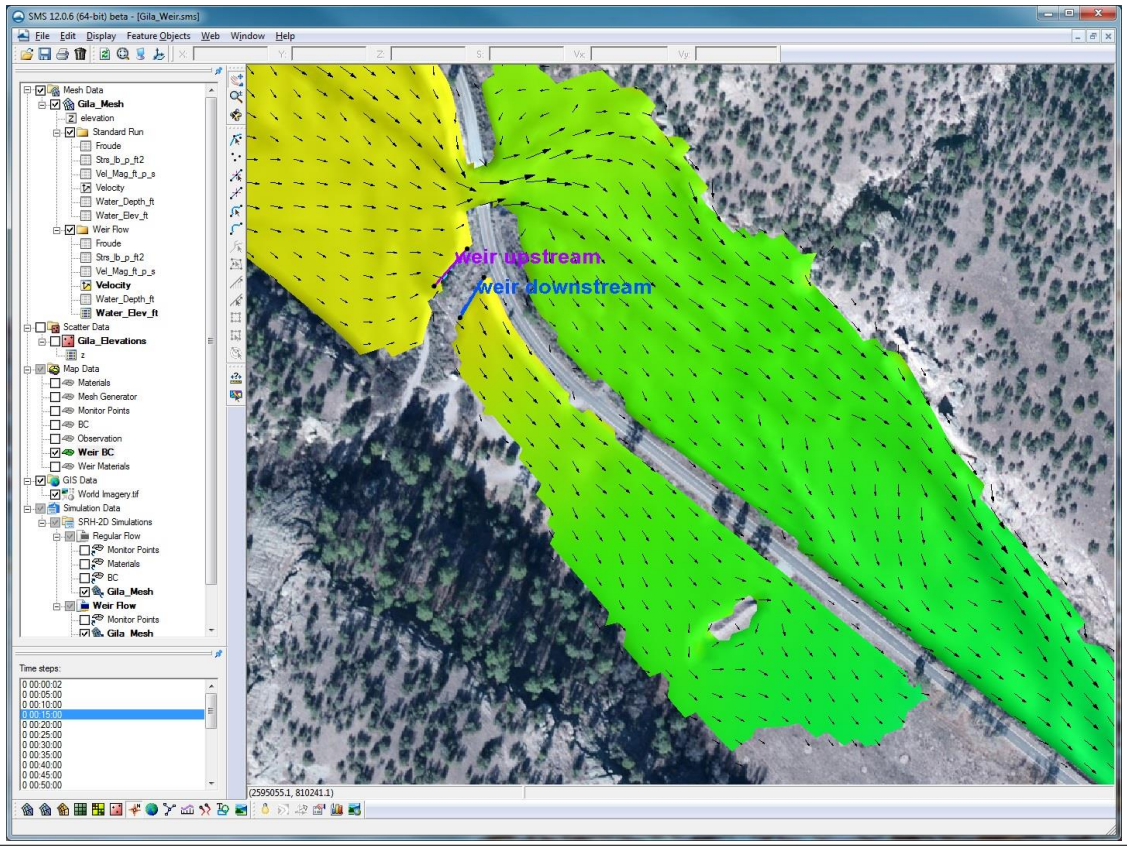
SRH-2D Tutorial

Weir Flow



Objectives

This tutorial demonstrates the process of creating a 1D weir structure for SRH-2D to model an overflow weir near a bridge structure. The "Simulations" tutorial should have been completed before attempting this one.

Prerequisites

- SMS Overview
- SRH-2D
- SRH-2D – Simulations

Requirements

- SRH-2D
- Mesh Module
- Scatter Module
- Map Module

Time

- 15–20 minutes

1 Model Overview

An existing SRH-2D model will be used to facilitate the setup for this tutorial. The area being modeled is located at the confluence of the west and middle forks of the Gila River, located in New Mexico.

Upstream of the confluence, water backs up around the bridge opening and floods over the roadway. To mitigate this flooding, an overflow weir has been proposed to help divert water into an overflow basin. In the model, the weir will be portrayed as two arcs representing the upstream and downstream faces of the weir structure.

Limitations of the SRH-2D weir structure are that it does not allow reverse flow, and that the momentum from the 2D computations on the approach side of the weir do not get carried through the structure. If it is desired to account for momentum and also create a scenario in which reverse flow occurs, a more appropriate approach would be to modify the geometry of the mesh to represent the weir based on the terrain. All files for this tutorial are found in the *SMS_SRH-2D_Weir/Input* folder.

2 Getting Started

To begin, do the following:

1. Open a new instance of SMS, or press *Ctrl-N* within SMS.
2. Select *File* | **Open…** to bring up the *Open* dialog.
3. Navigate to the *SRH2D_Weir/Input* folder for this project and select "Gila_Structure.sms".
4. Click **Open** to import the project.

The Graphics Window should appear similar to that shown in Figure 1.

In the Project Explorer, duplicates of the "Regular Flow" simulation and the "BC" coverage have already been made to aid in setting up the model. The duplicates have been renamed as "Weir Flow" and "Weir BC" respectively.

The process of duplicating these items was demonstrated in the "Simulations" tutorial. Creating duplicates of simulations or coverages allows making modifications to a model while still preserving the original simulation or coverages. This also enables creating several modeling scenarios in the same project and comparing the solutions.

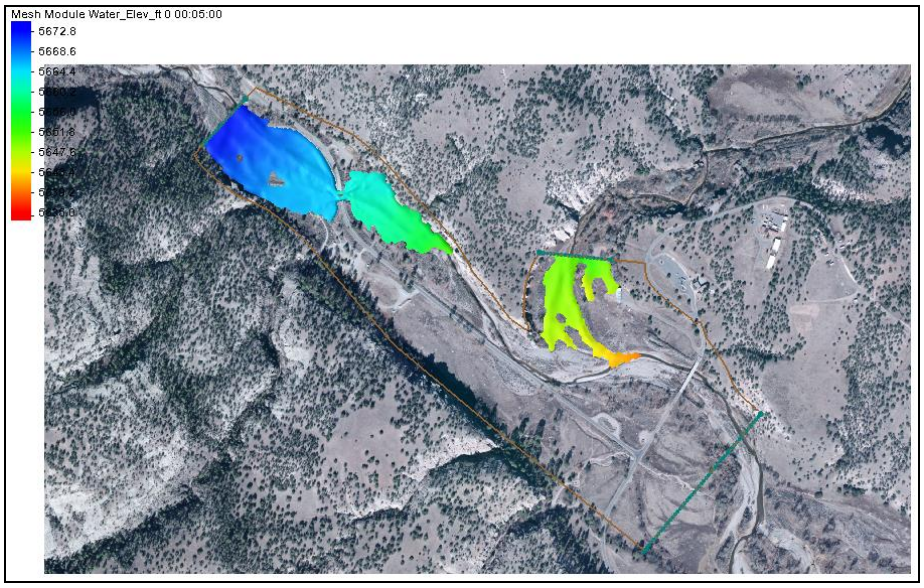


Figure 1 Gila_Structure.SMS project

The mesh datasets located under the "Regular Flow" folder in the Project Explorer are SRH-2D solution datasets of the existing flow conditions, without the weir structure. They have been provided to compare the effect that the overflow weir will have on the flooding.

3 Creating the Weir Structure

The weir structure will be created along a berm near the bridge that is located just upstream of the confluence (see Figure 2). The weir will represent a proposed physical weir with the crest set lower than the berm elevations to provide a flood relief structure. This should help to prevent roadway overtopping. In SMS, weir structures are defined by creating two arcs that represent the upstream and downstream faces of the weir.

3.1 Creating the Weir Structure Arcs

The first step in creating a weir structure is to create two arcs that will represent the faces of the weir. Once the arcs have been created in the map coverage and the coverage has been linked to a simulation, the weir structure will be defined.

1. **Zoom** into the location shown in Figure 2.
2. Select the "Z" dataset under "Gila_Mesh" in the Project Explorer to display the mesh elevations.
3. Select *Display* | **Display Options…** to open the *Display Options* dialog.
4. Select "2D Mesh" from the list on the left.
5. On the *2D Mesh* tab, turn on *Elements*.
6. Select **OK** to exit the *Display Options* dialog.

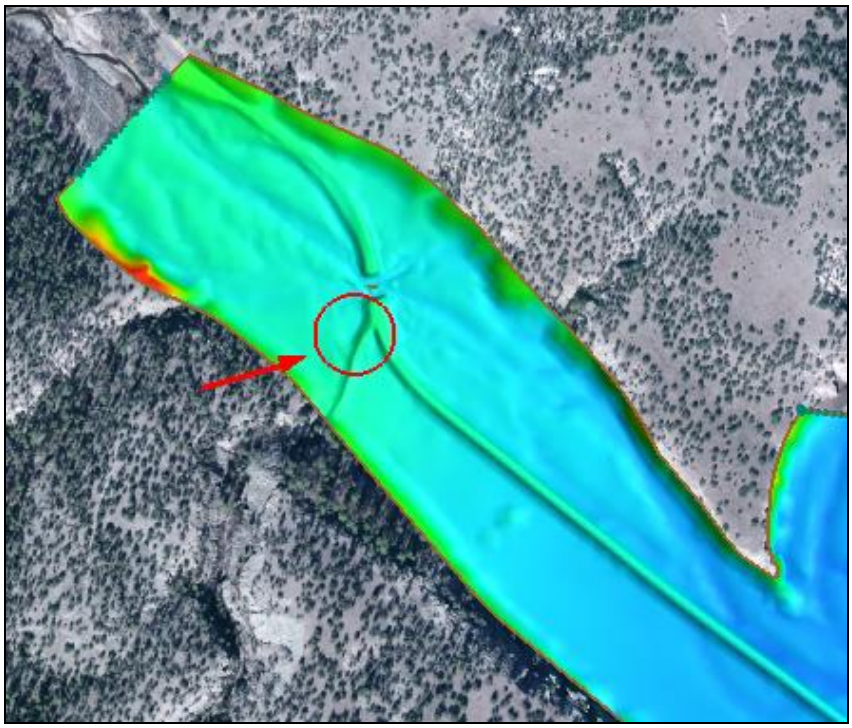


Figure 2 Weir location

7. In the Project Explorer, check the box next to the "Weir BC" coverage and select it to make it the active coverage.
8. Use the **Create Feature Arc** tool to create two arcs, one on the upstream face and one on the downstream face. The created arcs should look similar to Figure 3.

It is recommended that the mesh be created to contain quadrilateral elements within the area between these two arcs which represent the weir structure and that the structure arcs are aligned with a clean row of element edges.

Note: When drawing these arcs, they should be drawn in the same direction. After the first arc has been drawn, ensure that the second arc is drawn in the same direction (north to south or south to north). Drawing them in opposing directions may cause an error when running SRH-2D.

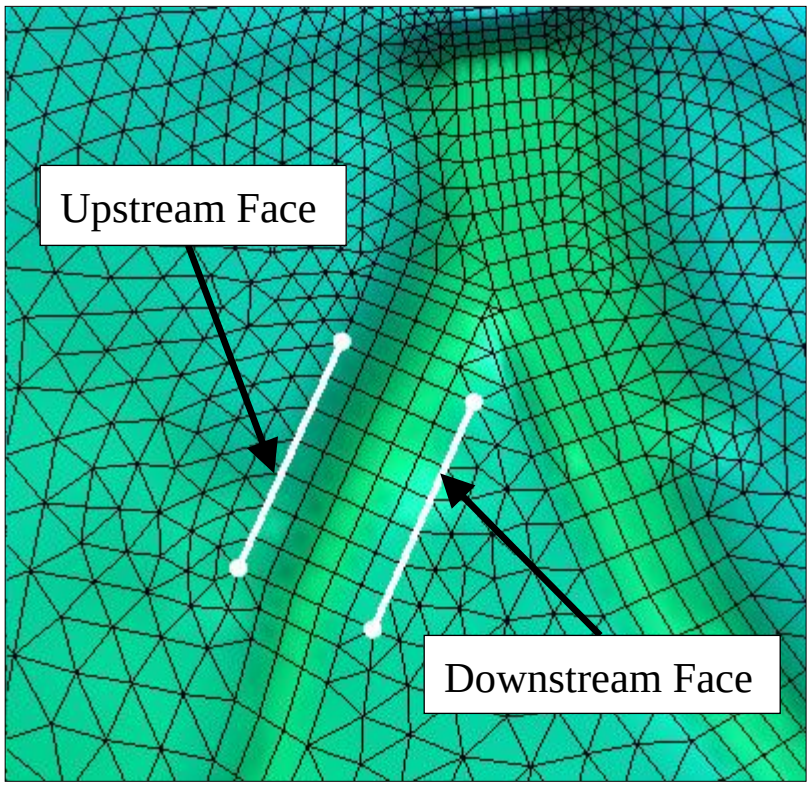


Figure 3 Weir structure arc locations

3.2 Assigning the Weir Attributes

The next step in creating a weir structure is to specify the arc type and define it by assigning attributes to the arcs.

1. Using the **Select Feature Arc** tool, select the upstream (left most) arc and take note of the ID for this arc (displayed at the bottom of the Graphics Window in SMS).
2. Hold the *Shift* key and select the downstream arc so that both of the arcs are selected.
3. Right-click on either arc and select **Assign Linear BC...** to bring up the *SRH-2D Linear BC* dialog.
4. Select "Weir" from the *Type* drop-down.

Note the assignment in the *Role* column of "weir upstream" and "weir downstream" to the two arcs, associated with their ID values in the *Object Id* column. If the ID displayed for "weir upstream" is not the same as noted above in step 1, switch the associations using the *Role* drop-down menus.

5. Select "ft" for the *Units*.
6. Enter "5667.5" for *Crest elevation*.
7. Enter "100" for *Length of Weir*.

8. Gravel roadway is the weir type that most closely relates to the berm. Select "Gravel" from the *Type* drop-down.
9. Select **OK** to exit the *SRH-2D Linear BC* dialog.

Several other weir types exist including: "paved", "single", "double", "sharp", "broad" and "user". With the "user" weir type, weir coefficients and dimensionless submergence factor coefficients *a* and *b* can be specified.

The dimensionless submergence factor coefficients are used to calculate the submergence coefficient as shown in the following equation:

$$C_s = \left[1 - \left(\frac{Z_D - Z_C}{Z_U - Z_C}\right)^a\right]^b$$

Where:

C_s = submergence coefficient

Z_D = average downstream water surface elevation

Z_C = average weir crest elevation

Z_U = average upstream water surface elevation

a = dimensionless submergence factor coefficient

b = dimensionless submergence factor coefficient

The following is the equation used by SRH-2D to calculate flow over a weir:

$$Q_w = C_s C_w \sqrt{g} L_w \left(Z_U - Z_C\right)^{3/2}$$

Where:

Q_w = flow rate

C_s = submergence coefficient

C_w = dimensionless discharge coefficient for unsubmerged weir flow

g = gravity

L_w = length of weir segment

Z_U = average water surface elevation along upstream arc

Z_C = average crest elevation

4 Creating a Monitor Line

SRH-2D monitor lines allow the extraction of flows and water surface elevation data from the model at a specified locations. A monitor line will be created near the downstream face of the weir in order to monitor the flow coming out of the weir structure.

1. Select the "Monitor" coverage to make it active.

2. Using the **Create Feature Arc** tool, create a monitor line closely offset from the downstream weir face arc (see Figure 4).

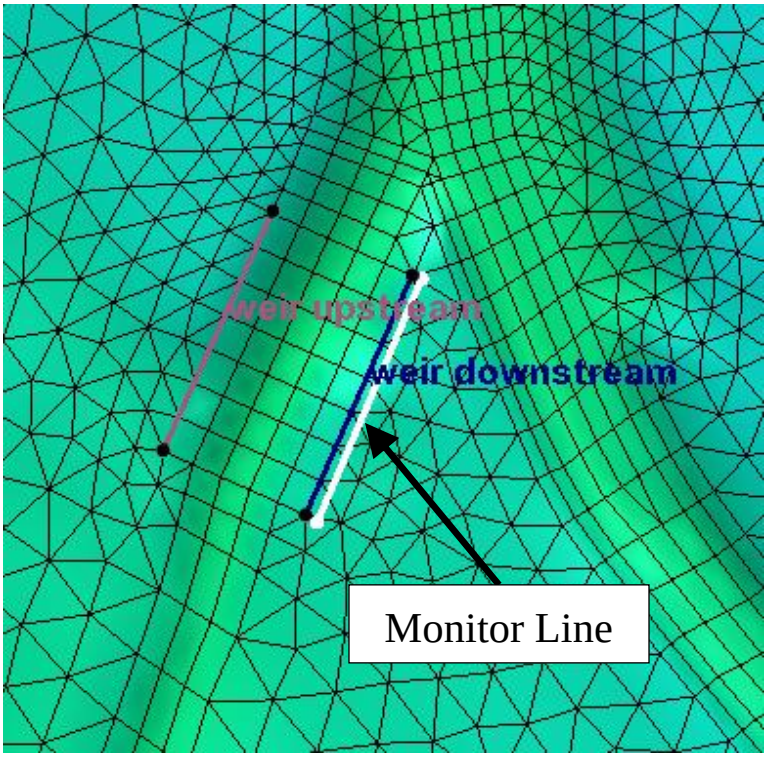


Figure 4 Monitor line offset from the downstream weir arc

5 Saving, Exporting, and Launching the Simulation

With the weir structure created, the model is ready to run. Next the model controls must be set. To do this:

1. Right-click on the "Weir Flow" simulation and select **Model Control…** to bring up the *Model Control* dialog.
2. Enter "Weir_Flow" in the *Case Name* field.
3. Leave all other settings at the default and click **OK** to close the dialog.

To save the project, export the simulation, and launch SRH-2D:

4. Right-click on the "Weir Flow" simulation and choose **Save, Export, and Launch SRH-2D** to launch the *Simulation Run Queue* dialog.
5. Select **OK** if a warning is displayed stating that the "Weir BC" coverage will be renumbered before exporting.
6. Click **Load Solution**, as shown in Figure 5. The solution datasets will now be listed in the Project Explorer under the folder "Weir Flow".
7. Click **Close** to exit the *Simulation Run Queue*.

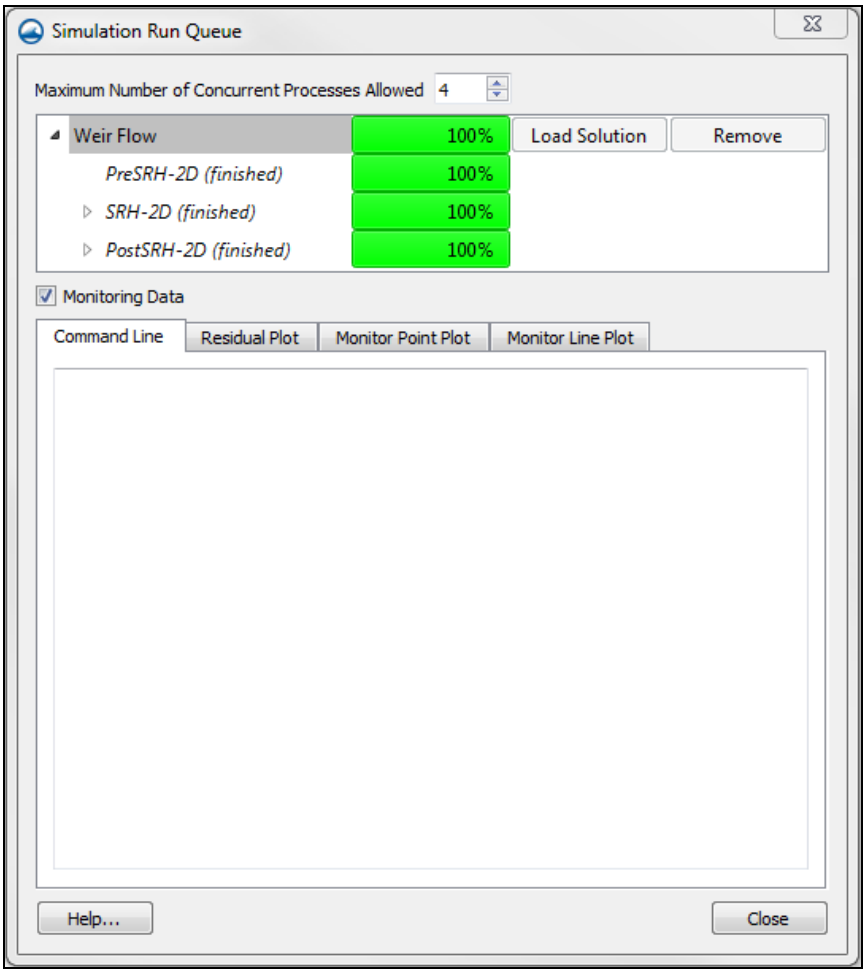


Figure 5 SMS Simulation Run Queue

8. **Frame** the project.
9. Turn off "Weir BC" in the Project Explorer.
10. Check the box next to "World Imagery.tif", if it is not already checked.

6 Analyzing the Results

6.1 Visualizing the Datasets

The datasets will now be visualized and the output from the monitor line will be viewed.

1. Select the "Water_Elev_ft" dataset in the "Weir Flow" folder to make it active.
2. Cycle through the time steps to view the water flowing through the weir and into the overflow basin. Notice that the water now flows over the weir structure and prevents overtopping and reduces water on the roadway north of the bridge. If desired, cycle through the other datasets to visualize them.

6.2 Viewing the Monitor Line Output File

A file was exported to the output files that lists the flows and average water surface elevation along the monitor line arc. This can be viewed in any text editor application.

1. Browse to the *SMS_SRH-2D_Weir/ Input/Gila_Structure/SRH-2D/Weir Flow* directory.
2. Using a text editor application, open the file "Weir_Flow_LN1.dat".
3. Observe the flows and average water surface elevations listed in the monitor line output file.

Monitor line output files will always be named according to the case name and monitor line number. For example, if the case name for a different run was "High_Tailwater" and two monitor lines existed in the model, the monitor line output files would be called "High_Tailwater_LN1.dat" and "High_Tailwater_LN2.dat" respectively.

The discharge flows and WSE for the weir structure are also written out to another output file called "Weir_Flow_Weir1.dat".

7 Conclusion

This concludes the "SRH-2D - Weir Flow"[1] tutorial. If desired, continue to experiment with the SMS interface or quit the program.

[1] This tutorial was developed by Aquaveo, LLC under contract with the Federal Highway Administration.