RAS Mapper Dam Breach Geometry

Workshop

Objective

In this workshop, you will learn how to create an HEC-RAS model from a digital terrain model (DTM). The general process will teach you how to create geospatial data in RAS Mapper to represent the river system and floodplain area specifically for performing a dam breach analysis with HEC-RAS.

Once the geometric data has been created, you will identify data that requires correction and enter remaining data to complete the RAS model.

NOTE: While this data is from an actual river system, the model and results of this workshop do not represent current or future conditions of the river. The United States Army Corps of Engineers has granted access to the information in this model for instructional purposes only. Do not copy, forward, or release the information without United States Army Corps of Engineers approval.

Background

You will be working on Bald Eagle Creek near Lock Haven, PA. A flow hydrograph will be used to simulate inflows to into the reservoir behind Sayer's Dam. The water surfaces will then be used in the GIS to perform floodplain mapping.



This workshop is comprised of two parts: geometric data development using HEC-RAS Mapper; and completion of the data in the HEC-RAS Geometric Editor.

Work quickly, but thoughtfully, and be sure to read each part carefully.

When you have questions, don't hesitate to ask! Lastly, don't get too carried away with being accurate – this is a workshop. It is intended to highlight the general use of using HEC-RAS Mapper for data development and editing.

1 Start a new HEC-RAS Project with Terrain

You will be starting from scratch with a new HEC-RAS project.

1.1 Create a new HEC-RAS Project

- 1. Create a **NEW** HEC-RAS project and give it a Name.
- 2. Go to the Geometric Data Editor and select **File | New Geometry Data**. Provide a name and press **OK**.

1.2 Import the Terrain Model

 Open RAS Mapper and set the Projection for the project, using the Tools | Set Projection for Project menu item. Browse to the "GISData" folder in the workshop folder and select the "projection.prj" file.

RAS Mapper Options				×
Project Settings	Coordinate Reference System			
Projection *	Coordinate Hadrande System			
General Render Mode Mesh Tolerances Global Settings General	Projection File: [C:NEC:VHEC-KAS/Class Definition: PROJCS['NAD_1983_StatePlane_Perns ['GCS_Noth_American_1983';DATUM[' ['GCS_1980',63781370,298,2572210') ['Degree': 0.017452282199433];PROJE ['Degree': 0.017452282199433];PROJE ['Tates_Nothing': 0.0] PRAMETER['Ce ['Standard_Parale]: 27:149;PRAMETER' ['Standard_Parale]: 27:149;PRAMETER'	ses 2022/H&H D_North_Ame 1]],PRIMEM["C ECTION ER["False_Ea intral_Meridian 333],PARAME ER	_FIPS_3701_Fee rican_1983".SPH Greenwich".0.0].U sting".1968500.0] "77.75].PARAM TER	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
RAS Layers	Warping Method			
Map Surface Fill	Default Method (GDAL Warp)			
Editing Tools	C Alternate HEC-RAS Raster Warpin	ng Method		
	Help me find a coordinate reference syst RAS Project Units: US Customary	tem: <u>spatialre</u>	ference.org	
		ОК	Cancel	Apply

- 4. Create a new terrain model using the **Tools | New Terrain** menu item.
- 5. Click to + button to add the terrain file. Use the "**BEC.tif**" file located in the "**GISData**" folder.

Set SRS		
+ Filename × BEC.tif	Projection (Same as Project)	Cell Size 10
<u>+</u> +		

6. Press the **Create** button to import the terrain data.

7. **Close** the dialog once the Terrain has been created.

2 Geometry Development

Use the RAS Mapper Editing Tools to create a 1D RAS model geometry. Pay attention to using the correct tool to **Add New** \mathcal{V} versus **Select / Edit** \mathcal{I} on the <u>selected</u> <u>layer</u>. Open the Geometry for Editing

- 8. Open **RAS Mapper**.
- 9. In RAS Mapper, Select the new Geometry layer, right-click and choose "**Edit Geometry**" or click the **Edit** button (Pencil).

Selected Layer: Ge	ometr	у 🧷
Geometrie	S	
⊡- ✓ Geome		PAG Company in the
(1/Em	02:	RAS Geometry Properties
Event Con	0	Edit Geometry
results	-	ar

2.1 Create the Storage Area for the Reservoir

- 10. Click on the **Storage Areas** layer.
- 11. Draw a polygon representing the reservoir (you don't have to be precise).
- 12. Provide a **Name**.
- 13. The Elevation-Volume relationship will be automatically extracted from the terrain.
- 14. You can plot the Elevation-Volume relationship for the polygon but rightclicking on the polygon and choosing **Plot Elevation-Volume Curve**.



*Typically, you would want to override the Elevation-Volume relationship with pre-dam survey information, as most likely, the terrain in the reservoir pool is not correct.

2.2 Create the 2D Flow Area Downstream of Sayers Dam

- 15. Expand the **2D Flow Areas** layer to see sub layers.
- 16. Click on the **Perimeters** layer
- 17. Draw a polygon representing the area downstream from the dam downstream past Lock Haven.
- 18. From the **2D Flow Area Editor**...
 - a. Set the Manning's n value for the 2D Area to **0.06**.
 - b. Generate Computation Points at a 500ft spacing

2D Flow Area Editor	
2D Flow Area: BaldEagleCr	
ell Properties	
Computation Points	
Points Spacing (ft) DX: 500 DY: 500	Mesh State = Complete
✓ Enforce Breaklines / Refinement Regions	Number of Cells = 3174 Average Face Length = 512 Average Cell Size = 261,831 Maximum Cell Size = 828,963 Minimum Cell Size = 199,492
Generate Computation Points	Mesh Status = Success: Created in 00:00:00.109
Hydraulic Cell/Face Properties	
Default Manning's n Value: 0.04	
Spatially Varied Manning's n on Faces	
Composite Classification Values in Cells	Compute Property Tables
Force Mesh Recomputation	Close

- 2. Create Breaklines along the levees by importing them from shapefile
 - a. Expand the 2D Flow Areas node
 - b. Right-click on the Breaklines layer and choose Import Features
 - c. Select the

d. Import the **Levee** shapefile for the upper, middle, and lower levee to the **Breaklines** layer.



e. **Right-click** on the **Breaklines** layer and choose **Enforce All Breaklines** to modify the mesh.



The mesh should look similar to the figure below.



2.3 Create the Additional Breaklines (as appropriate)

19. Select the Breakline layer

- 20. Create additional breaklines where appropriate to align cell faces! Note: looks for roads and other high ground that directs flow.
- 21. Enforce all breaklines (make sure the mesh computes)

2.4 Create Boundary Conditions

- 22. Click on the **Boundary Conditions Lines** layer.
- 23. Navigate to the most downstream end of the 2D Area and create a **BC Line** at the end of the 2D area on the outside of the 2D Area.
- 24. Provide a Name.

2.5 Create a SA/2D Connection for the Dam

- 25. Click on the SA/2D Connections structure layer
- 26. Layout the Inline Stucture (left to right when looking downstream).



*You may need to override the weir profile for the Structure from the SA/2D Connection editor in the Geometric Editor. Breach information is also accessed from the SA/2D Connection editor.

2.6 Manning's n Values - We are skipping the detail version of this today.

2.7 Compute Hydraulic Property Tables

27. Click on the 2D Flow Areas layer

28. Right-click on the 2D Flow Areas layer and choose the **Compute 2D Flow Areas Hydraulc Tables** menu item

SA/2D		Layer Properties	
Bounda	Ⅲ	Open Attribute Table	
+ Linpty	1	Edit Geometry Ctrl+E	
	2	View 2D Flow Area Properties	
	Q	Zoom to Layer	
		Move Layer	•
	1	Export Layer	•
		Open Folder in File Explorer	
		Select All Features Ctrl+A	e.
2	9	Find Ctrl+F	
		Compute 2D Flow Areas Hydraulic Tables	
	HT	Plot Property Table	+

2.8 Stop Editing

- 29. When **FINISHED** created features, select the **Geometries Node | Stop Editing** menu item.
- 30. Close RAS Mapper.

3 Finish Entering Geometric Data

If you haven't already, close RAS Mapper and open the **Geometric Schematic**. Your geometry will not be loaded automatically.

31. **Open** the geometry you created using RAS Mapper using the **File | Open Geometry** menu item.



3.1 Storage Areas

32. Select the **Elevation versus Volume Curve** method for the storage areas <u>and verify the data.</u>

Storage Area Editor				
Storage Area: Reservoir	ces to	this Storage	▼ ↓ Area	1 →
US XS: RS=15.88				
Area times depth metho Elevation versus Volume	d	/P	Area (Min Ele	acres): [ev: [
	Cur		Compu	Ite E-V table
	Fire	Eleva televation mu	tion Vo	Jumne Curve
0		Flevatio	n	Volume (
	1	584.871		0
	2	587.478		1.585
	3	589.234		6.463
	4	591.648		39.872
	5	594.571		257.501
	6	601.683		2092.732
	7	610 200		6116 EAG

33. You may also want to **filter** the points or replace with survey data.

3.2 SA/2D Connection Structure

34. Open the SA/2D Connection Structure editor.

·₩ Connectio	n Data Editor - Base Geometry Dptions <u>He</u> lp		×
Connection: Description	Dam		
From: To:	Storage Area: Reservoir Pool Set SA/2D Weir Length: 7423.00 2D Flow Area: BaldEagleCr Set SA/2D Centerline Length: 7423.02		
Structure Type: Flap Gates:	Weir, Gates, Culverts, Outlet RC and Outlet TS Cut profile from terrain No Flap Gates Clip Weir Profile to 2D Cells		
Gate I	Dam	 Legen Spillwa	d y
Outlet Bevation		TW Cell Mir Current Te	rrain
Outlet	800 800 1000 2000 3000 4000 5000 6000 7000	3000	
4	Station (ft)	 	

- 35. **Override** the **Weir** information.
 - a. Dam Crest @ 683 ft.

500	-it wide <i>F</i>	Auxillary S
1	Station	Elevation
1	0	683
2	2250	683
3	2250	657
4	2850	657
5	2850	683
6	7423	683

b. 500-ft wide Auxiliary Spillway @ 657 ft (on the left embankment)

c. Provide a Weir coefficient of **2.6** for the auxiliary spillway.

36. Add a **low-level outlet** - locate it in the channel.

- a. Invert Elevation @ 590 ft.
- b. Use a circular culvert with 2 ft diameter.
- 37. Consider what other geometry-related things have we not done?

-----Bonus – If time allows-----

If you have time, create an unsteady flow simulation and try to run the model. This will allow you to see if the geometry has been input properly!

4 Flow Data

After you have created the Geometry, add flow data to the RAS project.

38. Open the Unsteady Flow data editor

39. Choose the Add SA/2D Flow Area button

Add Boundary Condition Location				
Add RS	Add SA/2D Flow Area	Add Conn	Add Pump Sta	Add Pipe Node

40. Add the **Reservoir** Storage Area Boundary Condition location Select Storage Areas for BC's Storage Areas

Avail Storage Areas	Select Storage Areas for BC's (1)
BaldEagleCr	Reservoir Pool
Reservoir Pool	

41. Add the Lateral Inflow Hydrograph boundary condition

Boundary Condition Types			
Stage Hydrograph	Flow Hydrograph	Stage/Flow Hydr.	Rating Curve
Normal Depth	Lateral Inflow Hydr.	Uniform Lateral Inflow	Groundwater Interflow
T.S. Gate Openings	Elev Controlled Gates	Navigation Dams	IB Stage/Flow
Rules	Precipitation		

42. Enter a Lateral Flow Hydrograph for the Reservoir.

f. Enter a time series of data

Pead from DSS	before cimulation	(Colort	00 40
(eau ir uir 055	Defore sinulation	L Select L	ISS file and Path
ile:			
Enter Table		Data time interval	l: 1Day 💽 🗲
Select/Enter th	e Data's Starting Time Reference	<u> </u>	
Use Simulati	on Time: Date: 01JAN	1999 Time: 1200	
Fixed Start	Time: Date:	Time:	
	1		
No. Ordinates	Interpolate Missing Values	Del Row Ins Row	
		Hydrograph Data	
	Date	Simulation Time	Lateral Inflow
		(hours)	(cfs)
1	01Jan1999 1200	0:00:00	1
2	02Jan 1999 1200	24:00:00	1
3	03Jan1999 1200	48:00:00	1
4	04Jan 1999 1200	72:00:00	1
Time Step Adi	etment Ontions ("Critical" bound	ary conditions)	
Monitor this	budrograph for adjustments to	computational time step	
	riyalograpit lor adjustitertis to	computational unle step	
	as in Flow (without changing tim	e step):	
4 Time Step Adju	04Jan 1999 1200 istment Options ("Critical" bound is hydrograph for adjustments to one in Elow (without changing time	ary conditions) computational time step	1

g. Put in a **Min Flow** of **10,000** cfs for a steady profile.

Min Flow: 10000. Multiplier:

- 43. Enter a **Normal Depth** boundary condition with a slope, **S=0.0004**.
- 44. Set the Reservoir Storage Area **Initial Conditions** to an appropriate **Elevation** from the Initial Conditions tab

	Initial Elevation of Storage Areas/2D Flow Area	s (Optional)	Import Min SA Elevation(s)
Г	Keep initial elevations constant during warmup	2	
	Storage Area/2D Flow Area	Initial Elevation	
1	2D: BaldEagleCr		
2	SA: Reservoir Pool	630	

45. **Save** the flow data.

5 Simulate

Run the steady-flow simulation.

- 46. Open the **Unsteady Flow** simulation dialog.
- 47. Create a new **Plan** with a name and Short ID.
 - h. Set the **Simulation Time Window** to run for an hour.

i.	Set the	Computatio	on In	terval	to	1min
						1975

Plan: Initial		Short ID: Initial	
Geometry File:	Geometry		
Unsteady Flow File	: Flows		
Programs to Run	Plan Description		
 Geometry Preprocessor ✓ Unsteady Flow Simulation □ Sediment □ Post Processor □ Floodplain Mapping 			~
Simulation Time Window Starting Date:	01jan2222	Starting Time:	0000
Ending Date:	lo ijanzzzz	chung nine:	101001
Computation Settings Computation Interval:	1 Minute 💌	Hydrograph Output Interval:	1 Hour
Manping Output Interval:	1 Hour 🔻	Detailed Output Interval:	1 Hour
happing output the val			

48. **Compute** a water surface.

!!! Read the error messages and work through data deficiencies !!!
!!! HEC-RAS will provide warnings if the data are incomplete !!!

49. If the simulation runs, it means you successfully satisfied the data development requirements and flow data entry.

- nee to to missied computations			
Write Geometry Information	- <u> </u>		
ayer: COMPLETE			
Geometry Processor			
liver:	RS:		
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ime: 1.0000 01JAN2222 01:0	0:00 Iteration (1D): 0 Iteratio	n (2D): 1	
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