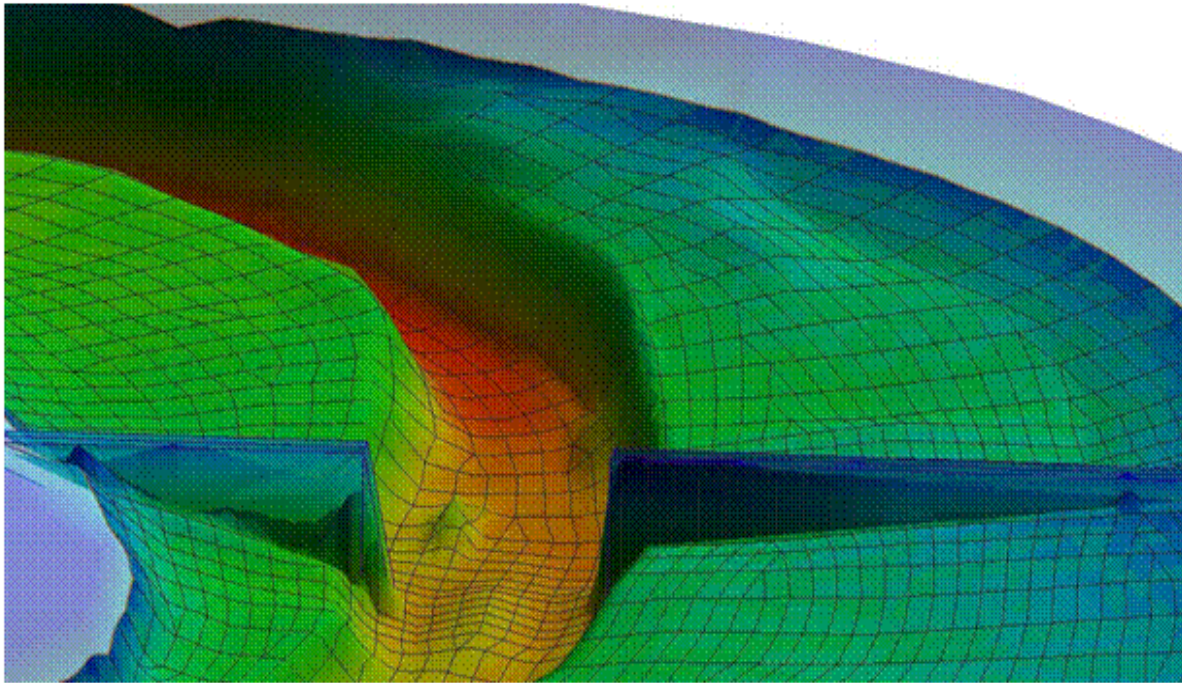


SMS 12.1 Tutorial

Feature Stamping



Objectives

Learn how to use conceptual modeling techniques to create numerical models that incorporate flow control structures into existing bathymetry. The flow control structures that will be created are abutments for a proposed bridge over Double Pipe Creek near Detour, Maryland. This will be done using feature stamping.

Prerequisites

- None

Requirements

- Map Module
- Mesh Module
- Scatter Module

Time

- 30–45 minutes

AQUAVEO™

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1 Opening a Background Image

To provide a base map and to help place the centerlines for the abutments of the proposed bridge, open an aerial photograph of Double Pipe Creek near Detour, Maryland.

To open the image:

1. Select **File** | **Open...** to bring up the *Open* dialog.
2. Select “All Files (*.*)” from the *Files of type* drop-down.
3. Browse to the *SMS_Feature_Stamping\data* folder and select “DoublePipeCreekPhoto.jpg”.
4. Click **Open** to import the image and exit the *Open* dialog.

SMS will display the aerial photograph as seen in Figure 1.

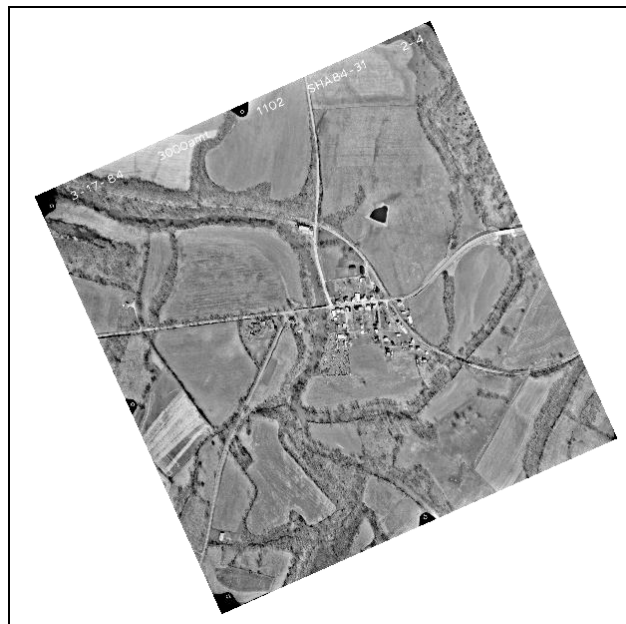


Figure 1 Aerial photograph of Double Pipe Creek near Detour, Maryland

2 Specifying the Coordinate System

With the background image imported into SMS, the coordinate system to be used needs to be set coordinate system to use to reference the data. The coordinate system is dependent on the data source.

To specify the coordinate system:

1. Select *Display / Projection...* to bring up the *Display Projection* dialog.
2. In the *Horizontal* section, select *No projection* and select “Feet (U.S. Survey)” from the *Units* drop-down.
3. In the *Vertical* section, select “Feet (U.S. Survey)” from the *Units* drop-down.
4. Click **OK** to close the *Display Projection* dialog.

3 Importing Bathymetric Data

This tutorial uses bathymetry from a survey of the area around Double Pipe Creek near Detour, Maryland before construction of the elevated road and bridge.

To import the survey data into SMS, do the following:

1. Select *File | Open...* to bring up the *Open* dialog.
2. Select “All Files (*.*)” from the *Files of type* drop-down.
3. Select “detour.xyz”.
4. Click **Open** to exit the *Open* dialog and bring up the *Step 1 of 2* page of the *File Import Wizard* dialog.
5. In the *File import options* section, turn on *Space*.
6. In the space between the *File import options* section and the *File preview* section, enter “2” as the *Start import at row* and turn off *Heading row*.
7. Click **Next** to go to the *Step 2 of 2* page of the *File Import Wizard* dialog.
8. Click **Finish** to close the *File Import Wizard* dialog and finish importing the survey data.

3.1 Showing the Contours

Now adjust the display options to show contours instead of scatter points.

1. Select *Display / Display Options...* to bring up the *Display Options* dialog.
2. Select *Scatter* from the list on the left.
3. On the *Scatter* tab, turn off *Points* and turn on *Contours*.
4. On the *Contours* tab in the *Contour method* section, select “Color Fill” from the first drop-down.

5. Enter “50” as the *Transparency*.
6. Click **OK** to close the *Display Options* dialog.

This survey file contains elevation data for Double Pipe Creek and its floodplain which includes the town of Detour, Maryland. The survey data has already been adjusted to the same local coordinate system as the image. Transparent contours of the survey points displayed over the background image are shown in Figure 2.





Figure 2 Bathymetry for Double Pipe Creek and its floodplain

4 Creating the Model Domain

Before creating a numerical model, a conceptual model will be created to define the extents of the model domain. By using a conceptual model, it is possible to take advantage of automatic meshing algorithms. The two sides of the model domain running along the length of Double Pipe Creek will be formed by extracting the 330 foot contour from the survey data. The ends of these two boundaries will then be connected to create the upstream and downstream boundaries of the model domain.

To define the model domain:

1. Right-click on “ Map Data” in the Project Explorer and select **New Coverage** to bring up the *New Coverage* dialog.
2. Select *Generic* | **Mesh Generator** as the *Coverage Type* and enter “Double Pipe Bridge” as the *Coverage Name*.
3. Click **OK** to close the *New Coverage* dialog.
4. Right-click on “ detour” in the Project Explorer and select *Convert* | **Scatter Contours** → **Map** to bring up the *Create Contour Arcs* dialog.
5. Enter “330” as the *Elevation* and “100” as the *Spacing along contour*.

6. Click **OK** to close the *Create Contour Arcs* dialog and generate arcs along the 330 foot contour. The resulting arcs run along the length of Double Pipe Creek (Figure 3).

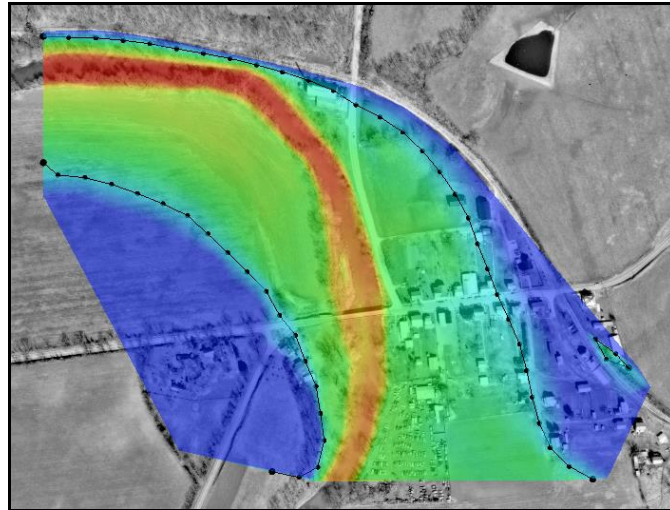






Figure 3 Contours with arcs

Notice the single looped on the extreme east side of the scatter set. Delete this arc by doing the following:

7. Select “ Double Pipe Bridge” to make it active.
8. Using the **Select Feature Arc**  tool, select the single looped arc and press *Delete* on the keyboard.

Feel free to **Zoom**  in if needed to select the arc or hide the background image to make it more visible.

9. Click **Yes** when asked to delete the selected arcs.
10. Using the **Create Feature Arc**  tool, create the upstream boundary arc as shown in Figure 4.

Notice that it is not at the end of the existing arcs.

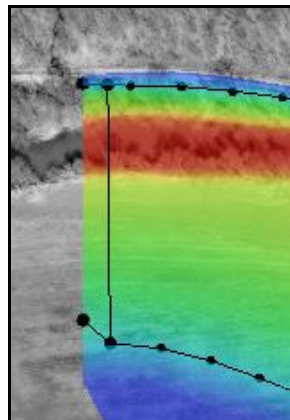



Figure 4 Upstream boundary arc

11. Using the **Create Feature Arc**  tool, create the downstream boundary arc as shown in Figure 5.

Again, notice that it is not at the end of the existing arcs.

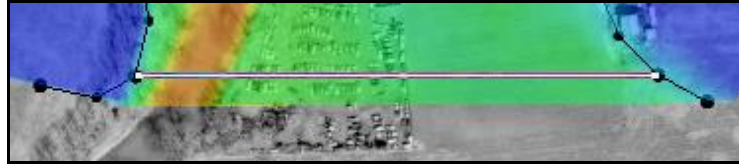



Figure 5 Downstream boundary arc

12. Using the **Select Feature Arc**  tool, delete the four dangling arcs beyond the upstream and downstream boundary arcs (indicated by arrows in Figure 6) by selecting each one and pressing the *Delete* key.
13. Click **Yes** when asked to delete the arcs.

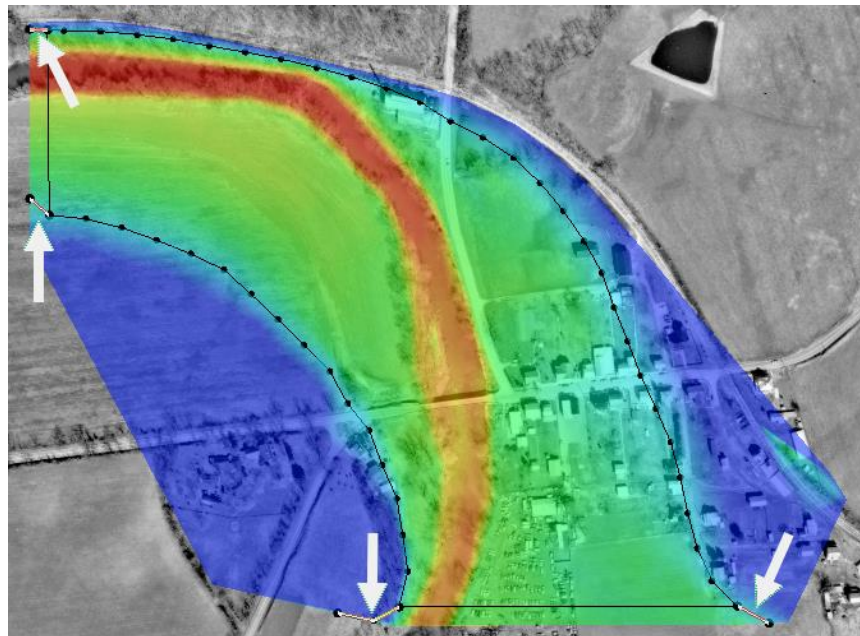




Figure 6 Dangling arcs to be deleted


The model domain extents are now defined in the “ Double Pipe Bridge” coverage. It is important to note that when creating a finite element mesh from a conceptual model, the bathymetry is interpolated from the scatter set. Therefore, the conceptual model should be within the bounds of the scatter set to avoid difficulties that arise when extrapolating data.


5 Creating a Mesh Without the Abutments

Next, create a finite element mesh that does not include the abutments. This represents the existing conditions model and the abutments would represent a proposed condition.

A conceptual model using the merged scatter set has been prepared. To import it, do the following:

1. Click  **Open** to bring up the *Open* dialog.
2. Select “NoAbutments.map” and click **Open** to import the file and exit the *Open* dialog.

All of the polygons forming this conceptual model reference the “ detour” scatter set. To create the numerical model, do the following:

3. Select “ No Abutments” to make it active.
4. Select *Feature Objects* | **Map** → **2D Mesh** to bring up the *2D Mesh Options* dialog.
5. Click **OK** to accept the defaults, close the *2D Mesh Options* dialog, and bring up the *Mesh Name* dialog.
6. Enter “Mesh” as the *Mesh Name* and click **OK** to close the *Mesh Name* dialog.

The mesh should appear similar to Figure 7.

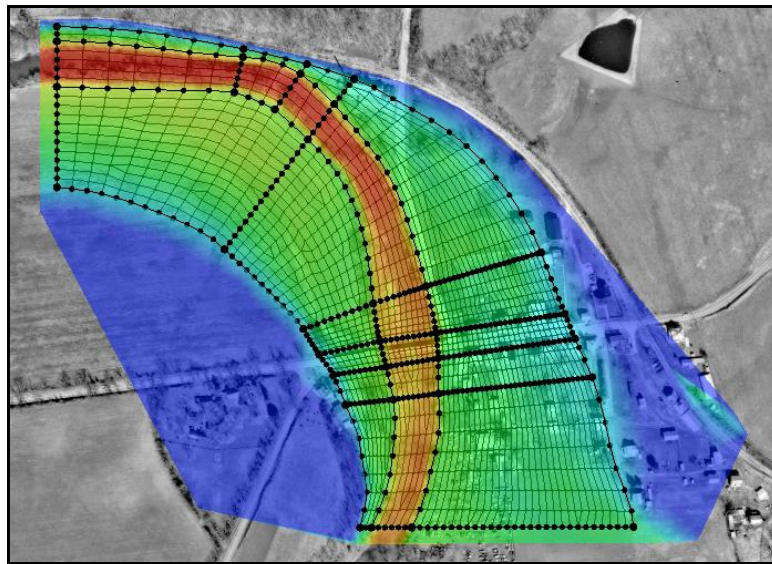




Figure 7 The 2D mesh

6 Creating the Abutments

As mentioned above, the abutments of the proposed roadway will be created using feature stamping. The stamping of the abutments for the proposed bridge over Double Pipe Creek is presented in five steps.

6.1 Setting Up a Stamping Coverage

SMS includes a “stamping” coverage type. It is used for positioning and defining the geometry of features to be forced (or “stamped”) into existing bathymetry. Set up the stamping coverage for this tutorial by doing the following:

1. Right-click on “ Map Data” in the Project Explorer and select **New Coverage** to bring up the *New Coverage* dialog.
2. Select *Generic | Stamping* as the *Coverage Type* and enter “Feature Stamp” as the *Coverage Name*.
3. Click **OK** to close the *New Coverage* dialog and bring up the *Stamping Coverage Attributes* dialog.
4. In the Underlying Geometry section, turn on Use cutoff.
5. Select “ Z” from the tree list.
6. Select “Elevation” from the *Bathymetry Type* drop-down.

This sets the elevation (Z) dataset of the detour scatter set as the bathymetry into which the stamped features will be forced. By setting the *Bathymetry Type* as “Elevation,” SMS knows that the selected dataset contains elevation values rather than depth values.

7. Click **OK** to close the *Stamping Coverage Attributes* dialog.

The project should appear similar to Figure 8.

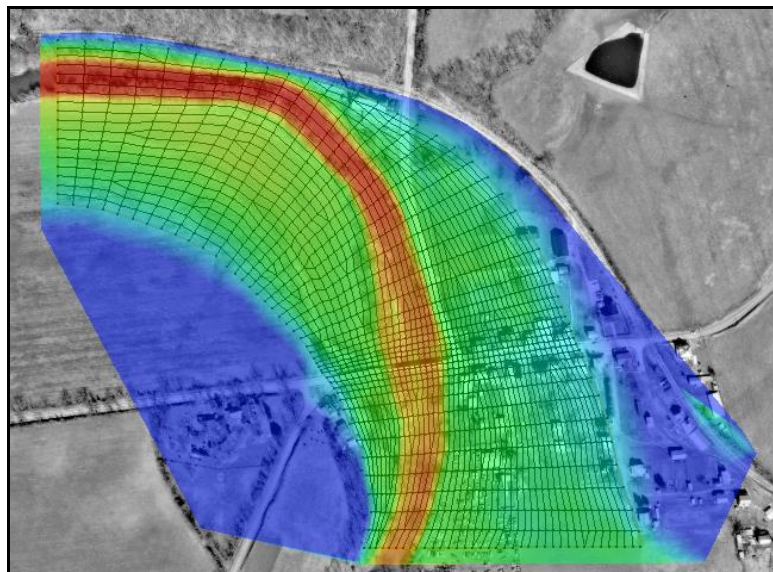





Figure 8 After the stamping coverage is set up

6.2 Positioning the Abutments

Now position the abutments by creating feature arcs along their centerlines. The accuracy in how the abutments intersect the existing bathymetry depends on how many vertices are distributed along the centerline arcs. For this tutorial, it is necessary to distribute the

vertices so they are closer together where the slope of the bathymetry changes rapidly near the banks of the creek and further apart where the slope is nearly flat in the floodplain.

To create the centerline arcs for the abutments, do the following:

1. Select “ Feature Stamp” to make it active.
2. Turn off “ Mesh” to make it easier to see the abutment.
3. **Zoom**  in to the area in the rectangle in Figure 9.

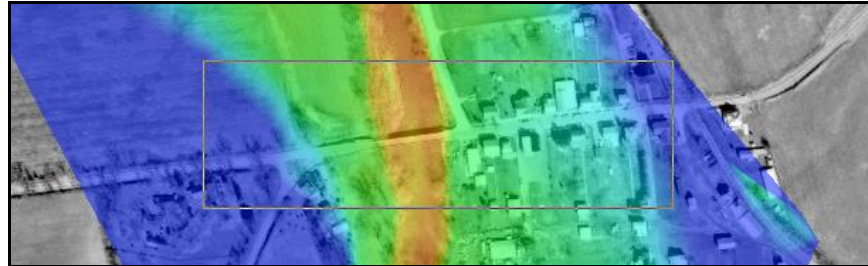



Figure 9 Zoom in to this area

4. Using the **Create Feature Arc**  tool, create two arcs representing the centerlines of the two abutments (east and west) as shown in Figure 10. Start the arcs at the point farthest from the bridge and end them at the bridge.

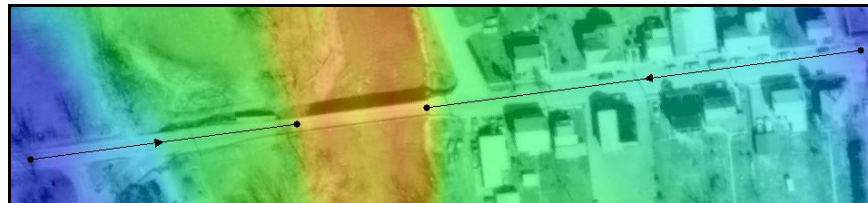



Figure 10 Abutment centerline arcs

Use the roadway in the aerial photograph to help position the centerline arcs and line them up with each other.

5. Using the **Select Feature Arc**  tool, select the centerline arc for the west abutment.
6. Select *Feature Objects* | **Redistribute Vertices...** to bring up the *Redistribute Vertices* dialog.
7. Select “Number of segments” from the *Specify* drop-down.
8. Enter “20” as the Number of segments.
9. Enter “0.1” as the *Bias*.

The *Bias* positions the vertices so that the distance between the last two vertices is 0.1 times the distance between the first two vertices.

10. Click **OK** to close the *Redistribute Vertices* dialog.

Repeat steps 5–10 for the east abutment centerline, entering “30” as the *Number of segments* and “0.1” as the *Bias*.

The abutment centerline arcs should appear similar to those in Figure 11.

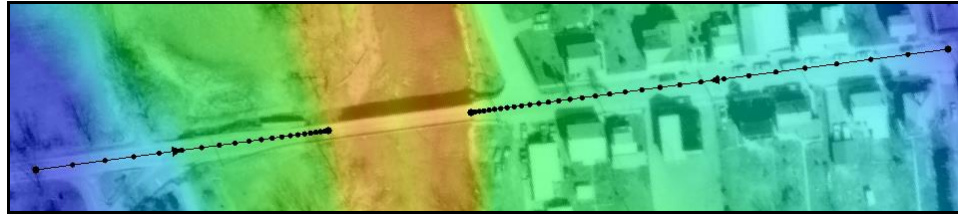


Figure 11 Abutment centerlines with redistributed vertices

6.3 Specifying the Geometry of the Abutments


Now that the abutments have been positioned with centerline arcs, specify their geometry by doing the following:

1. Using the **Select Feature Arc**  tool, double-click on the west abutment centerline arc to bring up the *Stamping Arc Attributes* dialog.
2. Enter “West Abutment” as the *Feature Name*.
3. Select “Fill Feature” from the *Stamping Type* drop-down.

This is because the abutment will be increasing the elevation of the existing bathymetry.

4. In the *Centerline (CL) Profile* section, click **Constant** → **Elevation** to bring up the *Constant* → *Elevation* dialog.
5. Enter “332.0” in the *Enter constant elevation* field and click **OK** to close the *Constant* → *Elevation* dialog.

This sets the elevation at each of the points along the centerline arc to 332.0 feet. The elevations for the points along the centerline can also be set individually using the spreadsheet in the *Centerline (CL) Profile* section.

Notice that in that spreadsheet, the first point along the centerline is marked with an arrow  to identify the point currently selected. Selecting any other row will move the arrow to that row.

The *Cross sections (CS)* section of the attributes dialog displays for viewing and editing the cross section of the current point. The views in the *Cross sections (CS)* section update to display the cross section of the currently-selected point.

To specify the cross sections at each point along the centerline, do the following:

6. In the *Centerline (CL) Profile* section, select the first row.
7. In the *Cross sections (CS)* section, click **Specify Top Width and Single Side Slopes** to bring up the *Top Width and Side Slopes* dialog.
8. Enter “25.0” as the *Top Width*, and “-1.0” as both the *Left Slope* and *Right Slope*.
9. Click **OK** to close the *Top Width and Side Slopes* dialog.

A simple cross section has now been specified.

10. To ensure these cross sections intersect the bathymetry when being stamped, enter “35.0” as the a *Maximum Distance from CL* for both the *Left Side* and *Right Side*.

Now copy this cross section to the remaining centerline points by doing the following:

11. At the bottom of the *Cross sections (CS)* section, click **Current CS** → **All CS**.
12. When asked if cross sections should be adjusted based on centerline elevation, click **Yes**.

Next, specify a slope on the end of the abutment by doing the following:

13. Click **Last End Cap...** to bring up the *Last End Cap* dialog.
14. Select “Sloped Abutment” from the *Type of end cap* drop-down.
15. Enter “0.0” as the *Angle*.
16. In the *Slope* section, enter “1.0” on the blank row in the *Distance from CS (ft)* column.
17. Enter “331.0” in the *Elevation (ft)* column.
18. To ensure the sloped abutment intersects the bathymetry, enter “25.0” as the *Maximum Distance from CS*.
19. Click **OK** to exit the *Last End Cap* dialog.
20. Click **OK** to close the *Stamping Arc Attributes* dialog.

Repeat steps 1 through 20 for the east abutment, entering “East Abutment” as the Feature Name.

The geometry for both the abutments has now been specified. For this tutorial, fairly simple features are being created to force into the existing bathymetry. The feature stamping interface inside SMS has been designed to create simple features quickly while allowing for the creation of more complex features. The definition is now ready to stamp the abutments and add them to the conceptual model.

6.4 Stamping the Abutments

To maintain the integrity of the conceptual model and the existing bathymetry, feature stamping creates a new coverage and a new scatter set for each stamped feature. If the conceptual model or the existing bathymetry becomes corrupted, it can be difficult to test multiple scenarios for the placement and geometric design of features being stamped.

To stamp the abutments into the existing bathymetry:

1. Select *Feature Objects* / **Stamp Features...** to bring up the *Stamp Features* dialog.
2. In the *Stamping Options* section, select “Mesh Generator” from the *Coverage Type* drop-down.
3. Click **Stamp** to stamp the features and close the *Stamp Features* dialog.

Notice that both a coverage and scatter set are added to the Project Explorer for each abutment. The Project Explorer should appear similar to Figure 12.

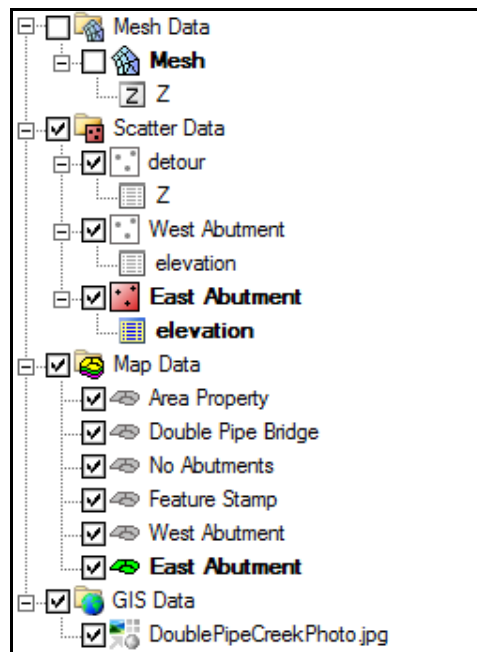




Figure 12 Project Explorer

7 Incorporating the Abutments into a Numerical Model

There are several ways to incorporate a stamped feature into a numerical model. Two methods will be illustrated in this tutorial. The first method uses the existing mesh elements and applies the stamped elevations to the nodes of the mesh. The second method creates a new mesh that uses the stamped elevations. The new mesh also has a different configuration of elements than the original mesh.

Both methods described here require a new scatter set that includes the stamped elevations. The second method also requires a new conceptual model. In general, the second method is the preferred approach to set up the elements to match the updated bathymetry.



To use the new scatter sets in the numeric model, combine them with the original data by doing the following:

1. Select “ Scatter Data” to switch to the  **Scatter Module**.
2. Select *Scatter* | **Merge Sets** to bring up the *Merge Scatter Sets* dialog.
3. In the *Overlapping region options* section, select *Merge all scatter points*.
4. In the *Select scatter sets to merge* section, click **Select All**.

This indicates that all available scatter sets should be merged.

5. Click **OK** to close the *Merge Scatter Sets* dialog and bring up the *Merge Report* dialog.

SMS triangulates the new set of merged scatter points at this point.

6. When done reviewing the report, click **Close** to exit the *Merge Report* dialog.
7. Turn off everything except “ Merged” in the Project Explorer.
8. Right-click on “ Merged” and select **Zoom to Scatter**.

Note that, in some cases, the merged scatter set (or TIN) may exceed the original stamped feature boundaries. If this happens, the TIN may need to be manually edited to more accurately represent the combined surface. This should not be the case in this tutorial.

The project should appear similar to Figure 13.

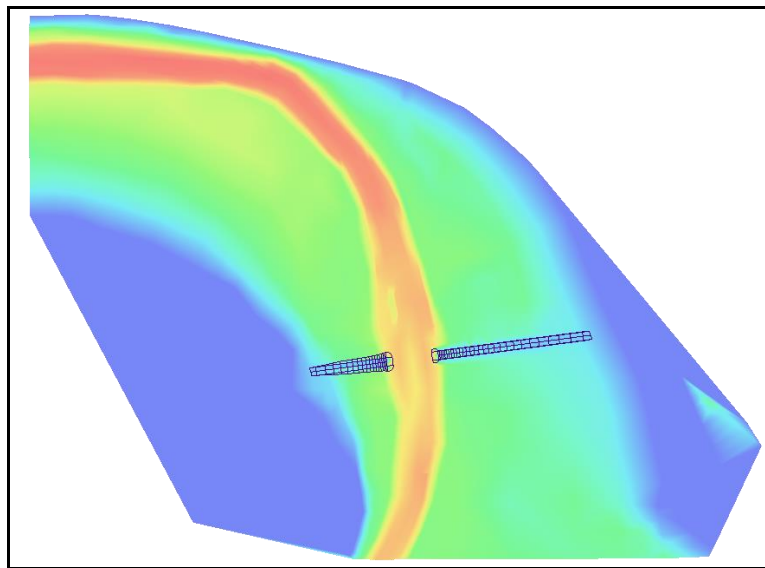








Figure 13 Merged scatter set

To integrate the abutments into a numerical model using this method:

1. Select “ Merged” in the Project Explorer to switch to the  **Scatter Module**.
2. Select *Scatter / Interpolate to Mesh* to bring up the *Interpolation* dialog.
3. In the *Scatter Set to Interpolate From* section, under “ Merged”, select the dataset “ elevation”.
4. In the *Other Options* section, turn on *Map Z*.
5. Click **OK** to close the *Interpolation* dialog.

In some cases, the differences in elevations are not noticeable. This can be adjusted via the *Display Options* dialog.

1. Click  **Display Options** to bring up the *Display Options* dialog.
2. Select “General” from the list on the left.

3. On the *General* tab, turn off *Auto z-mag* and enter “5.0” as the *Z magnification*.
4. Select “Scatter” from the list on the left.
5. On the *Scatter* tab, turn on *Contours*.
6. On the *Contours* tab in the *Contour method* section, select “Color Fill” from the first drop-down.
7. Enter “0” as the *Transparency* and click **OK** to close the *Display Options* dialog.
8. Turn on “ Mesh” in the Project Explorer.

The Rotate tool can be used to view the project from any angle, including the one in Figure 14. This allows the contours of the area in the project to be more easily seen.

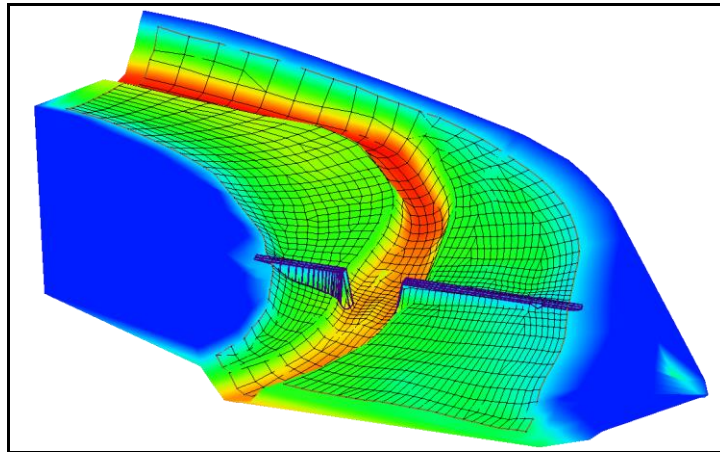



Figure 14 Rotated view with mesh turned on

9. Turn off “ Mesh” in the Project Explorer.

Breaklines are automatically created when using feature stamping. They force the contours to follow the abutment once triangulation is finished. The breaklines outlining the abutment are more easily seen with the mesh turned off (Figure 15).

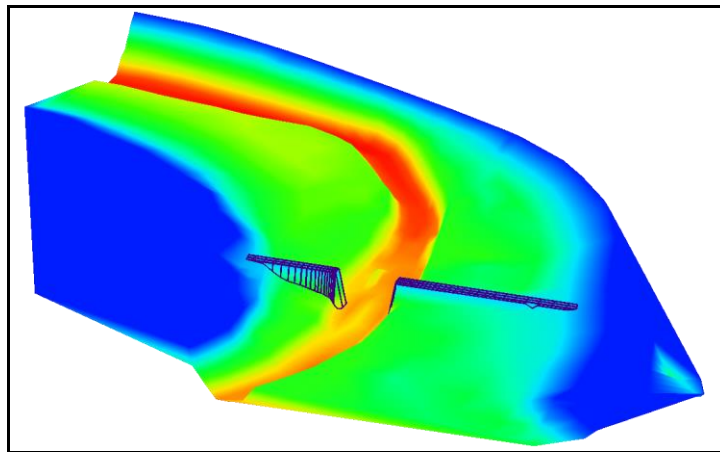


Figure 15 Rotated view with mesh turned off

8 Conclusion

This concludes the “Feature Stamping” tutorial. The following key concepts were discussed and demonstrated:

- Importing bathymetric data as a scatter set
- Creating a conceptual model to use for mapping
- Creating the mesh without the abutments
- Creating an abutments by using a stamping coverage

The same process can be used to create channels, pits, or mounds. If desired, experiment with some of these other options.