dataset the famous TR-20 main window is available:

File Menu

New WinTR-20 File
Open Existing TR-20 File
ReOpen Last Session

Covert old Data
Import HEC-RAS

Local Land Use
Local Soil / HSG

Save
Save As

Exit

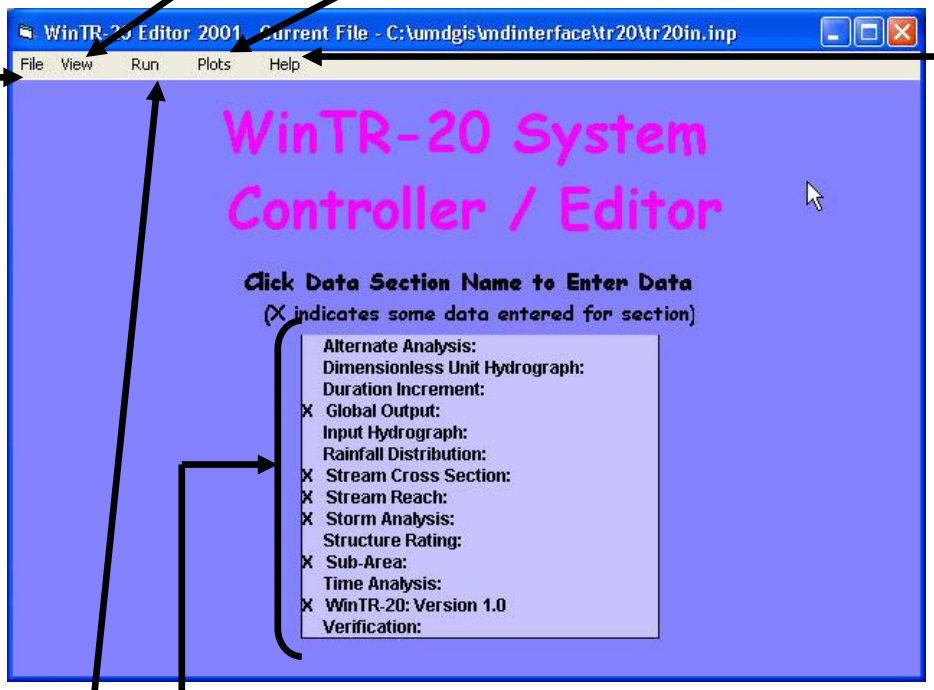
View Menu

Schematic
Input File

Printed Page File
Error File
Debug File
Hydrograph File
FloodEcon File

Plots Menu

(See Figure 3.7)
Graphics Output Window



Run

Performs
Calculation

Data Section Name to Enter Data

Alternative Analysis:
Dimensionless Unit Hydrograph:
Duration Increment:
Global Output:
Input Hydrograph:
Rainfall Distribution:
Stream Cross Section:
Stream Reach:
Storm Analysis:
Structure Rating:
Sub-Area:
WinTR-20 Version 1.00
Verification:

Help Menu

WinTR-20 System Diagram

Overview
Help Facilities
Getting Started

About Control / Editor

Figure 3.6: The WinTR-20 System Controller / Editor Main Window Button Bar

Clicking on **Plots** on the menu bar of the main window brings the Graphic Output window to the screen. The user must then select Graphic Type, or Multiple Hydrographs. Graphic Types includes Hydrograph, Peak Flow, and Time Analysis (Default on Hydrograph). Multiple Hydrographs choices include None, Storm, Alternate and Location (the Default is None).

Figure 3.7: Graphic Output Window

The WinTR-20 System Controller / Editor Main Window Button Bar (Figure 3.6) has the following options:

File: This set up for file management. Options available under the File menu includes: New WinTR-20 File, Open Existing WinTR-20 File, ReOpen Last Session, Covert old Data, Import HEC-RAS, Local Land Use, Local Soil / HSG, Save, Save As, and Exit.

View: The view menu currently includes: Schematic, Input File, Printed Page File, Error File, Debug File, Hydrograph File, and FloodEcon File.

Run: This option is used to perform the WinTR-20 calculations

Plots: The plots menu currently includes: Graphical Type (Hydrograph, Peak Flow, and Time Analysis), and Multiple Hydrographs (None, Storm, Alternate, and Location).

Help: This allows the user to get a display showing help information about the WinTR-20 System. Help files available under the Help menu includes WinTR-20 System Diagram, Overview, Help Facilities, Getting Started, and About Control / Editor (See Figures 3.3 - 3.5).

Data Section Name to Enter Data: The data section name list includes: Alternate Analysis, Dimensionless Unit Hydrograph, Duration Increment, Global Output, Input Hydrograph, Rainfall Hydrograph, Stream Cross Section, Stream Reach, Storm Analysis, Structure Rating, Sub-Area, Time Analysis, WinTR-20 Conversion, and Verification. By clicking on a Data Name the user brings up the window that allows data entry on the corresponding window. **Note: An X indicates some data entered for section.**

3.2 Steps in Using the WinTR-20 System Controller / Editor

- Starting a New WinTR-20 File
- Data Section Name to Enter Data
- Saving Data
- Performing the WinTR-20 calculations
- Viewing and printing results

Starting a New WinTR-20 File

Double-click on the WinTR-20 Icon. This will bring up the WinTR-20 System Controller/Editor window shown in Figure 3.9.

Figure 3.8: WinTR-20 Icon in Windows

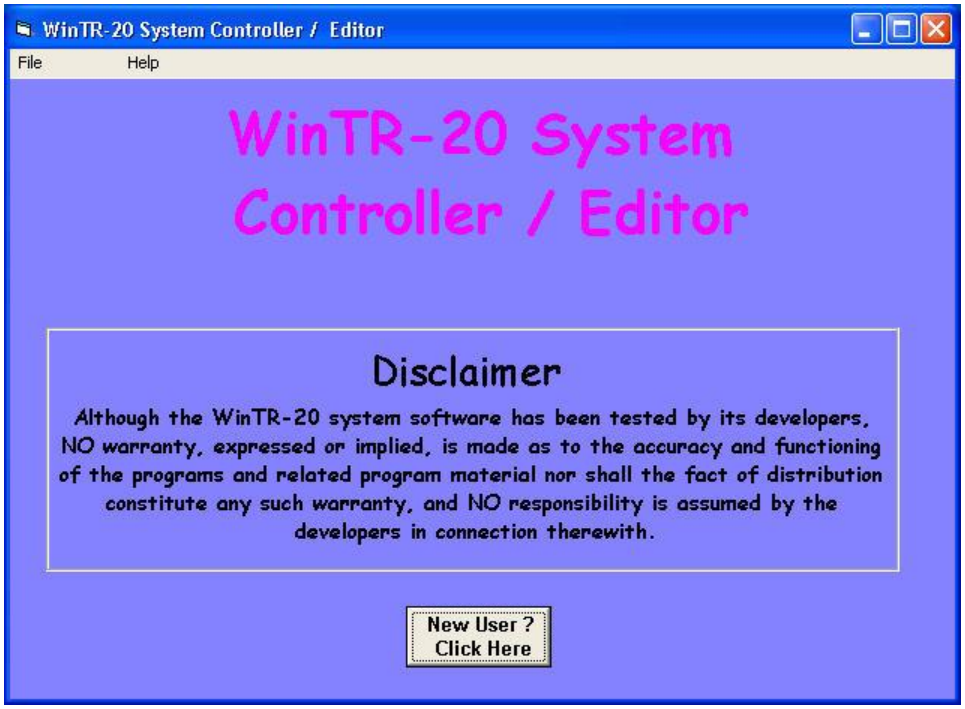


Figure 3.9: The WinTR-20 Main Window

To start a new project, Click on **File** menu on the main WinTR-20 System Controller / Editor window and select- **New WinTR-20 File (**Figure 3.10). This will bring up the WinTR-20 Identifier window as shown in Figure 3.11. Clicking on the Open Existing WinTR-20 File or ReOpen Last Session menu choices will bring up the WinTR-20 Identifier Window, which will contain (previously entered data). Click on **No Changes** (**Close)** or **Accept Changes (Close)**.

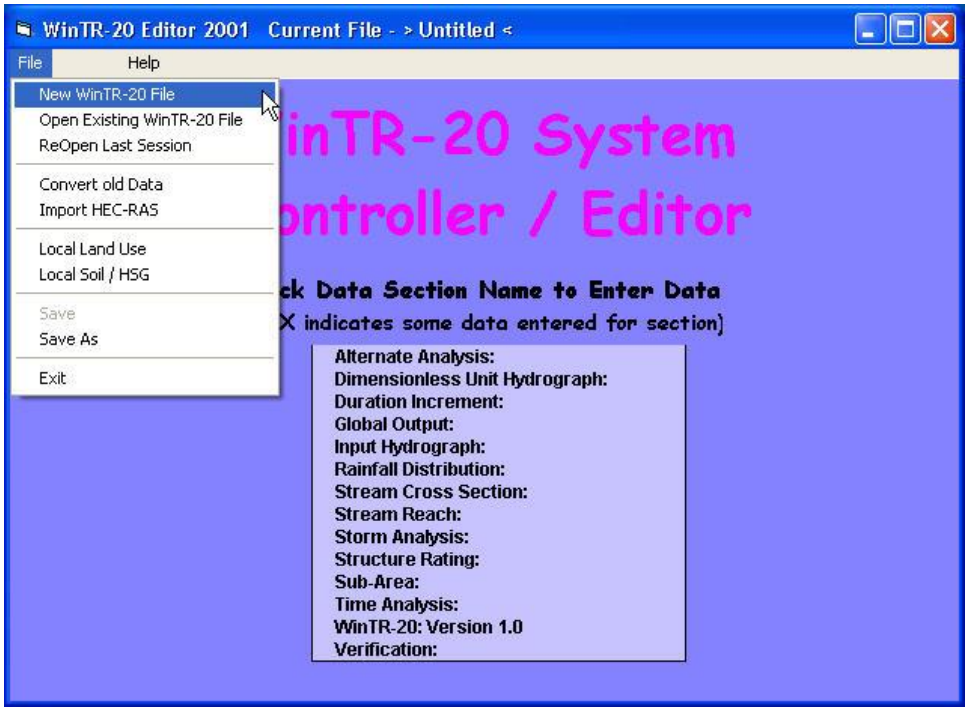


Figure 3.10: New WinTR-20 File Window

WinTR-20 Identifier window allows the user to **No Changes** or **Accept Changes** the Default Parameters, for Input Units Code (English or Metric), Output Units Code (English or Metric), and the Minimum Hydrograph Value (the default is 0.0). Users are encouraged to enter descriptive notes in the Watershed Description lines to help identify the files later. Click **No Changes (Close) or Accept Changes (Close).**

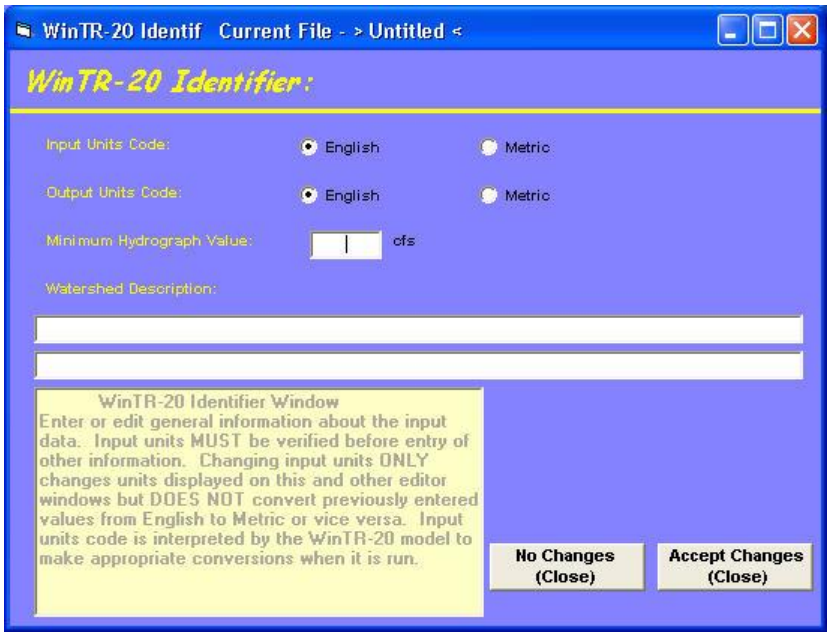
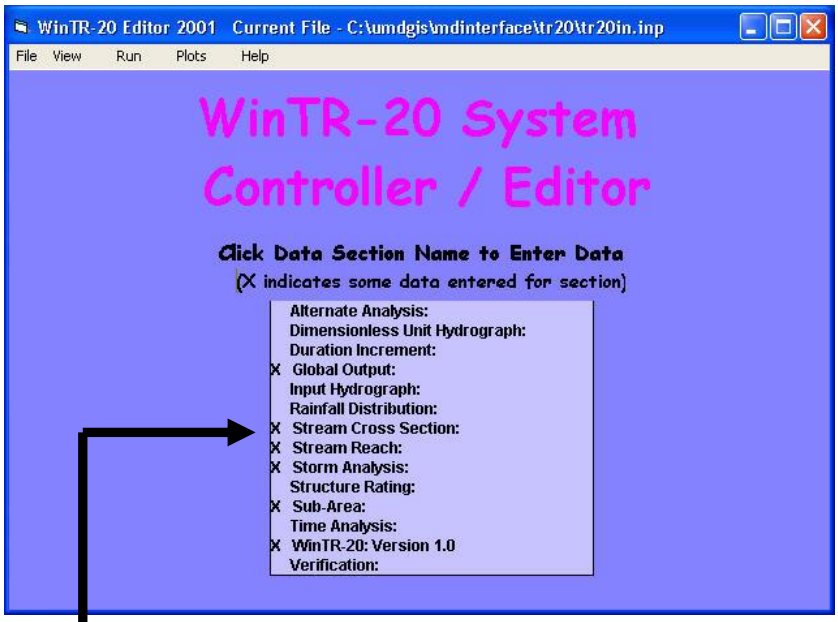


Figure 3.11: WinTR-20 Identifier Window

Data Section Name List

The next step is to enter the necessary data. Choose from the data section names list, which consists of Alternative Analysis, Dimensionless Unit Hydrograph, Duration Increment, Global Output, Input Hydrograph, Rainfall Distribution, Stream Cross Section, Stream Reach, Storm Analysis, Structure Rating, Sub-Area, Time Analysis, and Verification. Selecting the **Data Section Name** desired brings up a data entry window for that particular data.

Note: After the data are entered and accepted by the user, the user will see the X displayed on the left side of the data section name. **X indicates that there are some data entered from the user**. See Figure 3.12 shown below.



Data Section Name to Enter Data

Alternate Analysis:
Dimensionless Unit Hydrograph:
Duration Increment:
Global Output:
Input Hydrograph:
Rainfall Distribution:
Stream Cross Section:
Stream Reach:
Storm Analysis:
Structure Rating:
Sub-Area:
Time Analysis:
WinTR-20 Version 1.0
Verification:

Figure 3.12: Data Section Name to Enter Data Main Window

The basic data required for each of the options from the WinTR-20 System Controller / Editor for the Data Section Name to Enter Data Main Window (Figure 3.12) is as follows:

Note: The data entry windows that allow for entry and/or editing of input data contain additional Help in the form of the information about the current window and information about each variable to be entered. This Help is available by clicking the window or variable name on the entry window. A Help box opens in the lower left corner of the entry window and displays the window or variable name, its description and range of values (if appropriate). Only window and variable names show in **yellow** have such help available. (See Figure 3.13)

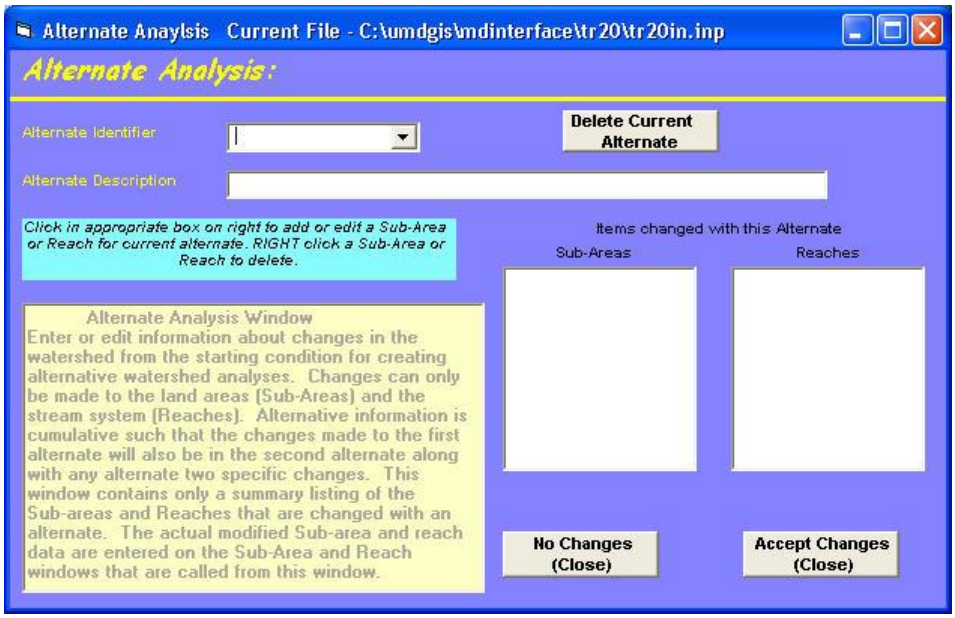


Figure 3.13: Additional Help Window

Alternate Analysis:

To enter alternative analysis data, click on the **Alternate Analysis** from the data section name list (Figure 3.6). Once the alternative analysis is selected, the Alternate Analysis Data Editor window will appear as shown in Figure 3.14 (your alternative analysis editor will come up with a blank window until you have entered the alternative analysis data).

Note: Changes can only be made to the land areas (Sub-Areas) and the stream system (Reaches).

To generate the alternate analysis for the model, do the following steps:

1. Enter **Alternate Identifier**. Hit Enter

2. Enter **Alternate Description**. Hit Enter

3. Enter the **Sub-Areas and / or Reaches** to be changed (the actual data modifying Sub-Areas and Reaches data are entered on the Sub-Areas and Reach windows that can be called from this window).

4. **Click** on **Accept Changes (Close)** button when done for the interface to accept the data.

5. Also, the user could delete the current alternate by clicking on **Delete Current Alternate** then repeating steps one through four as desired.

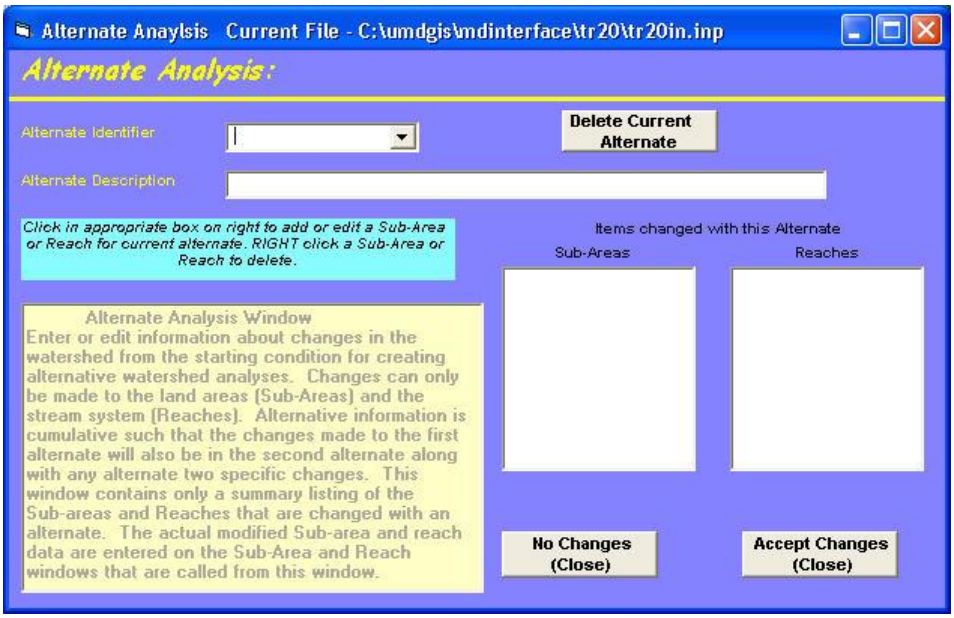


Figure 3.14: Alternate Analysis Window

Dimensionless Unit Hydrograph:

To enter dimensionless unit hydrograph data, click on the **Dimensionless Unit Hydrograph** from the data section name list (Figure 3.6). The Dimensionless Unit Hydrograph window will appear as shown in Figure 3.15 (your dimensionless unit hydrograph editor will come up with a blank window until you have entered the Dimensionless Unit Hydrograph Data). Any data entered here will be used in lieu of the standard dimensionless unit hydrograph.

Note: If the SCS standard dimensionless unit hydrograph is desired then no data should be entered on this window.

To generate the dimensionless unit hydrograph for the model, do the following steps:

1. Enter the **Dimensionless Unit Hydrograph** – the first point for the dimensionless unit hydrograph starts with zero and the last point should also be zero. Maximum point values should be 1.0.

   Note: Click grid cell to edit previously entered data. Right click to insert or delete a value.

2. **Display Data** button becomes visible when data has been entered (see figure3.15).

3. Click on **Display Data** button to view the dimensionless unit hydrogaph plot. An example of the Dimensionless Unit Hydrograph window is shown in Figure 3.16.

4. Also, the user could delete the current dimensionless unit hydrograph by clicking on **Delete DimHyd.**

5. Click on **Accept Changes (Close)** button when done for the interface to accept the data.

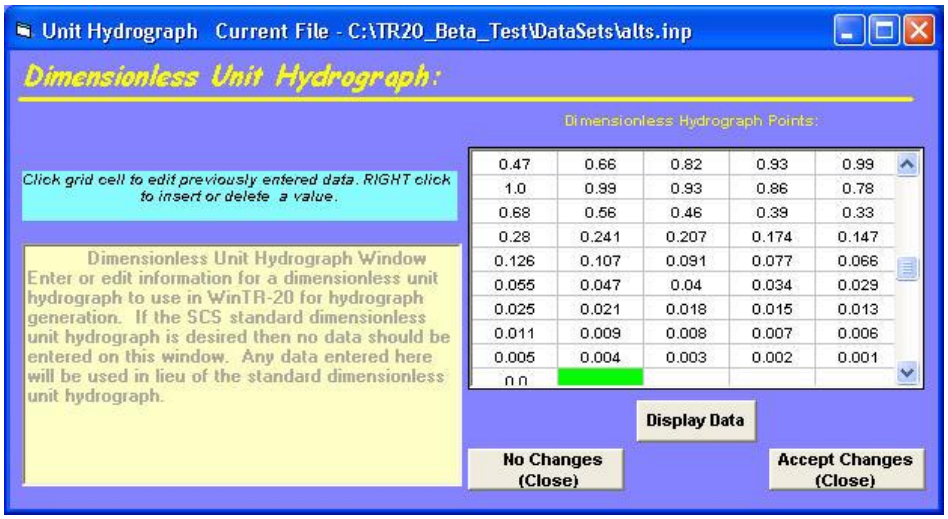


Figure 3.15: Dimensionless Unit Hydrograph Window

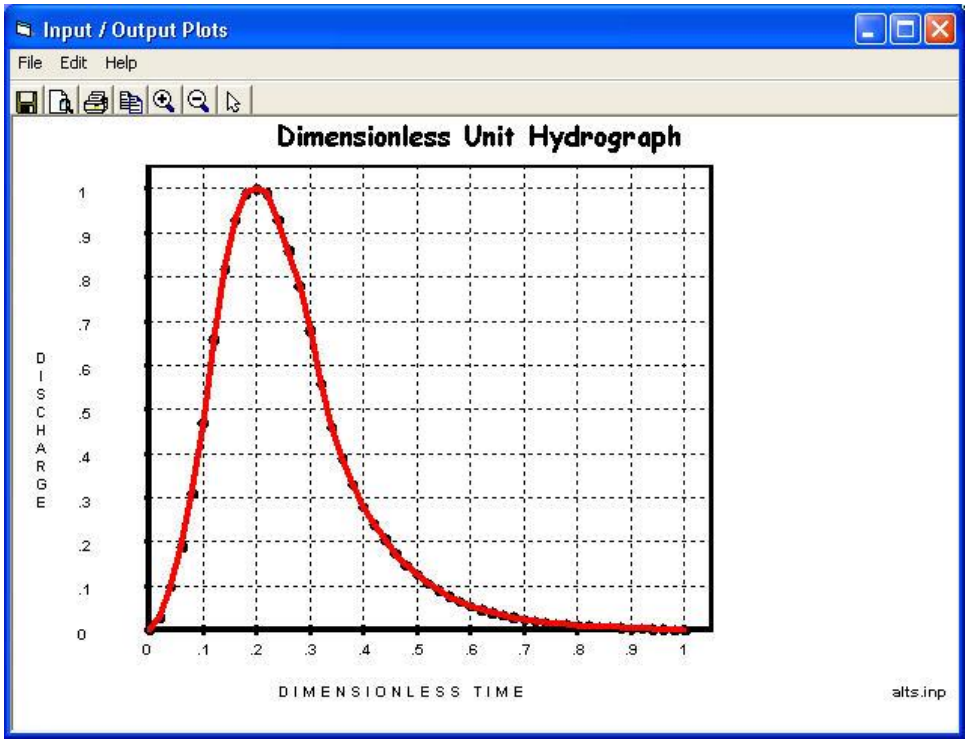


Figure 3.16: Display Data – Dimensionless Unit Hydrograph

Duration Increment:

Data should only be entered on the Duration Increment window if Flood Economics output is desired from WinTR-20. Selecting Yes as the default reach Flood Economic file code (Global Output Window) , or Yes or Blank as the reach Flood Economic file code (Stream Reach Window) will place peak flow and Duration Increment results in the Flood Economics file (***.ecn). To enter duration increment data, the user clicks on **Duration Increment** on the data section name list (Figure 3.6). Once the duration increment is clicked, the Duration Increment Data Editor window will appear as shown in Figure 3.17 (your alternative analysis editor will come up with a blank window until you have entered the duration increment data). To generate a Flood Economic output file from the model, do the following steps:

1. Select the **Duration Units** – either in Hours or Days.

2. Enter the **1st Duration in hour**. Hit Enter

3. Enter the **2nd Duration in hour**. Hit Enter

4. Enter the **3rd Duration in hour**. Hit Enter

5. Click on **Accept Changes (Close)** for the interface to accept the data.

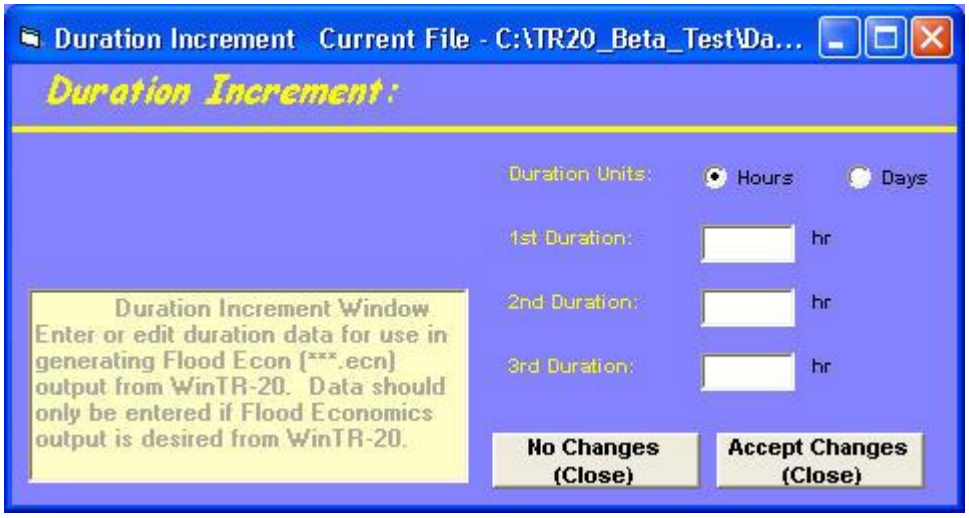


Figure 3.17: Duration Increment Window

Global Output:

To enter the global output, the user clicks on **Global Output** in the Main Window (Figure 3.6). Once this is selected, the Global Output window will appear as shown in Figure 3.18 (your global output editor will come up with some selected default values). To generate the global output for the model, do the following steps:

1. Enter the **Hydrograph Print Precision** – Number of decimal places to use for hydrograph flows in page formatted output. Hit Enter (Blank indicates the default value to1)

2. Enter **Minimum Hydrograph Display Flow** – Value of the smallest hydrograph flow point shown for hydrograph flows in page formatted output. Hit Enter (Blank indicates the default value 0.5 cfs)

3. Enter **Print Time Increment** – Time increment between hydrograph points. Hit Enter (Blank indicates the default value of the hydrograph generation time increment)

4. Select **Peak Output Code** for Sub-Area and Reach (Default values for both are **No**). Selecting **Yes** will produce Peak values for all Sub-Area and Reaches.

5. Select **Hydrograph Output Code** for Sub-Area and Reach (Default values for both are No). Selecting **Yes** will produce Peak values for all Sub-Area and Reaches.

6. Select **Time Analysis Output Code** for Sub-Area and Reach (Default values for both are **No**).

7. Select **Hydrograph File Code** for Sub-Area and Reach (Default values for both are **No**). Selecting **Yes** will produce Peak values for all Sub-Area and Reaches.

8. Select **Flood Economic File** Code for Reach (Default value is **No**). If "**Yes**" selected, then Duration Increment data must be entered.

9. **Click** on **Accept Changes (Close)** for the interface to accept the data.

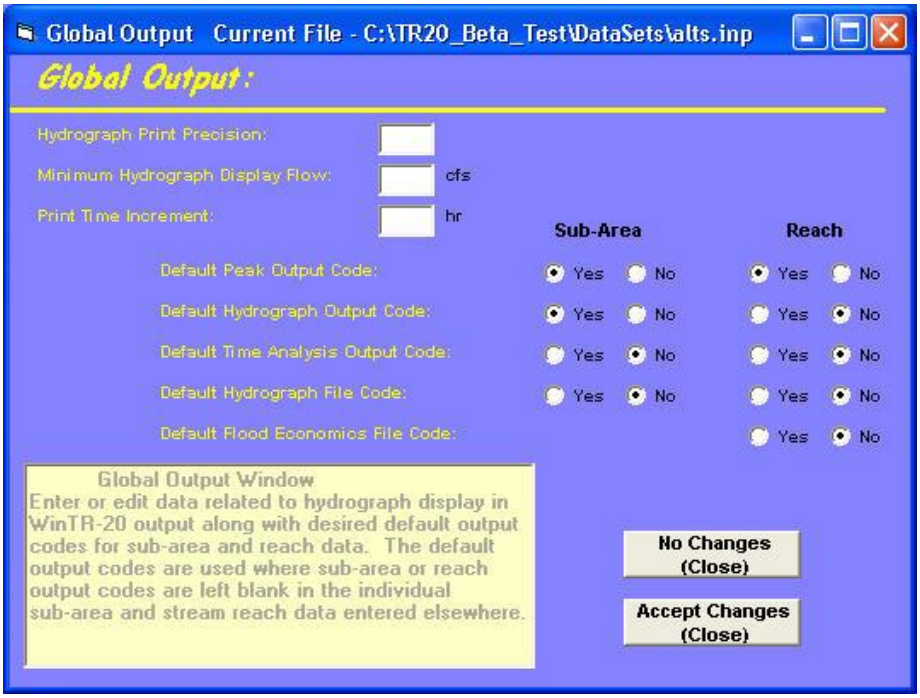


Figure 3.18: Global Output Window

Input Hydrograph:

To enter input hydrograph data, click on the **Input Hydrograph** from Main Window (Figure 3.6). Once the input hydrograph identifier is selected, the Input Hydrograph window will appear as shown in Figure 3.19 (your input unit hydrograph editor will come up with a blank window until you have entered the input hydrograph data).

To generate the input hydrograph for the model, do the following steps:

1. Enter **Input Hydrograph Identifier -** Unique alphanumeric string identifying the hydrograph. Hit Enter.

2. Enter **Input Hydrograph Reach Identifier** – Alphanumeric string identifying the upstream end of the reach where the hydrograph will be added. **This must match a Reach Identifier in the Stream Reach Data**. Hit Enter.

3. Enter **Input Hydrograph Start Time** – Time of the first input hydrograph point. (Blank indicates 0.0 hour). Hit Enter.

4. Enter **Input Hydrograph Time Increment** – Time increment used between the input hydrograph points (should be greater than 0.0). Hit Enter.

5. Enter **Input Hydrograph Drainage Area** (square miles or square kilometers) – Associated with the source of the input hydrograph. (Blank indicates the value is 0.0). Hit Enter.

6. Enter **Input Hydrograph Base Flow** (cubic feet per second or m3/sec) – Associated with the source of the input hydrograph. (Blank indicates 0.0). Hit Enter

7. Enter the **Input Hydrograph Flows** in cfs.

8. **Display Data** button should now be visible.

9. Click on **Display Data** button to view the input hydrograph plot. An example of the Input Hydrograph plot is shown in Figure 3.20.

10. Also, the user could delete the current input hydrograph by clicking on **Delete Hydrograph** then repeating steps one through nine as desired to enter a new input hydrograph.

11. Click on **Accept Changes (Close)** for the interface to accept the data.

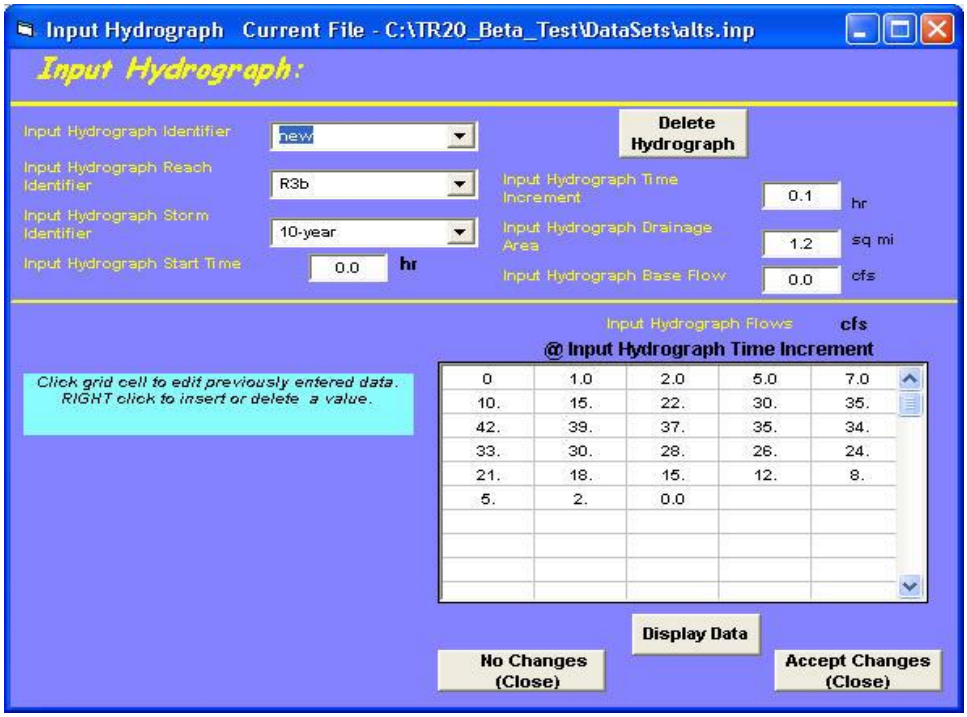


Figure 3.19: Input Hydrograph Window

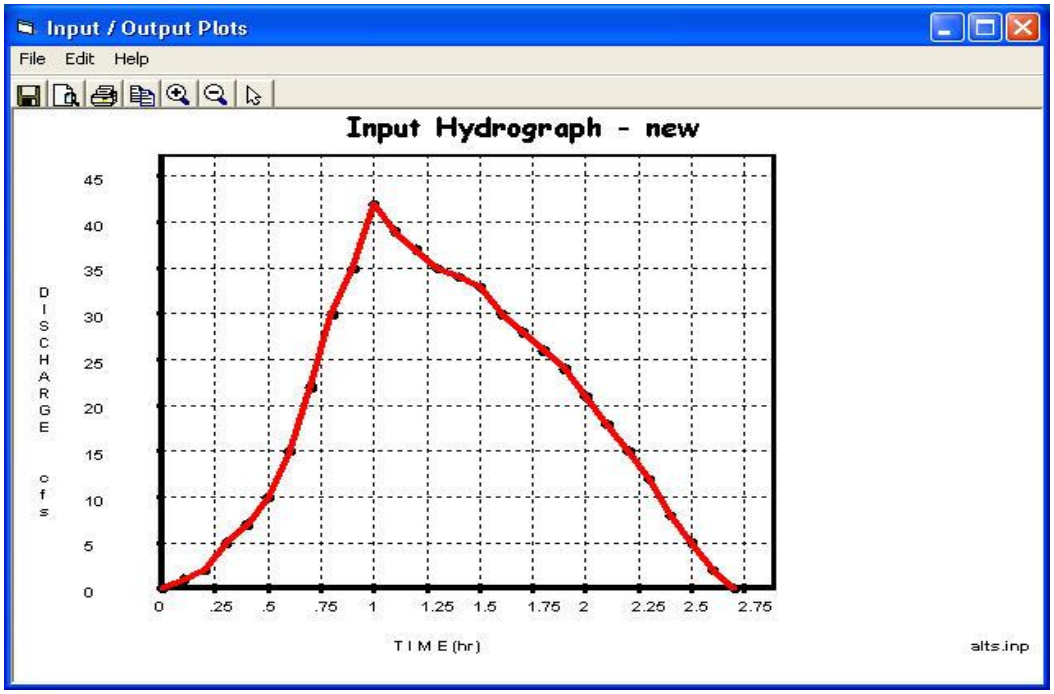


Figure 3.20: Display Data – Input Hydrograph

Rainfall Distribution:

Rainfall distribution can be either an actual storm or dimensionless synthetic storm. To enter rainfall distribution data, click on **Rainfall Distribution** from the Main Window (Figure 3.6). Once the rainfall distribution is selected, the Rainfall Distribution window will appear as shown in Figure 3.21 (your rainfall distribution editor will come up with a blank window until you have entered the rainfall distribution data).

To generate the rainfall distribution for the model, do the following steps:

1. Enter **Rain Table Identifier** – Unique alphanumeric string identifying the Rain Table. Be sure that the identifier name is different from any of the built-in standard rainfall table identifiers (see table 3.1 below). Hit Enter.

2. Enter **Rain Table Time Increment** – Uniform time increment between rain table points (hour). Hit Enter.

3. Enter **Mass Rainfall Points** – First point must be zero and subsequent points must be equal or increase. No blank fields are allowed within the rain table sequence. Rainfall points are considered dimensionless. There are several rainfall distributions built-in the program for users to select from (see Table 3.1 Rainfall Distribution Built-in Tables below). **These standardized rainfall distributions should not be entered here.**

Table 3.1: Rainfall Distribution Built-in Tables

Built-in Rainfall Identifier	Description
Type I	NRCS Type I – 24 hour storm
Type IA	NRCS Type IA – 24 hour storm
Type II	NRCS Type II – 24 hour storm
Type III	NRCS Type III – 24 hour storm
Type I(48)	NRCS Type I(48) – 24 hour storm
Type II(48)	NRCS Type II(48) – 24 hour storm
Type NM60	New Mexico Type IIA – 60 – 24 hour storm
Type NM65	New Mexico Type IIA – 65 – 24 hour storm
Type NM70	New Mexico Type IIA –70 – 24 hour storm
Type NM75	New Mexico Type IIA – 75 – 24 hour storm

4. **Display Data** button should be visible.

5. Click on **Display Data** button to view the rainfall distribution plot. An example of the Rainfall Distribution window is shown in Figure 3.22.

6. Also, the user can delete the current rainfall distribution by clicking on **Delete Distribution** button then repeating steps one through five as desired to enter a new rainfall distribution.

7. **Click** on **Accept Changes (Close)** for the interface to accept the data.

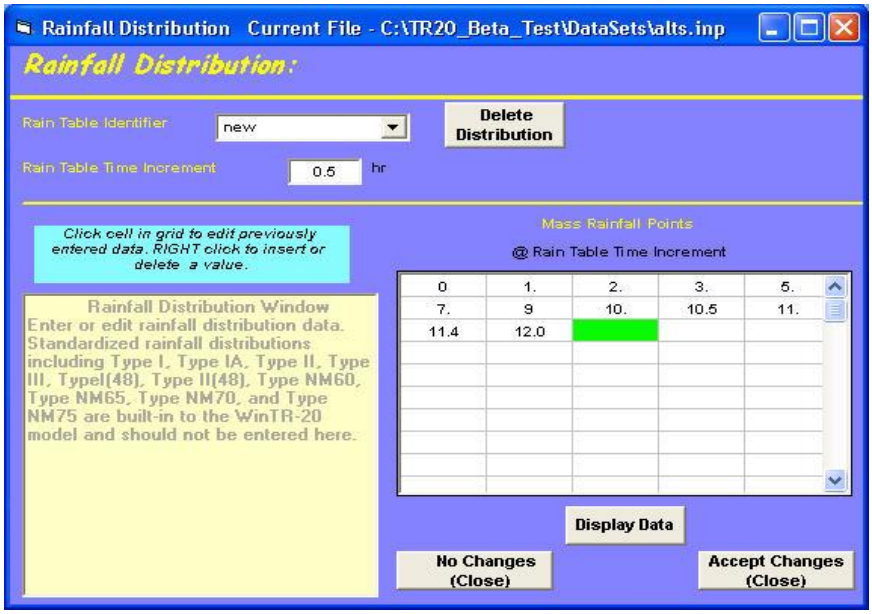


Figure 3.21: Rainfall Distribution Window

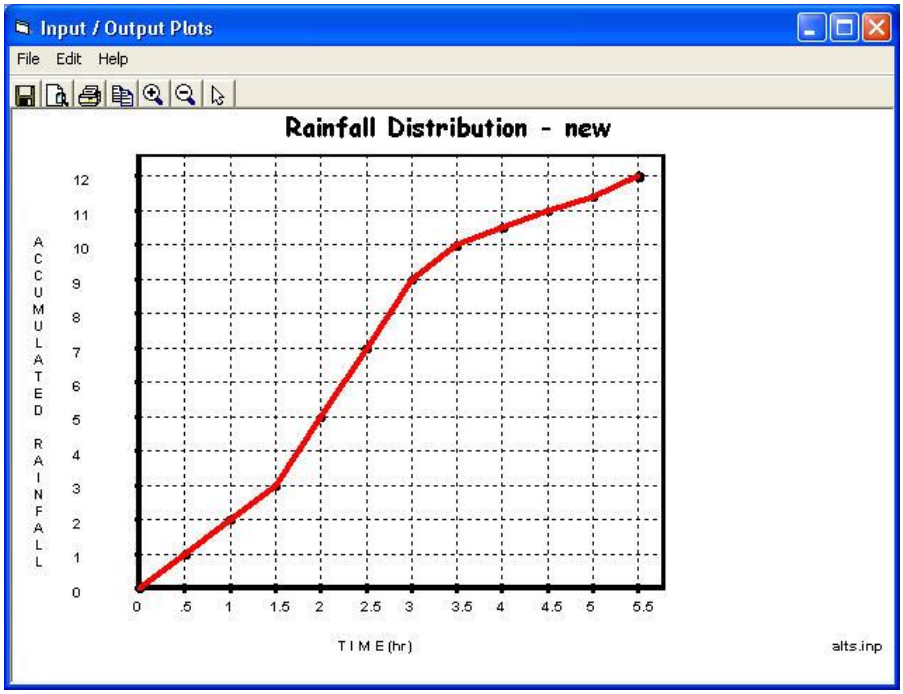


Figure 3.22: Display Data – Rainfall Distribution

Stream Cross Section:

To enter stream cross-section data, click on the **Stream Cross Section** from the Main Window (Figure 3.6). Once stream cross section is selected, the Stream Cross Section window will appear as shown in Figure 3.23 (your stream cross section editor will come up with a blank window until you have entered the rainfall distribution data).

To generate the stream cross section for the model, do the following steps:

1. Enter the **Cross Section Identifier** – Unique alphanumeric string identifying the cross section. Hit Enter

2. Enter **Bankfull Elevation** – Elevation at the top of the lowest blank in the cross section. Hit Enter.

3. Enter **Low Ground Elevation** – Elevation for lowest elevation in flood plain. The ground elevation may be lower than bankfull elevation. (Blank defaults to bankfull elevation). Hit Enter.

4. Enter **Stream Identifier** – Unique alphanumeric string identifying the stream where the cross section is located. Leave blank if Flood Economics output is not desired. Hit Enter.

5. Enter **Stream Station**– Valley station at the lower end of reach that is represented by the cross section. Leave blank if Flood Economics output is not desired. Hit Enter.

6. Enter the following variables for each cross section – Cross Section Elevation (feet), Cross Section Discharge (cfs), Cross Section End Area (sq.ft.), Cross Section Top Width (feet), and Cross Section Slope (dimensionless). Also, HEC-RAS Reformatter takes the HEC-RAS output file and develops rating a table formatted for WinTR-20. (See Chapter 6).

7. **Display Data** button should now be visible.

8. Click on **Display Data** button to view the cross section plot. An example of the Cross Section plot is shown in Figure 3.24.

9. Also, the user could delete the current stream cross section by clicking on the **Delete Cross Section** button then repeating steps one through eight as desired to enter a new stream cross section.

10. Click on **Accept Changes (Close)** for the interface to accept the data.

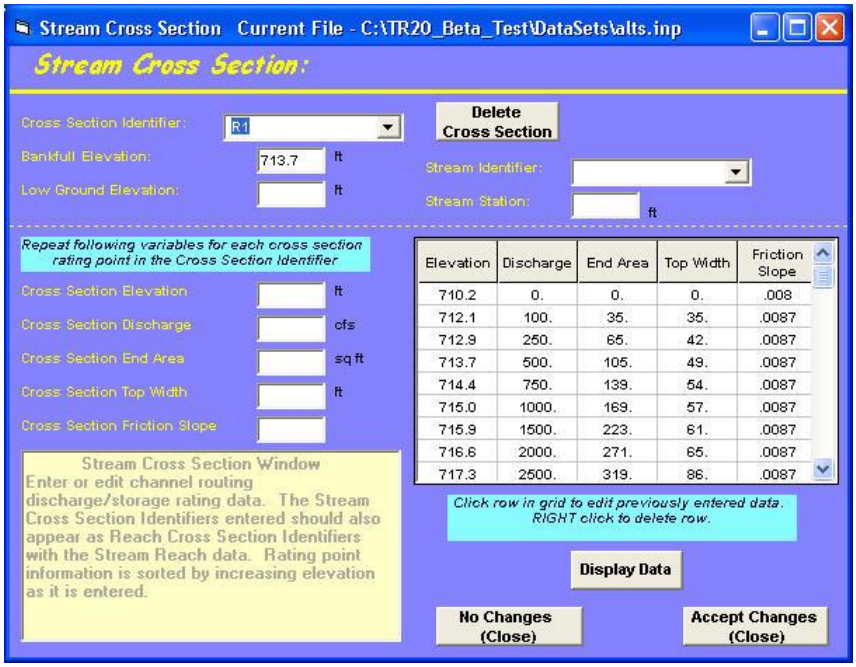


Figure 3.23: Stream Cross Section Window

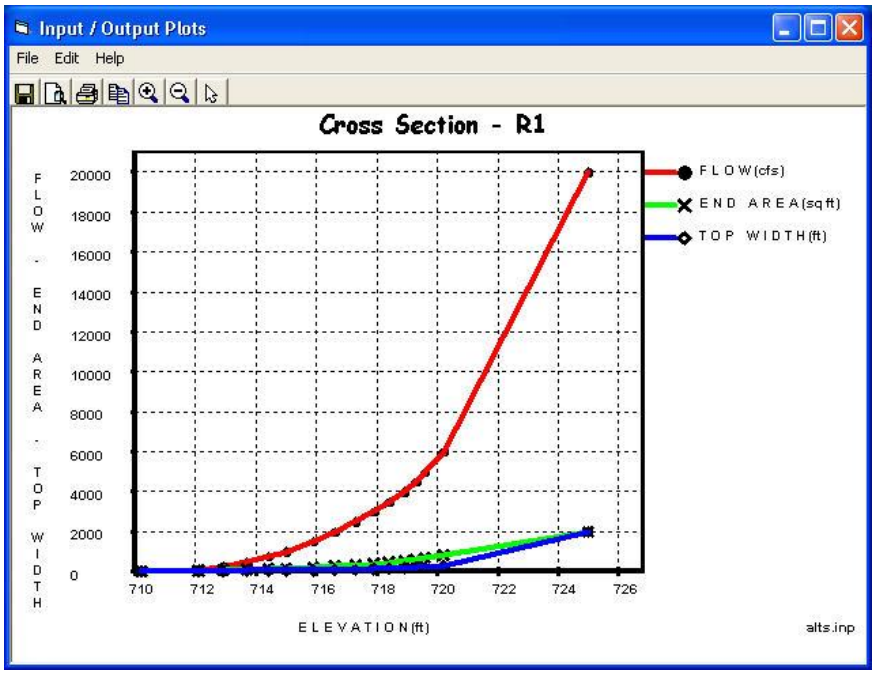


Figure 3.24: Display Data - Cross Section Plot

Stream Reach:

Recall that the term "Reach" applies to stream reaches and strcturees. To enter stream reach data, click on the **Stream Reach** from the Main Window (Figure 3.6). Once the stream reach is selected, the Stream Reach window will appear as shown in Figure 3.25 (your stream reach editor will come up with a blank window until you have entered the stream reach data).

To generate the stream reach for the model, do the following steps:

1. Enter the **Stream Reach Identifier** – Unique alphanumeric string identifying the stream reach. "Outlet" is not acceptable as a Stream Reach Identifier.

2. Enter **Stream Receiving Reach Identifier** – Name of the reach directly downstream from the Stream Reach Identifier. Must match another Stream Reach Identifier or enter OUTLET if reach flows directly to the watershed outlet.

3. Enter **Reach Cross-Section Identifier** – Name of the cross section data to use with this stream reach. Also, identifier must match a Cross Section Identifier in the Stream Cross Section Data. **Leave blank if the Reach Structure Identifier is entered and there is no split flow**.

4. Enter **Reach Structure Identifier** – Name for a structure that occurs in the stream reach. Enter only if there is a structure in the reach. The structure entered the identifier must match a Structure Identifier in the Structure Rating Data. **Leave blank if Reach Cross Section Identifier is entered.**

5. Enter **Reach Channel Length** – Length of the channel in the reach. Leave blank if the Reach Structure Identifier is entered.

6. Enter **Reach Valley Length** – Length of the valley flow path in the reach. Leave blank if Reach Structure Identifier is entered and blank will default to Reach Channel Length. Note: If the Reach Channel Length is same as the Reach Valley Length then only entered Reach Channel Length.

7. Select **Reach Peak Output Code** – Code to output Reach Peak flow data to printed page file. Acceptable values are "**Yes**", "**No**", or "**Blank**". Blank defaults to Default Reach Peak Output Code (Global Output).

8. Select **Reach Hydrograph Output Code** – Code to output Reach Peak Flow and Hydrograph data to printed page file. Acceptable values are "**Yes**", "**No**" or "**Blank**". Blank defaults to Default Reach Hydrograph Output Code (Global Output).

9. Select **Reach Flood Economics File Code** – Code to output Reach Flood Economics data to Flood Economics file. Acceptable values are "**Yes**", "**No**" or "**Blank**". Blank defaults to Default Reach Flood Economics File Code (Global Output). If selected "**Yes**", then Duration Increment data must be entered.

10. Enter **Split Flow Reach Identifier** – Name must match a Stream Reach Identifier in Stream Cross Section Data that receives the split flow at the upstream end or enter OUTLET if split flows directly to the watershed outlet. Leave blank if split flow is diverted out of the watershed.

11. Enter **Split Flow Cross Section Identifier** – Name must match a Cross Section Identifier in Stream Cross Section Data. Leave blank if split flow is determined by Starting Split Flow and/or Ending Split Flow or by drainage area fraction.

12. Enter **Starting Split Flow** – Starting flow for water in the split flow to the reach or diversion. Must be blank if Split Flow Cross Section Identifier is entered.

13. Enter **Ending Split Flow** – Ending flow of water in the split flow to the reach or diversion. Must be blank if Split Flow Cross Section Identifier is entered and also may be blank if there is no upper limit when using Starting Split flow.

14. Enter **Split Flow Drainage Area** – Estimated fraction of an accumulated drainage area that will go with the split flow reach or diversion. This should be most relective for the storm of interest.

15. Also, the user could delete the current Stream Reach by clicking on **Delete Reach,** then repeating steps one through fourteen as desired to enter and select a new stream reach.

16. Click on **Accept Changes (Close)** for the interface to accept the data.

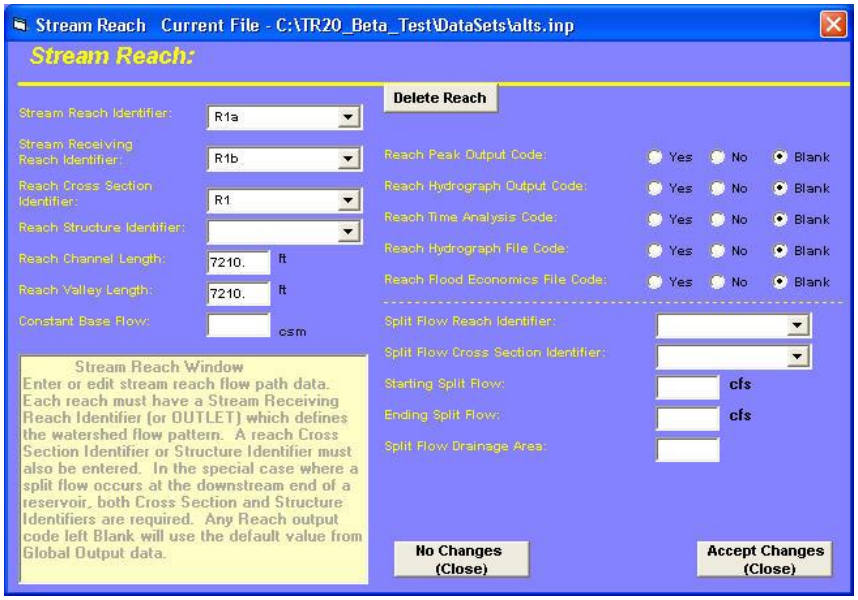


Figure 3.25: Stream Reach Window

Storm Analysis:

To enter storm analysis data the user clicks on **Storm Analysis** from the Main Window (Figure 3.6). Once the storm analysis identifier is selected, the Storm Analysis window will appear as shown in Figure 3.26 (your input storm analysis editor will come up with a blank window until you have entered the storm analysis data).

To generate the storm analysis for the model, do the following steps:

1. Enter **Storm Analysis Identifier -** Unique alphanumeric string identifying the storm to analyze.

2. Enter **Rain Gage Identifier -** Alphanumeric string identifying the rainfall event characteristics to use in part or the entire watershed for a storm. Leave blank if only one rain gage is used for the entire watershed. This identifier can be used to help designate the subarea(s) tha are exposed to different rainfall amounts, starting times, distributions, and/or antecedent runoff conditions than other subarea(s) for the same storm identifier, if applicable (usually done only for calibration purposes).

3. Enter **Gage Starting Point -** Starting time for the rainfall at the rain gage ID for the given storm ID. Blank indicates 0.0 hr.

4. Enter **Gage Rainfall** – Depth of the rainfall at the rain gage ID for the given storm ID. Leave blank if Rainfall Distribution represents an actual storm.

5. Enter **Gage Rain Table Identifier** – To identify the rain distribution at the rain gage ID for the storm ID. Gage Rain Table Identifier must match a Rain Table Identifier in Rainfall Distribution.

6. Enter **Antecedent Runoff Condition** – Antecedent runoff condition to apply to runoff curve numbers in the watershed areas that use the Rain Gage Identifier. Acceptable values are: 1- Dry, 2-Average, and 3-Wet. (Blank indicates 2). Based on procedure described in NEH part 630, Chapter 11.

7. Enter **2-Yr 24 Hr Rain** – Rainfall amount attributed to the 2yr 24 hour event. Needed for computing sheet flow portion of sub-area Tc. Leave blank if no sheet sub header records are included either with Sub-Areas or Alternate Areas.

8. Click on **Accept Changes (Close)** for the interface to accept the data.

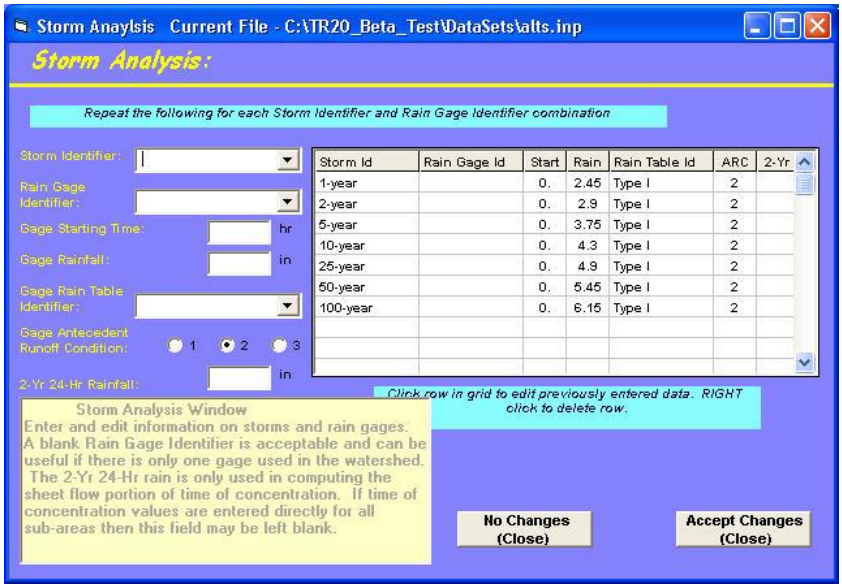


Figure 3.26: Storm Analysis Window

Structure Rating:

To enter structure-rating data, click on the **Structure Rating** from Main Window (Figure 3.6). Once the structure rating identifier is selected, the Structure Rating window will appear as shown in Figure 3.27 (your input structure rating editor will come up with a blank window until you have entered the structure data).

To generate the structure rating for the model, do the following steps:

1. Enter **Structure Identifier** – Unique alphanumeric string identifying the structure.

2. Enter **Structure Starting Elevation** – Starting elevation for routing hydrograph through the structure. Blank defaults to base flow discharge elevation.

3. Enter **Structure Elevation** – Elevation of one point on the structure elevation-discharge-storage relationship. Each structure elevation must increase from one line to the next.

4. Enter **Structure Discharge** – Discharge for the elevation point just referenced on the structure elevation-discharge storage relationship. Value for lowest elevation must be zero. Structure discharge must increase with elevation.

5. Enter **Structure Storage** – Storage Volume for the elevation point just referenced on the structure elevation-discharge-structure relationship. Value of the lowest elevation must be zero. Structure storage must increase with elevation.

6. **Display Data** button should now be visible.

7. Click on **Display Data** button to view the structure rating plot. An example of the Structure Rating plot is shown in Figure 3.28.

8. Also, the user could delete the current structure data by clicking on the **Delete Structure** button then repeating steps one through eight as desired to enter a new structure rating table.

9. Click on **Accept Changes (Close)** for the interface to accept the data.

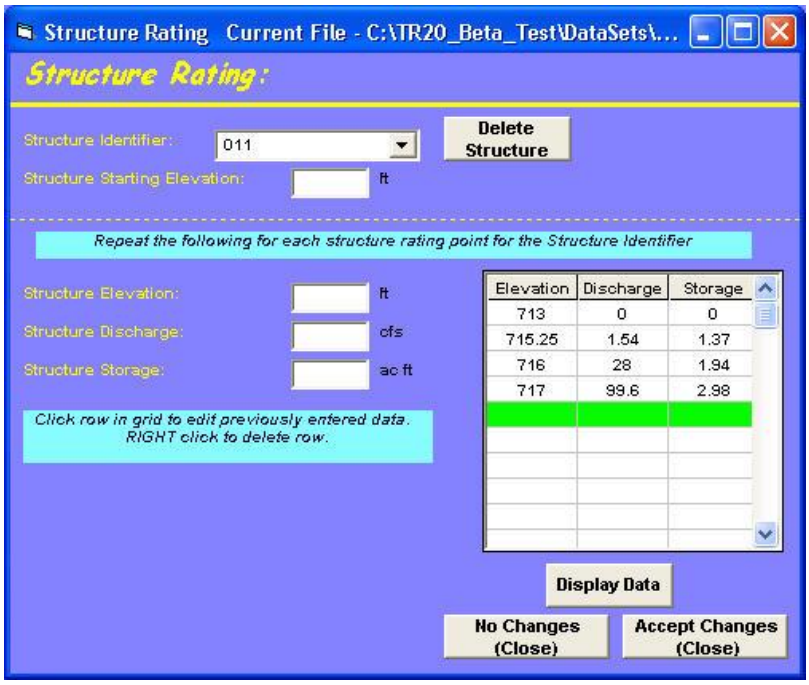


Figure 3.27: Structure Rating Window

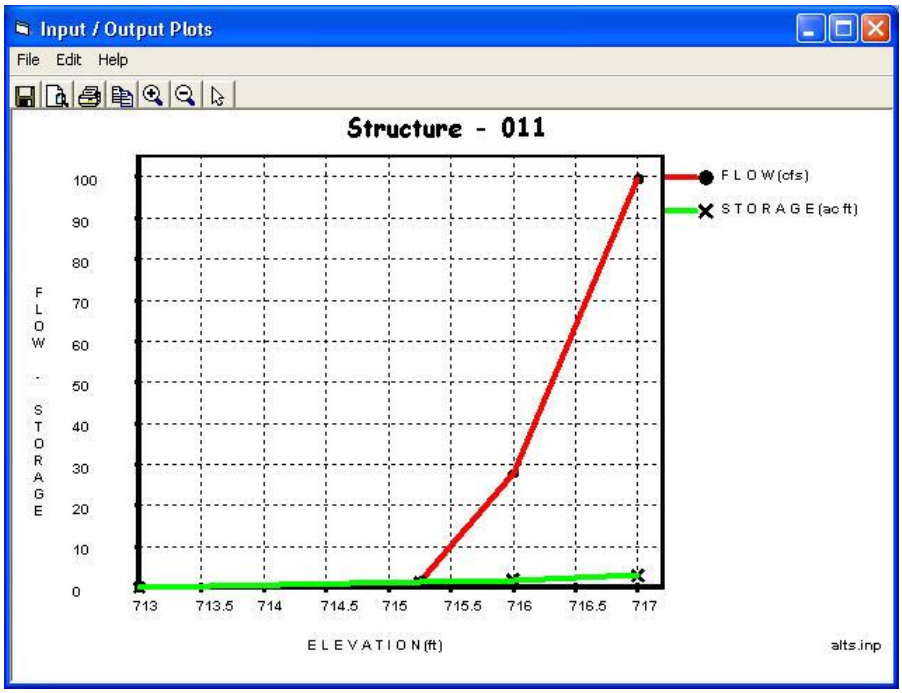


Figure 3.28: Display Data – Structure Rating

Sub-Area:

To enter sub-area data, click on the **Sub-Area** from Main Window (Figure 3.6). Once the sub-area identifier is selected, the Sub-Area window will appear as shown in Figure 3.29 (your input sub-area editor will come up with a blank window until you have entered the sub-area data).

To generate the sub-area for the model, do the following steps:

1. Enter **Sub-Area Identifier** – Unique alphanumeric string identifying the sub-area.

2. Enter **Sub-Area Reach Identifier** – Alphanumeric string identifying the upstream end of the reach where the runoff from the sub-area will be added. Must match a Reach Identifier in the Stream Reach Data. Enter OUTLET if sub-area joins the stream system at the watershed outlet.

3. Enter **Sub-Area Rain Gage Identifier** – Alphanumeric string identifying the rainfall gage to use for the sub-area. Must match the Gage Identifier in Storm Analysis data. Blank is acceptable if it matches a Gage Identifier.

4. Enter **Sub-Area Drainage Area** – Drainage area (sq.mi.) associated with the sub-area. Leave blank (and also leave the Sub-Area Weighted Curve Number blank) if the area will be accumulated from the Detailed Land Area data records (See Figure 3.28).

5. Enter **Sub-Area Weighted Curve Number** – Weighted Runoff Curve Number from the sub-area of the watershed. Leave blank (and also leave the Sub-Area Drainage Area blank) if the weighted curve number will be computed from the Detailed Land Area data records (See Figure 3.30).

6. Enter **Sub-Area Time of Concentration** – Time for runoff to travel from the hydraulically most distant point in the sub-area to the sub-area outlet. Leave blank if the value will be computed from the detailed Sheet, Shallow, and Channel records (See Figure 3.32).

7. Select **Sub-Area Peak Output Code** – Code to output Sub-Area Peak Flow data to printed page file. Acceptable values are: "**Yes**", "**No**" or "**Blank**". Blank defaults to Default Sub-Area Peak Output Code (Global Output).

8. Select **Sub-Area Hydrograph Output Code** – Code to output Sub-Area Hydrograph and Peak Flow data to printed page file. Acceptable values are: "**Yes**", "**No**" or "**Blank**". Blank defaults to Default Sub-Area Hydrograph Output Code (Global Output).

9. Select **Sub-Area Time Analysis Code** – Code to output Sub-Area Time Analysis data to printed page file. Acceptable values are: "**Yes**", "**No**", or "**Blank**". Blank defaults to Default Sub-Area Time Analysis Code (Global Output). Time analysis displays the duration of flow, specified by the user (as percent of peak) in the time analysis data.

10. Select **Sub-Area Hydrograph File Code** – Code to output Sub-Area Hydrograph data to hydrograph file. Acceptable values are: "**Yes**", "**No**" or "**Blank**". Blank defaults to Default Sub-Area Hydrograph File Code (Global Output).

11. **Land Use Details** button should visible if the user has nto entered data in the Sub-area drainage or weighted curve number boxes.

12. **Tc Detail** button should be visible if the user has not entered data in the Sub-area Time of Concentration box.

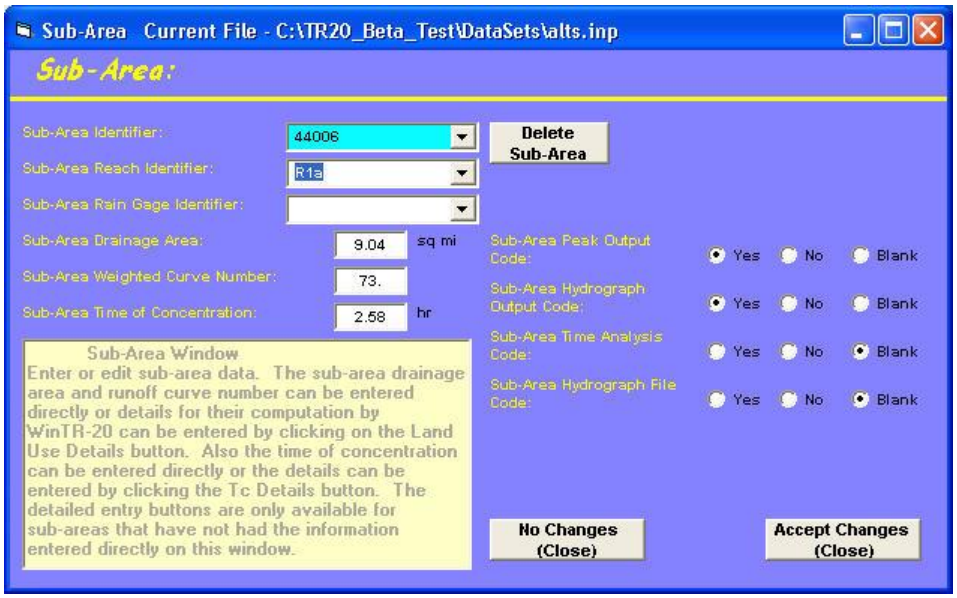


Figure 3.29: Sub-Area Window

13. To enter land use details data, click on the **Land Use Details** button. Once land use details is selected, the Land Use Areas window will appear as shown in Figure 3.30 (your land use areas editor will come up with blank window until you have entered the land use areas data).

    a. Enter **Sub-Area Identifier** – Unique alphanumeric string identifying the sub-area name. To verify that this is the sub-area intended for land use detailing.

    b. Enter **Land Use Area Drainage Area** – Drainage area associated with the land use and hydrologic soil group (HSG) for the sub-area. Click on the appropriate Land Use and Hydrologic Soil Group area box then enter the specific area (sq.mi.) if the input units selected as English in WinTR-20 main window.

    c. Enter **Land Use Area Hydrologic Soil Group (HSG)** – Hydrologic Soil Group for the land use area of the sub-area. Acceptable values are A, B, C, or D. The user has the option of defining their own land use and associated curve numbers based on hydrologic soil group. This is done back on the WinTR-20 Controller/Editor screen. Click on File, thean Local Land Use. Then put in the appropriated user defined curve numbers for Hydrologic Soil Group A, B, C and D for the four boxes. When complete, click on Accept Changes (Close).

This user defined Local Land Use data is then available on the Land Use Details routine for Sub-Area data input.

d. The **Display Local Soils** button is visible. By clicking on this Display Local Soil button, the Display Local Soil/HSG window will appear as shown in Figure 3.31 (the user is able to determine the Hydrologic Soil Group (HSG) that is associated with various soils).

e. To return back to the **Sub-Area** window editor, by click on Return to Sub-Area button.

f. Also, the user could delete the current **Sub-Area** (Land Use) by clicking on **Delete Land Use Details** button then repeating steps 13 a. through 13 f. as desired to enter new Sub-Area.

14. Click on **Return to Sub-Area** button to get back to Sub-Area window editor.

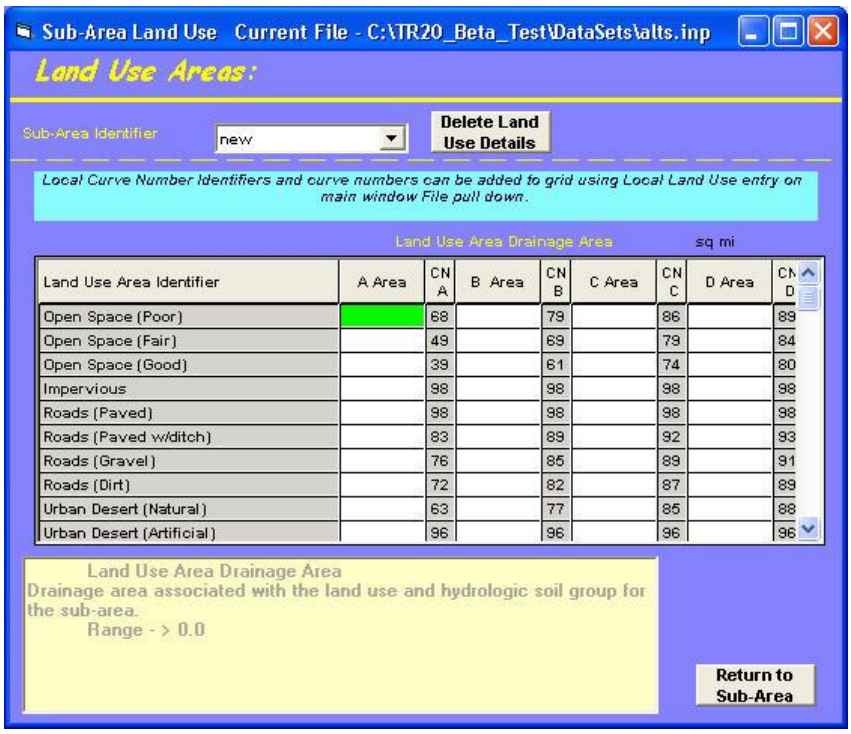


Figure 3.30: Land Use Areas Window

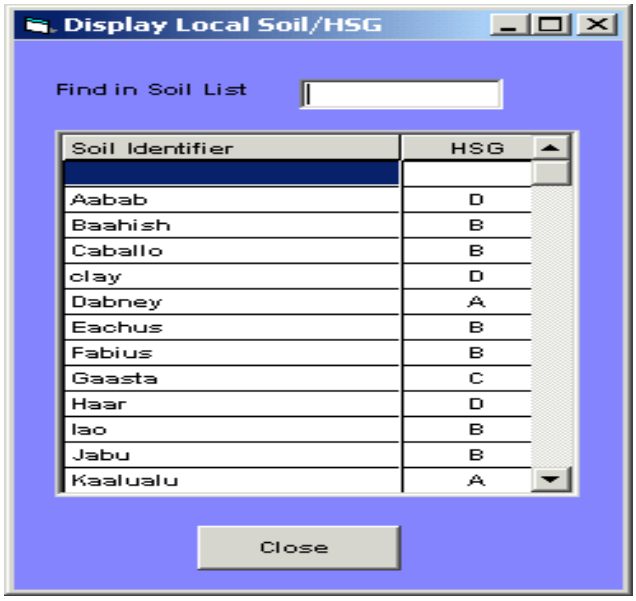


Figure 3.31 Display Local Soil/HSG Windows

15. To enter **Time of Concentration** data, click on the **Tc Details** button from the Sub-Area window editor. Once the Tc detail is selected, the Time of Concentration window will appear as shown in Figure 3.32 (your Time of Concentration editor will come up with a blank window until you have entered the time of concentration data). The Time of Concentration analysis performed here is based on the velocity method described in WinTR-55.

    a. The current **Sub-Area Identifier** name will appear on the Time of Concentration window.

    b. Enter **Sheet Flow Length** – Length along sheet flow path for sub-area. Generally, beyond 100 feet the flow becomes concentrated flow. Therefore, sheet flow length is limited to 100 feet (30m).
    Note: 2-yr rainfall for Sheet Flow is entered with Storm Analysis.

    c. Enter **Sheet Flow Slope** – Slope along the sheet flow path for the sub-area. (length/length or dimensionless).

    d. Enter **Sheet Flow Manning "n"** – Roughness coefficient (n) to use with sheet flow path for the sub-area. Leave blank if Sheet Flow Surface is entered. If blank and Sheet Flow Surface is also blank – the default value to 0.15. Note that these are significantly greater values than those used for open channel flow.

    e. Select the **Sheet Flow Surface** – Code representing the sheet flow path surface with the acceptable pull-down values. Leave blank if Sheet Flow Manning "n" is entered.

Sheet Flow Surface Code	Values
A - Smooth Surface	0.011
B - Fallow (no residue)	0.05
C - Cultivated < 20% residue	0.06
D - Cultivated > 20% residue	0.17
E - Grass-Range, Short	0.15
F - Grass, Dense	0.24
G - Grass, Bermuda	0.41
H - Woods, Light	0.40
I - Woods, Dense	0.80
J - Range, Natural	0.13

f. Enter **Shallow Concentrated Flow Length** – Length along shallow concentrated flow path for sub-area.

g. Enter **Shallow Concentrated Flow Slope** – Slope along shallow concentrated flow path for the sub-area.

h. Select **Shallow Concentrated Flow Surface** – Code representing the shallow concentrated flow path surface with the acceptable pull-down values.

Acceptable values are:
P - Paved U - Unpaved

i. Enter **Channel Flow Length** – Length along the channel flow path for sub-area.

j. Enter **Channel Flow Slope** – Slope along the channel flow path for sub-area. Leave blank if channel flow velocity is entered.

k. Enter **Channel Manning "n"** – Roughness coefficient "n" to use with channel flow path for the sub-area. Blank defaults to 0.04.

l. Enter **Channel Flow End Area** – Channel flow path channel cross sectional area to use for the sub-area.

m. Enter **Channel Flow Wetted Perimeter** – Channel flow wetted perimeter to use for the sub-area.

n. Enter **Channel Flow Velocity** – Channel flow velocity to use for the sub-area. Leave blank if End Area and Wetted Perimeter are entered.

o. The user could delete the current time of concentration by clicking on **Delete Tc Details** button then repeating steps 20 a. through 20 n. as desired to enter new time of concentration.

p. Click on **Return to Sub-Area** button to return Sub-Area Window.

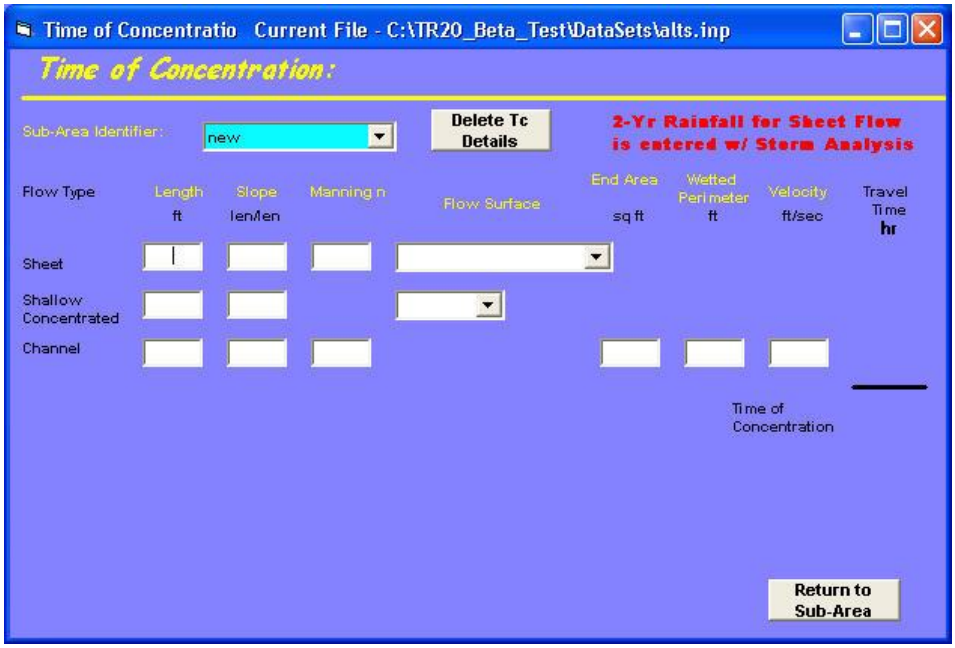


Figure 3.32: Time of Concentration Window

20. Click on **Accept Changes (Close)** for the interface to accept the data.

Time Analysis:

Time Analysis yieds the duration of flow for the user specified percentage of peack flow or the duration that flow depth has exceded a user specified elevations in either a stream reache or structure. To enter time analysis data, the user clicks on **Time Analysis** from the Main Window (Figure 3.6). Once time analysis is selected, the Time Analysis window will appear as shown in Figure 3.33 (the time analysis editor will come up with a blank window until data has been entered). Note that in order to view the results of Time Analysis, the user must click on the Time Analysis doce box for either Sub-Area or Stream Reach as appropriate.

To generate the time analysis data for the model, do the following steps:

1. Enter **Maximum Flow Percentage** – Percent of stream reach peak flow to be used for the time analysis determination. Maximum of 4 different percentages may be entered, and at least one must be entered. (Flow percentages will be sorted from lowest to highest for output)

2. Enter **Elevation Increment** – Height (elevation) above base elevation (Low Ground Elevation for Stream Cross Section Data or Starting Elevation for Structure Rating Data) to be used for elevation time analysis determination. Maximum of 4 different elevations may be entered and at least one must be entered. (Elevation increments will be sorted from lowest to highest for output)

3. Click on **Accept Data then Close** for the interface to accept the data.

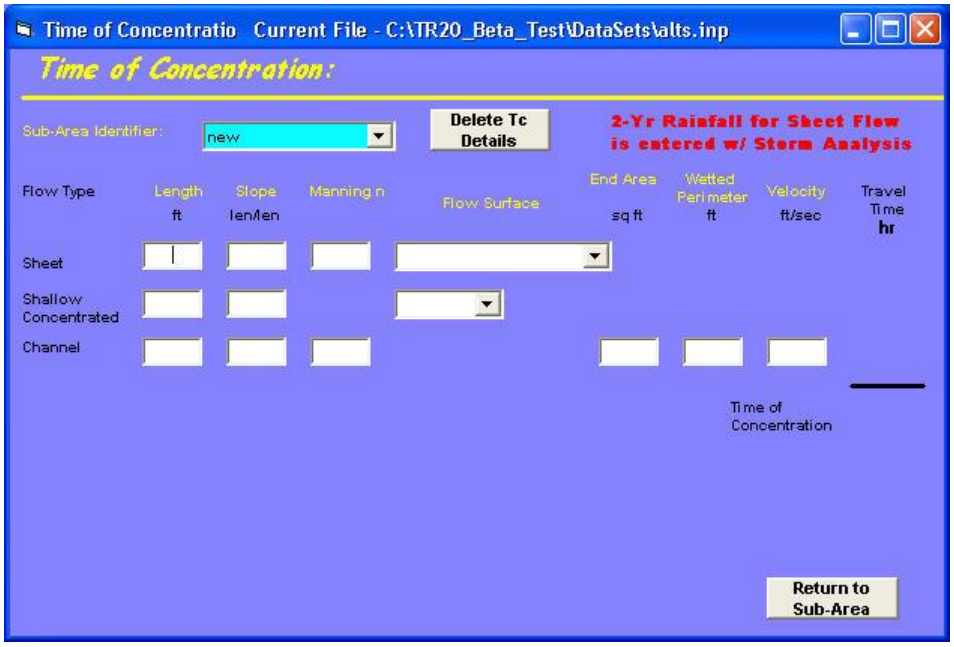


Figure 3.33: Time Analysis Window

Verification:

To enter verification data, the user clicks on **Verification** from the Main Window (Figure 3.6). Once verification is selected, the Verification window will appear as shown in Figure 3.34 (the verification editor will come up with a blank window until data has been selected). The user checks the blank boxes to request a particular verification item. The outputs of verification selections are printed out in the Debug file (*.dbg).

Figure 3.34: Verification Window

Read Data Section Verification Tables

The first 15 items on the verification window (through Verfication Read) refer to the reading of the data by the program. The output echoes the input and can be used as a check for data correctness. There are a few items to be aware of that may be different from what was actually entered. If metric data was entered, values will be expressed as English equivalents as all data are saved within WinTR-20 in English units. For input fields that were left blank, some may show the default for the field (if one exists) or it may show as a –999 in the table indicating that a blank was interpreted for this field. Also some blank fields may show as –999 indicating that the value entered was a blank. The data are listed by using the data section names as headers. If the read box is checked in the Verification window, and there is no entry for a particular data section, that section is not listed in the debug file.

Table 3.2: Verifications Tables
For all items, a check in the box means "**Yes**" and leaving the box blank means "**No**".

Read Data Section	Output in Debug File	Check Box	
Alternates Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Dimensionless Unit Hydrograph Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Duration Increment Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Global Output Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Input Hydrographs Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Rainfall Distribution Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Runoff Curve Numbers Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Stream Cross Sections Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Stream Reaches Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Storm Analysis Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Structure Ratings Read	Echo of input data after read in and data conversion.	Yes	Blank is No
Sub-Areas Read	Echo of input after read in and data conversion.	Yes	Blank is No
Time Analysis Read	Echo of input data after read in and data conversion	Yes	Blank is No
WinTR-20 Run Identifier Read	Echo of input data after read in and data conversion	Yes	Blank is No
Verification Read	Echo of input data after read in and data conversion	Yes	Blank is No
Storms and Rain Gage Combinations	Output gives Storm ID, Rain Gage ID, 2-yr 24hr Rain (if given), Rain starting time, Rain amount, ARC, and Rain Table ID.	Yes	Blank is No
Sub-Area Tc Computations	Output gives Sub-Area: Flow Type, 2-yr Rain, Length, Slope, Manning "n", Surface Code, Hydraulic Radius and Time.	Yes	Blank is No
Sub-Area CN Computations	Output gives Sub-Area: Sub-Area Identifier, Land Use Area Identifier, Hydrologic Soil Group (HSG), Curve Number Land Use Area, and the CN x Area Product.	Yes	Blank is No
Unique Sub-Area List	Output gives the number of Sub-Areas read from Sub-Area Data, the number of Sub-Areas added from Alternate Data and lists the added Sub-Area Identifiers.	Yes	Blank is No
Cross Section Rating Table	Output gives the discharge, end area, and rating exponent M for cross sections.	Yes	Blank is No

Table 3.2 (con't)

Pre-Processing Verification Section	Output in Debug File	Check Boxes	
Array Indexes / Reference Identifiers	Output gives Sub-Area Identifier, Reach Identifier, Reach Index, Rain Gage Identifier and Rain Gage Index for Sub-Area; The Reach Identifier, Receiving Reach Identifier and Index, Cross Section Identifier and Index, Structure Identifier and Index, Split Flow Reach Identifier and Index and Split Cross Section Identifier and Index for Reaches; the Input Hydrograph Identifier, Input Hydrograph Storm Identifier and Index for Input Hydrograph; the Storm Identifier, the Gage Rain Table Identifier and Index for the Storm.	Yes	Blank is No
Rainfall Distributions Used	Output gives the discharge, end area, and rating exponent M for cross sections.	Yes	Blank is No
Reservoir Emptying Time	Indicates whether to output Reservoir Emptying Time Section data after read in and data conversion.	Yes	Blank is No
Upstream Reach Components	Output gives the Reach Identifier, the numbers of Sub-Area, Input Hydrographs, and Reaches, the First and Last Array Indexes, and the Array Upstream Index Reach Identifier. Code indicating whether to output Upstream Reach.	Yes	Blank is No
Number of Hydrographs	Output gives the operations (Generate, Route, and Add), the Reach Identifier, the Reach Array Indexes for hydrograph Storage, and notes on Starting at X requires Y hydrographs to be stored, and the Selected Starting Reach requires Z hydrographs to be stored.	Yes	Blank is No
Watershed Analysis Steps	Output gives for each storm for each Operation (Generate, Route © , Route (S), Combine, Input Hydrograph, Split Flow, Split Flow with Lost Flow) the Reach or Sub-Area Identifier, the Receiving Reach Identifier, the Input Hydrograph or Split Flow Identifier, the Hydrograph Location (In1, In2, Out1, Out2), and Number of Points (Out1, Out2)	Yes	Blank is No
Non-circular Reach Flow Path	Output gives Pass Number, Reach Index, Upstream Count, and Reach Index for the Reaches Satisfied.	Yes	Blank is No
Alternate Update	Output gives for Alternates Sub-Area Identifier, Drainage Area, Tc, Runoff CN, Rain Table Identifier, the Receiving Reach Identifier, the Cross Section Identifier, Structure Identifier, Channel Length, Valley Length, Base Flow, and Split Flow (Reach Identifier, Cross Section Identifier, Starting Flow, Ending Flow, and Fractional Area).	Yes	Blank is No

Table 3.2 (con't)

Processing Verification Section	Output in Debug File	Check Boxes	
Hydrograph Generation	Output gives the Sub-Area, Rainfall Distribution, Storm, Rainfall Amount, Number of Points, the Rain starting time and time increment, the Mass Runoff, Runoff Curve Number, Number of Points, Runoff starting time and time increment, Sub-Area peak flow rate, time, and volume, the Hydrograph starting time and time increment, and the Peak Rate Factor conversion.	Yes	Blank is No
Hydrograph Channel Routing	Output gives by Storm: Reach, Peak Flow Rate and Time, Volume, and the Hydrograph point at the time increment and the number of points with the Initial and revised Routing step lengths; Wave Celerity, and Delta t. Routing Step Information includes Section data to Peak Flow (Flow Rate, Area, Friction Slope, Top Width, Exponent, and the Muskingum Parameters Weight (X) and Route (K), the routing Coefficient terms C1, C2, C3, the Courant Number, and Grid Reynolds's Number, and the Intermediate Hydrograph table).	Yes	Blank is No
Hydrograph Structure Routing	Output gives by Storm: Reach, Peak Flow Rate and Time, Volume, and the Hydrograph point at the time increment and the number of points. The Structure Elevation, Flow Rate, temporary Storage and working Curve Value, and the steps per hydrograph increment are also given.	Yes	Blank is No
Hydrograph Addition	Output gives by Storm and Reach: the Hydrograph, Hydrograph Storage Code, Start and End time and Time Increment for the 2 hydrographs to be added (1st In and 2 nd In), and the two addition combinations at the 2 time increments (1st Combo and 2 nd Combo). The Combination selected to keep is that with the highest peak; the Peak Flow Rate, Time, Volume, and the Hydrograph table is printed out for the one selected.	Yes	Blank is No
Hydrograph Flow Splitting	Output gives by Storm: for Original Reach, the Split Flow Reach, and the Remaining Reach: Peak Flow Rate and Time, Volume, and the Hydrograph point at the time increment and the number of points. The Elevation and Flow are also tabulated.	Yes	Blank is No
Flow Duration Computations	Output gives by Storm: Reach, Peak Flow Rate and Time, Volume, and the Hydrograph point at the time increment and the number of points. The Time Flow, Elevation Flow, and Flood Econ Data are also given.	Yes	Blank is No

The WinTR-20 input header sections can be assembled in any order except that the first record must be the WinTR-20 identifier. The Control / Editor generate the input file with the data section headers in a fixed order shown in Table 3.3. Only the data sections that actually have data associated with them are included in the general file.

Table 3.3: Control / Editor for WinTR-20 Input File

File Identifier
TR-20 Run Identifier (must be 1st section)
Analysis Definition
Sub-Area
Stream Reach
Storm Analysis
Rating and Hydrology Data
Stream Cross Section
Structure Rating
Input Hydrograph
Watershed Reference Data
Dimensionless Unit Hydrograph
Rainfall Distribution
Local Land Use
Output Related Data
Duration Increment
Global Output
Time Analysis
Verification

Saving Data

Once all the data are entered, the user should save the data onto the hard disk. This can be accomplished by selecting "**Save"** or "**Save As"** from the File pull down menu on the main window. See Figure 3.35 shown below. The "**Save"** choice is only available if the data has previously been given a file name.

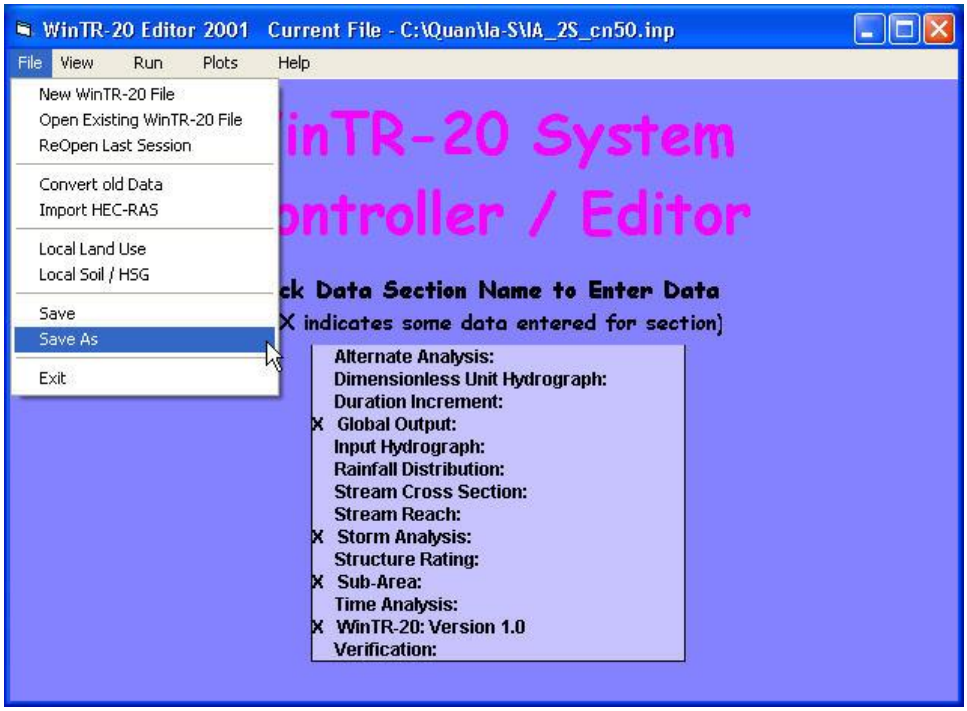


Figure 3.35: **"**Save" or "Save As" Window

Data will be saved into a file; the user then clicks **"Yes"** button to save. See Figure 3.36 below.

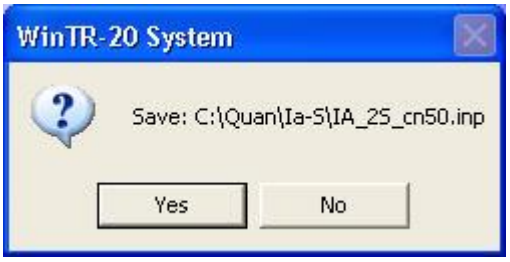


Figure 3.36: Data Saved in File Window

Performing WinTR-20 Calculation

Once all the data are entered and the file is saved, the user can perform the WinTR-20 calculations by clicking on "**Run"** from the main window (menu bar). An example of the Run – Perform WinTR-20 Calculation window is show in Figure 3.37.

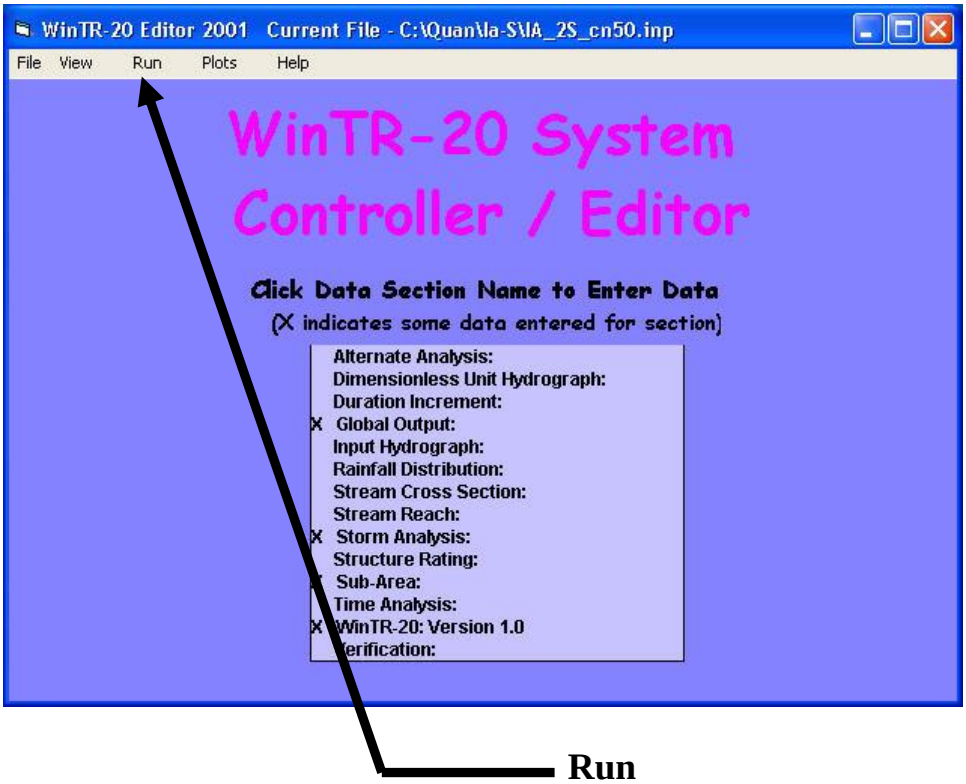


Figure 3.37: Run – Perform WinTR-20 Calculation

After WinTR-20 has finished the calculations, WinTR-20 will generate the WinTR-20 Printed Page File as shown in Figure 3.38. If the data has errors, the error File is shown in Figure 3.40.

Under the WinTR-20 Printed Page File window are the following options:

Print: Send the WinTR-20 Printed Page File to the printer.

View: The view menu currently includes: WinTR-20 Input File (See Figure 3.39), WinTR-20 Printed Page File (See Figure 3.38), WinTR-20 Error File (See Figure 3.40), WinTR-20 Debug File (See Figure 3.41), WinTR-20 Hydrograph (See Figure 3.42), and WinTR-20 FloodEcon File (See Figure 3.43).

The user then clicks on **Close** to close the WinTR-20 Printed Page File Window.

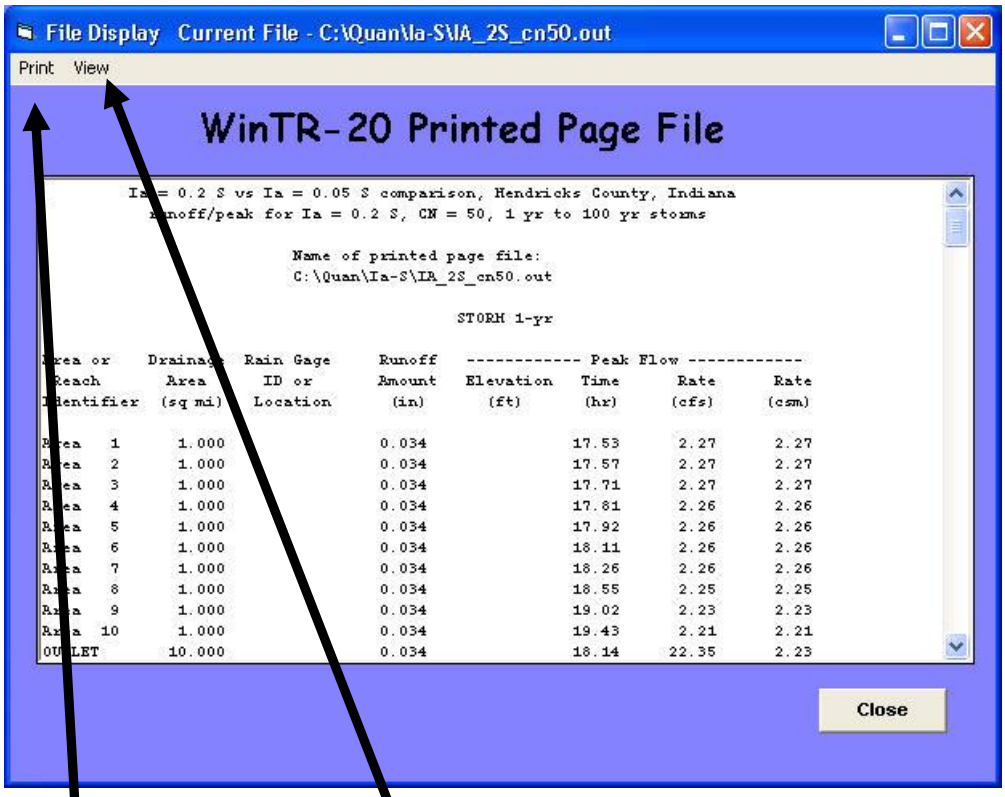


Figure 3.38: WinTR-20 Printed Page File

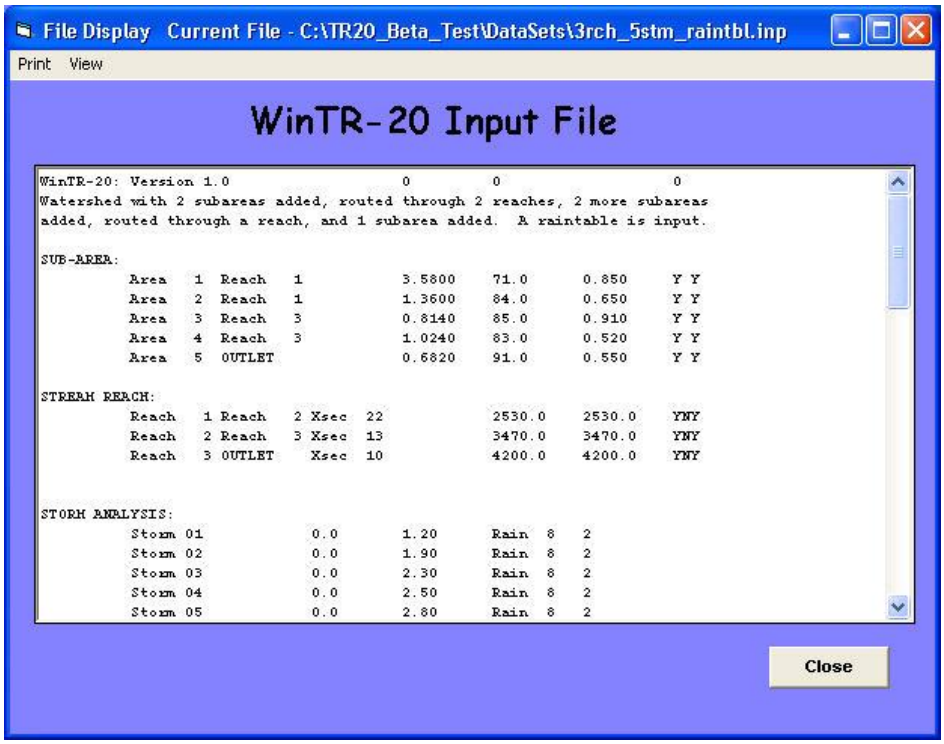


Figure 3.39: WinTR-20 Input File Window

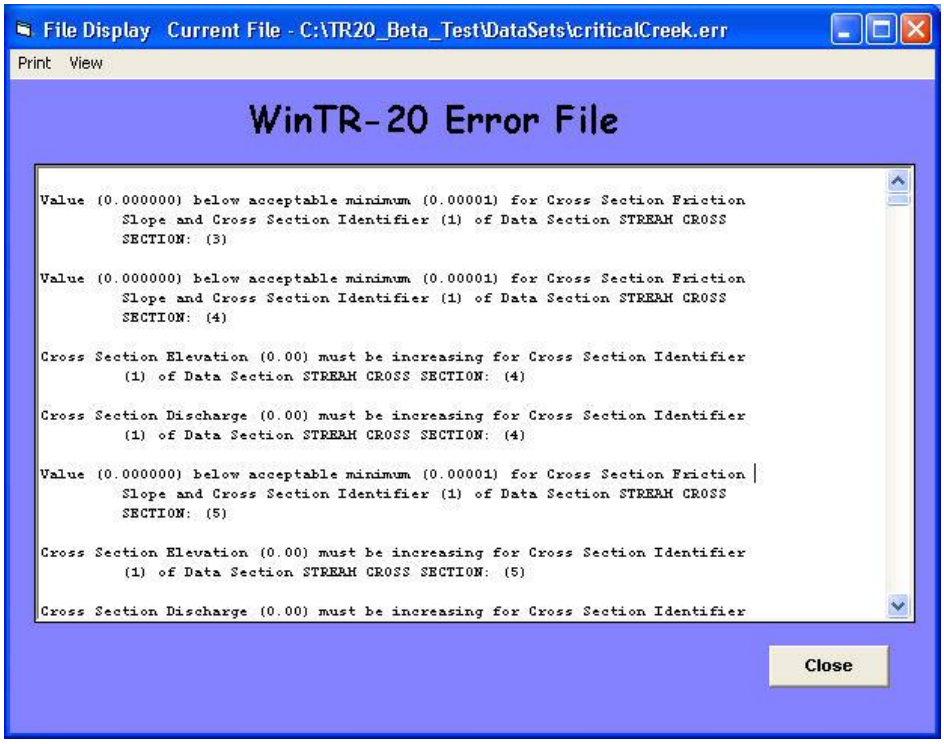


Figure 3.40: WinTR-20 Error File Window

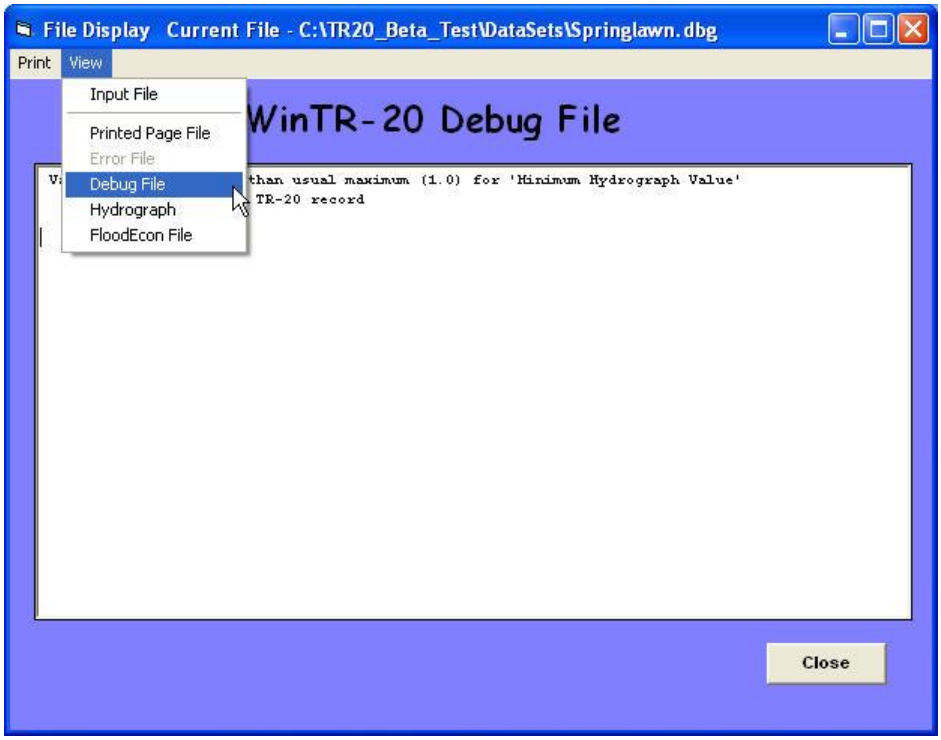


Figure 3.41: WinTR-20 Debug File Window

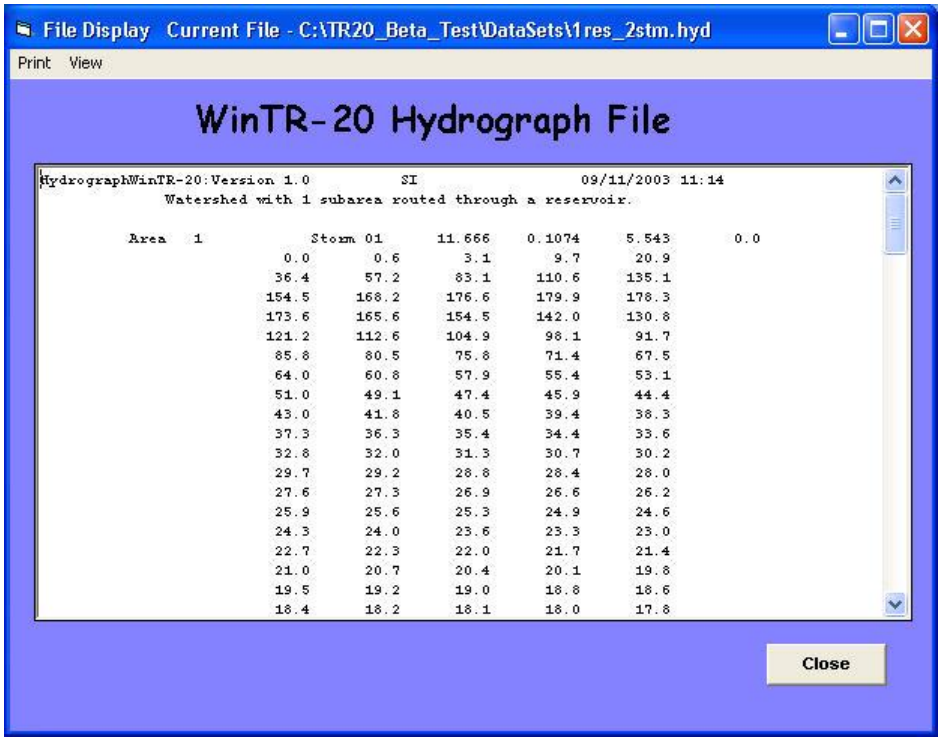


Figure 3.42: WinTR-20 Hydrograph File Window

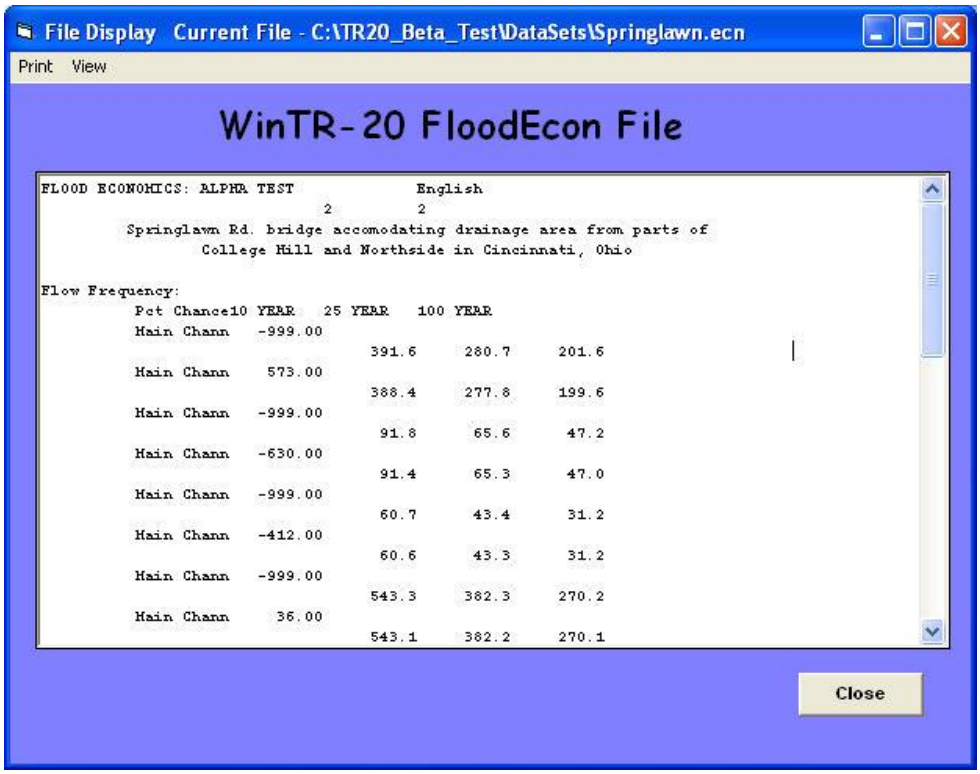


Figure 3.43: WinTR-20 FloodEcon File Window

Plotting, Viewing and Printing Results

After the WinTR-20 has finished the computations, the user can begin viewing, plotting and printing the results.

Under the WinTR-20 Main Window – View and Plots has the following options:

View: The view menu currently includes: Schematic (See Figure 3.45), Input File (See Figure 3.39), Printed Page File (See Figure 3.38), Error File (See Figure 3.40), Debug File (See Figure 3.41), Hydrograph File (See Figure 3.42), and FloodEcon File (Figure 3.43).

Plots: Brings up the Graphics Output window (See Figure 3.46 and Table 3.4 for more details).

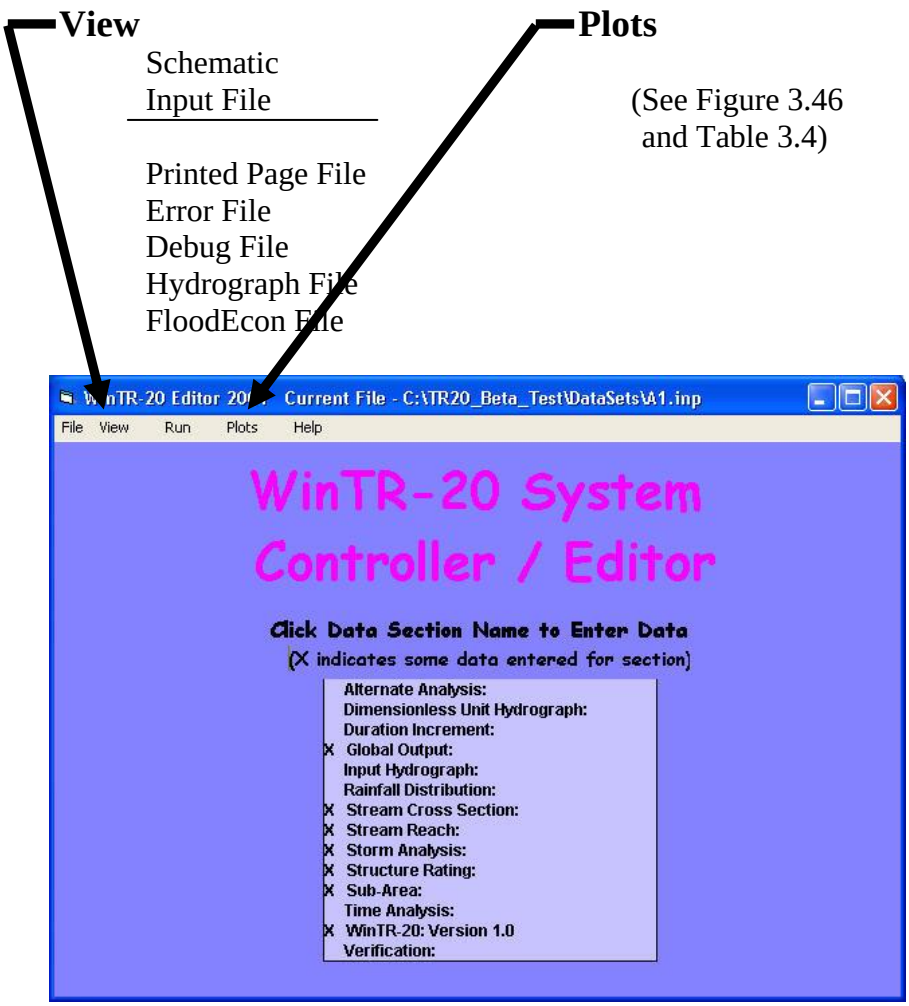


Figure 3.44: WinTR-20 Main Window

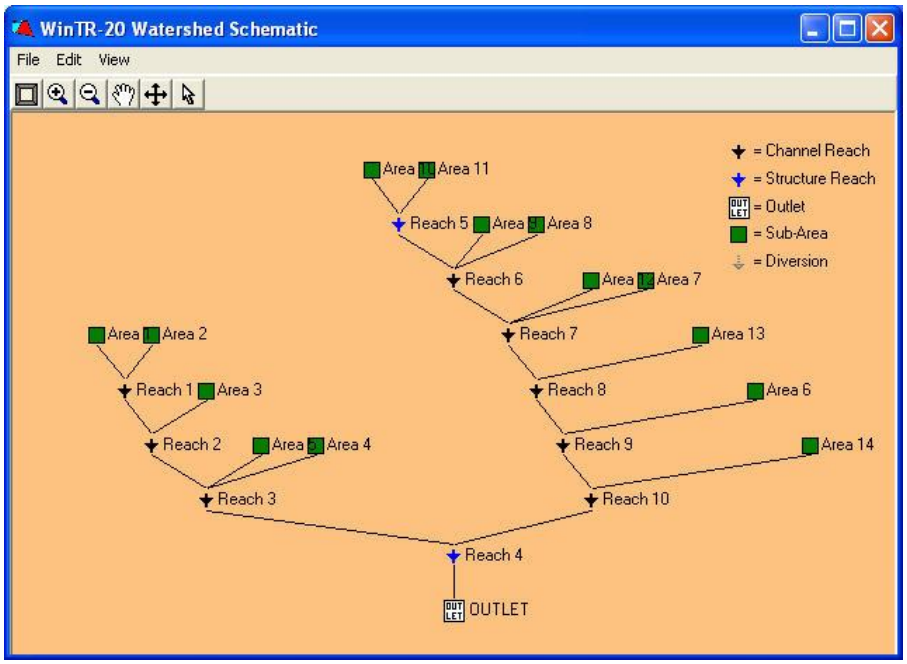


Figure 3.45: WinTR-20 Watershed Schematic Window

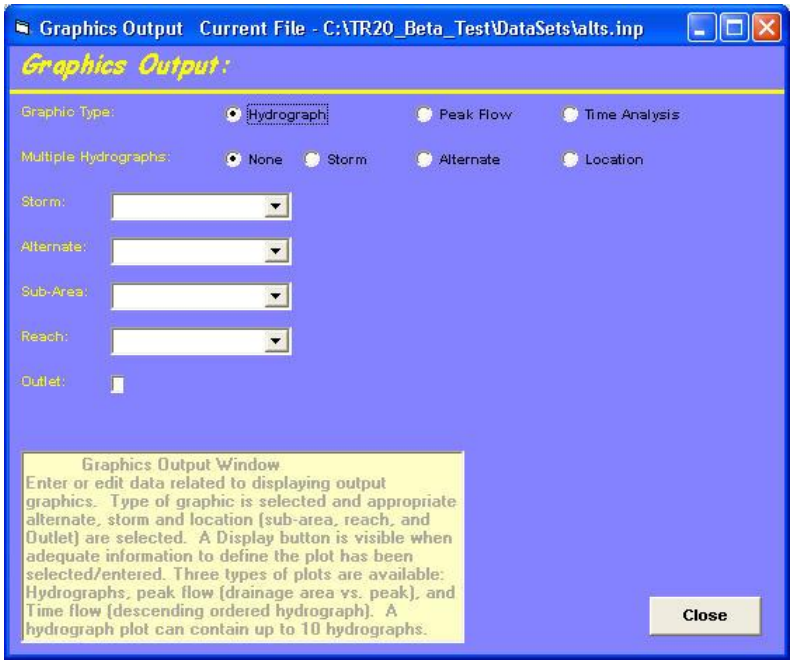


Figure 3.46: Graphics Output Window

Table 3.4: Graphics Output

Types	Check Box	Output File
Graphic Type		
Hydrograph	Select	Hydrograph Chart (.bmp)
Peak Flow	Select	Peak Flow Chart (.bmp)
Time Analysis	Select	Time Analysis (.bmp)
Multiple Hydrographs		
None	Select	
Storm	Select	
Alternate	Select	
Location	Select	

Location Identifier		
Storm	Pulldown menu	Hydrograph, Peak Flow, Time Analysis
Alternate	Pulldown menu	Hydrograph, Peak Flow
Sub-Area	Pull down menu	Hydrograph, Peak Flow
Reach	Pull down menu	Hydrograph, Peak Flow
Outlet	Check Box	Hydrograph, Peak Flow, Time Analysis

To generate a hydrograph plot, do the following steps:

1. **Graphic Type** - Default is set on Hydrograph option button.

2. **Multiple Hydrographs** – Default is set on None

3. Select **Storm** names. Click Enter to move down to Alternate.

4. Leave **Alternate** blank if no data is entered from the Main Window for Alternative Analysis.

5. Select **Sub-Area** names.

6. **Display** button is now visible.

7. Click on the **Display** button to view the Hydrograph plot for Sub-Area. An example of the Single Sub-Area - Hydrograph window is shown in Figure 3.49.

8. Plot Hydrograph for **Reach** – Select a reach name. Alternate and Sub-Area should be blanks.

9. Select either **Upstream** or **Downstream**.

10. **Display** button is visible.

11. Click on the **Display** button to view the Hydrograph plot for Reach. An example of the Reach Hydrograph window is shown in Figure 3.50.

12. If no data entered or found, the "**No data for requested plot found**" message will appear. Just click **OK,** as shown in Figure 3.47 Output Graphics Message. This indicates that the user did not specifiy that a hydrograph was requested for the sub-area or reach (see figure 3.29 and 3.25 for Hydrograph Output Code).

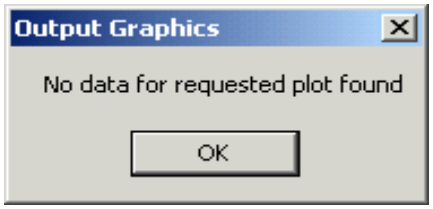


Figure 3.47: Output Graphics Message

13. Plot Hydrograph at the Outlet – Clicking on Outlet. Alternate, Sub-Area, and Reach should be blanks.

14. **Display** button should now be visible.

15. Click on the **Display** button to view the Hydrograph plot at the Outlet. An example of the Outlet - Hydrograph plot window is shown in Figure 3.51.

16. Plot **Multiple Hydrographs** – Click on Location button next to Multiple Hydrographs. Select a Storm name. Multiple Locations window is visible. Leave Alternate blank. Select from Sub-Area, Reach and Outlet. Each item selected will be listed on the Multiple Locations window as shown in Figure 3.48. Up to 10 multiple selections may be made.

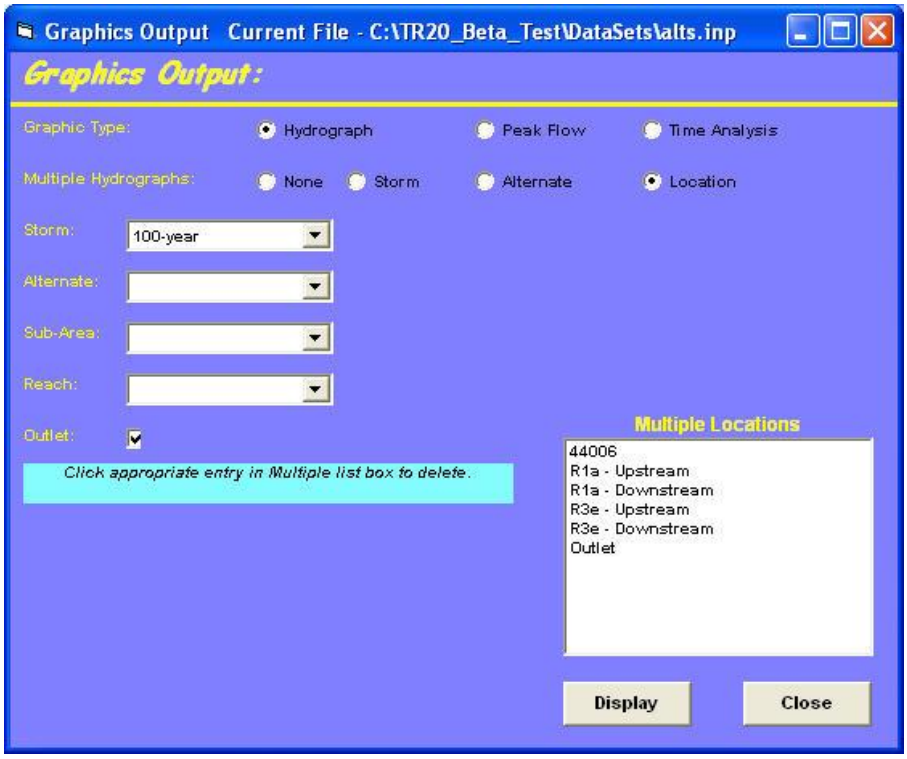


Figure 3.48: Multiple Locations Window

17. **Display** button should now be visible.

18. Click on the **Display** button to view the Multiple Hydrographs plot. An example of the Multiple Hydrographs plot is shown in Figure 3.52.

19. Click on **Close** to get back to the Main Window.

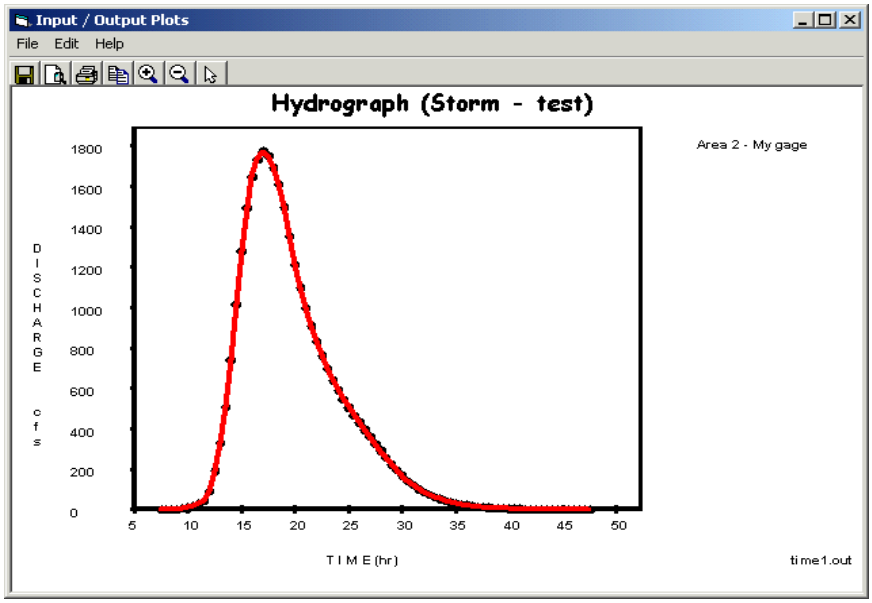


Figure 3.49 Single Sub-area - Hydrograph Window

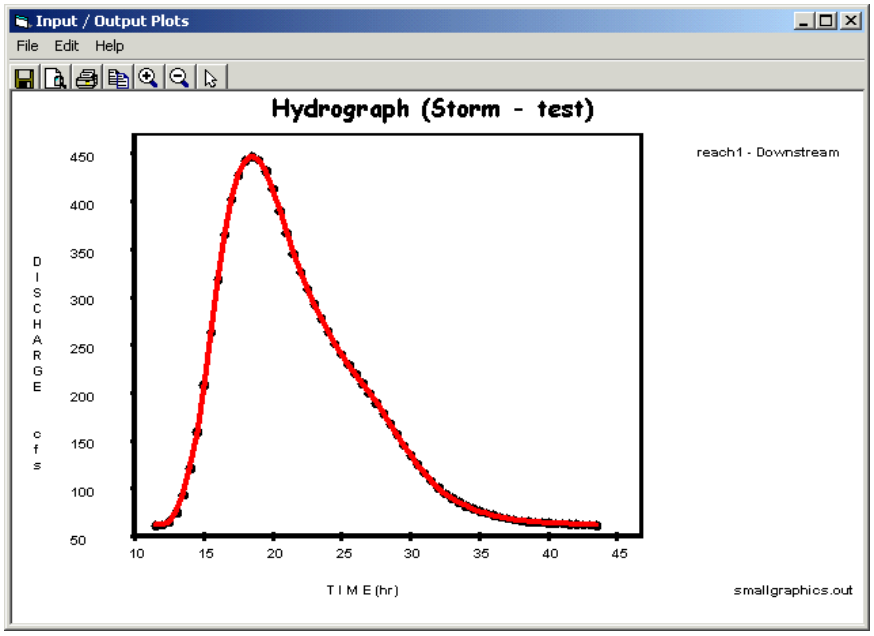


Figure 3.50: Reach – Hydrograph Window

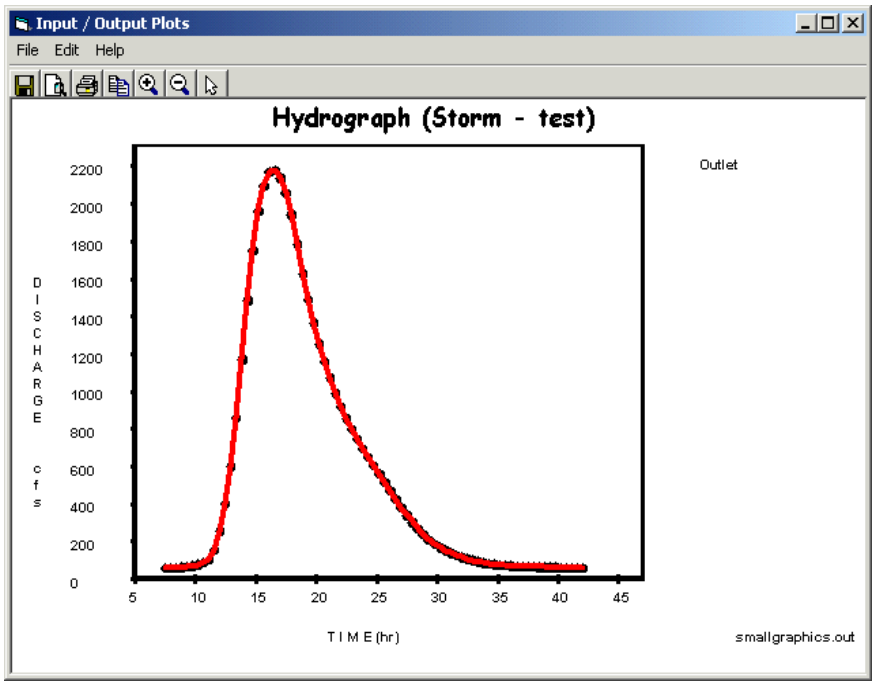


Figure 3.51: Outlet - Hydrograph Window

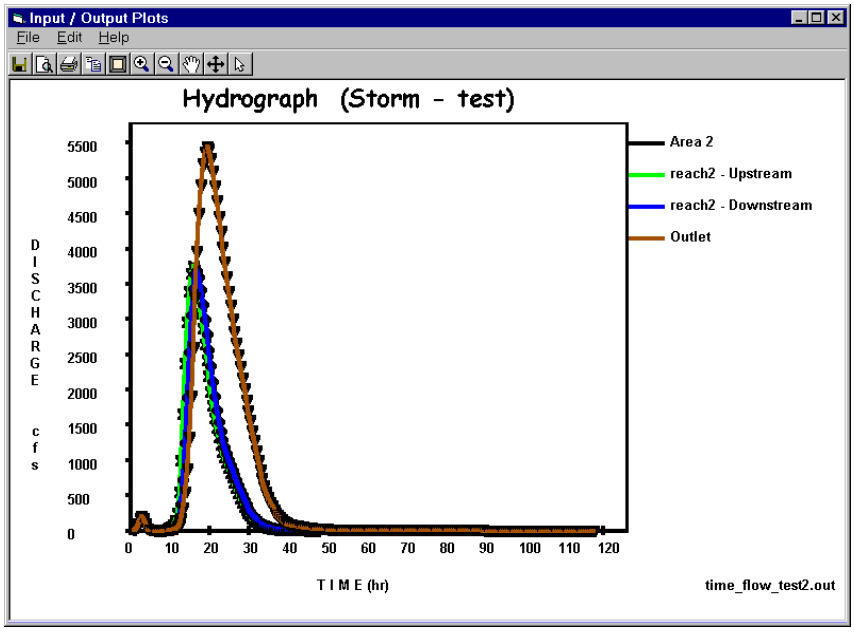


Figure 3.52: Multiple – Hydrograph Window

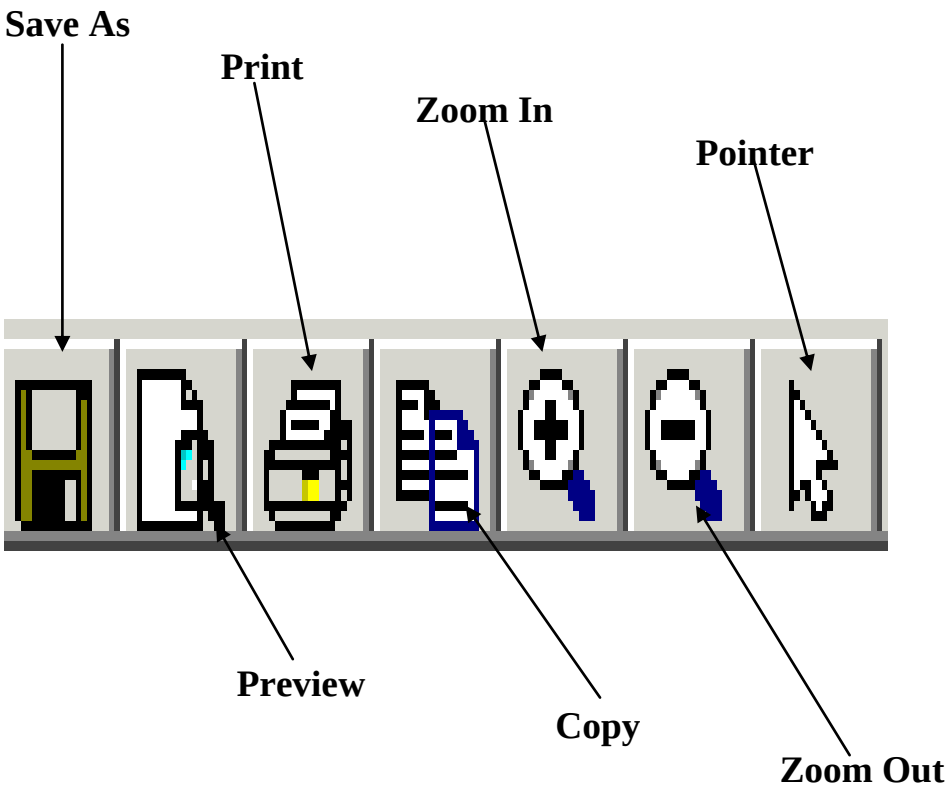


Figure 3.53 Tool Buttons – Hydrograph Window

Under the WinTR-20 Hydrograph plot window has the following options:

File: The file menu currently includes: Save As, Print Review, Print and Exit. (See Figure 3.54)

Edit: The edit menu currently includes: Copy, Zoom In, Zoom Out, Plot Points, Plot Lines, and Plod Grids. (See Figure 3.54)

Help: This would allow the user to view display showing help information. Help files available under the Help menu includes: Contents, Index, and About. (See Figure 3.54)

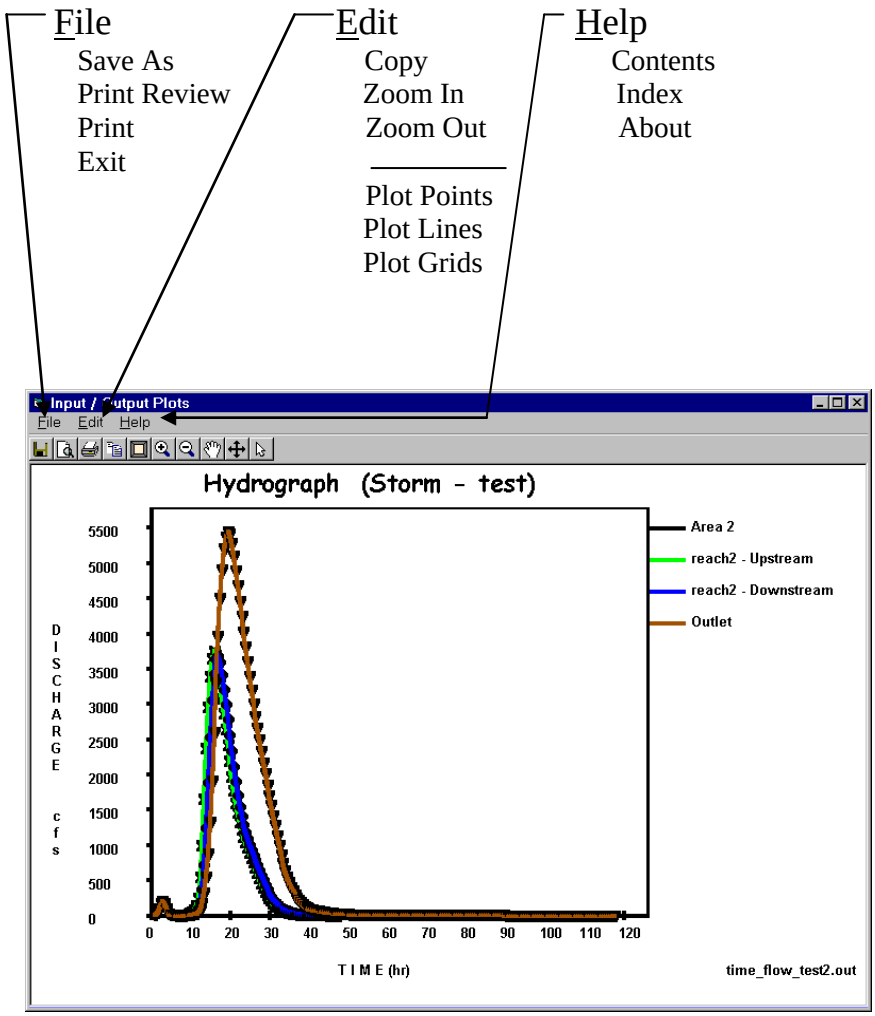


Figure 3.54: Menu Options – Hydrograph Window

To generate a Peak Flow plot, do the following steps:

1. Click on the **Peak Flow** option button.

2. Select **Storm** names.

3. Select **Flow Units** – either in cfs or csm.

4. Leave **Alternate** blank if no data is entered from the Main Window.

5. Select **Sub-Area** or **Reach** or **Outlet**. The user could select all.

6. **Display** button is now visible.

7. Click on **Display** button to view the Peak Flow plot. An example of the Peak Flow window is shown in Figure 3.52.

8. The plot can be shown as point and/or lines with or without a background grid. From the Edit pulldown menu, the user could select the plot by Points, Lines, and Grid. (See Figure 3.55)

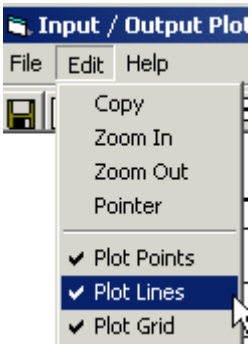


Figure 3.55: Edit – Plot Options Window

9. Click on **X** to close and return to Graphics Output Window.

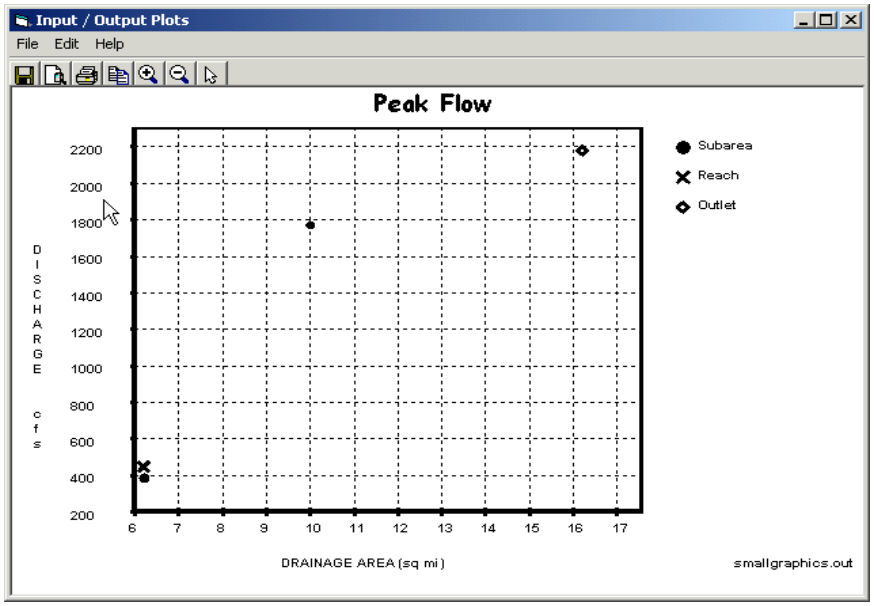


Figure 3.56: Peak Flow Window

To generate the Time Analysis plot, do the following steps:

1. Graphic Type – Click on **Time Analysis**.

2. Select **Storm** names.

3. Leave **Alternate and Sub-Area** blank.

4. Select **Reach** name – Upstream and downstream option button will be visible. Select either upstream or downstream.

5. **Display** button is now visible.

6. Click on **Display** button to view Single Reach -Time Analysis plot. An example of the Single Reach - Time Analysis Window shown as in Figure 3.57.

7. Plot Time Analysis at the Outlet – Click on Outlet.

8. Alternate, Sub-Area, and Reach should be blank.

9. **Display** button is now visible.

10. Click on **Display** button to view the Outlet-Time Analysis plot. An example of the Time Analysis-Outlet Window is shown in Figure 3.58.

11. Click on **X** to close and return to Graphics Output Window.

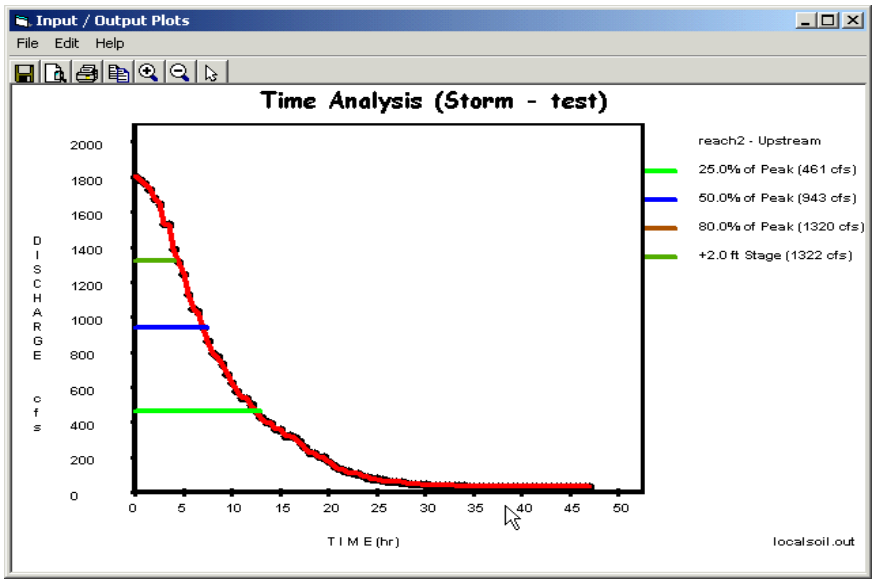


Figure 3.57: Single Reach -Time Analysis Window

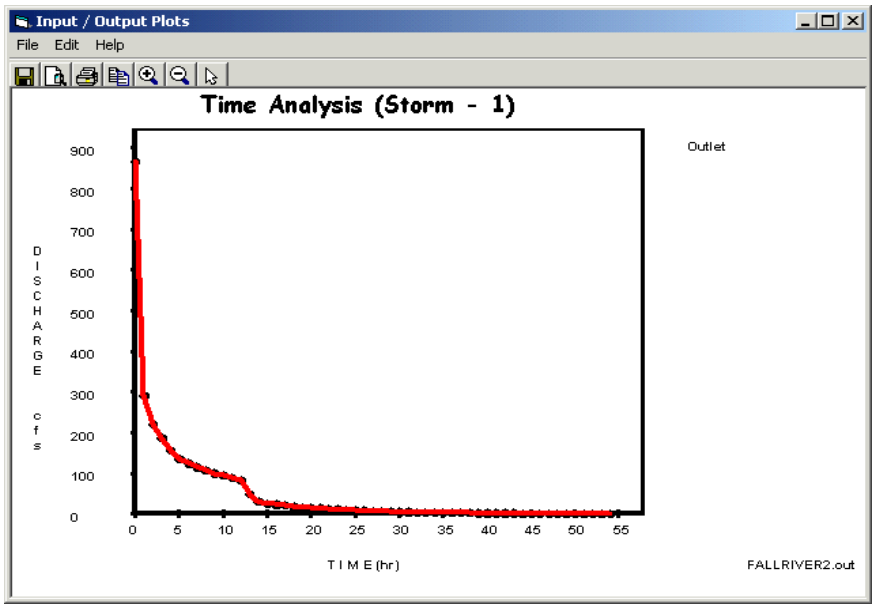


Figure 3.58: Outlet - Time Analysis Window

3.3 Converting Old TR-20 Data

An important feature of present the WinTR-20 is the ability to convert old TR-20 data (DOS) into the current WinTR-20 format. The converter program is a Fortran90 batch process and uses the TR-20 input specifications (Appendix C –TR-20 User Documentation) as the basis for input conversions. Refer to Appendix B for more information on how each data item from an old input data set is converted.

Before converting the old TR-20 data into the WinTR-20 format, there are several things that you should be aware of. First, the Input Files that are used by TR-20 convert. Secondly, not all of the old TR-20 data will be transferred to the WinTR-20 format. Thirdly, is the output files generated from the TR-20 Converter.

1. Input Files - There are one or two input files that are used by the TR-20 Converter: **Old TR-20 input filename**, and the **Old TR-20 input**.

   - **Old TR-20 input filename** - is optional and allows the entry of a filename for the Old TR-20 input file. The Old TR-20 Input Filename is "TR20Conv.fil" and contains only the name of the Old TR-20 input file and a blank line. If this file does not exist, or if the first line in it is blank, then "TR-20.dat" is used as the name of the Old TR-20 input file. When running the TR-20 model from the WinTR-20 Controller/Editor, the "TR20Conv.fil" is automatically generated.

   - **Old TR-20 input** – contains all of the data that is watershed specific for an Old TR-20 analysis. Refer to WinTR-20 User Documentation -Appendix A for more information on data converted.

2. Data Processing

- Converted Data is Incomplete

  - Most of the old TR-20 data will be transferred but some items such as IPEAKS and multiple changes in main time increment do not translate to the new format.

  - Entry of routing coefficients (x and m) in lieu of a reach cross section is no longer acceptable. Any reaches in old data sets that used the routing coefficients instead of cross section data will require additional **cross section data.**

  - Each reach in the watershed must refer to a stream cross section rating or structure rating.

  - The converter program will generate a top width value for each elevation (based on the depth and end area).

  - The converter program does not generate a friction slope and lists the friction slope as "**Missing**".

- Unconverted Items

  - The **IPEAKS** feature from old TR-20 will not be included in the Win TR-20.

  - Also, multiple main time increments are not used in the WinTR-20.

- Verify Converted Data

  - **While the converter attempts to convert as much of the old input data as possible. It is the responsibility of the user to verify that the converter data is still representative of the watershed being modeled.**

2. Output Files

- There are three output files generated from the WinTR-20 Converter. A listing of the error and warning messages can be found from the WinTR-20 User Documentation – Appendices D and E.

  a. New WinTR-20 file(xxx.inp)
  b. Error file (xxx.err)
  c. Debug file (xxx.dbg)

3.4 Importing HEC-RAS Data

As mentioned previously, the customized table needs to be organized once. When the table is saved, will be accessible any time HEC-RAS is operated. To customize the HEC-RAS output summary table, follow these steps in the order listed.

1. After running HEC-RAS for a project and plan, click the "**Profile Table**" icon or click "**View**", then "**Profile Table**". This will bring up a standard HEC-RAS output table. It is optional to display various reaches and profiles in this table. Select the profiles and reaches for which the TR-20 rating tables are desired.

2. Click "**Options**", then "**Define Table**".

3. Click "**Clear All Table Headings**", and then select variables to appear in the table. The order of this selection is important because the TR20_HEC-RAS_Rating program expects the variables in the following specific order.

   Select (double-click)
   "**Min Ch. El.**" (minimum channel elevation),
   "**LOB Elev**" (elevation of point where left overbank meets the channel bank),
   "**ROB Elev**" (elevation of point where right overbank meets the channel bank),
   "**W.S.Elev**" (computed water surface elevation for the profile),
   "**Q Total**" (total discharge at cross section),
   "**Flow Area**" (total flow area at cross section),
   "**Top Width**" (total cross section top width), and
   "**Friction Slope**" (slope of energy grade line for profile).

When each selection is made, the table is built on the screen with each added variable. After all eight variables are selected; the table is complete on the screen. Do not click "**OK**" yet.

4. Click "**Additional Options**". The table appearing on the screen includes bridges and culverts. Only valley cross sections are used in WinTR-20 so we would like to eliminate bridges and culverts from this table. In order to do this, make sure the only box checked on that window is "**Cross Sections**". If check marks appear in any other boxes, click those boxes to remove the check mark. Click "**OK**" to exit this window.

5. The next step is to save this customized table so it can be stored and then used whenever HEC-RAS is operated. In order to do this, click "**Options**", then "**Save Table**", and then enter a name for the table. One possible selection for the name is TR20 Rating Table. After naming the table, click "**OK**" to exit.

6. At this point, the table as named will appear in the list of "**User Tables**" as an option for viewing output. Click "**User Tables**" to verify that the table is saved with the assigned name.

7. Lastly create an ASCII text file with the selected profiles and reaches in the format shown on the screen. To do this, click "**File**" and "**Write to Text File**". Enter the name of the file to be saved (such as watershed"rating.txt"), then click "**SAVE**" to exit. This is the file, which the TR20_HEC-RAS_Rating program will use to develop the rating tables.

The City of Spring Valley has a flooding problem. From a preliminary water surface profile analysis, the point of significant flooding occurs when discharges exceed 2,300 cfs. The City would like protection from flooding for up to the 100-year event. An upstream reservoir has been proposed to reduce the peak discharges.

The watershed upstream of the city has a total drainage area of 8,806 acres (13.76 square miles). For this hydrologic analysis, the watershed is broken down into eight (8) sub-areas. Four (4) reaches are used for connecting the sub-areas and channel/storage routing. See Figure 1 for a plan view of the watershed.

Three Win-TR20 models will be developed to illustrate usage of the program:

Single Sub-Area Model (Example 1) – This is a model of one of the upstream tributaries. This will illustrate the set up of the simplest type of model – a single watershed without reaches. Times of concentration (T_c) and Runoff Curve Numbers (RCN) will be determined using the built-in calculation option which uses basic physical data of the sub-area (flow lengths/roughness for Tc and land use/soils for RCN).

Entire Upstream Watershed Model (Example 2) – This is a model of the entire watershed upstream of the City. The watershed will be comprised of 8 sub-areas and 4 reaches. The rating curves for the reaches were developed using HEC-RAS. This is considered the Present Condition Model.

Entire Upstream Watershed – With Reservoir in Place Model (Example 3) – This is a model of the entire watershed upstream of the City with the proposed reservoir in place. The rating curve for the structure is based on a two-stage riser design. This model uses Example 2 (present condition) as a base and adds the reservoir using the "Alternatives" option. This example illustrates the ability of the program to make graphical and tabular comparisons of "before and after" scenarios within the same model.

Entire Upstream Watershed- With Divert in Place Model (Example 4) - This is a model of the entire watershed upstream of the City with proposed divert in place. This example will illustrate the ability to divert some flow from the main stream and redirected the flow back to the main stream farther downstream.

Note: These examples emphasize the set up, running, and obtaining and viewing output. It is not the intent of these examples to provide detailed descriptions of input sources, design of structures, theory of hydrologic processes, and interpretation of output. Thus, discussion of these subjects is very limited.

Example 1 – Single Sub-Area Model

Purpose:

This example illustrates the model set up of sub-area 001, the furthest upstream tributary of the Spring Valley watershed. The following sub-area 001data is provided:

Land Use Details:

0.48 square miles of Row Crop (Straight Row – Poor HC[1]) – HSG[2] B
1.27 square miles of Row Crop (Straight Row + Crop Residue - Poor HC) – HSG B
1.27 square miles of Row Crop (Straight Row + Crop Residue - Good HC) – HSG B
0.34 square miles of Row Crop (Contoured + Crop Residue - Good HC) – HSG B
0.37 square miles of Pasture (Fair HC) – HSG B

Time of Concentration Details:

100 feet of sheet flow, 0.04 ft/ft grade (cultivated with > 20% residue cover)
+
3,100 feet of shallow concentrated flow, 0.004 ft/ft grade (unpaved)
+
13,300 feet of channel flow at 2 fps

Storm Details:

Return Period	24-hour Rainfall Amount	Rainfall Distribution	24-Hour Amount
2-year	2.93 inches	24-hour Type I	ARC 2
5-year	3.77 inches	24-hour Type I	ARC 2
10-year	4.38 inches	24-hour Type I	ARC 2
25-year	5.00 inches	24-hour Type I	ARC 2
50-year	5.53 inches	24-hour Type I	ARC 2
100-year	6.22 inches	24-hour Type I	ARC 2

Win-TR20 Identifier Record Entry

To get started, select "Shortcut to WinTR20 System" from the desktop. This will bring up the main Win-TR20 System Controller/Editor. From the File drop down menu, select "New WinTR-20 File":

[1] HC = **H**ydrologic **C**ondition
[2] HSG = **H**ydrologic **S**oil **G**roup

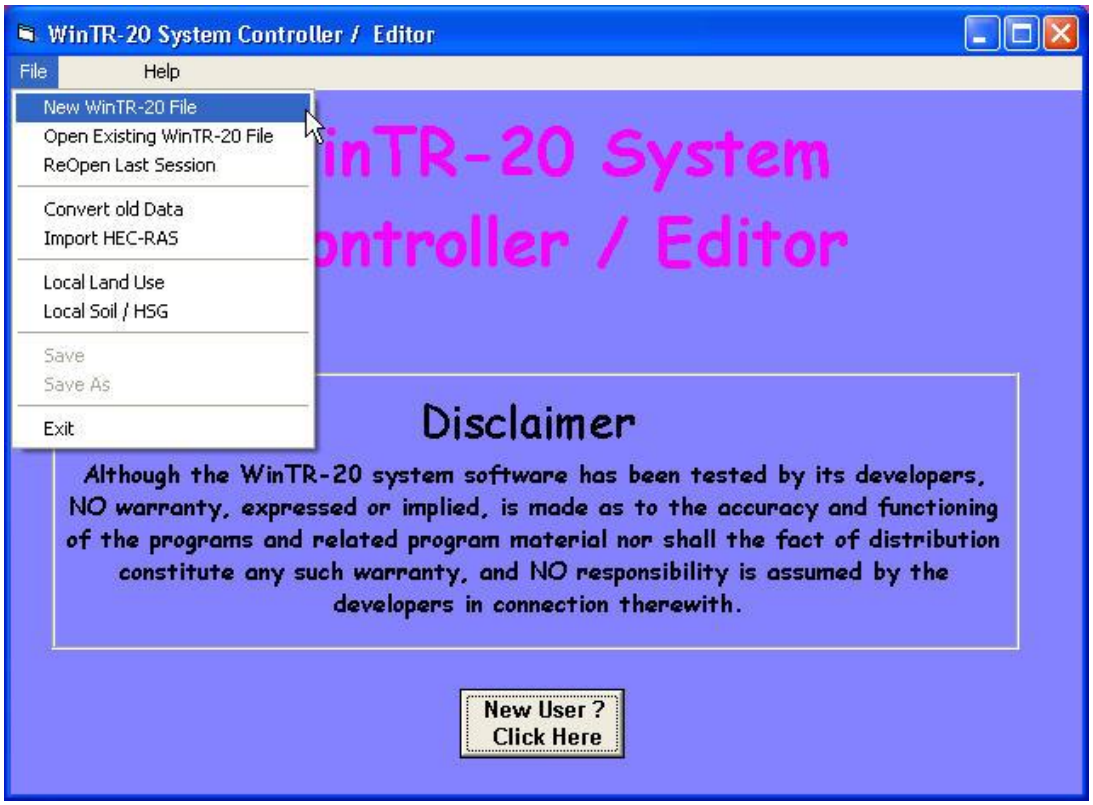


Figure 4.1:

This will bring up the WinTR-20 Identifier record. Keep the default English Input and Output Units. Set the minimum hydrograph value to 1.0 cfs then enter a description for your model. Select "**Accept Changes (Close)**" to continue.

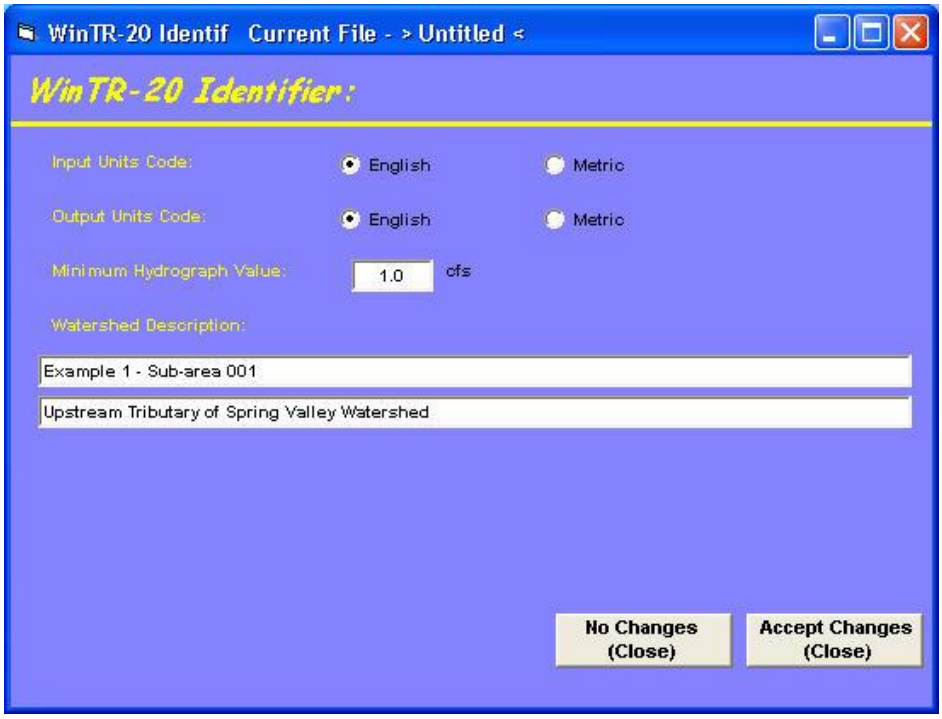


Figure 4.2: WinTR-20 Identifer Window

Sub-Area Data Entry

At this point, you are returned to main editor window. Notice that the "WinTR20 Version 1.0" line is now checked. A check by any of these lines indicates that data records now exist for that item. From this same menu, select "Sub-Area" to enter drainage area, runoff curve number (RCN), and time of concentration (Tc) for a sub-area. This will bring up a screen that looks like:

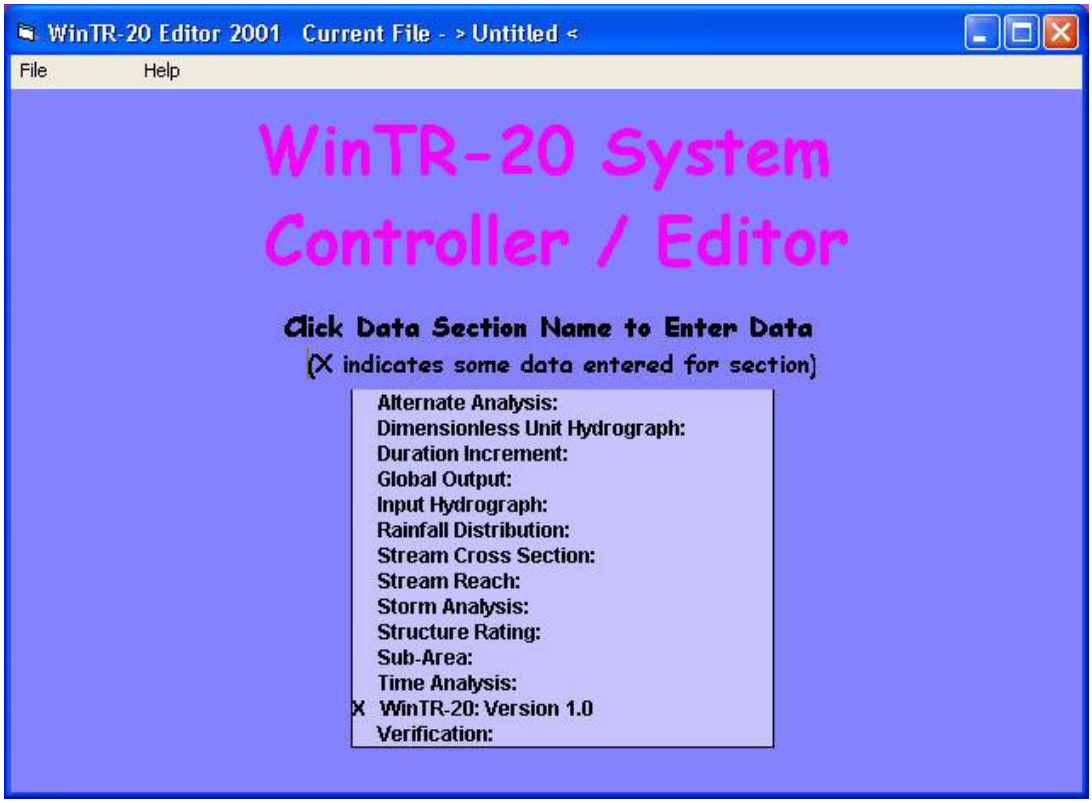


Figure 4.3: WinTR-20 Main Window

Let's call this sub-area "001". Enter this into the "Sub-Area Identifier" field and hit return. The next piece of data needed is the name of the reach that the sub-area flows into. This will be entered into the "Sub-Area Reach Identifier" field. The last outflow point of any Win-TR20 model, either with a singular sub-area or one with many sub-areas and reaches, is always designated as "Outlet". Enter "Outlet" in the "Sub-Area Reach Identifier" field.

Notice that when the sub-area name "**001**" was entered two new buttons popped up – "Land Use Details" and "Tc Details". The user has the choice of entering an RCN directly or, by using the "Land Use Details", entering Land Use by Hydrologic Soil Group and letting the program calculate the RCN. Tc is similar – either enters the value directly or,

by using “Tc Details”, enter flow path information and let the program calculate the Tc. For our first example, we will have the program calculate both from basic data.

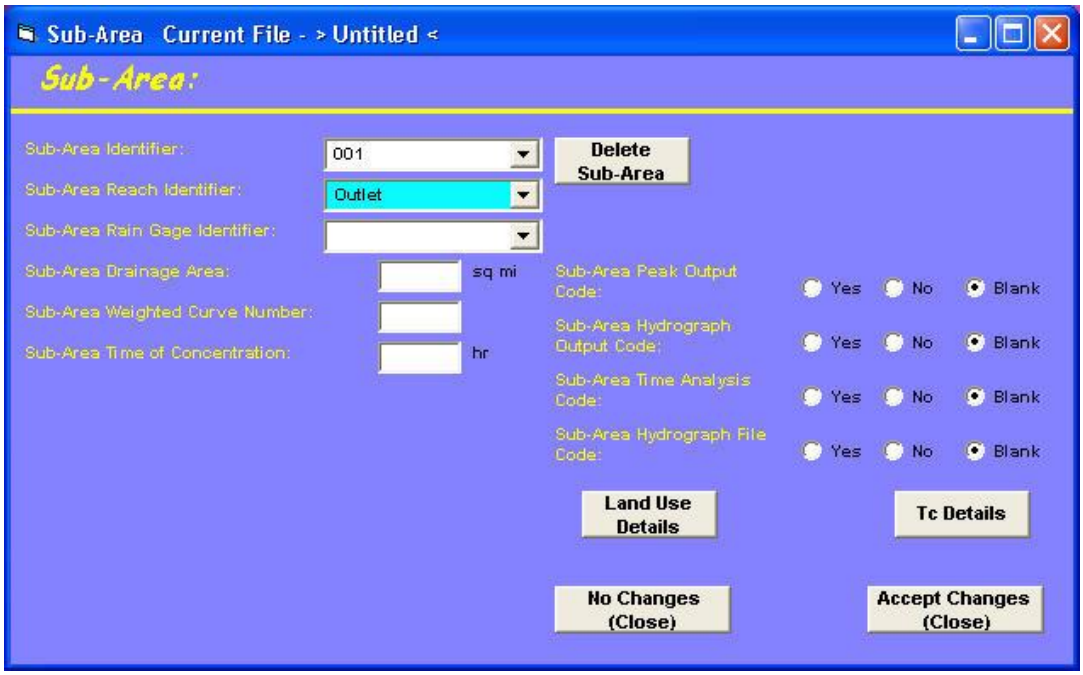


Figure 4.4: Sub-Area Window

When the “Land Use Details” button is selected, the user will enter the number of square miles of each land use/hydrologic soil group combination. A scroll bar on the right side of that window helps the user navigate through the 90 possible land use area identifiers. When this is done the program will calculate a composite RCN for that sub-area. In addition to the RCN, this step also sums the total drainage area size for the sub-area. The screen below shows the data entered in the form (the pasture land use and Row Crop (C+CR-Good) are entered but not visible on the screen shown). Note the result shown at the bottom of RCN details window: the total drainage is 3.73 square miles with a composite curve number of 76.8.

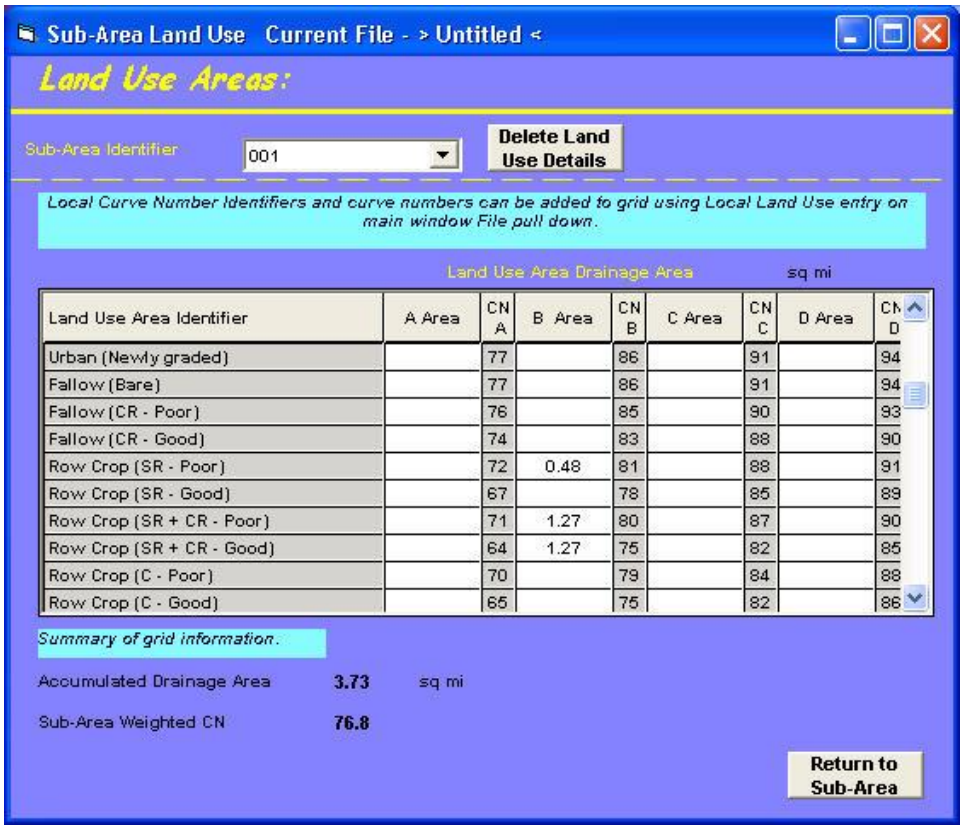


Figure 4.5: Land Use Areas Window

Select the "**Return to Sub-Area**" button. From the main sub-area window, select the "Tc Details" button. Enter the Tc details given in the problem description. After the data has been entered you should see a window similar to what is shown below[3]:

[3] Since Sheet Flow is a function of the 2-year precipitation amount, the time for this component of the Tc will not show up until that precipitation amount is entered within the Storm Analysis input window.

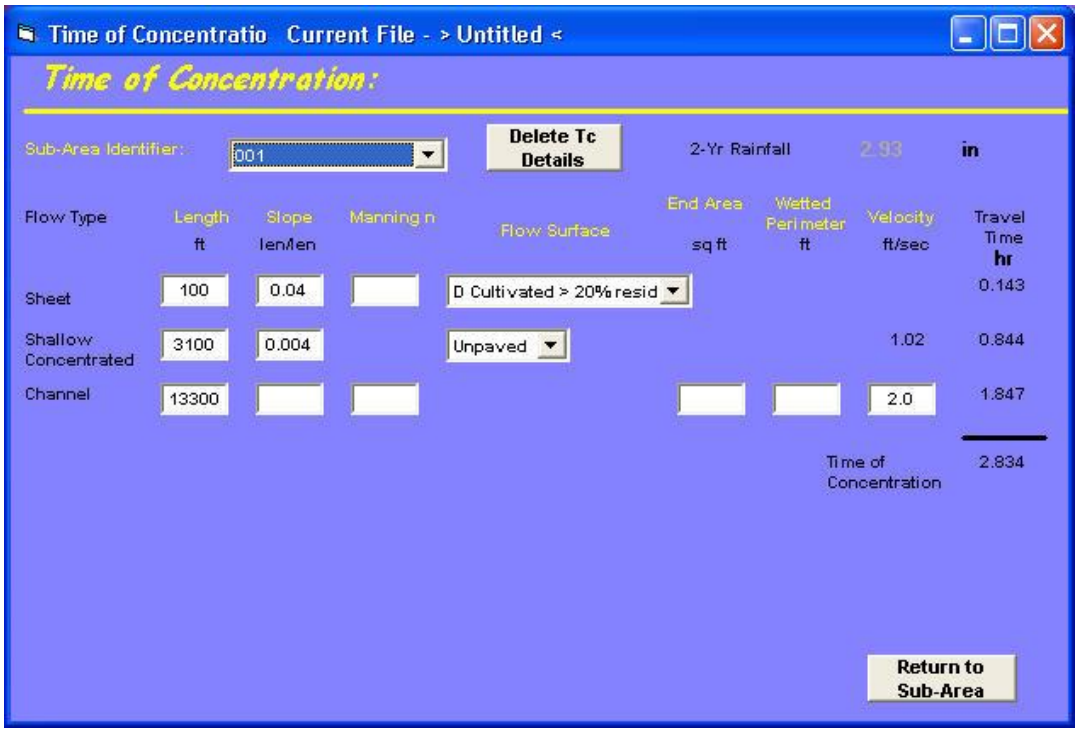


Figure 4.6: Time of Concentration Window

Note that when you return to the main sub-area menu, the entry windows for drainage area, RCN, and Tc do not appear. When data are entered using the "detail" method, these windows disappear. Note also the output options available. Any output option selected here would apply only to that sub-area. To apply the same output options to all sub-areas and reaches, "Global Output" would be used. This will be covered later.

Select the "**Accept Changes (Close)**" button to return to the main Controller/Editor window.

<u>Storm Analysis Entry</u>

Next, we need to enter the rainfall amounts, distribution, and antecedent runoff condition. From the WinTR-20 System Controller/Editor window select the "Storm Analysis" button. Within the storm identifier window, enter "2-yr" – this is just a text identifier to be used in the output. "Raingage Identifier" can be left blank if all sub-areas within the model use the same rainfall distribution (which these examples do). Enter 0.0 for starting time and 2.93 inches for Gage Rainfall. Click on the arrow next to the Gage Rain Table Identifier window and then select "Type I" from the drop down menu. Select the "2" (average) for the Gage Antecedent Runoff Condition. Enter 2.93 inches for the 2-yr 24-hr Rainfall[4]. Notice that as the values are entered, they show up in the table to the right.

[4] This entry is only used in Tc Detail Calculations. Sheet flow calculations require a 2-yr rainfall amount. For models with multiple storm analysis, this entry is only required on the first storm. If Tc is entered directly for all sub areas (Tc Details not used), this 2-yr rainfall amount is not a required entry.

To enter the remaining storms, simply place the cursor in the Storm Identifier window and type in the next storm identifier name (5-yr, 10-yr, etc.). Note that when you place the cursor in the Storm Identifier window, the previous storm's name remains highlighted until you type in the new name and hit the carriage return. After all storms have been entered, the Storm Analysis window should look like:

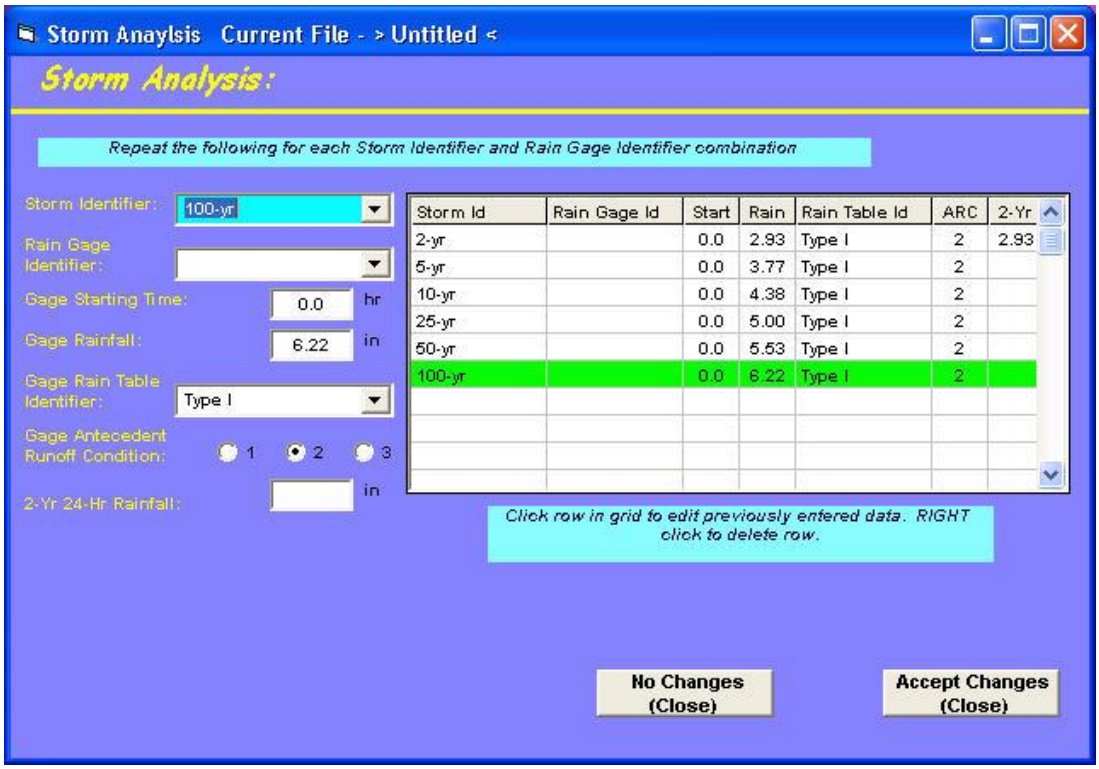


Figure 4.7: Storm Analysis Window

Select the "**Accept Changes (Close)**" button to return to the main Controller/Editor window.

<u>Setting Output Options</u>

The last step before running this example is setting the output options. Output options can be set in two places: 1) within the individual sub-area or stream reach record or 2) within the Global Output record. Using Global Output results in the same output option for ALL sub-areas and stream reaches. For this example, we'll use Global Output. Select "Global Output" from the main Controller/Editor window. For this first run, select "Default Peak Output Code" to "Yes". This results in the cleanest, most readable output. If you plan on using the hydrograph plotting option, you must select the "Hydrograph Output Code" either within the Global Settings or in the sub-area or reach where you want to make the plot. Unfortunately this can produce excessive output in the printed output page since the hydrographs are displayed in tabular format "on the fly" between peak flow calculations.

Below is a copy of the Global Output window for this example:

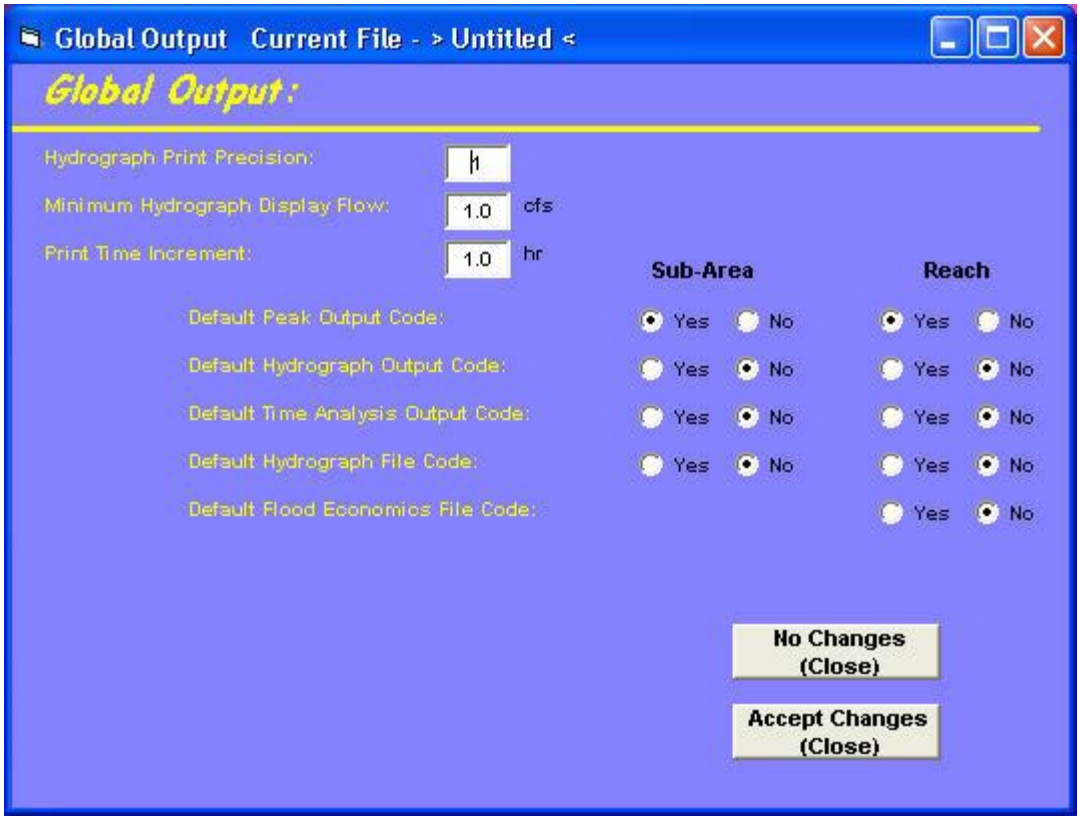


Figure 4.8: Global Output Window

Select "**Accept Changes (Close)**" to return to the WinTR-20 System Controller/Editor window.

<u>Viewing Schematic, Input, Running the Model</u>

Before the user can run the model, the input file must be saved. Select "**File**", and "**Save As**" from the WinTR-20 System Controller/Editor window. Give the file an identifiable name and place it in the desired directory. Once the file is saved, the "**View**" and "**Run**" options appear at the top of the Controller/Editor window. "**View**" allows the user to look at the watershed schematic and the input file in an ASCI format. A schematic view is applicable only to watersheds with more than one sub-area so this option does not apply to this example (see Example 2 for an example of a schematic plot). The input file for this particular example is viewable and is shown below:

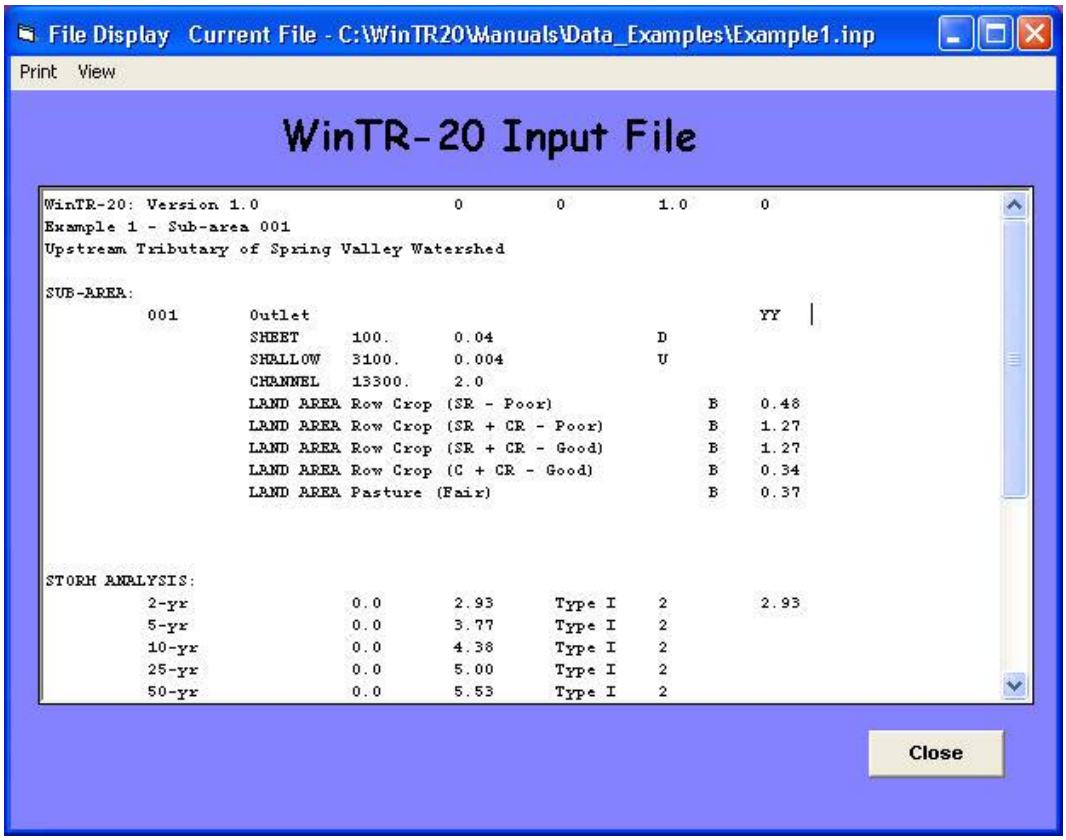
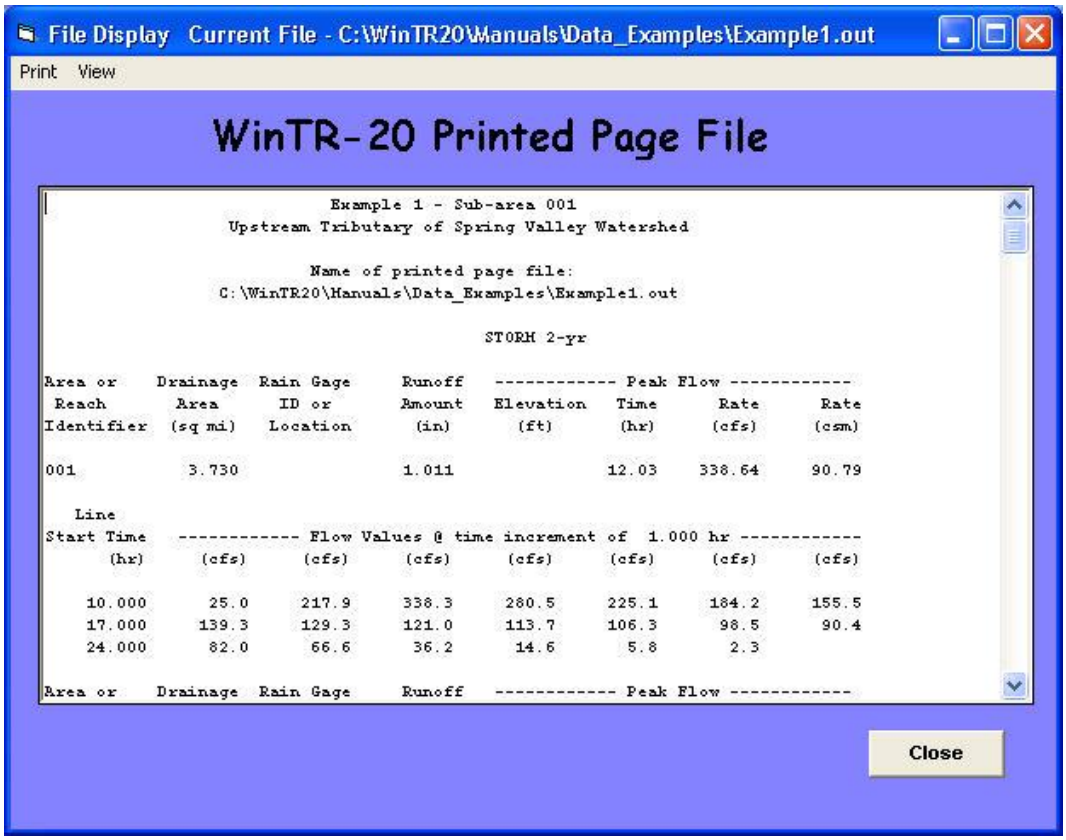


Figure 4.9: Example 1-WinTR-20 Input File

To run the model simply select "**Run**" from the WinTR-20 System Controller/Editor.

<u>Output – Printed Page</u>

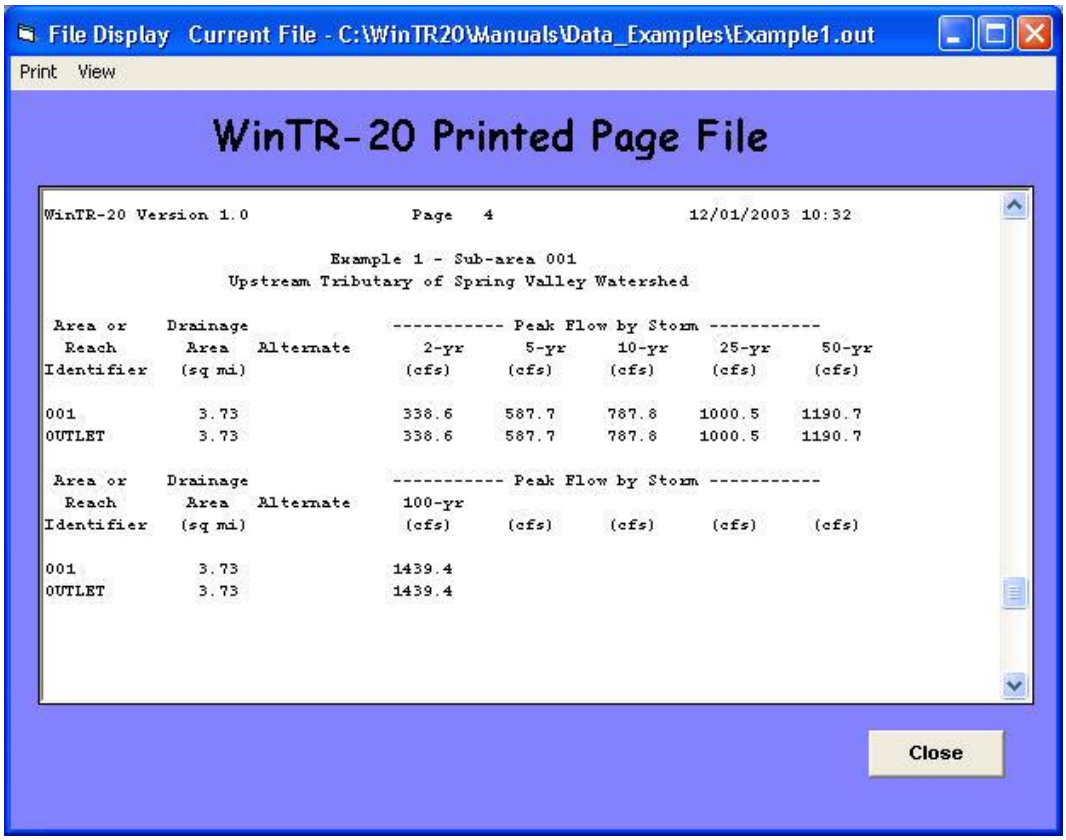
Following a successful run, the "**WinTR-20 Printed Page File**" window containing the output will appear. For this example, the "WinTR-20 Printed Page File" should appear as follows (top part of full output):




```
                    Example 1 - Sub-area 001
              Upstream Tributary of Spring Valley Watershed

                    Name of printed page file:
          C:\WinTR20\Manuals\Data_Examples\Example1.out

                                   STORM 2-yr

Area or    Drainage  Rain Gage     Runoff   ------------ Peak Flow ------------
 Reach       Area      ID or      Amount   Elevation   Time      Rate      Rate
Identifier  (sq mi)   Location     (in)       (ft)      (hr)     (cfs)     (csm)

001           3.730                1.011                12.03    338.64     90.79

   Line
Start Time   ------------ Flow Values @ time increment of  1.000 hr ------------
      (hr)      (cfs)      (cfs)      (cfs)      (cfs)      (cfs)      (cfs)      (cfs)

    10.000       25.0      217.9      338.3      280.5      225.1      184.2      155.5
    17.000      139.3      129.3      121.0      113.7      106.3       98.5       90.4
    24.000       82.0       66.6       36.2       14.6        5.8        2.3

Area or    Drainage  Rain Gage     Runoff   ------------ Peak Flow ------------
```

Figure 4.10: Example 1- Printed Page File

The first part of "WinTR-20 Printed Page File" output displays peak discharge information, drainage area, runoff amount, and time of peak for each sub-area and reach by storm. For this example, output for sub-area 001 is shown along with the "Outlet." Since this particular model only has one sub-area without any reaches, the results for these two locations will be same (sub-area 001 peak = outlet). Scrolling down this Printed Page to the bottom shows the summary table which lists only peak discharge by storm:




```
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                          Example 1 - Sub-area 001
                  Upstream Tributary of Spring Valley Watershed

 Area or    Drainage                ----------- Peak Flow by Storm -----------
  Reach       Area   Alternate        2-yr       5-yr      10-yr      25-yr      50-yr
Identifier   (sq mi)                 (cfs)      (cfs)      (cfs)      (cfs)      (cfs)

001            3.73                  338.6      587.7      787.8     1000.5     1190.7
OUTLET         3.73                  338.6      587.7      787.8     1000.5     1190.7

 Area or    Drainage                ----------- Peak Flow by Storm -----------
  Reach       Area   Alternate      100-yr
Identifier   (sq mi)                 (cfs)      (cfs)      (cfs)      (cfs)      (cfs)

001            3.73                 1439.4
OUTLET         3.73                 1439.4
```

Figure 4.11: Example 1 - Outlet

The ”WinTR-20 Printed Page File” is also automatically saved as a “*.out” file (* = input file name prefix) which can be brought into MS-Word, Notepad, etc. for printing or insertion into other project documents. It is saved to the same directory as the input file.

Hydrograph Plots

To view a hydrograph plot at a particular location, the hydrograph output code for that location must be set to “**Yes**.” This can be set at a specific location (within the specific sub-area or reach input window) or set globally for the whole watershed. The user should be aware that wherever this option is set, a tabular hydrograph will be included in the “WinTR-20 Printed Page File” also. This can produce voluminous output on the “WinTR-20 Printed Page File”, especially if the Global Output option is used.

For this example, go back into the “Global Output” window and set the hydrograph output code for sub-areas to “Yes” and then select the “**Accept Changes (Close)**” button to return to the WinTR-20 System Controller/Editor window. Notice that the “Run” option on the main menu bar is not shown. Since a change to the file was made (Global Output hydrograph now requested), the new input must be saved before the “**Run**” option appears. Select “**File**” then “**Save**” from WinTR-20 System Controller/Editor window and then “**Run**.” After the model runs, note that the “WinTR-20 Printed Page File” now contains a tabular hydrograph in between each storm:

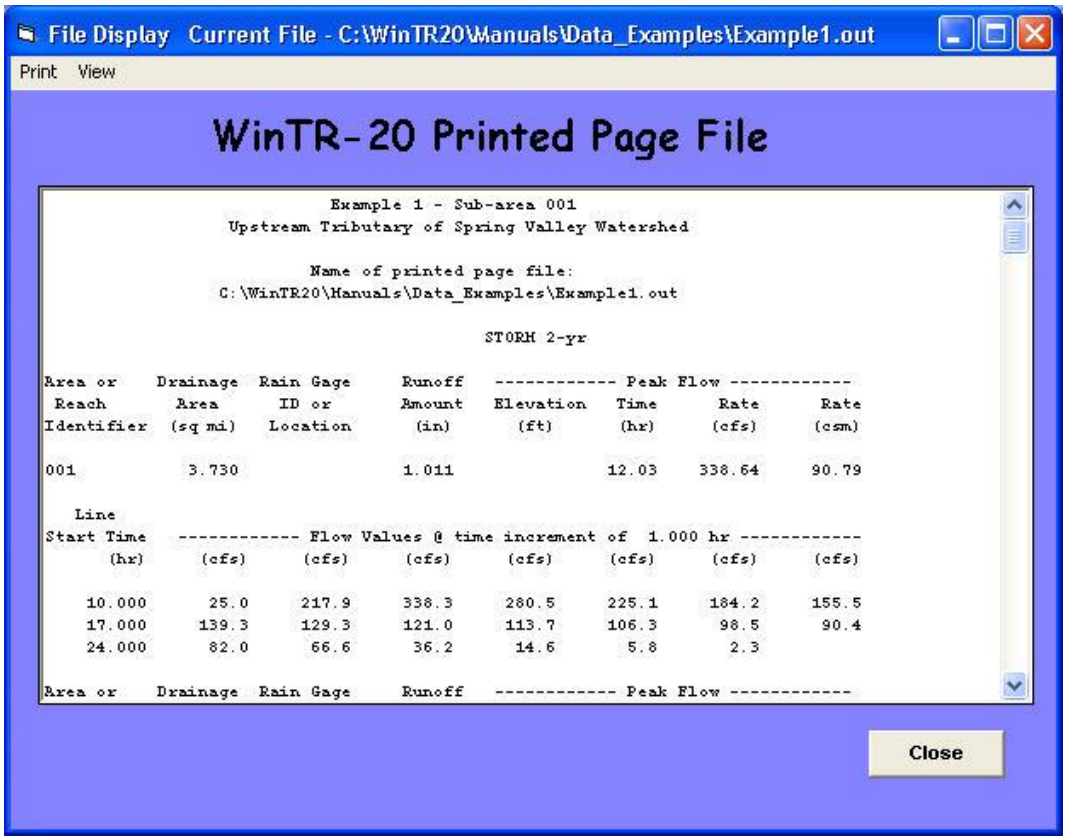


Figure 4.12.Example1 – Printed Page File

After closing the "WinTR-20 Printed Page File" window select "**Plots**" on the WinTR-20 System Controller/Editor window menu. Once in the "Graphics Output" window, use the drop down menus to select the 25-year storm and 001 from the Storm and "Sub-Area" choices respectively. The "Graphics Output" window should look like this:

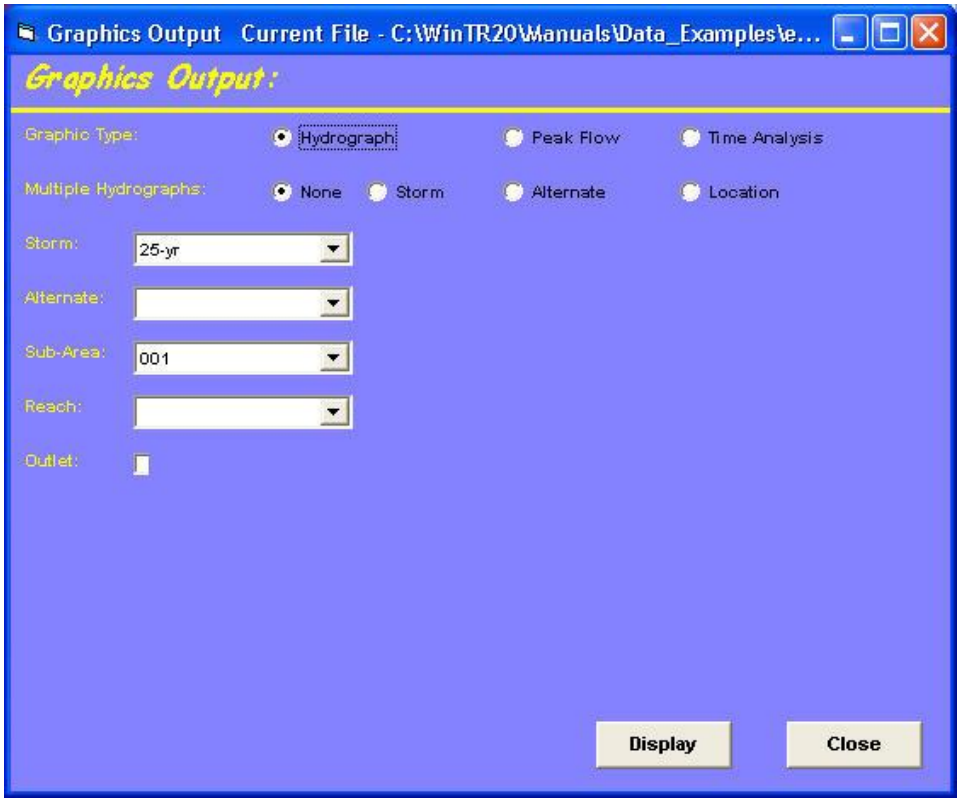


Figure 4.13 Graphics Output Window

Need to click another box to make "**Display**" button came up. Select "**Display**" and you should see the following:

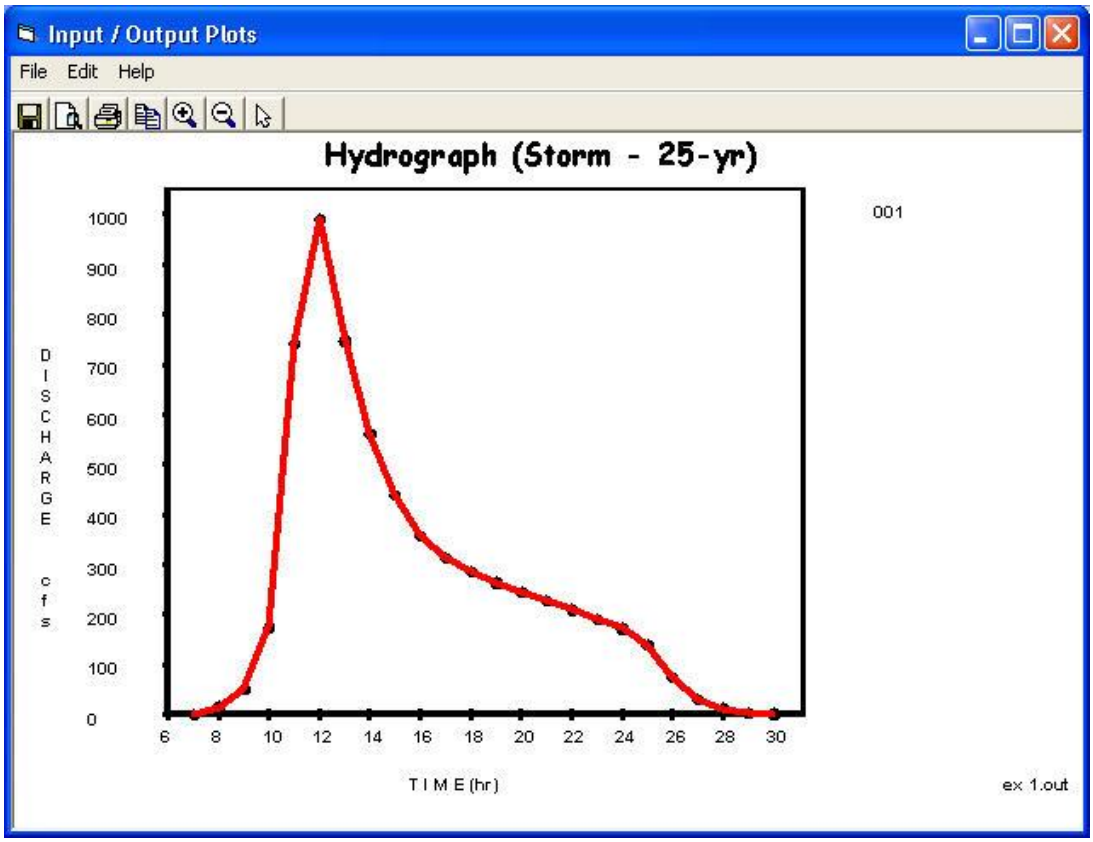


Figure 4.14: Hydrograph (Storm – 25-yr)

Multiple plots (storms or locations) can also be viewed. After closing out of the 25-year storm display and going back to the "Graphics Output" window, select "Storm" to the right of "Multiple Hydrographs." Directly below, in the pull-down menu to the right of "Storm," select the storms you would like to view. This is done by highlighting the storm name and pressing the return key. This action places each selected storm name in the "Multiple Storms" window located in the lower right. Selecting the "Display" button now should show all the selected storm hydrographs. For this example, we had selected the 2-, 10-, and 25-year events.

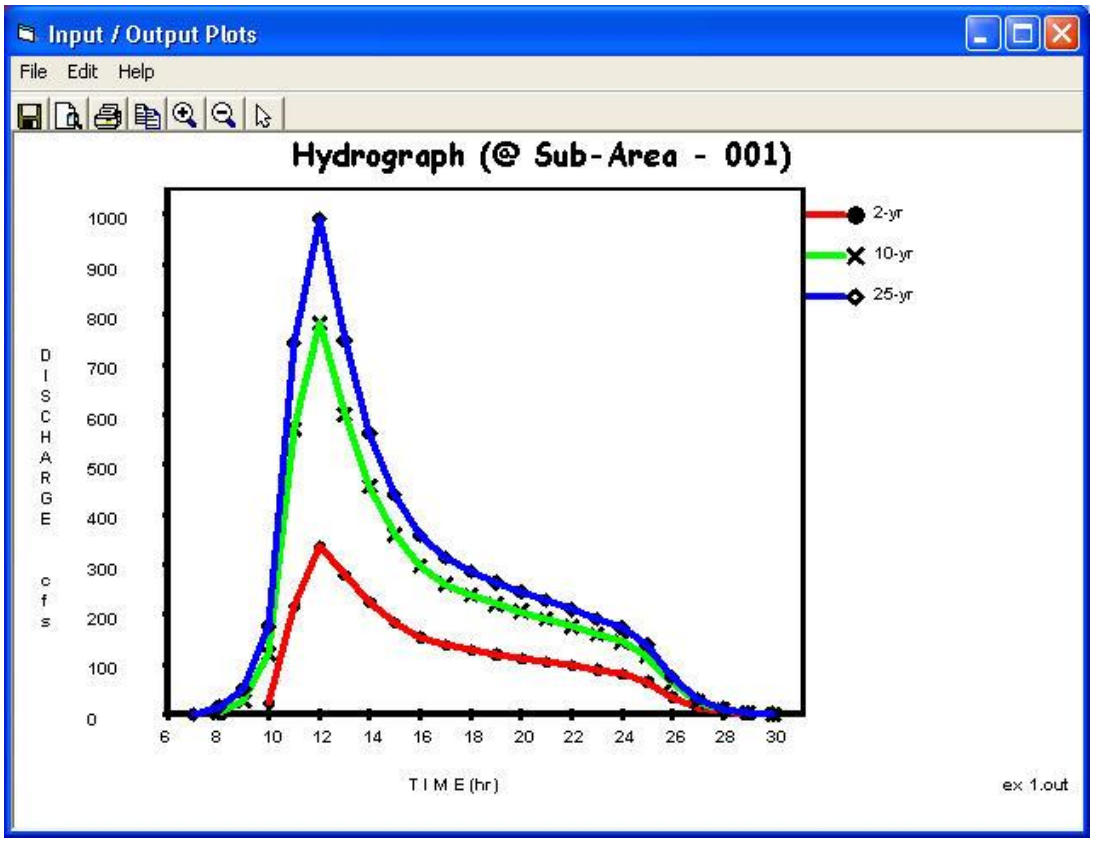


Figure 4.15: Multiple Hydrographs

Example 2 – Entire Upstream Watershed Model

For this example, we build upon Example 1 to include all the sub-areas and reaches for the entire watershed. The RCN's and Tc's are given directly for the remaining 7 sub-areas (we will not use the RCN and Tc details option as we did in Example 1). See the table below for RCN's, Tc's, and receiving reaches for each sub-area:

Sub-area	Drainage Area (mi2)	Runoff Curve Number	Time of Concentration (hours)	Reach that receives sub-area's runoff
001	From Example 1			R01
003	1.90	72	2.30	R02
005	0.94	70	1.77	R02
007	2.27	80	2.76	R03
009	0.88	76	1.99	R04
011	2.29	73	2.50	R04
013	0.38	81	0.98	Outlet
015	1.37	79	2.03	Outlet

Sub-Area Entry

Open the Example 1 model. In the WinTR-20 Identifier line, alter the description line to read "Example 2 – Entire Spring Valley Watershed" and select "**Accept Changes (Close)**". From the WinTR-20 System Controller/Editor window bring up the "Sub-area" input window.

Use the arrow to the right of the "Sub-Area Identifier" box to select "001" then hit the return key to bring in that sub-area's information. With this example, the model "Outlet" is now the on the west side of the city. Sub-area 001 no longer has "Outlet" as its downstream receiving reach. We need to change the "Sub-Area Reach Identifier" from "Outlet" to "R01." Right click in this box to highlight "Outlet." While highlighted, make the replacement by typing "R01" and then hitting return to get the program to accept the change. It should appear as shown below:

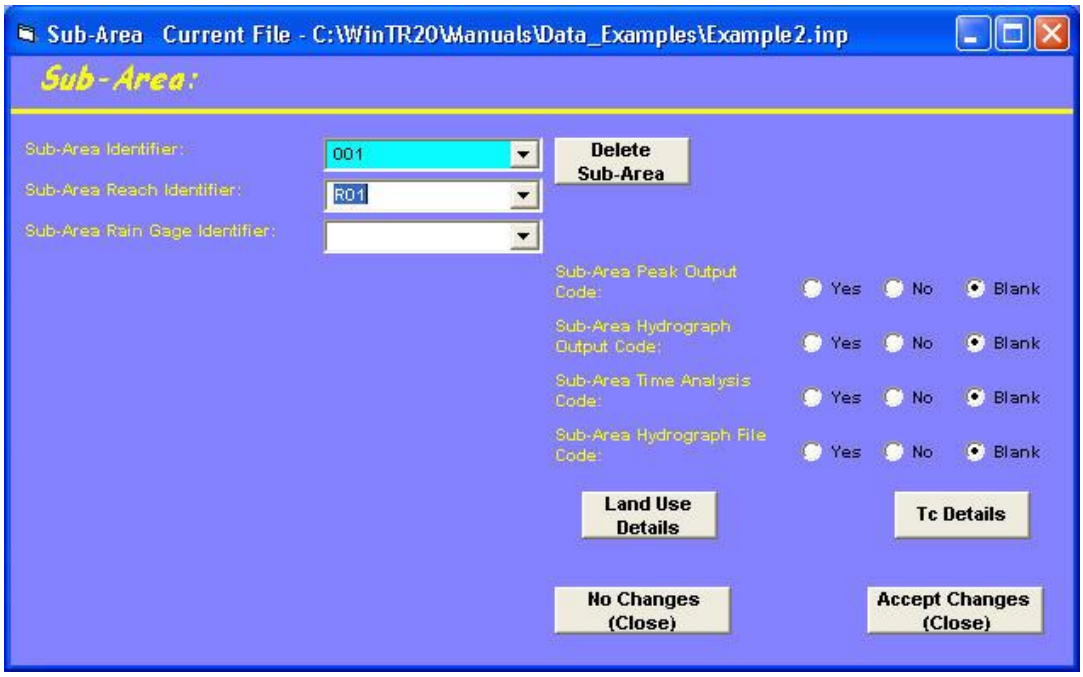


Figure 4.16: Sub-Area 001

Next, we'll add the information for all the other sub-areas. To do this, simply place the cursor in the "Sub-Area Identifier" window and click to highlight the current sub-area. Now, type the name of the sub-area you are about to enter and hit return (the data from the previous sub-area will remain in view until the return key is hit). Enter the remainder of the information for the sub-area. Below is how the screen should look after the data has been entered for sub-area 003:

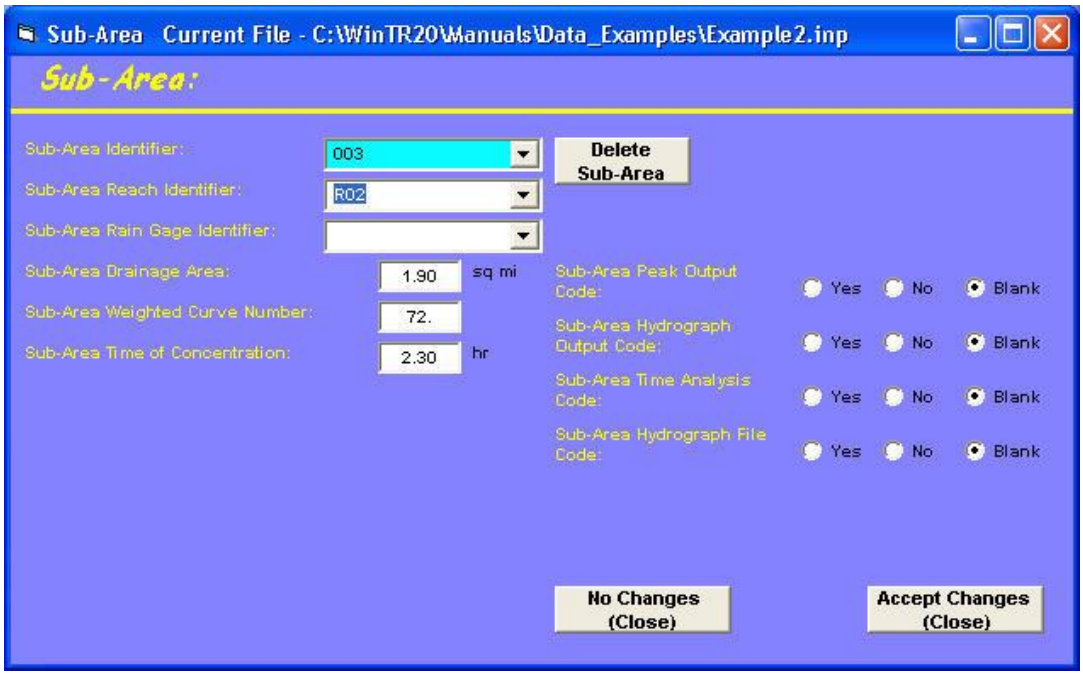


Figure 4.17: Sub-Area 003

Note that "Sub-Area Rain Gage Identifier" is left blank. This field would only be used if the watershed analysis uses different rainfall distributions between sub-areas. Since this example will be using the NRCS Rainfall Type I Distribution for the entire watershed, no entry is required.

Enter the remainder of the data for all the sub-areas. As the entry for each sub-area is completed, note that the list within the drop down windows next to the sub-area identifier and sub-area reach identifier grows to include new sub-areas and reaches. The screen captures below show how these drop down menus should appear once all the data have been entered. Click "**Accept Changes (Close)**" to leave this window.

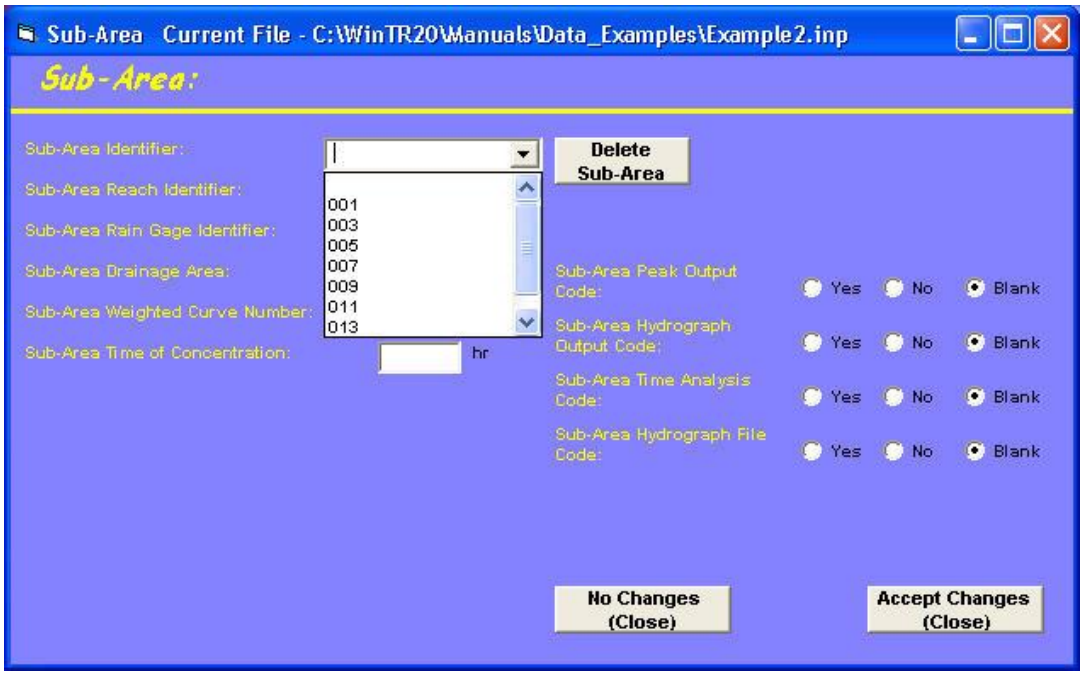


Figure 4.18

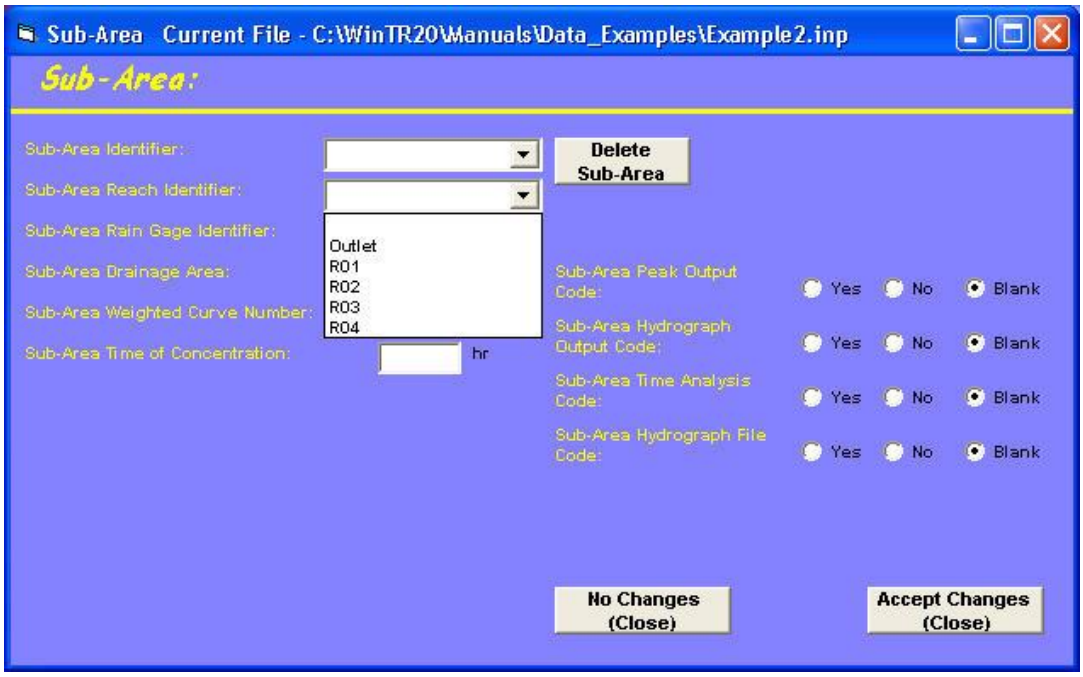


Figure 4.19

Reach Entry

Next, we'll fill out the reach information. From the main WinTR-20 System Controller/Editor window, select "Stream Reach." Within the stream reach window, the following information will be provided for each reach:

- The name of the downstream reach that receives this reach's flow
- If this is a "channel routing" reach, what is the name of the cross section rating curve associated with this reach and what are the channel and floodplain distances
- If this is a "structure routing" reach, what is the name of structure rating curve associated with this reach
- Base flow, if any, to add to this reach's hydrograph

The split flow options shown to the right are only used when the model includes diverting flows out of a reach. For this example, the split flow fields will be left blank.

If you had entered reach names during the sub-area entry above, all these names should appear in the drop down menu next to the "Stream Reach Identifier" window. Use this to highlight the reach you want to enter data for[5]. Below is a table containing basic reach information for this example.

[5] If you had decided to enter all your reach information before sub-area entry, the names will not automatically appear in this drop down menu and you will have to enter the names directly into the reach identifier window.

Stream Reach Identifier	Stream Receiving Reach Identifier	Stream Cross Section Rating Name	Reach Channel Length (ft)	Reach Valley Length (ft)
R01	R02	DF-6	6,870.	5,350
R02	R03	LB-4	12,130	10,560
R03	R04	LB-4	4,220	3,970
R04	Outlet	LL-31	4,260	3,800

Enter the data for each of the four reaches. The data entry for reach R01 should appear as shown below:

Figure 4.20

Once all four reaches have been entered click "**Accept Changes (Close)**" to leave this window and return to the WinTR-20 System Controller/Editor window.

Cross Section Rating Entry

Next, we need to enter the rating (elevation, discharge, end area, top width, and friction slope) for each stream routing reach. This information is developed outside of the Win TR-20 program using uniform flow relationships (i.e. Manning's Equation) or a non-uniform open channel hydraulics model (i.e. HEC-RAS). For this example, the data for the four reaches was determined using an HEC-RAS model. The ratings for the reaches are given in the table below (**bankfull elevations in bold**[6]). Recall that both reaches R02 and R03 both use the same stream cross section rating (LB-4).

Stream Cross Section DF-6

Elevation	Discharge (cfs)	End Area (ft2)	Top Width (ft)	Friction Slope (ft/ft)
1321.7	0.	0.	0.	0.0020
1323.7	28.	13.7	8.9	0.0022
1324.4	48.	23.4	22.7	0.0023
1325.6	118.	68.6	82.1	0.0030
1326.6	311.	260.5	278.3	0.0035
1327.0	526.	414.8	345.3	0.0029
1327.7	943.	644.2	364.3	0.0027
1328.2	1379.	832.3	372.6	0.0024
1328.7	1967.	1049.0	383.6	0.0021

Stream Cross Section LB-4

Elevation	Discharge (cfs)	End Area (ft2)	Top Width (ft)	Friction Slope (ft/ft)
1306.2	0.	0.	0.	0.0040
1307.6	28.	17.9	18.3	0.0042
1308.1	56.	28.1	20.6	0.0052
1308.7	95.	40.3	22.5	0.0068
1310.1	237.	78.1	29.3	0.0051
1311.0	506.	133.2	35.1	.0060
1312.4	622.	156.8	38.3	0.0040
1316.4	1886.	367.9	93.3	0.0037
1317.9	2758.	579.0	159.5	0.0025
1319.5	3934.	860.0	199.8	0.0020

[6]The bankfull and low ground elevation entries are used to adjust reach routing parameters which compensate for reaches having different floodplain and channel routing distances (usually channel routing distance is longer than floodplain routing distance). The program will use the lower of the two in deciding the flow amounts in the channel vs. floodplain.

Stream Cross Section LL-31

Elevation	Discharge (cfs)	End Area (ft2)	Top Width (ft)	Friction Slope (ft/ft)
1276.0	0.	0.	0.	0.00047
1278.9	50.	53.	40.	0.00047
1279.5	100.	84.	55.	0.00051
1280.4	250.	141.	78.	0.00065
1281.1	500.	218.	129.	0.00090
1281.7	750.	292.	160.	0.00108
1282.0	1000..	355.	166.	0.00111
1282.7	1500.	465.	177.	0.00103
1283.3	2000.	575.	186.	0.00088
1283.9	2500.	695.	196.	0.00074
1284.6	3000.	825.	207.	0.00062
1285.2	3500.	970.	233.	0.00054
1285.9	4000.	1130.	251.	0.00046
1286.5	4500.	1300.	265.	0.00041
1287.0	5000.	1425.	276.	0.00039

Back at the WinTR-20 System Controller/Editor window, select “Stream Cross Section” to begin the data entry process for these three ratings. When the “Stream Cross Section” editor window comes up, select the arrow to the right of “Cross Section Identifier” field. Notice that the three reaches requiring rating curves show up (DF-6, LB-4, LL-31).

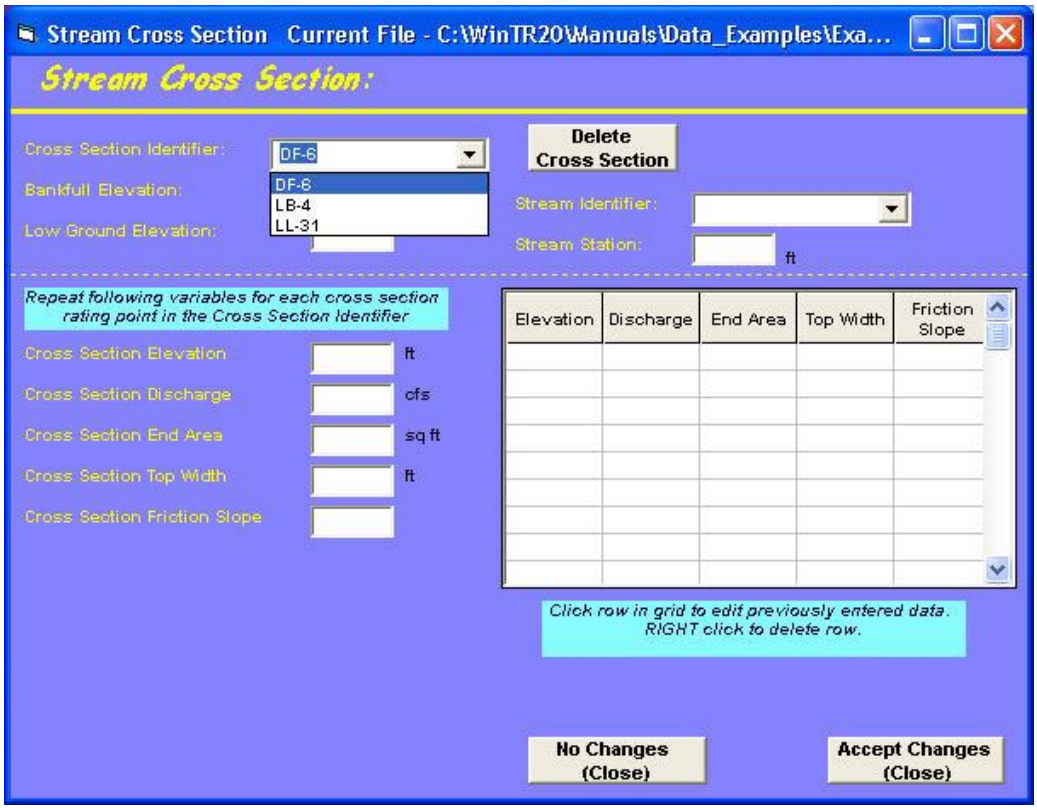


Figure 4.21

Highlight the DF-6 and then hit return. Enter all the data for this cross section (low ground elevation may be left blank). Note that the data are entered within the boxes on the right. When all four pieces of data (elevation, discharge, end area, top width, and friction slope) have been entered, hit return and the data is transferred to the table on the right hand side. Data cannot be directly entered or altered (except to delete a line) from within the table. If you realize you've made an entry error after the data is transferred to the table, simply click on the line in the table and the data are brought back into the four boxes on the left where they can be edited. When all the data have been entered, the screen should look like:

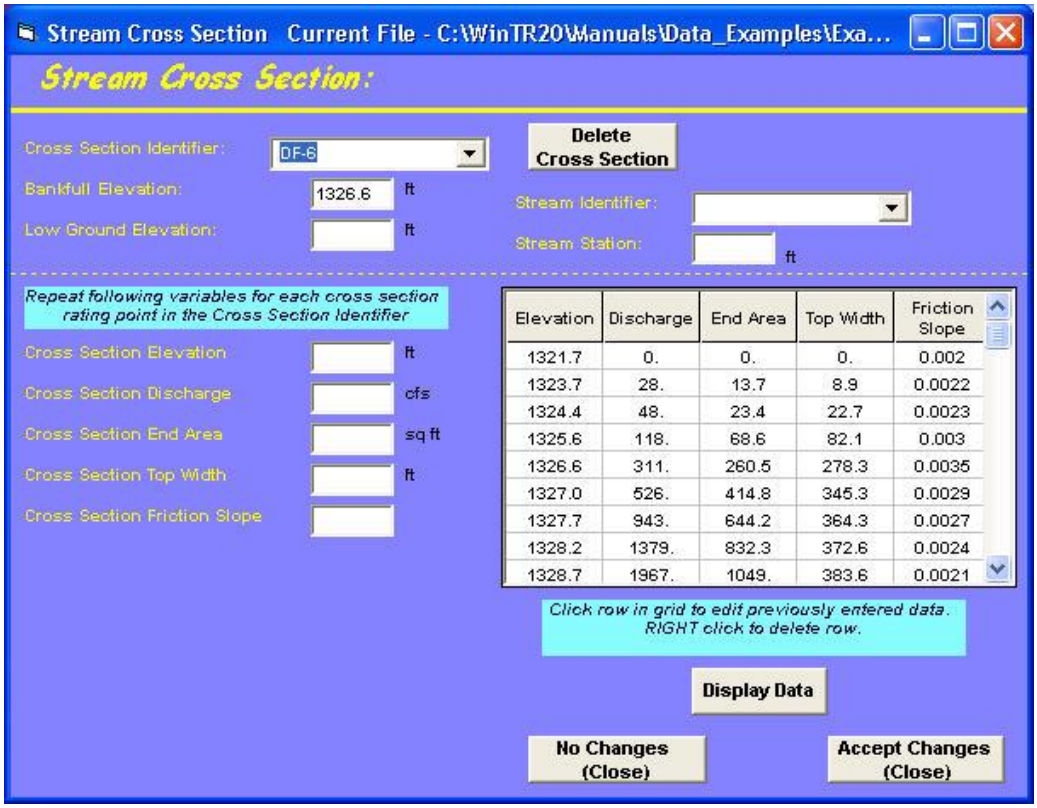


Figure 4.22:

You can view a plot of the data by selecting the "Display Data" button. This can be useful for checking for inconsistencies in the data. Below is a plot of the data for DF-6.

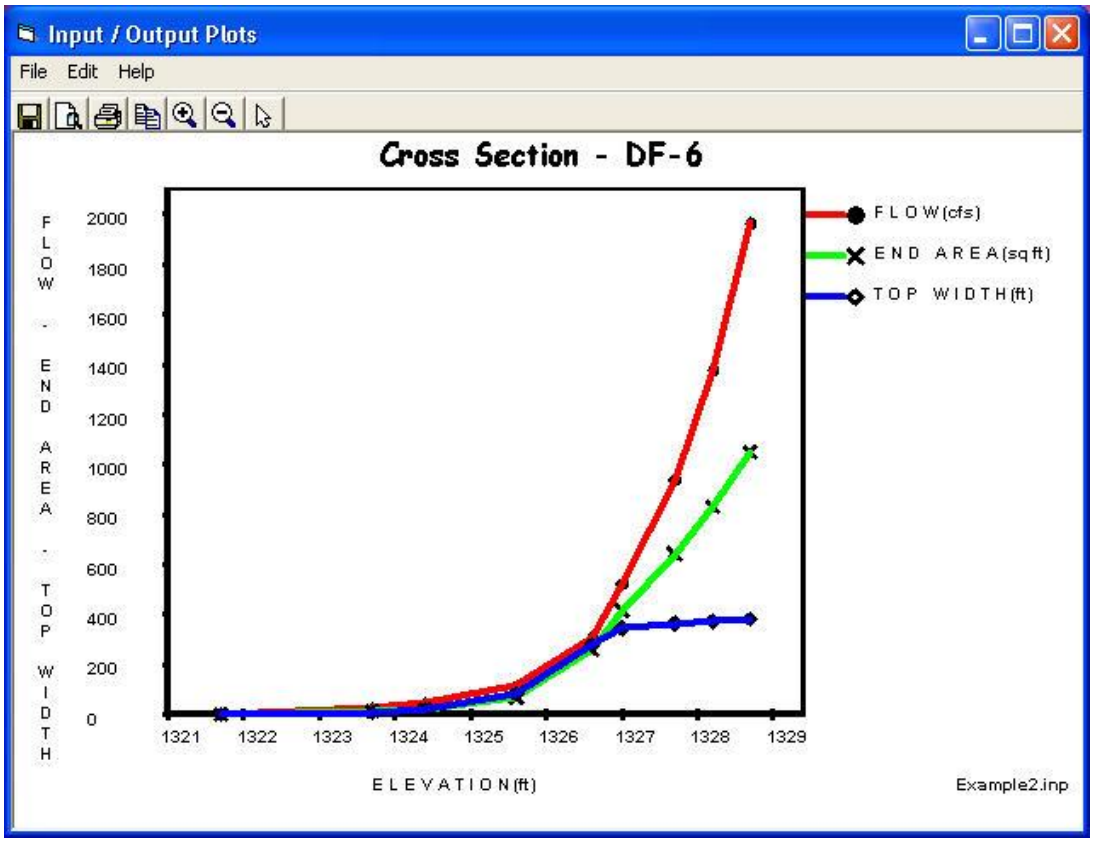


Figure 4.23:

After the first cross section has been entered, go back up and select the next cross section (LB-4) using the down arrow adjacent to "Cross Section Identifier." Enter the data for that cross section. Finally, repeat the process one more time to enter the final rating for cross section LL-31. Select "**Accept Changes (Close)**" when finished to return to the WinTR-20 System Editor/Controller window.

Entering the Storm Data

If you are building off Example 1, this data should already exist (check "Storm Analysis" from the WinTR-20 System Controller/Editor window). If not, see Example 1 on how to enter this data.

Setting Output Parameters

As pointed out in Example 1, it is best to make an initial run by selecting peak discharge information only. Selecting hydrograph output for plotting or tabular viewing at this point can clutter up the "WinTR-20 Printed Page File" output. From the WinTR-20 System Editor/Controller window select "Global Output." Once in "Global Output" select "Default Peak Output Code" for both sub-areas and reaches. Following this, select "**Accept Changes (Close)**" to return to the WinTR-20 System Editor/Controller window.

Viewing Schematic, Input, Running the Model

Before the user can run the model, the input file must be saved. Select "File," and "Save As" from the WinTR-20 System Controller/Editor window. Give the file an identifiable name and place it in the desired directory. Once the file is saved, the "View" and "Run" options appear at the top of the WinTR-20 System Controller/Editor window. "View" allows the user to look at the watershed schematic and the input file in an ASCII format. Select "View" then "Schematic." You should see the following window:

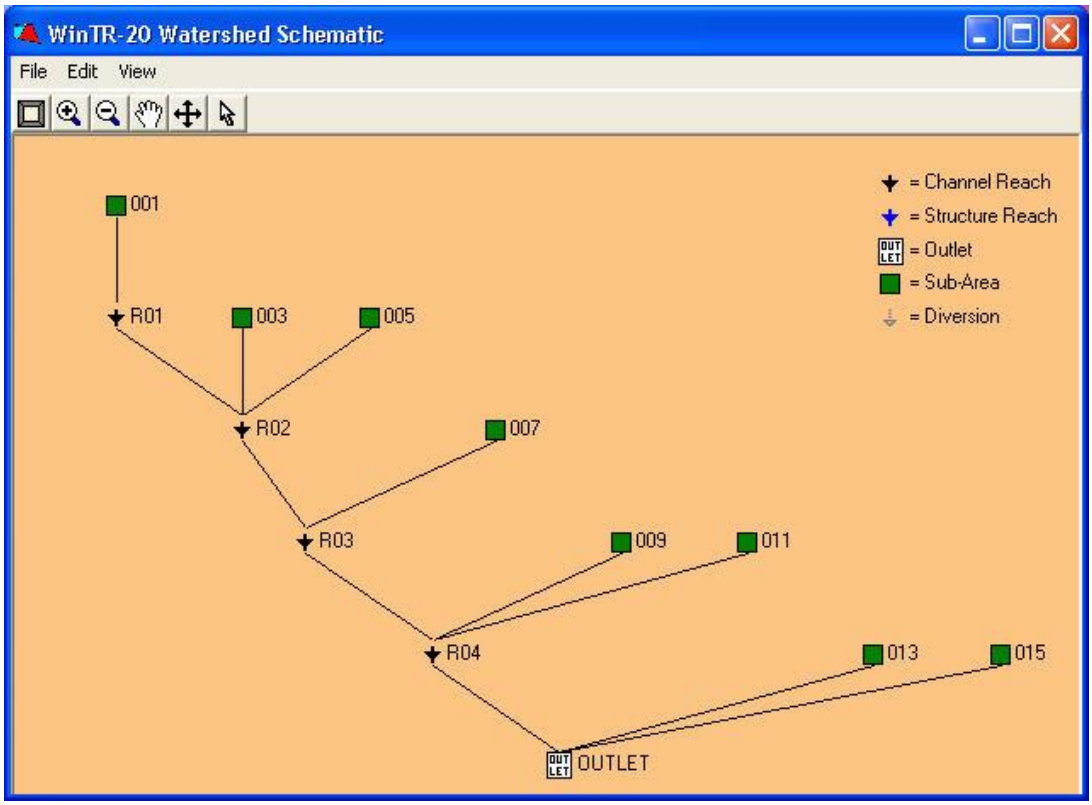


Figure 4.24: Example 2 -Schematic

Verify that the sub-areas and reaches logically represent the hydrologic routing of the watershed.

The input file for this particular example is viewable by selecting "View" then "Input File" from the pulldown menu, and is shown below:

```
WinTR-20: Version 1.0                    0         0         1.0       0
Example 1 - Sub-area 001
Upstream Tributary of Spring Valley Watershed

SUB-AREA:
          001       R01
                    SHEET     100.      0.04                D
                    SHALLOW   3100.     0.004               U
                    CHANNEL   13300.    2.
```

```
                    LAND AREA Row Crop (SR - Poor)              B    0.48
                    LAND AREA Row Crop (SR + CR - Poor)         B    1.27
                    LAND AREA Row Crop (SR + CR - Good)         B    1.27
                    LAND AREA Row Crop (C + CR - Good)          B    0.34
                    LAND AREA Pasture (Fair)                    B    0.37
          003       R02                1.90      72.       2.30
          005       R02                0.94      70.       1.77
          007       R03                2.27      80.       2.76
          009       R04                0.88      76.       1.99
          011       R04                2.29      73.       2.50
          013       Outlet             0.38      81.       0.98
          015       Outlet             1.37      79.       2.03

STREAM REACH:
          R01       R02       DF-6               6870.     5350.
          R02       R03       LB-4               12130.    10560.
          R03       R04       LB-4               4220.     3970.
          R04       Outlet    LL-31              4260.     3800.


STORM ANALYSIS:
          2-yr                0.0       2.93      Type I    2         2.93
          5-yr                0.0       3.77      Type I    2
          10-yr               0.0       4.38      Type I    2
          25-yr               0.0       5.00      Type I    2
          50-yr               0.0       5.53      Type I    2
          100-yr              0.0       6.22      Type I    2

STREAM CROSS SECTION:
          DF-6      1326.6
                    1321.7    0.        0.        0.        0.002
                    1323.7    28.       13.7      8.9       0.0022
                    1324.4    48.       23.4      22.7      0.0023
                    1325.6    118.      68.6      82.1      0.003
                    1326.6    311.      260.5     278.3     0.0035
                    1327.0    526.      414.8     345.3     0.0029
                    1327.7    943.      644.2     364.3     0.0027
                    1328.2    1379.     832.3     372.6     0.0024
                    1328.7    1967.     1049.     383.6     0.0021
          LB-4      1311.0
                    1306.2    0.        0.        0.        0.0040
                    1307.6    28.       17.9      18.3      0.0042
                    1308.1    56.       28.1      20.6      0.0052
                    1308.7    95.       40.3      22.5      0.0068
                    1310.1    237.      78.1      29.3      0.0051
                    1311.0    506.      133.2     35.1      0.0060
                    1312.4    622.      156.8     38.3      0.0040
                    1316.4    1886.     367.9     93.3      0.0037
                    1317.9    2758.     579.      159.5     0.0025
                    1319.5    3934.     860.      199.8     0.0020
          LL-31     1281.7
                    1276.0    0.        0.        0.        0.00047
                    1278.9    50.       53.       40.       0.00047
                    1279.5    100.      84.       55.       0.00051
                    1280.4    250.      141.      78.       0.00065
                    1281.1    500.      218.      129.      0.00090
                    1281.7    750.      292.      160.      0.00108
                    1282.0    1000.     355.      166.      0.00111
                    1282.7    1500.     465.      177.      0.00103
                    1283.3    2000.     575.      186.      0.00088
                    1283.9    2500.     695.      196.      0.00074
                    1284.6    3000.     825.      207.      0.00062
                    1285.2    3500.     970.      233.      0.00054

LOCAL LAND USE:


GLOBAL OUTPUT:
```

```
          1         1.0       1.0       YYNNN     YNNNNN
```

To run the model simply select "**Run**" from the WinTR-20 System Controller/Editor window.

Output – Printed Page

Following a successful run, the "WinTR-20 Printed Page File" window containing the output will appear. For this example, the "WinTR-20 Printed Page File" should contain the following information for this run (only the 2-year and peak discharge summary table at the end are shown here):

```
              Quick User Guide Example 2
            Entire Spring Valley Watershed

             Name of printed page file:
H:\wintr20 data sets\quick user guide examples\ex2.out

                              STORM 2-yr

 Area or    Drainage  Rain Gage     Runoff   ------------ Peak Flow ------------
  Reach       Area      ID or       Amount   Elevation   Time      Rate      Rate
 Identifier  (sq mi)   Location      (in)      (ft)      (hr)      (cfs)     (csm)

 001           3.730                1.011                12.03    338.64     90.79
 R01           3.730  Upstream      1.011   1326.65      12.03    338.64     90.79
 R01           3.730 Downstream     1.010   1326.63      13.64    328.32     88.02
 003           1.900                0.766                11.75    129.01     67.90
 005           0.940                0.675                11.31     60.09     63.92
 R02           6.570  Upstream      0.891   1310.82      13.46    452.37     68.85
 R02           6.570 Downstream     0.891   1310.82      14.18    451.18     68.67
 007           2.270                1.197                11.93    264.13    116.36
 R03           8.840  Upstream      0.970   1312.23      14.00    608.17     68.80
 R03           8.840 Downstream     0.970   1312.22      14.18    607.49     68.72
 009           0.880                0.967                11.33     92.88    105.54
 011           2.290                0.814                11.82    163.08     71.21
 R04          12.010  Upstream      0.940   1281.71      14.00    756.26     62.97
 R04          12.010 Downstream     0.940   1281.70      14.36    754.10     62.79
 013           0.380                1.258                10.52     89.74    236.17
 015           1.370                1.137                11.27    179.71    131.18
 OUTLET       13.760                0.968                14.18    847.53     61.59

 .
 .
                      (5-year through 100-year output not shown)
 .
 .
                          Quick User Guide Example 2
                        Entire Spring Valley Watershed

  Area or    Drainage              ----------- Peak Flow by Storm -----------
   Reach       Area   Alternate       2-yr      5-yr     10-yr     25-yr     50-yr
 Identifier   (sq mi)               (cfs)     (cfs)     (cfs)     (cfs)     (cfs)

 001            3.73                338.6     587.7     787.8    1000.5    1190.7
 003            1.90                129.0     251.2     353.9     466.3     567.3
 005            0.94                 60.1     126.0     182.5     245.0     301.5
 007            2.27                264.1     433.3     565.1     704.3     827.8
 009            0.88                 92.9     164.8     222.7     285.3     340.1
 011            2.29                163.1     308.6     428.7     560.1     677.9
 013            0.38                 89.7     145.1     187.8     232.5     271.5
 015            1.37                179.7     300.6     396.3     495.4     584.5
 R01            3.73                338.6     587.7     787.8    1000.5    1190.7
 DOWNSTREAM                         328.3     568.8     765.3     975.7    1164.6
```

```
R02            6.57                 452.4     797.0    1090.1    1418.4    1720.3
DOWNSTREAM                          451.2     793.7    1085.3    1412.6    1716.3
R03            8.84                 608.2    1065.9    1465.3    1929.4    2365.7
DOWNSTREAM                          607.5    1064.8    1463.5    1928.3    2362.7
R04           12.01                 756.3    1339.8    1883.5    2522.5    3095.3
DOWNSTREAM                          754.1    1337.5    1881.4    2511.6    3069.2
OUTLET        13.76                 847.5    1554.0    2176.3    2872.1    3486.3

 Area or    Drainage              ----------- Peak Flow by Storm -----------
  Reach       Area   Alternate     100-yr
Identifier   (sq mi)               (cfs)     (cfs)     (cfs)     (cfs)     (cfs)

001            3.73                1439.4
003            1.90                 704.0
005            0.94                 379.1
007            2.27                 990.5
009            0.88                 413.8
011            2.29                 837.4
013            0.38                 322.9
015            1.37                 702.9
R01            3.73                1439.4
DOWNSTREAM                         1412.6
R02            6.57                2135.0
DOWNSTREAM                         2126.6
R03            8.84                2943.0
DOWNSTREAM                         2933.9
R04           12.01                3845.2
DOWNSTREAM                         3777.5
OUTLET        13.76                4266.2
```

As mentioned in Example 1, the "WinTR-20 Printed Page File" is also automatically saved as an "***.out**" file (* = input file name prefix) which can be brought into MS-Word, Notepad, etc. for printing or insertion into other project documents. It is saved to the same directory as the input file.

Graphical Output

To be able to view hydrographs, the output option for the sub-area or reach of interest will have to be turned on. To simplify for this example, on the WinTR-20 System Controller/Editor window select "Global Output" and set the "Default Hydrograph Output Code" to "Yes" for sub-area and reach. This will create hydrographs for all reaches and sub-areas. Save the file then re-run it.

After closing the WinTR-20 Printed Page File window select "Plots" from the WinTR-20 System Controller/Editor window menu. "Graphic Output" can plot one location and one storm per plot or multiple locations and storms at once. How to view a single plot or multiple storms was described in Example 1.

For Example 2, we'll look at multiple locations. In the "Graphics Output" window, select "Location" from "Multiple Hydrographs". Next to "Storms", select 100-year from the drop down menu. Next to "Sub-area" box, select and then hit enter for both sub-areas 001 and 009. These locations should now show up in the "Multiple Locations" window in the lower right. Selecting "**Display**" will bring up a screen that looks like:

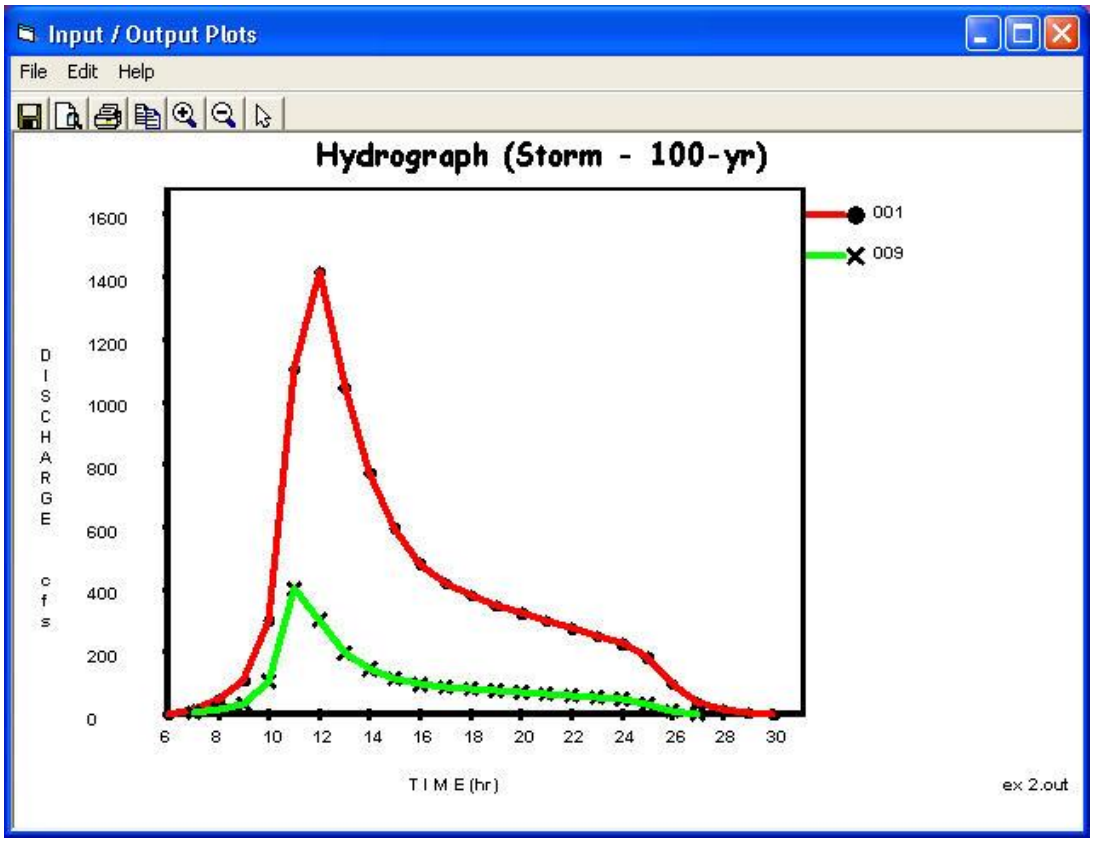


Figure 4.25:

Plotting multiple locations can also be used to graphically show the impacts of structure or reach routings. Close the current display to return to the "Graphics Output" window. Select each of the "001" and "009" within the "Multiple Location" window to delete them. Next, using the drop down window next to the "Reach:" box, select R01 then hit enter. You'll notice that "Upstream" and "Downstream" options show up to the right. Select both options. Notice that the "R01 – Upstream" and "R01 – Downstream" show up in the "Multiple Location" window. Selecting "**Display**" should bring up a screen that looks like:

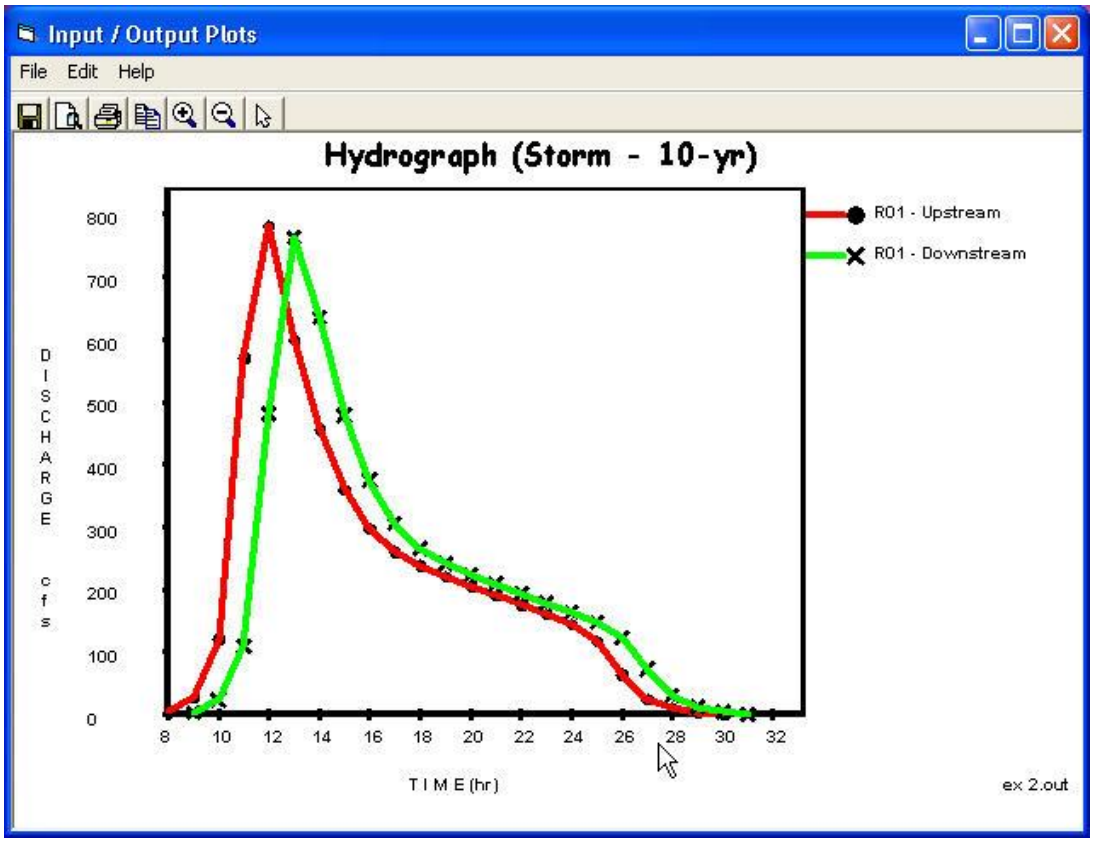


Figure 4.26:

Notice that there appears to be very little attenuation of the peak discharge from upstream to downstream of reach R01. The peak is translated in time approximately 1 hour.

Example Problem 3 below will demonstrate how to view multiple alternatives on the same plot (i.e. with and without a reservoir just upstream from the city).

Example 3 – Alternative – Adding An Upstream Reservoir

For this example, we will utilize the "Alternate" option within WinTR-20 to model the effects of an upstream reservoir on peak flows. Using "Alternate Analysis" allows the user to run and compare results of a "before and after" scenario within the same model. The advantage to this rather than having two separate models is that graphical and tabular comparisons can be made from a singular output.

The proposed structure site is located at the downstream end of reach R02. The rating for this structure is given in the table below:

Elevation	Discharge (cfs)	Storage (acre-feet)
1307.0	0.	717.0
1307.5	7.1	754.3
1308.0	14.2	792.1
1308.5	21.3	829.8
1309.0	28.4	867.5
1309.5	35.5	905.2
1310.0	42.6	942.9
1310.5	49.7	1060.8
1311.0	56.8	1178.7
1311.5	63.9	1296.5
1312.0	71.0	1414.4
1312.5	92.6	1532.3
1313.0	114.1	1650.1
1313.5	135.7	1768.0
1314.0	157.2	1885.9
1314.5	178.8	2003.7
1315.0	200.3	2121.6
1315.5	221.9	2239.5
1316.0	243.4	2357.3
1316.5	265.0	2475.2

The required changes to the model are:

1. Enter the structure data
2. Convert R02 from a reach routing to a structure routing (the reach routing is replaced by a level pool routing)

Enter Alternative Data

From the WinTR-20 Controller/Editor window, select "Alternate Analysis". This will bring up a window allowing you to enter an "Alternate Identifier" and "Alternate Description". Enter "with res" for the identifier and "reservoir located at the downstream end of R02" for a description. This window will look like:

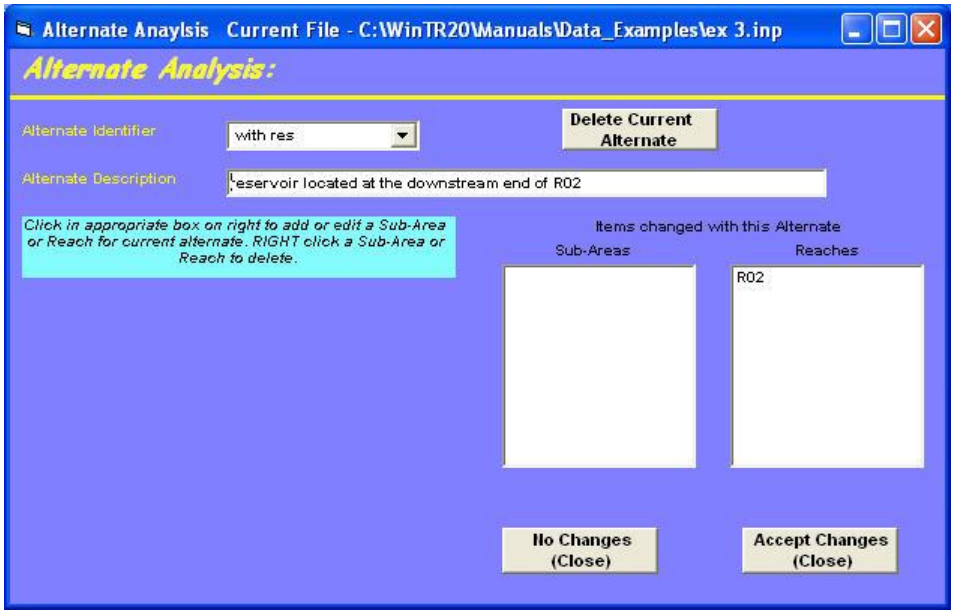


Figure 4.27:

In this window, underneath the text "Items changed with this Alternate" are two boxes labeled "Sub-Areas" and "Reaches". In order to change reach R02 to a structure, click in the "Reaches" box. This will bring up the main "Stream Reach" window. Using the drop down menu next to "Stream Reach Identifier" select R02. Fill this screen out as though you were just entering it for the first time (the data within R02 from the original analysis does not carry over to the alternative thus the receiving reach must be entered here also). Enter R03 for the downstream receiving reach and "Str" in the "reach structure identifier" box. This screen should now look like:

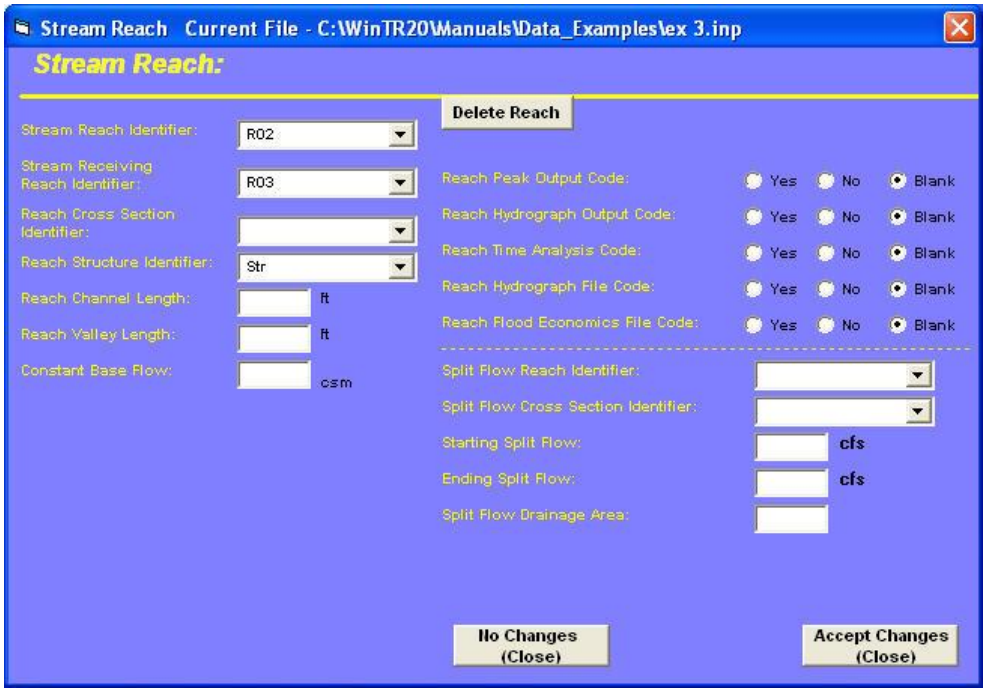


Figure 4.28:

Select "**Accept Changes (Close)**" for both the "Stream Reach" window and "Alternate Analysis" window to return to the WinTR-20 Editor/Controller window. This is a good time to save your data. Click on "WinTR-20 Version 1.0" and then add a new description to this model. Click "SaveAs" this data file as "ex 3.inp".

Enter Structure Data

Select "Structure Rating" from the WinTR-20 Editor/Controller window. Enter "Str" into the "Structure Identifier" name box. Leave the "Structure Starting Elevation" field blank. The program will assume the starting elevation is the base flow discharge elevation. As with the cross section data, the three elements per line (elevation, discharge, and storage) are entered in the three boxes in the middle of the screen. Pressing return after filling in the three points enters those values into the table on the right. Enter all the data and select "**Accept Changes (Close)**" to bring you back to the WinTR-20 Editor/Controller window. The screen capture shown below shows the completed "Structure Rating" input screen:

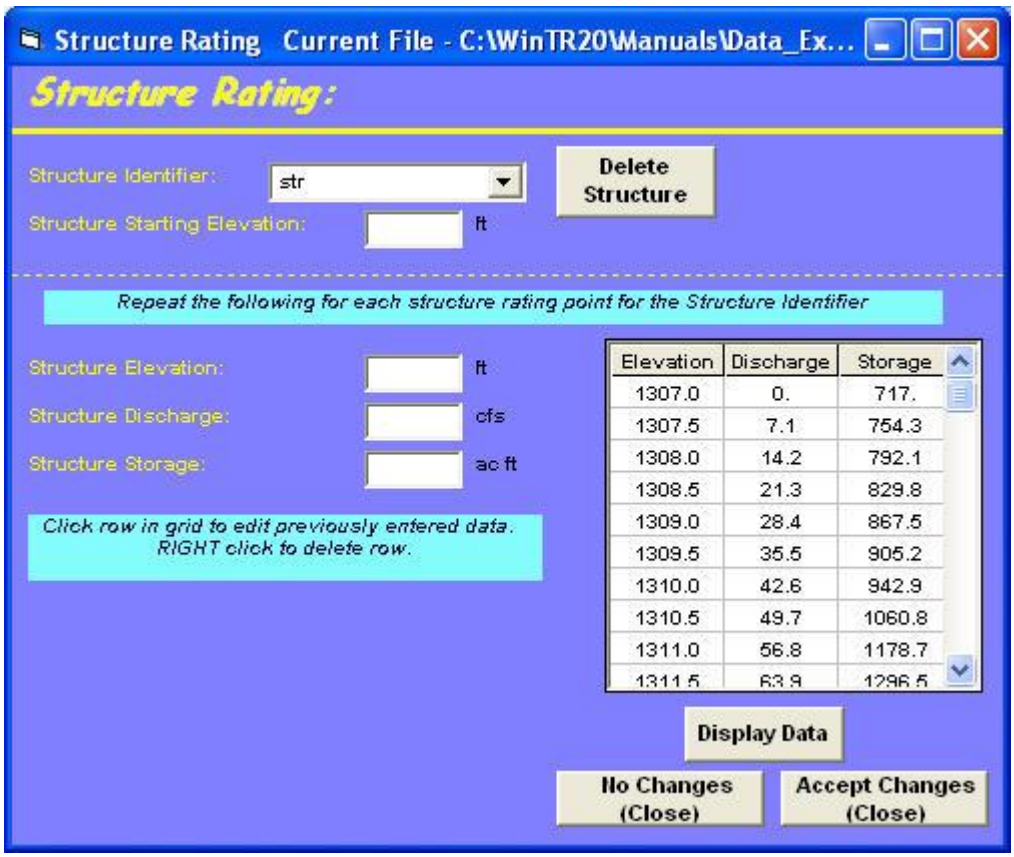


Figure 4.29:

Schematic, Viewing Input, and Running the Program

Select “File” then “Save” to get the “View” and “Run” buttons to appear. With this version of the program, when you view the schematic, it shows you the original data (i.e. the whole watershed without the reservoir). Future versions of the program will have the ability to view the schematics of alternatives.

When the model is run with alternate analysis present, the original model is run first, followed by the alternative model. Output, both graphical and tabular, will include results from both.

View the input data by going to “View” then “Input File”. Note the data that appears under the “Alternate Analysis” line:

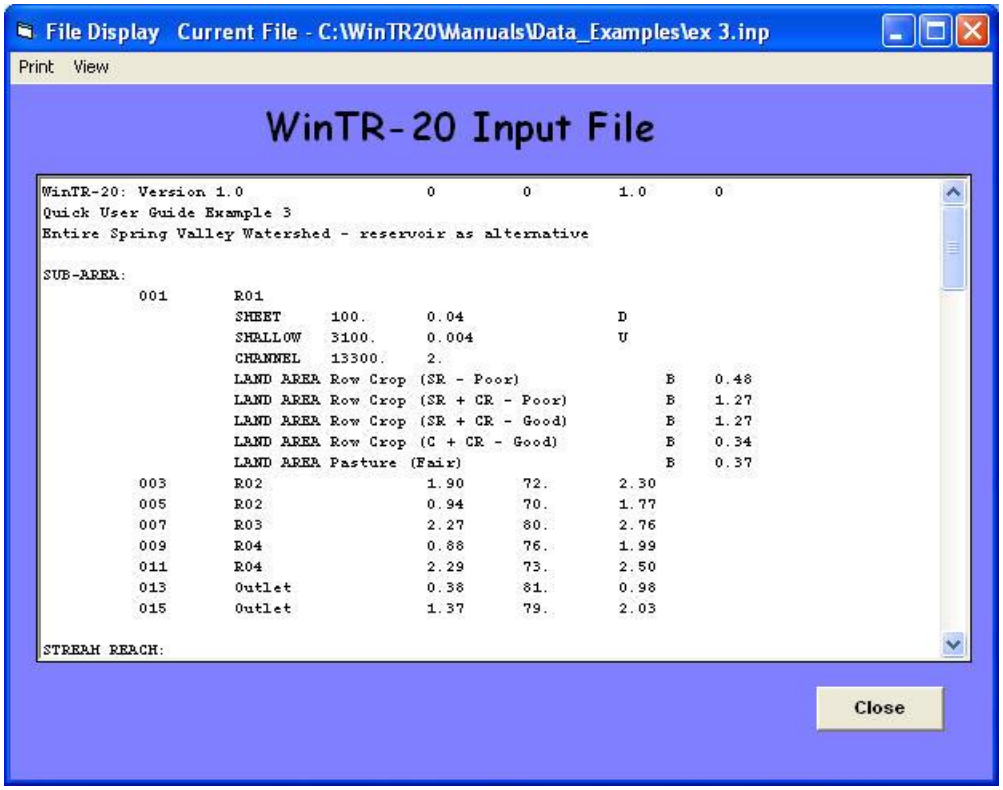
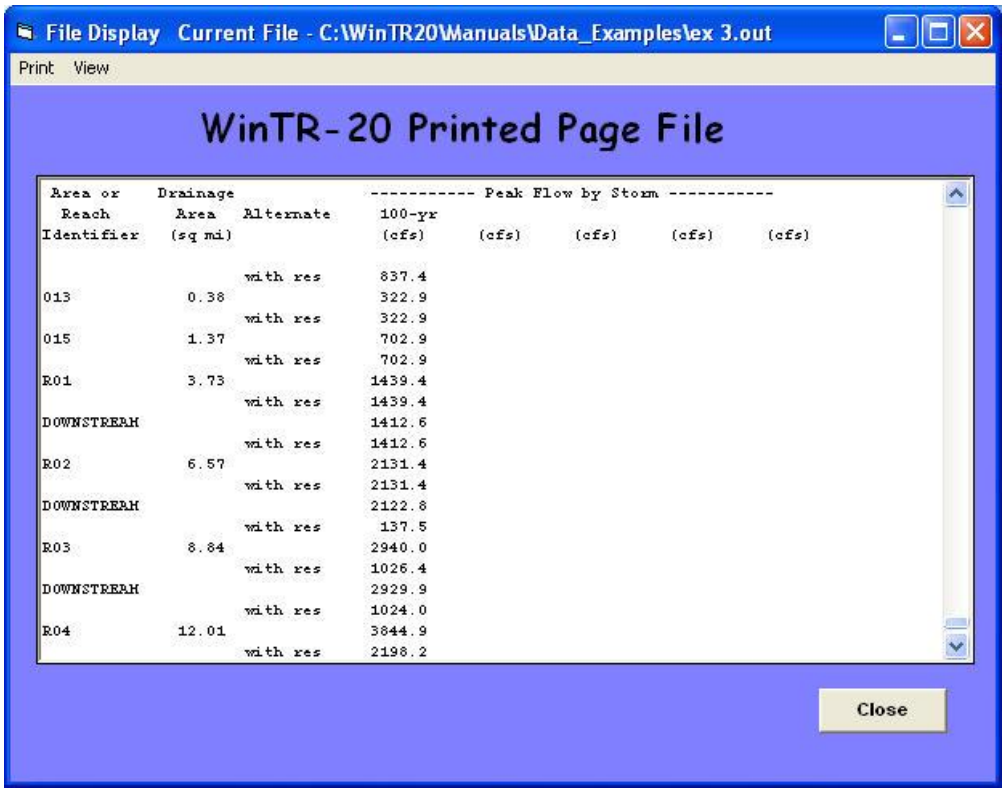


Figure 4.30:

After the original data set is run, the program then substitutes lines shown here for the original R02 line. The model is automatically run again with the substituted line. Knowing the structure of the input file and how WinTR-20 interprets input data is useful to advanced users who wish to simply manipulate the ASCII input files when creating new or altering existing models.

To run the model, along with the alternative, simply select “**Run**” from the main menu. When the “WinTR-20 Printed Page File” window pops up, scroll down to the peak

discharge summary table at the end. The 100-year storm portion of the summary should look like:



Area or Reach Identifier	Drainage Area (sq mi)	Alternate	---------- Peak Flow by Storm ---------- 100-yr (cfs)	(cfs)	(cfs)	(cfs)	(cfs)
		with res	837.4				
013	0.38		322.9				
		with res	322.9				
015	1.37		702.9				
		with res	702.9				
R01	3.73		1439.4				
		with res	1439.4				
DOWNSTREAM			1412.6				
		with res	1412.6				
R02	6.57		2131.4				
		with res	2131.4				
DOWNSTREAM			2122.8				
		with res	137.5				
R03	8.84		2940.0				
		with res	1026.4				
DOWNSTREAM			2929.9				
		with res	1024.0				
R04	12.01		3844.9				
		with res	2198.2				

Figure 4.31:

Note that comparisons between with and without the structure can be made from the same output. The results from the original (present conditions) run are along the line that has a blank under the alternate column[7]. The reservoir run results are on the line containing "with res" under the alternate column. Recall that the "with res" is the identifier that the user defined within the identifier box in the alternate analysis window. From the output, one can see that the reservoir reduces peak discharge from the 100-year event from 2,135 cfs down to 138 cfs. At the point just upstream of the city (at the Outlet point of the model), the reservoir reduces the 100-year peak discharge from 4,266 cfs down to 2,869 cfs.

Using Graphical Output For Models With Alternate Analysis

Recall from Examples 1 and 2 that the user had the ability plot multiple hydrographs for viewing. For this particular example, suppose we would like to plot the with and without reservoir alternatives for the 25-year event. First let's make a multiple plot for just downstream of the reservoir. From the WinTR-20 Controller/Editor window, select "Plots". Once in the Graphics Output window, select "Alternate" from "Multiple Hydrographs". Under "Storm", select the 25-year. Next, select the arrow next to the Alternate window. Notice that the alternate is shown as "with res" – select this and press return. To get the original run results to be included, select the blank line (see footnote 7)

[7] Future versions of the program will have an "original data" designation for the run of the base data. This will help clarify interpretations of both graphical and tabular output results.

above the “with res” and press return. Next, we need to select a hydrograph location to plot. For the results just at the outlet of the reservoir, we need the downstream end of reach R02. Under “Reach:” select R02 and press return. Notice the upstream and downstream choices are given. Select downstream. The Graphics Output window should appear similar to:

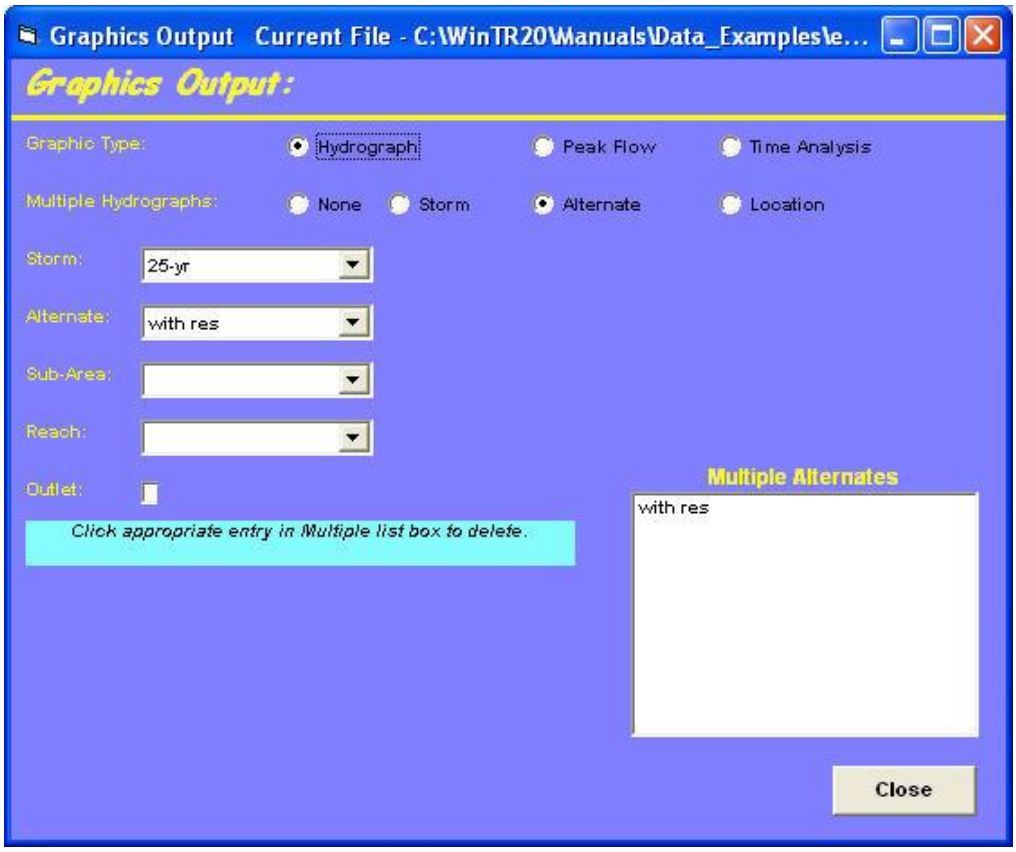


Figure 4.32:

When Select “**Display**” and you should see[8] (this plot has been zoomed in to 0 to 100 hours):

[8] If you get an error message at this point that states “No data for requested plot found” it likely means that the hydrograph output option has not been set. Go back to Global Output and select “yes” for sub-area and reach hydrographs, save the input, and rerun the model. The hydrograph plot should now work.

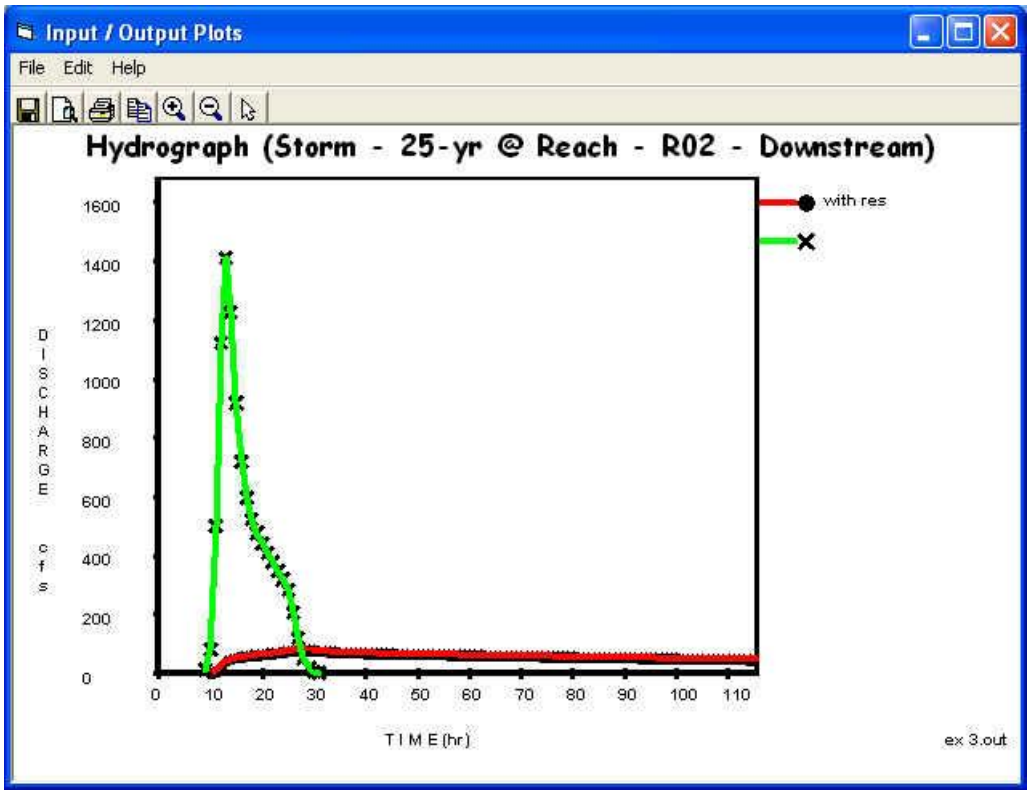


Figure 4.33:

For the impact of a reservoir just upstream of the city, close out of the current plot to return to the main "Graphics Output" window, and select the box next to "Outlet"and press "**Display**" button. That result should appear as (this plot has been zoomed in to the 0 to 50 hour view):

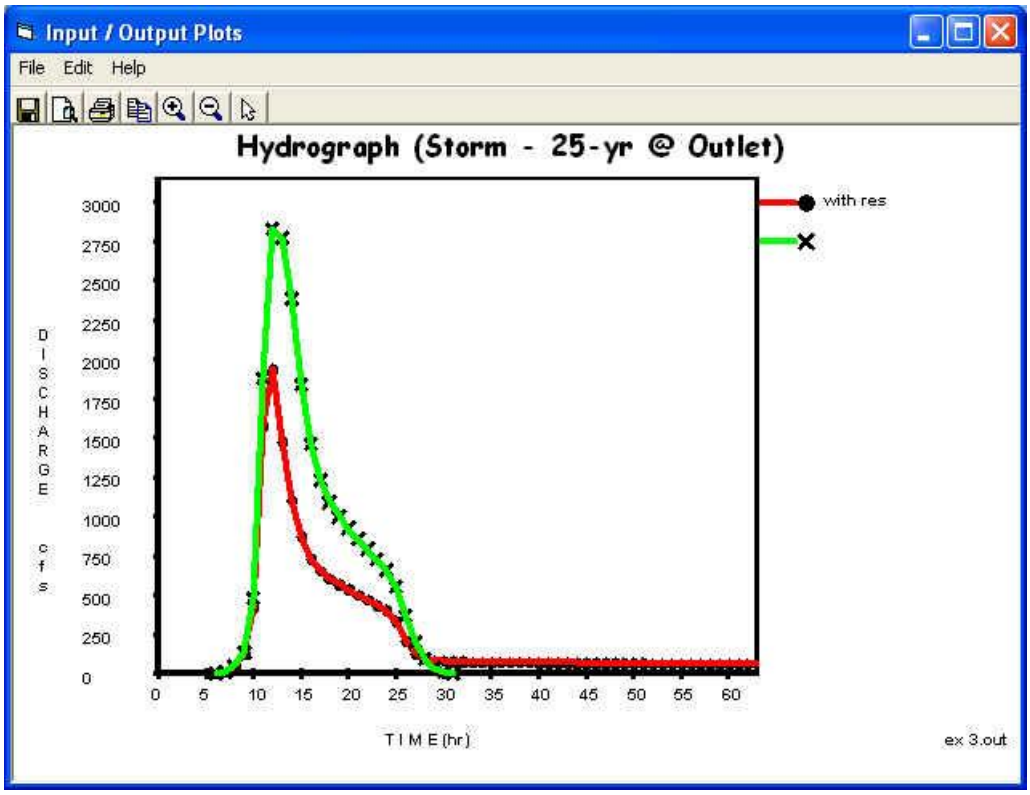


Figure 4.34:

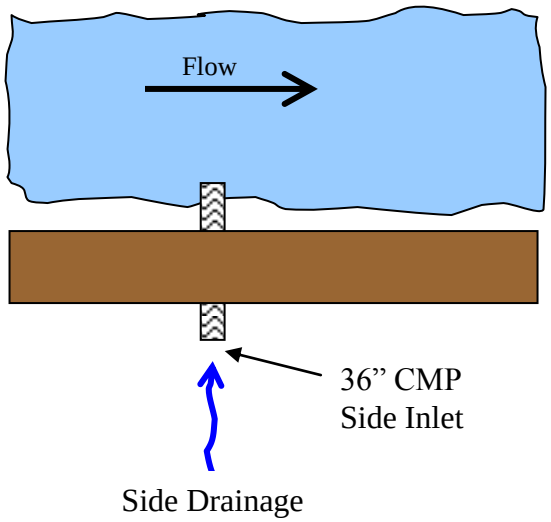
This final example utilizes two features not found in the previous examples: Input Hydrograph and Split Flow. Input Hydrograph allows the user to input a hydrograph directly into a WinTR-20 model. Inputting a historic hydrograph from gage information would be an example of this type of application. The Split Flow function in WinTR-20 will "split" an inflow hydrograph based on two stage-discharge relationships. An example of this would be where the user wants to model lateral diversion of water through a channel side weir.

Example #4 Scenario

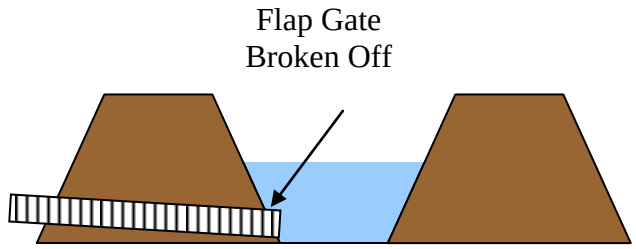
In this example, the flap gate has broken off from a side inlet along a diked section of channel. The user is asked to determine maximum flow and total runoff volume that leaves the channel by flow back through the side inlet for both an actual event and a 100-year hypothetical event.

Below is a plan and cross section view of the situation.

Plan View



Cross Section View



Data

Reach/Split Flow Ratings:

For this example, it is assumed that the flow out of the culvert is a single stage-discharge relationship (WinTR-20 cannot model flows with varying tailwater conditions). The stage-discharge-area-top width-friction slope for the main channel just upstream of the culvert was developed using HEC-RAS outside Win-TR20. This rating is shown below:

Elevation (msl)	Discharge (cfs)	End Area (sq ft)	Top Width (ft)	Friction Slope (ft/ft)
958.0	0.0	0.0	0.0	
961.8	50.	127.	47.	0.00011
962.3	100.	151.	50.	0.00026
962.7	200.	173.	53.	0.00069
963.1	300.	192.	55.	0.001129
963.4	400.	208.	57.	0.001571
963.6	500.	222.	59.	0.001999
963.8	600.	235.	66.	0.002446
964.0	700.	248.	70.	0.002819
964.3	800.	263.	76.	0.003103
964.6	1000.	285.	82.	0.003795
964.8	1100.	298.	115.	0.004025

The main channel is 2,000 feet long with the culvert on the upstream end of the entire reach.

The rating table for the culvert flow out of the channel was also developed externally to WinTR-20 (i.e. simple Inlet Control calculations, HEC-RAS, BPR charts, etc.). The rating is as follows:

Elevation (msl)	Discharge (cfs)
958.0	0.
959.2	5.
959.8	10.
960.4	15.
961.0	20.
961.9	25.
963.0	30.
963.4	35.
964.4	40.
965.6	45.

Storm Data:

Two events will be simulated. The first simulation will be to route an actual hydrograph (measured at a gage located in the upstream watershed) through the reach where the culvert is located. The gage data for the upstream watershed is as follows:

Time (hours)	Discharge (cfs)
0	0
1	1.
2	4.
3	9.
4	177.
5	273.
6	555.
7	680.
8	618.
9	523.
10	447.
11	389.
12	349.
13	320.
14	296.
15	275.
16	255.
17	310.
18	350.
19	375.
20	210.
21	150.
22	47.
23	75.
24	50.
25	27.
27	14.
28	5.
29	1.
30	0

For the other simulation, a 100-year return period event will be simulated. The data for this event is as follows:

- P_{100} = 6.5 inches
- 24-hour Type I Rainfall Distribution
- ARC = 2

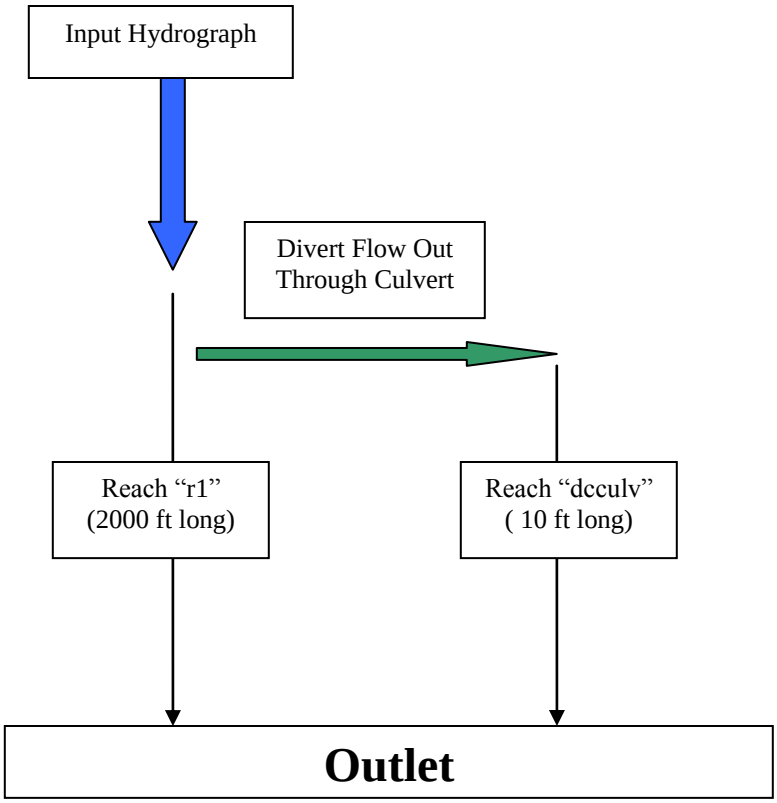
Sub-area Data:

The upstream watershed data is as follows:

- Drainage area = 4.0 square miles
- Runoff Curve Number = 75
- Time of Concentration = 5.5 hours

Notes on Basic WinTR-20 Setup

When the split flow data is entered, a receiving reach for that portion of flow must be specified. A very short reach (10') downstream of the culvert will be created for this purpose. This reach will be designated "dsculv". The same rating that is used for splitting the flows will be used for this short reach. Note that only a stage-discharge relationship was provided for the split out through the culvert. WinTR-20 requires a stage-discharge-end area-top width-friction slope data for both split flow and reach routing tables. To complete the rating table that will be used for both 1) the splitting of flow between the main channel and the culvert and 2) the reach routing downstream of the culvert, end area, top width and friction slope must be entered. For the end area and top width, the discharge itself will be used as "filler values" (anything could be used as long as they increase with elevation). For friction slope, assume 0.01 (ft/ft). These "filler values" will not affect the results since 1) the split routine will only use the stage-discharge portion of the table and 2) the downstream reach is so short (10') that the calculation reach inflow and outflow will essentially be identical. A simplified schematic of the example is shown below:

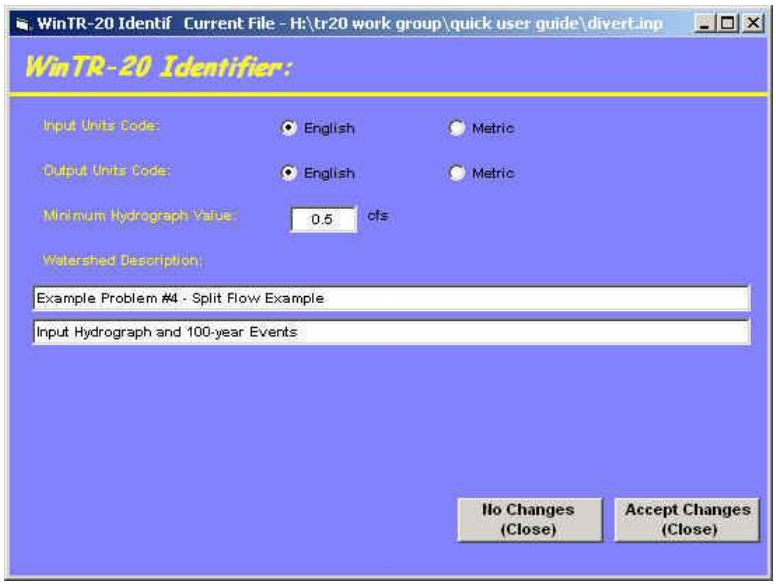


The reach "dsculv" is connected to the Outlet since WinTR-20 requires that all reaches have a receiving reach (another reach or the Outlet). In actuality, the diverted flow out of the culvert is lost from the system. The information needed to analyze this problem will be at the junction of the split flow. The output for the Output in this particular example will not be used.

Data Entry

WinTR-20 Identifier Record Entry: After starting the WinTR-20 System/Controller Editor and selecting "New WinTR-20 File" give the new input file a logical name and directory location. When the WinTR-20 Identifier screen comes up, enter 0.5 cfs for minimum hydrograph value and fill in a Watershed Description.

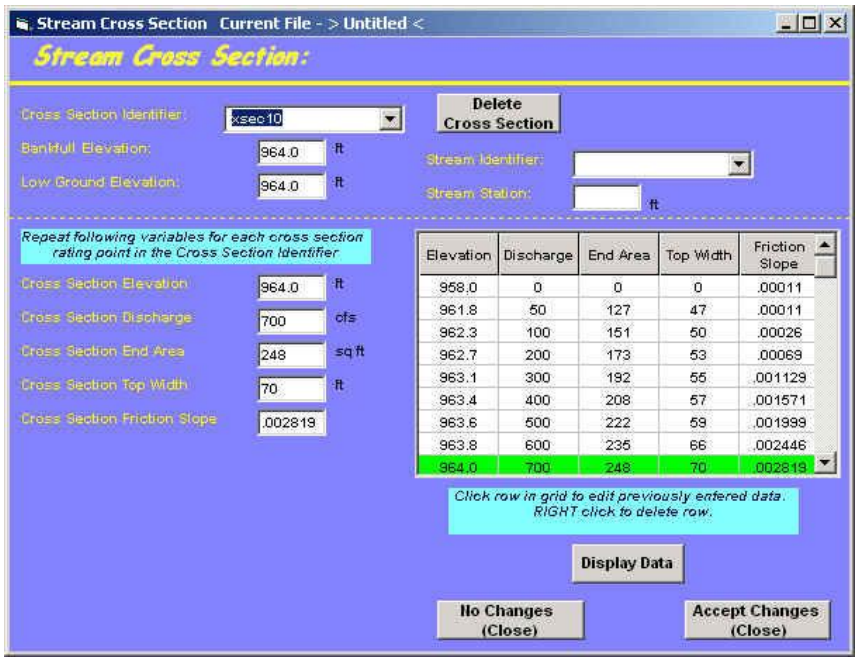
Insert 4sc1.jpg here



Input Reach and Split Rating Information:

Two rating curves are needed for this example. The first one will be called "xsec 10" which will describe the rating for the 2000 foot diked section of channel. The actual stage/discharge/end area/top width/friction slope information was developed from an outside program such as HEC-RAS. This data was provided in the beginning of this example description. From the main WinTR-20 Controller/Editor window select "Stream Cross Section:" and enter the data up to 1,000 cfs. The screen appears as shown below:

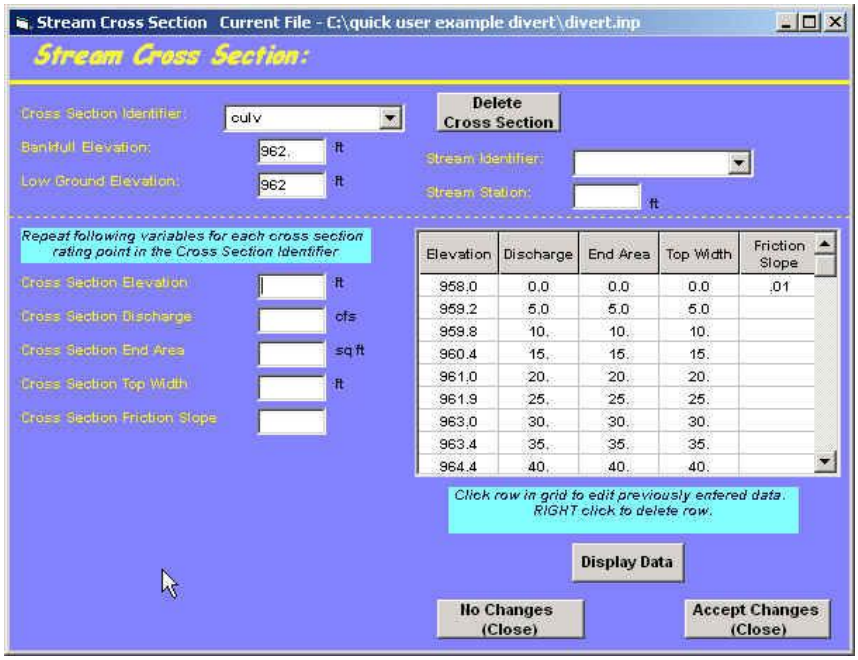
Insert 4sc9.jpg here



Select "Accept Changes (Close)" when all the data has been entered.

The second rating curve describes the hydraulics of the flow out of the channel through the culvert. This rating curve will be named "culv". The only information that the program needs to perform the split flow is stage and discharge. However, WinTR-20 requires that end area, top width, and friction slope fields must also be filled in. The stage/discharge relationship for the culvert is given at the beginning of this example description. See the section "Notes on Basic WinTR-20 Setup" above for details on what to use for the other fields. From the main WinTR-20 Controller/Editor screen select "Stream Cross Section:" and enter the data for this second rating as shown:

Insert 4sc10.jpg here



Note that if a single friction slope is to be used for all elevations; just one entry at the lowest elevation is required. Select "Accept Changes (Close)" when all the data has been entered.

<u>Input Stream Reach Data:</u>

For main diked reach that conveys the flows from the upstream drainage area will be named "r1". The user will need to enter:

- The stream reach identifier
  (= r1)
- The reach name that will be receiving the flow from reach "r1"
  (= outlet)
- The cross section identifier name containing the rating curve for reach "r1"
  (= xsec 10)
- Reach lengths for the reach routing that will occur within that reach
  (= 2,000 feet)
- The name of the reach that will be receiving the split flow from the culvert
  (= ds culv)
- The split flow cross section identifier name containing the rating curve for the culvert
  (= culv)

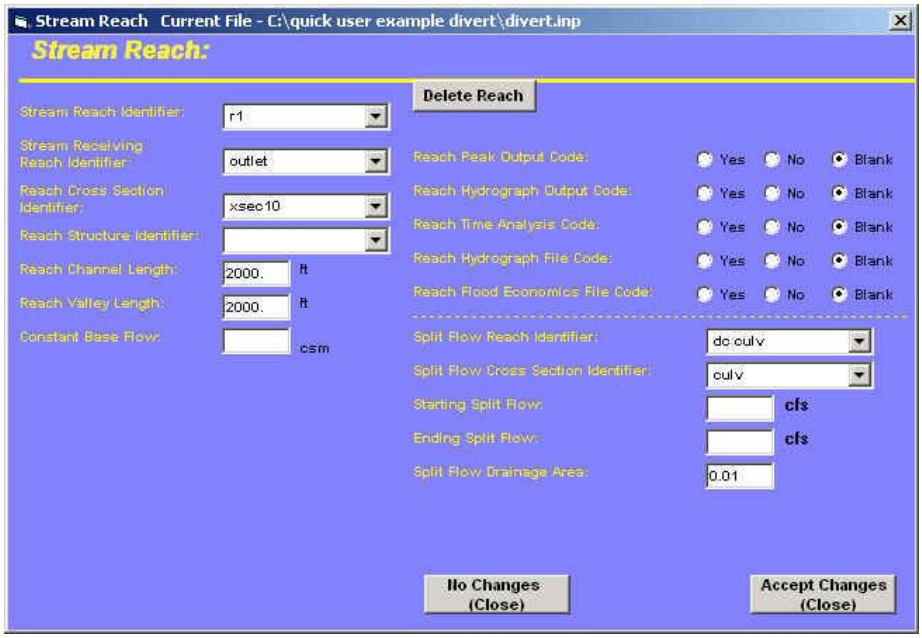
- The fraction of the total drainage area to associate with the split flow out through the culvert[9] (= 0.01)

Clicking on the yellow variable names within the editor will provide the user with useful information regarding each of the parameters.

Recall from the documentation that the split flow occurs at the upstream of the reach. In other words, a portion of the hydrograph is split off through the culvert at the upstream end of reach r1. The remaining flow going down r1 is then reach routed 2,000 feet using the rating curve xsec 10.

See the screen below for how data Reach r1 should appear in the Stream Reach screen:

Insert 4sc5.jpg here



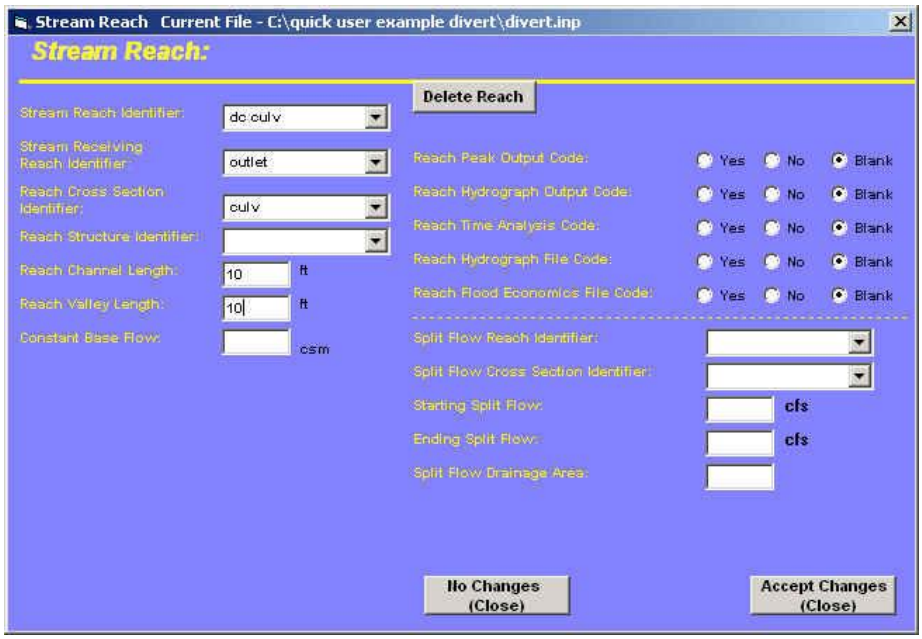
The reach just downstream of the culvert (actually up the side drainage coming into the diked main reach) will be named "dc culv". As mentioned earlier, this is simply a short 10 feet long reach to provide a receiving reach for the flow coming from the culvert. The information required for this reach includes:

- The stream reach identifier
  (= dc culv)
- The reach name that will be receiving the flow from reach "dc culv"
  (= outlet)
- The cross section identifier name containing the rating curve for reach "dc culv"
  (= xsec 10)
- Reach lengths for the reach routing that will occur within that reach
  (= 10 feet)

See the screen below for how data Reach dc culv should appear in the Stream Reach screen:

[9] The drainage area fraction will have no effect on the actual routings. It is used to convert runoff volumes into the units of watershed inches for export to printed page output.

Insert 4sc12.jpg here

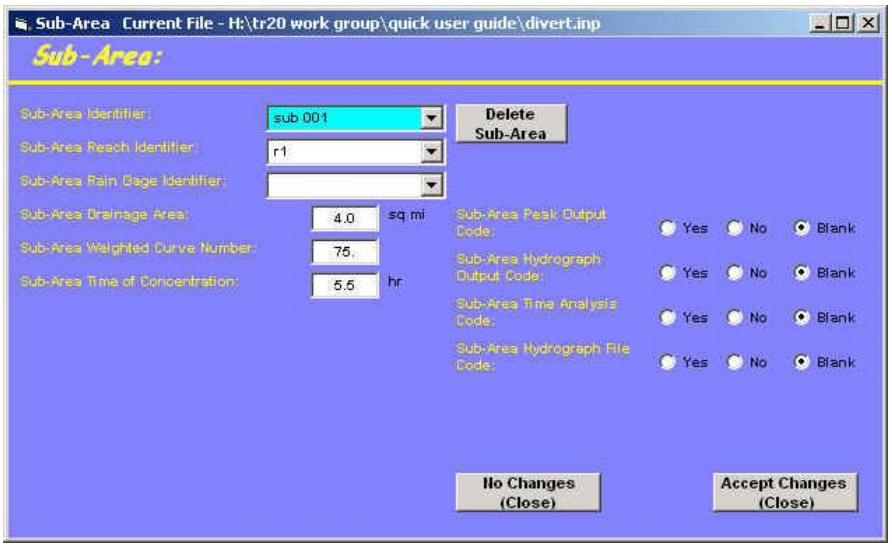


Select "Accept Changes (Close)" when data from both reaches have been entered.

<u>Input Sub-Area Data:</u>

Select "Sub-Area:" from the main System/Controller Editor page. Enter "sub 001" for the sub-area identifier. This flow from this sub-area will be going into the upper end of reach "r1". Select this from the pull down menu to the right of Sub-Area Reach Identifier. Fill out the rest of the data as shown below, and then select Accept Changes – Close" to return to the WinTR-20 Controller/Editor main window.

Insert 4sc17.jpg here

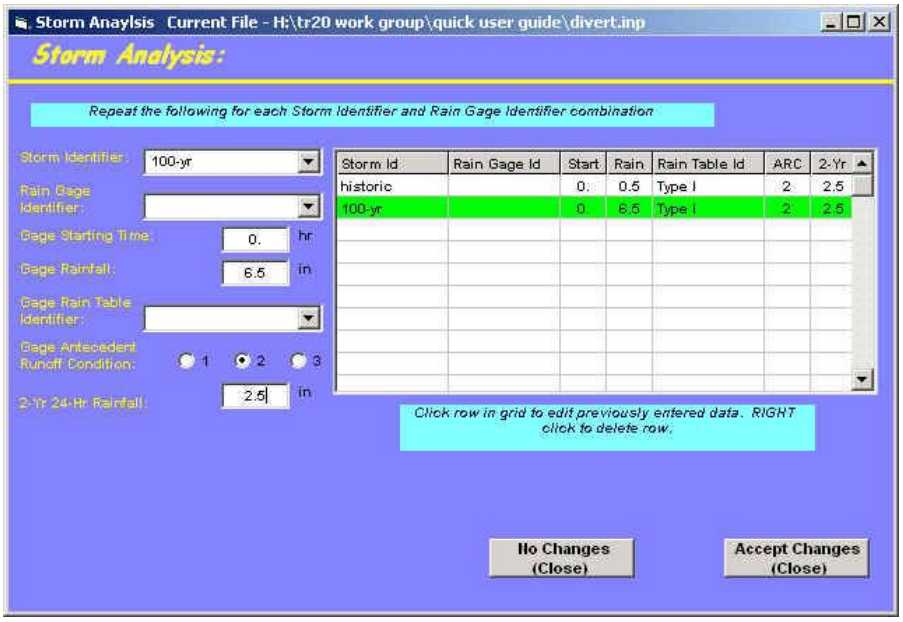


Select "Accept Changes (Close)" when the data has been entered.

Input Storm Data:

Two events are required for this example. The first one will be for the gaged event. This first event will have a Storm Id of "historic". We will need to enter a small enough rainfall depth such that no runoff will be generated from Sub-Area 001 (the user will enter the runoff directly using the "Read Hydrograph" for this event). Use 0.5". The second event, the 100-year, uses rainfall information given at the beginning at this example description. Use "100-yr" for a Storm Id for this event. From main WinTR-20 Controller/Editor, select "Storm Analysis:" and enter the data as shown below:

Insert 4sc13.jpg here



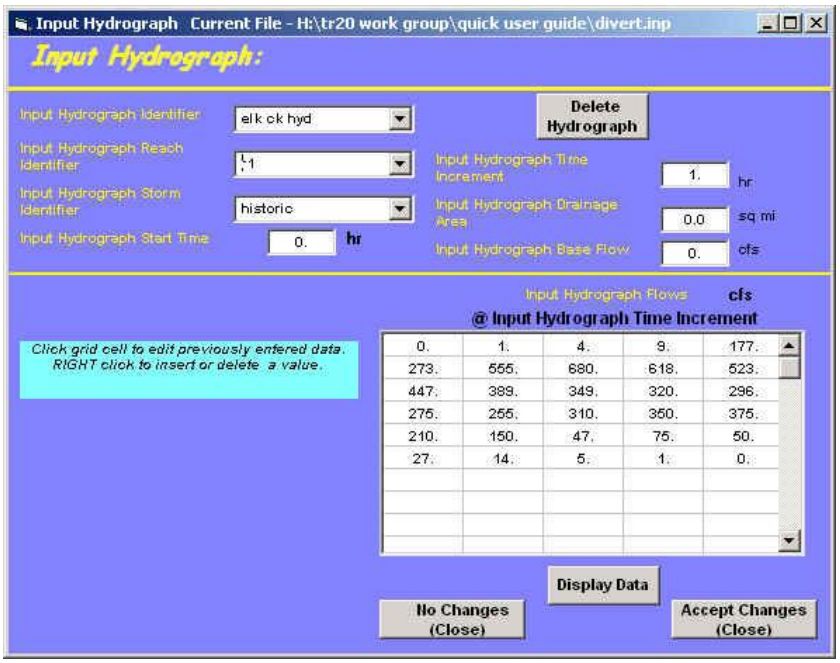
Select "Accept Changes – Close" to return to the main System/Controller Editor page.

Input Hydrograph Entry:

Back at the main WinTR-20 System Controller/Editor window, select "Input Hydrograph". Once the user is taken to the Input Hydrograph Input screen, enter "elk ck hyd" as an identifier for the input hydrograph. Using the pull down menu next the Input Hydrograph Reach Identifier, select "r1". This designates the Reach that the hydrograph will flow into is designated as "r1". Next, using the pull down menu next to the Input Hydrograph Storm Identifier window, select "historic". This identifier tells the program which Storm Event to use this hydrograph in.

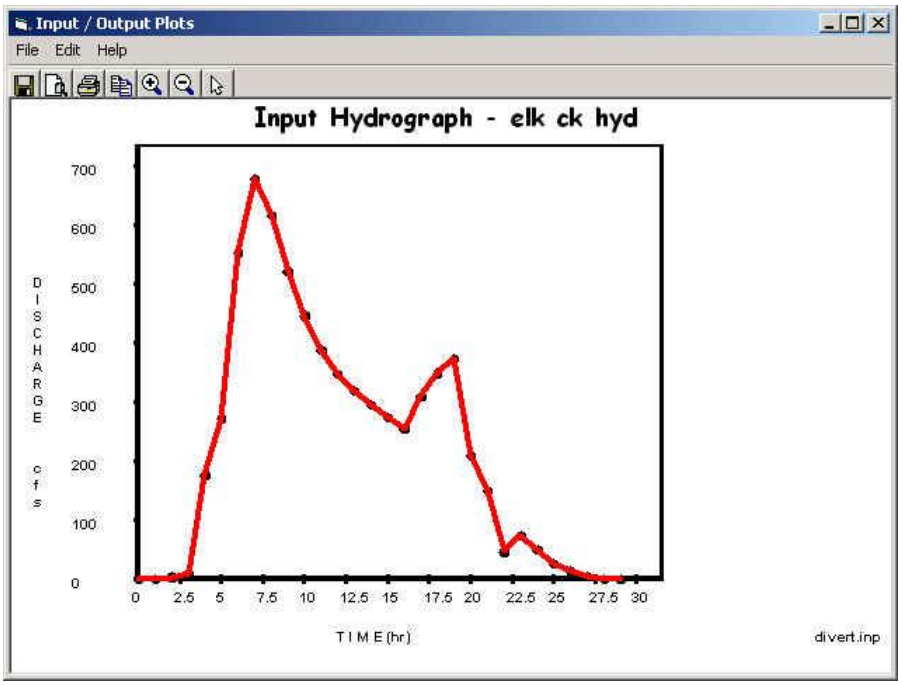
Note that the drainage area is set as 0.0 square miles. The reason for this is because this particular model contains a Sub-Area that has the 4.0 square miles associated with it already. If we were to enter 4.0 square miles within the Input Hydrograph data, the program accumulate this drainage area with the area from Sub-Area "sub 001" to come up with an erroneous 8.0 square miles at the split hydrograph point.

Insert 4sc3.jpg here



After the data has been entered, select the "Display Data" to view the hydrograph:

Insert 4sc4.jpg here



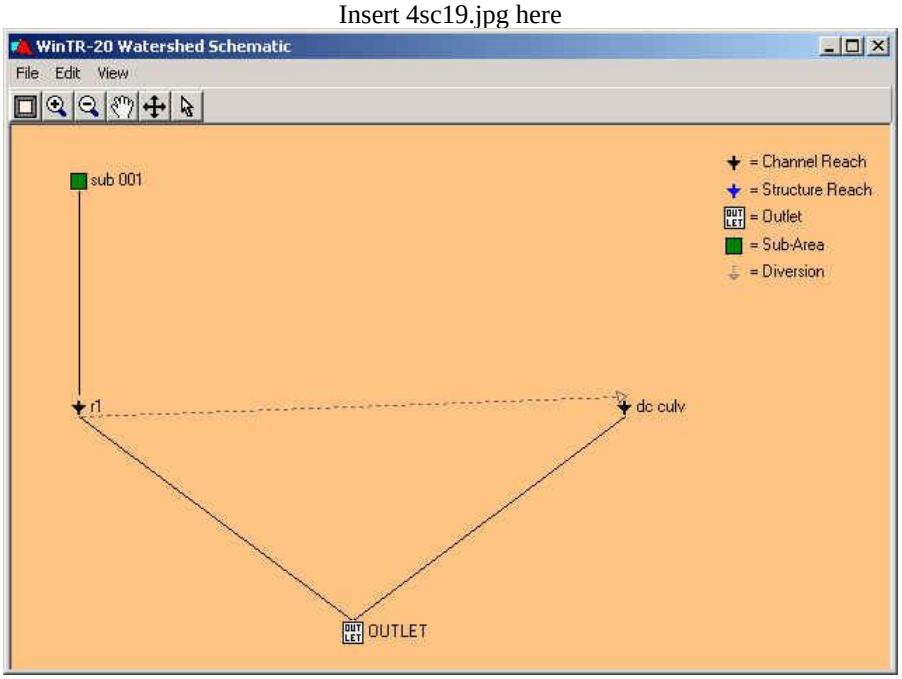
Close the hydrograph window and select "Accept Changes – Close" to return to the main System/Controller Editor screen.

Viewing Schematic, Running the Model, Viewing Output

Schematic:

After returning to the main System/Controller Editor, select "Default Peak Output Code" from within the "Global Output:" screen. Save the file. After saving, the "View" option should appear along the top of the window. Select "Schematic" from the "View" pull-down menu. It should appear as follows:

Insert 4sc19.jpg here



Running and Viewing Printed Page Output:

Closing out the schematic and returning to the main WinTR-20 Controller/Editor, select "Run" from the menu along the top. The resultant printed page output should appear as:

```
                    Example Problem #4 - Split Flow Example
                 Input Hydrograph and 100-year Events

                    Name of printed page file:
            H:\tr20 work group\quick user guide\divert.out

                                   STORM historic

Area or    Drainage  Rain Gage     Runoff   ------------ Peak Flow ------------
 Reach       Area      ID or       Amount   Elevation   Time      Rate      Rate
Identifier  (sq mi)   Location      (in)      (ft)       (hr)     (cfs)     (csm)

sub 001       4.000                 0.0                 24.00       0.0       0.0
r1            4.000  Upstream      2.629    963.95      6.98    677.37    169.34
r1            3.960 Downstream     2.399    963.87      7.33    635.17    160.40
dc culv       0.040  Upstream     25.404    963.87      7.33     37.35    933.79
dc culv       0.040 Downstream    25.401    963.87      7.33     37.35    933.79
OUTLET        4.000                2.629                7.33    672.52    168.13

                                   STORM 100-yr

Area or    Drainage  Rain Gage     Runoff   ------------ Peak Flow ------------
 Reach       Area      ID or       Amount   Elevation   Time      Rate      Rate
Identifier  (sq mi)   Location      (in)      (ft)       (hr)     (cfs)     (csm)

sub 001       4.000                3.712                13.79   1032.72    258.18
r1            4.000  Upstream      3.712    964.67     13.79   1032.72    258.18
r1            3.960 Downstream     3.470    964.59     13.79    991.94    250.49
```

```
dc culv       0.040  Upstream     27.620    964.59     13.79     40.78   1019.57
dc culv       0.040 Downstream    27.613    964.59     13.79     40.78   1019.57
OUTLET        4.000                3.711               13.79   1032.72    258.18

 Area or    Drainage              ----------- Peak Flow by Storm -----------
  Reach       Area   Alternate   historic    100-yr
Identifier   (sq mi)               (cfs)     (cfs)     (cfs)     (cfs)     (cfs)

sub 001        4.00                  0.0    1032.7
r1             3.96                677.4    1032.7
DOWNSTREAM                         635.2     991.9
dc culv        0.04                 37.4      40.8
DOWNSTREAM                          37.4      40.8
OUTLET         4.00                672.5    1032.7
```

The output can be interpreted as follows:

For the historic event, a maximum of 37 cfs is diverted out of the channel through the culvert. At the downstream of reach r1, the peak discharge is 635 cfs. The volume of water lost from the main channel through the culvert is approximately 49 Acre-Feet[10].

For the 100-year event, the peak discharge just upstream of the culvert is 1,033 cfs. The peak discharge diverted out of the channel through the culvert is 41 cfs. At the downstream end of reach r1, the peak discharge is 992 cfs. The volume of water lost from the main channel through the culvert is approximately 52 Acre-Feet.

Note the 0 cfs coming from sub 001 for the historic event. This worked as planned since we wanted only the runoff from the Input Hydrograph to end up at the split point. The 0.5" of rainfall generated no runoff. During the 100-year event, the 6.5" of rainfall generated 3.712" of runoff from sub 001. There was no Input Hydrograph associated with this event thus the only runoff at the split point was the WinTR-20 generated hydrograph.

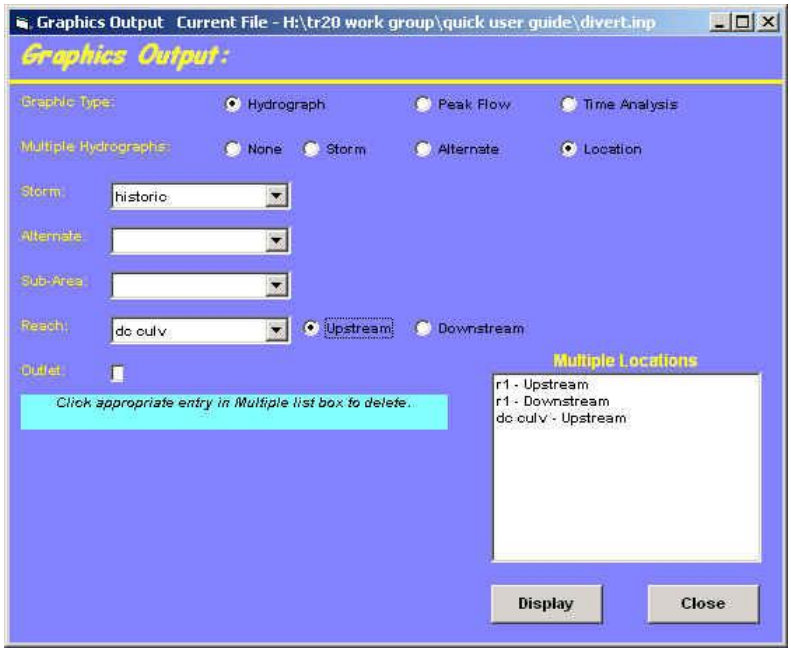
Viewing Hydrographs:

In order to view the hydrographs within WinTR-20, the hydrograph option for the sub-area or reach of interest must be selected for output. To make plots of all locations possible, set the hydrograph output option for sub-areas and reaches to "yes" within the Global Output screen. Save the file then run again. Now all the hydrographs should be interspersed within the printed page output.

Select "Plots" from the main WinTR-20 Controller/Editor window. Select "Hydrograph" as Graphic Type, "Location" next to the Multiple Hydrographs. Select the "historic" storm, then "r1" from the pull-down menu next to Reach. Select both upstream and downstream. These should now appear in the "Multiple Locations" box to the right. Next, go back to the pull down menu next to Reach and select "dc culv". Select upstream. The Graphics Output screen should now appear like:

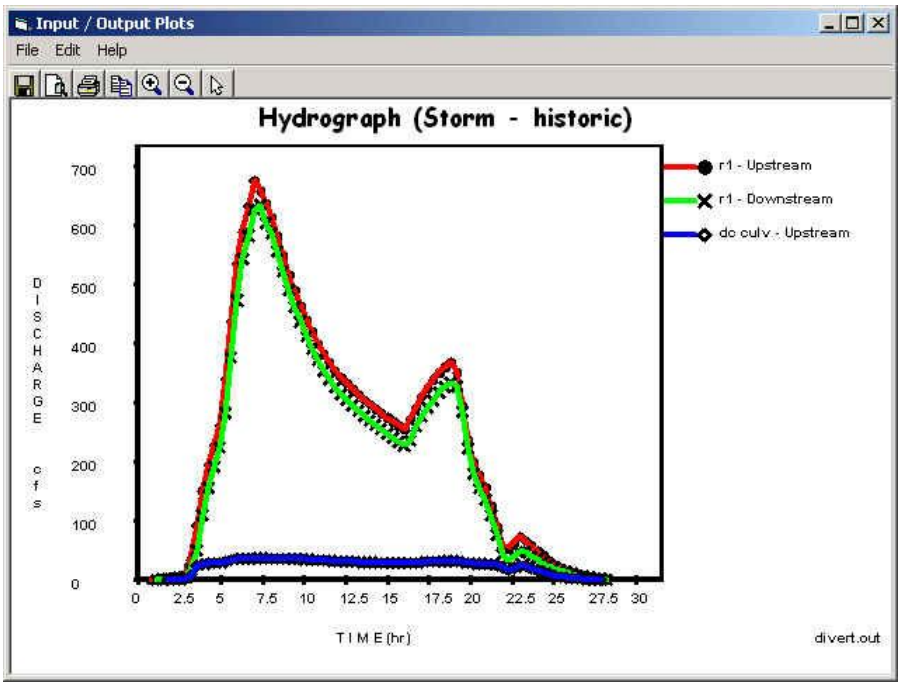
Insert 4sc15.jpg here

[10] (2.629 watershed inches – 2.399 watershed inches) x(4 mi^2) x (640 acres/mi^2)x(1 foot/12 inches)



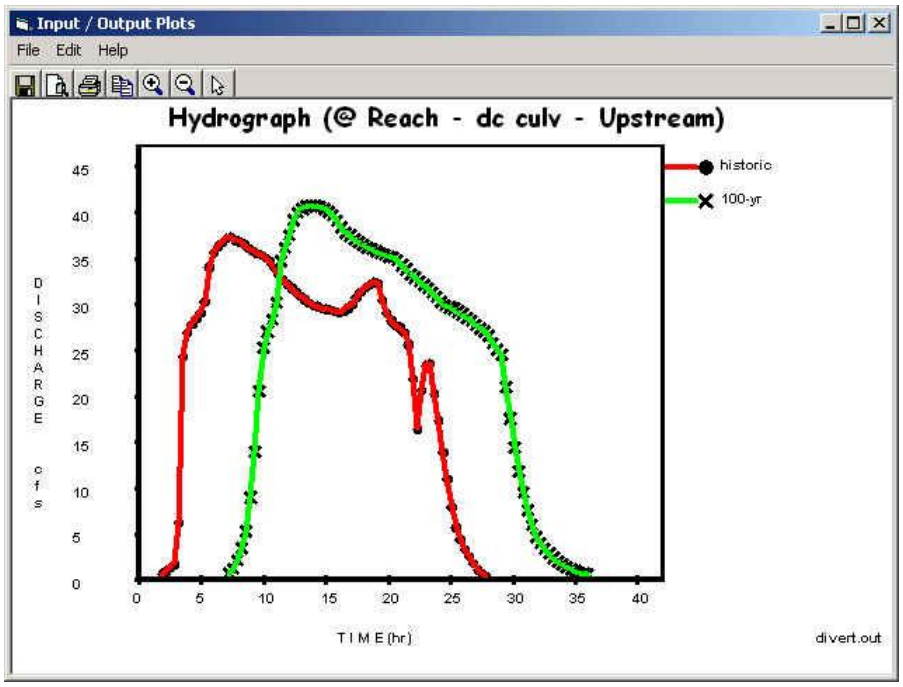
Finally, select display and you should see hydrographs showing the split of the r1 hydrograph upstream into the two hydrographs: 1) r1 downstream of the culvert and 2) through the culvert (dc culv).

Insert 4sc16.jpg here



The last graphic to be displayed is the diverted hydrograph by storm. Closing out the current plot and back at the Graphics Output screen, select "Storm" next to the Multiple Hydrographs section. From the Storm pull down menu, select "historic". From the Reach pull down menu select "dc culv" then select upstream and hit return. Next, go back up to the Storm pull down menu and select "100-yr" then hit return. The two storms should show up in the Multiple Hydrographs window to the right. Select

"Display" and the user should see the two individual hydrographs of the diverted flow out through the culvert for both the historic and 100-year event.



Chapter 5 WinTR-20 Converter

5.1 Description

The data converter transforms old TR-20 input data into the current WinTR-20 input format. The converter program is a Fortran90 batch process and uses the TR-20 input specifications (User Documentation, 2002) Appendix C) as the basis for input conversions. The Converter is included with the WinTR-20 system package, and is automatically placed in the subdirectory "Executables" during the installation process.

When the WinTR20 Controller/Editor is started, one of the File menu choices is "Convert old Data" (see Figure 5.1 File Menu – Main Window). Making this choice activates the TR-20 Converter and the program asks for an input file (see Figure 5.2):

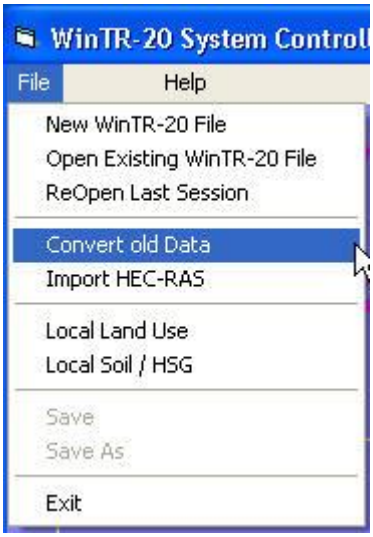


Figure 5.1 File Menu – Main Window

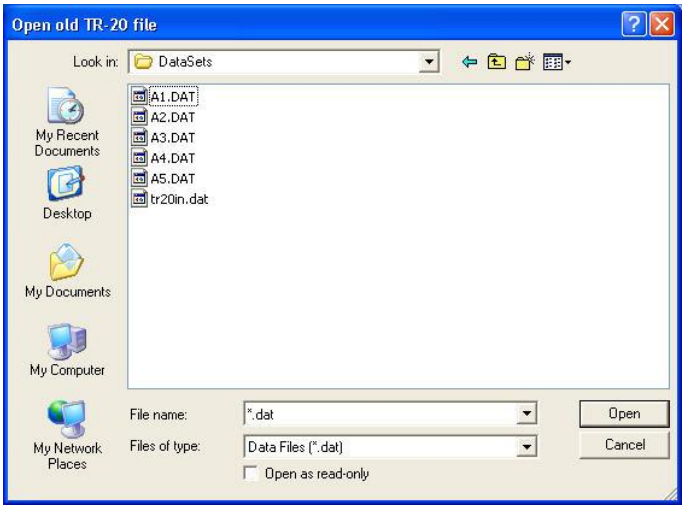


Figure 5.2 Open old TR-20 File Window

After locating the old file, the user clicks Open. The old data file may have any legal extension. During the conversion process the data file that is created is renamed "oldfilename.inp". (See Figure 5.3)

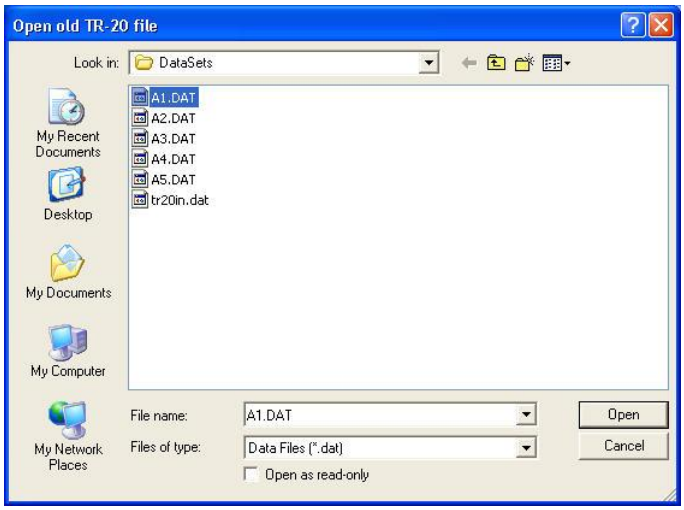


Figure 5.3 Input file selected: Data Converter

The program converts what it can of the input file, putting the data into the correct format for the new WinTR-20, and displays the Main WinTR-20 window. Where data needed by the new WinTR-20 is missing the converter flags this by printing "missing" in the appropriate data field.

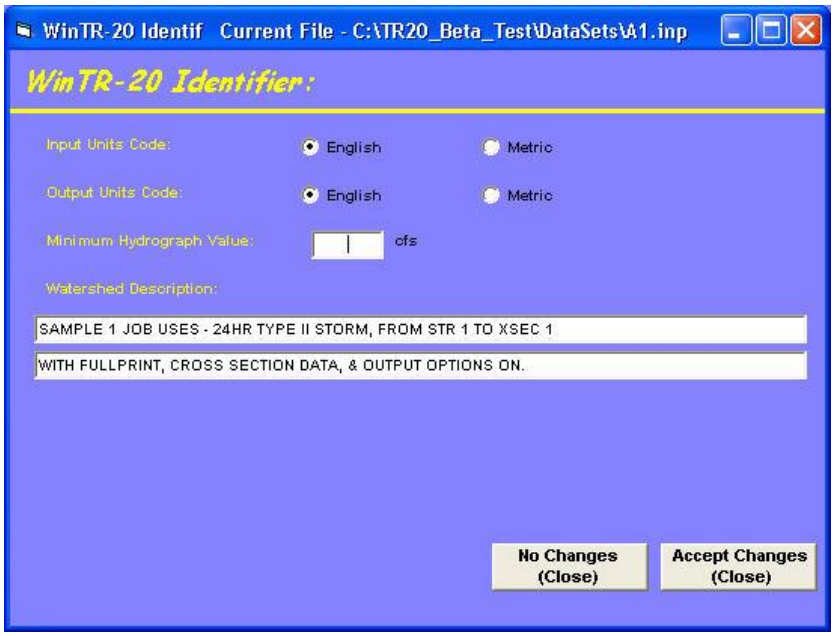


Figure 5.4 Converted input file WinTR-20 Identifier window.

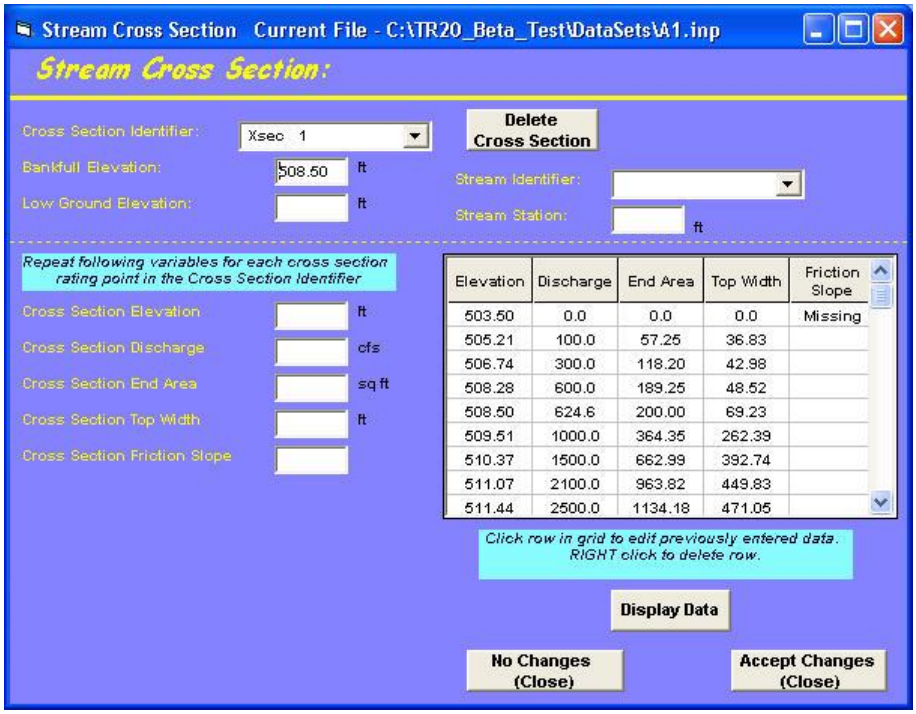


Figure 5.5 Converted input file, missing friction slope data in reach.

The user can now edit the file as necessary prior to running it in the WinTR-20 program. For instance, in the screen above, the friction slope is missing from the stream cross section data and needs to be added to the data before WinTR-20 will run successfully.

5.2 Converted Data is Incomplete

Most old data will be transferred but some items such as IPEAKS and multiple changes in main time increment do not translate to the new format. Entry of routing coefficients (x and m) in lieu of reach cross section rating data is no longer acceptable. Each reach in the watershed must refer to a stream cross section rating or structure rating. Also, the new input requires that a top width and friction slope be added for stream cross section data, which were not included in the older input data. The converter generates a top width value for each elevation based on the depth and end area, but it does not generate a friction slope and lists the friction slope as “Missing”. Any reaches in old data sets that used the routing coefficients (x and m) instead of cross section data will require additional cross section data. Thus, after conversion, most converted TR-20 data will need to be supplemented before it will run in the WinTR-20 model.

The IPEAKS feature and the option of using the rainfall table as a runoff table that were part of the old TR-20 have not been included in the WinTR-20 System model. If they are part of an old data set that is being converted, they do not cause an error as they are just not retained in the newly created input file. Also, multiple main time increments are not used in WinTR-20.

5.3 Verify Converted Data

While the converter attempts to convert as much of the old input data as possible, some situations may not convert as expected. It is the responsibility of the user to verify that the converted data is still representative of the watershed being modeled.

5.4 Output Files

Three output files are generated from the TR-20 Converter. They are the new WinTR-20 file (**xxx.inp**), an error file (**xxx.err**) and debug file (**xxx.dbg**). Any errors encountered while converting the data set are written to the error file. Any warning messages will be written to the debug file. A listing of the error and warning messages can be found in Appendices D and E.

5.5 Comparison of old and present WinTR-20

The data codes (number in column two of the data file) in the old input scheme that defined data types will not exist in the present scheme. The various data section names perform their function. In the present input scheme, data is generally entered in 10-column fields on each data entry line. A comparison of old TR-20 commands and present WinTR-20 data sections follows.

Table 5.1 Commands vs. Data Sections

Old TR-20 Command	Present TR-20 Data Section	Old TR-20 Command	Present TR-20 Data Section
ADDHYD	----	JOB	TR-20 Identifier
ALTER	Alternate Analysis	LIST	Alternate Analysis
BASFLO	Stream Reach	PEAKS	----
COMPUTE	Storm Analysis	RAINFL	Rainfall Distribution
DELETE	Alternate Analysis	REACH	Stream Reach
DIMHYD	Dimensionless Unit Hydrograph	READHD	Input Hydrograph
DIVERT	Stream Reach	RESVOR	Stream Reach
DURINC	Duration Increment	RUNOFF	Sub-Area
ENDATA	----	SAVMOV	----
ENDCMP	----	STRUCT	Structure Rating
ENDJOB	----	TITLE	TR-20 Identifier
INCREM	Global Output	XSECTN	Stream Cross Section
INSERT	Alternate Analysis	----	Time Analysis
IPEAKS	----	-----	Verification

Features of the old program no longer supported include capabilities associated with IPEAKS and PEAKS, the runoff table entered as a rainfall distribution, and the Data Check program. Data checking is now done within the WinTR-20 model itself.
Table 5-2 shows how each piece of data in the old files is used (or not used) in the new input format. The data are presented in the order in which they appear in the 1992 TR-20 user manual. Commands which do not transfer to the new format are shown in Appendix B.

Table 5-2: Old TR-20 Input Data and use in WinTR-20 System Input

JOB

Variable	Converter Usage
JOB	Identify as oldTR-20 Input
TR-20	Identify as oldTR-20 Input
Watershed ID	Used as part of watershed description
ECON	NOT USED
FULLPRINT	NOT USED
PASS=	NOT USED
SUMMARY	NOT USED
Plot Options	NOT USED

TITLE

Variable	Converter Usage
TITLE	Identify record type
Descriptive text	New Watershed Description

ENDJOB

Variable	Converter Usage
Data Code	NOT USED
ENDJOB	Identify record type
Operation Number	Identify record type

DURINC

Variable	Converter Usage
Data Code	Identify record type
DURINC	Identify record type
Data Code	NOT USED
Units for durations	New Duration Increment: Duration Units
Duration	New Duration Increment: Duration
Data Code	NOT USED
ENDTBL	NOT USED

XSECTN

Variable	Converter Usage
Data Code	Identify record type
XSECTN	Identify record type
Cross section ID Number	Part of New Stream Cross Section: Cross Section ID
Drainage Area	Used to convert discharge from csm to cfs
Bankfull Elevation	New Stream Cross Section: Bankfull Elevation
Zero Damage Elevation	New Stream Cross Section: Zero Damage Elevation
Low Ground Elevation	New Stream Cross Section: Low Ground Elevation
Data Code	NOT USED
Elevation	New Stream Cross Section: Cross Section Elevation
Discharge	New Stream Cross Section: Cross Section Discharge (may be modified by Drainage area above)
End Area	New Stream Cross Section: Cross Section End Area
Data Code	NOT USED
ENDTBL	NOT USED

STRUCT

Variable	Converter Usage
Data Code	Identify record type
STRUCT	Identify record type
Structure ID Number	Part of New Structure Rating: Structure ID
Data Code	NOT USED
Elevation	New Structure Rating: Structure Elevation
Spillway Discharge	New Structure Rating: Structure Discharge
Storage	New Structure Rating: Structure Storage
Data Code	NOT USED
ENDTBL	NOT USED

DIMHYD

Variable	Converter Usage
Data Code	Identify record type
DIMHYD	Identify record type
Time Increment	NOT USED
Data Code	NOT USED
Discharge/Peak Discharge Ratios	New Dimensionless Unit Hydrograph: Dimensionless Hydrograph Points
Data Code	NOT USED
ENDTBL	NOT USED

RAINFL

Variable	Converter Usage
Data Code	Identify record type
RAINFL	Identify record type
Rainfall Table	Part of new Rainfall Distribution: Rain Table Identifier
Runoff Option	NOT USED
Time Increment	New Rainfall Distribution: Rain Table Time Increment
Data Code	NOT USED
Accumulated Rainfall Depths	New Rainfall Distribution: Mass Rainfall Points
Data Code	NOT USED
ENDTBL	NOT USED

READHD

Variable	Converter Usage
Data Code	Identify record type
READHD	Identify record type
Operation Code	Identify record type
Storage Location	Used to determine New Input Hydrograph: Input Hydrograph Reach Identifier
Data Code	NOT USED
READHD	NOT USED
Operation Code	Identify record type
Starting Time	New Input Hydrograph: Input Hydrograph Start Time
Time Increment	New Input Hydrograph: Input Hydrograph Time Increment
Drainage Area	New Input Hydrograph: Input Hydrograph Drainage Area
Baseflow	New Input Hydrograph: Input Hydrograph Base Flow
Data Code	NOT USED
Discharge	New Input Hydrograph: Input Hydrograph Flow
Data Code	NOT USED
ENDTBL	NOT USED

RUNOFF

Variable	Converter Usage
Data Code	Identify record type
RUNOFF	Identify record type
Operation Code	Identify record type
Cross Section Id	NOT USED
Structure Id	NOT USED
Output Hydrograph Location	Used to identify downstream reach identifier
Contributing Drainage Area	New Sub-Area: Sub-Area Drainage Area
Runoff Curve Number	New Sub-Area: Sub-Area Weighted Curve Number
Time of Concentration	New Sub-Area: Sub-Area Time of Concentration
P/V Display Code	New Sub-Area: Sub-Area Peak Output Code
HYD Display Code	New Sub-Area: Sub-Area Hydrograph Output Code
ELEV Display Code	NOT USED
DUR Display Code	NOT USED
FILE Display Code	New Sub-Area: Sub-Area Hydrograph File Code
SUM Display Code	New Sub-Area: Sub-Area Peak Summary Output Code

RESVOR

Variable	Converter Usage
Data Code	Identify record type
RESVOR	Identify record type
Operation Code	Identify record type
Structure Id	Part of new Stream Reach: Reach Structure Identifier
Input Hydrograph Location	Used to identify downstream reach identifier for reach upstream
Output Hydrograph Location	Used to identify downstream reach identifier
Start Routing Elevation	New Structure Rating: If more than one structure starting elevation is specified for a structure a new structure rating is required.
P/V Display Code	New Stream Reach: Reach Peak Output Code
HYD Display Code	New Stream Reach: Reach Hydrograph Output Code
ELEV Display Code	NOT USED
DUR Display Code	New Stream Reach: Reach FLOOD ECONOMICS File Code
FILE Display Code	New Stream Reach: Reach Hydrograph File Code
SUM Display Code	New Stream Reach: Reach Peak Summary Output Code

REACH

Variable	Converter Usage
Data Code	Identify record type
REACH	Identify record type
Operation Code	Identify record type
Section Id	Part of new Stream Reach: Reach Cross Section Identifier
Input Hydrograph Location	Used to identify downstream reach identifier for reach upstream
Output Hydrograph Location	Used to identify downstream reach identifier
Reach Length	New Stream Reach: Channel Length
	PROCEDURE 1
Blank	Used to determine which procedure is used
Flood Plain Length	New Stream Reach: Reach Valley Length
	PROCEDURE 2
Routing Coefficient (x)	NOT USED
Routing Exponent (m)	NOT USED
P/V Display Code	New Stream Reach: Reach Peak Output Code
HYD Display Code	New Stream Reach: Reach Hydrograph Output Code
ELEV Display Code	NOT USED
DUR Display Code	New Stream Reach: Reach FLOOD ECONOMICS File Code
FILE Display Code	New Stream Reach: Reach Hydrograph File Code
SUM Display Code	New Stream Reach: Reach Peak Summary Output Code

ADDHYD

Variable	Converter Usage
Data Code	Identify record type
ADDHYD	Identify record type
Operation Code	Identify record type
Section Id	NOT USED
Structure Id	NOT USED
Input Hydrograph Location	Used to identify downstream reach identifier for reach or sub-area upstream
Input Hydrograph Location	Used to identify downstream reach identifier for reach or sub-area upstream
Output Hydrograph Location	Used to identify receiving reach
P/V Display Code	NOT USED
HYD Display Code	NOT USED
ELEV Display Code	NOT USED
DUR Display Code	NOT USED
FILE Display Code	NOT USED
SUM Display Code	NOT USED

SAVMOV

Variable	Converter Usage
Data Code	Identify record type
SAVMOV	Identify record type
Operation Code	Identify record type
Section Id	NOT USED
Structure Id	NOT USED
Input Hydrograph Location	Used to identify downstream reach identifier for reach upstream
Output Hydrograph Location	Used to identify receiving reach

DIVERT

Variable	Converter Usage
Data Code	Identify record type
DIVERT	Identify record type
Operation Code	Identify record type
Section Id	New Stream Reach: Cross section Identifier
Structure Id	NOT USED
Input Hydrograph Location	Used to identify downstream reach identifier for reach upstream
Output Hydrograph Location	Used to identify receiving reach
Output Hydrograph Location	Used to identify receiving reach
	PROCEDURE 1
Discharge	New Stream Reach: Starting Split Flow
Drainage Area fraction	New Stream Reach: Split Flow Drainage Area
Cross Section Id	NOT USED
	PROCEDURE 2
Blank	Used to determine which procedure is used
Drainage Area Fraction	New Stream Reach: Split Flow Drainage Area
Cross Section Id	New Stream Reach: Split Flow Cross section Identifier
P/V Display Code	NOT USED
HYD Display Code	NOT USED
ELEV Display Code	NOT USED
DUR Display Code	NOT USED
FILE Display Code	NOT USED
SUM Display Code	NOT USED

BASFLO

Variable	Converter Usage
Data Code	Identify record type
BASFLO	Identify record type
Operation Code	Identify record type
	PROCEDURE 1
Baseflow	New Stream Reach: Constant Base Flow
Blank	NOT USED
	PROCEDURE 2
Triangular Base Flow	NOT USED
Triangular Peak Time	NOT USED
Triangular Peak Time	NOT USED

INCREM

Variable	Converter Usage
Data Code	Identify record type
INCREM	Identify record type
Operation Code	Identify record type
Main Time Increment	New Global Output Data: Hydrograph Display Time Increment (Can only use one - if multiple Main Time Increments in job smallest is used)

COMPUT

Variable	Converter Usage
Data Code	Identify record type
COMPUT	Identify record type
Operation Code	Identify record type
From Section ID	NOT USED
From Structure ID	NOT USED
To Section ID	NOT USED
To Structure ID	NOT USED
Start Time	New Storm Analysis: Gage Starting Time
Rainfall Depth	New Storm Analysis: Gage Rainfall
Rainfall Duration	Used to modify Rain Distribution Rain Table Time Increment
Rain table Number	Used as part of Storm analysis: Rain Gage Identifier
Ant Runoff Cond	New Storm Analysis: Gage Antecedent Runoff Condition
Alternate Number	Used as part of Alternate Analysis: Alternate Identifier
Storm Number	Used as part of Storm Analysis: Storm Identifier

INSERT

Variable	Converter Usage
Data Code	Identify record type
INSERT	Identify record type
Operation Code	Identify record type
From Section ID	Used to look for 1st occurrence in previous standard control
From Structure ID	Used to look for 1st occurrence in previous standard control

ALTER

Variable	Converter Usage
Data Code	Identify record type
ALTER	Identify record type
Operation Code	Identify record type

DELETE

Variable	Converter Usage
Data Code	Identify record type
DELETE	Identify record type
Operation Code	Identify record type

Running the old data set in Table A-3 through the converter will produce the TR-20 System data file in Table 5-3

Table 5-3: Old TR-20 input data

```
JOB TR-20 SAMPLE 1            FULLPRINT                                        10
TITLE     JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 1                  20
TITLE     WITH FULLPRINT, CROSS SECTION DATA, & OUTPUT OPTIONS ON.             30
 2 XSECTN   001         1.00        508.50                                    40
 8                      503.50      0.0         0.0                           50
 8                      505.21      100.00      57.25                         60
 8                      506.74      300.00      118.20                        70
 8                      508.28      600.00      189.25                        80
 8                      508.50      624.56      200.00                        90
 8                      509.51      1000.00     364.35                       100
 8                      510.37      1500.00     662.99                       110
 8                      511.07      2100.00     963.82                       120
 8                      511.44      2500.00     1134.18                      130
 9 ENDTBL                                                                    140
 3 STRUCT      01                                                            150
 8                      521.5       0.0         17.0                         160
 8                      521.6       3.0         18.0                         170
 8                      521.8       15.         20.2                         180
 8                      522.0       33.         22.5                         190
 8                      522.2       54.         25.0                         200
 8                      522.4       79.         28.0                         210
 8                      526.2       948.        70.                          220
 8                      526.4       1009.       75.                          230
 8                      526.6       1071.       80.                          240
 8                      527.2       1265.       95.                          250
 9 ENDTBL                                                                    260
 6 RUNOFF 1    01     6 1.2         75.         0.33          1       1      270
 6 RESVOR 2    01 6   7 521.5                                 1 1     1      280
 6 REACH  3 001   7   5 5400.                                 1       1      290
   ENDATA                                                                    300
 7 INCREM 6             0.1                                                  310
 7 COMPUT 7    01 001               5.2         1.0         2 2  01  01      320
   ENDCMP 1                                                                  330
   ENDJOB 2                                                                  340
```

Table 5-4: Converted Input Data

```
WinTR-20: Version 1.0
SAMPLE 1 JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 1
WITH FULLPRINT, CROSS SECTION DATA, & OUTPUT OPTIONS ON.

SUB-AREA:
          Area   1  Reach   1               1.2000      75.0     0.330 YY

STREAM REACH:
          Reach   1 Reach   2           Struct   1                     YY
          Reach   2 OUTLET    Xsec   1                5400.0    5400.0 YY

STORM ANALYSIS:
          Storm 01                   0.0      5.20Type II            2

STREAM CROSS SECTION:
          Xsec   1      508.50
                        503.50       0.0       0.0       0.0   Missing
                        505.21     100.0     57.25     36.83
                        506.74     300.0    118.20     42.98
                        508.28     600.0    189.25     48.52
                        508.50     624.6    200.00     69.23
                        509.51    1000.0    364.35    262.39
                        510.37    1500.0    662.99    392.74
                        511.07    2100.0    963.82    449.83
                        511.44    2500.0   1134.18    471.05

STRUCTURE RATING:
          Struct   1    521.50
                        521.50       0.0     17.00
                        521.60       3.0     18.00
                        521.80      15.0     20.20
                        522.00      33.0     22.50
                        522.20      54.0     25.00
                        522.40      79.0     28.00
                        526.20     948.0     70.00
                        526.40    1009.0     75.00
                        526.60    1071.0     80.00
                        527.20    1265.0     95.00

Global Output:
                                   0.100
```

* The word “Missing” is placed in the data field for the friction slope value, which is required for the Muskingum-Cunge reach routing method. If the friction slope does not change in the rating, only one entry on the first line is needed.

Chapter 6 HEC-RAS Reformatter

6.1 Description

The Corps of Engineer's HEC-RAS water surface profile program is used by many NRCS engineers in lieu of the older and now obsolete WSP2 Water Surface Profile program (NEH Part 630 Chapter 31, 1994). One of the reasons for computing water surface profiles is to develop cross section rating tables used in the TR-20 model for the flood routing of stream reaches. The WSP2 program developed these tables as an output option. However, HEC-RAS does not automatically develop these tables in the correct format for WinTR-20. For this reason, a reformatter program (TR20_HECRAS_Rating.exe) has been developed that takes a HEC-RAS output file and develops rating tables formatted for input to WinTR-20 (Merkel, 1999). The TR20_HEC-RAS_Rating program is a stand-alone Fortran90 batch process program.

HEC-RAS has many optional output variables and allows for the development of customized tables with certain desired information. Such customized tables, once created and saved, can be accessible whenever HEC-RAS is run on the various projects and plans. Appendix G of User Documentation discusses in detail how to organize a HEC-RAS output table for use in the reformatter. The reformatter was written based on output from HEC-RAS version 3.12. As future releases of HEC-RAS and WinTR-20 are distributed, the reformatter will be tested and revised as needed to be compatible with both the newer HEC-RAS versions and the WinTR-20 model.

6.2 Input: Running the TR20_HEC-RAS_Rating program

The TR20_HEC-RAS_Rating program may be run from Windows Explorer, other file managers, or from the WinTR-20 Controller/Editor. To run it from the Controller/Editor, click the **File** menu on the Main window and then click **Import HEC-RAS** in the pull down menu. The program then prompts the user for the input file name.

The program will look for a file named Rating_Table.fil to retrieve the input and output file names. This is a user (or Controller/Editor)-created file with the input file name (HEC-RAS output table) entered on the first record followed by a blank line. Any program-generated error files will be named the same as the input file name except that the extension "**.err**" is substituted and the WinTR-20 input cross sections file will have an "**.inp**" extension. If the Rating_Table.fil file is not present or its first line is blank, a default name (**HECRAS.out**) is used for the input file. The other file names will then be **HECRAS.err** for the error file and **HECRAS.inp** for the WinTR-20 cross sections.

The reformatter reads the file created from HEC-RAS output as input. Reformatter output consists of a file with WinTR-20 cross section rating tables and an error file with any irregularities identified which would cause WinTR-20 execution problems.

6.3 Data Processing

6.3.1 River Station Identification and WinTR-20 Cross Section Number

WinTR-20 accepts alphanumeric cross section names of up to ten characters in length. HEC-RAS permits a River Station (cross section location) to be identified by an integer or decimal number up to eight characters in length. All cross sections in the HEC-RAS output file are included in the TR20_HEC-RAS_Rating output file. The contents of the HEC-RAS output file can be selected prior to saving the text file if not all of the HEC-RAS river stations or reaches are desired as WinTR-20 rating tables.

6.3.2 Bankfull Elevation

This elevation is placed on the WinTR-20 cross section header record. The assumption made is that Bankfull elevation is the lower of the left overbank elevation (LOB Elev) and right overbank elevation (ROB Elev). This is consistent with the definitions in WSP2 and WinTR-20. If Bankfull elevation is higher than the highest water surface profile elevation, it is set equal to the highest profile elevation. As no information is present for the Low Ground elevation it is left blank (in this case WinTR-20 assumes Low Ground elevation is the same as Bankfull elevation). Users can add these other elevations, if desired, to the cross section data prior to running WinTR-20.

6.3.3 Data Checking

Profile elevation, discharge, and area must increase with successive profiles in the table. WinTR-20 produces an error if elevation, discharge, or area does not increase from one profile to the next in the table. The Energy Grade slope is checked to see if it is 0.00001 or greater (there is a lower limit on slope in WinTR-20). If an error occurs, an error message is placed in the error file, which identifies the cross section and profile where it occurs. The data need to be revised in order for WinTR-20 to run successfully.

6.4 Number of profiles in the HEC-RAS output table

WinTR-20 requires a minimum of two non-zero discharge profiles in a cross section rating table. If there is only one profile run in HEC-RAS, an error is placed in the error file. Though there is no limit to the maximum number of profiles run in HEC-RAS or that are acceptable to WinTR-20, the TR20_HEC-RAS_Rating program has a limit of 200.

6.5 Output File

In the output file (actually a WinTR-20 input file), a WinTR-20 Run Identifier record and two WinTR-20 Watershed Description records (which contain the two title records from the HEC-RAS output table) are placed at the beginning of the file. These are provided for data identification (project, plan, etc) and for the possibility of importing this file to the

WinTR-20 Controller/Editor as an existing file. The reformatted cross section data then follows.

Appendix A: References

Computer Program for Project Formulation Hydrology (1964). C-E-I-R, Inc., January 1964, 145. pg.

TR20: Computer Program for Project Formulation - Hydrology, SCS, May 1965 (167 pg.), revised 1983 (294 pg.).

Part 630 Hydrology, National Engineering Handbook (formerly NEH-4), Numerous authors, 1985-2000.

Chapters 10 (Estimation of Direct Runoff from Storm Rainfall, 1985, 24 pg.), 15 (Travel Time, Time of Concentration and Lag Time, 1985, 16 pg.), 16 (Hydrographs, 1985, 26 pg.), 17 (Flood Routing, 1985, 93 pg.)

TR-20 System Documentation, Cronshey, 1999 (draft).

Documentation for TR-20 HEC-RAS rating reformatter program, Merkel, 1999 (draft).

TR-20 User Documentation, Cronshey, 2000 (draft).

Maidment, D. R. (ed.), Handbook of Hydrology, McGraw-Hill, 1993, 1422 pages.

Chow, V. T., Maidment, D. R, and Mays, L. W., Applied Hydrology, McGraw-Hill, 1988, 586 pages.

U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS User's Manual, Version 2.0, April 1997, Ponce, V.M., Engineering Hydrology, Prentice Hall, 1989, 640 pages.

USDA, Soil Conservation Service, Technical Release 55, Urban Hydrology for Small Watersheds, 1986, 160 pg.

USDA, NRCS, WinTR-55, 2000 (draft), 105 pg.

Appendix B: Comparison of Old and Present WinTR-20

The data codes (number in column two) in the old input scheme that defined data types will not exist in the present scheme. The various data section names perform their function. In the present input scheme, data is generally entered in 10-column fields on each data entry line. A comparison of old TR-20 commands and present WinTR-20 data sections follows.

Table B-1 Commands vs. Data Sections

Old TR-20 Command	Present WinTR-20 Data Section	Old TR-20 Command	Present WinTR-20 Data Section
ADDHYD	----	JOB	WinTR-20 Identifier
ALTER	Alternate Analysis	LIST	Alternate Analysis
BASFLO	Stream Reach	PEAKS	----
COMPUTE	Storm Analysis	RAINFL	Rainfall Distribution
DELETE	Alternate Analysis	REACH	Stream Reach
DIMHYD	Dimensionless Unit Hydrograph	READHD	Input Hydrograph
DIVERT	Stream Reach	RESVOR	Stream Reach
DURINC	Duration Increment	RUNOFF	Sub-Area
ENDATA	----	SAVMOV	----
ENDCMP	----	STRUCT	Structure Rating
ENDJOB	----	TITLE	WinTR-20 Identifier
INCREM	Global Output	XSECTN	Stream Cross Section
INSERT	Alternate Analysis	----	Time Analysis
IPEAKS	----	-----	Verification

Features of the old program no longer supported include capabilities associated with IPEAKS and PEAKS, the runoff table entered as a rainfall distribution, and the Data Check program. Data checking is now done within the WinTR-20 model itself.

Table B-2 shows how each piece of data in the old files is used (or is not used) in the new input format. The data are presented in the order in which they appear in the 1992 TR-20 user manual. Commands which do not transfer to the new format as shown in the table above are not included in the detail below.

Table B-2: Old TR-20 Input Data and use in present WinTR-20 System Input

JOB

Variable	Converter Usage
JOB	Identify as oldTR-20 Input
TR-20	Identify as oldTR-20 Input
Watershed ID	Used as part of watershed description
ECON	NOT USED
FULLPRINT	NOT USED
PASS=	NOT USED
SUMMARY	NOT USED
Plot Options	NOT USED

TITLE

Variable	Converter Usage
TITLE	Identify record type
Descriptive text	New Watershed Description

ENDJOB

Variable	Converter Usage
Data Code	NOT USED
ENDJOB	Identify record type
Operation Number	Identify record type

DURINC

Variable	Converter Usage
Data Code	Identify record type
DURINC	Identify record type
Data Code	NOT USED
Units for durations	New Duration Increment: Duration Units
Duration	New Duration Increment: Duration
Data Code	NOT USED
ENDTBL	NOT USED

XSECTN

Variable	Converter Usage
Data Code	Identify record type
XSECTN	Identify record type
Cross section ID Number	Part of New Stream Cross Section: Cross Section ID
Drainage Area	Used to convert discharge from csm to cfs
Bankfull Elevation	New Stream Cross Section: Bankfull Elevation
Zero Damage Elevation	New Stream Cross Section: Zero Damage Elevation
Low Ground Elevation	New Stream Cross Section: Low Ground Elevation
Data Code	NOT USED
Elevation	New Stream Cross Section: Cross Section Elevation
Discharge	New Stream Cross Section: Cross Section Discharge (may be modified by Drainage area above)
End Area	New Stream Cross Section: Cross Section End Area
Data Code	NOT USED
ENDTBL	NOT USED

STRUCT

Variable	Converter Usage
Data Code	Identify record type
STRUCT	Identify record type
Structure ID Number	Part of New Structure Rating: Structure ID
Data Code	NOT USED
Elevation	New Structure Rating: Structure Elevation
Spillway Discharge	New Structure Rating: Structure Discharge
Storage	New Structure Rating: Structure Storage
Data Code	NOT USED
ENDTBL	NOT USED

DIMHYD

Variable	Converter Usage
Data Code	Identify record type
DIMHYD	Identify record type
Time Increment	NOT USED
Data Code	NOT USED
Discharge/Peak Discharge Ratios	New Dimensionless Unit Hydrograph: Dimensionless Hydrograph Points
Data Code	NOT USED
ENDTBL	NOT USED

RAINFL

Variable	Converter Usage
Data Code	Identify record type
RAINFL	Identify record type
Rainfall Table	Part of new Rainfall Distribution: Rain Table Identifier
Runoff Option	NOT USED
Time Increment	New Rainfall Distribution: Rain Table Time Increment
Data Code	NOT USED
Accumulated Rainfall Depths	New Rainfall Distribution: Mass Rainfall Points
Data Code	NOT USED
ENDTBL	NOT USED

READHD

Variable	Converter Usage
Data Code	Identify record type
READHD	Identify record type
Operation Code	Identify record type
Storage Location	Used to determine New Input Hydrograph: Input Hydrograph Reach Identifier
Data Code	NOT USED
READHD	NOT USED
Operation Code	Identify record type
Starting Time	New Input Hydrograph: Input Hydrograph Start Time
Time Increment	New Input Hydrograph: Input Hydrograph Time Increment
Drainage Area	New Input Hydrograph: Input Hydrograph Drainage Area
Baseflow	New Input Hydrograph: Input Hydrograph Base Flow
Data Code	NOT USED
Discharge	New Input Hydrograph: Input Hydrograph Flow
Data Code	NOT USED
ENDTBL	NOT USED

RUNOFF

Variable	Converter Usage
Data Code	Identify record type
RUNOFF	Identify record type
Operation Code	Identify record type
Cross Section Id	NOT USED
Structure Id	NOT USED
Output Hydrograph Location	Used to identify downstream reach identifier
Contributing Drainage Area	New Sub-Area: Sub-Area Drainage Area
Runoff Curve Number	New Sub-Area: Sub-Area Weighted Curve Number
Time of Concentration	New Sub-Area: Sub-Area Time of Concentration
P/V Display Code	New Sub-Area: Sub-Area Peak Output Code
HYD Display Code	New Sub-Area: Sub-Area Hydrograph Output Code
ELEV Display Code	NOT USED
DUR Display Code	NOT USED
FILE Display Code	New Sub-Area: Sub-Area Hydrograph File Code
SUM Display Code	New Sub-Area: Sub-Area Peak Summary Output Code

RESVOR

Variable	Converter Usage
Data Code	Identify record type
RESVOR	Identify record type
Operation Code	Identify record type
Structure Id	Part of new Stream Reach: Reach Structure Identifier
Input Hydrograph Location	Used to identify downstream reach identifier for reach upstream
Output Hydrograph Location	Used to identify downstream reach identifier
Start Routing Elevation	New Structure Rating: If more than one structure starting elevation is specified for a structure a new structure rating is required.
P/V Display Code	New Stream Reach: Reach Peak Output Code
HYD Display Code	New Stream Reach: Reach Hydrograph Output Code
ELEV Display Code	NOT USED
DUR Display Code	New Stream Reach: Reach FLOOD ECONOMICS File Code
FILE Display Code	New Stream Reach: Reach Hydrograph File Code
SUM Display Code	New Stream Reach: Reach Peak Summary Output Code

REACH

Variable	Converter Usage
Data Code	Identify record type
REACH	Identify record type
Operation Code	Identify record type
Section Id	Part of new Stream Reach: Reach Cross Section Identifier
Input Hydrograph Location	Used to identify downstream reach identifier for reach upstream
Output Hydrograph Location	Used to identify downstream reach identifier
Reach Length	New Stream Reach: Channel Length
	PROCEDURE 1
Blank	Used to determine which procedure is used
Flood Plain Length	New Stream Reach: Reach Valley Length
	PROCEDURE 2
Routing Coefficient (x)	NOT USED
Routing Exponent (m)	NOT USED
P/V Display Code	New Stream Reach: Reach Peak Output Code
HYD Display Code	New Stream Reach: Reach Hydrograph Output Code
ELEV Display Code	NOT USED
DUR Display Code	New Stream Reach: Reach FLOOD ECONOMICS File Code
FILE Display Code	New Stream Reach: Reach Hydrograph File Code
SUM Display Code	New Stream Reach: Reach Peak Summary Output Code

ADDHYD

Variable	Converter Usage
Data Code	Identify record type
ADDHYD	Identify record type
Operation Code	Identify record type
Section Id	NOT USED
Structure Id	NOT USED
Input Hydrograph Location	Used to identify downstream reach identifier for reach or sub-area upstream
Input Hydrograph Location	Used to identify downstream reach identifier for reach or sub-area upstream
Output Hydrograph Location	Used to identify receiving reach
P/V Display Code	NOT USED
HYD Display Code	NOT USED
ELEV Display Code	NOT USED
DUR Display Code	NOT USED
FILE Display Code	NOT USED
SUM Display Code	NOT USED

SAVMOV

Variable	Converter Usage
Data Code	Identify record type
SAVMOV	Identify record type
Operation Code	Identify record type
Section Id	NOT USED
Structure Id	NOT USED
Input Hydrograph Location	Used to identify downstream reach identifier for reach upstream
Output Hydrograph Location	Used to identify receiving reach

DIVERT

Variable	Converter Usage
Data Code	Identify record type
DIVERT	Identify record type
Operation Code	Identify record type
Section Id	New Stream Reach: Cross section Identifier
Structure Id	NOT USED
Input Hydrograph Location	Used to identify downstream reach identifier for reach upstream
Output Hydrograph Location	Used to identify receiving reach
Output Hydrograph Location	Used to identify receiving reach
	PROCEDURE 1
Discharge	New Stream Reach: Starting Split Flow
Drainage Area fraction	New Stream Reach: Split Flow Drainage Area
Cross Section Id	NOT USED
	PROCEDURE 2
Blank	Used to determine which procedure is used
Drainage Area Fraction	New Stream Reach: Split Flow Drainage Area
Cross Section Id	New Stream Reach: Split Flow Cross section Identifier
P/V Display Code	NOT USED
HYD Display Code	NOT USED
ELEV Display Code	NOT USED
DUR Display Code	NOT USED
FILE Display Code	NOT USED
SUM Display Code	NOT USED

BASFLO

Variable	Converter Usage
Data Code	Identify record type
BASFLO	Identify record type
Operation Code	Identify record type
	PROCEDURE 1
Baseflow	New Stream Reach: Constant Base Flow
Blank	NOT USED
	PROCEDURE 2
Triangular Base Flow	NOT USED
Triangular Peak Time	NOT USED
Triangular Peak Time	NOT USED

INCREM

Variable	Converter Usage
Data Code	Identify record type
INCREM	Identify record type
Operation Code	Identify record type
Main Time Increment	New Global Output Data: Hydrograph Display Time Increment (Can only use one - if multiple Main Time Increments in job smallest is used)

COMPUT

Variable	Converter Usage
Data Code	Identify record type
COMPUT	Identify record type
Operation Code	Identify record type
From Section ID	NOT USED
From Structure ID	NOT USED
To Section ID	NOT USED
To Structure ID	NOT USED
Start Time	New Storm Analysis: Gage Starting Time
Rainfall Depth	New Storm Analysis: Gage Rainfall
Rainfall Duration	Used to modify Rain Distribution Rain Table Time Increment
Rain table Number	Used as part of Storm analysis: Rain Gage Identifier
Ant Runoff Cond	New Storm Analysis: Gage Antecedent Runoff Condition
Alternate Number	Used as part of Alternate Analysis: Alternate Identifier
Storm Number	Used as part of Storm Analysis: Storm Identifier

INSERT

Variable	Converter Usage
Data Code	Identify record type
INSERT	Identify record type
Operation Code	Identify record type
From Section ID	Used to look for 1st occurrence in previous standard control
From Structure ID	Used to look for 1st occurrence in previous standard control

ALTER

Variable	Converter Usage
Data Code	Identify record type
ALTER	Identify record type
Operation Code	Identify record type

DELETE

Variable	Converter Usage
Data Code	Identify record type
DELETE	Identify record type
Operation Code	Identify record type

Appendix C: Errors and Warning Messages

Error Message Text
1st **Win*TR-20*** input file record is not the required **Win*TR-20: Version 1.0*** record --- CANNOT PROCESS FILE
Blank numeric field (***Input Field Name***) for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Blank record encountered before end of ***Data Type*** for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Blank record expected at end of Data Section (***Data Section Header***)
Blank text field (***Input Field Name***) for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Blank ***Y/N or 0/1*** field (***Input Field Name***) for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Both ***Input Field name*** and ***Another Input Field Name*** cannot be the same (***Input***) for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Cannot find ***TR-20*** input data file (***Input File Name***)
Circular pattern detected for reaches
Data Section Name (***Data Section Header***) is not a ***TR-20*** header - Skip to next Data Section
Decimal point in integer field (***Input***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Deleted ***sub-area or reach*** (***Identifier***) for Alternate (***Alternate Identifier***) was not part of watershed
Duplicate ***Data Section Header*** section in ***TR-20*** input file
Duplicate ***Input Field Name*** (***Input***) encountered for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Entries ***Input Field Name and Another Input Field Name*** cannot both be blank for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Entry (***X.XXX***) for ***Input Field Name*** not greater than ***Another Input Field Name*** (***X.XXX***) for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Entry ***Input*** required when ***Another Input*** is entered for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Extraneous data in columns ***XXX***-***XXX*** for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
First or Last point of ***Data Type*** must be 0.0 for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Identifier (***Input***) for ***Input Field Name*** used with ***Data Type*** (***Data Type Value***) not found
Imbedded blank(s) in (***Input***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Imbedded sign(s) (+ or -) in (***Input***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Input Field Name (***Input***) must not decrease for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Input Field Name (***X.XXX***) must be increasing for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Input Field Name Elevation (X.XXX) must be within ***structure or cross section*** elevation range (***X.XXX*** - ***X.XXX***) for ***Structure or Cross section*** Identifier (***Identifier Value***)
Input for ***Identifier*** (***Identifier Value***) must include ***Input Field Name(s)*** or ***Data Section Sub-header*** data
Invalid character (***Input***) found in ***Y/N or 0/1*** input for ***Input Field Name*** field and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Less than two greater than zero ***Data Type***s for ***Input Field Identifier*** (***Identifier Value***)
Maximum number of hydrograph points (***XXXXX***) exceeded while ***channel routing, adding hydrographs, generating hydrographs, or storage routing*** (***Identifier***) for Alternate (***Alternate Identifier***) and Storm (***Storm Identifier***)
Missing ***AREAS or REACHES*** subheader in input for Alternate (***Alternate Identifier***)
More ***Data Type*** than expected (***XXX***) encountered for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***

Error Message Text
Multiple ***Data Section Sub-header*** subheaders provided for ***current reach and***, ***current sub-area and***, or ***blank*** ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Multiple decimal points in (***Input***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
No ***Data Type*** data read from ***TR-20*** input file
No decimal point in (***Input***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
No empty hydrograph storage location for saving ***Input Hyd, Sub-Area or Split Flow*** for Alternate ***Identifier Value*** and Storm ***Identifier Value***
No ***Input Field Name*** data entered for ***Another Input Field Name*** (***Input***)
No output using global codes, sub-area codes or reach codes were selected. No output - no run.
No rainfall data entered for Storm Identifier (***Identifier***) and Rain gage (***Identifier***) combination.
Non-numeric character(s) in (***Input***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Reach(***Reach Identifier***) for Alternate (***Alternate Identifier***) has no inflows at upstream end
Runoff curve numbers for Curve Number Identifier (***Identifier Value***) not increasing from Curve Number 'A' to Curve Number 'D'
Subheader (***Input***) encountered for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***, but not required ***Input Field Name or Another Input Field Name*** has been identified
Subheader ***Data Section Sub-header*** not used as ***Data Type*** provided for ***Input Field Identifier*** (***Identifier Value***) and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Text field (***Input Field Name***) contains more than ***X*** character(s) for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Too many ***Input Field Name***s encountered in ***Data Section Header*** data section
Two different ***Input Variable Name*** (***X.XXX*** & ***X.XXX***) entered for ***Another Input Variable Name*** (***Input Value***)
Unacceptable character(s) in (***Input***) for ***Input Field Name*** field for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Unexpected end of file encountered after ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Unexpected new ***Data Type*** encountered for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Unrecognized input data (***Input Record***) encountered for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Unrecognized ***Input Field Name*** value (***Input***) encountered for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Unrecognized subheader (***Input***) for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Value (***Input***) above acceptable maximum (***Minimum Input Value***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Value (***Input***) below acceptable minimum (***Minimum Input Value***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Value (***X.XXX***) converted from ***Input*** above acceptable maximum (***Maximum Input Value***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Value (***X.XXX***) converted from ***Input*** below acceptable minimum (***Minimum Input Value***) for ***Input Field Name*** and ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
X Record(s) not starting in column(s) ***XX and XX*** found in ***Data Section Header*** data - Entire data section skipped

Note: Some messages above may be written without " ***Identifier Name*** (***Identifier***) " of as not all input data sections use qualifying identifiers.

TR-20 Converter

Error Message Text
1st ***TR-20 Input Converter*** input file record is not the required ***TR-20 Input Converter: BETA TEST.05*** record --- CANNOT PROCESS FILE
Cannot find ***old TR-20*** input data file (***Input File Name***)
Data Section Name (***Operation Name***) is not a ***old TR-20*** header - Skip to next Data Section
Duplicate ***Operation Name*** section in ***TR-20 Input Converter*** input file
Entry (***X.XXX***) for ***Rain Table Depth/Ratio*** not greater than ***previous Rain Table Depth/Ratio*** (***X.XXX***) for ***rainfall number*** (***X***) of Data Section ***Data Section Header (XXX)***
First point of ***Data Type*** must be 0.0 for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Input Field Name (***X.XXX***) must be increasing for ***Identifier Name*** (***Identifier***) of Data Section ***Data Section Header (XXX)***
Runoff Option (CN = 100) for rainfall number ***X*** cannot be converted
Unrecognized ***Duration Units*** value (***Hour*** or ***Days)*** encountered for Data Section ***Data Section Header (XXX)***

HEC-RAS

Error Message Text
Cannot find ***Rating_Table*** input data file (***Input File Name***)
Entry (***X.XXX***) for ***Input Field Name*** not greater than ***Another Input Field Name*** (***X.XXX***) for ***River Station*** (***Identifier***) of Data Section ***HEC-RAS Data (XXX)***
Less than two profiles in HEC-RAS data. Cannot generate cross section data
Unexpected end of file encountered after ***HEC-RAS output file record*** (***Identifier***) of Data Section ***HEC-RAS Data (XXX)***

Appendix D: Warning Messages

Message Text
Gage Rainfall amounts for multiple Storm Identifiers are the same for Rain Gage Identifier (***Rain Gage Identifier***)
Multiple Gage Rain Table Identifiers assigned to Rain Gage Identifier (***Rain Gage Identifier***)
Reach Channel Length/Valley Length is greater than 2 for Reach ***Reach Identifier***
Reach Channel Length/Valley Length is less than 0.5 for Reach ***Reach Identifier***
Reference flow (***X.XXX***) exceeds highest cross section flow (***X.XXX***) for ***Reach Identifier*** Alternate - ***Alternate Identifier*** and Storm - ***Storm Identifier***
Reference flow (***X.XXX***) exceeds highest cross section flow (***X.XXX***) for Reach ***Reach Identifier*** and Storm - ***Storm Identifier***
Required storage-discharge combination (***XXX.XX***) exceeds highest structure working curve value (***XXX.XX***) while storage routing Reach ***Reach Identifier*** (Alternate - ***Alternate Identifier*** and Storm - ***Storm Identifier***)
Required storage-discharge combination (***XXX.XX***) exceeds highest structure working curve value (***XXX.XX***) while storage routing reach ***Reach Identifier*** (Storm - ***Storm Identifier***)
Runoff curve numbers (***XX.X***)for Curve Number Identifier (***Identifier Value***) are the same for all hydrologic soil groups
Structure starting elevation raised to baseflow discharge elevation for reach ***Reach Identifier***
Value (***X.XXX***) converted from (***X.XXX***) is greater than the usual maximum (***X.XXX***) for ***Input Field Name*** on record ***XXX*** of ***Data Section Header***
Value (***X.XXX***) converted from (***X.XXX***) is less than the usual minimum (***X.XXX***) for ***Input Field Name*** on record ***XXX*** of ***Data Section Header***
Value (***X.XXX***) is greater than the usual maximum (***X.XXX***) for ***Input Field Name*** on record ***XXX*** of ***Data Section Header***
Value (***X.XXX***) is less than the usual minimum (***X.XXX***) for ***Input Field Name*** on record ***XXX*** of ***Data Section Header***
Value (***XXX***) is greater than the usual maximum (***XXX***) for ***Input Field Name*** on record ***XXX*** of ***Data Section Header***
Value (***XXX***) is less than the usual minimum (***XXX***) for ***Input Field Name*** on record ***XXX*** of ***Data Section Header***