

Overview of HEC-RAS and Steps to Develop an HEC-RAS Model

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BUILDING STRONG®



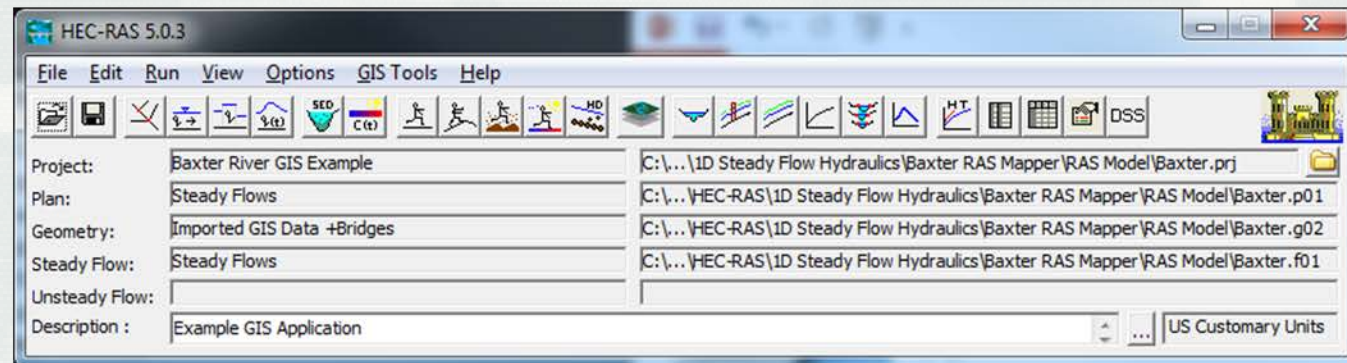
Starting HEC-RAS

- Double-click icon



- Main HEC-RAS Window

- ▶ Project
- ▶ Plan
- ▶ Geometry
- ▶ Flow



Classifications of Open Channel Flow

- Steady vs. Unsteady

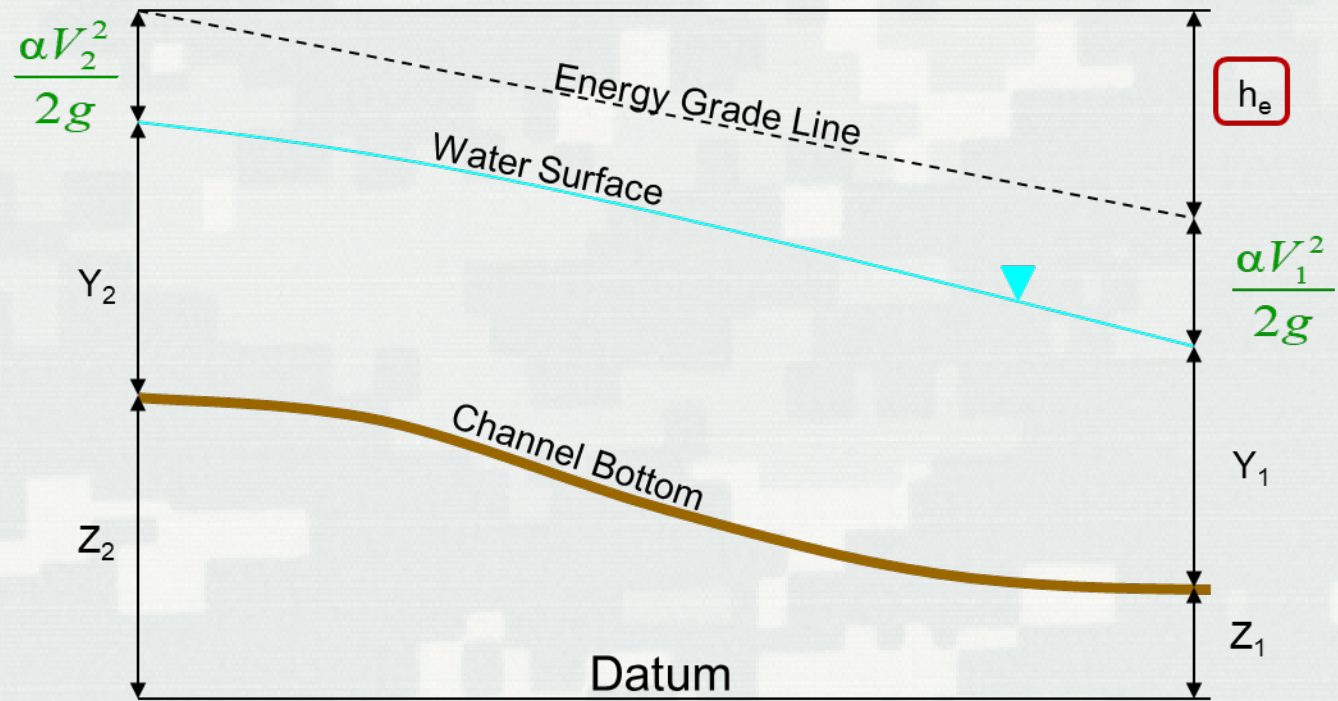
Steady Flow



Unsteady Flow



Energy Principles



$$Z_2 + Y_2 + \frac{\alpha_2 V_2^2}{2g} = Z_1 + Y_1 + \frac{\alpha_1 V_1^2}{2g} + h_e$$



Energy Losses

- Energy Losses:

$$h_e = L \bar{S}_f + C \left| \frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g} \right|$$

Friction losses + Contraction and Expansion



Friction Loss Calculations in HEC-RAS

- Friction loss is evaluated by the following equation in HEC-RAS:

$$h_f = \bar{S}_f L$$

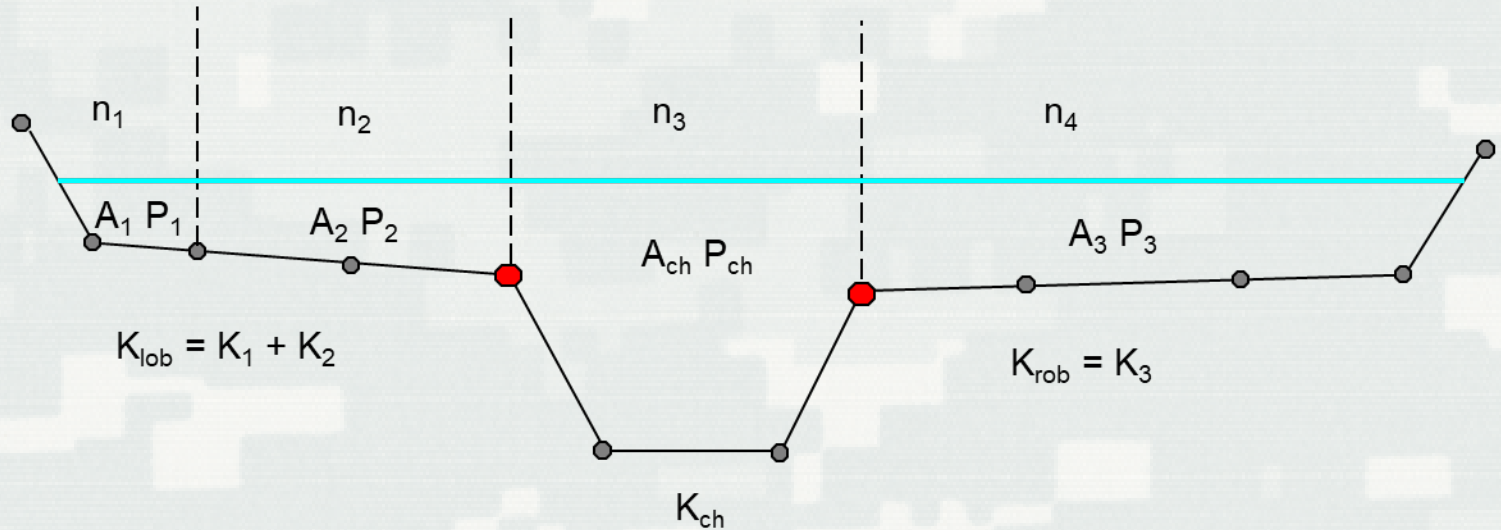
- The energy slope is from Manning's equation:

$$S_f = \left(\frac{Q}{K} \right)^2 \text{ where: } K = \frac{1.486}{n} A R^{2/3}$$



Conveyance Calculations

HEC-RAS Default Method



Steps to Develop a Hydraulic Model with HEC-RAS

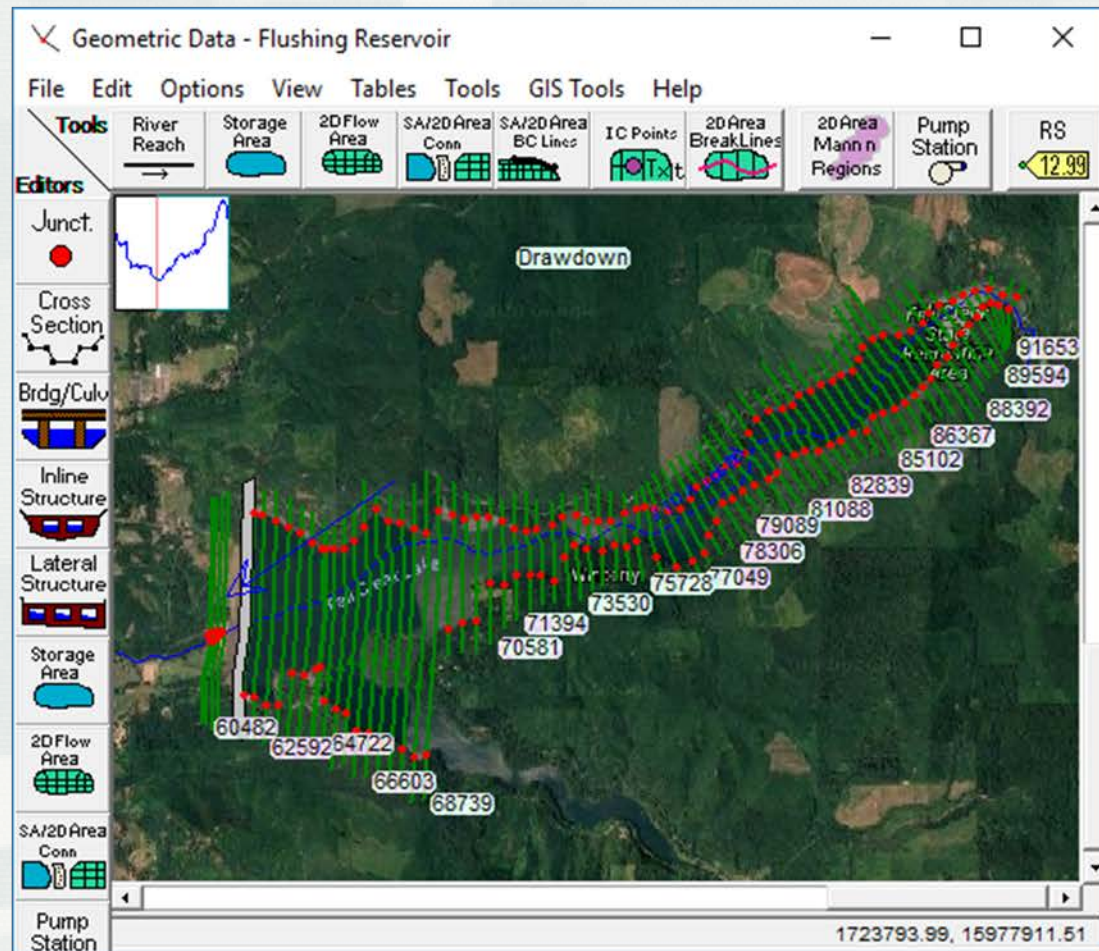
- Start a New Project
- Enter Geometric Data
 - ▶ Create or import geometry data and add structures
- Enter Flow and Boundary Data
- Establish a Plan and Perform the Computations
- Evaluate Model Results
- Adjust Model, as Necessary



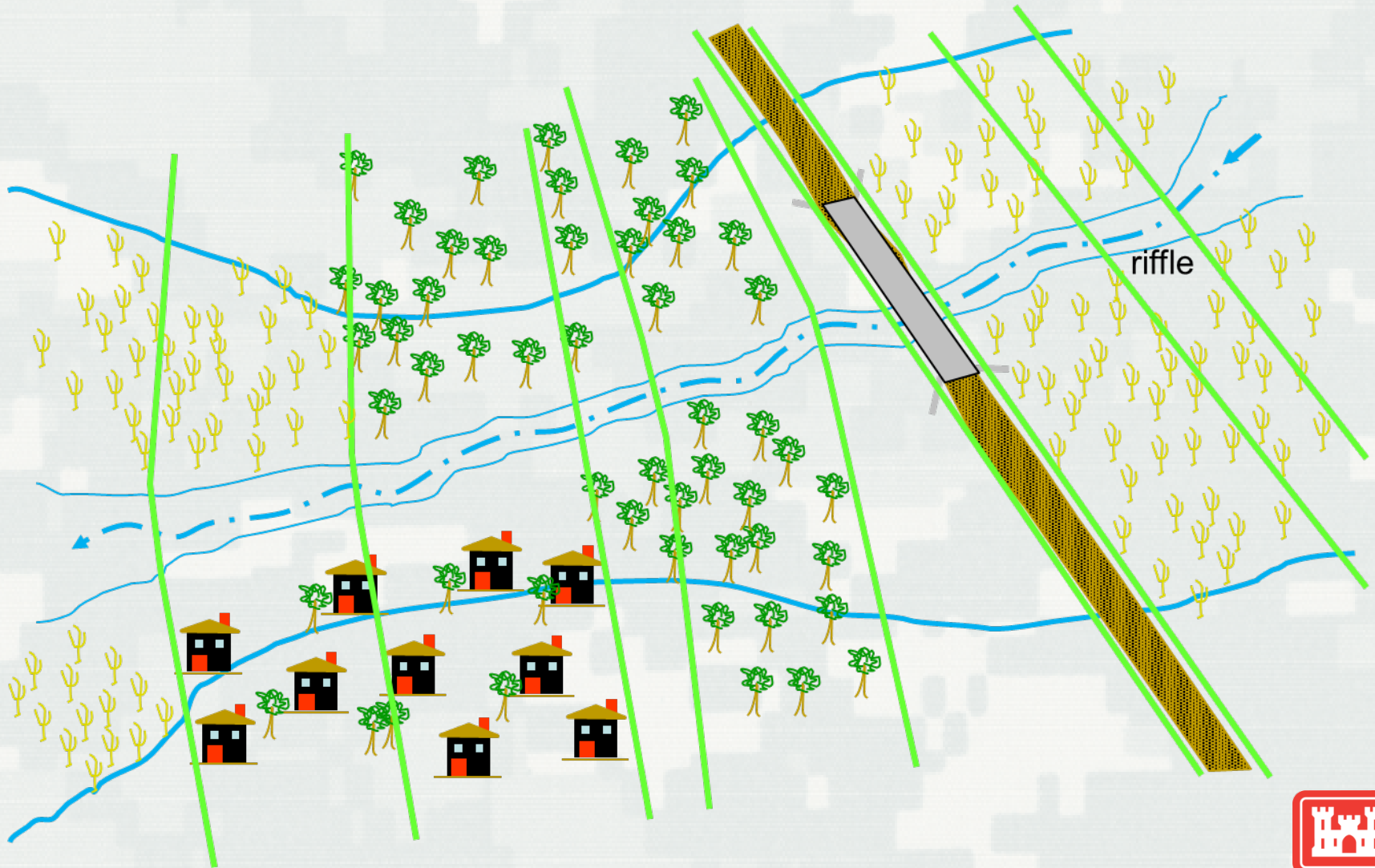


AS Geometric Data Editor

- Rivers/reaches
- Junctions
- River Stations
 - ▶ Cross section data
 - ▶ Hydraulic Structures



Cross Sections





Cross Section Data Editor

Cross Section Data - Flushing Reservoir

Exit Edit Options Plot Help

River:

Reach: River Sta.:

Description:

Cross Section Coordinates		
	Station	Elevation
1	0	1001.81
2	24.58	1000.31
3	37.69	997.85
4	67.19	993.92
5	111.43	984.9
6	157.31	976.77
7	167.14	973.58
8	186.81	970.64
9	229.41	961.74
10	260.55	958.39
11	285.13	954.25

Downstream Reach Lengths		
LOB	Channel	ROB
259.7	400.5	416.2

Manning's n Values		
LOB	Channel	ROB
0.1	0.06	0.1

Main Channel Bank Stations	
Left Bank	Right Bank
1093.94	1578.31

Cont/Exp Coefficient (Steady)	
Contraction	Expansion
0.1	0.3

Plot Options ☐ Keep Prev XS Plots ☒ P

Legend: Ground, Bank Sta



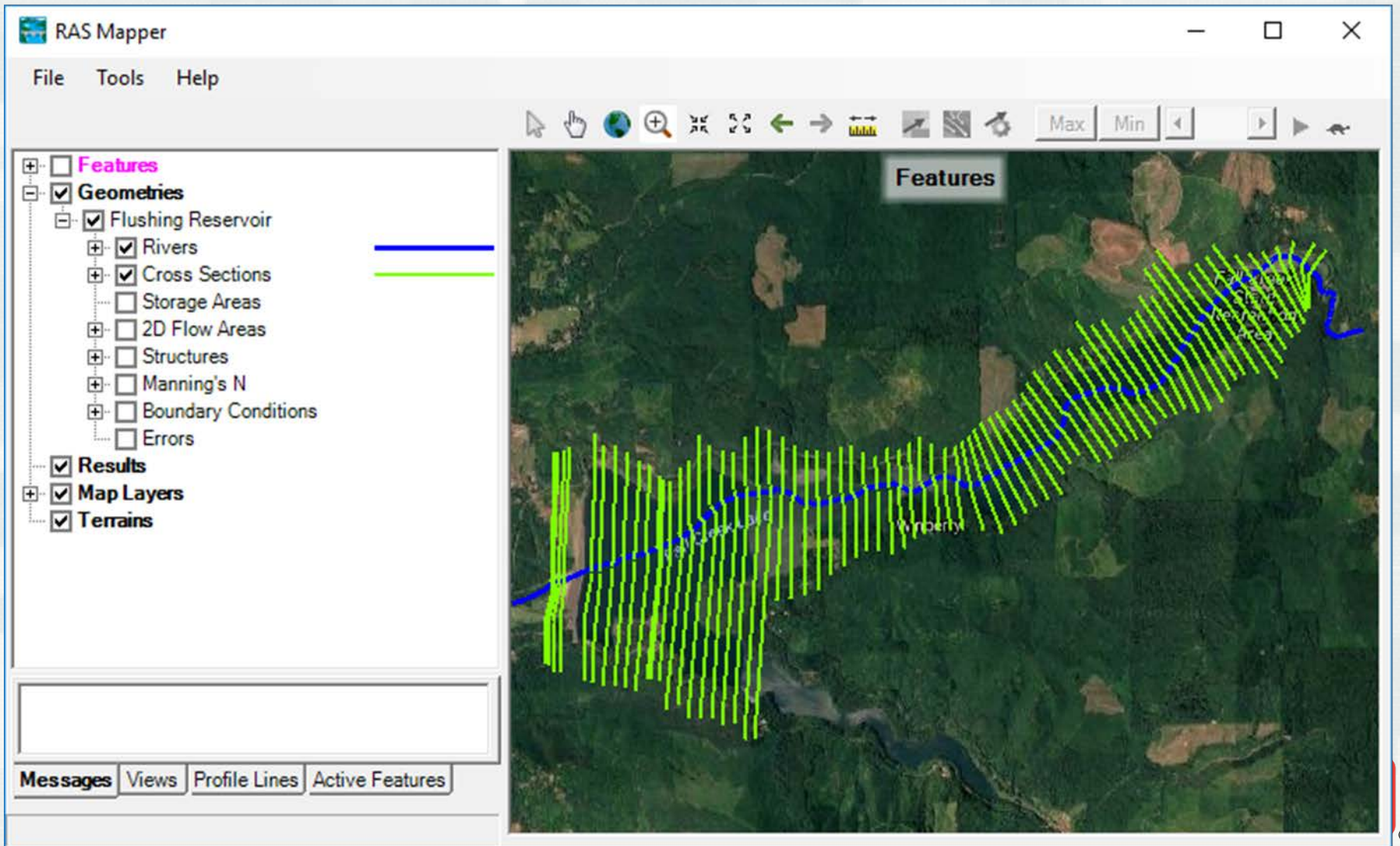
RAS Mapper

- Add a Terrain Model
- Create River network
- Create Bank Lines
- Create Flow Path Lines
- Locate Cross Sections
- Use Editors and Tables in RAS to complete additional data
 - ▶ Manning's n values, Ineffective flow areas, ...
 - ▶ Bridges, Culverts, ...





RAS Mapper

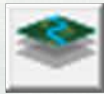




RAS Mapper Terrain

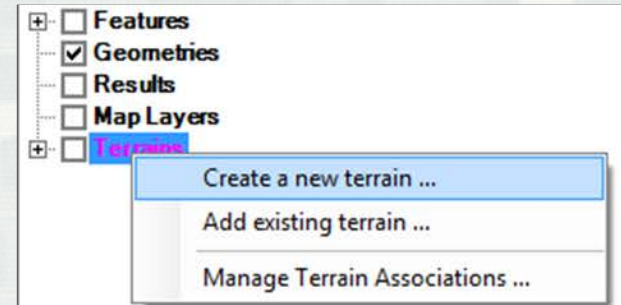
- Various formats are supported
 - ▶ Binary Floating Point Raster (FLT)
 - ▶ Esri Arc/Info Grid format
 - ▶ GeoTIFF (still rounds and compresses)
 - ▶ Others (e.g. USGS DEM, etc)
- Imported data is rounded to based on precision selected
 - ▶ Default is 1/32 (~0.03 ft) (1/128 for metric)
- Define Projection by importing a shapefile prj





RAS Mapper

- Add a New Terrain Layer



New Terrain Layer

Set SRS ...

Input Terrain Files

	Filename	Projection	Cell Size	Rounding	Info
	Terrain.tile1.tif	PROJCS["NAD_1983_StatePlane_California_III_...]	20	(na)	
	Terrain.tile2.tif	PROJCS["NAD_1983_StatePlane_California_III_...]	20	(na)	
	Terrain.tile3.tif	PROJCS["NAD_1983_StatePlane_California_III_...]	20	(na)	
	Terrain.tile4.tif	PROJCS["NAD_1983_StatePlane_California_III_...]	20	(na)	
	Terrain.tile5.tif	PROJCS["NAD_1983_StatePlane_California_III_...]	20	(na)	

Output Terrain File

Rounding (Precision): ☒ Create Stitches ☐ Merge Inputs to Single Raster

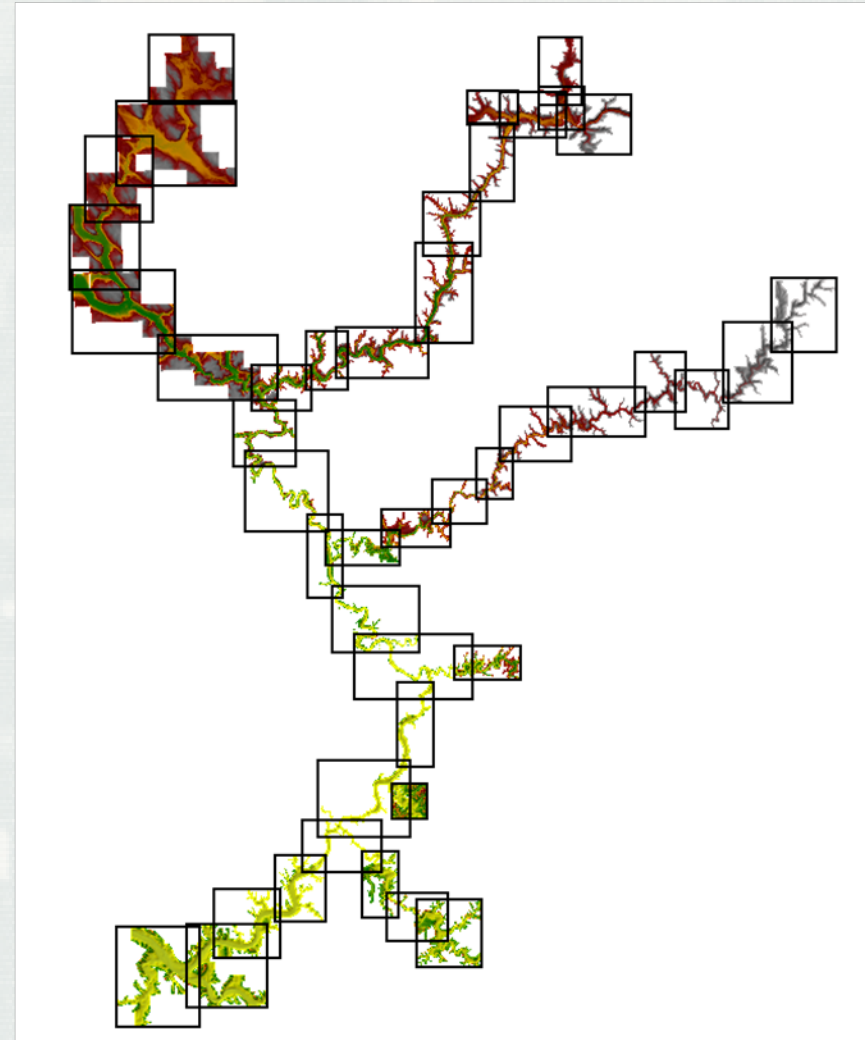
Vertical Conversion:

Filename:



RAS Mapper - Terrain

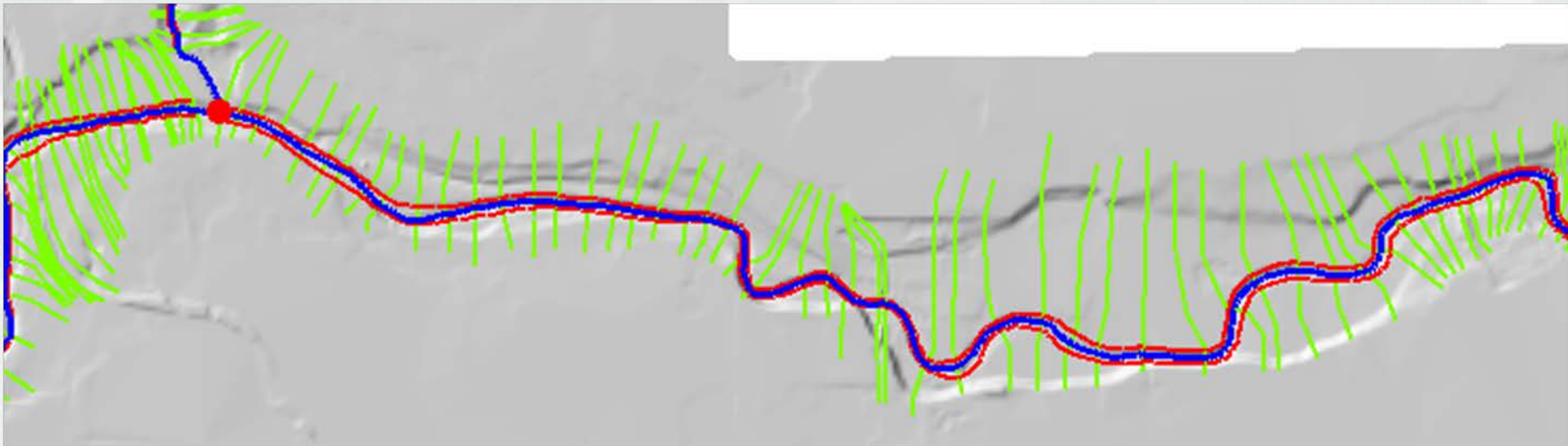
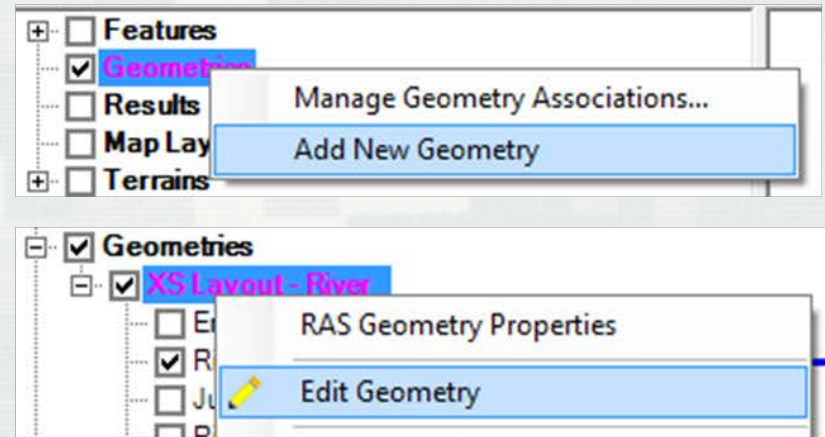
- Uses GeoTIFF format
 - ▶ Tiles data for more efficient storage
 - ▶ Compresses data for efficient storage
 - ▶ Pyramids data for fast visualization
 - Allows for on-the-fly inundation mapping
- Multiple Terrain Models as 1 Layer
- No file size limitations – BigTIFF supported





RAS Mapper

- Create a New Geometry
- Start Editing Geometry
- Create River, XS and other RAS Layers





Steady Flow Data Editor

- Number of Profiles
- Flow for each reach and each profile
- Flow Change at any cross section

Steady Flow Data - Steady Flows

File Options Help

Enter/Edit Number of Profiles (32000 max): Reach Boundary Conditions ... Apply Data

Locations of Flow Data Changes

River: Add Multiple...

Reach: River Sta.: Add A Flow Change Location

Flow Change Location			Profile Names and Flow Rates			
	River	Reach	RS	Big	Bigger	Biggest
1	Baxter River	Upper Reach	84816.	31500	67499.99	149400
2	Baxter River	Lower Reach	47694.	32000	69999.99	154000
3	Tule Creek	Tributary	10982.	499.9999	2500	4600

Storage Area Elevations Specified

Edit Steady flow data for the profiles (cfs)





Reach Boundary Conditions

- External Boundary Input
 - ▶ Subcritical - Downstream
 - ▶ Supercritical – Upstream
 - ▶ Mixed Flow – Upstream and Downstream
- Internal from Junctions

Steady Flow Boundary Conditions

☒ Set boundary for all profiles ☐ Set boundary for one profile at a time

Available External Boundary Condition Types

Known W.S. Critical Depth Normal Depth Rating Curve Delete

Selected Boundary Condition Locations and Types

River	Reach	Profile	Upstream	Downstream
Baxter River	Upper Reach	all		Junction=2
Baxter River	Lower Reach	all	Junction=2	Normal Depth S = 0.001
Tule Creek	Tributary	all		Junction=2

Steady Flow Reach-Storage Area Optimization ...

OK Cancel Help

Select Boundary condition for the downstream side of selected reach.





Steady Flow Analysis Window

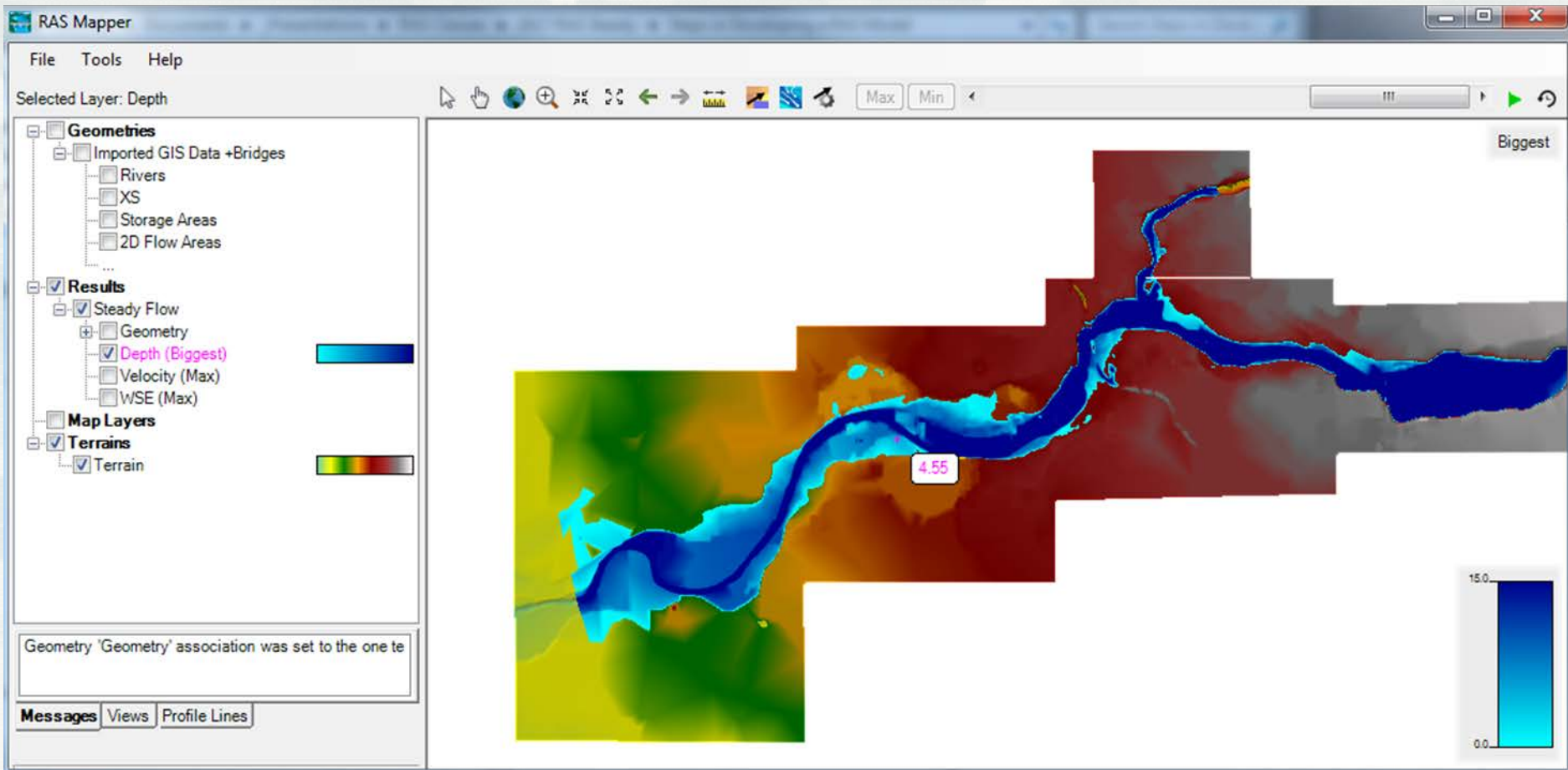
- Define Plan:
 - ▶ Plan Title
 - ▶ Short ID
 - ▶ Geometry file
 - ▶ Flow file
 - ▶ Flow Regime
- Compute

The screenshot shows the 'Steady Flow Analysis' window with the following fields and options:

- Plan :** Steady Flows
- Short ID :** Steady Flow
- Geometry File :** Imported GIS Data +Bridges
- Steady Flow File :** Steady Flows
- Flow Regime :** Subcritical (selected), Supercritical, Mixed
- Optional Programs :** Floodplain Mapping (unchecked)
- Plan Description :** (Empty text area)
- Compute** button
- Status bar:** Enter/Edit short identifier for plan (used in plan comparisons)









Viewing Results – RAS Mapper







Viewing Results

■ Graphics

- ▶ Cross sections 
- ▶ Water surface profiles 
- ▶ Generic plots – Any variable in profile 
- ▶ Rating Curves 
- ▶ XYZ Plot 
- ▶ Stage and flow hydrographs – Unsteady Flow Only 

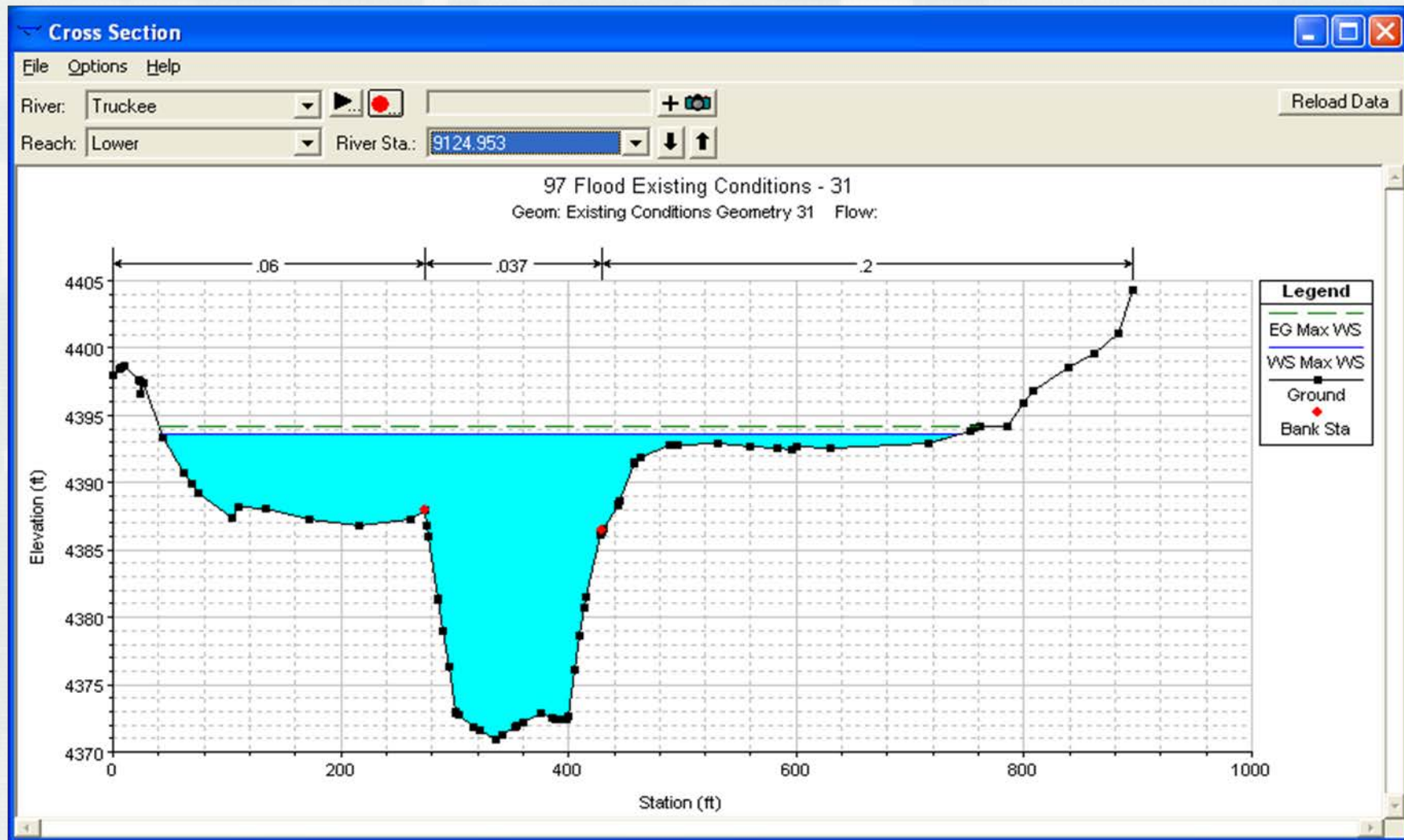
■ Tabular Output

- ▶ Pre-defined detailed tables 
- ▶ Pre-defined summary tables 
- ▶ User-define output tables





Cross Section Plot





Profile Plot

