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. This includes several components to represent different types of datasets, including representations of aquifers, 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. Subsurface Analyst is a subset of the AHGW Tools that is used to manage 2D and 3D hydrogeologic data, and create subsurface models including generation of borehole representations, cross sections, surfaces, and volumes.

In this tutorial will demonstrate how to create plots of borehole logs (e.g. geophysical data) data and add them to a 2D cross section map.

1.1 Background

Data used in this tutorial were made-up for demonstration in this tutorial. The geophysical logs do not reflect real datasets. The background cross section data are described in a separate tutorial: Creating 2D Cross Sections. Figure 1 shows the background cross section and layout map to which geophysical logs will be added. The green dots on the map represent wells that have related geophysical logs.
Figure 1  Background map and cross section to which borehole logs will be added.

1.2  Outline

The objective of this tutorial is to introduce the basic workflow and tools for adding borehole log plots to a cross section. The tutorial includes the following steps:

1. Understand the data structures used to store borehole logs.

2. Use the Create Geophysical Plot Wizard to add geophysical data onto an existing cross section.

3. Visualize and symbolize the plots in ArcMap.
1.3 Required Modules/Interfaces

The following components should be enabled in order to complete this tutorial:

- Arc View License (or ArcEditor\ArcInfo)
- Arc Hydro Groundwater Tools
- AHGW Tutorial Files

The AHGW Tools require having a compatible ArcGIS service pack installed. Check the AHGW Tools documentation to find the appropriate service pack for the version of the tools. The tutorial files should be downloaded to the computer.

2 Getting Started

Before opening the tutorial map, ensure that the AHGW Tools are correctly configured.

1. If necessary, launch ArcMap.

2. Open the ArcToolbox window by clicking ArcToolbox.

3. If “Arc Hydro Groundwater Tools” is not in the list of available toolboxes, follow steps 4–6. If it is already listed, skip to step 7.

4. Right-click anywhere in the ArcToolbox window and select Add Toolbox… to bring up the Add Toolbox dialog.

5. Browse to the Toolboxes\System Toolboxes folder and select “Arc Hydro Groundwater Tools.tbx”.

6. Click Open to exit the Add Toolbox dialog.

7. Expand “Arc Hydro Groundwater Tools”.

8. Expand “Subsurface Analyst”.

This tutorial will also use the Arc Hydro Groundwater Toolbar. The toolbar contains additional user interface components not available in the toolbox. If the toolbar is not visible, do the following:

9. Right-click on any visible toolbar and select Arc Hydro Groundwater Toolbar to make it visible.

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:
10. Select Geoprocessing | Geoprocessing Options… to bring up the Geoprocessing Options dialog.

11. In the General section, turn on Overwrite the outputs of geoprocessing operations.

12. In the Display / Temporary Data section, turn on Add results of geoprocessing operations to the display.

13. Click OK to exit the Geoprocessing Options dialog.

### 3 Opening the Map

Begin by opening a map containing some background data for the project.

1. Select File | Open… to bring up the Open dialog.

2. Browse to the Tutorials\subsurface analyst\XS2D_logplot folder.

3. Select “Roseville_logplot.mxd” and click Open to exit the Open dialog and import the model file.

Once the file has loaded, a map of the model boundary will appear with well features located within the model domain. Notice a cross section is in a separate data frame. The process of creating cross sections is described in detail in a separate tutorial: Creating 2D Cross Sections.

![Initial project showing the model boundary and cross section.](image)
4 Data Structure for Storing Borehole Logs

Borehole information is stored in a log table. Each row in the table represents a log value observed along the borehole. Data in the log table are referenced to well features. The WellID attribute in the log table relates to the HydroID of a well feature. Figure 3 shows an example of a Log table. Records in the table are indexed with a WellID to relate the vertical information with specific Wells. In addition, a Depth value defines the length along the borehole, and the FType defines the type of log data. The WellID, Depth, LogValue, and FType are recommended field names but can be modified.

To accommodate storing multiple logs of different types, there are three common approaches:

1. A separate table is created for each type of log.
2. All logs are stored in the same table and are differentiated by a different FType value.
3. Logs are stored in a single table but with a separate LogValue field for each log type. This option requires that all logs are sampled at the same depths along the well.

5 Adding Log Plots to a cross section

To create the log plots, use the Create Geophysical Plot Wizard:

1. In the Table of Contents, right-click on “Layers” and select Activate.

This data frame must be active when creating plots because it contains the well features.
2. If not selected when opening the map, select the four wells along section A-A’ highlighted in cyan as shown in Figure 4.

Tip: Use the Select By Attribute tool to select wells with the following expression: 
HasGeophysical = 1.

![Figure 4 Map showing selected wells that have related log data.](image)

3. Select the Create Geophysical Plot Wizard available on the Arc Hydro Groundwater Toolbar.

4. With the wizard enabled, select section line A-A’ (shown in red) to bring up the Create Geophysical Plot Wizard.

5. Step 1 of the wizard defines the cross section setup. Set the following parameters:

- **Number of wells selected** should show “4”.
- **Well unique ID field** set to “HydroID”.
- **Well reference elevation field** set to “LandElev”.
- **Data table** set to “LogData”.
- **Well ID field** set to “WellID”.
- **Depth field** set to “Depth”.
- **Depth value field** set to “LogValue”.
- **Data type field** set to “FType”.
- **Data type value** set to “Log1”.
- **Data type name** enter “Log1”.
- **Vertical exaggeration** set to “20”.
- **XS2D Catalog Table** set to “XS2D_Catalog”.
- The **Default output workspace** should point to the “Roseville_logplot.mdb\GeoPlot” directory.
- **Output Data Frame for Geophysical Data** set to “Section A-A”.

At this point the inputs should be similar to the ones shown in Figure 5.

![Create Geophysical Plot Wizard](image)

**Figure 5** Inputs for Step 1 in the Create Geophysical Plot Wizard

6. Select **Next** to continue to step 2 of the wizard.

In Step 2 of the wizard will define the plot and scale properties:

7. In Step 2 specify the following inputs:
   - **Plot width** set to “10,000”.
   - **Plot offset** set to “1,000”.
• Background vertical buffer set to “0”.
• For Plot position select Right.
• Scale label enter “Log1”.
• Scale vertical offset enter “300”.
• Maximum scale values enter “8”
• Minimum scale values enter “0”.
• Number of major ticks enter “5”.
• Number of minor ticks enter “0”.
• Scale location select Top.

At this point the inputs should be similar to the ones shown in Figure 6.

Figure 6  Inputs for Step 2 in the Create Geophysical Plot Wizard
8. Select **Next** to continue to Step 3

Step 3 of the wizard will define the output feature classes:

9. Make sure the output feature classes are created in the target workspace (in this case in the GeoPlot feature dataset).

10. Select the *Overwrite exiting feature with same data type* option.

At this point the inputs should be similar to the ones shown in Figure 7.

![Create Geophysical Plot Wizard](image)

**Figure 7**   Inputs for Step 3 in the Create Geophysical Plot Wizard

11. Select **Finish** to run the wizard.

Upon completion a new set of feature classes is added to the map. The cross section A-A’ data frame should show the log plots added to the cross section adjacent to the wells. Adjust the symbology of the features and activate labels.

12. Right-click on the “XS2D_GEOPLOT_SCALEBAR_6475” layer and selecting the **Label Features** option.

At this point the cross section should be similar to the one shown in Figure 8.
Understanding Log Plots

Log plots are constructed by a set of eight feature classes, three defining the scale bar, three for the plot, and two for the plot background. The symbology for each of the feature classes can be modified individually. The regular labeling options can be used in ArcMap to show labels on the scale bar and tick marks, as shown in Figure 9. If desired, experiment with the plots by toggling on and off the different features in the plot.
7 Adding multiple Log Plots to a Cross Section

It is possible to add multiple log plots and display them together in one cross section. The process of adding an additional log plot is the same as adding the first one (as described in section 5). However, this time a different source table and/or fields will be selected. Also, an offset will be specified such that both plots can be displayed together. To add an additional log plot:

1. In the Table of Contents, right-click on “Layers” and select Activate.

2. If not already selected, select the 4 wells along section A-A’ highlighted in green as shown in Figure 4.

3. Select the Create Geophysical Plot Wizard available on the Arc Hydro Groundwater Toolbar.

4. With the wizard enabled, select section line A-A’ (shown in red) to bring up the Create Geophysical Plot Wizard.

5. Step 1 of the wizard defines the cross section setup. Set the following parameters:
   - **Number of wells selected** should show “4”.
   - **Well unique ID field** set to “HydroID”.
   - **Well reference elevation field** set to “LandElev”.
   - **Data table** set to “LogData”.
   - **Well ID field** set to “WellID”.
   - **Depth field** set to “Depth”.
   - **Depth value field** set to “LogValue”.
   - **Data type field** set to “FType”.
   - **Data type value** set to “Log2”.
   - **Data type name** enter “Log2”.
   - **Vertical exaggeration** set to “20”.
   - **XS2D Catalog Table** set to “XS2D_Catelog”.
   - The **Default output workspace** should point to the “Roseville_logpolt.mdb\GeoPlot” directory.
   - **Output Data Frame for Geophysical Data** set to “Section A-A’”.

At this point the inputs should be similar to the ones shown in Figure 10.
6. Select **Next** to continue to step 2 of the wizard.

7. In Step 2 of the wizard define the plot and scale properties:
   
   - **Plot width** set to “10,000”.
   - **Plot offset** set to “12,000”.
   - **Background vertical buffer** set to “0”.
   - For **Plot position** select **Right**.
   - **Scale label** enter “Log2”.
   - **Scale vertical offset** enter “300”.
   - **Maximum scale values** enter “60”
   - **Minimum scale values** enter “0”.

---

Figure 10  
Inputs for Step 1 in the **Create Geophysical Plot Wizard** for adding an additional log plot to the cross section
- **Number of major ticks** enter “4”.
- **Number of minor ticks** enter “1”.
- **Scale location** select Top.

At this point the inputs should be similar to the ones shown in Figure 11.

![Create Geophysical Plot Wizard](image)

**Figure 11** Inputs for Step 2 in the Create Geophysical Plot Wizard for adding an additional log plot to the cross section

8. Select **Next** to continue to Step 3

In Step 3 of the wizard we define the output feature classes:

9. Make sure the output feature classes are created in your target workspace (in this case in the GeoPlot feature dataset).

10. Select the **Append** option. This ensures that the original plots are preserved and are not overwritten.

At this point the inputs should be similar to the ones shown in Figure 11.
Upon completion a new set of features is appended to the existing feature classes. The cross section A-A’ data frame now contains the additional log plots added to the cross section adjacent to the first set of plots as shown in Figure 13.
By changing the plot parameters you have the flexibility to customize the display of the plots on the cross section. Another common option is to display the plots stacked together as shown in Figure 14.

Figure 13  Two sets of log plots added to a cross section

Figure 14  A display of two stacked logs added to a cross section
8 Conclusion

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

- Borehole log data are stored in tabular format and can be added as log plots to cross sections in ArcMap.

- The Create Geophysical Plot Wizard is used to automate the process of creating log plots.

- Log plots are created from a set of feature classes defining the plot, the scale, and the plot background.

- Multiple log plots can be added to a cross section and custom layouts can be created.