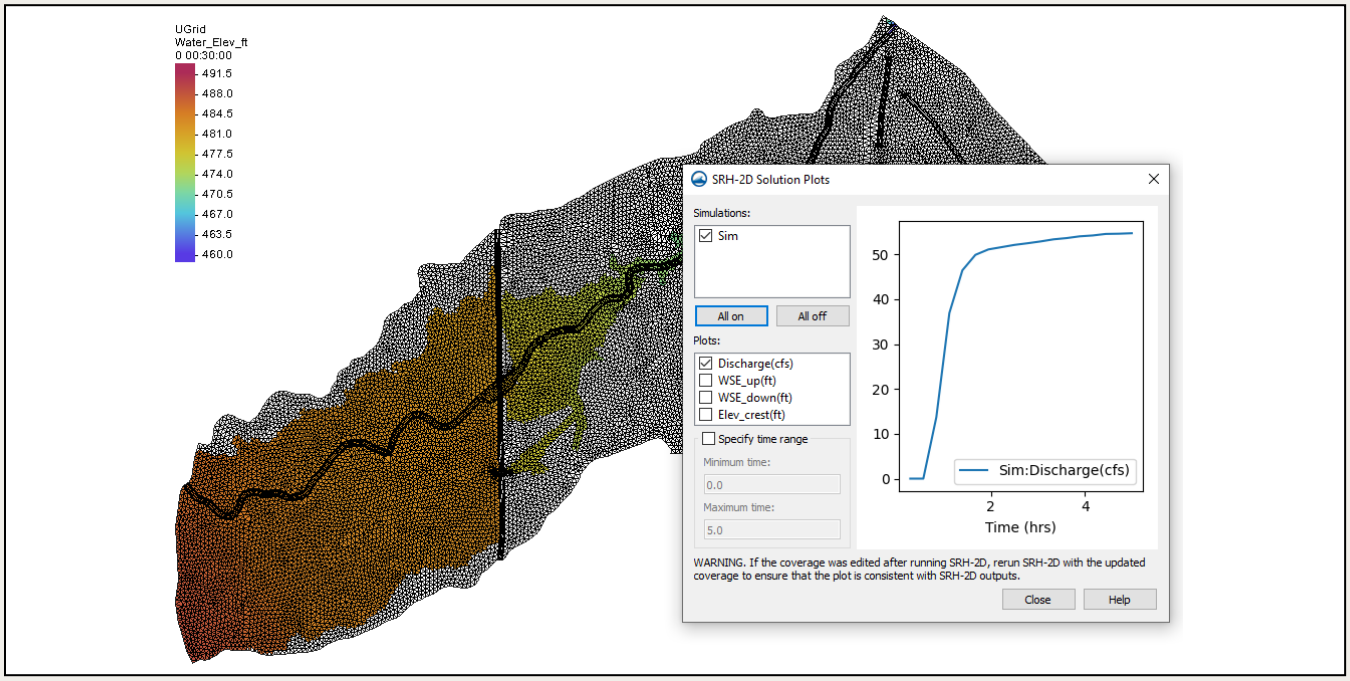
SMS 14.0 Tutorial

3D Structures (3 of 3) – SRH-2D: Including 3D Structures in Simulations

Adding a 3D Structure to a SRH-2D simulation



Objectives

This tutorial shows how to add 3D structures to a Sedimentation and River Hydraulics – Two-Dimensional (SRH-2D) simulation in the Surface-water Modeling System (SMS).

Prerequisite Tutorials

- Overview
- SRH-2D
- SRH-2D Simulations
- 3D Structures (1 of 3)
- 3D Structures (2 of 3)

Required Components

- SMS Core
- SRH-2D Model & Interface

Time

- 10–20 minutes

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1 Introduction

The Sedimentation and River Hydraulics – Two-Dimensional (SRH-2D) model is a two-dimensional (2D) hydraulic, sediment, temperature, and vegetation model for river systems developed at the United States Bureau of Reclamation (USBR) and sponsored by the United States Federal Highway Administration (FHWA).

This tutorial shows how to include 3D structures in a SRH-2D simulation. 3D structures can be used to represent a pressure bridge zone, culvert, or other structures that can be included with an SRH-2D model. SMS allows these structures to be modeled as a 3D unstructured grid, then included as part of a SRH-2D simulation run. In this tutorial, 3D structures have already been created and now need to be incorporated into an existing SRH-2D simulation. For more information about creating 3D structures, see the "3D Structures – Advanced Mesh Generation" tutorial.

This tutorial makes use of 2D mesh representing a section of the Clarke River near Murray, Kentucky. The project includes three 3D structures and an SRH-2D simulation. First, overtopping will be activated for the structures. Then, the structures will be linked to the simulation. Finally, the SRH-2D simulation will be run and the results examined using a plot.

2 Opening the SMS Project

Begin by opening an existing SMS project that includes an SRH-2D simulation and 3D structures:

1. Select *File* | **Open** to bring up the *Open* dialog.
2. Select "Project Files (*.sms)" from the *Files of type* drop-down.
3. Browse to the *data files* folder for this tutorial and select "start.sms".
4. Click **Open** to open the file into SMS and exit the *Open* dialog.

The project contains a SRH-2D simulation as well as multiple meshes, UGrids, and map coverages. The simulation parameters, materials, monitor points, and boundary conditions have been set.

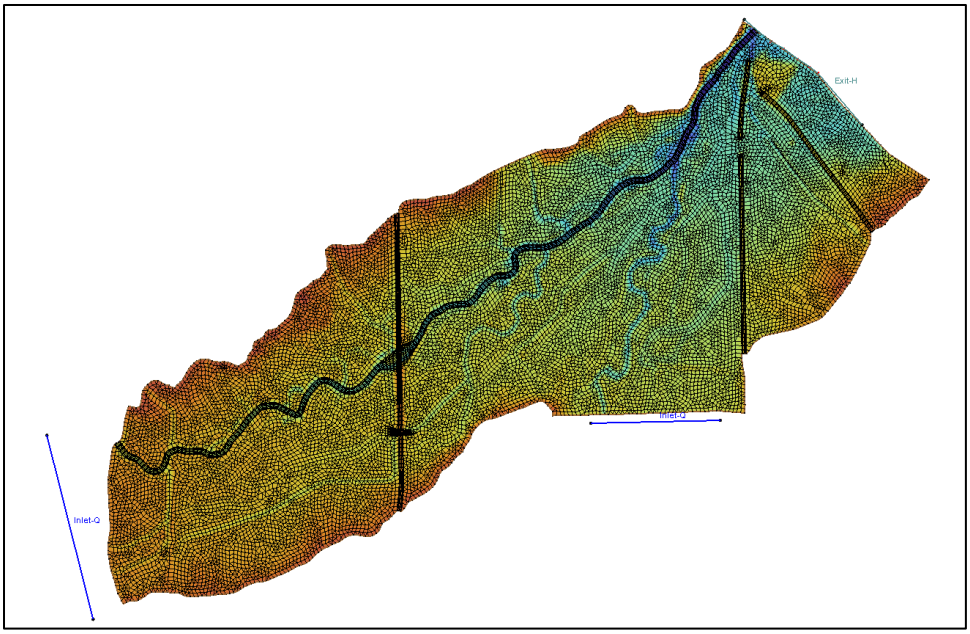

Figure 1 Initial project

This project includes three 3D structure coverages representing a bridge and two culverts. For information on the process of defining 3D structures see the "3D Structures (1 of 3)" and "3D Structures (2 of 3)" tutorials.

3 Reviewing the 3D Structures

The ceiling elevation of the 3D structures in the project will be used to compute pressure flow. Review the 3D structures by doing the following:

1. In the Project Explorer, right-click on the "Hwy 641" coverage and select **Edit Structure** to open the *Structure Properties* dialog.

Review the profiles of the structures (*Profiles* tab) and note the ceiling roughness coefficient (*Bridge Properties* or *Culvert Properties* tab). These are the values that will be used in the pressure computation.

2. When done, click **OK** to close the *Structure Properties* dialog.
3. Review the culverts by following steps 1–3 above for the "Hwy 641-Culvert_1" and "Hwy 641-Culvert_2" coverages.

To visualize the bridge and culverts, a 3D UGrid for each structure has been added to the project. The UGrids are not necessary to compute pressure flow but have been included for the sake of illustration. To view the 3D structures in the Graphics Window, complete the following:

4. In the Project Explorer, turn on the "UGrid Data" item.
5. Using the **Rotate** tool, rotate the Graphics Window to view the 3D bridge and culvert (Figure 2).
6. When done viewing the structures, select the **Plan View** macro.
7. Turn off the "UGrid Data" item in the Project Explorer.

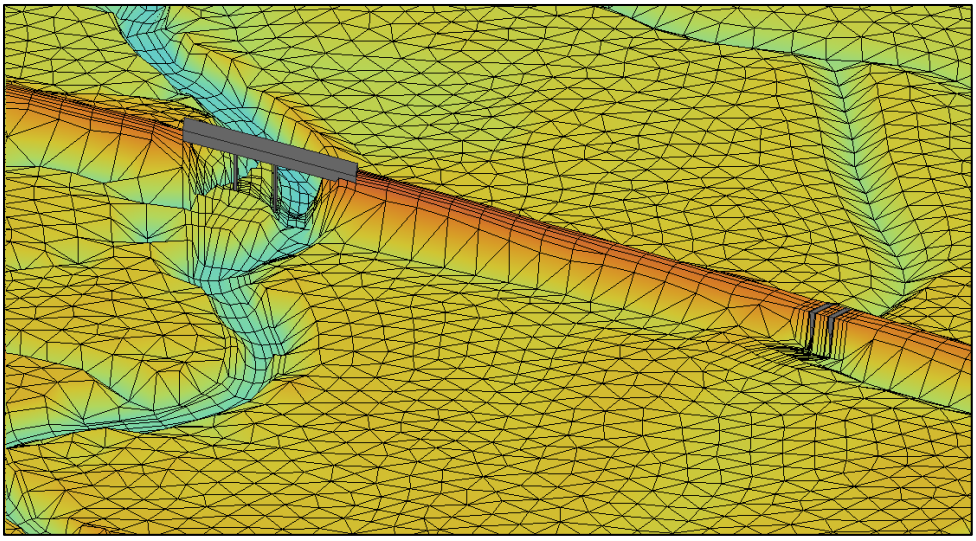

Figure 2 The 3D bridge (left) and culvert (right) structures.

4 Linking the 3D Structures

After reviewing the 3D structures, the structure needs to include overtopping and be linked to the simulation. To do this:

1. In the Project Explorer, right-click on the "Hwy 641" coverage and select **Edit Structure** to open the *Structure Properties* dialog.
2. Select the *Overtopping* tab.
3. Turn on the *Model overtopping* option.

This will allow overtopping for the structure to be included in the simulation run. When the SRH input files are exported from SMS, a Link-Weir BC will be created at the upstream and downstream faces of the bridge (or culvert); therefore, weir properties are associated with the structure when this option is turned on. The length of the weir is defaulted to the length of the structure center line arc. In this case, the length of the weir will be left at the default value.

4. Click **OK** to close the *Structure Properties* dialog.

Now add the structure to the simulation.

5. Right-click on the "Hwy 641" coverage and select the *Apply To* | **SRH-2D Simulations** → **Sim** command.
6. Repeat steps 1–5 for the "Hwy 641-Culvert_1" and "Hwy 641-Culvert_2" coverages.

Note that the weir length for "Hwy 641-Culvert_1" is set to a value of 7.0. This is because the culvert span (for the box culvert) is set to 7.0. The weir length is set to 15.5 for "Hwy 641-Culvert_2" because this culvert has two barrels at 7.0 ft diameter and a wall width of 1.5.

5 Saving and Running SRH-2D

Before running the model, the project should be saved with a new name. To do this:

1. Select *File* | **Save As** to bring up the *Save As* dialog.
2. For the *File name* enter “3d-structures.sms” and click **Save** to close the *Save As* dialog.

The project is now ready to run.

3. Right-click on the “ Sim” simulation and choose **Save Project, Simulation and Run**.
4. This brings up the *Simulation Run Queue* dialog.

As SRH-2D is running, feel free to review the plots from the simulation by selecting the SRH-2D process and stepping through the tabs for the plots.

5. Once SRH-2D is finished, click **Load Solution** to import the solution datasets.

6. Click **Close** to exit the *Simulation Run Queue* dialog.

Several solution datasets will appear in the Project Explorer.

6 Viewing the Results

Now to review the results of the model run:

1. Select the “ Water_Elev_ft” dataset to make it active.
2. Select the second Time Step.

Notice how the water constricts around the 3D structures (Figure 3). If needed adjust the display options.

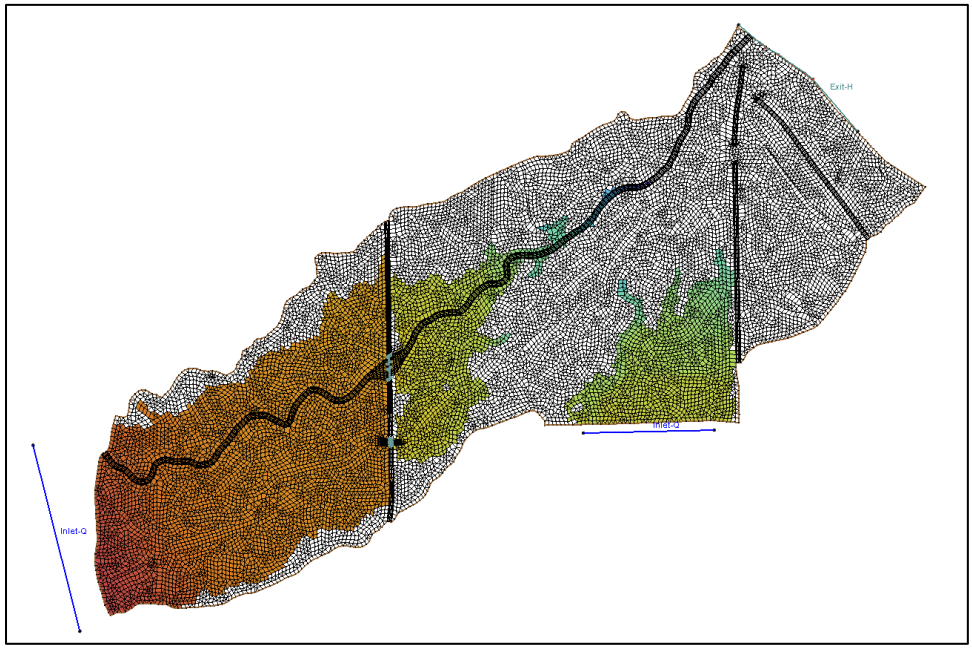

Figure 3 The "Water_Elev_ft" dataset at the second time step

6.1 Viewing 3D Structure Summary

The 3D structures can be used to view a plot of the simulation run at the structure location.

1. In the Project Explorer, right-click on the "Hwy 641" coverage and select **3D Structure Summary** to open the *3D Structure Summary* dialog.
2. Under *Plots*, turn on *Q-Overtopping (cfs)*.

Notice that this value is 0 meaning there is no overtopping.

3. Under *Plots*, turn off *Q-Overtopping* and turn on the following:
   - *WSE_up* (ft)
   - *WSE_down (ft)*
   - *Elev_crest (ft)*

Review the plots created at the structure location. The plots should appear similar to Figure 4.

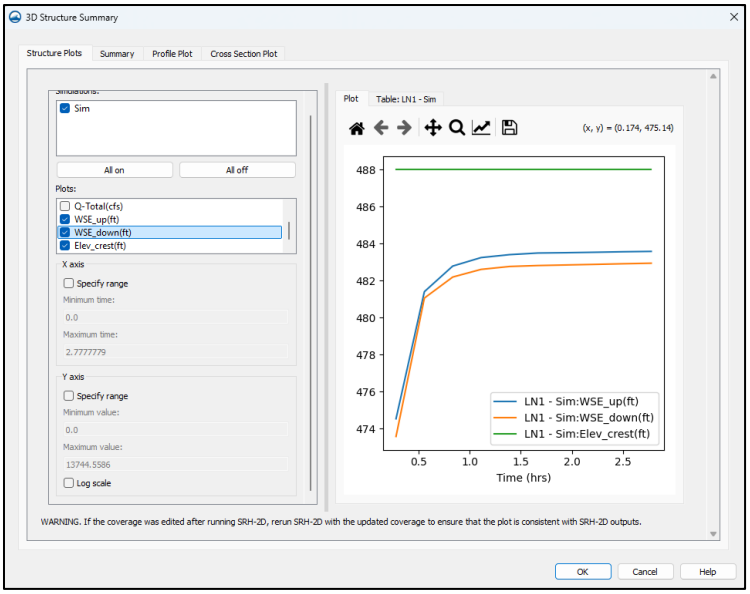

Figure 4 SRH-2D bridge structure solution plots

The summary dialog has three other tabs that show information about the simulation at the 3D structure. The *Summary* tab shows a table of the simulated flows and elevations at the structure for a selected time. The *Profile Plot* and *Cross Section Plot* show a plot of the 3D structure along with the ground elevation and water surface elevation.

4. Select the *Summary* tab to view the value at the selected time.
5. Select the *Profile Plot* tab.
6. Under the *Simulations* section, turn on *Sim*.

A profile plot is now displayed with the ground surface, water surface elevation and the 3D structure as intersected by the arc in the "Profile" coverage.

7. Select the *Cross Section Plot* tab.
8. Under the *Simulations* section, turn on *Sim*.

A Cross Section plot is now displayed with the ground surface, water elevation surface and 3D Structure as intersected by the center line of the 3D Structure.

9. When done, click **OK** to exit the *3D Structure Summary* dialog.

10. In the Project Explorer, right-click on the "Hwy 641-Culvert_2" coverage and select **Structure Summary** to open the *3D Structure Summary* dialog.
11. Under *Plots*, turn on *Q-Overtopping (cfs)*.

Notice that the culvert does show overtopping (Figure 5).

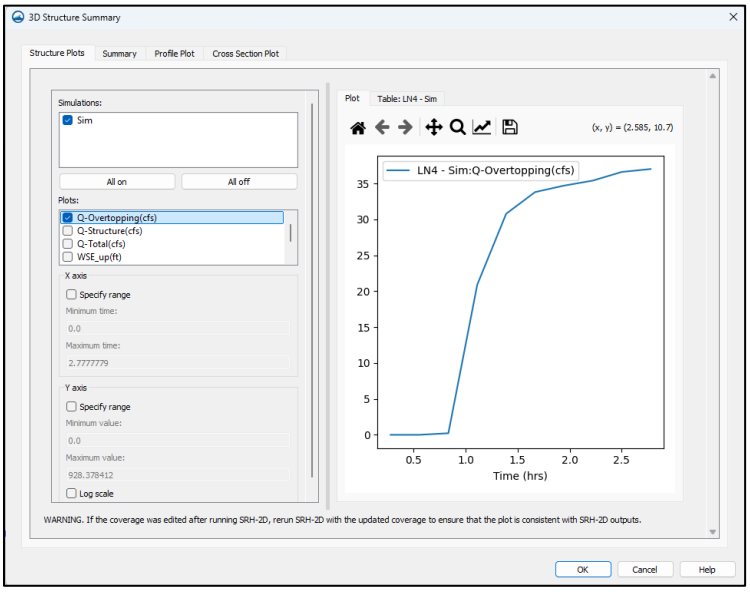

Figure 5 SRH-2D culvert structure solution plot showing overtopping

7 Conclusion

This concludes the "SRH-2D: Including 3D Structures in Simulations" tutorial. If desired, experiment with different options in this project. Some options could include:

- Add both a 3D bridge and 3D culvert structure to a SRH-2D simulation.
- Running an SRH-2D simulation and reviewing the result of including the 3D structures.