



**US Army Corps
of Engineers**
Hydrologic Engineering Center

Hydrologic Modeling System HEC-HMS

Release Notes

Version 2.1.1
February 2001

Introduction

Version 2.0 of the Hydrologic Modeling System (HEC-HMS) was completed in March 2000 and released for general use shortly thereafter. Interim release Version 2.0.3 was released for use in August 2000. New capabilities have been added to the program since that time. Version 2.1 was completed in December 2000 but was kept as an internal release because several defects were discovered and repaired. The new release is labeled Version 2.1.1 and is available for computers running the Microsoft Windows 2000/NT/98/95 operating systems or the Sun Microsystems Solaris operating system.

The Technical Reference Manual for Version 2.0 continues to accurately describe the mathematical models included in the program. The User's Manual labeled Version 2.1 has been expanded to include instructions on the use and application of the new features.

The installation program and all documentation are available on the HEC website at <http://www.hec.usace.army.mil>.

Installation

If you have not previously installed the program, obtain the installation program and run it. You will be prompted to specify locations for program files, sample projects, and other required information. You should reboot the computer before attempting to use the program. The method for upgrading earlier versions of the program depends on the method used originally to install the software. If you do not know how it was originally installed, you should skip to the instructions for upgrading from any other version.

Use the following steps to upgrade to the new version *if you installed Version 2.0.3 with the automatic installation program*:

1. Download the installation program from the HEC website to a temporary folder on the computer. Alternately, insert the provided CD-ROM or other media in the drive.
2. Run the installation program. In Windows Explorer, double-click the icon for the installation program.
3. Follow the on-screen prompts to upgrade the installed software. The program executable and related files will automatically be replaced with updated versions. The installation itself is not modified and project data are not affected.

Use the following steps to *upgrade to the new version from any other version* of the program:

1. Uninstall the version of HEC-HMS present on the computer; project data are not affected. Use the add/remove programs applet in the control panel to uninstall the program. Future upgrades are not expected to require uninstallation.
2. Download the installation program from the HEC website to a temporary folder on the computer. Alternately, insert the provided CD-ROM or other media in the drive.

3. Run the installation program. In Windows Explorer, double-click the icon for the installation program.
4. Follow the on-screen prompts to begin the installation process, specifying locations for program files, sample projects, and other required information.
5. Reboot the computer when the installation program finishes or before attempting to use the program.

New Users

The program has been designed to be easy to use. However, an understanding of how the program works is critical to producing accurate results. It is suggested that a new user read Chapter 3 of the User's Manual before attempting to start and use the program. Subsequently, start the program and construct the example application contained in Chapter 10. These two chapters provide the fundamental instruction necessary to effectively use the program.

Experienced Users

The User's Manual has been expanded to include information on new features added to the program. It has also been revised, where necessary, to describe features that have been changed for Version 2.1.1. A Technical Reference Manual is also available. It is recommended that experienced users read the topics, both in the User's Manual and Technical Reference Manual, for computational methods used frequently.

New Features

A user-specified s-graph transform method has been added to the subbasin element. The s-graph is entered in dimensionless form as the percentage of runoff from a unit of excess precipitation versus the percentage of subbasin lag. This allows a s-graph characteristic of a region to be used at any subbasin where a specific lag value can be specified. Individual s-graphs are entered in a *s-graph manager* that looks very much like the existing precipitation and discharge gage managers. The user can manually enter an s-graph, or retrieve one from a DSS file which enhances reusability. Each subbasin set to use the user-specified s-graph method has a selection list of available s-graphs specified in the manager.

A new precipitation method has been added to the meteorologic model called the SCS hypothetical storm. It implements the 24-hr design storms specified by the Natural Resources Conservation Service (NRCS) for the continental United States. The user can select a type I, Ia, II, or III storm depending on geographic location. A single precipitation depth is entered and used for all subbasins.

A storm centering parameter has been added to the frequency storm precipitation method. The new centering parameter controls the percentage of the storm duration that occurs before the duration of maximum intensity. For example, a 24-hour storm with a 25% storm centering would have the peak precipitation intensity at 6 hours. Previous versions of the program only implemented a 50% storm centering where half of the precipitation occurred before the duration of maximum intensity and half occurred after the maximum.

The enhanced frequency storm is still a balanced storm in that the peak 6 hours contains the peak 3 hours, etc.

Changed Features

The User-specified unit hydrograph transform method has been revised to store and retrieve data using a *unit hydrograph manager* which is similar to the s-graph manager already described. Individual unit hydrographs are entered in the manager. The user can manually enter a unit hydrograph, or retrieve one from a DSS file. Each subbasin set to use the user-specified unit hydrograph method has a selection list of available unit hydrographs specified in the manager. A unit hydrograph continues to be defined as the volume of unit excess precipitation versus time. Consequently, it continues to represent a specific watershed response and can only be reused for multiple models of the same watershed. Existing projects are automatically updated the first time they are opened in the new version of the program.

Closed Defects

A total of 122 defects have been repaired since the release of Version 2.0.3. A brief description of the most significant defects follows:

1. The program would crash during a compute when the kinematic wave transform method was used with zero diameter specified for a circular cross-section.
2. The program would crash during a compute when the kinematic wave transform method was used with a deep cross-section and no specified side slope.
3. Basin model paired data could be deleted when deleting a run if the basin model and run had exactly the same name.
4. The program could crash when trying to compute a run immediately after computing an optimization trial if they both used the same basin model but different control specifications with non-overlapping time windows.
5. Precipitation data for the first time step could be inaccurate if the control specifications time step was greater than the gage time interval.
6. The program would crash while trying to open a project if the run manager screen was also open.
7. The program could crash while canceling the close operation if the basin model had changed.
8. The linear reservoir baseflow method would crash if metric units were used in the basin model.
9. The program could crash while selecting a control specifications on the time parameters screen used when creating or editing a manual entry gage.
10. The program could crash under some circumstances when changing the latitude or longitude of a gage in the gage manager if a meteorologic model using the inverse distance precipitation method and that gage were also open at the same time.

11. The program would crash while closing the a meteorologic model using the inverse distance precipitation method if a gage had been changed from recording to non-recording.
12. The program would crash while attempting to add recording gages to a meteorologic model using the user-specified gage weights precipitation method if the project contained no precipitation gages.
13. The could crash under some extreme conditions while computing a run that used a meteorologic model with a user-specified gage weights precipitation method.
14. Optimization data and results would be lost if the basin model, meteorologic model, or control specifications used in an optimization run were renamed.
15. The program could crash in some extreme conditions when closing a project from the title bar after creating new hydrologic elements in a basin model.
16. The program would crash while computing a run if the basin model contained gridded subbasins and the meteorologic model was not set to use the gridded precipitation method.
17. Computed results were inaccurate for a subbasin using the kinematic wave transform with Muskingum-Cunge channel routing and circle or deep cross-section.
18. The program would crash while selecting a gage after copying a project.
19. Precipitation values in the summary table for a subbasin using the kinematic wave transform represented only plane 1. They now represent the area-weighted average of plane 1 and plane 2.
20. The computed outflow from a subbasin using the kinematic wave transform and Muskingum-Cunge channel routing could be zero under some conditions, even though excess precipitation was available to route.
21. The program would crash while attempting to open an unlisted project from a removable media drive if there was no media in the drive.
22. The program would crash after changing the loss rate in a subbasin to be soil moisture accounting and changing the transform to be kinematic wave.
23. The program would crash if the project were renamed after computing a run with at least one element with observed flow.
24. There was no validation checking during a HEC-1 import of time intervals specified on IT or IN cards.
25. The lag routing method could produce -0.0 flow under some conditions when the flow should be 0.0 .
26. While changing the loss rate method in a subbasin using the kinematic wave transform, the method was not correctly changed for the second plane.

27. Some files used for storing saved states, soil moisture accounting units, and optimization trials were not copied when a project was copied.
28. Run results computed after saving states part way through a run were inaccurate.
29. The program will stop responding if a project is opened that contains files set to read-only.
30. The program will crash while importing a HEC-1 file if only the first field on a BF record is used.
31. The program will crash after deleting a gage from a meteorologic model using the inverse distance precipitation method.
32. The soil moisture accounting model incorrectly computed evapotranspiration from the tension zone.

Open Defects

A total of 3 major defects are currently open and undergoing investigation and repair. Additional minor defects are currently open and will be repaired after completion of priority items. The following major defects are open:

1. The program may crash under some conditions when attempting to graph element results. The crash may occur before the graph has finished drawing, while moving or resizing the graph, or when closing a graph. The crashes occur whenever diversion flow from a diversion element is connected downstream to another element in the basin model. The crashes do not occur if the diversion flow *is not* connected downstream. The exact cause of the problem is unknown.
2. The non-recording gage option in the inverse distance precipitation method does not function correctly. The subbasin hyetograph is computed without using any of the data contained in the non-recording gage. It does work correctly for recording gages.
3. Optimization results will be lost if any of the hydrologic elements used in an optimization trial are renamed in the supporting basin model. Affected are the optimization location and any elements with parameters selected for optimization. The supporting basin model and other components can be renamed without affecting the optimization results; it is only the elements within the components that should not be renamed.

HEC-1 Differences

The recession baseflow method includes a recession constant for specifying the rate at which recession flow decreases with time. In HEC-HMS the parameter is defined as the ratio of the current recession flow to the recession flow one day earlier. In HEC-1 the parameter, called RTIOR, is defined as the ratio of the current recession flow to the flow one hour later. The following equation can be used to convert an HEC-1 recession constant for use in HEC-HMS:

$$\text{Recession Constant} = \frac{1}{(\text{RTIOR})^{24}}$$

The Clark method produces a unit hydrograph that theoretically has an infinite number of ordinates, because each ordinate on the tail of the unit hydrograph is computed by multiplying the preceding ordinate by a constant fraction. In both HEC-HMS and HEC-1, the tail of the unit hydrograph is truncated when the volume represented by the unit hydrograph exceeds 0.995. In HEC-HMS the ordinates are then adjusted to produce a volume of 1.000. No adjustment is made in HEC-1.

Hydraulic properties of channels with prismatic cross sections are computed differently in HEC-HMS and HEC-1. In HEC-HMS properties are computed from the physical properties of the channel, whereas in HEC-1 the properties are computed with formulas based on the kinematic wave assumption. In HEC-HMS the cross-sectional flow area is computed as:

$$A = y(w + zy)$$

and the ratio of wave speed, c , to flow velocity, v , is:

$$\frac{c}{v} = \frac{(10wzy) + (16zy^2\sqrt{z^2 + 1}) + (5w^2) + (6wy\sqrt{z^2 + 1})}{2(w + 2zy)(w + 2y\sqrt{z^2 + 1})}$$

where w is the bottom width, z is the side slope, and y is the flow depth. Velocity is computed using Manning's formula. In HEC-1 the cross-sectional flow area is computed as:

$$A = \left(\frac{Q}{\alpha}\right)^{\frac{1}{m}}$$

and the wave speed, c , is computed as:

$$c = \alpha m A^{m-1}$$

where α and m are kinematic parameters based on the channel shape.

Hydraulic properties of channels with 8-point cross sections are computed differently in HEC-HMS and HEC-1. In HEC-HMS the flow depth for a given discharge is determined from the cross-sectional characteristics and then area, top width, and wave speed are computed for that depth using the cross-sectional data. In HEC-1 the discharge, area, top width, and wave speed are computed for 20 depths and stored in a table. During the routing process, area, top width, and wave speed are interpolated from the table for each discharge value.

Future Plans

Planning is under way for two versions beyond the current release. Planning and design of future versions is a dynamic process and features for each version do change over time in response to funding and field requests. The following descriptions should be used as a general outline when anticipating new features.

Improved reservoir modeling will be the focus of the first version. Specification of pressure flow through an outlet structure will be included in the element definition. Spillway structures such as broad-crested and ogee weirs will also be included. Additionally, dam break capabilities similar to HEC-1 will be added. Additional reservoir features including a wider variety of outlet structures will be included in later versions.

Efficiency tools for planning studies, where the product is a frequency curve, will be the focus of the second version. Additional visualization capabilities will create graphs and tables of results from several elements or simulation runs. Report tools will be added to create appendix-quality records of basin or meteorologic model data.

A comprehensive program validation guide is currently under development and will be published when complete. The guide gives detailed information about the tests used to determine the accuracy of the mathematical models included in the program, for example, the SCS curve number loss method. The section for precipitation methods is currently complete in draft form. It was found that HEC-HMS accurately implements all features in all precipitation methods except for non-recording gages in the inverse distance method, as noted in the *Open Defects* section.

Documentation

The *Hydrologic Modeling System HEC-HMS: User's Manual* contains extensive information on installing and using the program. An example application is included to illustrate the steps necessary to produce results.

The *Hydrologic Modeling System HEC-HMS: Technical Reference Manual* contains information on how to use the various methods included in the program. The scientific origin and equation derivations are presented for each method. Specific solution algorithms for a method are discussed when necessary for a complete understanding. Application and parameter estimation for each method is also included.

The online help system within the program contains topics describing each screen of the graphical user interface.

Support Policy

Technical support for program users within the Corps of Engineers is provided through an annual subscription service. Subscribing offices can expect full support from HEC staff in the routine application of the program. Users are strongly urged to consult with HEC staff on the technical feasibility of using the program before beginning a project with unique requirements such as grid-cell hydrology, snow melt, or continuous simulation. Extended support for large or complex projects can be arranged with a contract agreement.

Support can not be provided to users outside the Corps of Engineers. Domestic and foreign vendors are available that provide fee-for-service support similar to the support provided to subscribing Corps offices. Such service agreements are between the user and the vendor and do not include HEC staff. Vendors do contact HEC on behalf of their users when unusual problems or errors are encountered.

Reporting of suspected program errors is unrestricted. We are continuously working to improve the program and possible bugs should always be reported. Reports should include a written description of the steps that lead to the problem and the effects that result from it. We will reply to all correspondence concerning program errors.

Request support or report program errors through the following channels:

- Call (530) 756-1104, 7:30 am to 4:30 pm PT Monday through Friday.
- Fax (530) 756-8250 any time.
- Write to U.S. Army Corps of Engineers, Hydrologic Engineering Center, 609 Second Street, Davis, CA 95616-4687 USA.
- Send email to *hms@usace.army.mil* on the internet.
- Visit our web site at <http://www.hec.usace.army.mil>.