GMS 7.0 TUTORIALS

Stratigraphy Modeling – Horizon Coverages

1 Introduction

This tutorial builds on the concepts taught in the tutorial entitled *Stratigraphy Modeling – Horizons and Solids*. In that tutorial, you created solids using horizons and cross sections. GMS uses 2D interpolation in the algorithm to define the solids. Sometimes the 2D interpolation tends to continue trends in the data which causes the areal extent of the solids to extend beyond where we would like them to. This tutorial illustrates a way to constrain the areal extent of the solids created using the *Horizons* → *Solids* command.

You should have completed the *Stratigraphy Modeling – Horizons and Solids* tutorial prior to this tutorial. You should also be familiar with how feature objects work. The *Feature Objects* tutorial provides a good introduction to using the map tools.

1.1 Contents

1.2 Outline

This is what you will do:

1. Create horizon coverages manually.
2. Create horizon coverages automatically.
3. Create solids from the horizon conceptual model.
4. Compare the solids made from a horizons conceptual to the solids created without a horizons conceptual model.

1.3 Required Modules/Interfaces

You will need the following components enabled to complete this tutorial:

- Sub-surface characterization
- Geostatistics
- Map

You can see if these components are enabled by selecting the *Help* | *Register*. If you do not have these components enabled, you can request a temporary password by contacting sales@aquaveo.com.

2 Getting Started

Let's get started.

1. If necessary, launch GMS. If GMS is already running, select the *File* | *New* command to ensure that the program settings are restored to their default state.

3 Reading Borehole Data

We will start by reading in the same set of boreholes that are used in the *Stratigraphy Modeling – Horizons and Solids* tutorial.

To read in the file:

1. Select the *Open* button .
2. Locate and open the directory entitled **tutfiles\Stratigraphy Modeling\horizons**.
3. Open the file named **xsects.gpr**.

4 Horizons -> Solids

Now we'll create solids the way that was outlined in the *Stratigraphy Modeling – Horizons and Solids* tutorial. The horizon IDs have already been assigned, and the cross sections created, so all we have to do is run the *Horizons* → *Solids* command.

1. In the *Project Explorer*, click on the *Borehole Data* folder to switch to the Borehole module.
2. Select the *Boreholes* | *Horizons* → *Solids* menu command.
3. Accept the default settings and click *Next*.
4. In the second step, set the dialog options as shown in Figure 1 below and click *Finish*.

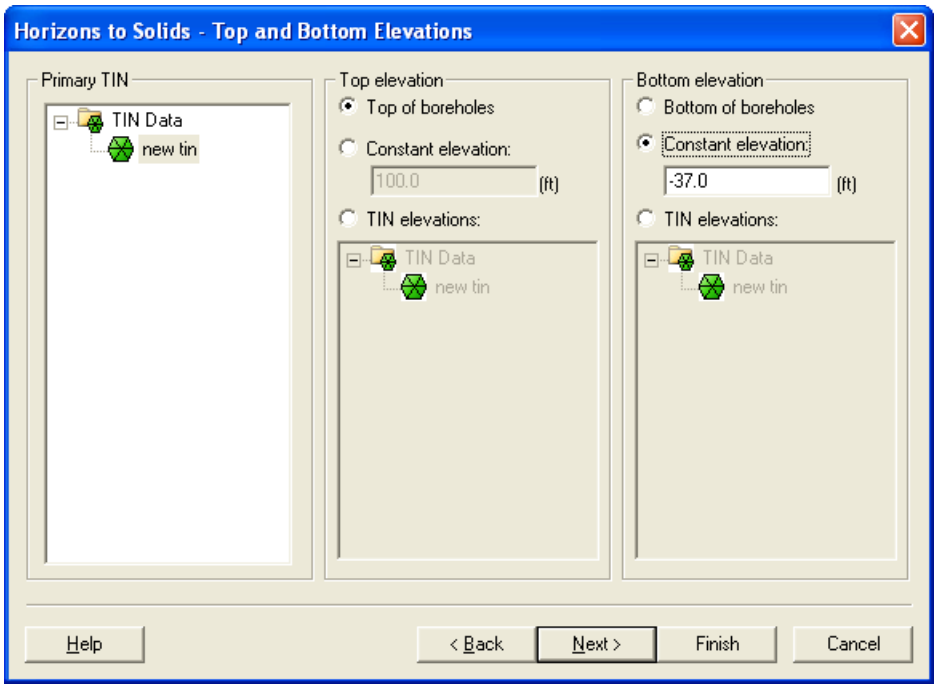

Figure 1. Horizons to Solids Wizard, step 2.

GMS now creates the solids.

4.1 View the Clean Sand Solid

Let's look at the Clean Sand layer (the green solid).

1. In the *Project Explorer* under the *Solid Data* folder, expand the *solids* folder to see the solids that were just created.
2. Turn off all the solids except for the **Clean_Sand 4** solid.
3. Select the *Display Options* button.
4. Turn on *Hole names* in the *Stratigraphy* section of the *Borehole* tab.
5. Select *Solid Data* in the list on the left.
6. Turn on the *Solid faces* and click *OK*.
7. Notice how the green solid intersects with cross section **5G-2G** even though there is no green material in that cross section.
8. Switch to the rotate tool and rotate the view to get a feel for the extent of the green solid. For example, notice how it passes through cross section 6G-8G outside of the green area in the cross section.

What you are seeing is the result of the interpolation that is used by the *Horizons* → *Solids* command. The interpolation identifies the trends in the data and continues the trends – sometimes further than we would like. Using horizon coverages allows us to constrain the interpolation.

5 Creating the Horizon Conceptual Model

We will now manually create a horizon conceptual model.

1. In the *Project Explorer*, right-click on the *Map Data* folder and select the *New Conceptual Model* command from the pop-up menu.
2. Change the *Name* of the conceptual model to **Horizons**.
3. Change the *Type* to **Horizons**.
4. Click *OK* to exit the dialog.

5.1 Horizon Coverage 4

Now we will create a new coverage and set up the attributes.

1. In the *Project Explorer*, right-click on the **default coverage** and select the *Duplicate* command. This will create a new coverage called "Copy of default coverage".
2. Drag the new coverage so that it is under the **Horizons** conceptual model, as shown in Figure 2. GMS will give you a warning that moving the coverage may change the attribute tables. Click *Yes* to dismiss the warning.

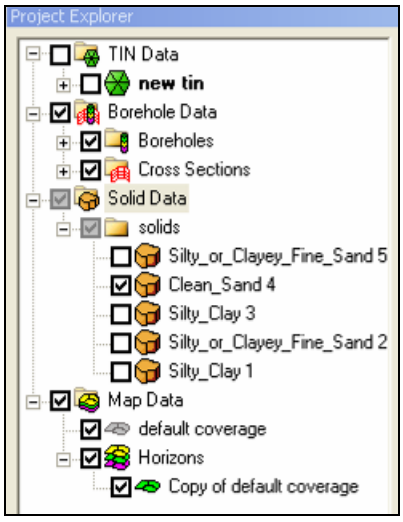

Figure 2. Project Explorer Showing Horizons Conceptual Model.

3. Right-click on the **Copy of default coverage** and select the *Coverage Setup* command.

4. Change the *Coverage name* to **4**. This is the horizon ID corresponding to the green material.

5. Change the *Horizon ID* to **4**.

6. Click *OK* to exit the dialog.

5.2 Defining the polygon

Now we need to create the polygon which will constrain the green material.

1. In the *Project Explorer*, turn off the **Clean_Sand 4** solid.

2. Make sure that coverage **4** is the active coverage. (The icon in the *Project Explorer* should be colored green, not grey. Select the icon to make it active if necessary).

3. Select the *Plan View* button.

4. Notice how part of the cross section lines are highlighted in red. The red portion represents the part of the cross sections where the green material exists. This red highlighting only appears when you are in plan view and the active coverage is a horizon coverage.

5. Switch between plan view and oblique view a few times, or rotate the view to convince yourself that the red highlighting seen in plan view exists where the green material is in the cross sections.

6. Switch back to *Plan View* if necessary.

7. Switch to the *Create Arc* tool.

8. Create 2 arcs similar to those identified by the arrows shown in Figure 3. Notice that the arcs surround the red highlighting on the cross sections.

Each of the vertices on the arcs will be used when interpolating the horizon. So creating an arc with more vertices will more strongly control the interpolation than an arc with fewer vertices.

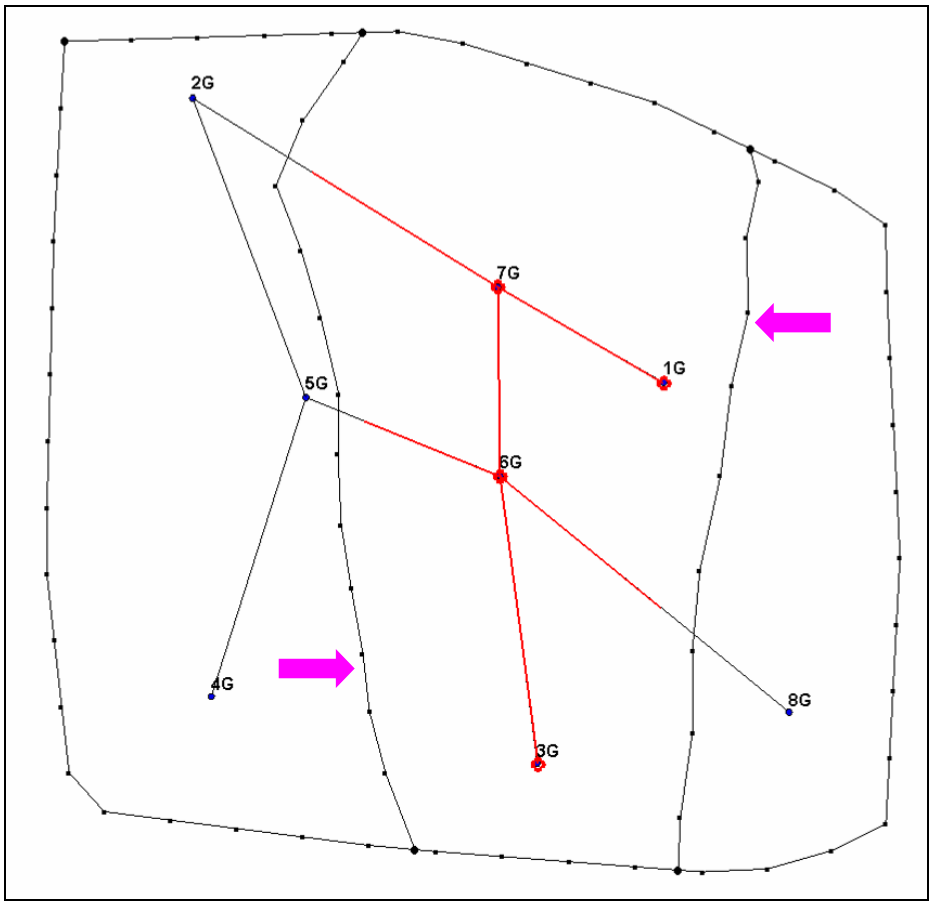

Figure 3. Arcs Created in the Horizon 4 Coverage (Identified by the Arrows).

5.3 Marking the outside-boundary arcs

Now we have to tell GMS which arcs are outside-boundary arcs. GMS uses this information to decide where the solid should be pinched out and where it should be allowed to continue until it hits the boundary and is cut off. The vertices on the outside-boundary arcs are not used when interpolating the horizon.

1. Switch to the *Select* tool .
2. While holding down the shift key, select the 2 arcs identified by the arrows shown in Figure 4.

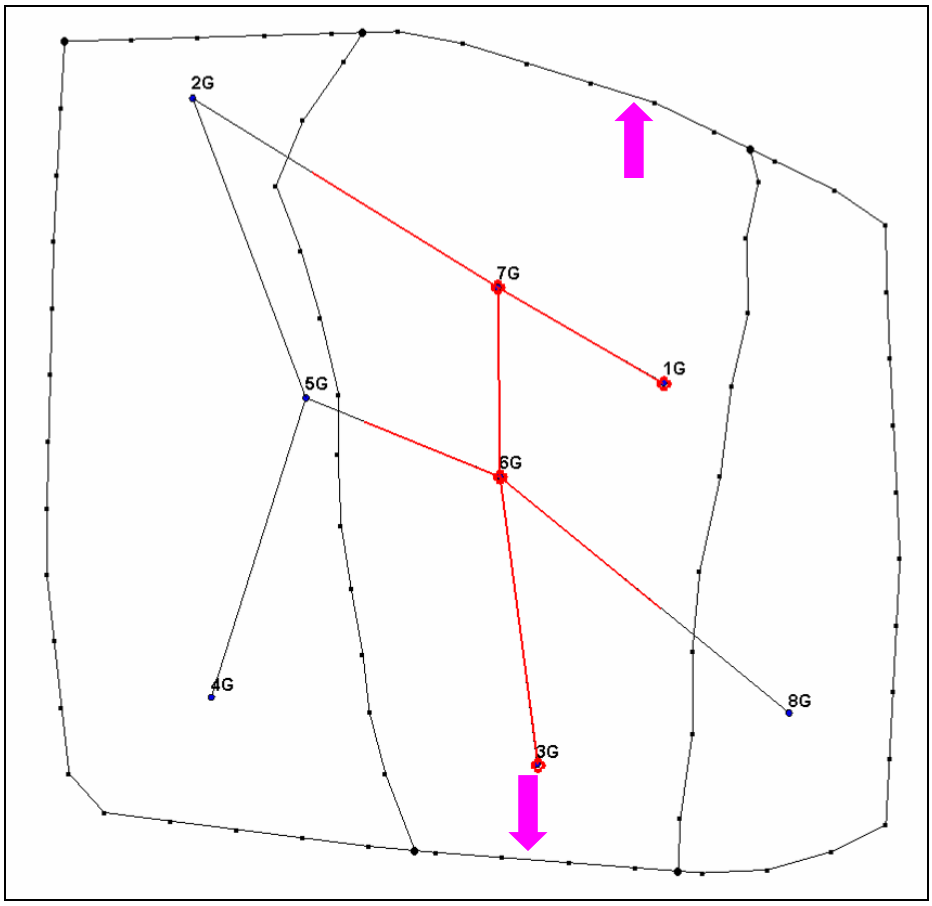

Figure 4. Arcs to be Marked as on the Outside Boundary.

3. Right-click on one of the selected arcs and select the *Attribute Table* command from the pop-up menu.

4. Turn on the *Outside Boundary* toggle for both arcs.

5. Click *OK* to exit the dialog.

6. Click anywhere in the background to unselect the arcs.

5.4 Build Polygons and Delete Polygons

Now we will build the polygons.

1. Select the *Feature Objects* | *Build Polygons* command.

2. Delete the two polygons on the left and right of the model identified by the arrows in Figure 5 (click inside each polygon to select it and hit the delete key). Solids will only be created where a polygon exists.

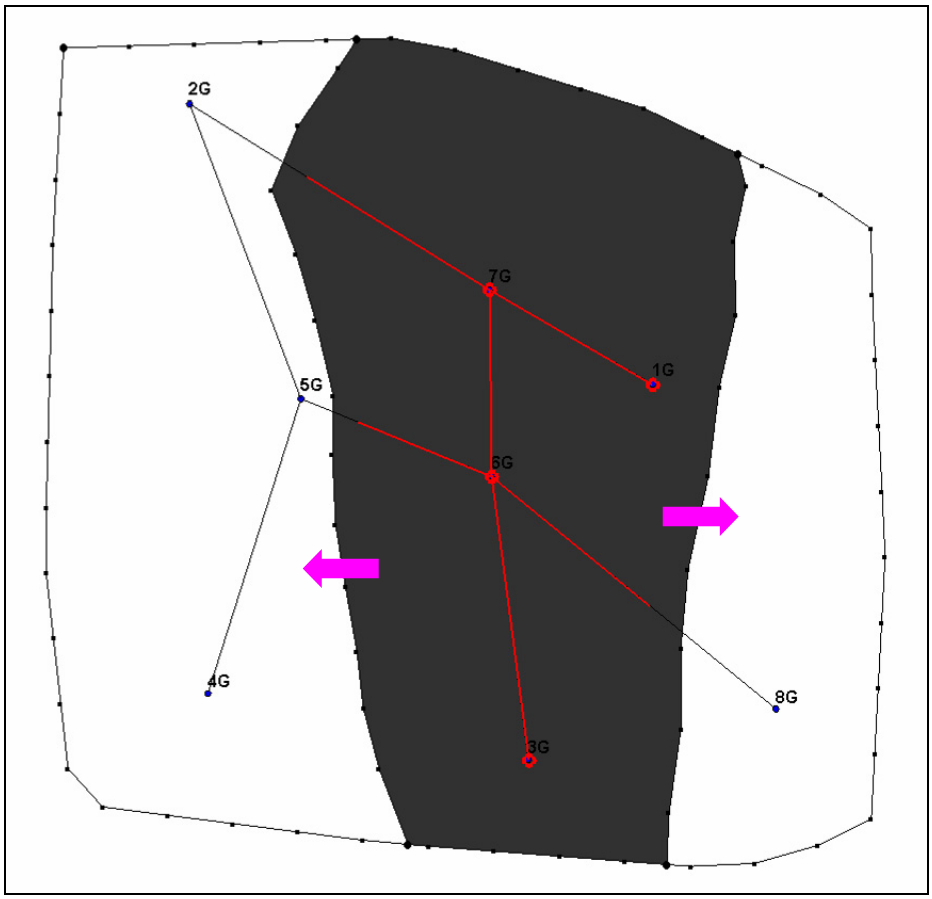

Figure 5. Polygons to be Deleted.

We are done creating the horizon coverage for the green material. At this point we could define horizon coverages for the other horizons, but for the purposes of this tutorial, we will just do horizon 4.

6 Horizons -> Solids

The horizons conceptual model is all set up now. We are ready to use it to create solids.

1. In the *Project Explorer*, click on the *Borehole Data* folder to switch to the borehole module.
2. Select the *Boreholes* | *Horizons* → *Solids* menu command.
3. Turn on the option to *Use horizons conceptual model*.
4. Click *Finish*.

GMS now creates the solids.

6.1 Comparing the results

The newly created solids were added to the *Project Explorer* in a new folder that should be called **solids (2)**.

1. Expand the **solids (2)** folder and turn off all the new solids except for the **Clean_Sand 4** solid. Notice that the boundary of the new solid is almost entirely inside the polygon we defined in the horizons coverage.

The boundary of the new solid won't exactly match the polygon boundary, and some triangles around the edges may overlap the polygon, but otherwise the solid is confined to the polygonal boundary.

2. Turn off and on the original **Clean_Sand 4** solid (in the folder called **solids**) to see how the new solid differs from the original.

The boundaries of the other new solids are identical to the other old solids because we only defined 1 horizon coverage (for horizon 4). You may want to verify that the boundaries for the other solids are indeed the same as before.

7 Automatically Create the Horizon Conceptual Model

Now that you've done it by hand, we will show you how you can create the horizon conceptual model much faster by letting GMS do it for you. When automatically building the coverages, you can choose whether or not to include cross sections. Typically, if you have cross sections, you'll want to use them.

7.1 Build Horizon Coverages

1. In the *Project Explorer*, right-click on the **Horizons** conceptual model and select the *Duplicate* command.

2. Rename the new conceptual model "**Horizons Auto**".

3. Delete coverage **4** under the **Horizons Auto** conceptual model.

4. Turn off the other coverage and conceptual model.

5. Right-click on the **Horizons Auto** conceptual model and select the *Build Horizon Coverages* command.

6. Make sure *Use all boreholes* is selected and click *Next*.

7. In the next step, select the **default coverage** as shown in Figure 6. Click *Next*.

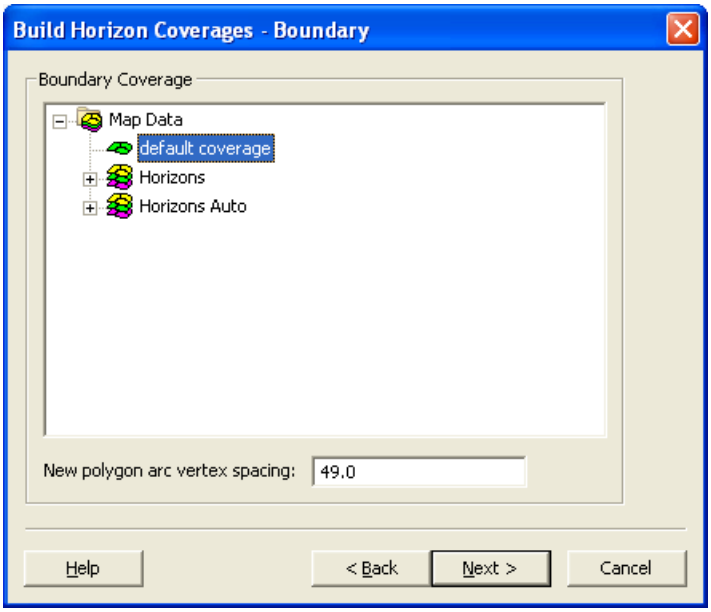

Figure 6. Selecting the Starting Coverage.

8. In the next step, no changes should need to be made. Make sure the options to *Use cross sections* and *Generate for each horizon* are selected and click *Finish*.

7.2 Examine the Horizon Coverages

Notice that 5 new coverages were created – one for each horizon. Let's look at them.

1. Switch to *Plan View* if necessary.

2. Examine the new coverages by selecting them in the *Project Explorer*. Compare the location of the polygons in each coverage with the red highlighting on the cross sections.

8 Building Solids

Now we will build solids with the conceptual model and compare the results with our previously constructed solids.

8.1 Create Solids From the Horizon Coverage

1. Click on the *Borehole Data* folder in the *Project Explorer* to switch to the borehole module.

2. Select the *Boreholes* | *Horizons* → *Solids* menu command.

3. Select the options as shown in Figure 7 and click *Finish*.

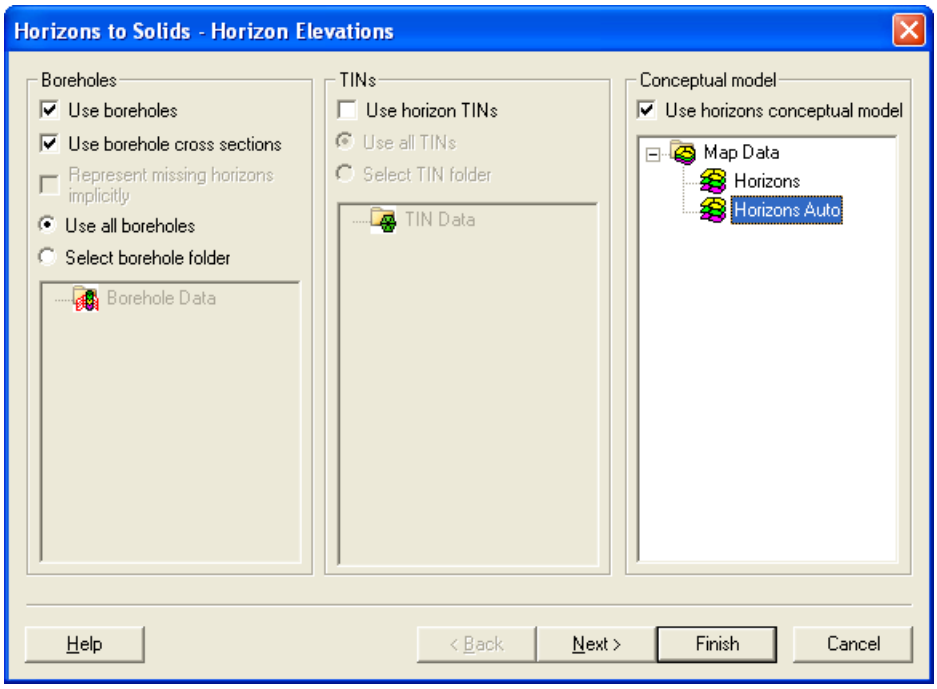

Figure 7. Horizons -> Solids, Using a Horizon Conceptual Model.

GMS now creates a whole new set of solids and puts them in a folder called **solids (3)** in the *Project Explorer*.

8.2 Compare the results

Let's compare the results.

1. Turn off all the solids.
2. In the **solids (2)** folder, turn on the *Silty_Clay 1* solid. Notice the area that it covers.
3. Turn off the solid you just turned on.
4. Turn on the corresponding solid (*Silty_Clay 1*) in the **solids (3)** folder. Notice the area that the solid covers.
5. Repeat steps 2 – 4 until you get a feel for the differences between the two solids.
6. Repeat steps 2 – 4 for the other solids.

You should notice how the solids created using the horizon conceptual model are constrained by the polygons in the horizon coverages.

9 Conclusion

This concludes the tutorial. Here are some of the key concepts in this tutorial:

- You can create a horizon conceptual model containing horizon coverages that constrain the areal extent of the solids.
- There is one horizon coverage per horizon ID.
- In a horizon coverage, you must identify which arcs are outside-boundary arcs.
- In a horizon coverage, you must only have polygons defined for the areas where you want the solids to be.
- When you select a horizon coverage and are in plan view, GMS highlights in red parts of the cross sections to show where on the cross sections the soil layer with the same horizon ID as the coverage exists.
- Horizon coverages can be created automatically.
- You can choose to use the borehole cross sections or not when you automatically create horizon coverages.