

ARC HYDRO GROUNDWATER TUTORIALS – SUBSURFACE ANALYST

Building 3D models with the horizons method

Arc Hydro Groundwater (AHGW) is a geodatabase design for representing groundwater datasets within ArcGIS. The data model helps to archive, display, and analyze multidimensional groundwater data, and includes several components to represent different types of datasets, including representations of aquifers and wells/boreholes, 3D hydrogeologic models, temporal information, and data from simulation models.

The *Arc Hydro Groundwater Tools* help to import, edit, and manage groundwater data stored in an AHGW geodatabase. This tutorial illustrates how to use the tools to manage subsurface data and create 3D representations of hydrostratigraphy. A basic familiarity with the AHGW data model is suggested, but not required, prior to beginning this tutorial.

1.1 Outline

In this tutorial we will be working with simplified subsurface data from Roseville, California. We will complete the following tasks:

1. Create section line features.
2. Explore the concept of horizons in a raster catalog.
3. Create GeoSection features.
4. Explore the Clip and Fill options when creating GeoSections and GeoVolumes.
5. Create GeoVolume features.
6. Transform 3D GeoSections to 2D cross section polygons.

1.2 Required Modules/Interfaces


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

- Arc View license (or ArcEditor/ArcInfo)
- 3D Analyst (the tools in this tutorial can be run without 3D Analyst, but you will not be able to visualize all the data)
- AHGW Tutorial Files

The *AHGW Tools* require that you have a compatible ArcGIS service pack installed. You may wish to check the *AHGW Tools* documentation to find the appropriate service pack for your version of the tools. *3D Analyst* is required for the latter portion of the tutorial involving 3D objects. If you do not have a license for *3D Analyst*, you will be unable to view the results of the tutorial. The tutorial files should be downloaded to your computer and saved on a local drive.

2 Getting Started

Before opening our map, let's ensure that the AHGW Tools are correctly configured.

1. If necessary, launch *ArcMap*.
2. If necessary, open the *ArcToolbox* window by clicking on the *ArcToolbox* icon .
3. If you have not already done so, add the *Arc Hydro Groundwater Toolbox* by right-clicking anywhere in the *ArcToolbox* window and selecting the *Add Toolbox...* command. Browse to the *Toolboxes\System Toolboxes* area and select and open the *Arc Hydro Groundwater Tools.tbx* file.
4. Expand the *Arc Hydro Groundwater Tools* item and then expand the *Subsurface Analyst* toolset to expose the *Subsurface Analyst* tools.
5. Right-click on any visible toolbar and select the *Arc Hydro Groundwater Toolbar* item.

When using geoprocessing tools you can set the tools to overwrite outputs by default, and automatically add results to the map/scene. To set these options:

6. Open *ArcMap/ArcCatalog* (if not already open).
7. Select the *Geoprocessing / Geoprocessing Options...* command.
8. Activate the option: “*Overwrite the outputs of geoprocessing operations*” as shown in Figure 1.
9. Enable the option to “*Add results of geoprocessing operations to the display*” as shown in Figure 1.
10. Select *OK* to exit the setup.

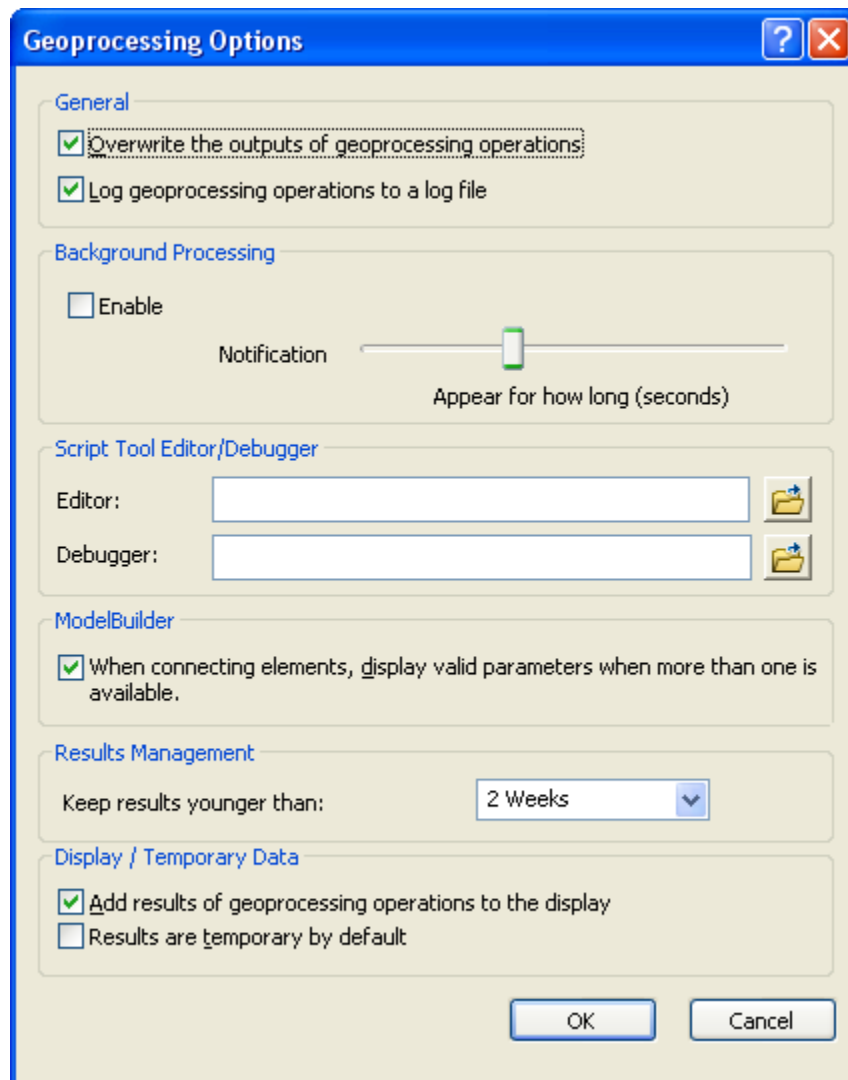


Figure 1 Setting Geoprocessing tools to overwrite outputs by default, and to add results of geoprocessing tools to the display.

3 Upgrading the geodatabase

Due to changes in the geodatabase between ArcGIS 9.3 and ArcGIS 10, if you are using ArcGIS 10 you will need to upgrade your geodatabase to be able to create 3D vertical features. If you are using version 9.3 you can skip the following steps.

1. Open ArcMap/ArcCatalog (if not already open).
2. Open the *Upgrade Geodatabase* geoprocessing tool located in the *Data Management Tools / Database* toolset.
3. Select the **Horizons.mdb** geodatabase as the *Input Geodatabase*.
4. Leave the defaults for the other parameters.

Your tool should be similar to the one shown in Figure 2.

5. Select *OK* to upgrade the geodatabase.

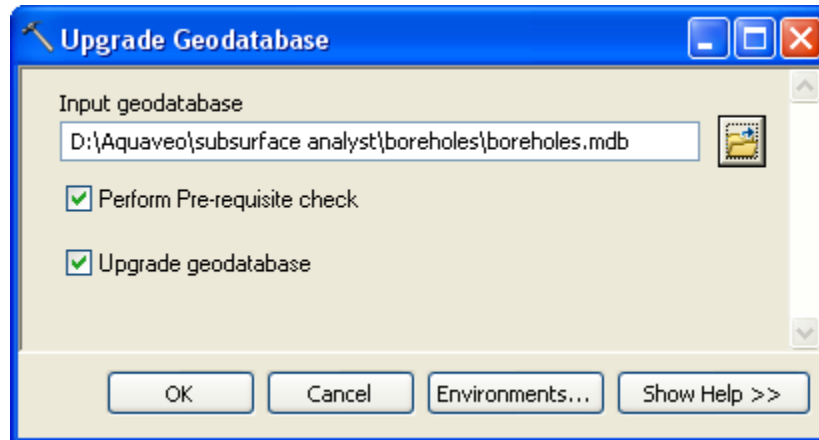


Figure 2 Settings of the Upgrade Geodatabase tool

4 The Groundwater Data Model

The AHGW data model includes a GeoSection feature class for storing cross sections (sometimes called “fence diagrams”). In the AHGW data model, GeoSections have both 3D and 2D representations. The SectionLine feature class is used to store polylines representing the locations of GeoSections. These polylines can be displayed in ArcMap and they are used to organize the 3D features in the GeoSection feature class. The GeoSection features consist of multipatches corresponding to each colored “panel” of a cross section. Each multipatch is related to the corresponding SectionLine via the SectionID field of the GeoSection feature class.

The AHGW data model also includes a GeoVolume feature class for storing 3D volumetric representations of hydrogeologic units using multipatches. Figure 3 shows the different datasets of the Hydrostratigraphy component.

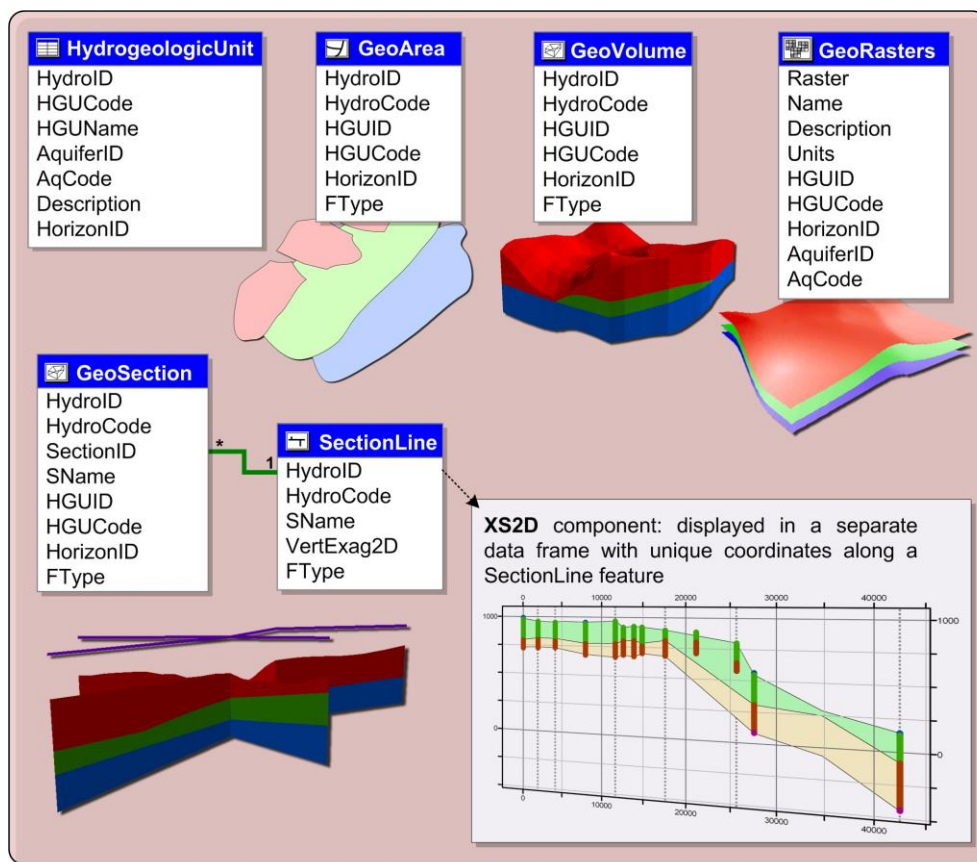


Figure 3 The Hydrostratigraphy component of the Arc Hydro Groundwater Data Model.

5 Horizons, Clip and Fill attributes

The term “horizon” refers to the top of each stratigraphic unit that will be represented in the groundwater model. Horizons are numbered consecutively in the order that the strata are “deposited” (from the bottom up). Horizons are defined at borehole contacts (interface between different materials on a borehole log). Each contact that you wish to represent in the groundwater model must have a horizon ID.

Horizons can be represented as rasters, one for each horizon ID. The rasters will typically be created by interpolating the borehole contact data for each horizon. When organized in a raster catalog, the rasters can be used to create GeoSection and GeoVolume features based on an attribute field containing the horizon ID. Figure 4 shows a schematic illustration of surfaces indexed with horizon IDs.

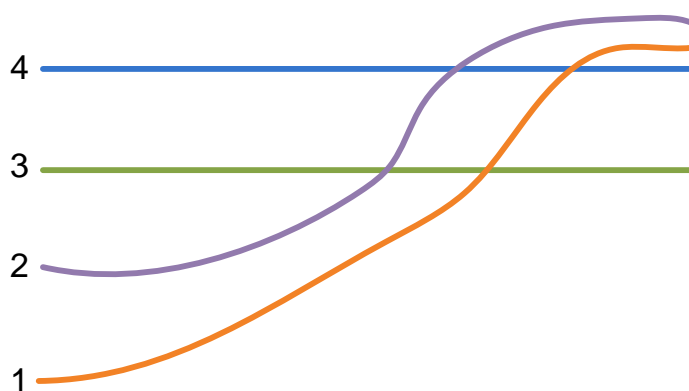


Figure 4 Sample horizons ordered by horizon ID values.

The tools that derive features from rasters include *Clip* and *Fill* fields to control the way the 3D model is constructed. The default value for *Clip* is zero, which means to not use clipping on a horizon. The default value for *Fill* is one, meaning that we should fill in between horizons to build GeoSection and GeoVolume features. Using the default options and running the tools on the data represented in Figure 4, we would get the results as seen in Figure 5.

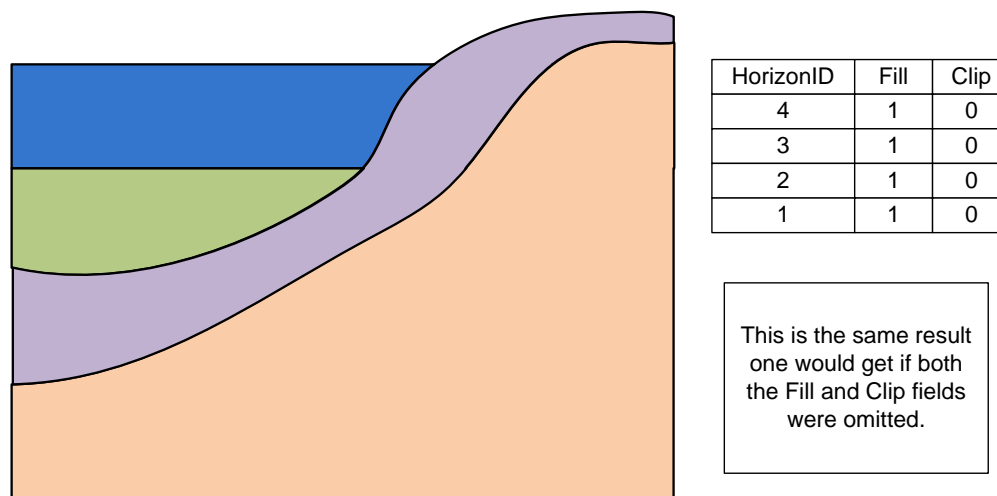
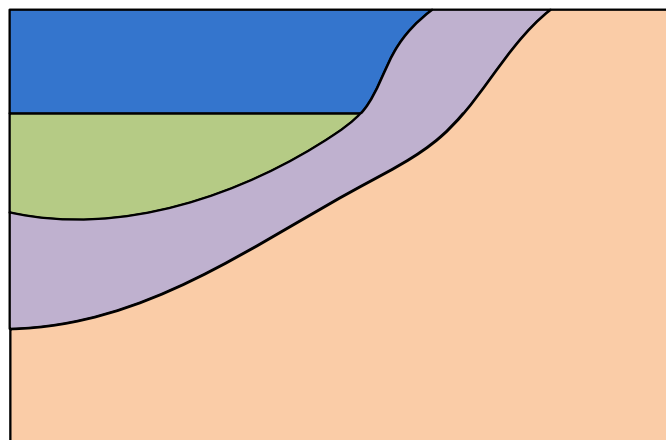


Figure 5 GeoSections showing the default clip and fill options.

The rasters used in creation of the raster catalog are often built from borehole contacts (points) which have been interpolated to rasters. Depending on the density of the points and the interpolation method used to build the rasters, there may be portions of the raster which do not accurately reflect the subsurface data. For example, the top horizon may come from actual measured land surface elevations, while the interpolated rasters for lower horizons may actually extend higher than the surface due to interpolation.

If a *Clip* field is used in a raster catalog containing horizon data, and the field value for a particular horizon is assigned to one, then that horizon will be used as a clipping plane. Horizons beneath the clipping horizon that extend above the clipping horizon will be cut off. Consider Figure 6, where the horizon with a *HorizonID* of 4 is assigned an attribute to *clip*. This would reflect the case where a horizon is used to represent measured

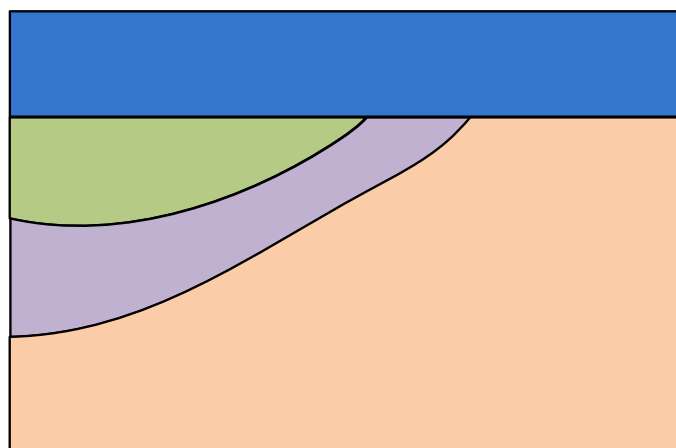
elevations at the surface. The portions of the bottom two features that extend above the horizon with a horizon ID of 4 have been clipped.



HorizonID	Fill	Clip
4	1	1
3	1	0
2	1	0
1	1	0

Figure 6 Using the clip option for the top horizon.

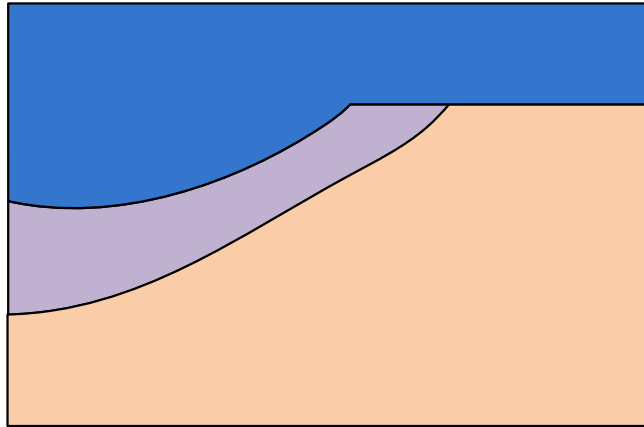
The clip option can also be used for horizons found in the middle of the subsurface data. This might be useful to model depositional strata located beneath the surface. An example of this can be found in Figure 7, where the surface with HorizonID = 3 is used as a clipping surface.



HorizonID	Fill	Clip
4	1	0
3	1	1
2	1	0
1	1	0

Figure 7 Using the clip option on other horizons.

The fill option, which is one by default, can be used to specify whether a horizon is filled in between adjacent horizons. A value of one is used in the Fill field to specify filling in between horizons, while a value of zero turns off filling. If the fill option is not turned on, then no horizon is created for that horizon ID. Such a horizon will still be used to define the boundaries of the features created by the tools. This can be seen in the example shown in Figure 8, where the surface represented by HorizonID = 3 is disabled as a filling surface.



HorizonID	Fill	Clip
4	1	0
3	0	1
2	1	0
1	1	0

Figure 8 Using the fill option.

6 Creating Section Lines

The first step will be to create a set of section line features from which the 3D features will be derived.

1. Open the map document **Horizons.mxd**.
2. Make sure the **Layers** data frame is activated (you can activate a data frame by selecting the data frame, right-clicking, and selecting *Activate*)
3. The map includes a boundary defining the extent of the 3D model as shown in Figure 9.

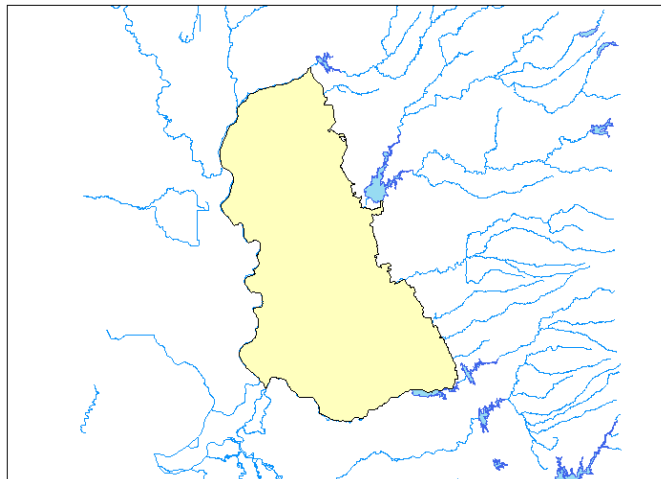


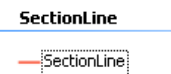


Figure 9 Boundary of the 3D model.

To start sketching section lines:

4. Select the *Start Editing*  *Start Editing* command in the Editor Toolbar.

5. In the *Create Features* window select the SectionLine symbology. This will enable editing of section lines.
6. Select the *Straight Segment* tool  from the Editor Toolbar.
7. Sketch a number of section lines covering the model domain, as shown in Figure 10. Make sure that the section lines do not extend the model domain.
8. Open the attribute table of the SectionLine feature class and assign a name, in the *SName* attribute, to each of the section lines you sketched.



At this point your map should be similar to the one shown in Figure 10.

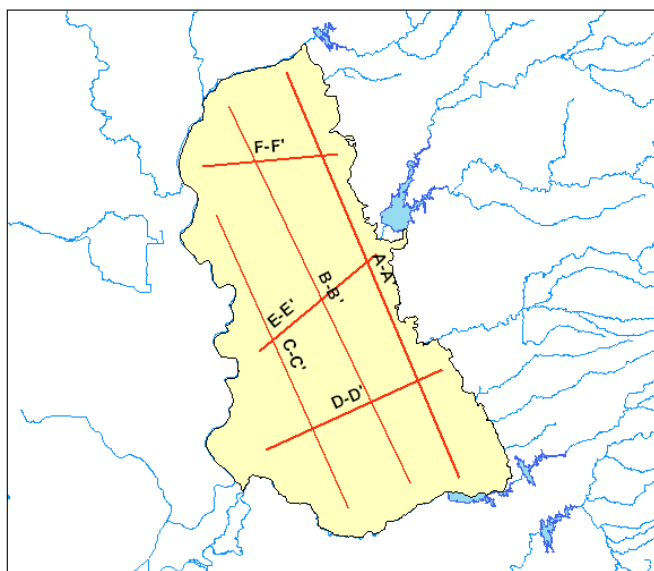



Figure 10 Section lines sketched within the model boundary.

Next, we will assign vertical exaggeration values to the section lines. The cross section features will be scaled based on the vertical exaggeration attribute.

9. Open the attribute table of the SectionLine feature class.
10. Make sure none of the features are selected. You can use the *Clear Selected Features* button  to clear the selection.
11. Right click on the Vertical Exaggeration field and assign a **vertical exaggeration value of 20** to the cross sections using the *Field Calculator* as shown in Figure 11.

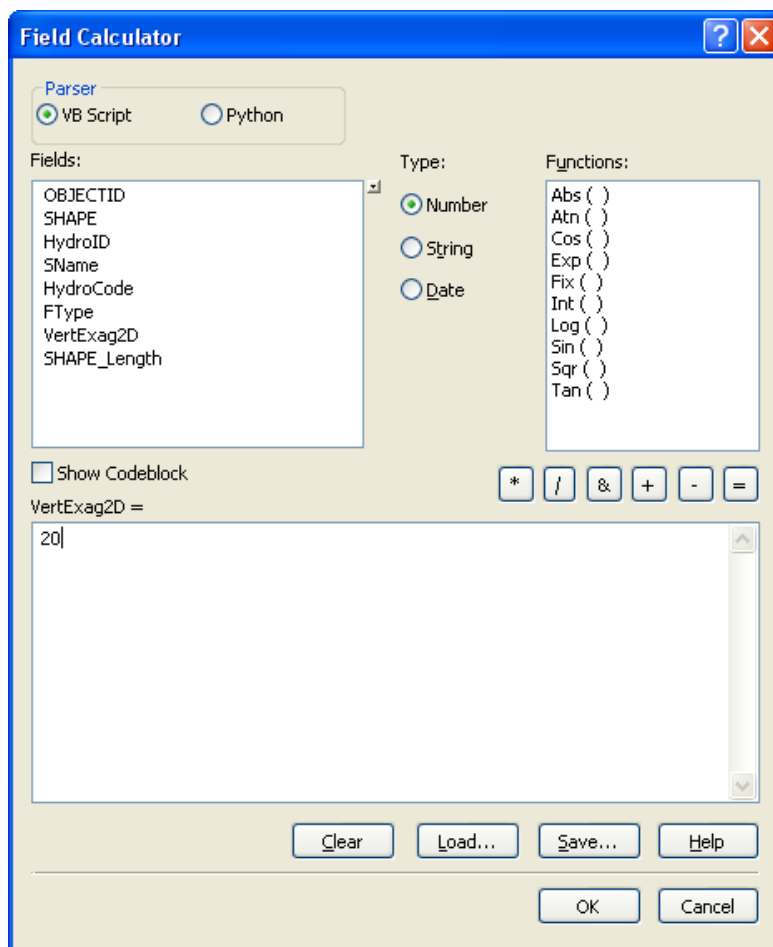




Figure 11 Assigning vertical exaggeration attributes using the Field Calculator.

12. Save the edits using the Save Edits  Save Edits command in the Editor Toolbar. Stop the edit session using the Stop Editing  Stop Editing command in the Editor Toolbar.

After creating the features we will assign HydroID values to them. The HydroID is the unique identifier of the feature within the geodatabase, and is used to create relationships between tables and feature classes. There are tools to help you manage your HydroIDs.

13. Open the Create Unique ID Table tool, located in the Groundwater Analyst toolset.
14. For the *Output UniqueID Table* browse to the **Horizons.mdb** geodatabase and specify **UniqueID** as the name of the table, as shown in Figure 12.
15. Leave the *Last HydroID Used* parameter equal to **1**.
16. Select **OK** to run the tool.

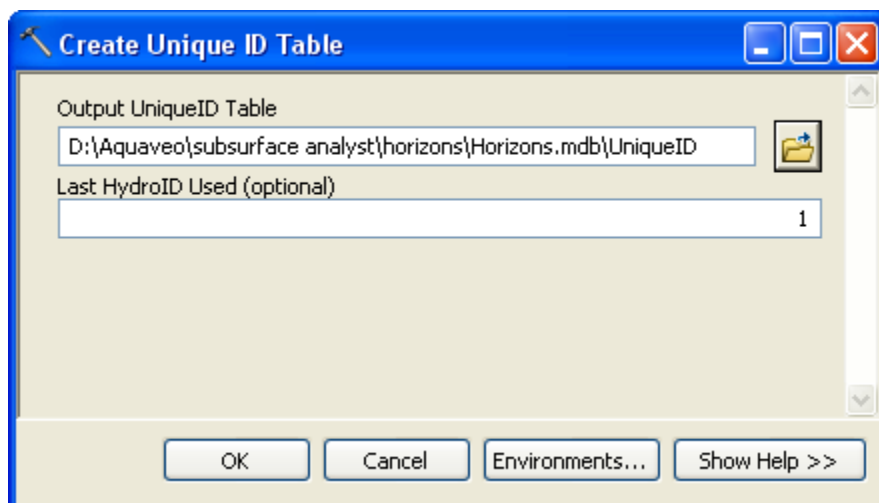


Figure 12 Creating a Unique ID table.

Once the tool has executed a new table named UniqueID should be added to your map. Next, we will populate the HydroID values for the SectionLine features.

17. Open the *Assign HydroID GW* tool available in the *Groundwater Analyst* toolset.
18. Specify the **UNIQUEID** table as the *Input UniqueID Table*.
19. Select the **SectionLine** features as the *Input Features to Assign HydroID*.
20. For the *HydroID Field of Input Features* select the **HydroID** field.

At this point your inputs should be similar to the ones shown in Figure 13.

21. Select **OK** to run the tool.

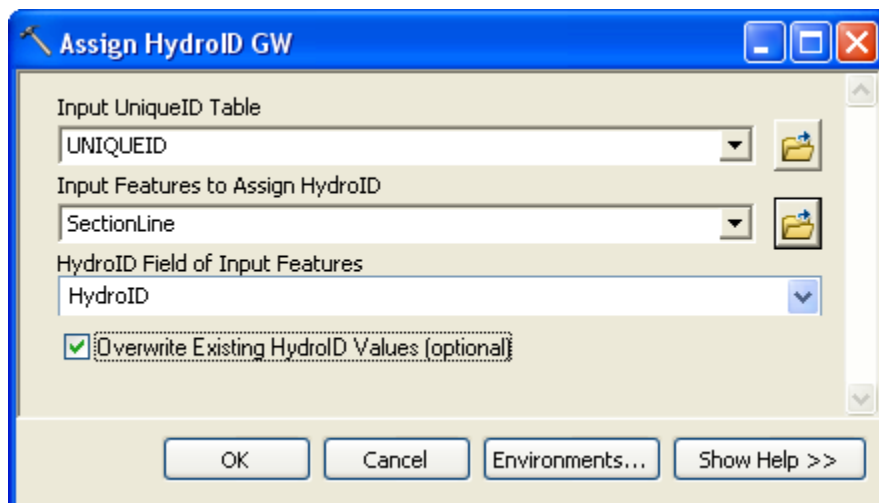


Figure 13 Assigning HydroIDs to SectionLine features.

You can open the attribute table of the SectionLine layer to see that HydroIDs were assigned to the features.

Next, we will create 3D GeoSection and GeoVolume features and visualize them in ArcScene.

7 Opening the Scene

We will begin by opening a scene of Roseville.

1. Open ArcScene.
2. *Select the File | Open* command and browse to the location on your local drive where you have saved the AHGW tutorials. Browse to the *subsurface analyst\horizons folder* and open the file titled **Horizons.sxd**.

Once the file has loaded you will see a scene of subsurface layers near Roseville. This data was obtained from a groundwater model created for the region (data was modified for the purpose of the tutorial to illustrate concepts and protect confidentiality). The file shows different rasters representing horizon data, which will be used to create GeoSection and GeoVolume features. The individual rasters are drawn using the Base Heights option under the Layer Properties to show their elevations in relation to each other (Figure 14).

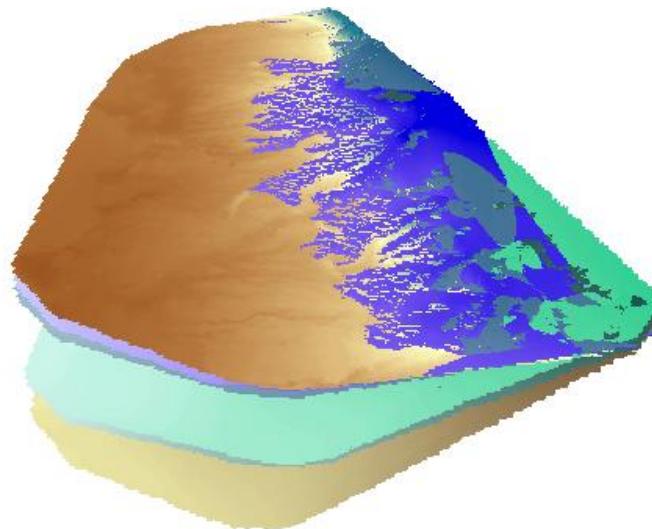


Figure 14 Rasters representing Horizon data.

The rasters are also organized in table format as a raster catalog. The rasters in the catalog overlap each other and contain different attributes to describe the horizons. The raster catalog will later be used to build GeoSection and GeoVolume features.

3. After examining the Scene, turn off the display of the individual rasters TOP1, TOP2, TOP4, TOP6, TOP7 and BOT7 in the Table of Contents.
4. Make sure the *GeoRasters* layer is selected in ArcScene. This is the raster catalog storing the same rasters representing the horizon data.
5. Right-click on the *GeoRasters* layer and select the *Open Attribute Table* command.

Figure 15 shows the raster catalog. Note that the table includes a Raster field for the rasters, along with a field called HorizonID which stores the order of strata representing the horizons.

OBJECTID	Shape *	Raster	Name	HorizonID	Clip	Fill	HGUID	Shape_Length	Shape_Area
7	Polygon	<Raster	TOP1	10	1	1	1	1094000	72046000000
8	Polygon	<Raster	TOP2	9	0	1	2	1094000	72046000000
9	Polygon	<Raster	TOP4	8	0	1	3	1094000	72046000000
10	Polygon	<Raster	TOP6	7	0	1	4	1094000	72046000000
11	Polygon	<Raster	TOP7	6	0	1	5	1094000	72046000000
12	Polygon	<Raster	BOT7	5	0	1	<Null>	1094000	72046000000

Figure 15 The raster catalog for the horizons data.

6. Close the GeoRasters attribute table.

8 Building GeoSection Features

The GeoSection features are an ideal starting point for creating subsurface data from horizons. The cross sections (or “fence diagrams”) created are simpler to create and easier to view than the solid GeoVolume features. The GeoSection features can be used to see if the interpolation options applied are reasonable before building GeoVolume features for the entire area covered by the rasters in the raster catalog.

To build the GeoSection features, we will need one or more SectionLine polyline features, which determine where the subsurface cross sections will be created, along with a raster catalog representing the horizon data, and the multipatch GeoSection feature class where the new features will be created.

The first step will be to create a new GeoSection feature class:

1. Open the Create GeoSection Feature Class tool located in the *Subsurface Analyst / Features* toolset.
2. For the *Output GeoSection Features* browse to the **Horizons.mdb\Data** feature dataset and specify **GeoSection** as the name of the feature class, as shown in Figure 16.
3. Leave the *Input Spatial Reference (optional)* empty. The *Horizons.mdb\Data* feature dataset has the correct XY and Z coordinate systems defined. Because we will be placing the *GeoSection* feature class in the feature dataset we do not need to specify a spatial reference.
4. Select *OK* to run the tool.

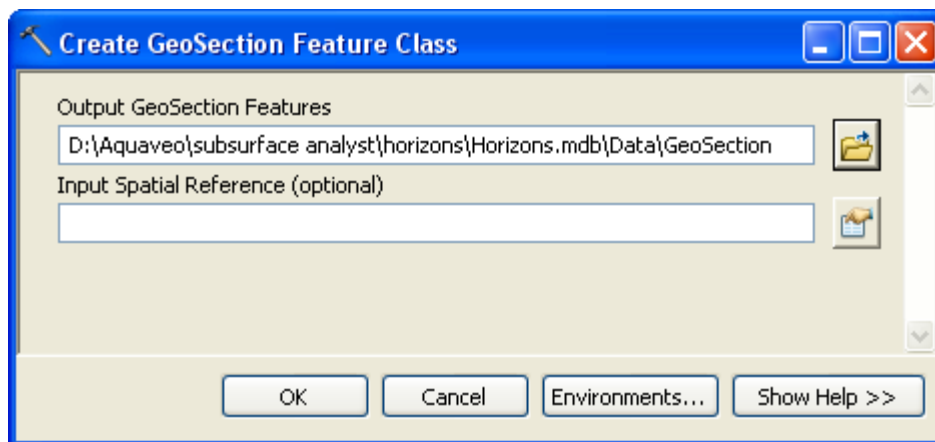


Figure 16 Settings for the Create GeoSection Feature Class tool.

A new feature class named GeoSection should be added to the scene. To build the GeoSection features we will use the Rasters To GeoSection tool:

5. Make sure you have the *SectionLine* feature class and the *GeoRasters* raster catalog loaded in *ArcScene*. If they are not loaded, add them from the geodatabase in the tutorial data.
6. Right-click on the *GeoRasters* layer and select the *Open Attribute Table* command. Note the options being used for the Clip and Fill fields of the raster catalog. The row in the raster catalog corresponding to the raster with the name of “TOPI” comes from a digital elevation model (DEM) of the ground surface elevation data. We have assigned it a clip value of 1 because we do not want any of the subsurface data extending above the elevation values at the ground level. Depending on the interpolation values used to generate the rasters stored in the raster catalog, there might be portions of the raster on the edges which exceed the ground surface elevation.
7. Close the attribute table when finished.

To run Rasters to GeoSections tool:

8. Double-click on the *Rasters to GeoSections* tool in the *Arc Hydro Groundwater Tools | Subsurface Analyst* toolset.
9. Select the *SectionLine* feature class for the *Input SectionLine Features*.
10. Select the *GeoRasters* raster catalog for the *Input Raster Catalog*.
11. Choose *HorizonID* for the *Raster Catalog Horizon ID* field.
12. Select the *Clip* and *Fill* fields as input for the optional Raster Catalog Clip and Fill field inputs.
13. Select the *HGUID* field as the *Raster Catalog HGUID Field*.
14. Enter a *Discretization Spacing* of **1000**.
15. Select the *GeoSection* feature class for the *Input GeoSection Features*.
16. Leave the *Append* option checked.

The tool should appear as in Figure 17.

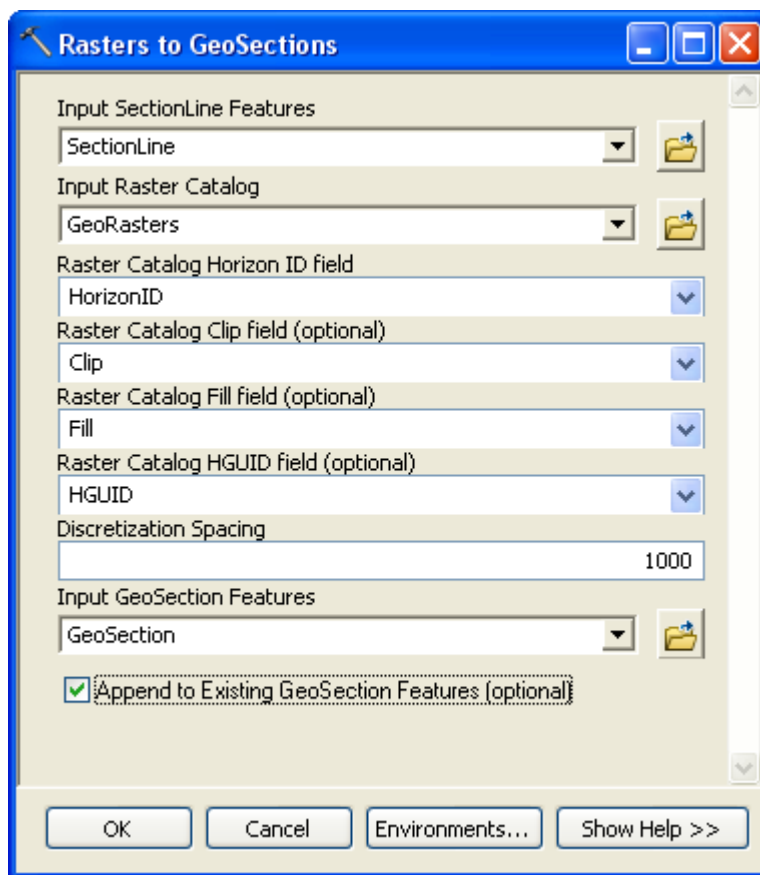


Figure 17 Input parameters for the Rasters to GeoSections tool.

17. Click on the *OK* button.

18. Click on the *Close* button when the tool has finished.

After running the tool, GeoSection features should appear as 3D features in ArcScene. If they do not appear, right-click on the GeoSection layer in the Table of Contents and select the *Refresh* option. Your scene should be similar to the one shown in Figure 18.

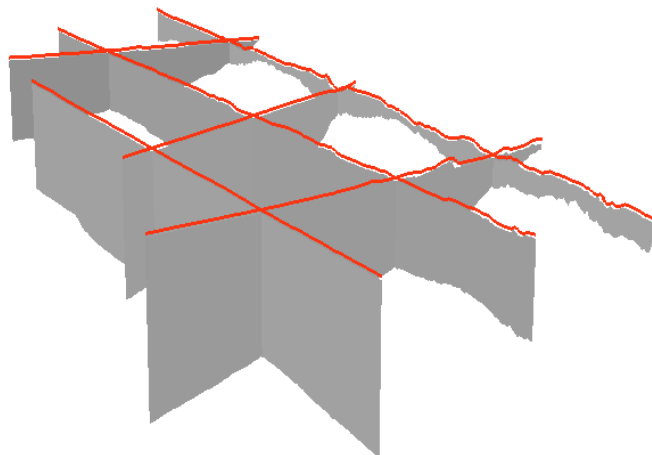


Figure 18 GeoSection features created by running the Rasters To GeoSections tool.

To better visualize the cross sections you can symbolize the GeoSections by the HorizonID used to build them.

19. Select the *GeoSection* layer in the Table of Contents, right-click and select **Properties**.
20. Select the *Symbology* tab and select the **Categories | Unique Values** option.
21. Select the **HorizonID** field as the Value field and select **Add All Values**.
22. Right-click in the area above the **Add All Values** button where the individual HorizonID values are displayed along with their colors, right click and select **Reverse Sorting**. This will sort the unique HorizonID values from the highest value at the top to the lowest value on the bottom.

Your dialog should be similar to the one shown in Figure 19, though the Color Ramp and colors for the HorizonID values may differ.

23. Select **OK** to exit the Layer Properties dialog.

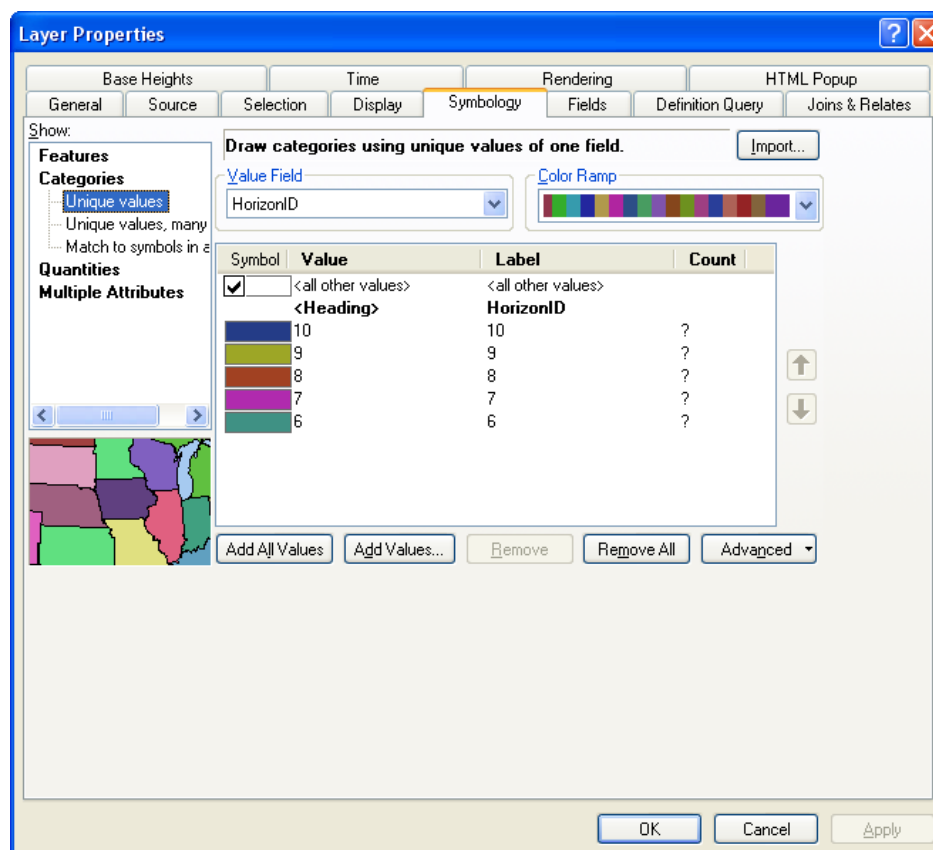



Figure 19 Symbolizing GeoSection features to show Horizon ID values.

24. Use the *Navigate* tool  in ArcScene to view the GeoSection features from multiple angles to view the results of the tool.

Your results should be similar to those found in Figure 20.

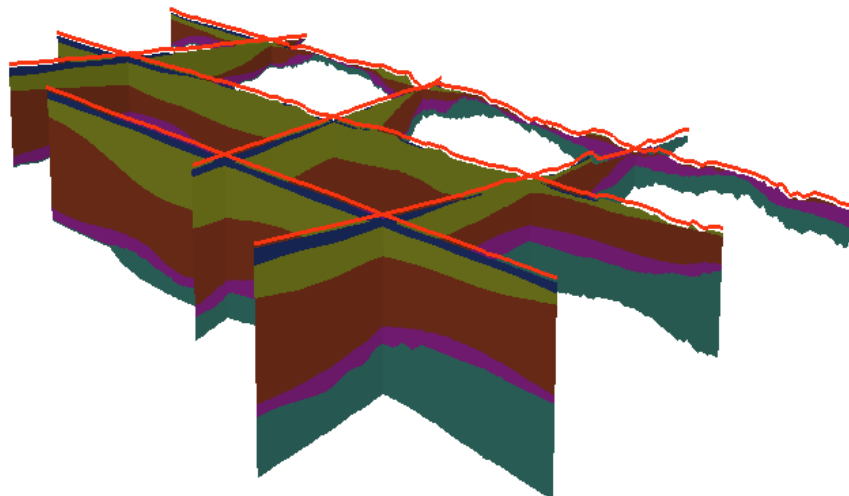


Figure 20 GeoSection features symbolized by the HorizonID field.

Next we will create 3D GeoVolumes to visualize the hydrogeologic units as volume elements.

9 Creating a Projection TIN

A TIN (Triangular Irregular Network) is used to define the extent of the GeoVolume features to be created, as well as to determine the size and extent of the triangle strips used to define the multipatch features. The number of triangles on the TIN determines the amount of processing that must be done, so a simplified TIN is included in this tutorial. The TIN used in the Rasters to GeoVolumes tool is referred to as a projection TIN, because the elevations on the TIN are not used, but the triangles are used only to define the shape and extent of the GeoVolumes.

A projection TIN has been provided in the tutorial for the benefit of those who do not have access to the *3D Analyst* extension. Turn on the *projtin4k* TIN layer in the Table of Contents to view it, which is shown in Figure 21.

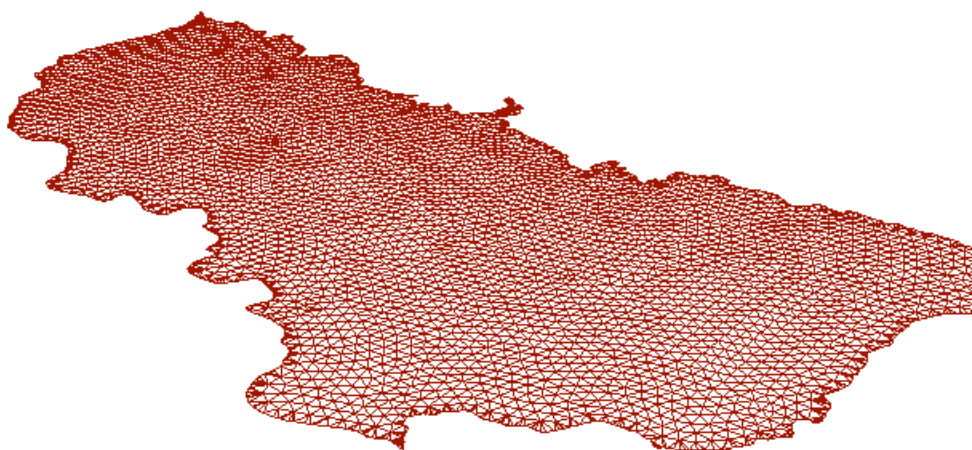


Figure 21 A projection TIN used for creating GeoVolume features.

Before continuing, turn off the *projtin4k* projection TIN in ArcScene.

For users with access to the *3D Analyst* extension, we can create a projection TIN with triangles of a specified size. For those without *3D Analyst*, please skip to the next section and use the provided *projtin4k* TIN for the remaining of the tutorial.

To create a projection TIN:

1. Make sure that the *3D Analyst* extension is enabled. Choose *Customize / Extensions...* from the menu. Make sure that “3D Analyst” is checked.
2. Double-click on the ***Polygon to TIN*** tool in the *Arc Hydro Groundwater Tools / Subsurface Analyst / TIN* toolset.
3. Choose ***ModelBoundary*** for the *Input Polygon Feature*. This sets the polygon we are using to define the boundary of the projection TIN.
4. Enter a spacing of **4000**. This will create equilateral triangles inside the TIN with edge spacing equal to the value entered. Irregular triangles will be created along the boundary of the TIN.
5. For the *Output Projection TIN*, you will create a new TIN. Browse to the same directory as where your geodatabase is located, and name the new TIN ***projtin***.
6. The *TIN Spatial Reference (optional)* parameter should automatically be populated based upon the spatial reference of the *Input Polygon Features* (NAD_1983_StatePlane_California_II_RIPS_0402_Feet). If it is not, select the ***Import*** option and browse to the ***Data*** feature dataset in the ***Horizons*** geodatabase.

The tool should appear as in Figure 22.

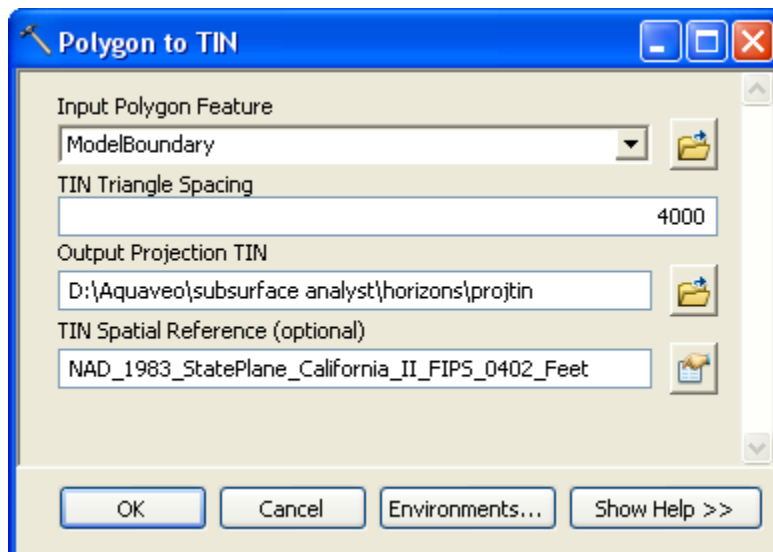


Figure 22 Input parameters for the *Polygon to TIN* tool.

7. Click on the ***OK*** button.
8. Click on the ***Close*** button when the tool has finished.

If you cannot create your own TIN using the *Polygon to TIN* tool (because you do not have a license for the *3D Analyst* extension), you can use the *projtin4k* TIN in place of the *projtin* TIN which is referenced in the remainder of the tutorial.

10 Building GeoVolume Features

Once acceptable clip and fill options have been determined and a projection TIN has been defined, GeoVolume features can be created to generate a 3D volume of the horizons data. The Rasters to GeoVolumes tool contains the same options (as the *Rasters To GeoSections* tool) for clipping and filling in between rasters.

Before creating GeoVolume features from the rasters we need to create a GeoVolume feature class:

1. Open the **Create GeoVolume Feature Class** tool located in the *Subsurface Analyst / Features* toolset.
2. For the *Output GeoVolume Features* browse to the **Data feature dataset** in the *Horizons geodatabase*, as shown in Figure 23.
3. Click on the **OK** button to run the tool.
4. Click on the **Close** button when the tool has finished.

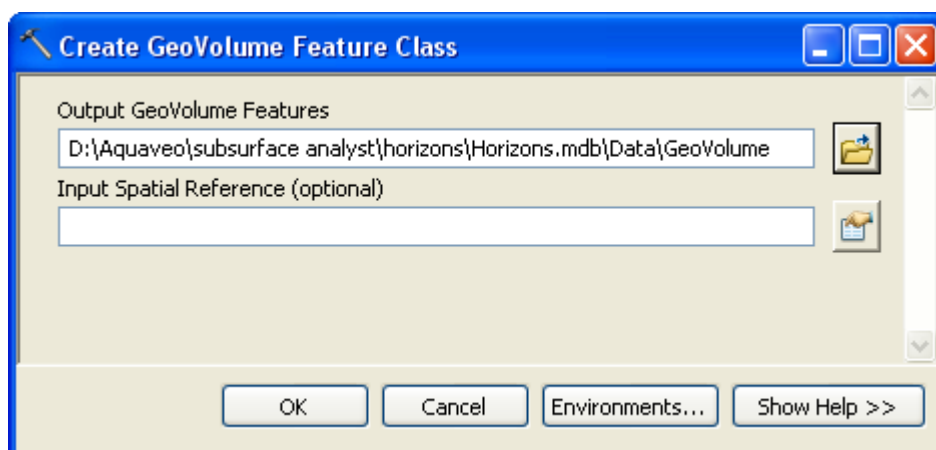


Figure 23 Input parameters for the Create GeoVolume Feature Class tool.

A new GeoVolume feature class should be added to the scene. To build the GeoVolume features:

5. Make sure you have the *projtin4k* TIN and *GeoVolume* feature class along with the *GeoRasters* raster catalog loaded in ArcScene. If they are not loaded, add them from the geodatabase in the tutorial data.
6. Double-click on the **Rasters to GeoVolumes** tool in the *Arc Hydro Groundwater Tools / Subsurface Analyst* toolset.
7. Choose the *projtin4k* TIN (or the *projtin* TIN you optionally created in the previous section if you have a *3D Analyst* extension) for the *Input Projection TIN*.
8. Choose the *GeoRasters* raster catalog for the *Input Raster Catalog*. Choose the *HorizonID*, *Clip*, *Fill*, and *HGUID* fields for the raster catalog field options.
9. Leave the *Minimum MultiPatch Thickness* with the default value of 1. Sections of the GeoVolume that have a thickness less than this value will not be created.
10. Select the *GeoVolume* feature class for the *Input GeoVolume Features*.

11. Leave the Append toggle **checked**.

The tool should appear as in Figure 24.

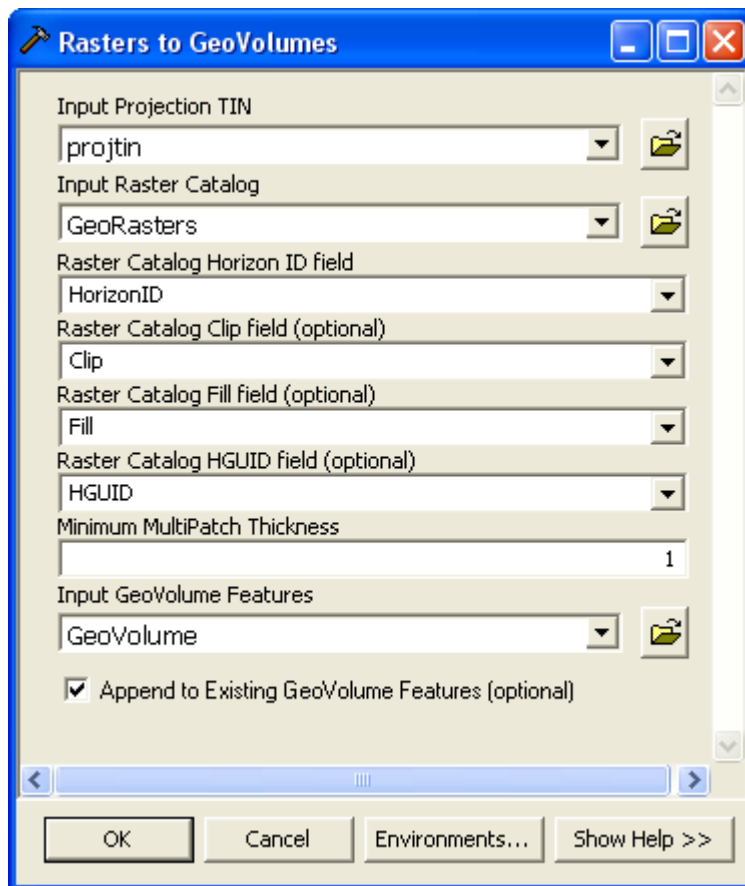


Figure 24 Input parameters for the Rasters to GeoVolumes tool.

12. Click on the **OK** button.
13. Click on the **Close** button when the tool has finished.

After running the tool, GeoVolume features should appear as 3D features in ArcScene. If they do not appear, right-click on the GeoVolume layer in the Table of Contents and select the Refresh option.

To better visualize the results you can symbolize the GeoVolumes by the HorizonID used to build them.

14. Select the *GeoVolume* layer in the Table of Contents, right-click and select **Properties**.
15. Select the *Symbology* tab and select the **Categories | Unique Values** option.
16. Select the **HorizonID** field as the Value field and select **Add All Values**.
17. Right-click in the area above the **Add All Values** button where the individual HorizonID values are displayed along with their colors, right click and select **Reverse Sorting**. This will sort the unique HorizonID values from the highest value at the top to the lowest value on the bottom.

Your dialog should be similar to the one shown in Figure 25, though the Color Ramp and colors for the HorizonID values may differ.

18. Select **OK** to exit the Layer Properties dialog.

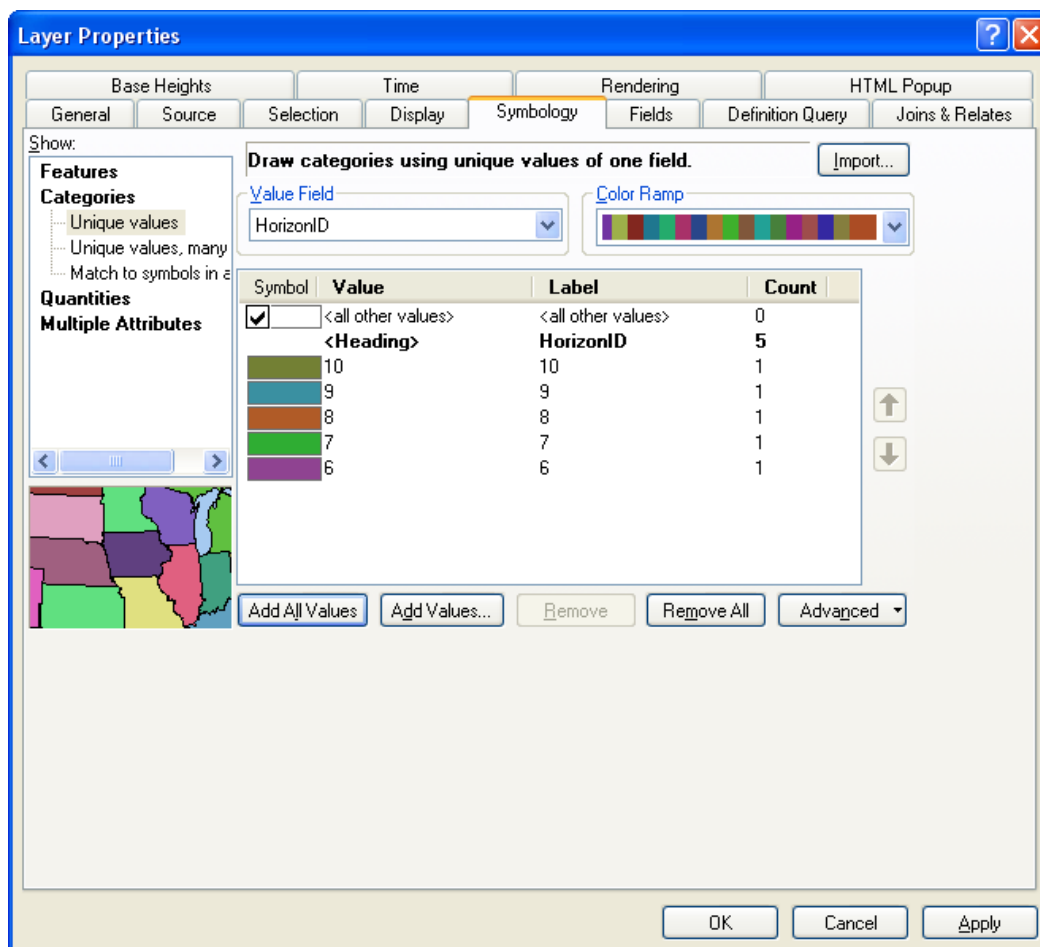





Figure 25 Symbolizing GeoVolume features to show HorizonID values.

19. Use the *Navigate* tool  in ArcScene to view the GeoVolume features from multiple angles to view the results of the tool.
20. Turn on the *3D Effects* toolbar if it is not currently enabled.
21. In the *Layer* option on the *3D Effects* toolbar, select the GeoVolume layer.
22. Click on the *Layer Face Culling* button  ( in ArcGIS 9.3) on the *3D Effects* toolbar. Choose the *Hide front side of areal features* option. This will allow you to see the inside of the GeoVolume features, along with the GeoSection features previously created.

Your results should be similar to those found in Figure 26.

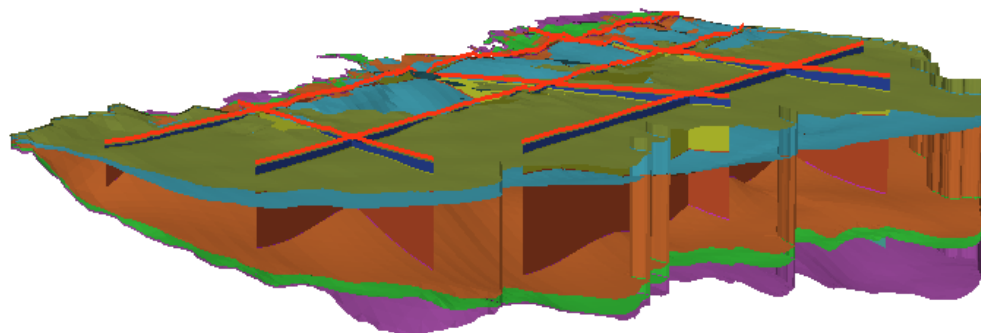


Figure 26 *GeoVolume features built using the Rasters to GeoVolumes tool and drawn according to the HorizonID value, with the front sides of the features hidden. GeoSection features are also shown inside the GeoVolumes.*

You can also use the *Field Filter* in the AHGW Toolbar. To view a single GeoVolume, select the GeoVolume layer in the table of contents. Then use the *Field Filter* to filter based on the HGUID or Horizon fields.

11 Using the HGU Color Manager

The features in the GeoSection and GeoVolume feature classes are different representations of the same hydrogeologic units. The HGU Color Manager can be used to apply a common set of colors to display features tied to the same HorizonID fields.

1. Select the **HGU Color Manager** command in the *Subsurface* menu in the Arc Hydro Groundwater Toolbar. If the toolbar is not open, right-click on any visible toolbar and select the *Arc Hydro Groundwater Toolbar* item.
2. Click on the **Setup button**.
3. Change the settings to match those shown in Figure 27. Note that we are using the *HydroID* and *HGUName* fields in the *HydrogeologicUnit* table to manage the display.
4. Click on the **OK** button.

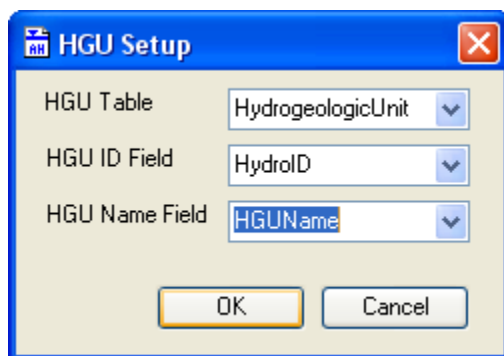


Figure 27 *Settings for the HGU Setup dialog.*

5. Turn off the *GeoRasters* option in the *Apply* column at the bottom.
6. Click on the Color Picker buttons in the *Symbology* column and pick a color for each of the five *HorizonID* values (listed in the *HGU ID* column).

Your setting should be similar to the ones shown in Figure 28.

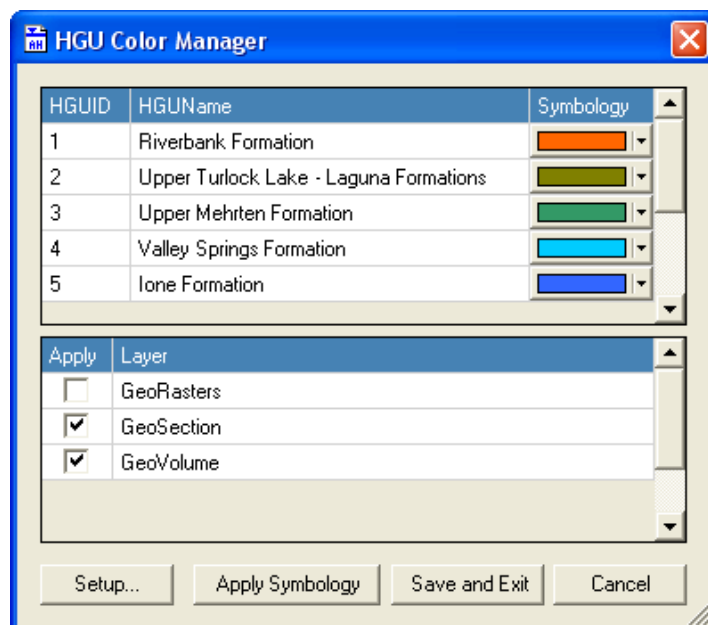


Figure 28 Sample settings for the HGU Color Manager

- Click on the *Apply Symbology* button to apply your changes.

Note that the selected color scheme has been applied to all of the selected scene layers.

- Click on the *Save and Exit* button.

Upon clicking the *Save and Exit* button the *HGU Color Manager* saves the selected colors (as numbers) in the *HGUColor* field of the *HydrogeologicUnit* table. Now whenever you use the *HGU Color Manager* in ArcMap or ArcScene those same colors will be available for application to your features. You may wish to open the *HydrogeologicUnit* table and view the results.

12 Transforming GeoSections to 2D Cross Sections


Subsurface Analyst includes a set of tools for creating 2D cross sections named *XS2D Editor*. These tools enable you to create a new data frame with features transformed from a real coordinate system (x, y, and z) to a 2D cross section coordinate system where x is the length along the cross section line and y is the vertical dimension. Applying these transformations allow us to sketch sophisticated cross sections using the rich editing tools available in ArcMap. *Subsurface Analyst* includes tools for transforming between 3D to 2D as necessary. The process of creating a XS2D data frame and the associated feature classes is described in a separate tutorial.

In this section we will transform the 3D GeoSections derived from the raster and create a set of 2D cross section polygons which will be displayed in ArcMap.

- Close the scene and open the map *Horizons.mxd*.

Notice that the map includes two data frames. One contains the 2D data including the SectionLine features and background data, and the XS2D data frame that includes a

XS2D_Panel feature class. In addition the map includes a XS2D_Catalog table that is used to manage XS2D feature classes.

2. Make sure the **Layers** data frame is activated (you can activate a data frame by selecting the data frame, right-clicking, and selecting *Activate*)
3. Use the **Select** tool  to select the section line you want to transform.

Before we can run the tool we need to update the XS2D_Catalog table to reflect the selection (in reality you will not need to do this because you will be creating the cross section data frame using the XS2D Wizard).

4. Open the SectionLine attribute table to see the HydroID of the section line you selected (for example SectionLine with HydroID = 5 was selected in the solution file).
5. Open the XS2D_Catalog table, right-click on the SectionID field and select the *Calculate Field* option.
6. Set the SectionID in the XS2D_Catalog table equal to the HydroID of the selected SectionLine feature, as shown in Figure 29 (notice that you might need to enter a number different than 5 shown in the figure depending on your section line selection).
7. Select **OK** to run the *Field Calculator*.

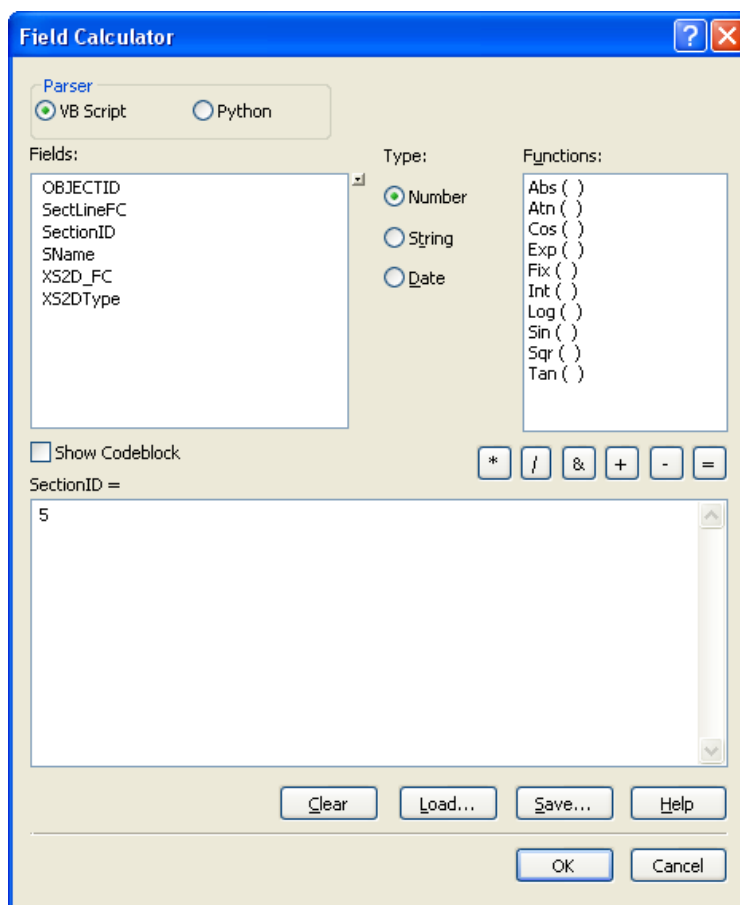



Figure 29 Populating the SectionID value using the Field Calculator

Next, we will transform GeoSections into 2D polygons in the XS2D_Panel feature class:

8. Add the **GeoSection** feature class into the map by selecting the *Add Data* command  and browsing to the **Horizons.mdb/data** feature dataset.
9. Open the *Transform GeoSection to XS2D Panel* tool located in the *Subsurface Analyst / XS2D Editor* toolset.

Make sure your settings are as shown in Figure 30.

10. Click on the *OK* button.
11. Click on the *Close* button when the tool has finished.

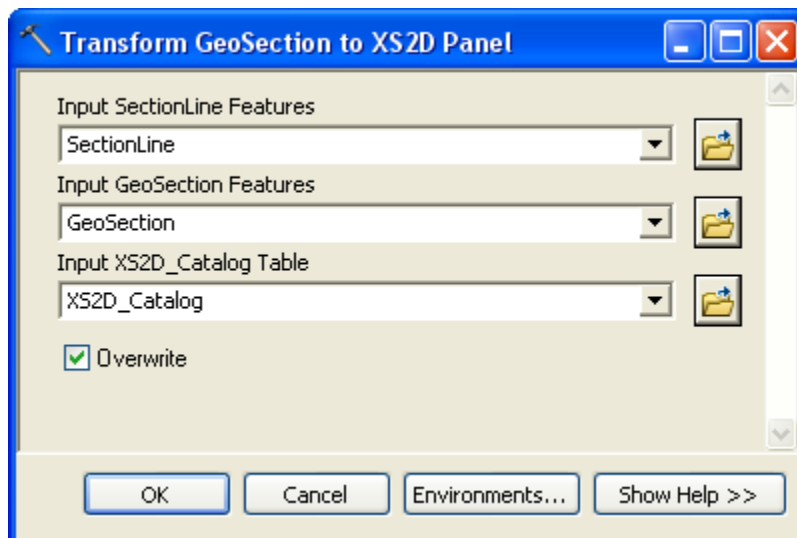


Figure 30 Settings for the *Transform GeoSection To XS2D Panel* tool.

A set of polygons should be added to the XS2D_Panel feature class. If you can't see the polygons, activate the XS2D data frame, select the XS2D_Panel layer, right-click, and select the *Zoom To Layer* option. You can symbolize the 2D cross sections based on the HGUID using the HGU Color Manger (activate the XS2D data frame first). Your final layout should show the 2D cross sections as shown in Figure 31.

Tip – the transformation of 3D cross sections to 2D panels is also dependent on the direction the SectionLine was digitized. If your transformed panels look reversed (e.g. drawn from west to east instead of east to west) you can reverse the section lines direction using the *Reverse Section Line Orientation* tool available in the *Subsurface Analyst / XS2D Editor* toolset.

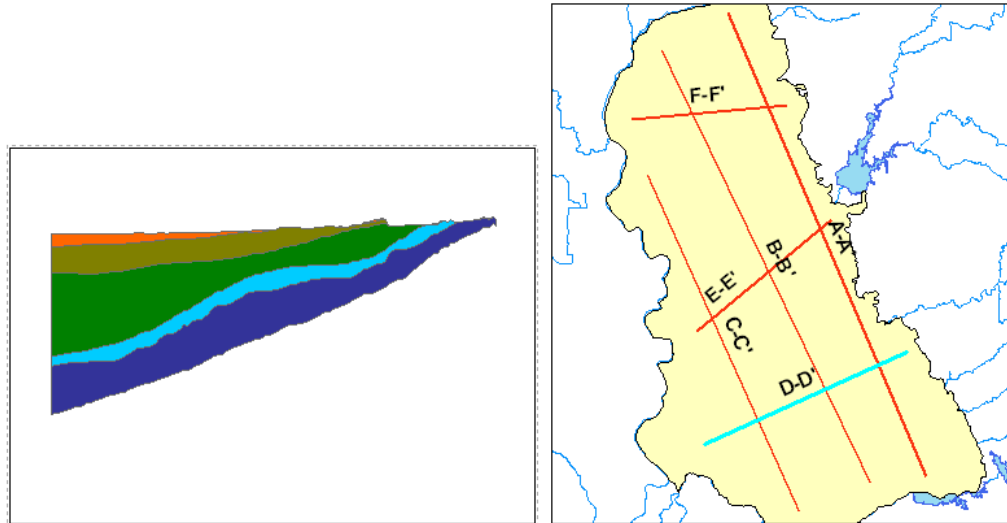


Figure 31 View of 2D cross section features created from GeoSections.

13 Conclusion

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

- SectionLine features are sketched in ArcMap and are the base for creating 3D GeoSections.
- Horizons can be used to represent stratigraphic units.
- Horizons stored in a raster catalog can be the basis for creating GeoSection and GeoVolume features.
- Clip and fill options can be used to manage the way GeoSection and GeoVolume features are created.
- A projection TIN is used to define the GeoVolume features created from the raster catalog.
- The HGU Color Manager is used for managing the symbology of multiple layers representing hydrogeologic units.
- GeoSection features can be transformed to 2D polygons (XS2D Panels) and displayed in ArcMap.