Chapter 6

Computing Water Surface Profiles

After the input data file for HEC-2 has been created, checked with EDIT2 and the errors corrected, the data can be submitted to the HEC-2 program to compute water surface profiles. This section describes the basic operation of the HEC-2 program, the program output files, and program options for output.

6.1 HEC-2 Program Execution

The HEC-2 program can be easily executed from MENU2. Move the cursor to option **<3>**, press the **<SPACE BAR>** until **Run HEC2** is displayed, and then press **<ENTER>**. The files defined at the bottom of the menu display will be used by HEC-2. If the same output filename is used for an EDIT2 run and then with HEC-2, the output file will be written over. This should not be a problem because most people do not save their EDIT2 output once they have eliminated the input data errors.

The HEC-2 program uses the input data file as its input. If the ED record, described in Section 4.2, was used for EDIT2, it can remain in the data file. HEC-2 will ignore the record. If a free-format data file is used (described in Section 4.2), the HEC-2 program will convert the data into fixed-format, the same as EDIT2. The program user should save the fixed-format file for use with HEC-2 because it saves the added time for format conversion every time you execute the program.

To execute HEC-2 as a separate program, at the DOS prompt enter:

HEC2 INPUT= "filename" OUTPUT="filename" TAPE95="filename"

where: "filename" = the input, output, and TAPE95 filenames
(e.g., HEC2 INPUT=HEC205.DAT OUTPUT=HEC205.OUT TAPE95=HEC205.T95)

This assumes that the program and data are in the current default drive. Otherwise, also indicate the proper drive for the program and data. If the input and/or output filenames are not given, the program will request the names for the files. If you respond with the **<ENTER>** key, the default filename will be used.

As HEC-2 computes water surface profiles, it will send messages to the screen. The first is the "Title" from fields two through four on the third title record (T3). Following the "Title," the message:

Starting profile number #
CWSEL for cross section xx is yy

where: # is the sequential number of the profile.
xx is the cross section number.
yy is the computed water surface elevation.

These messages are written to the screen so you will know how far your job has progressed.
When the job is complete, the following message will be displayed:

Normal program termination

If you are operating from MENU2, the following message will also be displayed:

Strike a key when ready . . .

This allows you to see any error messages that may be written to the screen from an abnormal termination. Missing input data or illegal data characters can cause FORTRAN error messages, which are written to the screen.

6.2 Program Output Files

As indicated above, there are several input/output files associated with HEC-2. Besides the standard INPUT and OUTPUT, there are TAPE95 and TAPE10. TAPE95 is an unformatted output file with all the variables, listed in the User's Manual Input Description under the J3 record, written for each section and every profile computed. TAPE10 is the file containing the fixed-format input data, if a free-format data file was read as INPUT.

There are two additional output files you can request. The archive option (see AC input description in the HEC-2 User's Manual) provides a formatted output file, similar to the intermediate output file TAPE95. The archive file is written to TAPE96 and contains the input plus the same output variables as TAPE95, except they are formatted. This means they can be read with LIST or printed like any other standard ASCII file.

An HEC-2 modified input file can be created and saved for subsequent computations. (See the J2 record, Field 8, IBW, input description of the HEC-2 User's Manual.) The intent is for applications using the CHIMP routine, where the user can request the data set, as modified by the channel modification routine. The file contains the input data, as modified by all the HEC-2 options used. The modified input file is written to TAPE16.

To save any HEC-2 generated file, such as TAPE96 or TAPE16, you can specify the filename on the command line, or you can rename the file. Use the DOS COPY or REN (RENAME) commands. For example, from the DOS prompt enter:

REN TAPE96 REDFOX.ARC

This will rename TAPE96 to REDFOX.ARC. The TAPE files are rewritten every time HEC-2 is run, so you must change the name of any file you want to save before running HEC-2 again.

6.2.1 OUTPUT - Formatted Output File

OUTPUT is the "print" file from HEC-2. Generally, this file would go directly to the printer or to a disk file. Because the printer is usually very slow, it is often easier to write the HEC-2 output to a disk file and review it with a program like LIST. There may be several computer runs required before the final results are obtained. By using the disk file approach, only the final results would be sent to the printer.

The OUTPUT file is easy to review from MENU2. Move the cursor to **"4. Display output to console"**, and press **<ENTER>**. This will call LIST with the output filename. To help locate specific areas in the output file, there are labels of ***PROF #** (where # is the number of the profile) at the start of each profile. At the start of the output for each cross section, there is a ***SECNO #** (where # is the cross section number). By using the appropriate find command to locate a character string (e.g., **F** in LIST), the user can find the start of any profile's output and the start of any cross section's output. Portions of the output file can be printed from LIST; **P** turns the printer on or off. Press **<F1>**, while in LIST, to see available LIST commands.

The entire output file can be sent to the printer from MENU2. At **"4. Display output to console"**

press the **<SPACE BAR>** to display **"Display output to printer"**, and press **<ENTER>**. This will send the output file to the printer with the utility program PROUT. PROUT will recognize the carriage control characters in the output file and thus provide spacing and paging as a high-speed printer would. PROUT output can be set to eighty or 132 columns. PROUT does not set the printer width; that must be done external to the program.

The DOS COPY command can be used to send the output file to the printer (e.g., COPY A:TEST5.OUT PRN). However, this will tie up the computer while the file is printing. Alternatively, the DOS PRINT command can be used, (e.g., PRINT A:TEST5.OUT). The system will request the name of the print device; simply press **<ENTER>** to send the output to the printer. This approach does not tie up the computer. However, neither of the above approaches will allow your printer to recognize the print control characters in column one of the output file. Therefore, the printed output will not start a new page or skip lines the way the file would be normally printed if directed to the printer at the time of execution.

To use PROUT as a separate program, at the DOS prompt enter:

PROUT "filename" "column width"

where: "filename" is the output file to print
"column width" is the column width for the printer

(e.g., PROUT A:TEST5.OUT 132)

6.2.2 TAPE95 - Intermediate Profile Results

This file contains the results of the profile calculation written for summary output displays. When HEC-2 is computing the profile, it is also writing the results to TAPE95 after each cross section computation is complete. When the last profile is complete, the program develops requested summary tables by reading the results from TAPE95 and writing the requested data in the summary table format. Refer to the J3 record description in the User's Manual for a description of the summary table capability of HEC-2.

The TAPE95 file is a binary file and cannot be read with a text editor. However, the summary output portion of the HEC-2 program has been converted to a separate program SUMPO, and graphical displays can be developed with program PLOT2. These programs use TAPE95 as the "input" and interactively provide output. Chapter 8 provides a description of the SUMPO program, and Chapter 9 provides a description of PLOT2. Also, utility program READ95 can be used to convert a binary TAPE95 file to an ASCII text file.

The MENU2 default extension option automatically provides for an extension of "**.T95**" for the TAPE95 file. However, if you did not define an alternative file name for TAPE95, you will need to rename TAPE95 to avoid writing over it with a subsequent execution of HEC-2. Every time HEC-2 is run, TAPE95 is written over again. If you are running more than one HEC-2 model, use the DOS command RENAME to save the file under a new file name.

To save TAPE95 under a new name enter:

RENAME TAPE95 "filename" (e.g., RENAME TAPE95 TEST5.T95)

The DOS COPY command can also be used to save TAPE95 under a different name and, if desired, in a different location.

6.3 Output Control

The HEC-2 User's Manual describes program output in Chapter 6. Table 4, in that Chapter, lists various output options and the control records required to activate those options. Standard Test 5 illustrates the use of the options to suppress the printer plot of profiles (J2.3 = -1), to develop summary tables (J3 record) and to control the sequential output (J5 record). You can review the input and output for Test 5 by looking at files HEC205.DAT and HEC205.OUT, respectively. These files are provided on the diskettes with the HEC-2 program package.

The HEC-2 program automatically prints a plot of the computed profile at the end of each profile computation, if there are five or more cross sections. Cross section printer plots must be requested (variable IPLOT on J2.2 or X1.10). Test 1 provides an example of cross section and profile printer plots (see file HEC201.OUT). With the availability of PLOT2 to provide a graphic display of cross sections and profiles, there is little value to the printer profile plot. By setting the PRFVS variable to minus one (J2.3) for each profile, the printer plots will be suppressed.

The J3 record is provided in the input data file to define the desired summary tables. The Input Description in the User's Manual describes the options available. There are predefined tables that are called with a single code number, and there are user-defined tables that are created by listing the code number for the variables desired. Test 5 shows an example of each.

The advantage of using the summary tables is the convenience of seeing the computed results for all the profiles displayed together for each cross section. The summary tables are at the end of the OUTPUT file. By looking at the end of the output first, the user can get an overview of the computed results. Chapter 6 provides some suggestions for reviewing the HEC-2 output. If there are tables that were not requested at the time of execution, they can be developed using the SUMPO program described in Chapter 7.

The J5 record can be used to selectively eliminate or request sequential output for cross sections. The J5 option is sometime used to reduce printed output from HEC-2 to a minimum. A better approach is the use of a disk file for the HEC-2 output. The sequential output contains helpful information for the analysis of the computed profile. If there are inconsistencies in the computed results, the sequential file is usually necessary to analyze the problem.

6.4 Model Calibration

Model calibration is an important phase of the initial model development. The number and accuracy of the cross sections and the loss coefficients are the most important (significant) input items. The calibration process should start with the best estimates for loss coefficients and a reasonable range for their values. By computing profiles for historic floods and checking computed results with observed values, some measure of the model accuracy can be determined.

If loss coefficients are to be adjusted during the calibration process, it is reasonable to assume that the absolute value of the coefficients are not known, but the relative magnitude among the coefficients may be reasonable. The input variable FN (J2.6) is a factor to multiply all the Manning's `n' values in the model. By using the FN factor, the `n' values can be proportionally raised and lowered. This approach is convenient for calibration and sensitivity analysis.

The other major model adjustments are with the cross sections. The spacing of the cross sections is one of the most important factors in the accuracy of the computed profile. Results from the Water Surface Profile Accuracy Study indicate that the spacing between sections is more important than the absolute accuracy of the sections themselves (USACE, 1986). Typically, there is an insufficient number of sections. If more sections cannot be obtained from the field, the repeat section capability and available topographic mapping should be used to add cross sections where needed in the model.

Chapter 7 provides some suggested items to review in the HEC-2 output. Generally, the initial model will require adjustment to the input parameters and additional data. The program user should never assume that the model is adequate just because the program can execute the data set.

6.5 File Archives

The entire HEC-2 INPUT, TAPE95 and OUTPUT files for a project can be maintained on a diskette for future reference or computations. By using the DOS COPY command, the files can be transferred to a diskette, which can be stored with other project documents. Also, the diskette could be a part of the project report. The HEC-2 archive option, described in Section 6.2, can also be used to provide a complete input/output file.

A filename convention, like that used in the MENU2 package, provides a convenient, easily recognized, set of information. Assuming all the information was on a hard-disk (drive C), the following DOS commands can be used to copy the information to a diskette:

COPY C:PROJECT.DAT A:
COPY C:TAPE95 A:PROJECT.T95
COPY C:PROJECT.OUT A:

where: **PROJECT** is the filename used for the study.

With all the project files on a diskette, the information is readily available for review. The original input data could be used to make additional profile computations. Selected portions of the HEC-2 output file can be printed by writing them to a separate file and then copying that file to the printer. Another way possibly, is to use the SUMPO program to extract the desired summary tables from TAPE95 for printing. Also, PLOT2 can be used to plot cross sections with the input file and profiles with TAPE95.