US Army Corps of Engineers®

Hydrologic Engineering Center

River Analysis System
HEC-RAS

Release Notes

Version 4.0.0

March 2008

Introduction

Version 4.0.0 of the River Analysis System (HEC-RAS) is now available. This version supersedes version 4.0 Beta, which was released in November of 2006 to the general public, and version 3.1.3, which was released in May of 2005. 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
    a. Temperature modeling
    b. Transport and fate of a limited set of constituents
4. User Defined Rules for Controlling Gate Operations
5. Modeling Pressurized Pipe Flow
6. Pump Station Override Rules
7. Hager's Lateral Weir equation
8. New Channel Design/Modification Tools
9. Geo-Referencing Tools
10. New Gate Types
11. New Functionality for Lateral Weirs
12. Additional Graphical Outputs
13. Shortcut Keys for Graphics
14. User's Manuals 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.

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.

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. Transport and Fate of a limited set of water quality constituents is now also available in HEC-RAS. The currently available water quality constituents are: Dissolved Nitrogen (NO_3-N, NO_2-N. NH_4-N, and Org-N); Dissolved Phosphorus (PO_4-P and Org-P); Algae; Dissolved Oxygen (DO); and Carbonaceous Biological Oxygen Demand (CBOD).

This is the first release of the HEC-RAS water quality module. It has been tested by comparing simulation results against other identically configured water quality models including QUAL2Kw and CE-QUAL-W2. Model results are generally in agreement. Although every effort has been put forth to test the reliability of this model, this water quality code is new and has not yet been applied to a large collection of datasets.

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.

Hager's Lateral Weir Equation

HEC-RAS has the option for using Hager's weir equation for lateral weirs. The equation is the same as the standard weir equation, except the weir discharge coefficient is computed automatically based on physical and hydraulic properties. For more information on Hager's equation for the lateral discharge coefficient, see Chapter 8 of the Hydraulic Reference manual, and 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.

HEC-RAS Manuals and Help System

The HEC-RAS Manuals (User's manual, Hydraulic Reference manual, and Applications Guide) have 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 User's manual, and completely new chapters have also been added to the manuals (Chapters 17, 18, and 19 of the User's manual, and Chapter 13 of the Hydraulic Reference manual). 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.

User Interface Improvements.

The following is a list of user interface improvements:

1. An option was added to the breach editor to allow the user to enter a separate weir coefficient for the breach area. Previously the breach area used the same weir coefficient as was entered for the top of dam/levee.

2. A Date chooser was added in places where dates are entered.

3. The computation messages that came out on the Unsteady flow computation window are now written to a text file. This allows for these messages to be viewed when the computational window is closed.

4. From the main RAS window, the File menu option "Debug Report (Compress ..." copies all the files needed for the current plan into a single compressed file. The compression format was "7z", but has been changed to "zip" so that the file will look like a compressed folder to the operating system and users can look inside and add files without additional software (like 7-zip). This will facilitate passing data to other user's or sending data sets to HEC for reporting bugs.

5. Linear routing for storage area connections and over lateral weirs used to not require the users to specify an elevation. It was always a good practice to specify an elevation, but now it is required.

6. A new tool to set the bank stations for selected water surfaces up just out of the water was added to the geometric schematic editor under Tools. This will allow users to run a flow rate that they feel is a bank full rate (i.e. 1.5 or 2 year flow), then set all of the bank stations just above that water surface elevation automatically.

7. Velocity GIS export now informs users in the dialog the number of cross sections with detailed distribution information.

Problems Repaired

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

1. **Pressure Flow at a Bridge.** For pressure flow at a bridge, where the downstream inside cross section iis the most constrictive opening, the program was not checking for supercritical flow at the cross section just downstream of the bridge.

2. **Storage Areas.** There was a limit of 500 storage areas. This is now unlimited, in that it is dynamically dimensioned when you execute the program.

3. **Rules Boundary Conditions Editor.** The application of Rules to a storage area connections did not work. This has now been made functional in version 4.0.

4. **Rules Boundary Conditions Editor.** There was a maximum of 20 rule operations that performed a Get or Set operation. If the rules set used more than 20 of these type of operations, the 21's and subsequent did not function correctly. This was fixed for version 4.0, and there is now no limit on the number of this type of operation.

5. **Rules Boundary Conditions Editor.** Not all of the Rule "Set Variables" operations, for instance the Operation called "Structure.Flow Maximum", were working properly. These were fixed for the final release version.

6. **Permanent Ineffective Flow Areas.** For unsteady flow, permanent ineffective flow areas were not always working properly when the wsel was higher than the ineffective flow elevation. On accession the program computed incorrect hydraulic variables for the area above the permanent ineffective flow area. This was fixed.

7. **Mixed Flow Option for Unsteady Flow.** With the Mixed flow option on, Unsteady flow computations would occasionally "lockup" if there was a bridge or culvert in the model.

8. **Levee Breaches.** For a levee breach, when output was computed in the post processor, the amount of flow going over the levee was being reported incorrectly. The [DSS] hydrograph output flow was correct.

9. **No. of Hydrograph Output Locations.** The number of Hydrograph output locations (for unsteady flow) was still limited to 800 locations maximum. This has been made unlimited, in that it is dynamically allocated. The user is only limited by the amount of RAM on their computer.

10. **Unsteady Flow Start time Problem.** If the user entered starting time (unsteady flow) was not a multiple of the Hydrograph Output interval and the Detailed Output interval, the program would report incorrect results at various time steps. For example, if the Hydrograph Output Interval is every 5 minutes, the time window can start at 0100 or 0105, but not 0101.

11. **Ground Water Flow.** Groundwater flow was being computed incorrectly due to a mistake in the units (i.e. the Darcy coefficient was not being used with consistent units between the interface and the computational engine).

12. **Critical Depth Computation.** There was a computational error with in the computation of critical depth in conjunction with a cross section that contained Blocked Obstructs.

13. **Encroachments at Multiple Opening Bridges/Culverts.** For a multiple opening bridge with encroachments, there was a bug if the upstream cross section and the downstream cross section did not "line up" (did not use the same starting stationing).

14. **Manning's N Computation with Lidded Cross Sections.** For a cross section with a lid, if the lid did not cross over the entire channel, the composite Manning's n computation was incorrect.

15. **Velocity Distribution Plot/Table with ICE.** The flow/velocity distribution plot and table for a cross section that has ice was not reporting the regions with ice only correctly.

16. **Cumulative Volume Output.** The reported flow volume computations at structures (bridge, culvert, inline, etc.) have been made more accurate. This is an output change only. These volumes are not used during the hydraulic computations.

17. **Ineffective Flow Areas in Unsteady Flow.** If both overbanks have ineffective flow areas all the way up to or inside of the channel (that is, there is no "active" flow area in either overbank) then the ineffective storage was being ignored during the unsteady flow computations. This was a very series problem, as it would not allow water to go out into storage, and thus not allow for hydrograph attenuation. This was fixed. Any model that has ineffective flow areas inside of or right up against both banks of the channel, with no active overbank area, should be run with the new program to see the significance of this mistake.

18. **Internal Stage/Flow Boundary Condition.** While this boundary condition type has been available for a while, it was not very flexible, and had limited use. This boundary condition type has been made more flexible and can be used at any internal cross section to force

stages or flows, and it can also be used just upstream of an inline structure to force the stage upstream of the structure or the flow coming out of the structure.

19. **Bridge Piers.** A bridge pier that was only defined on the upstream or downstream side of the bridge was not being handled correctly.

20. **Simultaneous Unsteady Flow Runs.** Trying to run multiple RAS unsteady flow data sets at the same time in the same directory was causing a run time error. The program uses a set of scratch files when it runs, if the files are in the same directory, both runs are trying to read and write to the same scratch files.

21. **Gate Operations with Restart Files.** If a data set had a restart file, the program would not use the gate controls from the current plan (for instance, the water surface elevations to open or close the gates). Instead, it was incorrectly using the gate controls from the plan that was used to create the restart file.

22. **Hydrograph Output Interval.** There was a problem if the Hydrograph Output Interval was set to Monthly.

23. **Lateral Structure Connected to Multiple Cross sections.** For a lateral structure that is connected to multiple cross sections on the tailwater side, various bugs have been fixed.

24. **Lateral Structure Connection.** For a lateral structure, setting the tailwater connection type to “Out of the System” sometimes caused a run time error.

25. **Negative Flow Through Piping Failure.** A piping failure breach (for a dam/levee failure) was not allowing negative flow, once the tailwater became higher than the headwater. If the breach fully collapsed, this was not an issue.

26. **ICE at Bridges.** Ice computations at bridges had a bug when the ice in the overbanks was a different thickness than the ice in the channel.

27. **Storage Area Connections.** For storage area connections, the geometry preprocessor was ignoring the [optional] user entered maximum flow.

28. **Pump Override Rules.** For advanced pump rules, the override based on time was not always working correctly.

29. **Detailed Log Output.** If the Write Detailed Log Output for Debugging was checked, but the starting time was left blank, then the detailed output didn't always start at the correct time (blank should start at the initial starting time). The ending time being left blank was also causing problems.

30. **Minor Losses with k values.** For minor losses, "K loss" (Steady Flow data under Set Internal Changes in WS and EG), the program was using velocity (k * v) instead of velocity head (k * v^2/2g) to compute the losses.

31. **Restart File.** For a data set using a restart file, after loading the restart file the program was incorrectly performing one "warm up" time step. This could cause a minor difference in the results and it was also causing occasional output problems with the post processor.

32. **Bridge Culvert Editor.** The menu Option for "Class B Defaults" (was called "Momentum Class B Defaults", but was renamed because it applies to energy bridge computations as well.

33. **Batch Mode Computations.** Run Batch mode was made to work with quasi unsteady flow plans, in addition to the current steady flow and unsteady flow plans.

34. **Regional Language Settings.** The program was modified to run regional language settings other than English (Decimal point still needs to be the delimiter).

35. **Plan comparison on profile plot**. If more than one plan was selected for comparison, and one of them had no output profiles (had not yet been run), then clicked on the "Profiles" button to drop down the list of available profiles, caused the program to generated an exception and crashed.

36. **Debug Report.** The option to create a Debug Report (Compress current plan files) from the main HEC-RAS windows File menu did not include restart files. This option has been fixed so that it now includes the restart file in the debug report compressed file.

37. **Internal Boundary Curves**. The error checking for the program limited the number of points on the free flow curve to 80, when the actual limit is 100.

38. **Bridge Skew Option.** The Bridge Skew option, when used with a multiple opening, was not properly handled and caused the program to crash.

39. **Flow Multiplier for Hydrographs.** Unsteady flow hydrographs that had data entered in the table (as opposed to DSS), and that had a flow multiplier factor, would caused the program to crash when the Plot button was pressed.

40. **Summary Output Tables.** Summary Output tables crashed when tabulating multiple plans when the first one had not been computed.

41. **Channel Modifications.** The method for computing main channel bank stations for channel modification editor was improved.

42. **Errors, Warnings, and Notes window**. The Copy to clipboard button cause the program to crash. This has been fixed and now the data can be copied to the clipboard.

43. **Stage and Flow Hydrograph Plot.** The stage and flow hydrograph plot window had a problem when viewing lateral structures that had a river station 8 characters in length. The appropriate DSS paths were not found and the data that is in the DSS file was not plotted.

44. **User Specified Reach Order.** When the geometry had a user specified reach order for computations, and one of the reaches in the system had a storage area for a boundary condition, the program would produce an error trying to write the boundary condition file.

45. **Renaming River Reaches.** Renaming a river reach did not change the name in the steady flow DSS Connection information.

46. **USACE Survey Data Format.** The USACE Survey format sometimes has more than one decimal place in the RS field, this caused problems in RAS, when this occurs, only the first period is retained.

47. **Culvert Editor.** The culvert editor had a problem that it left one of the text fields with a grey background (thus un editable) when switching between culvert shapes.

48. **Open Air Overflow Gates.** Open Air Overflow gates had a graphics problem on the XS plot when there was more than one gate group with open air gates.

49. **Background Maps.** The background raster images for the geometry schematic are limited in path lengths of 127 characters. When a longer path was used, the program generated an error that was not helpful. Now it displays a dialog that informs the users that the path length is too long.

50. **Node Names.** When the node names start with a number, some of the quick links, like jump to a cross section from the bridge editor, go to the wrong cross section. This bug has been fixed.

51. **Water Temperature Modeling**. There was an error when the computed water surface went below the first point on the hydraulic property tables from the preprocessor.

52. **RAS API Interface.** The RAS Controller service had an error in the Output_GetNodes function. This has been fixed.

53. **Sediment GUI**. The caption on the sediment data window now reflects the new file name when it is Saved AS Sediment and Quasi-Unsteady files now alert users if the attempt is made to close RAS without saving.

54. **Metric Units Problems in Sediment Editors.** Rating curve stage in Quasi Unsteady flow editor was labeled as m2 for SI units - changed to m. The Temperature Editor labels SI Temp as F - Changed to C. Max erosion depth was limited to less than the user specified depths, due to this variable not being converted to English units for the computations. When using SI units RAS used sediment densities of 1.19, 0.835 and 0.385, these were inappropriate and have been changed to 1489, 1041 and 480 kg/m3 for Sand, Silt and Clay respectively. Flow-load rating curve was not converted to English units before being sent to the computational engine, which expected it in English units.

55. **Sediment Computations Through Bridges**. There were a few Computational bugs for bed change determination at bridges, which were fixed.

56. **Downstream Boundary Conditions for Sediment Computations.** If a user specified a downstream boundary condition that either went supercritical or even below the cross section, the software tried to use it. Current version of the sediment module is limited to subcritical flow calculations, so downstream boundaries are now limited to critical depth and higher.

57. **Sediment Plots**. Gradation and flow-load plots were being plotted in an arithmetic scale, these were changed to log scale plots. Several additional sediment plot types have also been added, including the ability to plot cross section bed change.

58. **Copeland Stable Channel Method**. A bug was introduced into the computation of average depth for this method in the 4.0 beta release. This bug has been fixed for the final 4.0 release.

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.