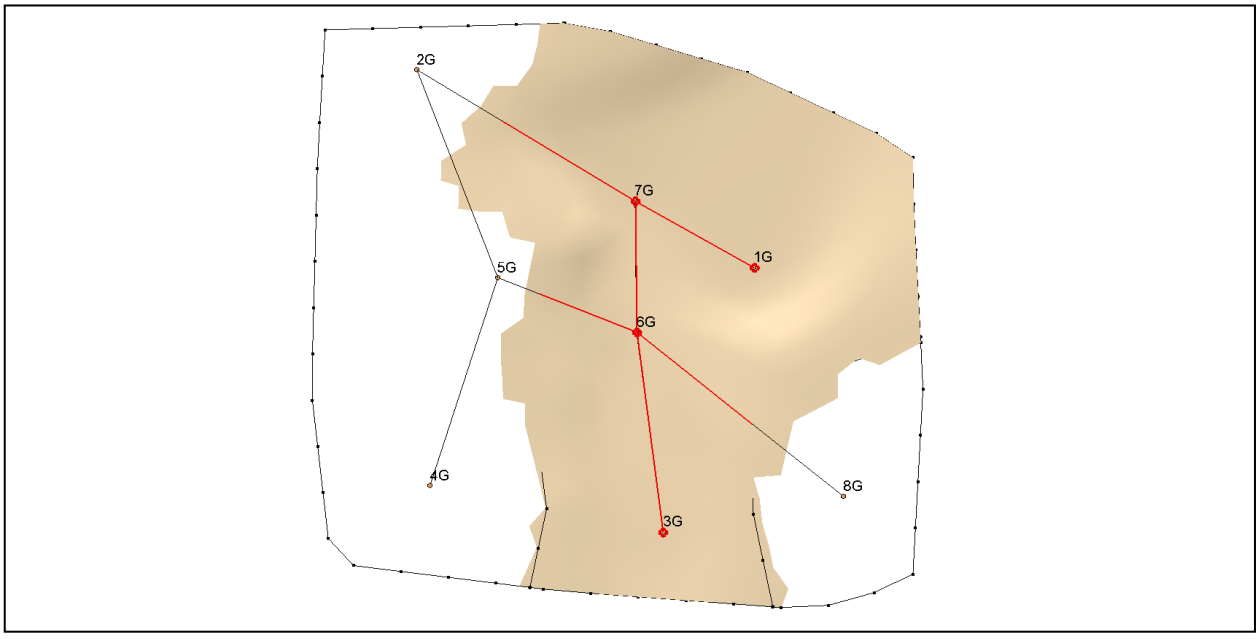
GMS 10.0 Tutorial

Stratigraphy Modeling—Horizon Coverages

Use horizon coverages to help control the **Horizons** → **Solids** operation



Objectives

Learn how to constrain the areal extent of the solids created using the **Horizons** → **Solids** command.

Prerequisite Tutorials

- Stratigraphy Modeling—Horizons and Solids

Required Components

- Sub-surface Characterization
- Geostatistics
- Map Module

Time

- 20-30 minutes

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1 Introduction

This tutorial builds on the concepts taught in the tutorial entitled "Stratigraphy Modeling—Horizons and Solids." In that tutorial, solids were created using horizons and cross sections. GMS uses 2D interpolation in an algorithm to define the solids. Sometimes the 2D interpolation continues trends in the data that cause the areal extent of the solids to extend beyond what is desired. This tutorial illustrates a way to constrain the areal extent of the created solids using the **Horizons → Solids** command.

1.1 Outline

These are the steps of the tutorial:

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 model to the solids created without a horizons conceptual model.

2 Getting Started

Do the following to get started:

1. If necessary, launch GMS.

2. 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

The tutorial will start by reading in the same set of boreholes that were used in the "Stratigraphy Modeling—Horizons and Solids" tutorial.

To read in the file:

1. Select the **Open** button.
2. In the Open dialog browser, locate and open the directory entitled *Tutorials\Stratigraphy_Modeling\Horizon_Coverages.*
3. Choose the file named "xsects.gpr."
4. Select **Open**.

4 Horizons → Solids Command

The next step is to create solids as outlined in the "Stratigraphy Modeling – Horizons and Solids" tutorial. The horizon IDs have already been assigned, and the cross sections have already been created, so all that is necessary is to 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. In the *Horizons to Solids* dialog, accept the default settings by clicking **Next**.
4. As seen in Figure 1, set the *Top elevation* to *Top of boreholes.* Under *Bottom elevation*, select *Constant Elevation* and set it as "-37.0."
5. Click **Finish**.

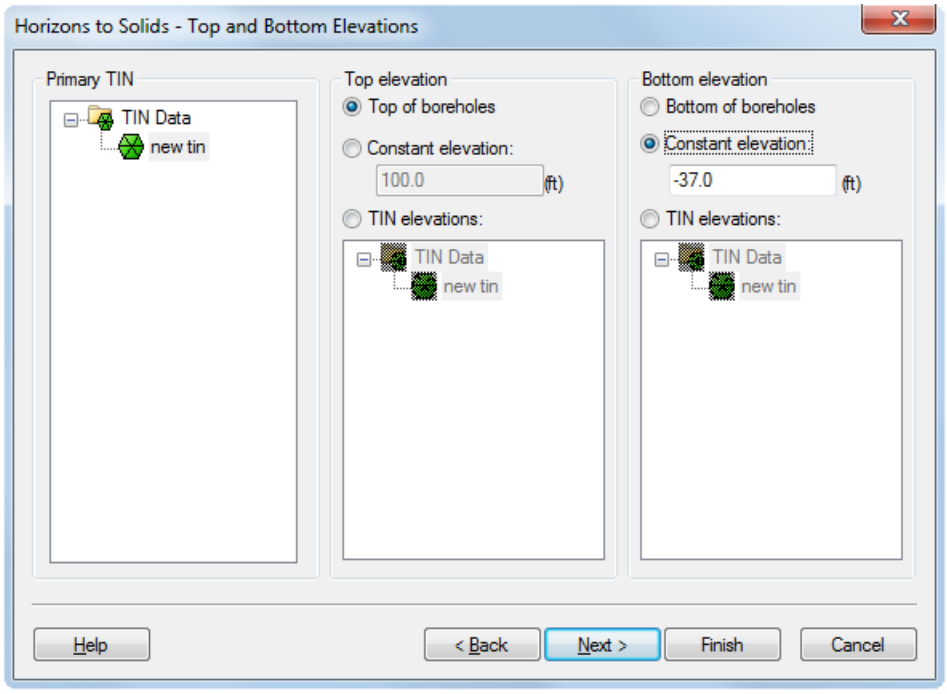

Figure 1 Horizons to Solids wizard

GMS will now create the solids.

4.1 Viewing the Clean Sand Solid

Do the following to look at the clean sand layer.

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 to bring up the *Display Options* dialog.
4. Make sure *Borehole Data* is selected in the list on the left.
5. Turn on *Hole names* in the *Stratigraphy* section of the *Borehole* tab.
6. Then select *Solid Data* in the list on the left.
7. Turn on the *Solid faces*, and click **OK**.
8. Notice how the layer intersects with cross section **5G-2G** even though there is no clean sand material in that cross section.
9. Switch to the **Rotate** tool and rotate the view to get a feel for the extent of this solid. For example, notice how it passes through cross section 6G-8G outside of the clean sand area in the cross section.

What is displayed here is the result of the interpolation that the **Horizons → Solids** command used. The interpolation identifies the trends in the data and continues the trends—sometimes further than is desirable. Using horizon coverages allows us to constrain the interpolation.

5 Creating the Horizon Conceptual Model

The next step is to 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. In the *Conceptual Model Properties* dialog, 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

The tutorial will now illustrate how to create a new coverage and set up the attributes.

1. In the Project Explorer, right-click on "default coverage" and select the **Duplicate** command. This will create a new coverage called "Copy of default coverage."

2. Drag the new coverage on top of the "Horizons" conceptual model. This will move the coverage to that folder as shown in **Error! Reference source not found.**. GMS will give the user a warning that moving the coverage may change the attribute tables. Click **Yes** to dismiss the warning.

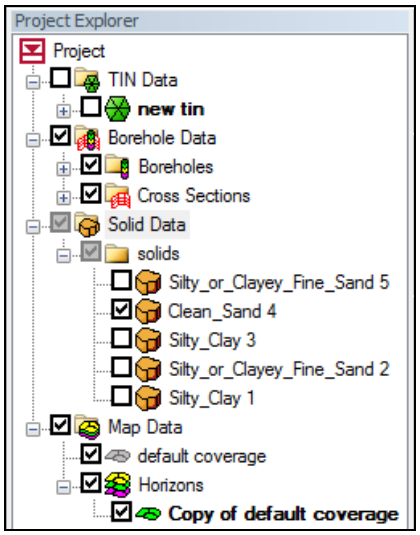

Figure 2 Project Explorer showing horizons conceptual model

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

4. In the *Coverage Setup* dialog, change the *Coverage name* to "4." This is the horizon ID corresponding to the clean sand material.

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

6. Click **OK** to exit the dialog.

5.2 Defining the polygon

Now it is necessary to create the polygon which will constrain the clean sand material.

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

2. Select the coverage "4" icon to make sure it is the active coverage.

3. Also turn on coverage "4" by placing a checkmark in the box.

4. Select the **Plan View** button.

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

6. Switch between **Plan View** and **Oblique View** a few times, or **Rotate** the view to make it seem like the red highlighting in plan view exists where the clean sand material exists in the cross sections.

7. Switch back to **Plan View**.

8. Switch to the **Create Arc** tool.

9. Create 2 arcs similar to those identified by the arrows shown in **Error! Reference source not found.**. 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 is recommended because it will more strongly control the interpolation than an arc with fewer vertices.

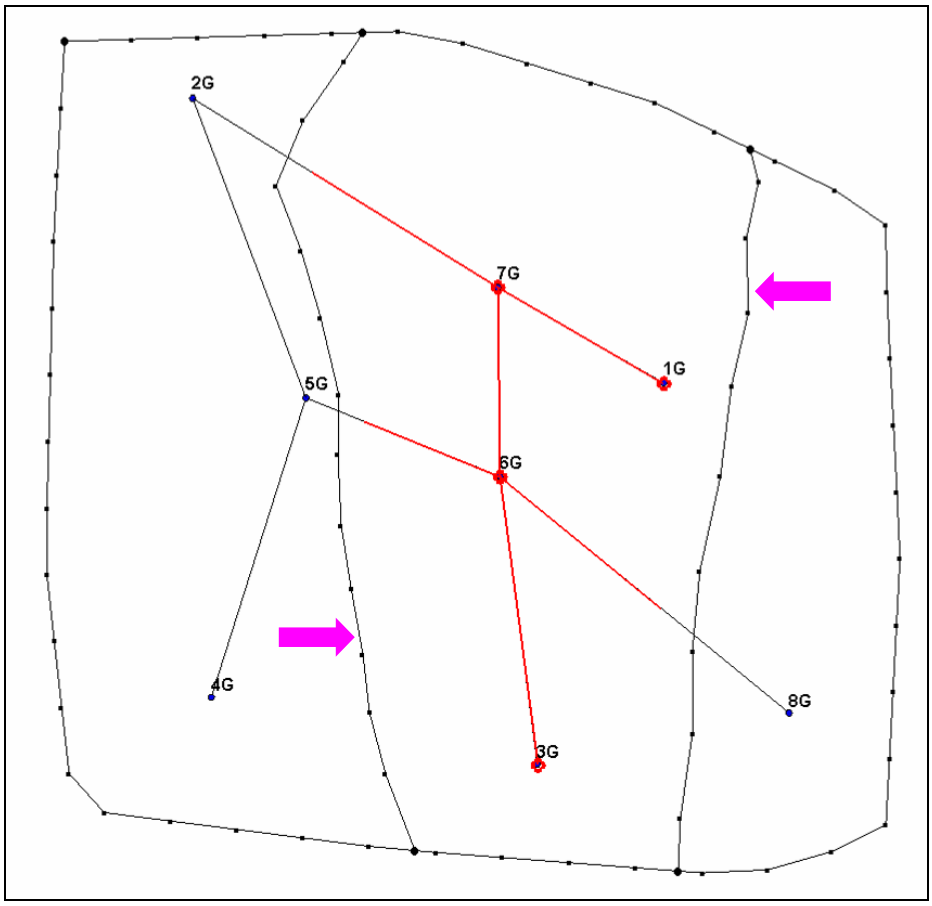

Figure 3 Arcs (identified by arrows) created in the Horizon 4 coverage

5.3 Marking the outside-boundary arcs

Now it is necessary to tell GMS which arcs are outside-boundary arcs. GMS uses this information to decide where the solid should end and where it should be allowed to continue until it hits the cut-off boundary. 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 **Error! Reference source not found.**.

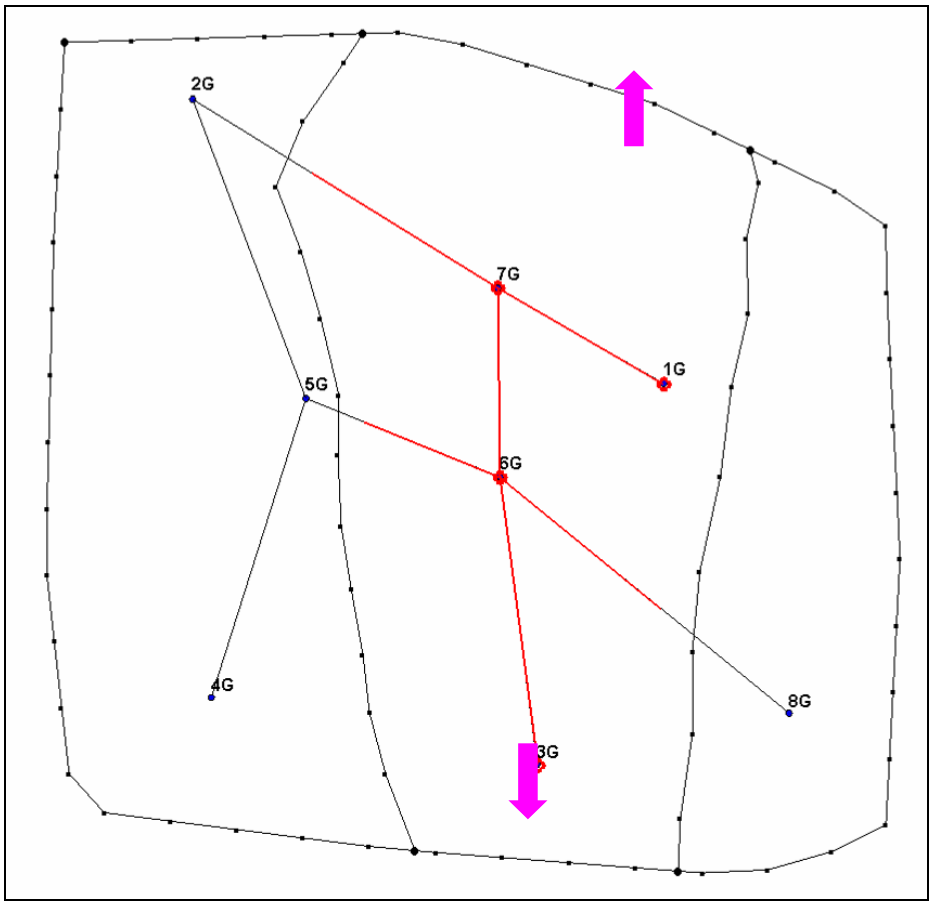

Figure 4 Arcs (identified by arrows) to be marked as on the outside boundary

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

4. In the *Attribute Table* dialog, turn on the *Outside Boundary* checkbox for both arcs.

5. Click **OK** to exit the dialog.

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

5.4 Building and Deleting Polygons

The next step is to 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 by clicking inside each polygon to select it and hitting the *Delete* key. Solids will only be created where a polygon exists.

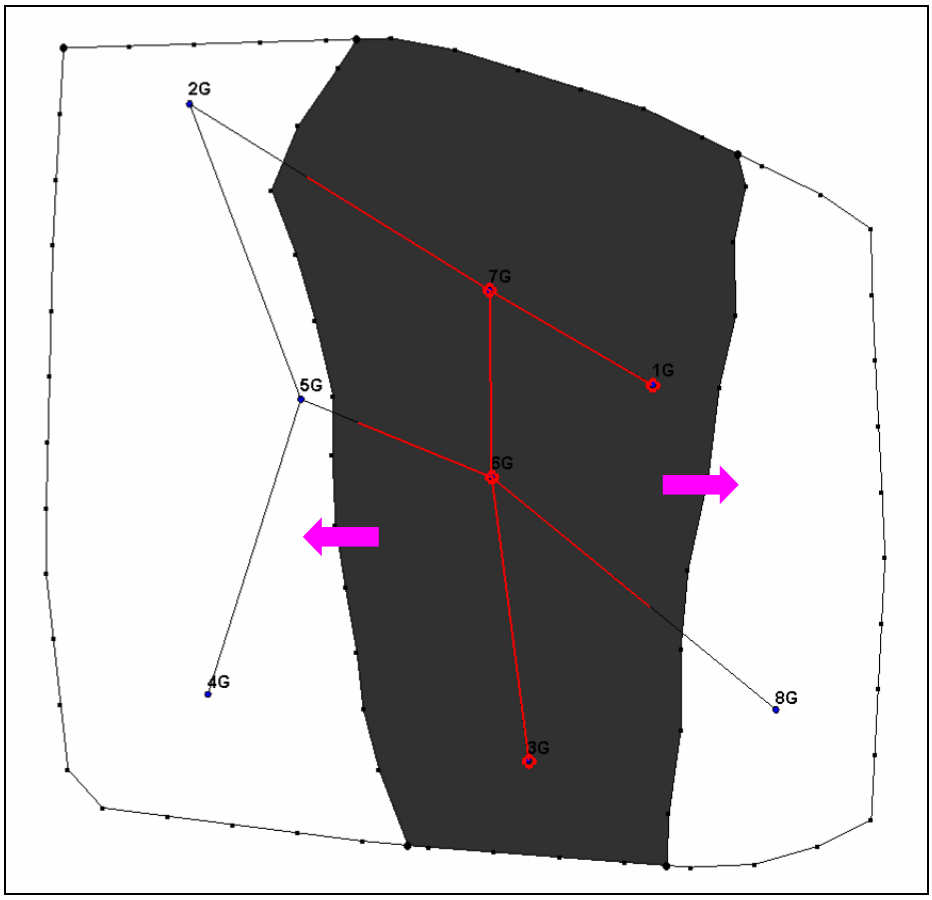

Figure 5 Polygons (identified by arrows) to be deleted

The user is now done creating the horizon coverage for the clean sand material. At this point, the user could define horizon coverages for the other horizons, but for the purposes of this tutorial, it is only necessary to do horizon 4.

6 Horizons → Solids Command

The horizons conceptual model is all set up now. It is now ready to use in creating 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. In the *Horizons to Solids* dialog under the *Raster Catalog* section, turn on the option to *Use horizons conceptual model*.

4. Click **Finish**.

GMS will now create 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 that was 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 this tutorial only defined 1 horizon coverage (for horizon 4). Note that only one horizon coverage exists per horizon ID. The user 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 the user has created the horizon conceptual model by hand, this tutorial will show the user how to create it much faster by letting GMS do it automatically. When automatically building the coverages, it is possible to choose whether or not to include cross sections. Typically, if the model has cross sections, it's natural to want to use them.

7.1 Building Horizon Coverages

1. In the Project Explorer, right-click on the "Horizons" conceptual model and select the **Duplicate** command, which will create a conceptual model named "New Model."

2. Right-click on "New Model" and select **Properties** from the pop-up menu.

3. In the *Conceptual Model Properties* dialog, rename the new conceptual model "Horizons Auto."

4. Right-click on coverage "4"  under the "Horizons Auto" conceptual model and select **Delete**.

5. Turn off both the "Horizons" coverage and conceptual model "4" .
6. Right-click on the "Horizons Auto" conceptual model and select the **Build Horizon Coverages** command.
7. In the *Build Horizon Coverages* dialog, make sure *Use all boreholes* is selected, and click **Next**.
8. In the next step, select the "default coverage" as shown in **Error! Reference source not found.**.
9. Click **Next**.

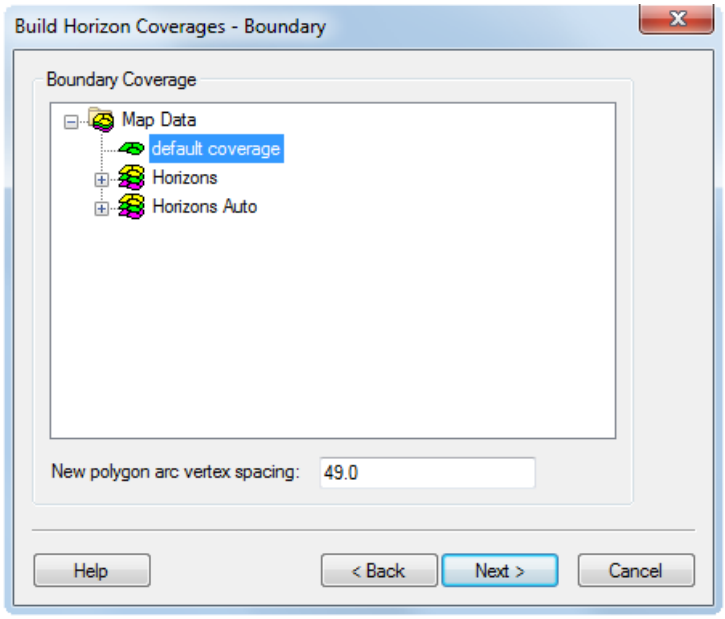

Figure 6 Selecting the starting coverage

10. Make sure the options to *Use cross sections* and *Generate for each horizon* are selected.
11. Click **Finish**.

7.2 Examining the Horizon Coverages

Notice that 5 new coverages were created—one for each horizon.

1. Switch to **Plan View** if necessary.
2. Examine the new coverages by selecting them in the Project Explorer.

8 Building Solids

The next process is to build solids with the conceptual model and compare the results with the previously constructed solids.

8.1 Creating 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. In the *Horizons to Solids – Horizon Elevations* dialog, accept the default options as shown in **Error! Reference source not found.**. Click **Finish.**

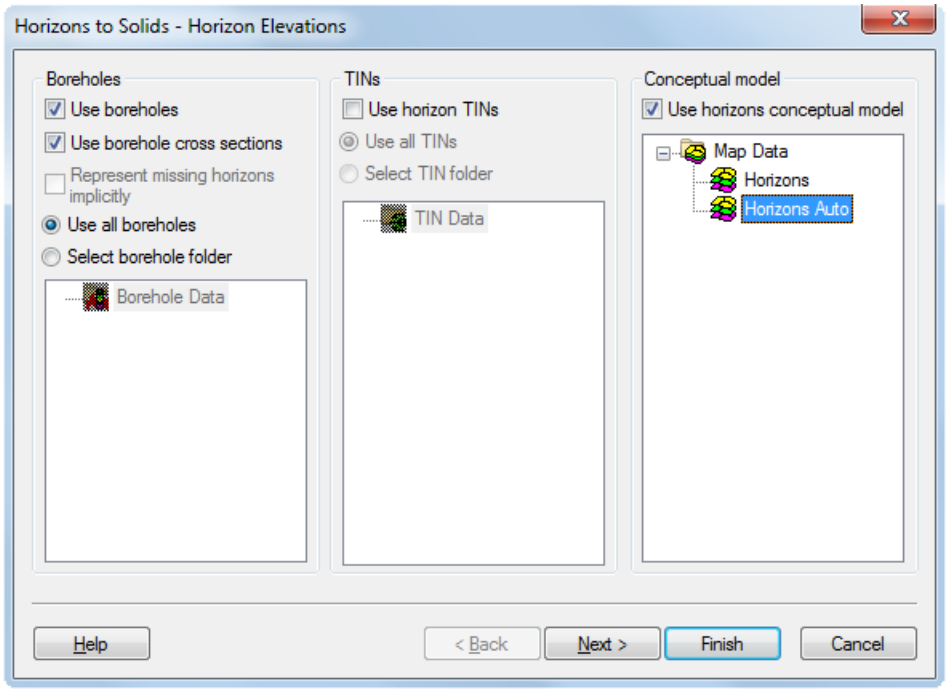

Figure 7 Horizons to Solids dialog using a horizon conceptual model

GMS will now create a whole new set of solids and put them in a folder called "solids (3)" in the Project Explorer.

8.2 Comparing the results

To compare the results, do the following:

1. Turn off all the solids in all three solids folders.

2. In the "solids (2)" folder, turn on the "Silty_Clay 1" solid. Notice the area that it covers.

3. Turn off the solid that was 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 the user gets a feel for the differences between the two solids.

6. Repeat steps 2–4 for the other solids.

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:

- Horizon coverages can be created manually and automatically.
- The user can choose whether or not to use the borehole cross sections when he or she automatically creates horizon coverages.
- Solids can be created from the horizon conceptual model.
- It is possible to create a horizon conceptual model containing horizon coverages that constrain the areal extent of the solids.
- One horizon coverage exists per horizon ID.
- In a horizon coverage, the user must identify which arcs are outside-boundary arcs.
- In a horizon coverage, the user must have only polygons defined for the areas where the solids should appear.
- When the user selects a horizon coverage and is in plan view, GMS highlights in red parts of the cross sections to show where the soil layer with the same horizon ID as the coverage exists on the cross sections.

