Hydrologic Engineering Center

River Analysis System
HEC-RAS

Release Notes

Version 4.0.0 Beta

November 2006

Approved for Public Release – Distribution Unlimited

Introduction

Version 4.0 of the River Analysis System (HEC-RAS) is now available. This version supersedes version 3.1.3, which was released in May of 2005 to the general public. Several new simulation features have been added to the program since that time. Version 4.0 of HEC-RAS includes the following new features:

1. Sediment Transport/Movable Bed Modeling
2. Sediment Impact Analysis Methods (SIAM)
3. Water Quality Capabilities (Temperature Modeling)
4. User Defined Rules for Controlling Gate Operations
5. Modeling Pressurized Pipe Flow
6. Pump Station Override Rules
7. New Channel Design/Modification Tools
8. Geo-Referencing Tools
9. New Gate Types
10. New Functionality for Lateral Weirs
11. Additional Graphical Outputs
12. Shortcut Keys for Graphics
13. User's Manual and Help System

Other minor enhancements were also added. The development team has also continued careful and systematic testing of the program since the last release. The results of that testing in combination with reports from users has allowed the identification and repair of various problems. Some problems that did not affect results but caused problems in the program interface have been repaired without being specifically documented.

The *Hydraulic Reference Manual* for Version 3.1 continues to accurately describe the data requirements and mathematical models included in the program. New simulation capabilities have been added to the program and are not included in the manual. The manual is currently undergoing a major revision to expand documentation of existing mathematical models and fully describe the newly added models.

The *Applications Guide* also continues to accurately describe how to apply the program to various engineering problems. However, the guide is undergoing revision to add guidance on how to use new features of the program to more efficiently solve problems.

Installation

The installation program and all documentation are available on the HEC website at http://www.hec.usace.army.mil . This new release is installed independently of any previous versions of the program. Users may have the new version and previous versions of HEC-RAS software installed simultaneously for parallel use or testing. This new version is fully compatible with projects developed in any previous version of the program. However, once a project has been opened in Version 4.0 and saved, it may not be possible to open it with an older version of the software and reproduce the old results (i.e. the software is not fully forward compatible).

The new installation package is designed to be easy to use. It will take you through the steps of selecting a directory for the program files and making other settings. Use the following steps to install the program on the Microsoft Windows® operating system:

1. Download the installation package from the HEC website to a temporary folder on the computer. If the software was provided to you on a CD-ROM or other media, insert it in the appropriate drive.

2. Run the installation program. In Windows Explorer, double-click the icon for the installation program. You must have administrator privileges to run the installer.

3. Follow the on-screen prompts to install the program.

New Capabilities

Sediment Transport/Movable Bed Analyses

This component of the modeling system is intended for the simulation of one-dimensional sediment transport/movable boundary calculations resulting from scour and deposition over moderate time periods (typically years, although applications to single flood events are possible).

The sediment transport potential is computed by grain size fraction, thereby allowing the simulation of hydraulic sorting and armoring. The model is designed to simulate long-term trends of scour and deposition in a stream channel that might result from modifying the frequency and duration of the water discharge and stage, or modifying the channel geometry. This system can be used to evaluate deposition in reservoirs, design channel contractions required to maintain navigation depths, predict the influence of dredging on the rate of deposition, estimate maximum possible scour during large flood events, and evaluate sedimentation in fixed channels.

For details on how to use the sediment transport capabilities in HEC-RAS, please review Chapter 17 of the User's Manual.

Sediment Impact Analysis Methods (SIAM)

SIAM is a sediment budget tool that compares annualized sediment reach transport capacities to supplies and indicates reaches of overall sediment surplus or deficit. SIAM is a screening level tool to compute rough, relative responses to a range of alternatives, in order to identify the most promising alternatives (which should then be modeled in more detail). The algorithms in SIAM evaluate sediment impact caused by local changes on the system from a sediment continuity perspective. The results map potential imbalances and instabilities in a channel network and provide the first step in designing or refining remediation.

Users can begin with existing geometry and flow data and develop a set of sediment reaches with unique sediment and hydraulic characteristics. The SIAM program will then perform sediment transport capacity computations to determine potential imbalances and instabilities in a channel network. SIAM does not predict intermediate or final morphological patterns and does not update cross sections, but rather indicates trends of locations in the system for potential sediment surpluses or deficits. The results can be used to design or refine remediation efforts in the system.

For details on how to perform a SIAM analysis in HEC-RAS, please review Chapter 18 of the User's Manual.

Water Quality Analysis

This component of the modeling system is intended to allow the user to perform riverine water quality analyses. An advection-dispersion module is included with this version of HEC–RAS, adding the capability to model water temperature. This new module uses the QUICKEST-ULTIMATE explicit numerical scheme to solve the one-dimensional advection-dispersion equation using a control volume approach with a fully implemented heat energy budget. Future versions of the software will include the ability to perform the transport of several water quality constituents.

For details on how to use the water quality capabilities in HEC-RAS, please review Chapter 19 of the User's Manual.

User Defined Rules for Controlling Gate Operations

The operating procedures for determining and controlling the releases from reservoirs and other types of hydraulic structures can be quite complex. HEC-RAS allows flexibility in modeling and controlling the operations of gates at hydraulic structures through the use of rules. Examples of variables that could be used to control releases from a hydraulic structure are: current flows and water surfaces at the structure, current flows and stages at a downstream or upstream cross section location, time considerations (winter,

morning, etc), and/or previously computed values (accumulated outflows, running averages, etc). Rule operations in HEC-RAS are available for inline hydraulic structures, lateral hydraulic structures, and storage area connections that contain gates.

For details on how to use the User Defined Rules Capabilities for controlling gate operations in HEC-RAS, please review Chapter 16 of the User's Manual.

Modeling Pressurized Pipe Flow

HEC-RAS can be used to model pressurized pipe flow during unsteady flow calculations. This is accomplished by using the Priessmann slot theory applied to the open channel flow equations. To model pressure flow with HEC-RAS, the user must use cross sections with a Lid option. The cross section is entered as the bottom half of the pipe and the Lid is entered as the top half of the pipe. Any shape pipe can be modeled, however, the details of the pipe shape will depend on how many points the user puts in for the bottom (cross section) and the top (Lid).

In general, lids can be added to any cross section in the HEC-RAS model. Several cross sections in succession with lids can be used to represent a pipe. Multiple interconnected pipes can be modeled. Lidded cross sections can be used around stream junctions to represent pressurized junctions. However, HEC-RAS does not compute minor losses at junctions, bends, or where pipes change size. This is currently a limitation in modeling pressurized pipe flow with HEC-RAS. Lateral flows can be modeled by either using lateral structures with culverts, or by directly inputting hydrographs as lateral flow boundary conditions. The lateral structure option can be used to mimic drop inlets connecting the surface flow to the pipe.

For details on how to use the Pressurized Pipes capabilities in HEC-RAS, please review Chapter 16 of the User's Manual.

Pump Station Override Rules

Advanced control rules have been added to the Pump Station capabilities of HEC-RAS in order to override normal pump operations. Override rules make it easy to turn pumps on and off based on time of day, as well as target flows and stages from any location in the model. Rules can also be set to override the total pump station maximum or minimum flow capacity.

For details on how to use the Pump Station Override Rules Capabilities in HEC-RAS, please review the section on Pump Stations in Chapter 6 of the User's Manual.

New Channel Design/Modification Tools

The channel design/modification tools in HEC-RAS allow the user to perform a series of trapezoidal cuts into the existing channel geometry or to create new channel geometry. The current version of HEC-RAS has two tools for performing channel modifications. These tools are available from the Tools menu of the Geometric Data editor and are labeled Channel Design/Modification and Channel Modification (original). The tool labeled Channel Design/Modification is a new tool for HEC-RAS version 4.0. The tool labeled Channel Modification (original) is the original channel modification tool developed for HEC-RAS.

For details on how to use the Channel Design/Modifications Capabilities in HEC-RAS, please review Chapter 13 of the User's Manual.

Geo-Referencing Tools

GIS tools in HEC-RAS are provided on the Geometric Data editor on the GIS Tools menu. The GIS Tools provide capabilities for editing and modifying x and y coordinates associated with the river network, cross sections, bridges/culvert, hydraulic structures, and other features in HEC-RAS. These GIS coordinate data can be edited directly through the different table options or computed based on the data available. The GIS Tools also provide visual displays of the data that can be exported to the GIS for processing.

For details on how to use the Geo-Referencing Tools in HEC-RAS, please review the section on Geo-Referencing an HEC-RAS Model in Chapter 6 of the User's Manual.

New Gate Types

Two new gate types have been added into HEC-RAS for use with Inline Hydraulic Structures, Lateral Structures, and Storage Area Connections. These gate types are: overflow gates with a closed top; overflow gates with an open top. Additionally the ability for the user to enter a set of User defined curves to represent a gate(s), has also been added as an option.

For details on the new gate types and user defined gate curves in HEC-RAS, please review the section on Inline Hydraulic Structures in Chapter 6 of the User's Manual.

New Functionality for Lateral Structures

In previous versions of HEC-RAS a lateral weir could be set up to span several cross sections of the channel it was attached to (head water side). However, for the channel receiving flow (tailwater side), the program was limited to sending the flow to only a single cross section location. The user can now set the tailwater location to a range of cross sections. The program distributes the flow across this range of cross sections, and it also uses the full range for

evaluating tailwater submergence on the lateral weir. We have also added the ability to override/set the spacing between cross sections on the lateral structure. This allows the user to have lateral structure lengths that are longer or shorter than the cross section reach lengths.

For details on the new Lateral Structures features, please review Chapter 6 of the User's manual.

Additional Graphical Outputs

New graphical outputs have been developed for Sediment Transport Computations, SIAM analyses, and Water Quality Computations. Additionally, when performing an unsteady flow analysis the user can optionally turn on the ability to view output at the computation interval level. This is accomplished by checking the box labeled Computation Level Output on the Unsteady Flow Analysis window (In the Computations Settings area on the window).

For details on the new graphical outputs for unsteady flow computations in HEC-RAS, please review the section on Viewing Computational Level Output for Unsteady Flow in Chapter 9 of the User's Manual. For more information on graphical outputs for Sediment Transport Analysis, SIAM, and Water Quality Analysis, please review their perspective chapters in the User's manual.

Shortcut Keys for Graphics

A couple of shortcut key features have been made available for all of the graphic windows. They are:

Shift Key: When the shift key is held down and the mouse pointer is over the graphic window, the mouse pointer will change to a "hand" which puts it in a panning mode.

Control Key: When holding down the control key and the mouse pointer is over the graphic window, the pointer changes to a measuring tool. The user can create a line or polygon by clicking the mouse pointer with as many points as they want. When the Control Key is released, the program will display a dialog containing: the line length, area of a polygon when the first and last point are closed; the x distance traveled; the y distance traveled; the slope of the bounding box containing the data. The X and y coordinates of the data points are also sent to the windows clipboard, which is very handy for getting GIS coordinates for cross sections.

User's Manual and Help System

The HEC-RAS User's Manual has been completely updated for the 4.0 software release. All of the chapters have received updated text and graphics. New information has been added to chapters 13 and 16 of the

manual, and completely new chapters have also been added (Chapters 17, 18, and 19). Additionally, the help system has been completely revamped. The new help system directly uses the user's manual PDF file. The software still has context sensitive help, in that, while on any editor if you select the help menu option or press the F1 key, a help window will appear with the correct section of the manual displayed.

Problems Repaired

The following is a list of bugs that were found in version 3.1.3 and fixed for version 4.0:

1. **Velocity Output at Bridges.** During unsteady flow calculations, if reverse flows occurred through a bridge, the software would report values of zero for velocities at the cross section just upstream of the bridge. This was only an output mistake, and did not effect the computation of the water surface and flow.

2. **Family of Rating Curves for Unsteady Flow.** For bridges, culverts, storage area connections, and lateral structures, in which a family of curves are generated from the Unsteady flow pre-processor, several changes have been made to the code that generates these curves. The previous version of HEC-RAS was on occasion getting some bad points in the curves, which would cause all of the curves in that zone to have a problem. We have fixed several known problems, as well as improved the way we interpolate between the curves.

3. **Submerged Culvert Flow.** When the outlet of a culvert is submerged, the culvert can act as a siphon if the inlet is also submerged. In some cases, RAS was treating the culvert as a siphon even though the water surface at the inlet was slightly below the top of the culvert (that is, the inlet was not fully submerged).

4. **Storage Area Connections.** Having more than 10 storage area connections in the model could, in rare cases, cause a "GUI didn't allocate arrays large enough," error.

5. **Perched Bridges.** A perched bridge (the low chord on the bridge is higher than minimum elevation in the overbanks) that was being modeled as a cross section with a lid, was not always computing flow in the overbanks properly.

6. **Dam Break Piping Failure.** During a dam break, the transition from a piping failure to an open breach was not always being computed correctly.

7. **Bridge Momentum Computations.** For a bridge that was being solved with the momentum method, version 3.1.3 would allow a slight drop in the energy grade line as the calculations proceeded

from the downstream internal bridge section to the upstream internal bridge section. Version 4.0 will disregard the momentum solution if this happens (and usually defaults to the energy solution).

8. **Bridge Pressure and Weir Flow Computations.** For bridges with pressure and weir flow, the reported flow distribution (the amount of flow in the channel versus the left and right overbanks) was not always correct. This was only an output reporting problem, not a problem with the calculations of the water surfaces.

9. **Pump Station Inflow to a Storage Area.** For a storage area that was receiving flow from a pump station, the inflow to the storage area was being incorrectly reported in some cases. This was not a problem with the computations (i.e. the correct flow was being used for the computations), just in reporting the flows in the output file and interface.

10. **GIS Data Import of Levees.** The data importer would not import levees unless the cross section bank stations were also imported.

11. **Importing HEC-HMS Version 3.0 and Greater Flow Data from HEC-DSS.** With the release of HEC-HMS version 3.0, there was a change to they way flow data was sent to HEC-DSS files. Before all data was sent as single precision numbers. Now HEC-HMS sends all its results as double precision numbers. Previous versions of HEC-RAS (Version 3.1.3 and earlier) were only set up to read the data as single precision numbers. So, versions 3.1.3 and earlier of HEC-RAS would not correctly read flow data from HEC-DSS if it was created by HEC-HMS version 3.0 and later.

    If you are still using HEC-RAS 3.1.3 or earlier, users can download HEC-DSSVue and a special plug-in that will allow you to convert a double precision HEC-DSS file to a single precision HEC-DSS file. HEC-DSSVue and the plug-in are available from our web page.

12. **Cross Section Interpolation.** A few data sets were sent to us where the cross section interpolation routines were not correctly interpolating geometry and/or other cross section properties. Many of these data sets had cross sections with “Lids”, while some were problems with interpolating Manning’s n values.

13. **Lateral Structure Stationing.** If a lateral structure did not start at a stationing of zero, it was not always located exactly correct along the cross sections.

14. **Metric Units Output for Hydraulic Radius.** The program was incorrectly reporting the Hydraulic radius to the 2/3 power in the output. This was a conversion from English to metric units error.

15. **Abutment Scour Problem.** On occasion the program would compute a projected abutment/road embankment length that was incorrect. This only came up under rare circumstances, and depended on how the stationing of the cross section just upstream of the bridge, and the approach cross section, were entered.

16. **K2 Factor for Abutment Scour.** This factor was being interpolated from a graph that was presented in an earlier version of the HEC-18 manual. For abutment attack angles that were very mild, the interpolated values were not very good. The latest HEC-18 manual now has an equation. We have changed the code to use this equation.

17. **Pipe Arch Culverts.** For very small pipe arch culverts, the user would enter a Rise and the program was incorrectly calculating the span. This was only for Pipe Arch Culverts with smaller than 18 inch corner radius.

18. **Corrugated Metal Box Culverts.** Many corrugated metal box culverts actually have sloping inward side walls and rounded corners at the top. The slope of these walls and the curvature of the corner radius can vary with manufacturers. HEC-RAS does not account for the sloping wall or the rounded corner radius. User's must come up with an equivalent span and rise in order to match the area correctly. It is suggested to use the correct rise, and adjust the span to get the correct area of the culvert. That way the program will get the transition from low flow to pressure flow at the correct elevation.

19. **Storage Area of a Cross Section for Unsteady Flow.** HEC-RAS was incorrectly calculating the available storage area above a permanent ineffective flow area, when the permanent ineffective area intersects the ground between the first two or last two points of the cross section.

20. **Limit of 500 Hydrograph Output Locations for Unsteady Flow.** The previous version of HEC-RAS had a limit of 500 locations for output hydrographs when performing unsteady flow calculations. The problem was also enhanced by the fact that HEC-RAS automatically computed output hydrographs at specific locations by default. This limit has been done away with. The number of hydrograph locations is now allocatable, and only limited by the memory in your computer.

21. **Restart File for Unsteady Flow Calculations.** There were some problems in reading a Re-Start file for use as initial conditions of an unsteady flow run. These problems have been corrected.

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. Extended

support for large or complex projects can be arranged under a separate reimbursable project 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. A list of vendors can be found at http://www.hec.usace.army.mil .

Reporting of suspected program errors is unrestricted and we will reply to all correspondence concerning such errors. 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. If we cannot reproduce the reported problem, we may ask you to send a copy of your project.

Report program errors through the following channels:

- Go to our web site at www.hec.usace.army.mil then go to the HEC-RAS support page.
- Send email to hec.ras@usace.army.mil on the internet.
- Write to:

  U.S. Army Corps of Engineers

  Hydrologic Engineering Center

  609 Second Street

  Davis, CA 95616 USA.