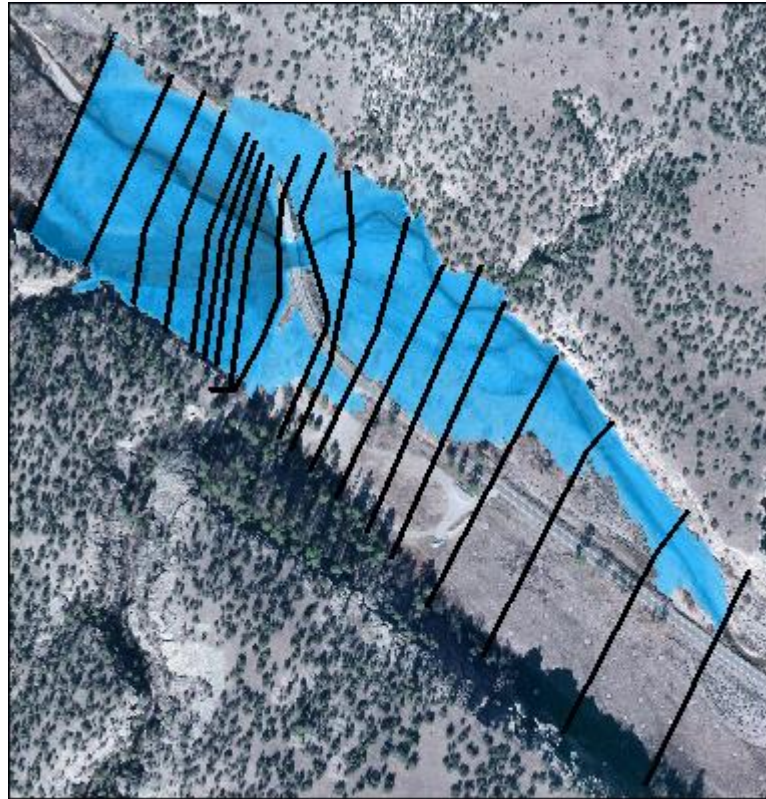




SRH-2D Tutorial

2D Summary Table



Objectives

Learn the process of making a summary table to compare the 2D hydraulic model results with 1D hydraulic model results. This tutorial introduces a method of presenting a 2D hydraulic solution created by SRH-2D mapped onto a 1D hydraulic HEC-RAS model layout.

Prerequisites

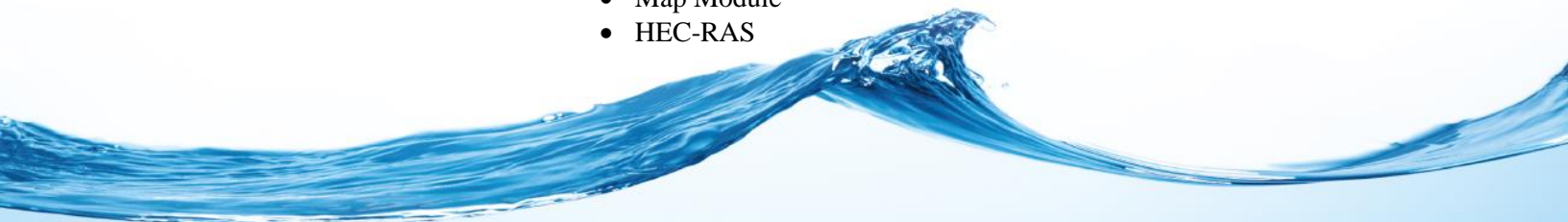
- SRH-2D Simulations

Requirements

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

Time

- 20–30 minutes



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1 Introduction

This tutorial reviews an existing HEC-RAS 1-D model for the area around a bridge crossing along the West Fork of the Gila River located in New Mexico. The cross section geometries and the line and point properties associated with the cross sections can be exported from HEC-RAS and imported into SMS.

This model will be opened and viewed within HEC-RAS. The geometry and cross section properties will then be exported into a GIS format to allow importing into SMS.

Within SMS, the cross sections and their properties will be viewed. They will then be converted into 2D scatter data which could be used in the construction of a 2D model. A pre-built SRH-2D model and solution will be opened into SMS to be used to generate a summary table of the SRH-2D solution containing a summary of the results at each cross section.

Although results from an SRH-2D model will be used in this tutorial, the steps demonstrated apply equally to various other 2D hydraulic models.

2 Viewing the 1D HEC-RAS Model

First, start with opening and viewing the original HEC-RAS model within the HEC-RAS interface. HEC-RAS should already have been installed at this point.¹

1. Open HEC-RAS.
2. Choose *File* | **Open Project...** to bring up the *Open Project* dialog.
3. Browse to the *Summary_Table\data files\HEC-RAS_1D_Files* folder and select “GilaRiverBridge.prj”.
4. Click **OK** to import the project and close the *Open Project* dialog.

¹ An installer for HEC-RAS can be obtained at <http://www.hec.usace.army.mil/software/hec-ras/downloads.aspx>.

5. Select *View* | **X-Y-Z Perspective Plots...** to bring up the *X-Y-Z Perspective Plot* dialog.

The 100-year flow solution should appear similar to Figure 1.

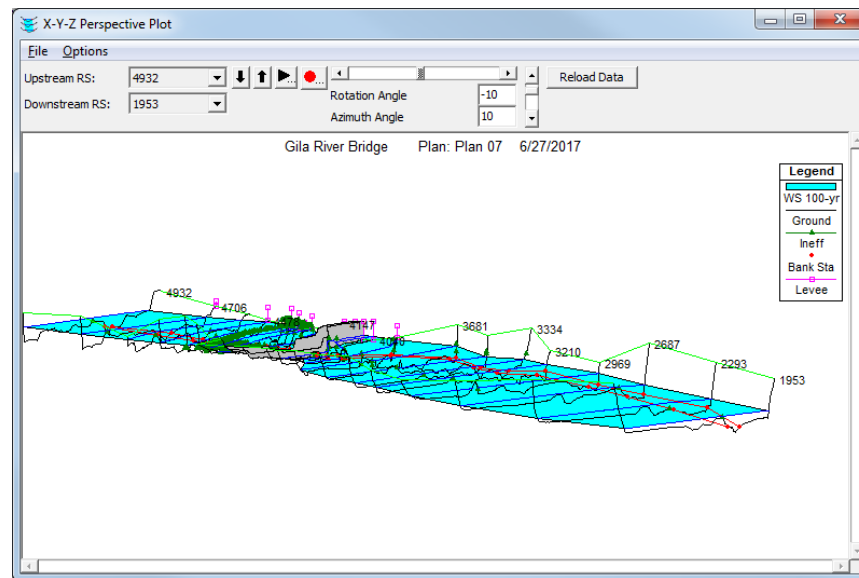







Figure 1 X-Y-Z Perspective Plot dialog

6. When finished viewing the plot, click the  in the top right corner to close the *X-Y-Z Perspective Plot* dialog.
7. Select *View* | **Cross-Sections...** to bring up the *Cross Section* dialog.
8. Use the up  and down  arrows to the right of the *River Sta.* drop-down to review the various cross sections.
9. When finished reviewing the cross sections, click the  in the top right corner to close the *Cross Section* dialog.
10. To view a summary of computed values for each of the cross sections, select *View* | **Profile Summary Table...** to bring up the *Profile Output Table – Standard Table 1* dialog.
11. When finished reviewing the table, click the  in the top right corner to close the *Profile Output Table – Standard Table 1* dialog.

For additional information on using HEC-RAS, refer to the HEC-RAS documentation.²

3 Exporting HEC-RAS GIS Data

Now to export the HEC-RAS GIS data, including cross sections and their properties.

1. Select *File* | **Export GIS Data...** to bring up the *GIS Export* dialog (Figure 2).

This dialog allows custom selection of what data to export. Only certain types of HEC-RAS geometry data can be imported into SMS.

² See <http://www.hec.usace.army.mil/software/hec-ras/documentation.aspx>.

2. Click **Browse...** to bring up the *Enter/Select GIS Export File* dialog.
3. Browse to the *Summary_Table\data files* folder.
4. Enter “Gila_Export” as the *File name* and click **Save** to close the *Enter/Select GIS Export File* dialog.
5. Turn off all options in the *Results Export Options* section.
6. In the *Geometry Data Export Options* section, turn on *River (Stream) Centerlines*, *User Defined Cross Sections*, *Interpolated Cross Sections*, *Bank Stations*, and *Manning’s n*.

The *GIS Export* dialog should appear similar to Figure 2. These options make sure the *River (Stream) Centerline* will be exported.

In SMS, the stream centerline will be displayed as a feature arc with attributes within a 1D hydraulic centerline coverage type. All *User Defined Cross Sections* and any *Interpolated Cross Sections* will also be exported. The Gila River model in this tutorial does not have any interpolated cross sections. The cross sections will be displayed in SMS as feature arcs with attributes within a 1D hydraulic cross section coverage type.

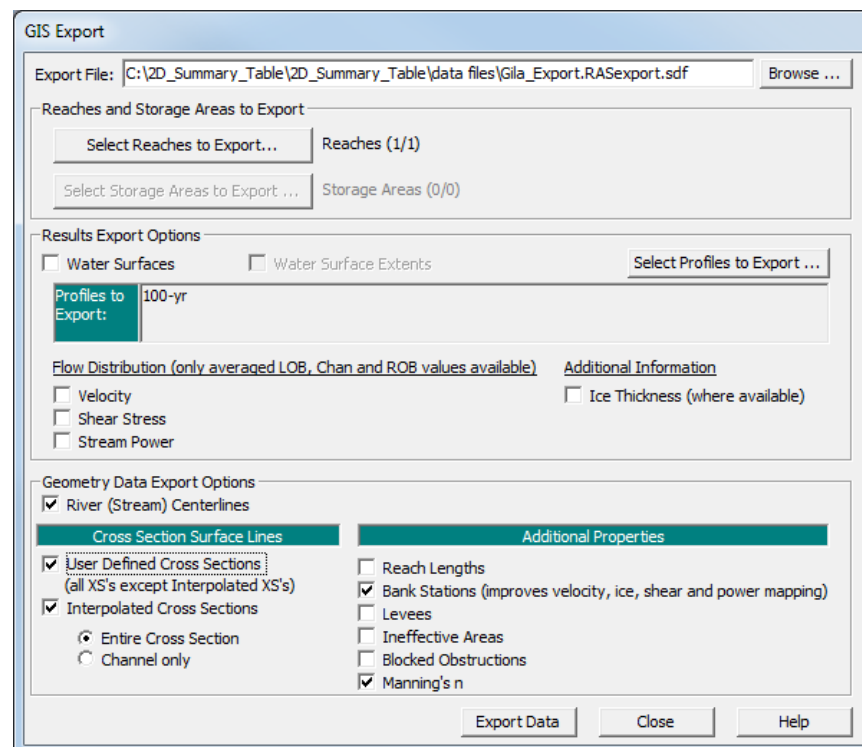


Figure 2 GIS Export dialog

Note that although other items can be exported—*Water Surfaces*, *Velocity*, *Shear Stress*, and *Stream Power* for the results export, and *Reach Lengths*, *Levees*, *Ineffective Areas*, and *Blocked Obstructions* for the geometry data—these items cannot currently be viewed in SMS. For this reason, they will not be exported.

For HEC-RAS projects with multiple reaches and multiple profiles, a custom selection can also be made so that only reaches and profiles that are of interest are exported. This Gila model only has one reach and one profile, so these options will not be used here.

7. Click **Export Data** to create the exported GIS file and close the *GIS Export* dialog.
8. If a dialog appears confirming of the location of the export file, click **OK**.

4 Importing the GMS File into SMS

SMS will now be opened and the interface will be prepared for importing the GIS file.

4.1 Setting the Display Projection

To prepare for importing the GIS data, specify the proper projection. These steps only apply to HEC-RAS models that are georeferenced to a specific coordinate system.


1. Open SMS.
2. Select *Display* | **Display Projection...** to bring up the *Display Projection* dialog.
3. In the *Horizontal* section, select *Global Projection* to bring up the *Horizontal Projection* dialog. If it does not appear, click **Set Projection...** to bring up the dialog.
4. Click **Library...** to open the *Select Projection* dialog.
5. Using the drop-down menu, set the *Projection* to be “UTM”.
6. Set the *Zone* to “12 (114°W – 108°W – Northern Hemisphere)”.
7. Set *Datum* to “NAD83”.
8. Set the *Planar Units* to “FEET (U.S. SURVEY)”.
9. Click **OK** to close the *Select Projection* dialog.
10. Click **OK** to close the *Horizontal Projection* dialog.
11. In the *Vertical* section, change the *Datum* to “NAVD 88(US)”.
12. Make sure the *Units* are set to “Feet (U.S. Survey)”.
13. Click **OK** to close the *Display Projection* dialog.


4.2 Importing the GIS File

Now to import the GIS file by doing the following:

1. Select *File* | **Open...** to bring up the *Open* dialog.
2. Browse to the *Summary_Table\data files* folder and select “Gila_Export.RASexport.sdf”.
3. Click **Open** to import the file and exit the *Open* dialog.

Two new map coverages appear in the Project Explorer:

- “ Gila_Export.RASexport CL” contains the HEC-RAS stream centerline and bank arcs. The centerline was defined and exported from HEC-RAS. The bank arcs are created in SMS from the bank stations defined at each cross section.

- “ Gila_Export.RASexport XSEC” contains the HEC-RAS cross sections.

The project should appear similar to Figure 3.

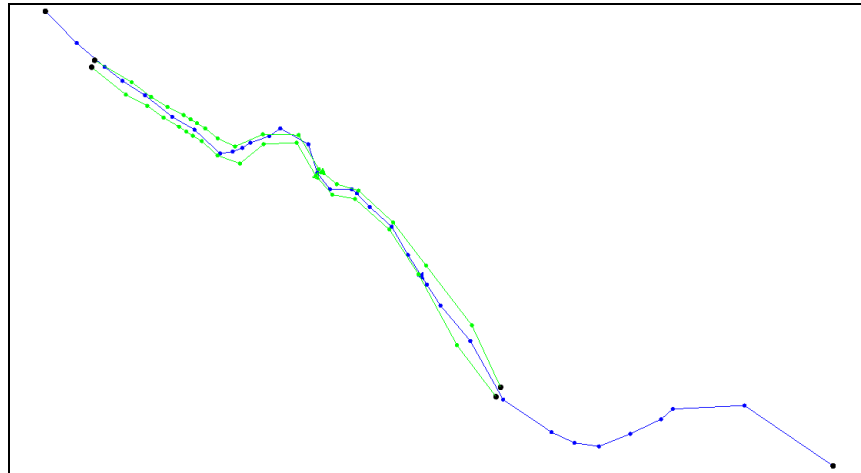




Figure 3 Imported centerline and bank arcs



4.3 Setting Individual Object Projection

1. Right-click on “ Gila_Export.RASexport CL” and select **Projection...** to bring up the *Projection* dialog.
2. In the *Horizontal* section, select *Global Projection*.
3. In the *Vertical* section, select “NAVD 88(US)” from the *Datum* drop-down.
4. Click **OK** to close the *Projection* dialog.
5. Repeat steps 1–4 for “ Gila_Export.RASexport XSEC”.

The individual object projections have now been set.

4.4 Setting Display Options and Rotating the Project

An oblique view of the cross sections can be seen using the rotate tool as follows:

1. Select “ Gila_Export.RASexport XSEC” to make it active.
2. Select *Display* | **Display Options...** to bring up the *Display Options* dialog.
3. Select “General” from the list on the left.
4. On the *General* tab, in the *Drawing Options* section, turn off *Auto z-mag* and enter “5.0” as the *Z magnification*.
5. Click **OK** to close the *Display Options* dialog.
6. Use the **Rotate**  tool to rotate the view by clicking and dragging within the SMS display window.

The varying elevations along the cross section should be easily viewed while rotating (Figure 4).

7. When finished, click **Plan View**  to return to a top-down view.

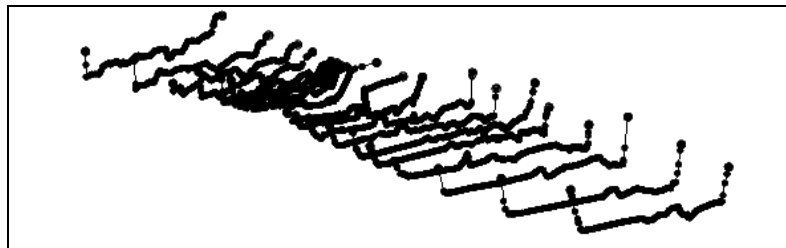


Figure 4 Varying elevations in the cross sections

4.5 Adding a Background Image

Finally, import a background image to provide a reference for the location and terrain.

1. Select *File* | **Open...** to bring up the *Open* dialog.
2. Select “Gila_Imagery.tif” and click **Open** to import the background image and exit the *Open* dialog.

The project should appear similar to Figure 5.






Figure 5 Background image providing context for project

5 Cross Sections and the River Centerline

5.1 Viewing Cross Sections

The exported cross sections and their attributes were written out to a cross section database when it was opened in SMS. This section will demonstrate how to view the features and attributes within the cross section database.

1. Select “ Gila_Export.RASexport XSEC” to make it active and switch to the **Map**  module.
2. Using the **Select Feature Arc**  tool, double-click on any one of the cross sections to bring up the *River Cross Section Attributes* dialog.

Notice that the *Reach Name* and *Station* were carried over in the export.

3. Click **Assign Cross Section** to bring up the *Assign Cross Section Profile* dialog.

A profile of the cross section will be displayed (Figure 6).

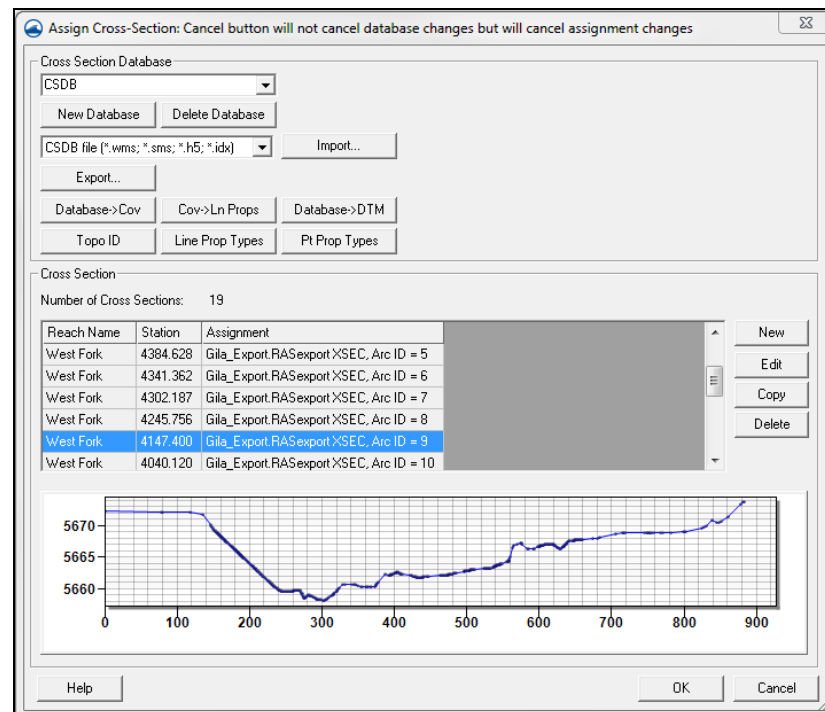


Figure 6 Assign Cross Section Profile dialog

4. In the *Cross Section* section, click **Edit** to bring up the *Cross Section Attributes* dialog.

The *Cross Section Attributes* dialog (Figure 7) provides a suite of editing tools for modifying a cross section. No edits will be made for this tutorial, but it is good to be familiar with what can be done here.

- The *Geom Edit* tab provides tools for editing distances along cross sections and elevations.
- The *Geo Ref* tab allows for several methods of georeferencing a single cross section.
- The *Line Props* and *Point Props* tabs will be discussed in subsequent steps.
- The *Merge* tab provides tools for merging cross sections if multiple sources of data exist for one single cross section.
- The *Filter* tab provides tools for filtering out redundant or unwanted points in a cross section.

5. Select the *Line Props* tab.

Notice that the Manning's n roughness values were imported from the SDF file and can be viewed here.

6. Select the *Point Props* tab.

Notice that the locations of the left and right banks were imported from the SDF file and can be viewed here.

7. Click **Cancel** to close the *Cross Section Attributes* dialog.
8. Click **Cancel** to close the *Assign Cross Section Profile* dialog.
9. Click **Cancel** to close the *River Cross Section Attributes* dialog.

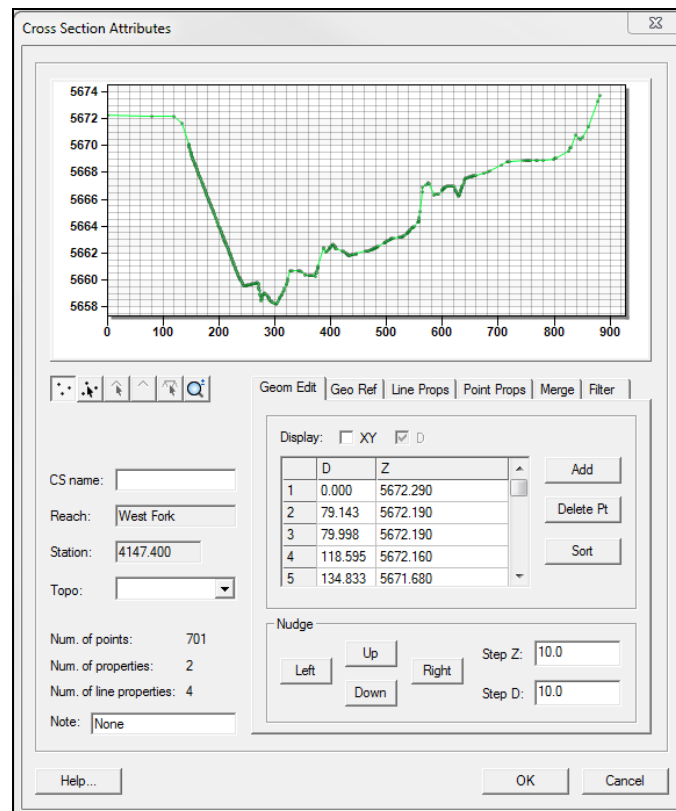
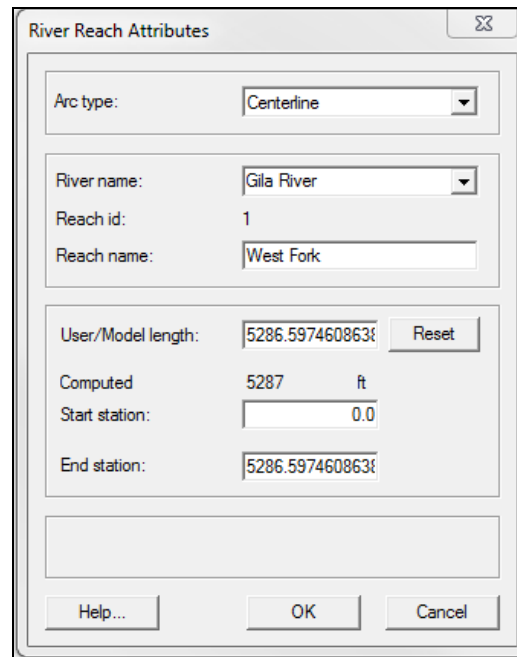


Figure 7 Cross Section Attributes dialog

5.2 Viewing the River Centerline

The reach centerline was also exported and can be viewed along with its attributes.

1. Select “ Gila_Export.RASexport CL” to make it active.
2. Using the **Select Feature Arc** tool, double-click on the centerline arc (the longest of the three arcs) to bring up the *River Reach Attributes* dialog (Figure 8).
3. Notice that the *River Name*, *Reach Name*, *Computational Length*, *Start Station*, and *End Station* are all attributes that were exported from the original HEC-RAS project.
4. Select **Cancel** to close the *River Reach Attributes* dialog.



The dialog box is titled "River Reach Attributes". It contains the following fields and controls:


- Arc type:** A dropdown menu with "Centerline" selected.
- River name:** A dropdown menu with "Gila River" selected.
- Reach id:** A text box containing the number "1".
- Reach name:** A text box containing "West Fork".
- User/Model length:** A text box containing "5286.597460863". To its right is a "Reset" button.
- Computed:** A text box containing "5287" followed by "ft".
- Start station:** A text box containing "0.0".
- End station:** A text box containing "5286.597460863".



At the bottom of the dialog are three buttons: "Help...", "OK", and "Cancel".



Figure 8 River Reach Attributes dialog

6 Converting Cross Sections to 2D Scatter Points




The elevations that were read in the cross sections are also assigned to the feature vertices along the arc. In the absence of any other elevation data these can be used for the creation of the 2D model domain. The elevations along each of the cross sections can be converted to a 2D scatter set (TIN). The scatter set can then be used to assign elevations to a 2D finite element mesh. The process of assigning elevations to a finite element mesh will not be covered in this tutorial.

1. Right-click on “ Gila_Export.RASexport XSEC” and select *Convert | Map → 2D Scatter* to bring up the *Map → Scatter* dialog.
2. In the *Create Scatter Point Set Source* section, select *Arc end points and vertices*.
3. In the *Scatter Point Z-Value Source* section, select *Arc end points and vertex elevations*.
4. Enter “Gila XSEC Scatter” as the *New scatter point set name*.
5. Click **OK** to close the *Map → Scatter* dialog and create the new scatter set.

A new “ Gila XSEC Scatter” entry should appear under “ Scatter Data” in the Project Explorer.

6. Turn off “ Gila_Export.RASexport CL” and “ Gila_ExportRASexport XSEC” in the Project Explorer.

The scatter set is a triangulated irregular network (TIN) of elevation points. The triangles can be viewed and contours can be generated to help visualize how the elevations are represented with the scatter set.

7. Right-click on “ Scatter Data” and select **Display Options...** to bring up the *Display Options* dialog.
8. Select “Scatter” from the list on the left.
9. On the *Scatter* tab, turn on *Triangles* and click **OK** to close the *Display Options* dialog.
10. **Zoom**  and **Pan**  to observe the triangulation of the scatter data.

Note that the triangulation simply connects the cross sections. The centerline or bank arcs or other cross section features are not incorporated into the triangulation.

11. **Frame**  the project.

The project should appear similar to Figure 9.

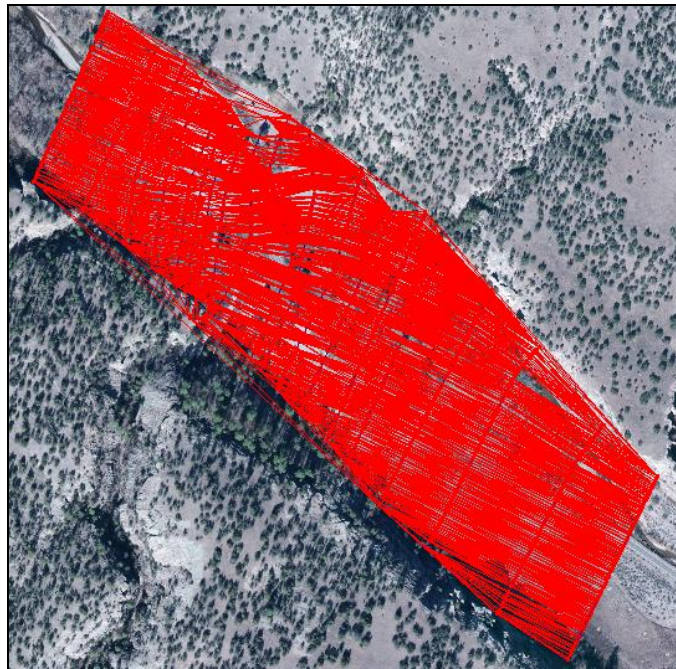



Figure 9 Triangulation visible

12. Click **Display Options**  to open the *Display Options* dialog.
13. Select “Scatter” from the list on the left.
14. On the *Scatter* tab, turn off *Triangles* and turn on *Contours*.
15. On the *Contours* tab, in the *Contour method* section, select “Color Fill” from the first drop-down.
16. Enter “30” as the *Transparency* and click **OK** to close the *Display Options* dialog.

The project should appear similar to Figure 10.

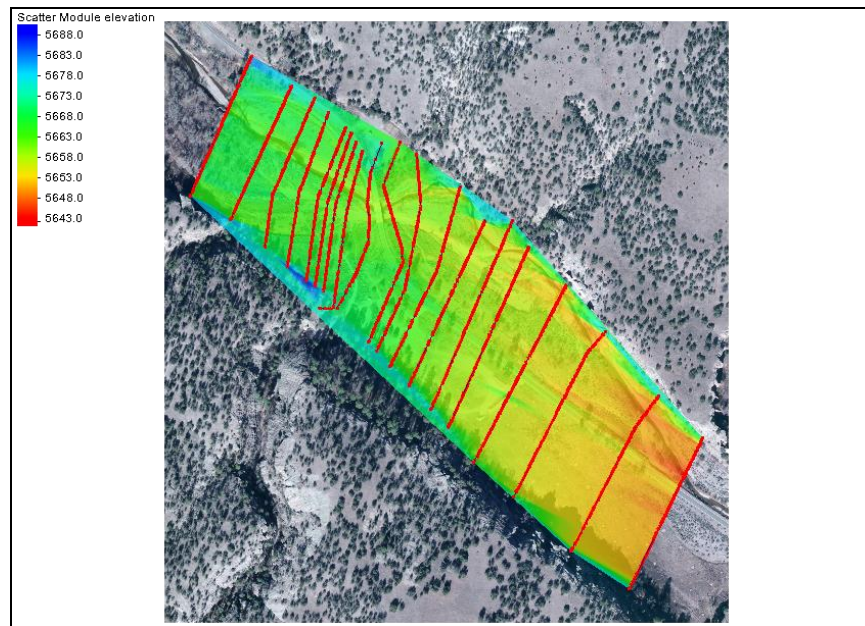


Figure 10 Scatter set with contours visible

Since the centerline and bank arcs are not included in the triangulation, the channel is not continuous from one cross section to the next. Breaklines could be added to the triangulation to improve the quality of representation of the floodplain in three dimensions. SMS could not create breaklines from the centerline because HEC-RAS does not require that the centerline be consistent with the cross section definitions. Notice that the centerline arc here intersects the bank arcs in several locations.

The quality of this TIN as a 2D representation of the floodplain is poor. Even with break lines, the surface does not have any information between cross sections. This illustrates one of the limitation of the ability of a 1D model to provide a true representation.

USGS digital elevation models (DEMs) and LiDAR data have become more available lately, making 2D modeling a viable option for many. With supplemented elevation data, an SRH-2D model has been constructed to show an example 2D model of the Gila River. The results of the model will now be imported into SMS and reviewed.

7 Importing SRH-2D Model Results

The first step is importing the finite element mesh containing all of the ground elevation values. Then a model solution file containing the SRH-2D model results will be imported.

1. Turn off “ Gila XSEC Scatter” in the Project Explorer.


This turns off the display of the scatter points, including the scatter point contours.

2. Select *File* | **Open...** to bring up the *Open* dialog.
3. Select “Gila_2D_Mesh.h5” and click **Open** to import the file and exit the *Open* dialog.

The unstructured grid should appear similar to Figure 11.










Figure 11 The unstructured grid

4. Right-click on “ Mesh Data” and select **Display Options...** to bring up the *Display Options* dialog.
5. Select “2D Mesh” from the list on the left.
6. On the *2D Mesh* tab, click **All Off** and turn on *Contours* and *Mesh Boundary*.
7. On the *Contours* tab, in the *Contour method* section, select “Color Fill from the first drop-down.
8. Enter “20” as the *Transparency* and click **OK** to close the *Display Options* dialog.
9. Analyze the mesh contours representing the elevations and notice that most of the terrain details have been captured in the mesh elevations.

The mesh contours generally match the features on the background image (Figure 12). The elevations found in the mesh are what SRH-2D used to compute a solution.

10. Select *File* | **Open...** to bring up the *Open* dialog.
11. Select “Q100yr_XMDF.h5” and click **Open** to import the file and exit the *Open* dialog.

This imports the SRH-2D solution, including additional “ Gila_Mesh” datasets:

- “ Froude”
- “ Strs_lb_p_ft2”
- “ Vel_Mag_ft_p_s”
- “ Water_Depth_ft”
- “ Water_Elev_ft”
- “ Velocity”.

Review the datasets as desired.

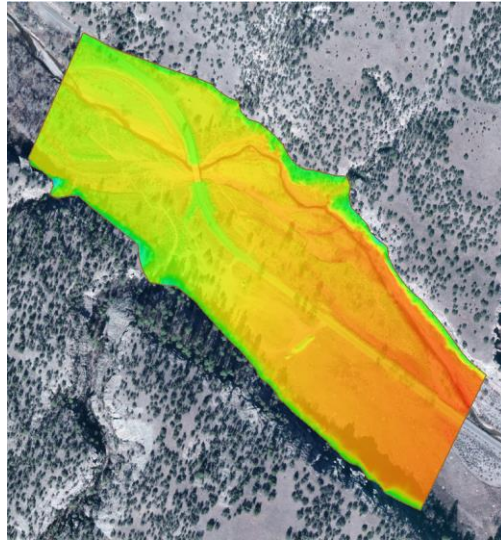



Figure 12 The mesh contours match the background image features

8 Generating a Results Summary Table

A summary table listing solution values for each cross section will now be generated. The report table created by SMS is similar to the HEC-RAS summary table report. SMS can report the minimum, maximum, and/or average values along a given cross section.

1. Right-click on “ Gila_Export.RASexport XSEC” and select **Summary table...** to bring up the *Summary Table Options* dialog.
2. In the *Summary* section, click **Select...** to the right of *Data source* to bring up the *Select Tree Item* dialog.

The available mesh datasets should appear in the *Select Tree Item* dialog.

3. Select “Gila_Mesh” from the tree and click **OK** to close the *Select Tree Item* dialog.
4. Below *Data source*, select “Full cross-section” from the drop-down.

Note that there are three different options for computing cross section values and reporting them in the table:

- Full cross-section (computes values across the entire cross section)
- Main channel only (computes values for just the channel portion of a cross section (between bank arcs))
- Overbanks and main channel (computes values for the main channel portion of a cross section as well as the left and right overbanks)

The second and third options require the existence of bank arcs.

5. Check the box in the *Min* column on the *Z* row.
6. In the *Ave* and *Max* columns, check the boxes on the *Froude*, *Vel_Mag_ft_p_s*, and *Water_Elev_ft* rows.

Note that since the 2D hydraulic solution values vary along any given cross section, multiple values could be reported in the table. Options exist to report the minimum, maximum and average value along a cross section.

7. For the datasets selected in step 6, make sure the value for each in the *Timestep* column is “0 00:24:00”.

SMS uses the last time step in the dataset as a default.

8. In the *Advanced Calculations* section, in the *Datasets* section, make sure the fields match the following table.

Type	Dataset	Timestep
Velocity	Velocity	0 00:24:00
Depth	Water_Depth_ft	0 00:24:00
WSE	Water_Elev_ft	0 00:24:00
Elevation	Z	0 00:00:00

9. In the *Calculations* section, turn on *Flow* and *Width*.

The *Summary Table Options* dialog should appear as in Figure 13.

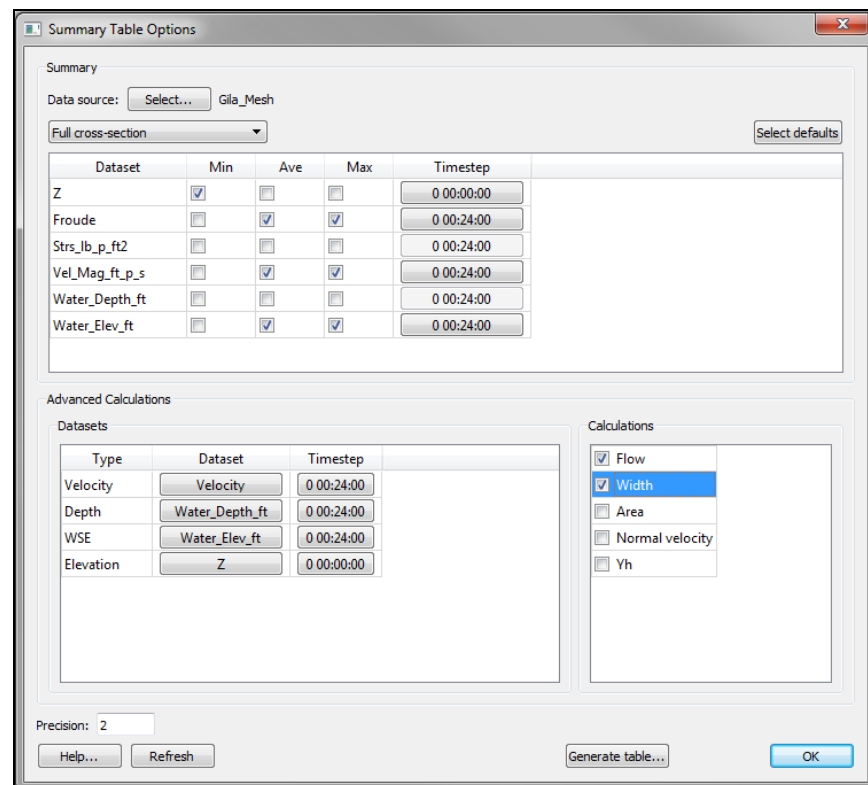


Figure 13 Summary Table Options dialog

10. Click **Generate table...** to bring up the *Summary Table* dialog.

The *Summary Table* dialog should appear as in Figure 14.

Summary Table

Summary

Reach	Station	Flow	Width	Z			Froude		Vel_Mag_ft_p_s		Water_Elev_ft	
				Min	Ave	Max	Ave	Max	Ave	Max		
West Fork	1953.98	14291.37	698.62	5644.88	0.37	0.98	4.18	10.48	5653.96	5656.75		
West Fork	2293.89	14307.99	768.99	5648.11	0.4	1.44	4.19	10.78	5655.51	5656.9		
West Fork	2687.04	14318.39	827.26	5650.29	0.45	1.61	4.49	11.1	5657.63	5659.35		
West Fork	2969.39	14221.20	835.13	5650.45	0.37	0.79	3.78	8.0	5659.53	5661.38		
West Fork	3210.47	14370.74	856.31	5652.02	0.35	0.98	3.79	8.91	5661.0	5664.46		
West Fork	3334.76	14326.84	864.62	5653.25	0.36	0.9	3.81	9.32	5661.68	5662.88		
West Fork	3466.12	14410.59	738.74	5654.61	0.45	0.87	4.33	11.89	5662.88	5663.62		
West Fork	3681.02	14348.67	763.37	5655.69	0.39	0.65	3.99	7.88	5664.32	5668.27		
West Fork	3886.94	14380.85	737.72	5656.06	0.34	0.93	3.57	11.61	5665.29	5666.74		
West Fork	4040.12	13966.44	797.22	5658.13	0.36	1.42	3.76	18.31	5666.06	5668.28		
West Fork	4147.4	12409.51	692.11	5658.22	0.19	0.49	2.58	9.56	5670.87	5671.92		
West Fork	4245.76	11648.79	687.04	5659.53	0.16	0.99	2.25	6.52	5671.67	5671.86		
West Fork	4302.19	12370.40	703.78	5659.95	0.16	0.75	2.42	6.42	5671.7	5674.86		
West Fork	4341.36	13146.59	712.16	5660.06	0.17	0.69	2.54	6.16	5671.69	5673.47		
West Fork	4384.63	13627.38	708.32	5659.79	0.17	0.57	2.52	5.65	5671.7	5671.76		
West Fork	4478.63	14324.61	720.18	5660.64	0.19	0.84	2.75	6.51	5671.74	5671.77		
West Fork	4581.12	14334.67	694.84	5660.85	0.2	0.45	2.85	7.13	5671.82	5672.78		
West Fork	4706.27	14408.71	627.97	5661.4	0.26	0.56	3.5	8.04	5671.95	5672.14		
West Fork	4932.6	14221.14	665.70	5662.83	0.32	1.31	3.53	9.75	5672.79	5681.8		

Help...

Export...

Copy to clipboard

OK

Figure 14 Summary Table dialog

Notice that the summary table options selected in steps 2–9 match the columns shown for each cross section in Figure 14. This summary table can be exported as a text file or copied to the clipboard and pasted into a spreadsheet program for analysis. Buttons for exporting and copying are found in the lower left corner of the *Summary Table* dialog.

At this point, HEC-RAS could also be opened and a summary table generated there. The summary table generated by HEC-RAS will have some similarities with the summary table created by SMS from the SRH-2D data. Differences found in the summary tables would be due to many different factors as these two approaches to hydraulic modeling are very different.

11. When done viewing and exporting the summary table contents, click **OK** to close the *Summary Table* dialog.
12. Click **OK** to close the *Summary Table Options* dialog.

9 Saving a Project File

All the data in this project can be saved to an SMS project file. When a project file is saved, separate files are created for the map, scatter data, and mesh data. The project file is a text file that references the individual data files.

To save all this data for use in a later session:

1. Select *File* | **Save New Project...** to bring up the *Save* dialog.
2. Select "Project Files (*.sms)" from the *Save as type* drop-down.
3. Enter "Gila_1D2D.sms" as the *File name*.
4. Click **Save** to save the project files and close the *Save* dialog.

10 Conclusion

This concludes the “2D Summary Table”³ tutorial. Topics covered in this tutorial included:

- Viewing a HEC-RAS model
- Exporting HEC-RAS GIS data
- Importing HEC-RAS GIS data into SMS
- Viewing HEC-RAS GIS data in SMS
- Converting cross sections to scatter points
- Importing and viewing an SRH-2D model
- Generating a summary table of 2D model results along each cross section
- Saving a project file

If desired, continue to experiment with the SMS interface or quit the program.

³ This tutorial was developed by Aquaveo, LLC under contract with the Federal Highway Administration.