Unsteady Flow Analysis Using HEC-RAS

June 4-8, 2018
Davis, California

Objectives

This course is intended to provide participants with the knowledge to effectively utilize the HEC-RAS software to analyze hydraulic conditions that require one-dimensional unsteady flow modeling.

Topics include: River mechanics and the unsteady flow equations; using HEC-DSS data with HEC-RAS; overview of unsteady flow modeling; data requirements for unsteady flow models; boundary and initial conditions; overview of model output; modeling bridges and culverts; inline and lateral hydraulic structures; storage areas and storage area connections; model calibration; model stability, accuracy, and sensitivity; trouble shooting; modeling urban areas; and advanced features for unsteady flow (mixed flow regime, pump stations, dam and levee breaching).

Prerequisites

Participants must have a good background in open channel hydraulics and be familiar with the HEC-RAS software. Basic HEC-RAS input and output data requirements **will not** be covered in this class. It will be assumed that you already know how to use the software for performing a steady flow analysis. Familiarity with the unsteady flow equations and numerical solution techniques is desirable. Participants should be in positions requiring them to perform complex hydraulic analysis.

Instructors:
Cameron Ackerman (Course Coordinator)
Gary Brunner
Stanford Gibson
Mark Jensen
Alex Sanchez
Steve Piper (RMA Contractor)

Monday, Day 1:

8:00 - 9:00 a.m.	**INTRODUCTIONS, OVERVIEW, AND PRE-TEST** (Director, Ackerman)	
9:00 - 9:20 a.m.	BREAK	
9:20 - 10:30 a.m.	1.1 Lecture:	**RIVER MECHANICS AND INTRO TO UNSTEADY FLOW EQUATIONS** (Brunner)

Description and comparisons of various types of flow (e.g., 1-D, 2-D, steady, unsteady, etc.). Introduction to the unsteady flow equations and solution techniques.

10:40 - 11:45 a.m.	1.2 Lecture:	**OVERVIEW OF UNSTEADY FLOW MODELING WITH HEC-RAS** (Brunner)

Overview of HEC-RAS capabilities for modeling unsteady flow. Discussions of relevant input and output.

11:45 - 1:00 p.m.	ICE BREAKER LUNCH	
1:00 - 2:00 p.m.	1.3 Lecture:	**USING HEC-DSS DATA WITH HEC-RAS** (Jensen)

Discussions of the basic concepts of HEC-DSS; getting data into a DSS file; reading data from DSS; writing results to DSS; and viewing data stored in DSS.

2:00 - 2:15 p.m.	BREAK	
2:15 - 3:15 p.m.	1.4 Lecture	**DATA REQUIREMENTS FOR UNSTEADY FLOW MODELS** (Ackerman)

Types of data required, sources and availability. Limitations and flexibility of HEC-RAS with regard to data. Focus on preparing geometric data (cross sections) and processing that data with the HEC-RAS Pre-Processor (HTAB).

3:15 - 4:30 p.m.	1.5 Workshop:	**PRE-PROCESSING GEOMETRIC DATA** (Ackerman, Jensen)

This workshop will be used to learn how to set cross-sectional table properties; pre-process the cross sections into tables of elevation versus conveyance, area, and storage; and to review the output from the pre-processor.

4:30 - 5:00 p.m.	**REVIEW:**	Workshop 1.5 (Ackerman)

Tuesday, Day 2:

8:00 - 9:15 a.m.	2.1 Lecture:	**BOUNDARY AND INITIAL CONDITIONS** (Sanchez)
	Description of the various types of unsteady flow boundary conditions needed and available within HEC-RAS. Discussion of initial conditions and how to establish them.	
9:15 - 9:30 a.m.	BREAK	
9:30 -10:30 a.m.	2.2 Lecture:	**OVERVIEW OF MODEL OUTPUT** (Jensen)
	Overview of available output from unsteady flow modeling. Discussions of optional output and how to obtain it.	
10:30 - 12:00 noon	2.3 Workshop:	**BASIC UNSTEADY FLOW MODELING** (Sanchez, Jensen)
	Students will learn how enter the necessary data; run the pre-processor, perform the unsteady flow calculations; and review the results of an unsteady flow model.	
12:00 - 1:00 p.m.	LUNCH	
1:00 – 1:30 p.m.	**REVIEW:**	Workshop 2.3 (Sanchez)
1:30 - 2:30 p.m.	2.4 Lecture:	**MODELING BRIDGES AND CULVERTS** (Ackerman)
	Overview of input data for bridges and culverts. Entering hydraulic table parameters for bridges and culverts. Reviewing pre-processor output and unsteady flow output for bridges and culverts.	
2:30 - 4:30 p.m.	2.5 Workshop:	**MODELING BRIDGES AND CULVERTS** (Ackerman, Piper)

Wednesday, Day 3:

8:00 - 8:30 a.m.	**REVIEW**:	Workshop 2.5 (Ackerman)
8:30 - 9:30 a.m.	3.1 Lecture:	**INLINE AND LATERAL HYDRAULIC STRUCTURES** (Gibson)

Discussions of modeling inline and lateral hydraulic structures. Entering spillway and weir data, lateral culverts, and rating curves. Connecting lateral structures to storage areas and other reaches. Controlling gate settings. Reviewing output for inline and lateral structures.

9:30 - 9:45 a.m.	BREAK	
9:45 - 10:30 a.m.	3.2 Lecture:	**STORAGE AREAS AND STORAGE AREA CONNECTIONS** (Jensen)

The purpose of storage areas and how to model them. Connecting storage areas to other storage areas using storage area connections. Input and output for storage areas and storage area connections.

10:30 - 12:00 noon	3.3 Workshop:	**LATERAL HYDRAULIC STRUCTURES, STORAGE AREAS, AND STORAGE AREA CONNECTIONS.** (Jensen, Gibson)
12:00 - 1:00 p.m.	**LUNCH**	
1:00 - 1:30 p.m.	3.3 Workshop Continued	
1:30 – 2:00 p.m.	**REVIEW**	Workshop 3.3 (Jensen)
2:00 - 2:15 p.m.	BREAK	
2:15 - 3:15 p.m.	3.4 Lecture:	**CALIBRATION OF UNSTEADY FLOW MODELS** (Brunner)

Interpretation, use, and reliability of field data. Which parameters to calibrate and adjust, problems and solutions. Calibration for large alluvial streams.

3:15 - 5:00 p.m.	3.5 Workshop:	**CALIBRATION OF THE MISSISSIPPI - OHIO RIVER** (Brunner, Ackerman)

Students will learn how to adjust model parameters to replicate water surface elevations, discharges, and travel times.

Thursday, Day 4:

8:00 - 8:30 a.m.	**REVIEW:**	Workshops 3.5 (Brunner)
8:30 - 9:45 a.m.	4.1 Lecture:	**COMMON MODEL STABILITY PROBLEMS** (Brunner)

Cross-section spacing. Selection of model computational time step. Controlling iterations, tolerances, and other model stability factors. Understanding model sensitivity and the parameters that are most significant.

9:45 - 10:00 a.m.	BREAK	
10:00 - 10:45 a.m.	4.2 Lecture:	**DETECTING AND FIXING MODEL STABILITY PROBLEMS** (Brunner)

Detecting stability problems. Discussions will include how to turn on and review detailed log output from the unsteady flow model run.

10:45 – 12:00 noon	4.3 Workshop	**TROUBLE SHOOTING** (Brunner, Ackerman)

Students will learn how to detect and fix model stability problems.

12:00 - 1:00 p.m.	LUNCH	
1:00 - 1:30 p.m.	4.3 Workshop - Continued	
1:30 – 2:00 p.m.	**REVIEW:**	Workshop 4.2 (Brunner)
2:30 – 3:30 p.m.	4.4 Lecture	**ADVANCED FEATURES FOR UNSTEADY FLOW** (Piper)

This lecture will cover how to model mixed flow regime situations, pump stations, dam break analysis, levee breaching, and Pressurized Pipe modeling.

3:30 – 5:00 p.m.	4.5 Workshop	**DAM AND LEVEE BREACHING** (Piper, Gibson)

Students will learn how to use HEC-RAS to perform a dam breaching analysis, as well as a levee breaching analysis.

Friday, Day 5: 1

8:00 – 8:30 a.m. **REVIEW:** Workshops 4.5 (Piper)

8:30 – 9:30 a.m. 4.4 Lecture: **INTRODUCTION TO THE RULES EDITOR** (Piper)

This lecture will introduce students to using the rules editor for controlling gates at Inline and lateral structures, as well as storage area connections. Other uses for the rules editor will also be introduced.

9:30 - 9:45 a.m. BREAK

9:45 – 10:15 a.m. 4.4 Interactive Demonstration: **RULES EDITOR** (Piper)

A student interactive demonstration of the use of rules will be given.

10:15 - 11:15 a.m. **POST TEST, COURSE CRITIQUE, AND CLOSING REMARKS** (Ackerman)