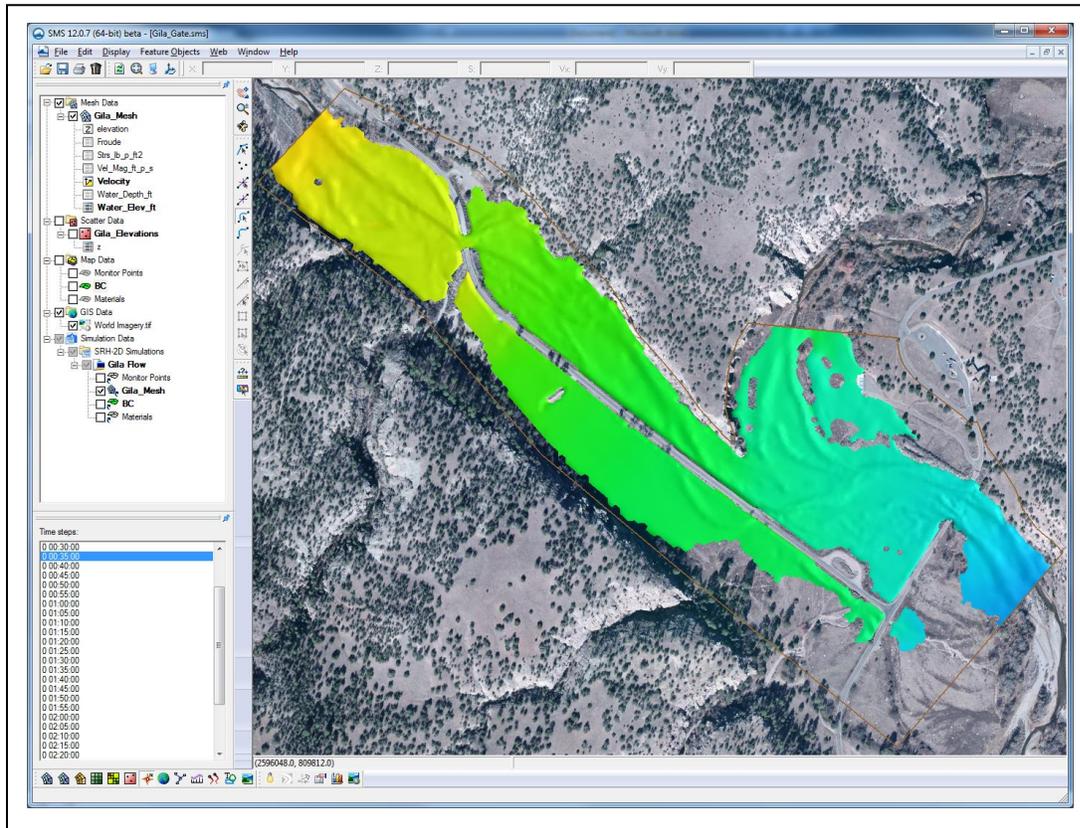


## SMS 12.2 Tutorial SRH-2D – Gates



### Objectives

This tutorial demonstrates the process of modeling Gates in SRH-2D. The “SRH-2D” tutorial should have been completed before attempting this one. All files for this tutorial are found in the “Data” folder within the “SRH2D\_Gate” folder.

### Prerequisites

- SRH-2D

### Requirements

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

### Time

- 15–20 minutes



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## 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.

In this model simulation, excess flow passes through an overflow weir and into a drainage basin. The water is then released further downstream through a vertical gate. This tutorial will demonstrate the creation of a gate boundary condition within SMS to simulate flow through a gate using SRH-2D.

The process of creating a simple model and then duplicating the simulation and adding structures or other model features to the duplicated simulation can be a useful way of comparing changes in a model.

## 2 Getting Started

To begin, open an existing SRH-2D model:

1. Open a new instance of SMS, or press *Ctrl-N* to reset it.
2. Select *File | Open...* to bring up the *Open* dialog.
3. Navigate to the *Data* folder for this project and select “Gila\_Flow.sms”.
4. Click **Open** to import the project file and close the *Open* dialog. The Graphics Window will appear as in Figure 1.

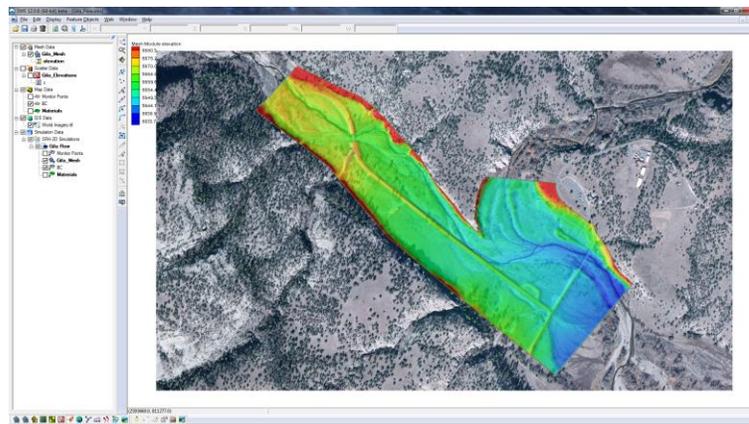


Figure 1 Gila\_Flow.sms project

### 3 Creating the Gate Boundary Condition

Gate boundary conditions are defined by creating a pair of arcs in the boundary condition coverage, one on the upstream face and one on the downstream face of the gate structure. A polygon specifying the area between the arcs is also created in the materials coverage and defined as an unassigned material type. The arcs are then defined as a gate in SMS and attributes of the gate are specified.

#### 3.1 Creating the Boundary Condition Arcs

The first step is to create arcs within the boundary condition coverage that represent the gate structure near the intersection of the two roads as displayed in Figure 2.

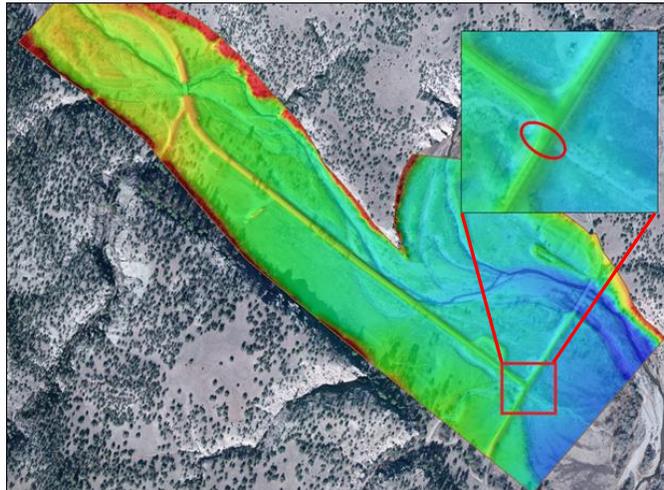


Figure 2 Zoomed in on the gate location

1. **Zoom**  into the gate location shown in the Figure 2 inset.
2. Select *Display* | **Display Options...** to open the *Display Options* dialog.
3. Select “2D Mesh” from the list on the left.
4. In the *2D Mesh* tab, turn on *Elements*.
5. Select **OK** to exit the *Display Options* dialog.
6. In the Project Explorer, select the “ BC” coverage to make it active.
7. Using the **Create Feature Arc**  tool, create two arcs, one on each side of the road (Figure 3). These arcs will define the upstream and downstream faces of the gate boundary condition.

In most cases, both a gate structure and a culvert would be included in a scenario such as this. For simplification purposes, this tutorial uses only a 1D gate with flow computed which implies the existence of a culvert sufficiently large as to not impede flow under the road.

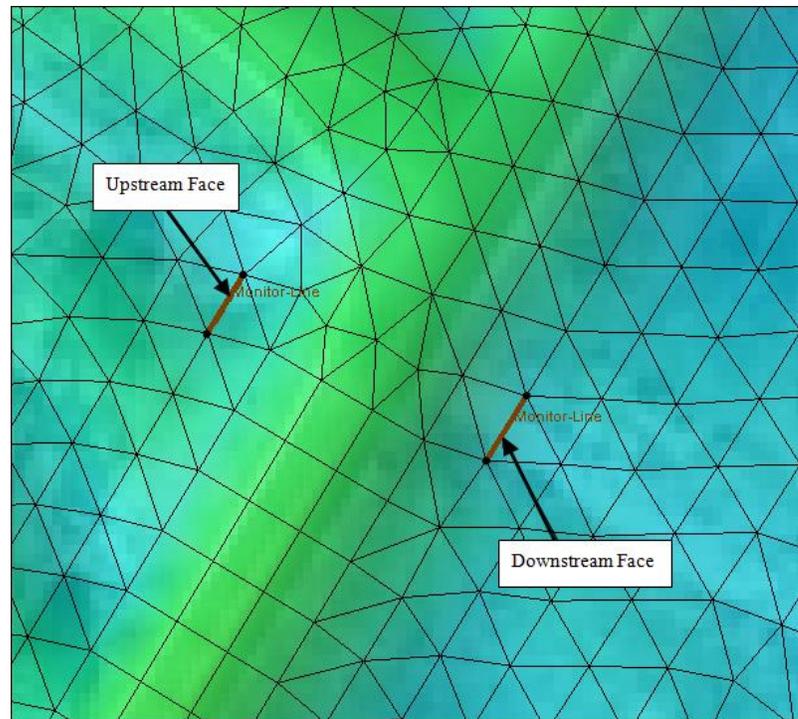


Figure 3 Upstream and downstream gate boundary condition arcs

- Using the **Select Feature Point**  tool, select the top left arc node (upstream) and manually enter the X and Y values from Figure 4 into the coordinate fields at the top of the Graphic Window.

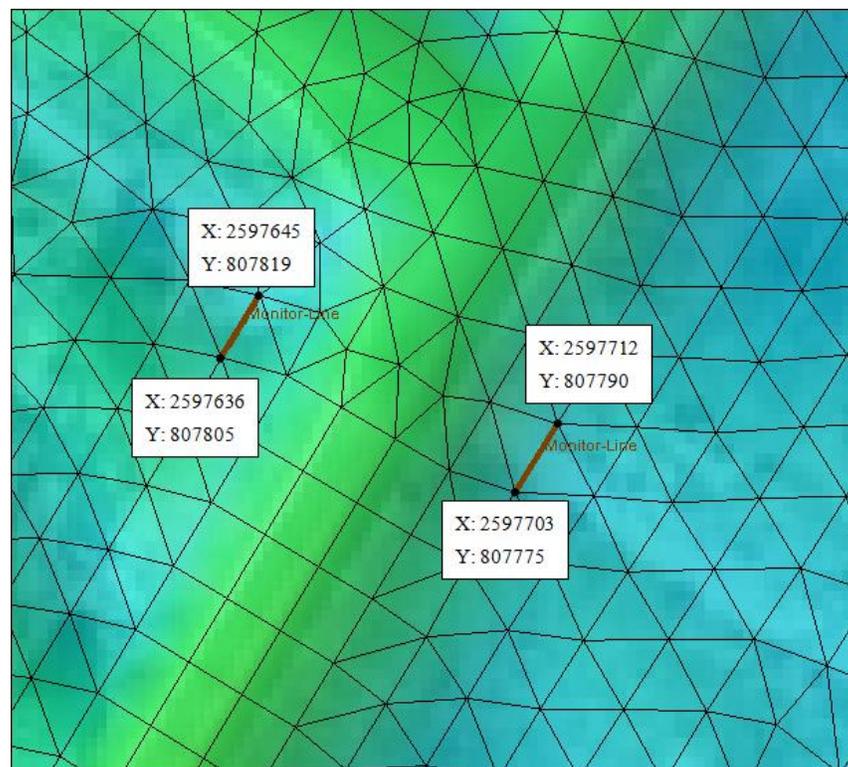


Figure 4 Coordinates for the four nodes

9. Repeat step 8 for the remaining nodes, and using the data from Figure 4.
10. If any vertices exist along these arcs, they should be selected and deleted using the **Select Feature Vertex**  tool and pressing the *Delete* key.

### 3.2 Assigning the BC Attributes and Defining the Gate

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The next step in creating a boundary condition is to specify the boundary condition (BC) type and define the attributes of the gate. 1D gates within SRH-2D simulate the flow of an underflow gate such as a vertical lift gate or radial gate. These types of gates behave as an orifice when the water surface is above the top of the gate opening and as a weir when the water surface is below the top of the gate opening.

If the gate to be modeled is an overflow gate, such as a flap gate, sector gate, or roller gate, these can simply be modeled as a weir structure in SRH-2D. The gate in this tutorial will be defined as a vertical underflow gate.

To do this, do the following:

1. Using the **Select Feature Arc**  tool, select the upstream (leftmost) arc and take note of the ID for this arc (displayed at the bottom of the Graphics Window).
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 “Gate” from the *Type* drop-down.
5. Note the *Role* assignment of “gate upstream” and “gate downstream” to the two arcs, associated with the *Object ID* values. If the *Object ID* displayed for gate upstream is not the same as noted above in step 1, switch the associations using the drop-down in the *Role* column.
6. Select “ft” from the *Units* drop-down.
7. Scroll down and enter “5649” in the *Crest Elevation* field. This represents the elevation of the base upon which the gate closes, or channel bottom.
8. Enter “3” in the *Height of Gate Opening* ( $H_g$ ). This represents the opening measured vertically from the base of the structure to the top of the gate opening as shown in Figure 5.

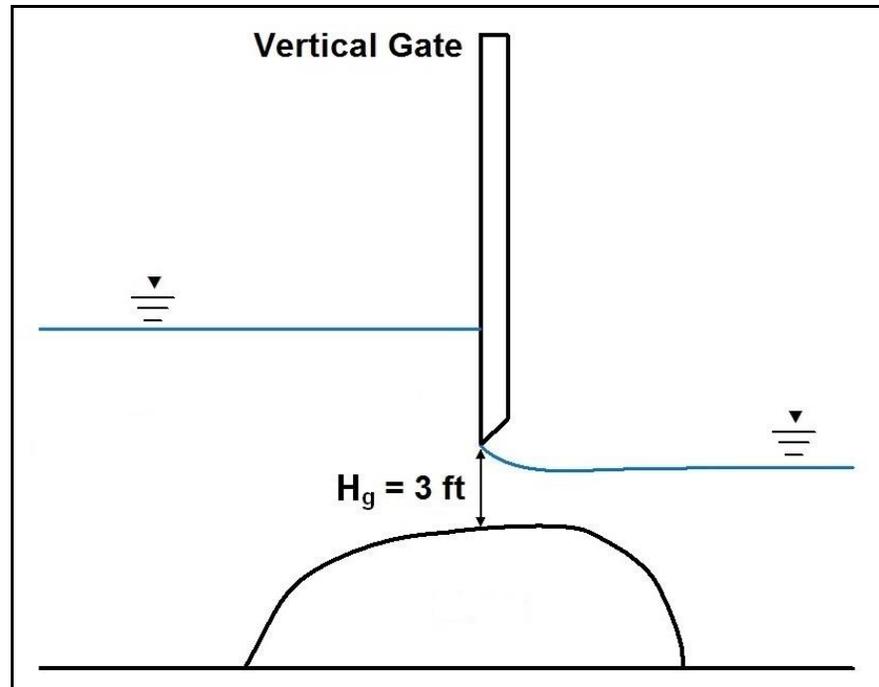


Figure 5 Height of gate opening

9. Enter “16” for *Width of Gate Opening*. This represents the horizontal width of the gate opening.
10. Enter “0.61” for *Contract Coefficient with Underflow Orifice*. This is used to calculate the discharge coefficient, which is then used to determine the flow under the gate.
11. Select “Gravel” from the *Type* drop-down.
12. Select **OK** to exit the *SRH-2D Linear BC* dialog.

### 3.3 Modifying the Materials Coverage

In order to properly define a gate boundary condition in SMS, the materials coverage must also be modified. SMS requires that the material type of the elements between the two faces of the gate be specified as “Unassigned”. Any element with an unassigned material type will be defined as a “No-flow”/ inactive element.

1. Turn off “ Mesh Data” and “ GIS Data” in the Project Explorer.
2. Turn on the “ Materials” coverage and select it to make it active.
3. Using the **Create Feature Arc**  tool, click out a rectilinear arc that encloses the area between the two gate arcs (Figure 6). Use the visible inactive gate arcs from the “BC” coverage as a guide when drawing the enclosed area.

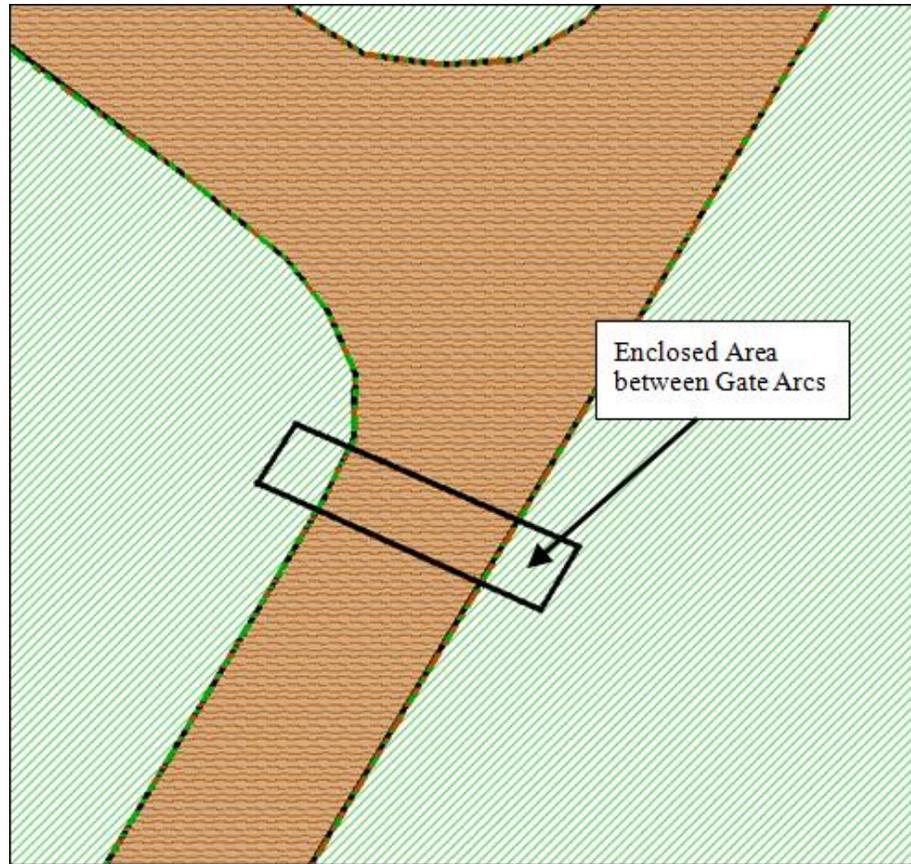


Figure 6 Enclosed area between gate arcs

4. Select *Feature Objects* | **Build Polygons**. Three polygons will be created: one on each side of the road and one directly beneath the road.
5. Using the **Select Feature Polygon**  tool, select the three polygons by holding down the *Shift* key and selecting them.
6. Right-click and choose **Assign Material Properties** to bring up the *Assign Material Properties* dialog.
7. Select “unassigned” from the *Materials* list on the left.
8. Click **OK** to close the *Assign Material Properties* dialog.

The Graphics Window should appear similar to Figure 7. Some of the displays for the materials may differ, but the material types should be the same. The dotted lines are from the shift preview and can be turned off by pressing *Shift + Q*. The shift preview simply shows how the materials will be assigned to the mesh.

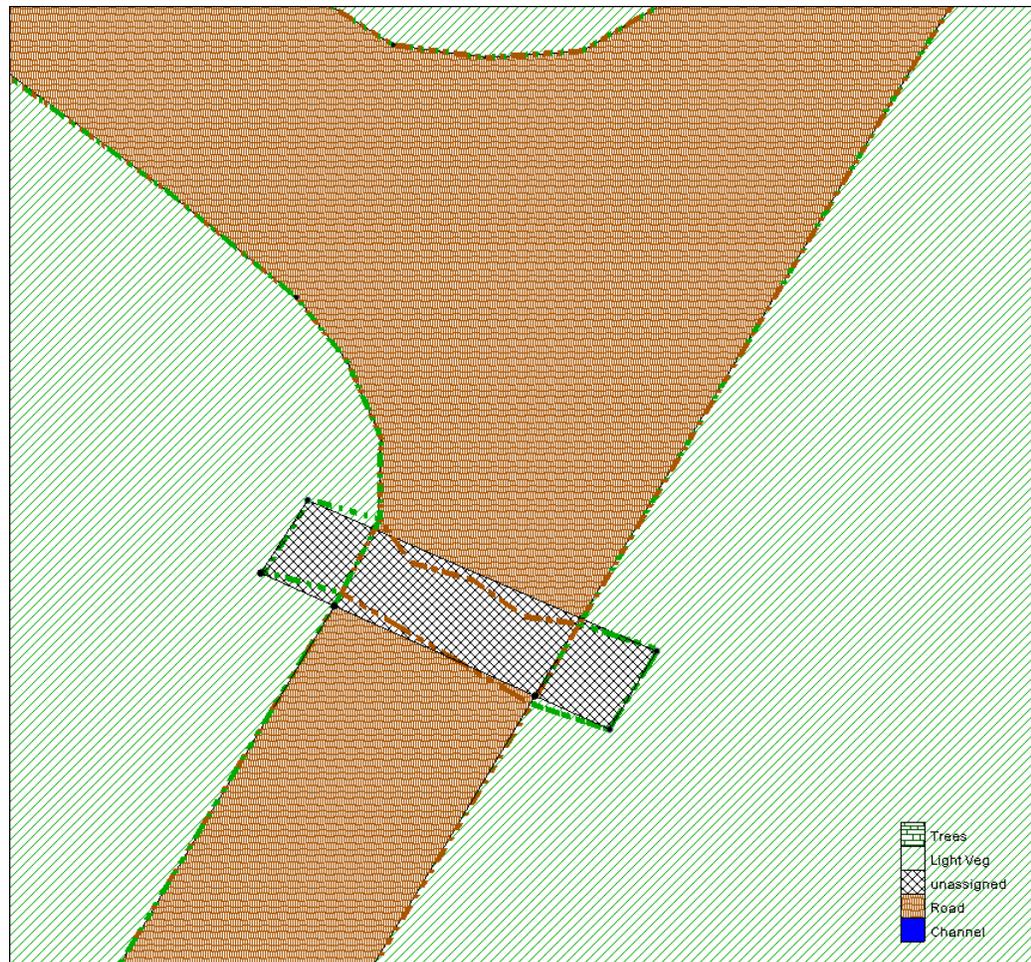


Figure 7 Edited material coverage

## 4 Saving and Running the Simulation

Now that the gate structure has been created and defined, set up the simulation by doing the following:

1. Right-click on the “ Gila Flow” simulation in the Project Explorer and choose **Model Control...** to bring up the *Model Control* dialog.
2. Enter “Gate\_Flow” as the *Case Name*.
3. Click **OK** to accept all other default settings and close the *Model Control* dialog.

To save the project, do the following:

1. Select *File* | **Save as...** to bring up the *Save As* dialog.
2. Enter “Gila\_Gate.sms” in the *File name* field
3. Select “Project Files (\*.sms)” from the *Save as type* drop-down.
4. Click on **Save** to save the project and close the *Save As* dialog.

## 4.1 Running the Simulation

Now the simulation can be run:

1. Right-click on the “Gila Flow” simulation and choose **Save, Export, and Launch SRH-2D**.
2. Click **OK** if a warning is displayed stating that the “Materials” coverage will be renumbered before exporting. This brings up the *SRH-2D: Gila Flow* dialog and a wrapper window with three windows (Figure 8).

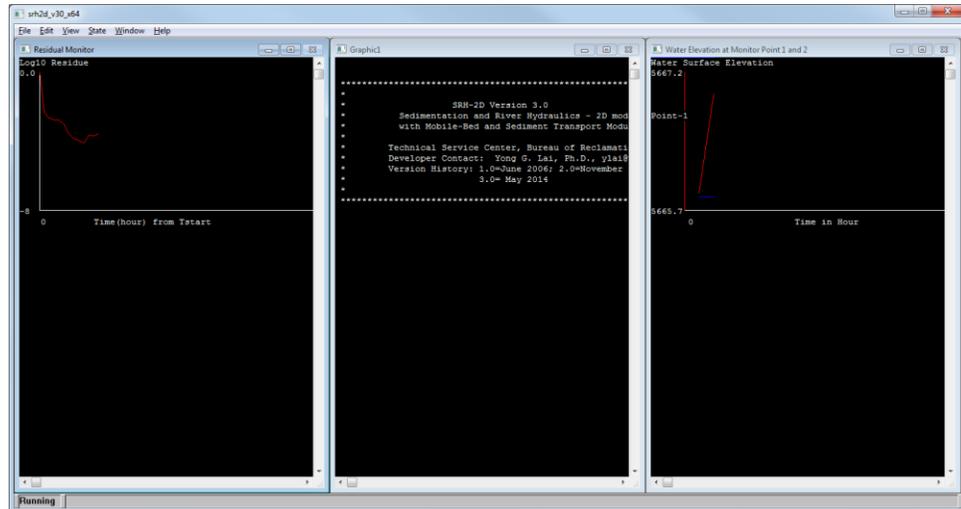


Figure 8 Wrapper window showing SRH-2D running status

When saving, exporting and launching SRH-2D, SMS will initialize and run pre-SRH, the SRH-2D preprocessor. The run process may take several minutes, depending on the processing capabilities of the computer running it. When pre-SRH has finished running, SRH-2D will begin to run.

3. Once SRH-2D is finished running, a small dialog will appear. Click **Yes** to close the wrapper window and return to the *SRH-2D: Gila Flow* dialog.
4. Turn on *Load Solution* and click **Exit** to close the *SRH-2D: Gila Flow* dialog. The solution datasets will now be listed in the Project Explorer under “Gila\_Mesh”.
5. **Frame**  the project.
6. Turn on “ Mesh Data” and “ GIS Data” in the Project Explorer.
7. Turn off the “ Materials” and “ BC” coverages in the Project Explorer.
8. Select *Display | Display Options...* to bring up the *Display Options* dialog.
9. Select “2D Mesh” from the list on the left.
10. On the *2D Mesh* tab, turn off *Elements*.
11. Click **OK** to close the *Display Options* dialog.

## 5 Analyzing the Results

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The simulation goes through several phases that will be discussed in this section.

1. Select the “ Water\_Elev\_ft” mesh dataset to make it active.
2. Select the “00:00:02” time step to make it the active time step.
3. Step through the simulation time steps while observing the water surface elevation displayed. From times “00:00:02” until “00:30:00” the water flows over the weir and into the overflow basin, approaching the gate.
4. Select time “00:35:00” and observe that the water has reached the gate and is now flowing through the gate.
5. **Zoom**  in close enough to easily view the contours around the gate structure.

The crest elevation was specified as 5649 feet and the height of the gate opening was specified as three feet. This means that, until the water surface elevation reaches an elevation of 5652 feet, SRH-2D will compute the flow through the structure using a weir flow equation.

Once the water surface elevation reaches an elevation of 5652 feet, SRH-2D will begin to compute the flow through the structure as a submerged gate.

6. Right-click on the “ Water\_Elev\_ft” dataset and choose **Dataset Contour Options...** to bring up the *Dataset Contour Options – Water\_Elev\_ft* dialog.
7. In the *Data range* section, turn on *Specify a range*.
8. Enter “5649” in the *Min* field and “5652” in the *Max* field.
9. Select **OK** to close the *Dataset Contour Options – Water\_Elev\_ft* dialog. Notice that at time “00:35:00”, the water surface elevation is still below 5652 ft along the gate arc.
10. Select the time step “00:40:00”. Notice that the water surface elevation is now equal to or greater than 5652 ft signifying that the gate has been submerged and flows are now being computed as a submerged gate.
11. Continue to step through the time steps. Notice that somewhere around time 01:30:00 the water surface elevation begins to drop below 5652 ft signifying that the gate is no longer submerged and it has entered the weir flow regime once again.
12. Continue to toggle through the time steps. Notice that the water surface elevation continues to drop as water flows under the gate.

## 6 Conclusion

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This concludes the “SRH-2D – Gates”<sup>1</sup> tutorial. If desired, further analysis could be performed by the user to evaluate other aspects of the model. Continue to experiment with the SMS interface or may quit the program.

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<sup>1</sup> This tutorial was developed by Aquaveo, LLC under contract with the Federal Highway Administration.