#### Dam and Levee Breach

Workshop

### 1 Objective

In this workshop, you will learn how to:

- Enter and edit dam and levee breach data
- Perform unsteady breach simulations
- Perform sensitivity analyses on timestep and breach parameters
- Review and interpret pertinent dam and levee breach output

# 2 Background

You will be working with a dataset for Sayers Dam on Bald Eagle Creek in central Pennsylvania. Sayers Dam is approximately 15 miles upstream of the town of Lock Haven. See the figure below to become acquainted with the dataset.

In this workshop, you will add a piping breach to the inline structure representing Sayers Dam and analyze the impact of the breach on the town lock Lock Haven downstream. Additionally, you will add an overtopping breach to one of the levees protecting Lock Haven.



#### 3 Enter Dam Breach Parameters

- 1. Start HEC-RAS and **open** the "**Bald Eagle Creek Example Dam Break Study**" project.
- 2. Open the Unsteady Flow Analysis window and create a new plan using Save Plan As Option from the file menu.

L Unsteady Flow Analysis	×	
File Options Help		
New Plan	Short ID: PMF	
Open Plan	ditions Geometry - 1D	•
Save Plan	From HMS	-
Save Plan As 🔓	plion	

- 3. Name the new plan (and short ID) "Froehlich".
- 4. **Open** the **Dam Breach Data** editor from the Unsteady Flow Analysis window as shown below.

LU	nstea	idy Flo	ow Analysis			×
File	Opt	ions	Help			
Plan:	~	Stag Flow Flow Sea	ge and Flow Output Locations w Distribution Locations w Roughness Factors sonal Roughness Factors			•
া ব ব		Uns Uns Uns	omated Roughness Calibration teady Encroachments teady Encroachments (new) gaged Lateral Inflows			~
Sim		Dan Lev SA (	n (Inline Structure) Breach ee (Lateral Structure) Breach Connection Breach	e:	1200 0000	
Cor Cor Maj	Cor Computation O Mar Output Options Pro Friction Slope N Friction Slope N	nputation Options and Tolerances put Options tion Slope Method for Cross Sections tion Slope Method for Bridges	erval: sl: Dam a	2 Minute 1 Hour nd Leve	•	
		Sed	ial Backwater Flow Optimizations			)

5. Select the **Parameter Calculator** tab and **enter the input data** as shown below:

Breach Plot   Breach Pr	ogression Simplifie	ed Physical   Physica	al Breaching (DLBrea	ch) Parameter Cal	
Top of Dam Elevation	(ft): 68	33 Breach	Bottom Elevation (fl	t): 585	
Pool Elevation at Failu	re (ft): 67	76.8 Pool Vo	lume at Failure (acre	ft): 180000	
MacDonald Dam Crest Width (ft):	. 2:	Failure Slope o	mode: fUS Dam Face Z1 (F	Piping            H:V):         3.5	
Earth Fill Type: Non	-homogeneous or Ro	ckfill 💌 Slope o	f DS Dam Face Z2 (h	H:V): 3.5	
-Xu Zhang (and Von T Dam Type: Dam wit	Thun) th corewall	▼ Dam Er	odibility:	Medium 💌	
Method	Breach Bottom Width (ft)	Side Slopes (H:V)	Breach Development Time (hrs)		
MacDonald et al	718	0.5	2.48	Select	
Froehlich (1995)	440	0.9	3.17	Select	
Froehlich (2008)	407	0.7	2.80	Select	
Von Thun & Gillete	361	0.5	0.81	Select	
Xu & Zhang	u & Zhang 294		4.81 *	Select	

- In the table of breach methods at the bottom, press Select the Froehlich (2008) method. This will copy the calculated parameters to the pane on the left.
- 7. Next, enter a Center Station of 5250 ft, and Initial Piping Elev of 620 ft. Check the Breach This Structure box.
- 8. Don't forget to click **Breach This Structure Breach This Structure**
- 9. Switch to the **Breach Plot** tab to visualize the final breach dimensions:



10. Select OK to close the editor. Save the Plan.

## 4 Compute and Review Results

11. **Compute** the plan with the dam breach and answer the questions below.

<u>Question</u>: What time does the breach begin? How did you determine that?

12. **Open** the **Breach Time Series Plot** from the main window. Then open the **Cross Section Plot** and **animate** them together.





*Question: What is the peak flow leaving the dam due to the breach, and what is the total peak flow leaving the dam. Why are they different?* 

# 5 Timestep Sensitivity

- 13. Create a new plan using **Save Plan As**. Name the Plan "Froehlich\_10S".
- 14. <u>Set the **timestep** of the plan to **10 seconds**</u>. **Save** and **compute.**
- 15. **Compare** hydrographs from the 10-second- and 2-minute plans.

<u>Question</u>: What differences in stage and flows did you find between the two plans? Which timestep do you think is more appropriate for this dam breach problem?

#### 6 Breach Parameter Sensitivity

- 16. Create a new plan by using **Save Plan As** and name the new plan "**VonThun**"
- 17. **Change** the breach parameters for Sayers Dam to reflect the **Von Thun breach method**. You can do this by selecting Von Then & Gillette method from the **Parameter Calculator**.
- 18. Save the plan and compute.
- 19. **Compare profiles and hydrographs** from the Froehlich and Von Thun plans.

<u>Question</u>: What differences do you see in the results when comparing the Von Thun and Froehlich plans? Where do you see the most differences?

#### 7 Add Levee Breach at Lock Haven

20. Create a new plan by using **Save Plan As** and name the new plan "**VonThun \_Levee**". In this plan you will add a levee breach to the most upstream lateral structure (sta. 23100) protecting Lock Haven shown below.



21. **Open** the **Levee Breach Data Editor** from the Unsteady Flow Analysis window and enter a levee breach for **lateral structure 23100** as shown below.

Lateral Structure  Bald Eagle C	r. Lock Haven	23100		•	J T	Delete this Breach	n Delete	all Breaches		
Breach This Structor Breach Method:	ure	Bread	ch Plot   I	Breach Pr	ogression	Simplified Physi	cal   Physical	Breaching (D	(LBreach)	Parame
User Entered Data	•		Bald 8	Eagle Cre	ek Exampl	e Dam Break Stud	y Plan:	4/16/2022	4/16/2022	
Center Station:	700									
Final Bottom Width:	500		580					_ [	Legend	
Final Bottom Elevation:	558								Lat Struct	E.
Left Side Slope;	1		5/0]						Final Bread	:h
Right Side Slope:	1	£	560							
Breach Weir Coef:	2.6	tion (								
Breach Formation Time (hrs):	5	Eleva	550							
Failure Mode: Overto	pping 💌	1.00	1							
Piping Coefficient:	0.5		540							
Initial Piping Elev:			1							
Trigger Failure at: WS Ele	v 🔻		530		500	1000	1500	2000		
Starting WS	579					Station (ft)	1.1.1	0.505		
		100								

- 22. For this plan, decrease the **Mapping Output Interval** to **5 Minutes**. This will help better visualize the inundation behind the levees later.
- 23. Save the plan and compute.
- 24. **Compare** the **profiles** and **hydrographs** results from the two Von Thun plans.

# <u>Question</u>: How much did the lateral weir breach change the maximum water surface elevation at storage area 192? How did the breach impact water surface elevations in Bald Eagle Creek?

#### 25. Open RAS Mapper and zoom to the Lock Haven area.

26. Turn on the "**PointsofInterest**" shapefile that shows locations of three road intersections in Lock Haven.



27. Turn on the **Depth** layer for the levee breach plan and **animate** the layer to visualize the inundation behind the levees.

<u>Question</u>: For the levee breach plan, what time does water first arrive at the Main & Mill location. What time is the water surface elevation at a maximum at Main & Mill?

<u>Question</u>: For the levee breach plan, what time does water first arrive at the Church & Washington location. What time is the water surface elevation at a maximum at Church & Washington?

<u>Question</u>: Are the three storage areas (190, 191, and 192) an adequate approach to model the area behind the levee? Does the model output make "hydraulic sense?" (Hint: display the water surface elevations layer in RAS Mapper). What could be done to improve the results?

#### 8 2D Area Sensitivity

- 28. In this section you will explore the differences between using 1D Storage Areas and 2D Areas for modeling the leveed area.
- 29. From the "**Von Thun\_Levee**" plan, create a new plan with **Save Plan As**. Name the Plan "**VonThun\_Levee\_2D**"
- 30. This project included an existing 2D Geometry called **"Existing Conditions-2D**". **Change the Geometry** in the plan to the 2D geometry.

📐 Unste	eady Flow Analysis				×	
File O	ptions Help					
Plan: Vor	Thun_Levee_2D	Short ID: VonThun_Levee_		VonThun_Levee_2D	2D	
	Geometry File:	Existing Conditions -2	D		•	
Program	Unsteady Flow Fly: ms to Run ometry Preprocessor steady Flow Simulation Sediment	PMF Event from HMS Plan Description			~	

#### 31. Save the plan and compute.

32. **Open RAS Mapper** and **zoom** to the Lock Haven area. **Animate** the **depth** layer.

<u>*Question:*</u> What differences do you see between the 2D and 1D inundations behind the levees?