Appendix M
Part 2

WETSORT

U.S. Army Corps of Engineers
Memphis District

Determination of Wetland Elevation
from Daily Water Surface Elevations
Using the Computer Program WETSORT

US Army Corps of Engineers, Memphis District
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INTRODUCTION

This document describes how the computer program WETSORT can be used to determine a wetland elevation from daily water surface elevations. In addition to this Introduction section, the document contains an Instructions for Running WETSORT section, a References section, and Appendices A through F. An example problem is included, illustrating a typical application of WETSORT for a stream channel and floodplain in the southeast United States.

NRCS Technique

The method used in WETSORT has been published by the USDA National Resources Conservation Service in the *Engineering Field Handbook*, Chapter 19 (1997). Twenty pages selected from Chapter 19 are included for reference in Appendix-A. WETSORT is simply a utility program to quickly and accurately process many years of water surface elevation data according to the NRCS method. WETSORT is only used to analyze surface water--not shallow groundwater or topsoil moisture.

Program Origen

WETSORT was written in the FORTRAN 77 language by the US Army Corps of Engineers, Vicksburg District. The WETSORT source code of the version used in the example problem is listed in Appendix-F. The source code is brief, partly because the computations are simple, and partly because the program calls subroutines from a library to deal with dates and to retrieve data from the DSS file.

WETSORT obtains all of its run control input from keyboard entries, but obtains the daily water surface elevation data from a binary file in the Corps HEC-DSS format. The Data Storage System (DSS) is the Corps' water data management software. WETSORT produces an ASCII output file.

WETSORT dates back to at least 1995. A windows feature dating back to at least 1997 provides an easy way for the user to input run control data to WETSORT. Although the windows version is convenient, it

is not as versatile as the DOS version used in this document to work the example problem. The version used to work the example problem allows any flooding duration to be input. In contrast, the windows version is hard-coded to calculate durations that are 5 and 12.5 percent of the growing season, rather than to accept a user-determined duration.

Concept

Ideally, wetlands are occupied by species of plants that tolerate standing water, or moist soil, or occasional flooding lasting several continuous days during the growing season. Since WETSORT is not applicable to evaluating moist soil or shallow groundwater, the discussion here will focus only on the rise and fall of water surface elevations in a wetland over time.

In a wetland, the general absence of non-water tolerant plant species below a certain elevation is associated with a history of flooding at approximately that elevation during the growing season. The flooding lasts long enough at that elevation to kill non-water tolerant plants. The number of days of flooding sufficient to kill non-water tolerant plants is called the duration. During a single growing season, the highest elevation continuously flooded for the lethal duration is the wetland elevation for that growing season, and also for that calendar year. Of course, over a period of years, the annual wetland elevation varies randomly about some representative elevation.

In Figure 1 below, the dashed water surface elevation represents such a representative wetland elevation. All vegetation rooted below the dashed line is water tolerant. In this figure, the low flow elevation of the stream is somewhat lower than the wetland elevation. Of course, there are degrees of water tolerance among plants, and it is the role of the biologist to identify the marker species for an analysis and the duration to be used in a WETSORT analysis. The bell curve to the right of the figure represents the distribution of annual wetland elevations.

Since flooding varies randomly from year to year, the annual wetland elevation varies randomly also. WETSORT facilitates the identification of a median wetland elevation determined from a multi-year analysis period. The median wetland elevation is considered representative for characterizing the long-term average wetland elevation at a site.

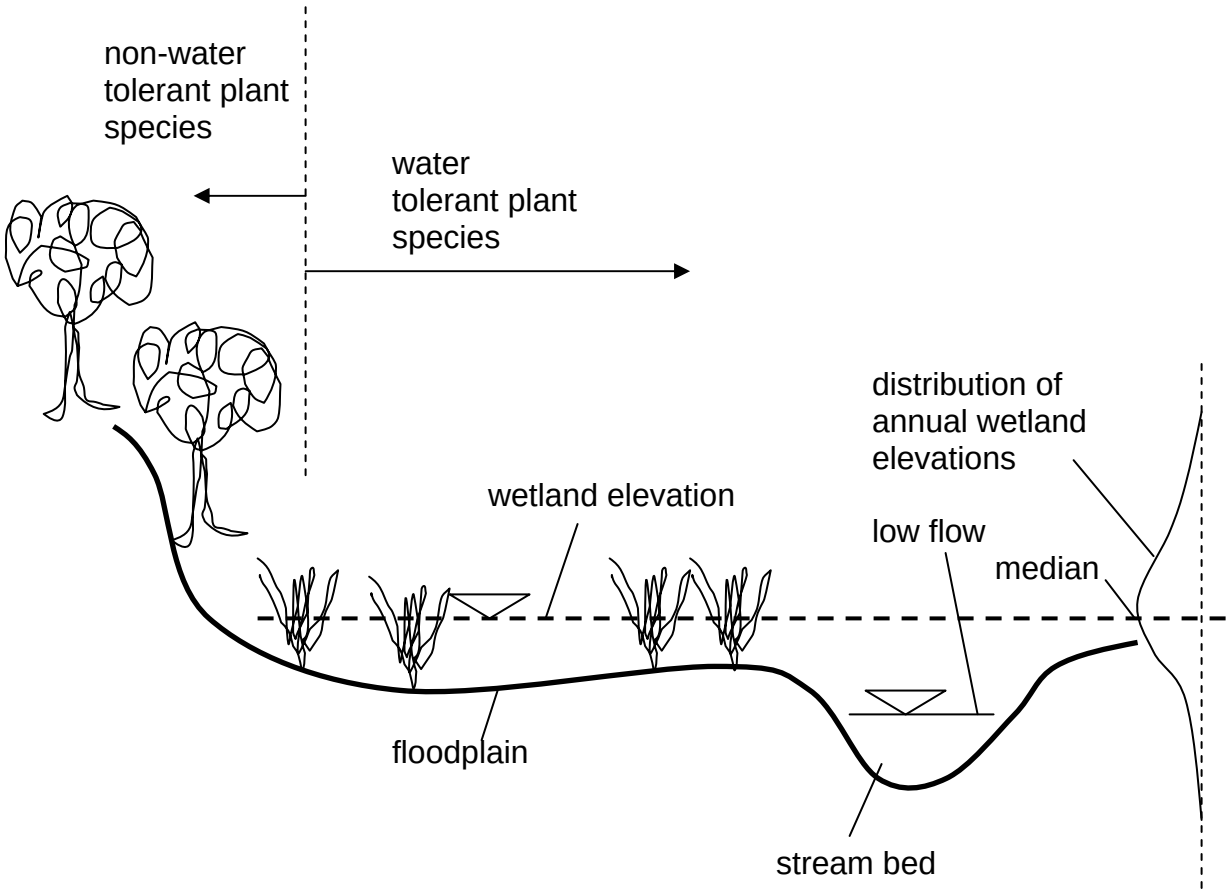

Figure 1. Section of Stream and Floodplain

The growing season is the only part of the year for which WETSORT analyzes water surface elevations. The beginning and ending dates of the growing season must be specified by the user. In Figure 2 the growing season begins on 20MAR and ends on 10NOV (a total of 236 days), and this is the growing season used in the example problem.

In some analyses a flat number of days, such as 15, for example, is specified as the duration--this is how the example problem is set up. However, in some project analyses, percentages of the growing season have been calculated and rounded to the nearest day. For example, percentages of 5 and 12.5 percent have been used in projects, with the intent of bracketing a zone of elevations that may, or may not, be

wetlands. Land below the 12.5 percent elevation has been considered definitely a wetland. Land above the 5 percent elevation has been considered definitely not a wetland. The elevation zone between the 5 and 12.5 percent elevations was to be checked to determine if it were a wetland.

If the 5 and 12.5 percent durations had been used in the example problem, the durations would have been 12 and 30 days. For 5 percent of the 236-day growing season, 11.8 days can be rounded to 12 days. For 12.5 percent of the 236-day growing season, 29.5 days, can be rounded to 30 days.

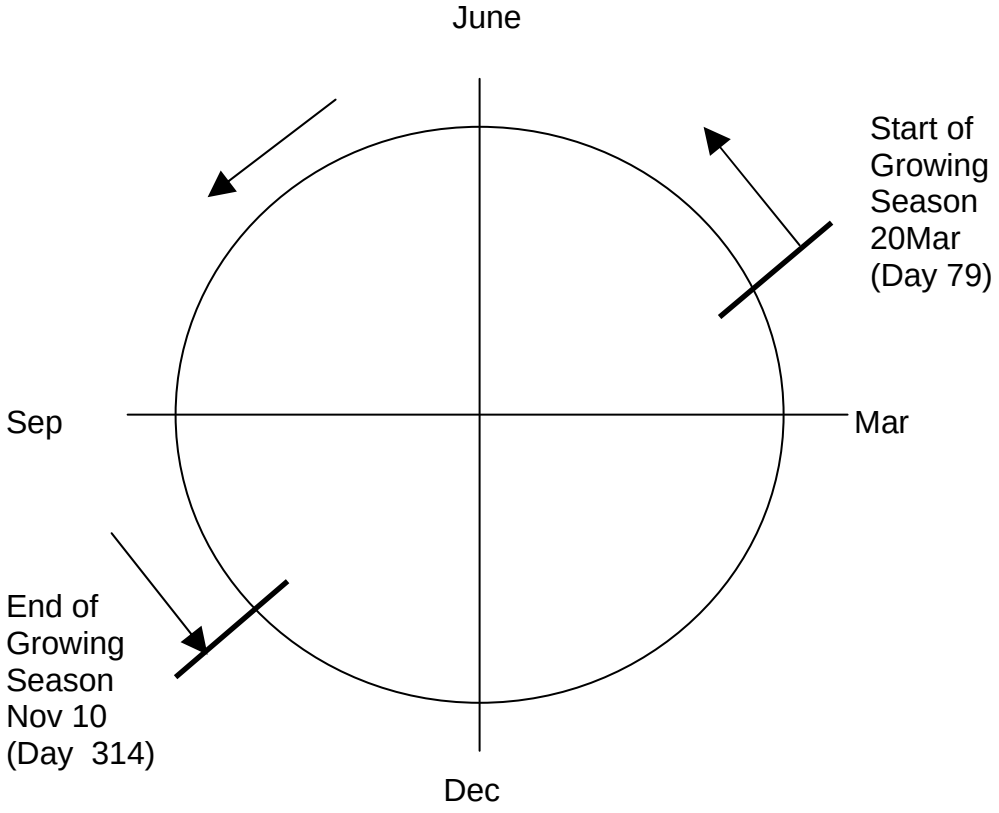

Figure 2. Example Growing Season
20Mar to 10Nov, Inclusive (236 Days)

INSTRUCTIONS FOR RUNNING WETSORT

Version

The instructions in this section apply to a 1995 version of WETSORT the Memphis District received from the Vicksburg District. The characteristics of the source code and executable files are listed in Table 1, below. This version of WETSORT runs in the Microsoft Windows Command Prompt window. Although not a windows application, the program is very easy to run.

Table 1. WETSORT File Characteristics

File Name	File Size KB	Date	Time
WETSORT.FOR	11	11/9/1995	3:40 pm
WETSORT.EXE	467	11/9/1995	3:40 pm

File Location

The executable file WETSORT.EXE and the DSS file containing the daily stage data should be in the same folder, or directory, of the computer. For example, the two files could be placed in a folder named "WET" under the C: drive of the computer, i.e., "C:\WET." WETSORT will write its output file into this same folder.

Command Prompt "DOS" Window

It is possible to start WETSORT by double-clicking the WETSORT.EXE file in Windows Explorer, which will bring up the DOS window. However, after making the necessary entries from the keyboard, the DOS window may disappear as the program runs.

Since it is desirable to see the trace of the program run in the DOS window, it is better to first open the DOS window and then run WETSORT, which does preserve the trace of program execution. The DOS window will remain open after program execution. The DOS window can be opened by clicking the sequence *Start, Programs, Accessories, Command Prompt*. The traditional DOS commands are used to move to the folder where WETSORT.EXE and the DSS file are. Placing the folder immediately under the C: drive makes this maneuver easy, as shown in the commands listed below.

Command Prompt Window
(Keystrokes are in **bold**)

U:\>	Suppose computer is initially set on a drive named "U".
U:\> **C: (enter)**	This changes from the U drive to the C drive.
C:\>	Computer is now set to C drive.
C:\> **CD WET (enter)**	This changes to the folder named WET.
C:\WET>	Computer is now set in WET folder.
C:\WET> **WETSORT (enter)**	Executes the WETSORT program.

Keyboard Input

All of the input used to control the execution of WETSORT is provided via the keyboard. The DSS input file only provides daily water surface elevation data.

The DOS window trace of the example WETSORT run is provided in three pages of screen shots located in Appendix-C. Screen shot page 1 of 3 records the program prompts and keyboard entries for the example problem. The very first line on page 1 of 3 is the execution command line, and shows that for this run the files were located in a folder U:\HUNTR\~wetsort>.

The first prompt is for the output filename. In response, WETEXMPL.OUT was entered.

The second prompt is for the stream name. In response, NOWHERE RIVER was entered.

The third prompt is for the gage location. In response, LOST HIGHWAY BRIDGE was entered. It is important to realize that "gage location" simply means any identifiable location, since WETSORT can be used on either historical gage data or synthetic input derived from numerical models.

The fourth prompt is for the starting year of the WETSORT analysis. In response, 1971 was entered.

The fifth prompt is for the ending year of the WETSORT analysis. In response, 1990 was entered, for a total of 20 years to be analyzed.

The sixth prompt is for the starting month of the growing season. In response, 3 was entered, representing March.

The seventh prompt is for the starting day of the growing season. In response, 20 was entered, representing 20March.

The eighth prompt is for the ending month of the growing season. In response, 11 was entered, representing November.

The ninth prompt is for the ending day of the growing season. In response, 10 was entered, representing 10November.

The tenth prompt is for the number of days of "five percent duration." In response, 15 was entered. Note that 15 is not five percent of the 236 day growing season (instead, 12 days is approximately five percent). It is important to realize that the phrase "five percent" is simply a title. The phrase "five percent" reflects an expectation by the programmer that the number of days input would indeed amount to five percent of the growing season, but actually any integer value ranging from 1 to the total number of days in the growing season is permissible.

The eleventh prompt is for the gage zero. In response, a 0.00 was entered. The gage zero is a constant that is added to all the daily water surface values. The gage zero allows stage data to be converted to sea level elevations. In this example, the DSS values are stages, rather than elevations, but for simplicity the gage zero was left at zero, which amounts to no conversion. Therefore, in the output file values in the stage and elevation columns are identical.

The twelfth prompt is for the DSS filename. In response, WETEXMPL.DSS was entered. It is important to type the full filename, including the extension ".DSS".

The thirteenth prompt is for the DSS pathname. In response, the path /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAGE//1DAY/PUB/ was entered. The path must begin and end with the forward slash, "/". Also, the parts must be separated by the forward slash. NOWHERE RIVER is Part-A. LOST HIGHWAY BRIDGE is Part-B. STAGE is Part-C. Part-D is to be omitted, but the double slash is necessary. 1DAY is Part-E. PUB is Part-F. Note that Part-C must either be STAGE or ELEV. Also, Part-E must be 1DAY. Parts A, B, and F are arbitrary names.

After the DSS pathname has been typed-in and the enter key struck, the program runs. If there are no problems with the input, records of data being read from the DSS file will be traced to the DOS window. This usually takes only a fraction of a second. In this program run, the trace of DSS records fills most of screen shot page 1 of 3, all of page 2 of 3, and virtually all of the page 3 of 3. Each block of text reflects one year of data being retrieved from the DSS file. At the bottom of page 3 of 3 is the phrase "Stop-Program terminated", which is the sign of a successfully completed run. The command prompt widow returns to the prompt for the folder, "U:\HUNTR\~wetsort>".

WETSORT does not give the user opportunities to go back and correct entries. If the user wishes to stop keyboard entry and start afresh, the program can be stopped by pressing the letter "C" while holding down the control key. The "CLS" command can be used to clear the screen.

Output File

WETSORT produces a single ASCII output file. In this example, the name of the output file is WETEXMPL.OUT, which was prompted-for in the DOS window during execution. The output file is divided into two parts. The first part is an echo of run control input, followed by a table listing the results in chronological order. The second part is repeat of the echo of run control input, followed by a table listing the results in descending order of annual wetland elevation. The example problem output file is listed in Appendix-D.

To allow the output file to be printed in large type in the appendix, the file was split into two files, WETEXMPL1.OUT and WETEXMPL2.OUT, and the top-most titles and the page numbers on the printouts were generated by Microsoft notepad, rather than WETSORT.

For the first part, shown in WETEXMPL1.OUT, the input control information consists of the output filename, the stream name, the gage location, the starting month and day of the growing season, the ending month and day of the growing season, and the duration in days. The table in chronological order lists, from left to right, a row number, the stage, the elevation (stage plus gage zero), and the starting and ending dates of the instance of duration that results in the highest wetland elevation for each year in the analysis period. It would be difficult to scan this file and spot a median wetland elevation.

For the second part, shown in WETEXMPL2.OUT, the input control information and the results are the same as for the first part, except the results in the table are sorted in descending order of wetland elevation. The ordered elevations make it easy to spot the median value, which is

adopted as the wetland elevation of the analysis period. If the number of years in the analysis period is odd, then the central sorted wetland elevation is the median elevation. For example, if an analysis period consisted of 19 years, then the median elevation would be the 10-ranked elevation in the sorted table.

If the number of years in the analysis period is even, then the median is the mean of the central pair of sorted elevations. In the example problem, the analysis period is 20 years, so the median wetland elevation is the mean of the central pair of sorted elevations--26.60 and 26.50--corresponding to the 10th and 11th sorted years. Therefore, the wetland elevation for the example problem is 26.55, and **this is the "ANSWER" of the WETSORT analysis.**

Plots of Data

A plot of the example problem stage data from 1971 through 1990 inclusive is shown in Appendix-B, with the stages plotted in a solid blue line. The stages range from roughly 6 feet to 35 feet, and tend to be highest in winter and spring. Although the patterns are similar from year to year, the detail is overwhelming. It would be very difficult for a person to scan this plot by eye and estimate a wetland elevation for the analysis period.

A plot of stage data for the year 1971 is shown in Appendix-E, with stages plotted in a thick red line. The winter and spring stages are the highest. The summer and fall stages are the lowest, but they are also the most frequently fluctuating. The plot has been marked-up by hand to show the 20MAR to 10NOV growing season and the instance of duration that sets the wetland elevation for 1971. As it happens, the wetland elevation is set by the very first possible instance of 15-day duration in the growing season--20MAR to 3APR. It is the lowest elevation--17.7 feet--within the duration that sets the hydrologic elevation for that instance of duration, and for the overall growing season and calendar year.

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US Army Corps of Engineers, Hydrologic Engineering Center, *CPD-79 HEC-DssVue, HEC Data Storage System Visual Utility Engine, Users Manual*, Version 1.2, May, 2005 (Revised Jan, 2006).

US Army Corps of Engineers, Vicksburg District, *WETSORT*, unpublished FORTRAN 77 computer program, circa 1995.

US Department of Agriculture, National Resources Conservation Service, *Part 650 Engineering Field Handbook, Chapter 19, Hydrology Tools for Wetland Determination*, August, 1997.

APPENDICES

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NRCS DOCUMENTATION
OF METHOD

United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

Part 650
Engineering Field Handbook

Chapter 19 Hydrology Tools for Wetland Determination

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Issued August 1997

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Preface

This chapter of the Engineering Field Handbook is an outgrowth of a meeting of hydraulic and water management engineers in Wilmington, Delaware, in October 1991. The participants developed a list of hydrology tools that help delineate wetlands. Various task groups were formed for each tool. Send comments to the Natural Resources Conservation Service (NRCS), Conservation Engineering Division, Washington, DC, or the Wetland Sciences Institute, Beltsville, Maryland.

The membership in the task group is as follows:

Stream and Lake Gage	**Bill Merkel,** NRCS, Beltsville, MD
Runoff Volumes	**Bob Kluth**, NRCS, Lincoln, NE (retired) **Rodney White,** NRCS, Fort Worth, TX (retired) **Helen Moody,** NRCS, Beltsville, MD **Don Woodward**, NRCS, Washington, DC
Remote Sensing	**R.H. Griffin,** NRCS, Fort Worth, TX **Bill Merkel**, NRCS, Beltsville, MD **Rodney White**, NRCS, Fort Worth, TX (retired)
DRAINMOD	**Virgil Backlund**, NRCS, Davis, CA **Sal Palalay**, NRCS, Chester, PA (retired) **Jeff Healy**, NRCS, Indianapolis, IN (retired) **Frank Geter**, NRCS, Fort Collins, CO **Ron Marlow,** NRCS, Washington, DC
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Drainage Guides	**Don Woodward**, NRCS, Washington, DC
Observation Wells	**Don Woodward**, NRCS, Washington, DC **Andrew Warne,** Corps of Engineers, Vicksburg, MS

Chapter 19 Hydrology Tools for Wetland Determination

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Chapter 19 Hydrology Tools for Wetland Determination

650.1900 Introduction

This chapter of the Engineering Field Handbook presents seven tools or procedures to use in the evaluating the hydrology of potential wetlands. Each tool is used in one or more states to assist in the determination of wetlands. These tools are analytical techniques that can be used to supplement the documentation of wetland hydrology determination.

The use of each tool depends on local conditions. The technical discipline leaders in each state office should determine the applicability of the individual tool(s) in their area. The selection of the appropriate tool(s) should be coordinated with the Environmental Protection Agency, Corps of Engineers, and Fish and Wildlife Service. Each procedure or tool is described in a separate section of this chapter.

The criteria for duration and frequency of inundation and saturation are in Section 527.4 of the National Food Security Act Manual (NFSAM). Different durations were used with the various procedures to indicate that the procedure is independent of the criteria.

The seven tools are:

- Stream gage data to establish the hydrology of over- or out-of-bank flooding.
- Water budget analysis to estimate daily runoff values, which can be used to determine the water balance of any wetland. A curve of drainage area versus depressional surface area to determine the frequency and duration of inundation of playas.
- Aerial photographic analysis to establish the frequency of occurrence and duration of inundation.
- DRAINMOD computer program to establish the degree of saturation of a wetland under a wide range of drained and nondrained conditions.
- Scope and effect equations to evaluate the effects of drainage measures on wetlands.
- Drainage guides, which provide useful information for evaluating drainage systems.
- Observation well data to establish the saturated conditions of a wetland.

650.1901 Use of stream and lake gages

(a) Applicable situations for use

Stream and lake gage data can be used to document the timing duration and frequency of inundation of the area adjacent to streams and lakes. Daily flow or stage data are used to determine the duration and frequency of overbank inundation. For a riverine situation, duration and frequency information at stream gage locations may be extended upstream or downstream using water surface profile information. Procedures for gathering stream gage data and computing water surface profiles are found in standard references.

Even if a site near a stream gage does not have sufficient topographic or stream gage data, some knowledge of the site can be obtained from analyses of the stream gage.

(b) Data required

The following data are required:

- Daily flow values or lake levels for a minimum of 10 years of data.
- Cross section information, and relationship of discharge versus stage if discharges are used.
- Topographic information for area of concern.
- Water surface profile information (if point of concern is not at the gage site).

(c) Sources of data

Various Federal, State, and county agencies have placed gages on many streams and lakes. Stream and lake gage data are available from the Corps of Engineers (COE), Tennessee Valley Authority (TVA), U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Bureau of Reclamation (BOR), various highway departments, and state or local public works agencies.

Various types of gage data are published. They include mean daily discharge, mean daily stage, peak stage and discharge for flood events, and mean daily lake level.

The primary source of data is the USGS Water Resources Data publication for each state.

(d) Limitations

(1) Knowledge and experience required

General knowledge of water surface profile computations and stream hydraulics and statistical techniques is required.

(2) Climatic regions of applicability

This procedure is applicable to all climate regions.

(3) Factors affecting the accuracy of results

The concept in this procedure is that the hydrograph can indicate what discharge or stage is exceeded for a particular duration, frequency, or both. At least 10 years of data are needed to apply this procedure. The accuracy of the procedure increases as the length of record increases.

If discharges are used, a relationship of stage versus discharge is needed to convert discharge into stage. The accuracy is a function of the cross section information. The stage is most accurately determined at the gage site. To accurately determine inundated areas using this information along the stream, the water surface profiles and topographic maps must be accurate. Even at the gage site, some topographic survey information may be needed to determine the limits of inundation if the topographic map is insufficient. The accuracy is a function of the contour interval of the map. Stream gage data may be extended upstream or downstream up to 1,000 feet without the use of a water surface profile.

Stream gage data may be used in the following situations:

1. A stream overflows and stays out of bank for the time required to meet wetland hydrology criteria.
2. A stream overflows and returns within banks in a time period less than the wetland hydrology criteria duration. The out-of-bank area must then be considered to confirm if over-bank-flow time plus time remaining ponded or saturated meets the wetland hydrology criteria. A simple water budget for the area may determine if ponding meets the ponding wetland criteria. This type of analysis is outside the scope of this chapter.
3. Areas next to a lake that may be subject to inundation because of periodic fluctuation in water level.
4. The water level in the lake may return to a normal level in less time than that required to meet the wetland hydrology criteria. The lake shore area must then be considered to confirm if the time flooded by the lake plus the time remaining ponded, saturated, or flooded meets the wetland hydrology criteria.

This section discusses situations 1 and 3. Situations 2 and 4 involve combining the methodology in situations 1 or 3 with analysis from other technical documents. Situations 2 and 4 involve analysis of the soil moisture in the soil profile using a standard water budget technique.

(e) Methodology

Methodology is a 9-step process.

Step 1. Determine growing season and duration as defined in Part 527.4 of the National Food Security Act Manual. The WETS table can be used to determine the growing season.

Step 2. Obtain available data or develop data relating to stream hydrology and hydraulics. This includes gage records, both upstream and downstream (if possible), of the site being evaluated. If the gage records are daily discharges, data relating discharge to stage must be obtained. See National Engineering Handbook, Section 4 (NEH-4), Chapter 14, Stage-Discharge Relationships. Other useful data available on many streams include water surface profiles. Water surface profiles are important where only one stream gage is located on the stream or where the potential wetland is not close to the gaging station.

Step 3. Develop a water surface profile, which is a plot of water surface elevation versus distance along a stream. The water surface elevation can represent a specific discharge or a flow frequency, such as a 2-year or 100-year discharge. A water surface profile is developed using computer programs that use cross section data, roughness data, distance along a stream, and bridge and culvert information. WSP2 and HEC2 are typical water surface computer programs used by NRCS and COE respectively.

Step 4. Use as many continuous years of gage records as can be obtained. The record should be representative of current conditions. For example, if a major dam has been installed and flow conditions have changed or channel excavation has occurred that would influence gage readings, then the gage records may be invalid and should not be used.

Step 5. Determine the highest stage of each year that is exceeded for the duration set by NFSAM or relevant criteria. Consider only gage records during the growing season. For example, if the inundation criterion is 10 days, record the lowest stage occurring within 10 days of high flow. Next, move the 10-day period forward 1 day and record the lowest stage occurring during those 10 days of high flow. It is assumed that all flows larger than the smallest flow within the criteria duration will be out of bank. Repeat this process for the entire growing season. The highest of these recorded stages is the value to use for that year. This search could be done on the larger flood events that would be expected to produce the highest 10-day stages and not for every 10-day interval of the growing season.

Repeat this process for as many years of gage data as daily records are available. If the record is broken, then determine if the discontinuous record is really representative of the site's hydrology.

Example 19–1 illustrates the determination of the elevation exceeded for 10 consecutive days on the Smith River at Brooking, Oregon, for 1989. The growing season is from March 1 to October 31. Figure 19–1 is a plot of mean daily elevation for March and April 1989, which represents the part of the growing season with the highest overall stage levels.

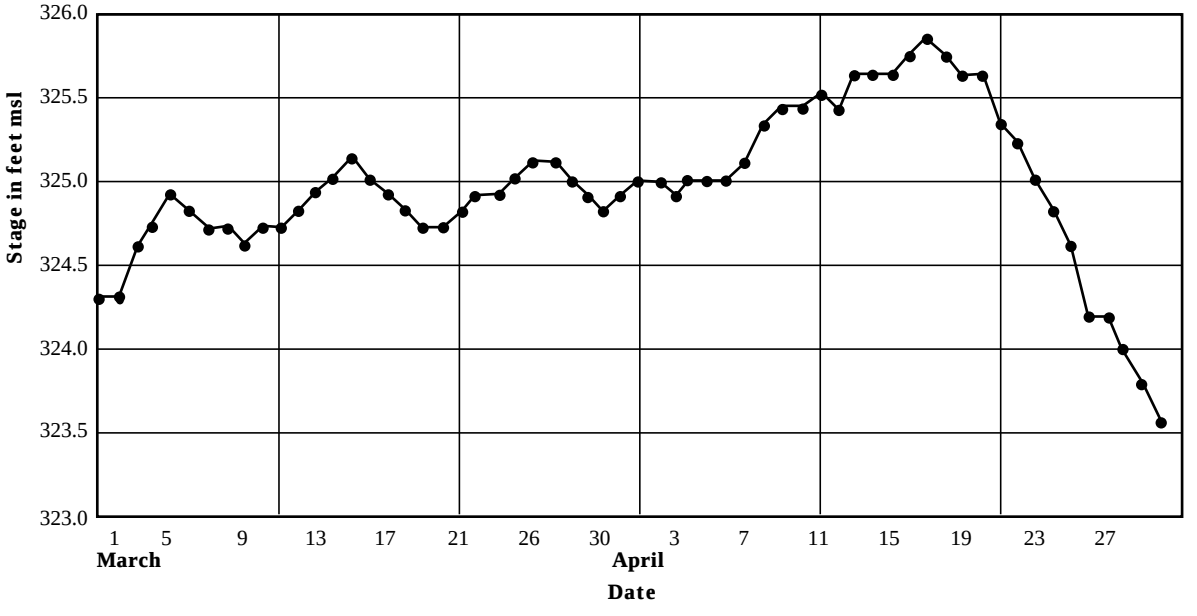
Example 19–1 Determination of elevation exceeded for 10 consecutive days

March 1–10, the lowest elevation = 324.3 feet
March 2–11, the lowest elevation = 324.3 feet.

Elevations exceed 325 in April, so these days should be checked.
April 7–16, the lowest elevation = 325.1 feet.
April 8–17, the lowest elevation = 325.3 feet.

Thus the lowest elevation that was exceeded for 10 consecutive days during 1989 was 324.3 feet.

Figure 19–1 Mean daily elevation for March and April 1989 for Smith River at Brookings, Oregon



Step 6. Tabulate the stage readings determined for each year of record for the gage in descending order (highest elevation first). The median value is the value where half of the stage readings are higher and half are lower. If an odd number of years of record is used, the middle event is the median elevation. If an even number of years of record is used, then compute the average elevation between the two middle years as the median. Example 19–2 shows the selection of the median.

Step 7. Repeat steps (4) through (6) for the second gage, if available.

Step 8. If there are two gages and if water surface profiles are not available, use the following procedure to determine median elevation. Measure the distance between the two gages along the stream and the distance from the site to the nearest of the two gages. Assume a straight line water surface between the gages and interpolate the elevation at the site based on the proportion of the distance to the gage and the distance between the two gages.

Using the data in table 19–1, the elevation at the site would be:

$$140 - [(5/20) \times 40] = 130 \text{ feet.}$$

If water surface profiles are available, interpolate the elevation at the site based on relationships of stage and discharge (and possibly frequency) at the gage locations and at the site.

Step 9. To relate the water level with the land surface, establish elevations at the site in question by a topographic survey or contour map.

Example 19–2 Selection of median stage reading

11 years of data are available and ordered from highest to lowest.

335 329 326 325.3 324 323.5 320 319 317 314 308

The median is **323.5** because 5 values are higher and 5 are lower.

10 years of data are available and ordered from highest to lowest.

335 331 329 328 325 323 322 321 320 315

The median would be **324** because it is the average of the 5th and 6th value.

Table 19–1 Example data to figure elevation

Location	Distance (miles)	15-day median elevation
Downstream gage	0	100
Site	15	?
Upstream gage	20	140

(f) Sample documentation

An area on the banks of the Tar River near Rocky Mount, North Carolina, is to be evaluated. It is assumed that the area must be inundated for 15 days during the growing season of March 1 to October 31 to have wetland hydrology present.

A stream gage is located on the Tar River at North Carolina Highway 97 in Rocky Mount, North Carolina. The USGS Water Resources Data for North Carolina include records from August 1976 to the present time. Average daily discharge data are published along with peak discharges and associated stages.

The first step is to determine the 15-day duration elevation for each year of record. Normally, the complete record is used, but in this example only 6 years are shown (table 19–2). Data for 6 years (1986 to 1991) are duplicated in the following pages with the 15-day duration discharge marked.

Example 19–3 shows records for Pamlico River Basin. The selection of the lowest flow during the high flow period is shown on pages 19–7 through 19–12.

These discharges are then ranked and the median calculated. The values ranked are 2,529, 1,300, 1,240, 679, 513, and 444. Because the number of years is even, the average of the third and fourth values is calculated. The median is 960 cubic feet per second. Because of the large difference between these values, a better estimate would result if more years were analyzed.

The next steps are to determine the stage and elevation that apply to the discharge of 960 cubic feet per second. From the publications of USGS Water Resources Data, the stage versus discharge for peak discharges is plotted and a smooth curve drawn through the points (figure 19–2). The discharge-stage curves can also be obtained from the agency responsible for the gage.

The stage associated with 960 cubic feet per second is 6.1 feet. This stage is then added to the gage datum of 53.88 feet to get an elevation of 60 feet. This elevation is then compared to the elevation of the land where the wetland determination is to be made. Any land below the elevation 60 on the flood plain would be inundated for at least 15 days by out-of-bank flooding during the growing season in 50 percent of the years, thus meeting the wetland criterion used.

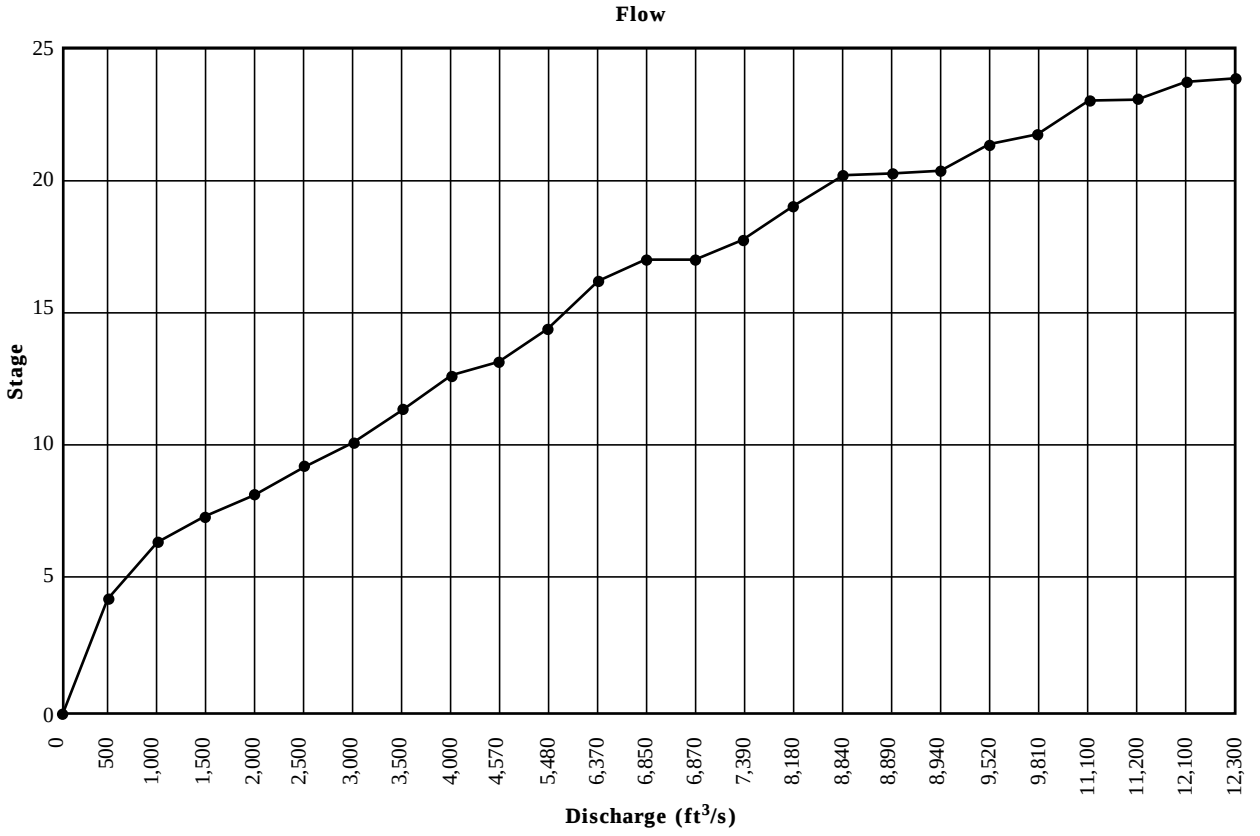
It should be noted that this elevation applies only in the immediate vicinity of the stream gage. If the area in question extends either far downstream or upstream of the road, water surface profiles would be required to determine the elevation.

In this procedure we assume that there are no levees between the stream and potential wetland.

Table 19–2 15-day duration elevation, 1986–1991

Year	Month-day	Discharge	Ranked
1986	3–25	444	2529
1987	4–15	1,300	1300
1988	4–27	513	1240
1989	5–11	2,529	679
1990	4–12	1,240	513
1991	3–12	679	444

Figure 19–2 Stage versus discharge plot for Tar River at Rocky Mount, North Carolina



Example 19–3 Water discharge records for Pamlico River Basin

Pamlico River Basin—02082585 Tar River at NC 97 at Rocky Mount, NC

Location—Lat 35°57'15", long 77°47'15", Edgecombe County, Hydrologic Unit 03020101, on left bank 20 feet downstream from bridge on NC 97, 0.5 mile upstream from Cowlick Branch, and 1.0 mile north-northeast of Rocky Mount.

Drainage area—925 square miles.

Water-Discharge Records

Period of Record—August 1976 to current year.

Revised Records—WDR NC-81-1: Drainage area.

Gage—Water-stage recorder. Datum of gage is 53.88 ft. above National Geodetic Vertical Datum of 1929.

Remarks—No estimated daily discharges. Records good except those below 10 ft^3/s, which are fair. Some regulation at low flow by mill above station. The city of Rocky Mount diverted an average of 17.8 ft^3/s for municipal water supply, most of which was returned as sewage below station.

Cooperation—Chemical and biological data shown in last table were provided by the North Carolina Department of Natural Resources and Community Development.

Average Discharge—10 years, 906 ft^3/s, 13.30 in/yr.

Extremes for Period of Record—Maximum discharge, 12,300 ft^3/s May 1, 1978, gage height, 23.66 ft; minimum, 6.1 ft^3/s Oct. 2, 1983, gage height, 2.84 ft.

Extremes for Current Year—Maximum discharge, 8,180 ft^3/s Nov. 26, gage height, 19.06 ft; minimum, 8.3 ft^3/s July 3, gage height, 2.96 ft.

Discharge, in cubic feet per second, water year October 1985 to September 1986 (mean values)

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	75	138	2670	403	655	897	494	249	264	101	46	696
2	242	140	3980	406	597	98	473	223	194	109	51	490
3	413	139	4430	444	542	710	459	211	164	20	210	368
4	234	419	2870	458	529	189	441	197	149	16	123	252
5	78	876	1280	472	512	102	440	158	139	26	77	202
6	116	2400	968	439	484	145	441	127	134	43	66	246
7	129	3200	834	378	495	152	502	138	135	54	226	197
8	139	2140	746	358	500	153	617	97	153	58	124	239
9	134	721	658	339	527	154	681	83	142	60	88	197
10	127	456	612	319	518	155	579	83	134	62	98	118
11	162	361	565	313	550	245	587	82	129	64	182	155
12	65	322	547	347	582	360	357	82	126	64	423	213
13	110	738	738	337	632	407	421	82	123	64	363	188
14	102	34	930	332	665	717	400	102	118	30	491	134
15	104	77	1650	313	597	1430	391	106	128	51	1060	210
16	104	119	1310	304	549	2880	330	106	106	50	823	58
17	104	148	907	298	532	3510	185	105	108	55	449	114
18	106	197	742	296	520	2440	240	112	106	53	313	109
19	109	136	630	344	1590	1160	302	113	105	54	715	106
20	111	247	571	467	932	1070	327	125	104	54	1230	108
21	141	369	528	553	1670	1420	344	175	106	53	1150	107
22	143	1670	499	512	1140	1580	338	840	93	54	2440	104
23	146	3990	474	423	675	1330	356	1410	57	49	3250	102
24	132	5250	481	374	576	883	341	790	61	47	2950	99
25	143	6640	482	361	549	444	323	441	83	46	899	96
26	159	7970	470	612	549	657	312	319	88	45	519	95
27	154	6170	425	1100	569	634	297	260	90	53	299	120
28	143	1300	393	1750	584	592	276	315	92	58	1260	73
29	133	868	395	1420	—	560	269	300	260	53	1260	173
30	128	1370	399	960	—	529	257	274	140	52	2520	55
31	128	—	391	757	—	505	—	299	—	48	1940	—
Total	4312	48605	32575	16189	18820	26977	11780	8004	3841	1676	25635	5454
Mean	139	1620	1051	522	672	870	393	258	128	54.1	827	182
Max	413	7970	4430	1750	1670	3510	681	1410	264	109	3250	696
Min	65	34	391	296	484	102	185	82	57	16	46	55
CFSM	.15	1.75	1.14	.56	.73	.94	.42	.28	.14	.06	.89	.20
In	.17	2.0	1.3	.65	.76	1.1	.47	.32	.15	.07	1.0	.22

Cal YR 1985	Total 275431	Mean 755	Max 7970	Min 34	CFSM .82 In 11
WRT YR 1986	Total 203870	Mean 559	Max 7970	Min 16	CFSM .60 In 8.2

Example 19–3 Water discharge records for Pamlico River Basin—Continued

Pamlico River Basin—02082585 Tar River at NC 97 at Rocky Mount, NC

Location—Lat 35°57'15", long 77°47'15", Edgecombe County, Hydrologic Unit 03020101, on left bank 20 feet downstream from bridge on NC 97, 0.5 mile upstream from Cowlick Branch, and 1.0 mile north-northeast of Rocky Mount.

Drainage area—925 square miles.

Water-Discharge Records

Period of Record—August 1976 to current year.

Revised Records—WDR NC-81-1: Drainage area.

Gage—Water-stage recorder. Datum of gage is 53.88 ft above National Geodetic Vertical Datum of 1929.

Remarks—No estimated daily discharges. Records good. Some regulation at low flow by mill above station. The city of Rocky Mount diverted an average of 17.8 ft^3/s for municipal water supply, most of which was returned as treated effluent below station.

Cooperation—Chemical and biological data shown in last table were provided by the North Carolina Department of Natural Resources and Community Development.

Average Discharge—11 years, 928 ft^3/s, 13.62 in/yr.

Extremes for Period of Record—Maximum discharge, 12,300 ft^3/s May 1, 1978, gage height, 23.66 ft; minimum, 6.1 ft^3/s Oct. 2, 1983, Oct 10, 1986; minimum gage height, 2.84 ft Oct 2, 1983.

Extremes for Current Year—Maximum discharge, 12,100 ft^3/s Apr 18, gage height, 23.55 ft; minimum, 6.1 ft^3/s Oct 10, minimum gage height, 2.86 ft Dec 4.

Discharge, in cubic feet per second, water year October 1986 to September 1987 (mean values)

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	56	74	161	713	1330	6660	1730	1080	313	228	100	69
2	79	80	122	1800	1660	8390	1670	951	247	197	102	45
3	139	134	139	2910	1480	8830	1310	996	296	144	101	46
4	28	11	27	3751	1450	8220	1150	976	379	116	100	46
5	87	145	283	2250	1370	8660	1170	935	395	57	94	268
6	81	34	437	1091	1150	8170	1230	857	456	287	91	115
7	81	86	355	791	959	3370	1110	728	345	346	102	77
8	85	158	283	634	846	1420	964	653	316	269	97	78
9	274	43	246	546	725	1290	569	613	260	210	98	63
10	63	156	260	518	673	2890	777	555	213	172	107	72
11	12	26	216	519	601	4300	725	497	190	164	89	80
12	17	46	310	484	562	5540	738	469	177	165	84	173
13	57	83	710	450	528	5750	844	448	165	144	84	331
14	94	85	959	420	524	4190	835	412	159	127	83	608
15	112	120	632	390	505	1820	1300	395	247	117	94	777
16	16	115	459	376	518	1410	6550	319	161	113	87	503
17	142	106	337	375	783	1270	10100	449	242	110	79	347
18	21	102	317	744	1140	1190	11800	428	415	116	75	211
19	80	109	294	4160	1490	1240	11200	356	948	113	75	155
20	79	111	275	6920	1700	1690	10700	605	635	109	72	664
21	78	111	255	7470	1710	1620	9490	762	414	105	70	514
22	76	110	248	8070	1940	1580	5620	902	322	103	71	418
23	73	111	231	9110	4110	1240	2080	730	325	103	66	273
24	72	193	653	9510	5160	1030	1560	553	350	101	57	226
25	78	25	1040	8850	5880	2000	2930	470	491	107	55	170
26	144	144	1890	6730	5900	156	4730	367	547	107	53	142
27	28	47	3100	3000	5890	466	4560	394	353	102	48	123
28	69	134	1950	1860	5770	1140	2730	405	428	102	44	105
29	84	111	855	1430	—	2270	1970	436	292	103	44	230
30	137	46	589	1250	—	3320	1260	320	270	99	49	88
31	14	—	459	1160	—	2400	—	109	—	98	99.2	—
Total	2456	2855	18092	88280	56354	103222	103402	18380	10261	4434	2470.2	7020
Mean	79.2	95.2	584	2848	2013	3330	3447	593	342	143	79.7	234
Max	274	193	3100	9510	5900	8830	11800	1080	948	346	407	777
Min	12	11	24	675	505	156	725	319	159	57	44	46
CFSM	.09	.10	.63	3.08	2.18	3.60	3.73	.64	.37	.15	.09	.25
Inch	.10	.11	.73	3.55	2.27	4.15	4.16	.74	.41	.18	.10	.28

Cal Yr 1986	Total 141779.0	Mean 388	Max 3510	Min 11	CFSM .42	In. 5.70
WTR Yr 1987	Total 417226.2	Mean 1143	Max 11800	Min 11	CFSM 1.24	In. 16.8

Example 19–3 Water discharge records for Pamlico River Basin—Continued

Pamlico River Basin—02082585 Tar River at NC 97 at Rocky Mount, NC

Location—Lat 35°57'15", long 77°47'15", Edgecombe County, Hydrologic Unit 03020101, on left bank 20 feet downstream from bridge on NC 97, 0.5 mile upstream from Cowlick Branch, and 1.0 mile north-northeast of Rocky Mount.
Drainage area—925 square miles.
Period of Record—August 1976 to current year.
Revised Records—WDR NC-81-1: Drainage area.
Gage—Water-stage recorder. Datum of gage is 53.88 ft above National Geodetic Vertical Datum of 1929.
Remarks—Records good except for estimated daily discharges, which are fair. Some regulation at low flow by mill above station. The city of Rocky Mount diverted an average of 19.9 ft^3/s for municipal water supply, most of which was returned as sewage below station. Minimum discharge for period of record and current water year also occurred on Sep. 24; result of temporary regulation.

Discharge, cubic feet per second, water year October 1987 to September 1988 (daily mean values)

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	21	70	499	1120*	587	365	475	482	174	140	67	84
2	82	97	474	*800	566	301	350	319	144	126	111	49
3	104	97	378	*850	722	379	404	408	13	126	39	126
4	107	94	292	*1300	916	407	457	278	207	242	111	98
5	102	140	243	*1880	1229	43	416	600	225	168	118	113
6	103	115	211	*2150	2160	510	396	751	230	82	79	87
7	123	100	170	*1680	1970	488	415	916	209	59	80	86
8	110	96	78	*1180	1210	472	460	816	162	65	93	73
9	109	81	69	*780	924	470	365	668	175	97	130	77
10	119	75	101	*750	815	460	482	530	179	73	83	85
11	126	78	133	*692	876	546	444	474	142	169	26	114
12	114	75	175	*600	1790	710	418	423	158	143	121	101
13	111	121	206	*570	2210	736	523	239	218	127	100	76
14	109	140	208	*560	2430	623	765	239	167	118	54	72
15	105	78	308	526	1840	560	872	276	124	121	60	90
16	108	69	350	377	1310	504	792	291	106	122	133	86
17	111	73	477	448	4080	458	668	315	102	120	121	85
18	111	63	564	695	952	415	520	362	248	103	62	71
19	104	98	458	956	891	484	669	274	250	54	75	57
20	102	96	364	1490	702	518	1190	570	190	107	88	59
21	101	108	342	1910	814	532	1840	486	281	104	99	64
22	102	81	342	2270	684	541	1640	402	358	123	116	162
23	104	79	383	1770	674	505	1071	268	372	124	131	101
24	108	132	415	1160	587	448	819	371	303	111	90	33
25	180	74	388	900	549	420	636	255	241	110	44	149
26	224	93	356	898	520	411	572	356	176	108	45	100
27	115	106	358	1000	510	503	513	243	194	120	47	233
28	107	156	638	1120	405	626	370	245	162	242	95	187
29	85	292	1030	948	454	655	560	243	141	126	64	137
30	20	465	1850	733	—	578	511	243	158	125	121	11
31	32	—	1720	567	—	509	—	240	—	93	64	—
Mean	105	155	438	1054	1047	505	654	406	200	120	86.1	98.9
Max	224	465	1850	2270	2430	736	1840	916	372	242	133	233
Min	20	63	69	377	405	301	350	239	102	54	26	33
Inch	.13	.01	.55	1.31	1.22	.63	.79	.51	.24	.15	.11	.12

*Estimated

Statistics of monthly flow data for period of record, by water year (WY)

Mean	220.2	561.4	819.0	1568	1624	1994	1646	896.2	682.3	384.3	336.1	218.5
Max	566.8	1905	1720	3230	3280	3577	3447	2361	2238	1316	826.9	805.1
(WY)	1980	1980	1984	1978	1983	1983	1987	1978	1982	1984	1986	1979
Min	70.4	74.5	141.9	254.0	546.3	476.9	359.3	258.2	128.0	54.1	79.7	84.3
(WY)	1981	1981	1981	1981	1977	1981	1981	1986	1986	1986	1987	1980

Summary statistics	1988 water year		Period of record	
Average flow	400.4		883.9	
Highest annual mean			1500	1984
Lowest annual mean			261.9	1981
Highest daily mean	2430	Feb 14	12100	May 1, 1978
Lowest daily mean	20	Oct 30	6.6	Oct 3, 1983
Instantaneous peak flow	2510	Feb 14	12300	May 1, 1978

Summary statistics	1988 water year		Period of record	
Instantaneous peak stage	8.94	Feb 14	23.66	May 1, 1978
Instantaneous low flow	5.7	Sep 23	5.7	Sep 23, 1988
Annual runoff (inches)	5.88		13.0	
10 percentile	890		2190	
50 percentile	238		406	
98 percentile	65		70	

Example 19–3 Water discharge records for Pamlico River Basin—Continued

Pamlico River Basin—02082585 Tar River at NC 97 at Rocky Mount, NC

Location—Lat 35°57'15", long 77°47'15", Edgecombe County, Hydrologic Unit 03020101, on left bank 20 feet downstream from bridge on NC 97, 0.5 mile upstream from Cowlick Branch, and 1.0 mile north-northeast of Rocky Mount.
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Revised Records—WDR NC-81-1: Drainage area.
Gage—Water-stage recorder. Datum of gage is 53.88 ft above National Geodetic Vertical Datum of 1929.
Remarks—Records good except for estimated daily discharges, which are fair. Some regulation at low flow caused by mill above station. The city of Rocky Mount diverted an average of 19.4 ft^3/s for municipal water supply, most of which was returned as treated effluent below station. Minimum discharge for period of record and current water year, result of temporary regulation.

Discharge, cubic feet per second, water year October 1988 to September 1989 (mean daily values)

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	143	631	1160	350	303	5960	2310	7310	60	1220	509	401
2	103	1440	730	483	302	6680	2890	9200	198	804	813	347
3	20	2900	563	772	306	3750	1940	8920	314	560	1290	301
4	331	2670	420	943	284	7260	1370	7950	338	509	1040	278
5	126	1240	364	727	340	5780	1300	6750	599	473	748	270
6	99	821	305	597	410	5150	2820	5590	1040	491	510	137
7	81	639	272	520	560	6200	4030	4590	1350	524	420	183
8	365	571	248	476	674	4850	6110	4860	1440	643	419	185
9	240	451	249	462	666	5310	6510	4100	1420	893	369	183
10	181	392	262	493	700	5630	6050	2948	1250	653	342	212
11	151	316	259	515	638	4560	5740	2529	1030	489	303	145
12	143	274	264	667	546	3060	3930	2298	775	389	312	155
13	101	249	272	754	472	2290	2090	1780	873	362	353	*150
14	50	226	1100	872	436	2030	1620	1360	1030	402	413	*160
15	50	210	624	1070	406	2510	1790	1100	1200	779	416	*200
16	55	200	119	972	370	2720	2470	1480	1100	1160	751	*250
17	67	233	69	809	411	2360	3400	1560	1770	1610	900	*220
18	66	238	128	680	589	2970	2700	1400	2750	3310	1430	*190
19	126	247	120	601	779	2320	1750	1180	2380	4250	2990	*180
20	89	288	121	546	1040	1910	1450	909	1650	4540	4250	*170
21	136	263	115	488	2010	1740	1130	794	2360	2160	2600	*180
22	150	256	111	447	4920	1400	990	832	3390	872	1020	*170
23	189	245	113	402	6870	2050	937	501	3320	674	711	*180
24	201	235	149	387	7760	4950	864	725	2320	504	503	*170
25	28	210	204	366	7760	6680	770	697	1900	477	463	*160
26	240	204	237	359	8270	7500	1830	560	2000	415	1500	*200
27	188	207	243	342	7080	7170	2590	570	1320	374	2160	*300
28	151	243	259	331	5180	7070	3300	507	904	329	1090	*240
29	130	780	224	329	—	4610	2610	459	720	335	694	*220
30	120	1170	225	318	—	1790	4830	398	803	345	533	*180
31	129	—	261	302	—	1750	—	433	—	392	443	—
Mean	148	592	316	561	2146	4301	2733	2725	1699	998	977	211
Max	365	2900	1160	1070	8270	7500	6510	9200	3390	4540	4250	401
Min	20	200	69	302	284	1400	770	398	198	329	303	137
In.	.18	.71	.39	.70	2.42	5.36	3.30	3.40	1.69	1.24	1.22	.25

* Estimated

Statistics of monthly flow data for period of record, by water year (WY)

Mean	214.7	563.8	780.3	1491	1664	2172	1452	1037	737.5	461.5	385.4	217.9
Max	566.8	1905	1720	3230	3280	4301	3447	2725	2238	1316	977.3	805.1
(WY)	1980	1980	1984	1978	1983	1989	1987	1989	1982	1984	1989	1979
Min	7034	74.5	141.9	254.0	546.3	476.9	359.3	258.2	128.0	54.1	79.7	84.3
(WY)	1981	1981	198=1	1981	1977	1981	1981	1986	1986	1986	1987	1980

Summary statistics	1989 water year		Period of record	
Average flow	1422		925.3	
Highest annual mean		1500	1984	
Lowest annual mean		261.9	1981	
Highest daily mean	9200	May 2	12100	May 1, 1978
Lowest daily mean	20	Oct	6.6	Oct 3, 1983
Instantaneous peak flow	9520	May 2	12300	May 1, 1978

Summary statistics	1989 water year		Period of record	
Instantaneous peak stage	21.23	May 2	23.66	May 1, 1978
Instantaneous low flow	5.9	Oct 6	5.7	Sep 23, 1988
Annual runoff (inches)	20.9		13.6	
10 percentile	4400		2310	
50 Percentile	579		419	
95 percentile	121		72	

Example 19–3 Water discharge records for Pamlico River Basin—Continued

Pamlico River Basin—02082585 Tar River at NC 97 at Rocky Mount, NC

Location—Lat 35°57'15", long 77°47'15", Edgecombe County, Hydrologic Unit 03020101, on left bank 20 feet downstream from bridge on NC 97, 0.5 mile upstream from Cowlick Branch, and 1.0 mile north-northeast of Rocky Mount.
Drainage area—925 square miles.
Period of Record—August 1976 to current year.
Revised Records—WDR NC-81-1: Drainage area.
Gage—Water-stage recorder. Datum of gage is 53.88 ft above National Geodetic Vertical Datum of 1929.
Remarks—Records good except for estimated daily discharges, which are fair. Some regulation at low flow caused by mill above station. The city of Rocky Mount diverted an average of 19.4 ft^3/s for municipal water supply, most of which was returned as treated effluent below station. Minimum discharge for period of record and current water year, result of temporary regulation.

Discharge, cubic feet per second, water year October 1989 to September 1990 (mean daily values)

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	*513	*388	*410	1020	1350	1100	7160	1360	3140	160	64	1130
2	1010	*400	*320	1230	1180	1070	6330	2430	1390	170	59	657
3	2190	*809	*250	1730	1070	1440	6350	2340	860	222	89	382
4	3640	*1480	*200	1440	1040	1690	5600	2250	1100	315	76	286
5	4300	*1860	*460	1120	865	1830	5770	2250	880	367	101	245
6	2990	*1270	864	1080	1330	1600	5750	2310	732	264	89	202
7	963	*896	274	1110	1550	1220	3640	2330	596	278	79	187
8	673	*608	1260	1720	1200	1070	2170	1850	485	145	73	163
9	798	*758	1980	2300	1090	985	2430	1160	464	157	172	165
10	459	*1210	3270	3130	1780	930	1750	952	414	136	2470	230
11	*395	*1990	2590	3440	2390	627	1650	1270	362	132	1700	231
12	*372	*1400	2140	2070	3530	890	1240	2510	343	127	971	235
13	*340	*966	3550	1390	370	855	1130	2160	320	123	514	01
14	*319	*722	4620	1160	2260	781	1030	1200	302	186	341	252
15	*303	*964	5400	1030	1400	751	973	963	280	318	290	280
16	*296	*869	5580	942	1240	767	978	805	270	329	246	153
17	*289	*1420	4140	905	1570	789	1450	705	263	387	283	158
18	*309	*1100	2260	869	3080	1450	1390	608	256	554	255	315
19	*851	*900	2040	827	4690	1920	1150	551	269	237	239	82
20	*2690	*780	1941	819	5100	1940	1020	447	248	373	316	289
21	*2930	*670	2770	1281	3990	1350	892	444	197	305	307	96
22	*1940	*900	1600	1620	2800	1050	822	586	256	238	252	31
23	*1170	*1200	1100	1720	1940	911	829	846	308	190	375	49
24	*783	*1600	923	1420	2140	828	840	1000	323	83	2620	77
25	*608	*2100	870	1140	2280	789	792	861	315	109	4440	88
26	*515	*2900	797	1260	1800	754	717	683	286	93	3590	135
27	*462	*1700	270	1990	1360	719	664	596	244	81	211	28
28	*433	*1050	211	3160	1170	712	608	663	172	76	1640	32
29	*409	*740	221	2820	—	2320	551	1580	206	92	972	46
30	*400	*530	162	1650	—	5680	829	2430	123	78	1290	74
31	*401	—	774	1420	—	6930	—	3250	—	74	1270	—
Mean	1079	1130	1708	1575	2109	1485	2207	1401	513	205	880	217
Max	4300	2900	5580	3440	5100	6930	7160	3250	3140	554	4440	1130
Min	289	388	162	819	865	712	551	444	123	74	59	28
In.	1.35	1.36	2.13	1.96	2.38	1.85	2.66	1075	.62	.26	1.10	.26

* Estimated

Statistics of monthly flow data for period of record, by water year (WY)

Mean	276.4	604.2	846.6	12497	1696	2123	1805	1063	721.5	415.3	420.8	217.8
Max	1079	1905	1720	3230	3280	4301	3447	2725	2238	1316	977.3	805.1
(WY)	1990	1980	1984	1978	1983	1989	1987	1989	1982	1984	1989	1979
Min	70.1	74.5	141.9	254.0	546.3	476.9	359.3	258.2	128.0	5431	79.7	84.3
(WY)	1981	1981	1981	1981	1977	1981	1981	1986	1986	1986	1987	1980

Summary statistics	1990 water year		Period of record	
Average flow	1204		945.2	
Highest annual mean		1500	1981	
Lowest annual man		261.9	1981	
Highest daily mean	7160	Apr 1	12100	May 1, 1978
Lowest daily mean	28	Sep 27	6.6	Oct 3, 1983
Instantaneous peak flow	7390	Apr 1	12300	May 1, 1978

Summary statistics	1990 water year		Period of record	
Instantaneous peak stage	7.74	Apr 1	23.66	May 1, 1978
Instantaneous low flow	8.6	Sep 19	5.7	Sep 23, 1988
Annual runoff (inches)	17.7		13.9	
10 percentile	2670		2350	
50 Percentile	860		437	
95 percentile	86		73	

Example 19–3 Water discharge records for Pamlico River Basin—Continued

Pamlico River Basin—02082585 Tar River at NC 97 at Rocky Mount, NC

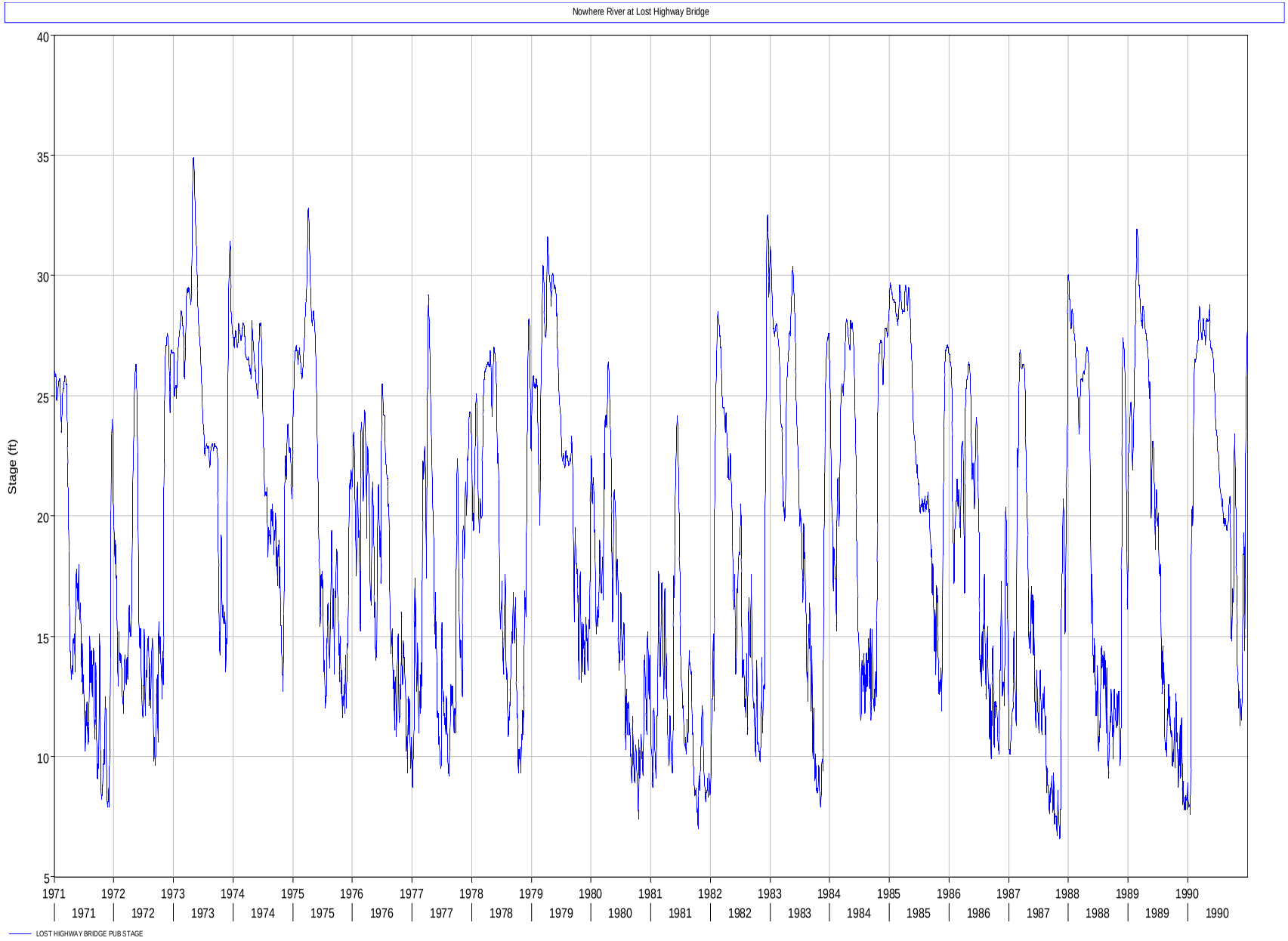
Location—Lat 35°57'15", long 77°47'15", Edgecombe County, Hydrologic Unit 03020101, on left bank 20 feet downstream from bridge on NC 97, 0.5 mile upstream from Cowlick Branch, and 1.0 mile north-northeast of Rocky Mount.
Drainage area—925 square miles. Period of Record—August 1976 to current year. Revised Records—WDR NC-81-1: Drainage area.
Gage—Water-stage recorder. Datum of gage is 53.88 ft above National Geodetic Vertical Datum of 1929.
Remarks—No estimated daily discharges. Records good. Some regulation at low flow caused by mill above station. The city of Rocky Mount diverted an average of 24.1 ft^3/s for municipal water supply, most of which was returned as treated effluent below station. Minimum discharge for period of record and current water year, result of temporary regulation. Gage-height telemeter at station.

Discharge, cubic feet per second, water year October 1990 to September 1991 (mean daily values)

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	79	222	843	823	821	1990	4371	915	267	87	419	192
2	102	201	700	1410	767	667	4810	1290	175	94	413	128
3	58	191	526	1290	686	359	3838	877	212	133	226	98
4	64	177	449	4111	634	1470	1310	612	168	109	205	98
5	68	168	392	924	688	2791	957	468	301	123	175	98
6	192	161	512	805	58	3358	847	463	247	118	103	119
7	139	148	616	960	898	1930	813	342	282	113	118	210
8	119	147	632	1870	669	1200	744	369	185	105	93	164
9	117	141	601	3230	801	992	674	347	142	90	105	133
10	118	345	581	4000	762	858	670	323	128	85	162	102
11	136	308	558	3180	681	749	576	3873	105	131	165	101
12	93	338	509	2850	613	679	550	291	96	89	137	89
13	108	446	437	4200	582	679	495	286	96	101	341	106
14	107	381	375	5200	573	836	584	257	91	107	259	119
15	96	297	224	5471	496	1091	544	288	141	115	889	117
16	123	249	329	4391	585	1380	308	362	137	104	847	118
17	131	228	384	1690	472	1050	745	134	93	109	672	117
18	146	211	366	1610	477	1060	727	156	102	103	429	105
19	144	200	370	1520	489	1440	565	330	96	84	240	97
20	133	183	370	1630	527	2310	889	599	155	92	196	118
21	124	215	532	1930	612	1790	775	805	149	71	154	116
22	121	156	879	2780	654	1180	744	860	141	77	132	82
23	231	194	1220	2120	684	961	754	715	107	82	130	67
24	344	190	1140	1340	563	952	793	509	95	80	109	102
25	1510	197	842	1120	526	897	653	406	89	75	89	107
26	1490	198	652	969	515	796	511	327	99	69	8	117
27	822	198	521	886	517	129	471	274	108	77	141	111
28	610	209	601	824	562	662	477	272	101	100	135	105
29	454	416	637	784	—	689	453	340	89	305	132	104
30	313	895	687	779	—	1390	625	314	90	545	156	102
31	258	—	723	833	—	3150	—	287	—	423	184	—
Total	8550	7500	18200	32577	16983	39115	31474	14141	4209	4004	7633	3442
Mean	276	253	587	2019	607	1262	1049	456	140	129	246	115
Max	1510	865	1220	5470	521	3358	4810	1290	301	545	889	210
Min	58	141	224	779	472	359	453	134	89	69	87	67
CFSM	.30	.27	.63	2.18	.66	1.36	1.13	.49	.15	.14	.27	.12
In.	.34	.30	.73	2.52	.68	1.57	1.27	.57	.17	.16	.31	.14
Mean	276	501	829	1531	1623	2065	1476	1022	683	396	409	211
Max	1079	1905	1720	3230	3260	4301	3447	2725	2238	1316	977	805
(WY)	1990	1980	1984	1978	1983	1989	1987	1989	1982	1984	1989	1979
Min	70.4	74.5	142	254	546	477	359	258	128	54.1	79.7	84.3
(WY)	1981	1981	1981	1981	1977	1981	1981	1986	1986	1986	1987	1980

Summary statistics	1990 calendar year		1991 water year		1977-1991 water years	
Annual total	353444		217908			
Annual mean	9678		597		922	
Highest annual mean				1500	1984	
Lowest annual mean				262	1981	
Highest daily mean	7160	Apr 1	5470	Jan 15	12100	May 1, 1978
Lowest daily mean	28	Sep 27	58	Oct 3	6.6	Oct 3, 1983
Annual 7-day minimum	60	Sep 27	76	Jul 21	40	Jul 3, 1986
Instantaneous peak flow			5480	Jan 15	12300	May 1, 1978
Instantaneous peak stage			14.43	Jan 15	23.66	May 1, 1978
Instantaneous low flow			7.2	Nov 1	5.7	Sep 23, 1988
Annual runoff (CFSM)	1.05		.68		1.00	
Annual runoff (inches)	14.21		8.76		13.54	
10 percentile	2290		1250		2280	
50 Percentile	601		344		430	
95 percentile	118		98		99	

APPENDIX - B
EXAMPLE PROBLEM
PLOT OF STAGES
1971 - 1990


Nowhere River at Lost Highway Bridge
Stage (ft)
40
35
30
25
20
15
10
5
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
LOST HIGHWAY BRIDGE PUB STAGE

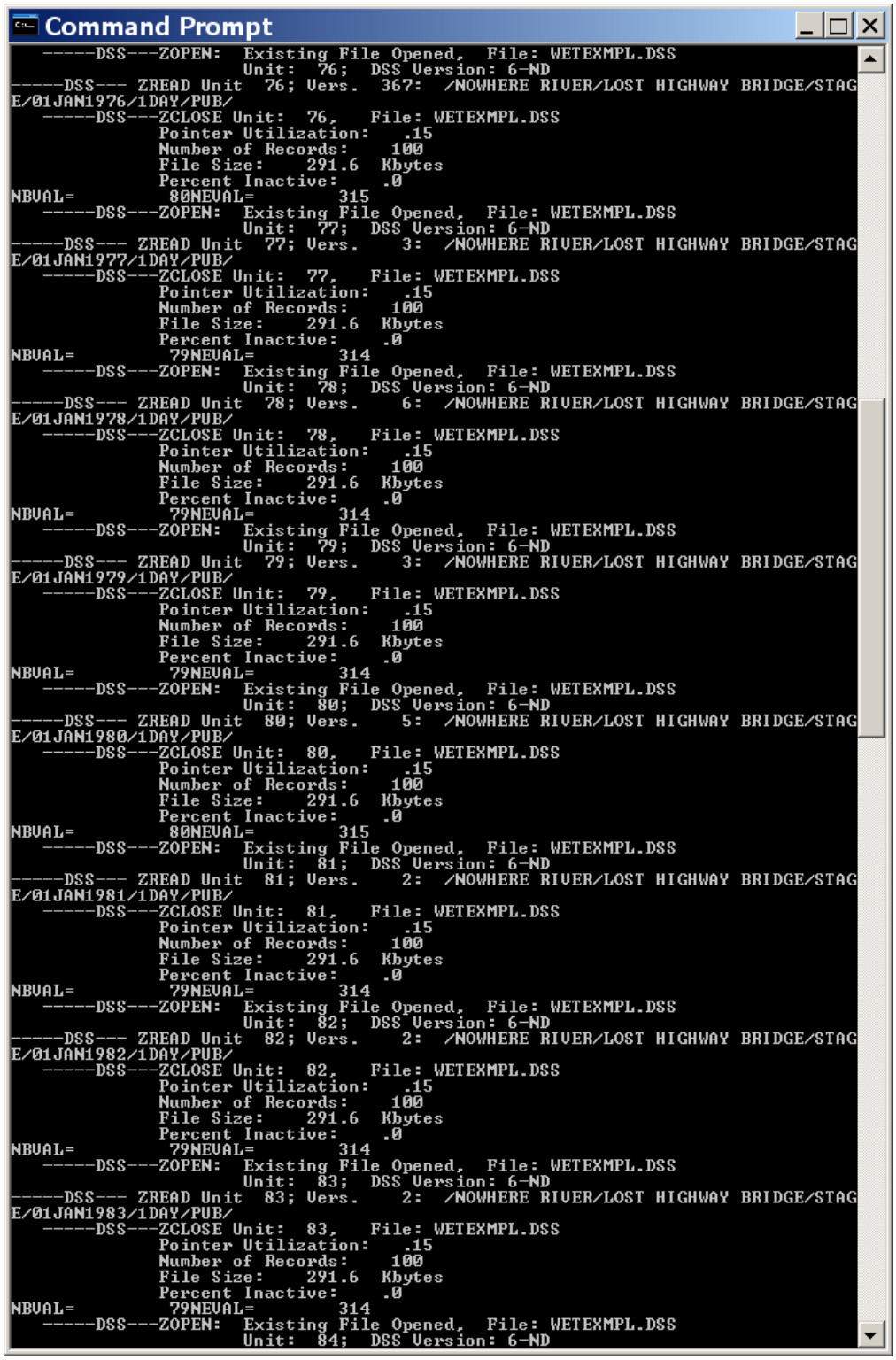
APPENDIX - C
EXAMPLE PROBLEM
WETSORT DOS WINDOW
SCREEN SHOTS

Screen Shot of DOS Window During WETSORT Execution

Command Prompt

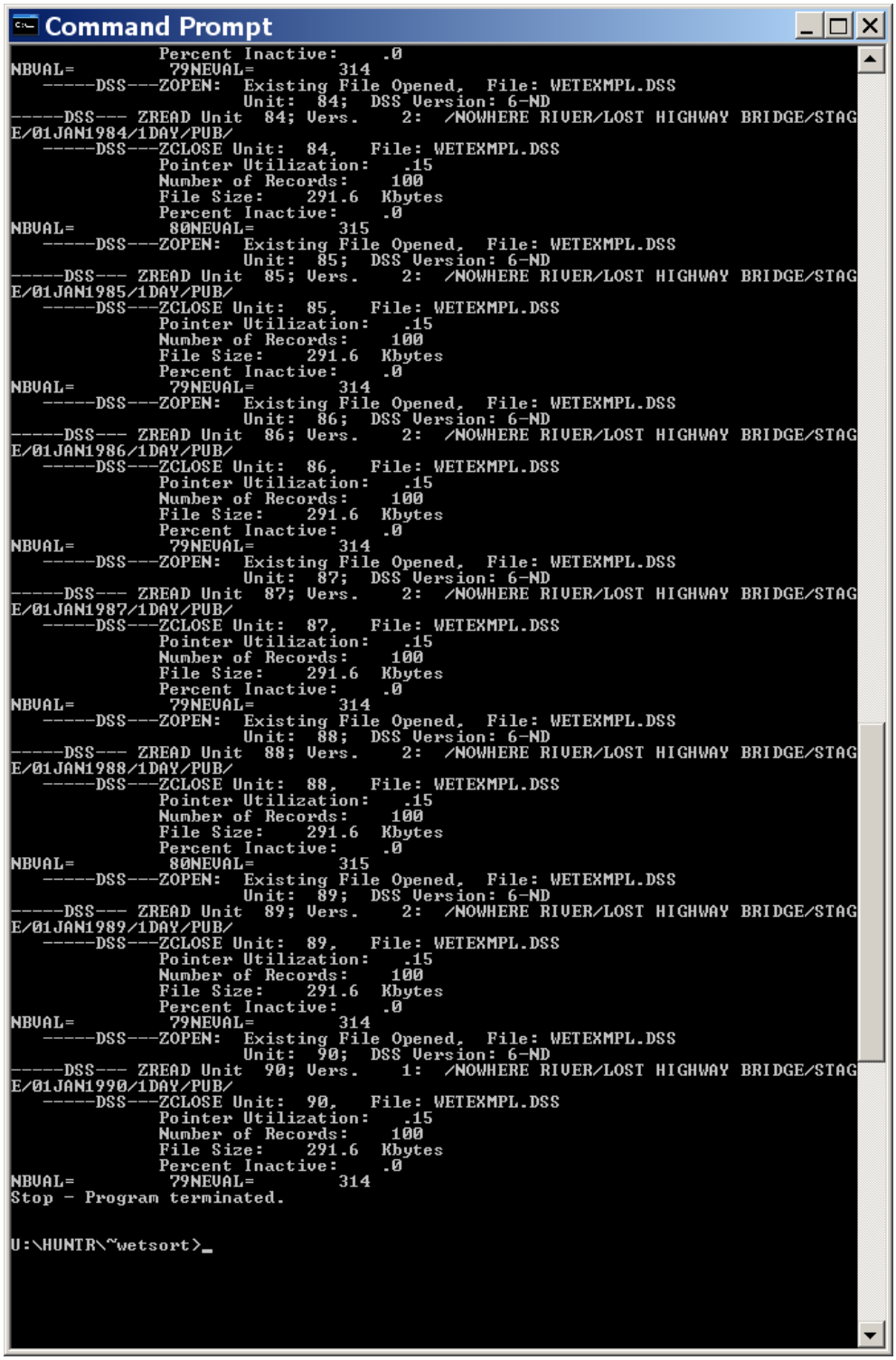
```
U:\HUNTR\~wetsort>WETSORT
ENTER YOUR OUTPUT FILENAME :
WETEXMPL.OUT
ENTER STREAM NAME :
NOWHERE RIVER
ENTER LOCATION OF GAGE :
LOST HIGHWAY BRIDGE
ENTER STARTING YEAR :
1971
ENTER ENDING YEAR :
1990
ENTER STARTING MONTH OF GROWING SEASON :
3
ENTER STARTING DAY OF GROWING SEASON :
20
ENTER ENDING MONTH OF GROWING SEASON :
11
ENTER ENDING DAY OF GROWING SEASON :
10
ENTER NUMBER OF DAYS OF FIVE PERCENT DURATION :
15
ENTER GAGE ZERO :
0.00
ENTER YOUR DSS FILENAME :
WETEXMPL.DSS
ENTER PATHNAME (no D part) :
/NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAGE//1DAY/PUB/
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  71;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  71; Vers.    3:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1971/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  71,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:    .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  72;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  72; Vers.    3:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1972/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  72,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:    .0
NBVAL=         80NEVAL=        315
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  73;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  73; Vers.    3:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1973/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  73,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:    .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  74;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  74; Vers.    3:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1974/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  74,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:    .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  75;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  75; Vers.    3:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1975/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  75,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:    .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  76;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  76; Vers.  367:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1976/1DAY/PUB/
```

Screen Shot of DOS Window During WETSORT Execution



```
Command Prompt
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  76;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  76; Vers.  367:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1976/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  76,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:     .0
NBVAL=         80NEVAL=        315
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  77;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  77; Vers.    3:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1977/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  77,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:     .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  78;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  78; Vers.    6:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1978/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  78,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:     .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  79;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  79; Vers.    3:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1979/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  79,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:     .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  80;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  80; Vers.    5:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1980/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  80,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:     .0
NBVAL=         80NEVAL=        315
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  81;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  81; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1981/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  81,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:     .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  82;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  82; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1982/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  82,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:     .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  83;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  83; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1983/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  83,   File: WETEXMPL.DSS
              Pointer Utilization:   .15
              Number of Records:    100
              File Size:    291.6  Kbytes
              Percent Inactive:     .0
NBVAL=         79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  84;  DSS Version: 6-ND
```

Screen Shot of DOS Window During WETSORT Execution



```
Command Prompt
                Percent Inactive:     .0
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                      Unit:  84;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  84; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1984/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  84,   File: WETEXMPL.DSS
                Pointer Utilization:    .15
                Number of Records:    100
                File Size:    291.6  Kbytes
                Percent Inactive:     .0
NBVAL=           80NEVAL=        315
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  85;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  85; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1985/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  85,   File: WETEXMPL.DSS
                Pointer Utilization:    .15
                Number of Records:    100
                File Size:    291.6  Kbytes
                Percent Inactive:     .0
NBVAL=           79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  86;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  86; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1986/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  86,   File: WETEXMPL.DSS
                Pointer Utilization:    .15
                Number of Records:    100
                File Size:    291.6  Kbytes
                Percent Inactive:     .0
NBVAL=           79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  87;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  87; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1987/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  87,   File: WETEXMPL.DSS
                Pointer Utilization:    .15
                Number of Records:    100
                File Size:    291.6  Kbytes
                Percent Inactive:     .0
NBVAL=           79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  88;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  88; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1988/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  88,   File: WETEXMPL.DSS
                Pointer Utilization:    .15
                Number of Records:    100
                File Size:    291.6  Kbytes
                Percent Inactive:     .0
NBVAL=           80NEVAL=        315
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  89;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  89; Vers.    2:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1989/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  89,   File: WETEXMPL.DSS
                Pointer Utilization:    .15
                Number of Records:    100
                File Size:    291.6  Kbytes
                Percent Inactive:     .0
NBVAL=           79NEVAL=        314
   -----DSS---ZOPEN:  Existing File Opened,  File: WETEXMPL.DSS
                      Unit:  90;  DSS Version: 6-ND
-----DSS--- ZREAD Unit  90; Vers.    1:  /NOWHERE RIVER/LOST HIGHWAY BRIDGE/STAG
E/01JAN1990/1DAY/PUB/
   -----DSS---ZCLOSE Unit:  90,   File: WETEXMPL.DSS
                Pointer Utilization:    .15
                Number of Records:    100
                File Size:    291.6  Kbytes
                Percent Inactive:     .0
NBVAL=           79NEVAL=        314
Stop - Program terminated.

U:\HUNTR\~wetsort>_
```

APPENDIX - D
EXAMPLE PROBLEM
WETSORT ASCII
OUTPUT FILE

WETEXMPL.OUT

NOWHERE RIVER
LOST HIGHWAY BRIDGE

MONTH/DAY GROWING SEASON BEGINS 3/ 20
MONTH/DAY GROWING SEASON ENDS 11/ 10
NUMBER OF DAYS OF FIVE PERCENT DURATION = 15

			----STARTING---			-----ENDING----		
	STAGE	ELEV	MON	DAY	YR	MON	DAY	YR
1	17.70	17.70	3	20	1971	4	3	1971
2	25.30	25.30	5	6	1972	5	20	1972
3	32.90	32.90	4	27	1973	5	11	1973
4	27.00	27.00	6	10	1974	6	24	1974
5	30.80	30.80	4	1	1975	4	15	1975
6	24.20	24.20	6	30	1976	7	14	1976
7	26.60	26.60	4	6	1977	4	20	1977
8	26.20	26.20	3	31	1978	4	14	1978
9	29.90	29.90	4	6	1979	4	20	1979
10	24.40	24.40	4	10	1980	4	24	1980
11	22.00	22.00	6	4	1981	6	18	1981
12	23.50	23.50	3	20	1982	4	3	1982
13	29.00	29.00	5	13	1983	5	27	1983
14	27.60	27.60	5	8	1984	5	22	1984
15	28.70	28.70	4	5	1985	4	19	1985
16	25.70	25.70	4	21	1986	5	5	1986
17	26.10	26.10	3	20	1987	4	3	1987
18	26.50	26.50	4	16	1988	4	30	1988
19	28.00	28.00	3	29	1989	4	12	1989
20	28.10	28.10	4	25	1990	5	9	1990

-----SORTED TABLE-----

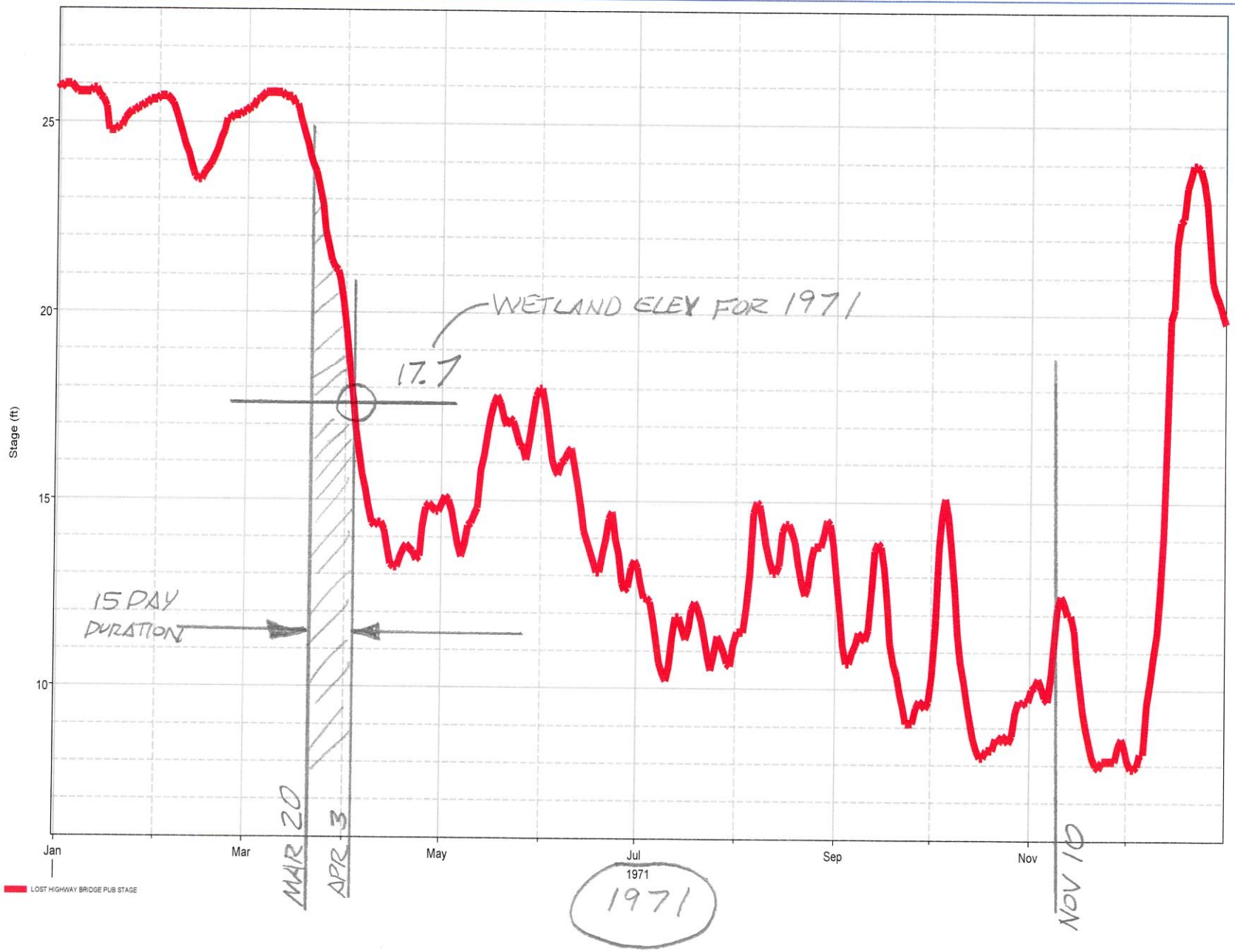
NOWHERE RIVER
LOST HIGHWAY BRIDGE

MONTH/DAY GROWING SEASON BEGINS 3/ 20
MONTH/DAY GROWING SEASON ENDS 11/ 10
NUMBER OF DAYS OF FIVE PERCENT DURATION = 15

			----STARTING---			-----ENDING----		
	STAGE	ELEV	MON	DAY	YR	MON	DAY	YR
1	32.90	32.90	4	27	1973	5	11	1973
2	30.80	30.80	4	1	1975	4	15	1975
3	29.90	29.90	4	6	1979	4	20	1979
4	29.00	29.00	5	13	1983	5	27	1983
5	28.70	28.70	4	5	1985	4	19	1985
6	28.10	28.10	4	25	1990	5	9	1990
7	28.00	28.00	3	29	1989	4	12	1989
8	27.60	27.60	5	8	1984	5	22	1984
9	27.00	27.00	6	10	1974	6	24	1974
10	26.60	26.60	4	6	1977	4	20	1977
11	26.50	26.50	4	16	1988	4	30	1988
12	26.20	26.20	3	31	1978	4	14	1978
13	26.10	26.10	3	20	1987	4	3	1987
14	25.70	25.70	4	21	1986	5	5	1986
15	25.30	25.30	5	6	1972	5	20	1972
16	24.40	24.40	4	10	1980	4	24	1980
17	24.20	24.20	6	30	1976	7	14	1976
18	23.50	23.50	3	20	1982	4	3	1982
19	22.00	22.00	6	4	1981	6	18	1981
20	17.70	17.70	3	20	1971	4	3	1971

APPENDIX - E
EXAMPLE PROBLEM
PLOT OF THE YEAR 1971

Nowhere River, Lost Highway Bridge



APPENDIX - F
WETSORT FORTRAN 77
SOURCE CODE

```
      DIMENSION KYR(55,370),KMON(55,370),KDAY(55,370),YELEV(55,370),
     &SMAX(55),IBEGIN(55),NUMDAYS(55)
      CHARACTER OUTFILE*37
      CHARACTER STREAM*40
      CHARACTER LOC*40
      CHARACTER PAGE*2
  101 FORMAT(A)
      PRINT *,'ENTER YOUR OUTPUT FILENAME : '
      READ(*,101)OUTFILE
      NUM=2
      OPEN(NUM,FILE=OUTFILE)
      PRINT *,'ENTER STREAM NAME : '
      READ(*,101)STREAM
      PRINT *,'ENTER LOCATION OF GAGE : '
      READ(*,101)LOC
      PRINT *,'ENTER STARTING YEAR : '
      READ(*,*)IBYEAR
      PRINT *,'ENTER ENDING YEAR : '
      READ(*,*)IEYEAR
      PRINT *,'ENTER STARTING MONTH OF GROWING SEASON : '
      READ(*,*)IBMONTH
      PRINT *,'ENTER STARTING DAY OF GROWING SEASON : '
      READ(*,*)IBDAY
      PRINT *,'ENTER ENDING MONTH OF GROWING SEASON : '
      READ(*,*)IEMONTH
      PRINT *,'ENTER ENDING DAY OF GROWING SEASON : '
      READ(*,*)IEDAY
      PRINT *,'ENTER NUMBER OF DAYS OF FIVE PERCENT DURATION : '
      READ(*,*)IDUR
      PRINT *,'ENTER GAGE ZERO : '
      READ(*,*)GZ
      CALL GETDSS(IBMONTH,IBDAY,IBYEAR,IEMONTH,IEDAY,IEYEAR,YELEV
     &,KMON,KDAY,KYR,NUMDAYS)
C
C     COMPUTE VALUES
C
       WRITE(2,*)' '
       WRITE(2,*)'                      ',OUTFILE
       WRITE(2,*)' '
       WRITE(2,*)'    ',STREAM
       WRITE(2,*)'    ',LOC
       WRITE(2,*)'                      '
       WRITE(2,104)IBMONTH,IBDAY
       WRITE(2,106)IEMONTH,IEDAY
       WRITE(2,105)IDUR
       WRITE(2,*)' '
       WRITE(2,*)'                        ----STARTING---   -----ENDING-
     &---'
       WRITE(2,*)'        STAGE    ELEV   MON   DAY    YR   MON   DAY
     &YR'
       WRITE(2,*)'       ------  ------   ---   ---   ---   ---   ---
     &---'
      DO 30 K=1,IEYEAR-IBYEAR+1
         SMAX(K) = 0.
         DO 15 II=1,NUMDAYS(K)-(IDUR-1)
            SMIN = 10000.
            DO 20 KK=II,II+(IDUR-1)
               IF(YELEV(K,KK).LT.SMIN) SMIN = YELEV(K,KK)
```

```
   20       CONTINUE
            KK=KK-1
            IF(SMIN.GT.SMAX(K)) THEN
               SMAX(K) = SMIN
               IBEGIN(K) = KK-(IDUR-1)
            ENDIF
   15    CONTINUE
         WRITE(2,102) K,SMAX(K),SMAX(K)+GZ,KMON(K,IBEGIN(K)),
     &              KDAY(K,IBEGIN(K)),
     &              KYR(K,IBEGIN(K)),KMON(K,IBEGIN(K)+(IDUR-1)),
     &              KDAY(K,IBEGIN(K)+(IDUR-1)),KYR(K,IBEGIN(K)+(IDUR-1))
  102 FORMAT(I6,2F8.2,6I6)
   30 CONTINUE
C
C
C
C    SORT TABLE
C
C
      DO 160 M=1,IEYEAR-IBYEAR+1
        N=IEYEAR-IBYEAR+2-M
        DO 150 MM=1,N
        IF (SMAX(MM).GE.SMAX(MM+1)) GO TO 150
        SMAXT=SMAX(MM)
        KMONT=KMON(MM,IBEGIN(MM))
        KDAYT=KDAY(MM,IBEGIN(MM))
        KYRT=KYR(MM,IBEGIN(MM))
        KMONTT=KMON(MM,IBEGIN(MM)+(IDUR-1))
        KDAYTT=KDAY(MM,IBEGIN(MM)+(IDUR-1))
        KYRTT=KYR(MM,IBEGIN(MM)+(IDUR-1))
        SMAX(MM)=SMAX(MM+1)
        KMON(MM,IBEGIN(MM))=KMON(MM+1,IBEGIN(MM+1))
        KDAY(MM,IBEGIN(MM))=KDAY(MM+1,IBEGIN(MM+1))
        KYR(MM,IBEGIN(MM))=KYR(MM+1,IBEGIN(MM+1))
        KMON(MM,IBEGIN(MM)+(IDUR-1))=KMON(MM+1,IBEGIN(MM+1)+(IDUR-1))
        KDAY(MM,IBEGIN(MM)+(IDUR-1))=KDAY(MM+1,IBEGIN(MM+1)+(IDUR-1))
        KYR(MM,IBEGIN(MM)+(IDUR-1))=KYR(MM+1,IBEGIN(MM+1)+(IDUR-1))
        SMAX(MM+1)=SMAXT
        KMON(MM+1,IBEGIN(MM+1))=KMONT
        KDAY(MM+1,IBEGIN(MM+1))=KDAYT
        KYR(MM+1,IBEGIN(MM+1))=KYRT
        KMON(MM+1,IBEGIN(MM+1)+(IDUR-1))=KMONTT
        KDAY(MM+1,IBEGIN(MM+1)+(IDUR-1))=KDAYTT
        KYR(MM+1,IBEGIN(MM+1)+(IDUR-1))=KYRTT
  150 CONTINUE
  160 CONTINUE
C
C
C     WRITE OUT SORTED TABLE
C
C
      PAGE='\f'C
      WRITE(2,*)PAGE
      WRITE(2,*)' '
      WRITE(2,*)'                 -----SORTED TABLE-----'
      WRITE(2,*)' '
      WRITE(2,*)'    ',STREAM
      WRITE(2,*)'    ',LOC
```

```
      WRITE(2,*)'                                '
      WRITE(2,104)IBMONTH,IBDAY
      WRITE(2,106)IEMONTH,IEDAY
      WRITE(2,105)IDUR
  104 FORMAT('     MONTH/DAY GROWING SEASON BEGINS  ',I3,'/',I3)
  105 FORMAT('     NUMBER OF DAYS OF FIVE PERCENT DURATION = ',I3)
  106 FORMAT('     MONTH/DAY GROWING SEASON ENDS  ',I3,'/',I3)
      WRITE(2,*)' '
      WRITE(2,*)' '
      WRITE(2,*)'                        ----STARTING---   -----ENDING-
     &---'
      WRITE(2,*)'        STAGE    ELEV   MON   DAY    YR   MON   DAY
     &YR'
      WRITE(2,*)'       ------  ------   ---   ---   ---   ---   ---
     &---'
C
      DO 170 K=1,IEYEAR-IBYEAR+1
      WRITE (2,102)K,SMAX(K),SMAX(K)+GZ,KMON(K,IBEGIN(K)),
     &             KDAY(K,IBEGIN(K)),
     &      KYR(K,IBEGIN(K)),KMON(K,IBEGIN(K)+(IDUR-1)),
     &      KDAY(K,IBEGIN(K)+(IDUR-1)),KYR(K,IBEGIN(K)+(IDUR-1))
  170 CONTINUE
C
C
C
      STOP
      END
C
      SUBROUTINE GETDSS(IBMONTH,IBDAY,IBYEAR,IEMONTH,IEDAY,IEYEAR,YELEV
     &,IMO,IDA,IYR,NUMDAYS)
      DIMENSION YELEV(55,366),IMO(55,366),IDA(55,366),IYR(55,366),
     &XELEV(366),NUMDAYS(55)
      CHARACTER CNAME*64,CNNAME*64,CTIME*4,CPATH*80
      LOGICAL LEXIST
      INTEGER IDAY(12)
      DATA IDAY / 31,28,31,30,31,30,31,31,30,31,30,31/
      PRINT *,'ENTER YOUR DSS FILENAME : '
  100 format (A)
      READ(*,100)CNAME
      CALL ZFNAME(CNAME,CNNAME,NNAME,LEXIST)
      IF(.NOT.LEXIST)THEN
         WRITE(*,*)'*** The DSS file does not exist. ***'
         STOP
      ENDIF
      PRINT *,'ENTER PATHNAME (no D part) :'
      READ(*,100)CPATH
      CTIME='2400'
      DO 231 NY=IBYEAR,IEYEAR
            CALL GETDSSDATA(CPATH,CTIME,IBMONTH,IBDAY,NY,IEMONTH,
     &                      IEDAY,NY,CNNAME,XELEV)
            NVAL=0
            IDAY(2)=28
            IF(INT(NY/4.0).EQ.(NY/4.0))IDAY(2)=29
            DO 232 NM=IBMONTH,IEMONTH
                  IF(NM.EQ.IBMONTH)THEN
                        BEGDA=IBDAY
                  ELSE
                        BEGDA=1
```

```
                    ENDIF
                    IF(NM.EQ.IEMONTH)THEN
                          ENDDA=IEDAY
                    ELSE
                          ENDDA=IDAY(NM)
                    ENDIF
                    DO 233 ND=BEGDA,ENDDA
                          NVAL=NVAL+1
                          YELEV(NY-IBYEAR+1,NVAL)=XELEV(NVAL)
                          IYR(NY-IBYEAR+1,NVAL)=NY
                          IMO(NY-IBYEAR+1,NVAL)=NM
                          IDA(NY-IBYEAR+1,NVAL)=ND
  233               CONTINUE
                    NUMDAYS(NY-IBYEAR+1)=NVAL
  232       CONTINUE
C
C
C            DO 887 I=1,NUMDAYS(NY-IBYEAR+1)
C                   WRITE(*,*)IMO(NY-IBYEAR+1,I),IDA(NY-IBYEAR+1,I),
C     &IYR(NY-IBYEAR+1,I),YELEV(NY-IBYEAR+1,I)
C  887       CONTINUE
C
C
  231 CONTINUE
      RETURN
      END
C
      SUBROUTINE GETDSSDATA(CPATH,CTIME,IBMONTH,IBDAY,IBYEAR,
     &IEMONTH,IEDAY,IEYEAR,CNNAME,DSSVALUES)
      DIMENSION DSSVALUES(5000)
      INTEGER IFLTAB(1200),NDATE,IDAY(12)
      INTEGER*4 IOFSET
      CHARACTER CNNAME*64,CDATE*20,CTIME*4,CUNITS*8,CTYPE*8,CPATH*80
      REAL VALUES(366)
      DATA IDAY / 31,29,31,30,31,30,31,31,30,31,30,31/
      CALL ZOPEN (IFLTAB,CNNAME,IOSTAT)
      IF(IOSTAT.NE.0)THEN
        WRITE(*,*)'*** Error opening DSS file ***'
        STOP
      ENDIF
      INUM=IEYEAR-IBYEAR
      IYEAR=IBYEAR
      IY=0
      II=0
 5005 IY=IY+1
 5006 CNT=1
      NVALS=365
      IF(INT(IYEAR/4.0).EQ.(IYEAR/4.0))NVALS=366
      JULS=IYMDJL(IYEAR,01,01)
      CALL JULDAT (JULS,104,CDATE,NDATE)
      CALL ZRRTS (IFLTAB,CPATH,CDATE,CTIME,NVALS,VALUES,
     *            CUNITS,CTYPE,IOFSET,ISTAT)
      CALL ZCLOSE(IFLTAB)
      IF(ISTAT.EQ.4.OR.ISTAT.EQ.5)THEN
        IYEAR=IYEAR+1
        IF(IYEAR.GT.IEYEAR)THEN
          IY=IY-1
          GOTO 999
```

```
      ENDIF
      GOTO 5006
    ELSEIF(ISTAT.GT.10)THEN
      WRITE(*,5010)ISTAT
      GOTO 999
    ENDIF
5010 FORMAT(' A "fatal" error occurred in ZRRTS. ISTAT = ',I2)
    IDAY(2)=28
    IF(NVALS.EQ.366)IDAY(2)=29
    DO 800 MV=1,NVALS
      IF (VALUES(MV).EQ.-901.0.OR.VALUES(MV).EQ.-902.0) THEN
        MV2=MV
 801    IF (VALUES(MV2+1).EQ.-901.0.OR.VALUES(MV2+1).EQ.-902.0) THEN
          MV2=MV2+1
          GOTO 801
        ENDIF
        IF (MV.EQ.1.) THEN
          REPVAL=VALUES(MV2+1)
        ELSE
          REPVAL=(VALUES(MV-1)+VALUES(MV2+1))/2
        ENDIF
        DO 802 MV3=MV,MV2
          VALUES(MV3)=REPVAL
 802    CONTINUE
        IF (MV2-MV.GE.4) THEN
          WRITE(*,*)' '
          WRITE(*,*)'*** WARNING!!! - 5 or more consecutive missing va
   *lues! ***'
          WRITE(*,*)' '
        ENDIF
      ENDIF
 800 CONTINUE
 100 format (A)
    NBVAL=1
    NEVAL=NVALS
    IF(IYEAR.EQ.IBYEAR)THEN
       NUMDAYS=0
       DO 220 NM=1,12
          DO 221 ND=1,IDAY(NM)
             NUMDAYS=NUMDAYS+1
             IF((IBMONTH.EQ.NM).AND.(IBDAY.EQ.ND)) THEN
                NBVAL=NUMDAYS
                GOTO 228
             ENDIF
 221      CONTINUE
 220   CONTINUE
    ENDIF
 228 IF(IYEAR.EQ.IEYEAR)THEN
       NUMDAYS=0
       DO 222 NM=1,12
          DO 223 ND=1,IDAY(NM)
             NUMDAYS=NUMDAYS+1
             IF((IEMONTH.EQ.NM).AND.(IEDAY.EQ.ND)) THEN
                NEVAL=NUMDAYS
                GOTO 229
             ENDIF
 223      CONTINUE
 222   CONTINUE
```

```
      ENDIF
 229  WRITE(*,*)'NBVAL=',NBVAL,'NEVAL=',NEVAL
      DO 250 NVAL = NBVAL,NEVAL
           II=II+1
           DSSVALUES(II) = VALUES(NVAL)
  250 CONTINUE
      IYEAR=IYEAR+1
      IF(IYEAR.LE.IEYEAR)GOTO 5005
C 999 CALL ZCLOSE(IFLTAB)
  999 RETURN
      END

      SUBROUTINE EXIST (FNI)
      CHARACTER FNI*37,AL*80
    5 OPEN (4,FILE=FNI)
      READ(4,20,END=48)AL
   20 FORMAT(A)
      CLOSE(4)
      RETURN
   48 WRITE(*,40)
   40 FORMAT(' File does not exist.')
   10 FORMAT (' Enter correct filename using proper specs :')
      WRITE (*,10)
      READ(*,20)FNI
      CLOSE(4,STATUS='DELETE')
      GOTO 5
      END

      SUBROUTINE OVERWRITE (FNO,NUM)
      CHARACTER FNO*37,AL*80,QQ*1
    5 OPEN (NUM,FILE=FNO)
   20 FORMAT (A)
      READ(NUM,20,END=48)AL
   40 FORMAT(' File exists, overwrite it? (Y/N)')
   45 WRITE(*,40)
      READ(*,20)QQ
      IF(QQ.EQ.'Y'.OR.QQ.EQ.'y')GOTO 48
      IF(QQ.EQ.'N'.OR.QQ.EQ.'n') THEN
   30   FORMAT(' Enter new filename :')
        WRITE(*,30)
        READ(*,20)FNO
        GOTO 5
      ENDIF
      GOTO 45
   48 CLOSE(NUM,STATUS='DELETE')
      OPEN(NUM,FILE=FNO)
      RETURN
      END
```