CHAPTER 1

Introduction

Welcome to the Hydrologic Engineering Center's River Analysis System (HEC-RAS). This software allows you to perform one-dimensional steady and unsteady flow hydraulics. Future versions will support sediment transport calculations.

The current version of HEC-RAS supports one-dimensional, steady and unsteady flow, water surface profile calculations. This manual documents the hydraulic capabilities of the Steady and unsteady flow portion of HEC-RAS. Documentation for sediment transport calculations will be made available as these features are added to the HEC-RAS.

This chapter discusses the general philosophy of HEC-RAS and gives you a brief overview of the hydraulic capabilities of the modeling system. Documentation for HEC-RAS is discussed, as well as an overview of this manual.

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General Philosophy of the Modeling System

HEC-RAS is an integrated system of software, designed for interactive use in a multi-tasking, multi-user network environment. The system is comprised of a graphical user interface (GUI), separate hydraulic analysis components, data storage and management capabilities, graphics and reporting facilities.

The system will ultimately contain three one-dimensional hydraulic analysis components for: (1) steady flow water surface profile computations; (2) unsteady flow simulation; and (3) movable boundary sediment transport computations. A key element is that all three components will use a common geometric data representation and common geometric and hydraulic computation routines. In addition to the three hydraulic analysis components, the system contains several hydraulic design features that can be invoked once the basic water surface profiles are computed.

The current version of HEC-RAS supports Steady and Unsteady Flow Water Surface Profile calculations. New features and additional capabilities will be added in future releases.

Overview of Hydraulic Capabilities

HEC-RAS is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels. The following is a description of the major hydraulic capabilities of HEC-RAS.

Steady Flow Water Surface Profiles. This component of the modeling system is intended for calculating water surface profiles for steady gradually varied flow. The system can handle a single river reach, a dendritic system, or a full network of channels. The steady flow component is capable of modeling subcritical, supercritical, and mixed flow regime water surface profiles.

The basic computational procedure is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is utilized in situations where the water surface profile is rapidly varied. These situations include mixed flow regime calculations (i.e., hydraulic jumps), hydraulics of bridges, and evaluating profiles at river confluences (stream junctions).

The effects of various obstructions such as bridges, culverts, weirs, spillways and other structures in the flood plain may be considered in the computations. The steady flow system is designed for application in flood plain management and flood insurance studies to evaluate floodway encroachments. Also, capabilities are available for assessing the change in water surface profiles due to channel improvements, and levees.

Special features of the steady flow component include: multiple plan analyses; multiple profile computations; multiple bridge and/or culvert opening analysis, and split flow optimization at stream junctions and lateral weirs and spillways.

Unsteady Flow Simulation. This component of the HEC-RAS modeling system is capable of simulating one-dimensional unsteady flow through a full network of open channels. The unsteady flow equation solver was adapted from Dr. Robert L. Barkau's UNET model (Barkau, 1992 and HEC, 1997). This unsteady flow component was developed primarily for subcritical flow regime calculations.

The hydraulic calculations for cross-sections, bridges, culverts, and other hydraulic structures that were developed for the steady flow component were incorporated into the unsteady flow module. Additionally, the unsteady flow component has the ability to model storage areas and hydraulic connections between storage areas, as well as between stream reaches.

Sediment Transport/Movable Boundary Computations. 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 will be possible).

The sediment transport potential is computed by grain size fraction, thereby allowing the simulation of hydraulic sorting and armoring. Major features include the ability to model a full network of streams, channel dredging, various levee and encroachment alternatives, and the use of several different equations for the computation of sediment transport.

The model will be 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.

HEC-RAS Documentation

The HEC-RAS package includes several documents, each are designed to help the modeler learn to use a particular aspect of the modeling system. The documentation has been divided into the following three categories:

Documentation	Description
User's Manual	This manual is a guide to using the HEC-RAS. The manual provides an introduction and overview of the modeling system, installation instructions, how to get started, simple examples, detailed descriptions of each of the major modeling components, and how to view graphical and tabular output.
Hydraulic Reference Manual	This manual describes the theory and data requirements for the hydraulic calculations performed by HEC-RAS. Equations are presented along with the assumptions used in their derivation. Discussions are provided on how to estimate model parameters, as well as guidelines on various modeling approaches.
Applications Guide	This document contains a series of examples that demonstrate various aspects of the HEC-RAS. Each example consists of a problem statement, data requirements, general outline of solution steps, displays of key input and output screens, and discussions of important modeling aspects.

Overview of This Manual

This manual presents the theory and data requirements for hydraulic calculations in the HEC-RAS system. The manual is organized as follows:

- Chapter 2 provides an overview of the hydraulic calculations in HEC-RAS.
- Chapter 3 describes the basic data requirements to perform the various hydraulic analyses available.
- Chapter 4 is an overview of some of the optional hydraulic capabilities of the HEC-RAS software.

- Chapters 5, 6, 7, and 8 provide detailed discussions on modeling bridges; culverts; multiple openings; and inline weirs and gated spillways.
- Chapter 9 describes how to perform floodway encroachment calculations.
- Chapter 10 describes how to use HEC-RAS to compute scour at bridges.
- Chapter 11 describes how to model ice-covered rivers.
- Chapter 12 describes the equations and methodologies for stable channel design within HEC-RAS.
- Appendix A provides a list of all the references for the manual.
- Appendix B is a summary of the research work on "Flow Transitions in Bridge Backwater Analysis."
- Appendix C is a write up on the computational differences between HEC-RAS and HEC-2.
- Appendix D is a write up on the "Computation of the WSPRO Discharge Coefficient and Effective Flow Length."