Unsteady Flow Modeling for Dam Safety Studies
Workshop Solution

Introduction

In this workshop you were introduced to using the Inline Structure capabilities in HEC-RAS, and performing unsteady flow computations with both reservoir modeling approaches covered in the previous lecture.

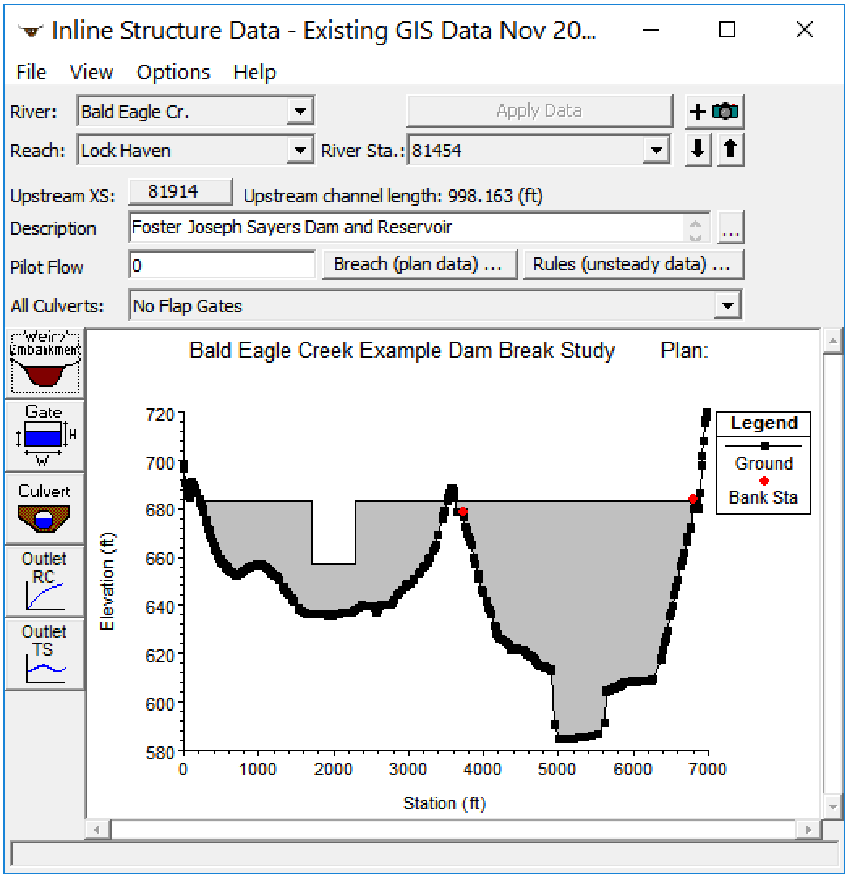
NOTE: While this data is from an actual river system, the model and results of this workshop do not represent current or future conditions of the river. The United States Army Corps of Engineers has granted access to the information in this model for instructional purposes only. Do not copy, forward,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

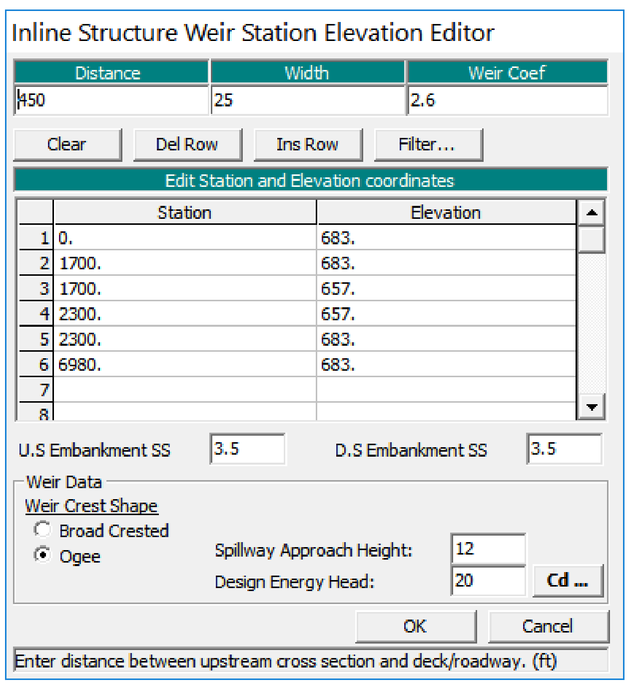
Problem Description

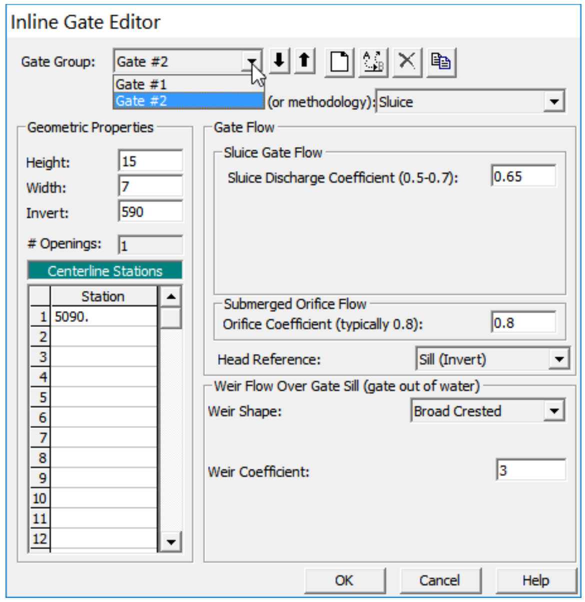
A project file (**UnsteadyFlowDamSafety.prj**) titled "**Bald Eagle Creek Example Dam Break Study**" was placed in your workshop directory. This data file included the bathymetry of the river but not the dam. You were asked to add the dam and experiment with two methods to define the reservoir.

Part A. Cross Section Reservoir Method

1. Open the project file.
2. Add inline structure to the geometry file with the following specifications:

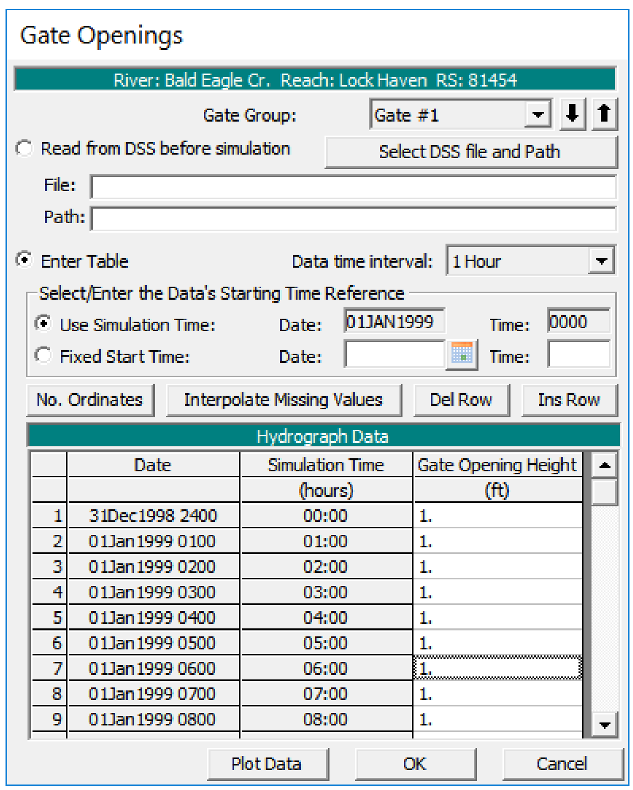

Inline Structure Data - Existing GIS Data Nov 20...
File View Options Help
River: Bald Eagle Cr.
Apply Data
Reach: Lock Haven
River Sta.: 81454
Upstream XS: 81914
Upstream channel length: 998.163 (ft)
Description
Foster Joseph Sayers Dam and Reservoir
Pilot Flow
0
Breach (plan data) ...
Rules (unsteady data) ...
All Culverts:
No Flap Gates
Weir/Embankment
Gate
Culvert
Outlet RC
Outlet TS
Bald Eagle Creek Example Dam Break Study Plan:
Elevation (ft)
Station (ft)
Legend
Ground
Bank Sta


Inline Structure Weir Station Elevation Editor
Distance
Width
Weir Coef
450
25
2.6
Clear
Del Row
Ins Row
Filter...
Edit Station and Elevation coordinates
Station
Elevation
1 0. 683.
2 1700. 683.
3 1700. 657.
4 2300. 657.
5 2300. 683.
6 6980. 683.
U.S Embankment SS 3.5
D.S Embankment SS 3.5
Weir Data
Weir Crest Shape
Broad Crested
Ogee
Spillway Approach Height: 12
Design Energy Head: 20
Cd ...
OK
Cancel
Enter distance between upstream cross section and deck/roadway. (ft)



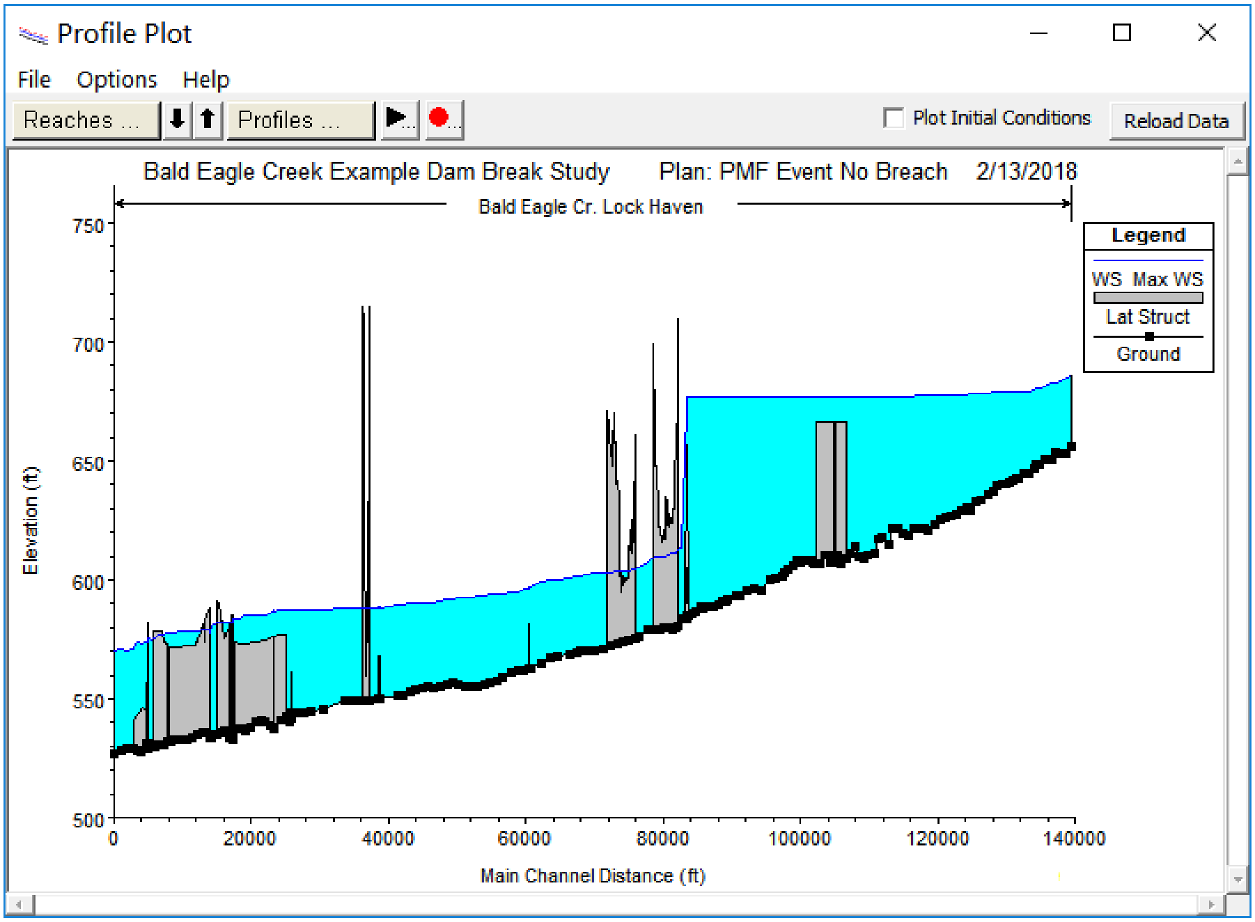
3. Set Gate Openings.

Open the unsteady flow editor. Add a boundary condition location at Station 81454 IS. Click on the blank field. Select **T. S. Gate Openings** as the boundary condition. Set each entry in the time series to a gate opening of 1 ft.



4. Compute.

Save your geometry and flow data. Open the **Unsteady Flow Analysis Window**. Press compute. Once the calculations are complete, review the output and answer the following questions.



Which levees (lateral weirs) are overtopped? **All But 80300**

What is the maximum water surface elevation at station 19487? **584.92 ft**

What is the maximum reservoir pool elevation? **676.89 ft**

Does the emergency spillway pass the PMF as designed? **Yes, the spillway is sufficient with about 6 feet to spare above the maximum pool elevation during the PMF**

What other calculations should be done to ensure the emergency spillway size is adequate? **Wind/wave and freeboard analysis should also be performed**

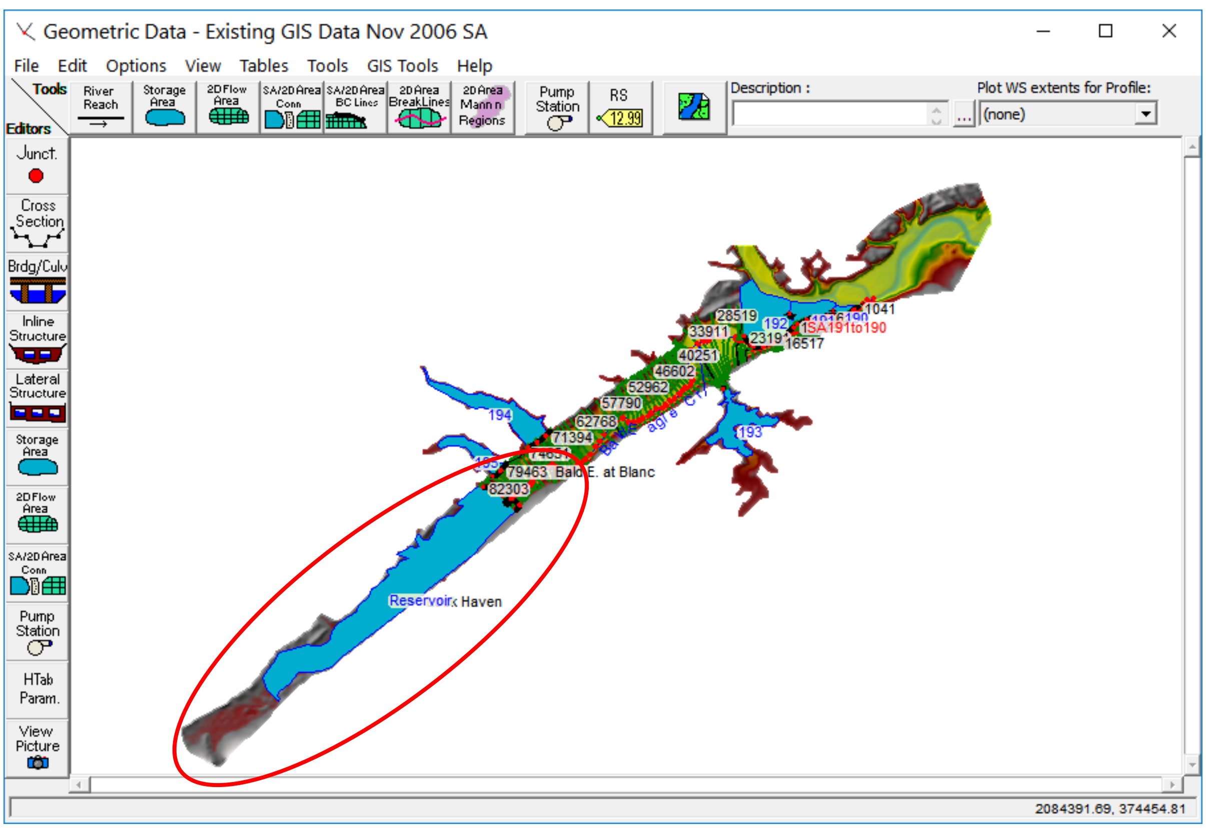
Part B. Storage Area Reservoir Method

1. Create New Geometry
Create a new geometry by saving the existing geometry with a new name reflecting the use a storage area for the reservoir.

2. Delete Cross Sections.
You were asked to set up a new geometry and plan in which the reservoir is modeled as a storage area. You had to save two cross sections upstream of the inline structure, then delete all of the other nodes upstream of the dam. You can delete multiple cross sections by selecting **Delete Nodes** under the **Edit** menu on the geometric data editor. You also needed to delete any storage areas and lateral weirs that were associated with these cross sections.

3. Create Storage Area.
Create a storage area by pressing the **Storage Area** button on the top of the geometric editor. The Storage area can have any shape you choose, but in order for the mapping output to plot appropriately it should be drawn to resemble the outline of the extent of the cross sections upstream of the dam.

4. Add Area-Capacity Reservoir Information
Next open the storage area and define the elevation-volume curve. (This can be copied from Dam Area-Capacity Table.xls). Press the **Plot Vol-Elev** button to view the curve.



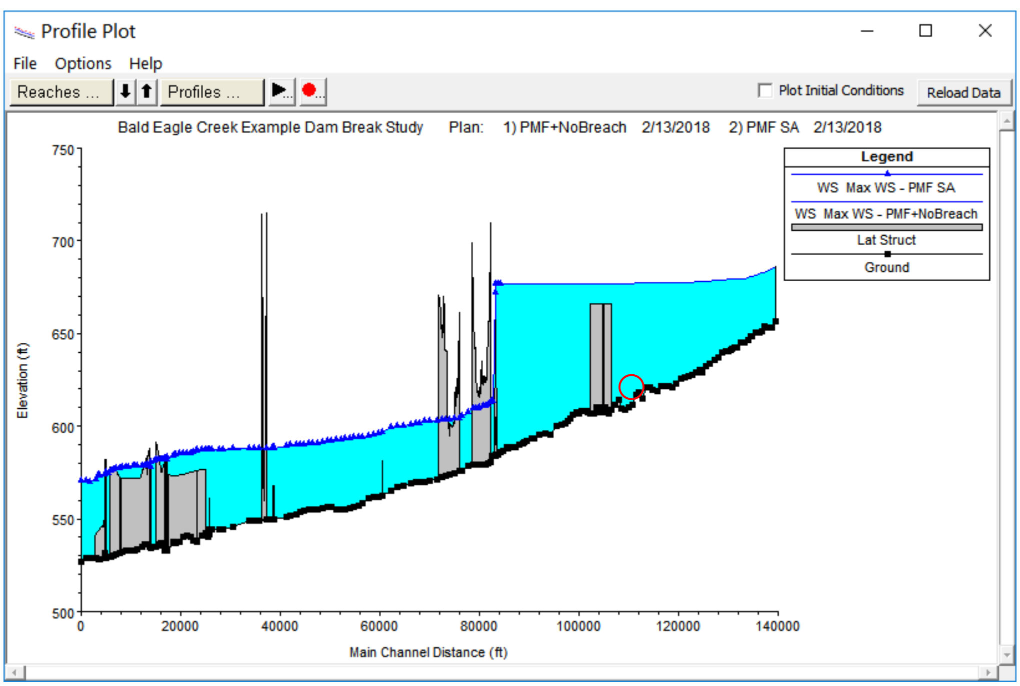
5. Connect Reach to Storage Area.
To set the storage area as your upstream boundary condition go to the **Edit** menu on the Geometric Data editor and select the **Move Object** option. Then drag the end of your stream centerline into the bounds of the storage area. If it is already in the storage area polygon just move it slightly. A message will appear asking if you want to connect the upstream end of this reach to the storage area. Select Yes.

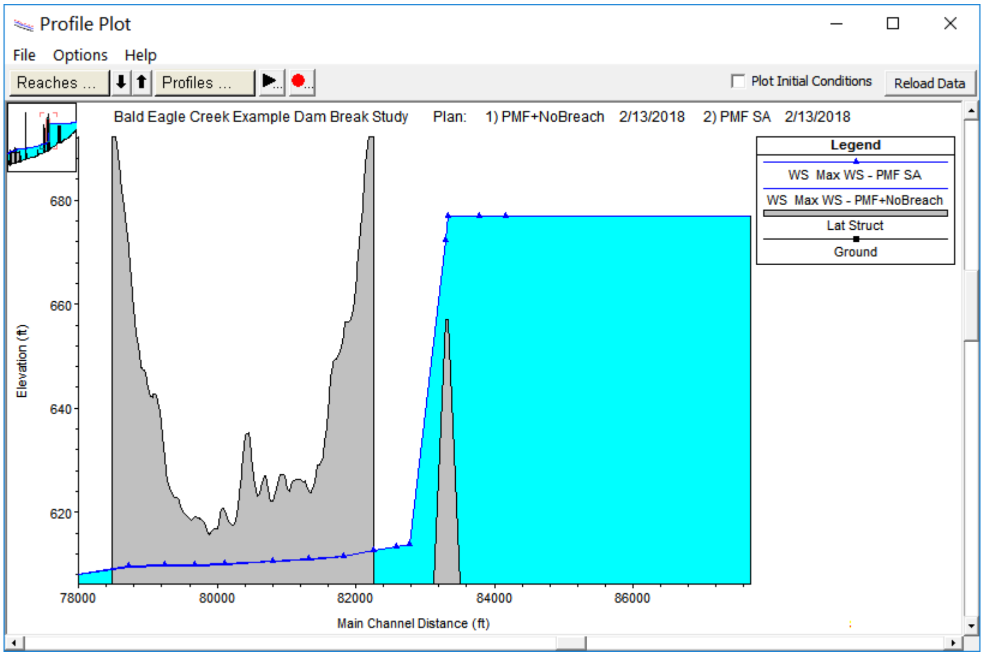
6. Create New Unsteady Flow Data file with SA
Open the unsteady flow editor. Create a new Unsteady Flow Data file by saving the existing flow data with a new name reflecting the use of the Storage Area.

7. Set Initial and Boundary Conditions.
Delete all boundary conditions that originally flowed into the deleted cross sections. All of that flow must still be accounted for however. So we must add a lateral hydrograph to the storage area. Since you can only add one lateral hydrograph to each storage area, a DSS record was created that combines these flows. Select the new storage area that you created and press the **Add a Boundary Condition Location** button. Then select the boundary condition type field and select **Lateral Inflow Hydr**. Select the DSS file **Bald_Eagle_Creek.dss** and the record:

//POOL HW/FLOW/01DEC1998/15MIN/RUN:PMF-EVENT/

8. Compute and Compare.
Create a new plan that uses the new geometry and flow files. Run the new plan. Compare the results





8. Questions

What is the maximum water surface elevation at station 19487? **585.04 ft**

What is the maximum reservoir pool elevation? **676.94 ft**

Are you satisfied with how similar the answers are between the two methods of modeling the reservoir pool?
They are within about a tenth of a foot – that's really good

How can the discrepancy between the profiles be explained?
There are several possible explanations for a discrepancy:

(1) If the elevation-volume curve differs from the elevation-volume relationship defined by the cross sections

(2) The cross section plan routs the flow through the reservoir using full unsteady flow routing with the cross sections. Travel time of the flow will be based on the velocities computed through the cross sections. The storage area approach has flow entering the upstream end, which immediately is available at the dam, but it is spread out over the entire storage area. Therefore it will pass flows though faster. Differences between the methods can also produce different peak flows and stages. However, for this example they were minimal.

Explain why you might consider using one method over the other?
If a reservoir is long and skinny, and there is a significant lag between water entering the pool and a flow response at the dam, you may want to consider using cross sections to better model the propagation of the flood wave through the reservoir.