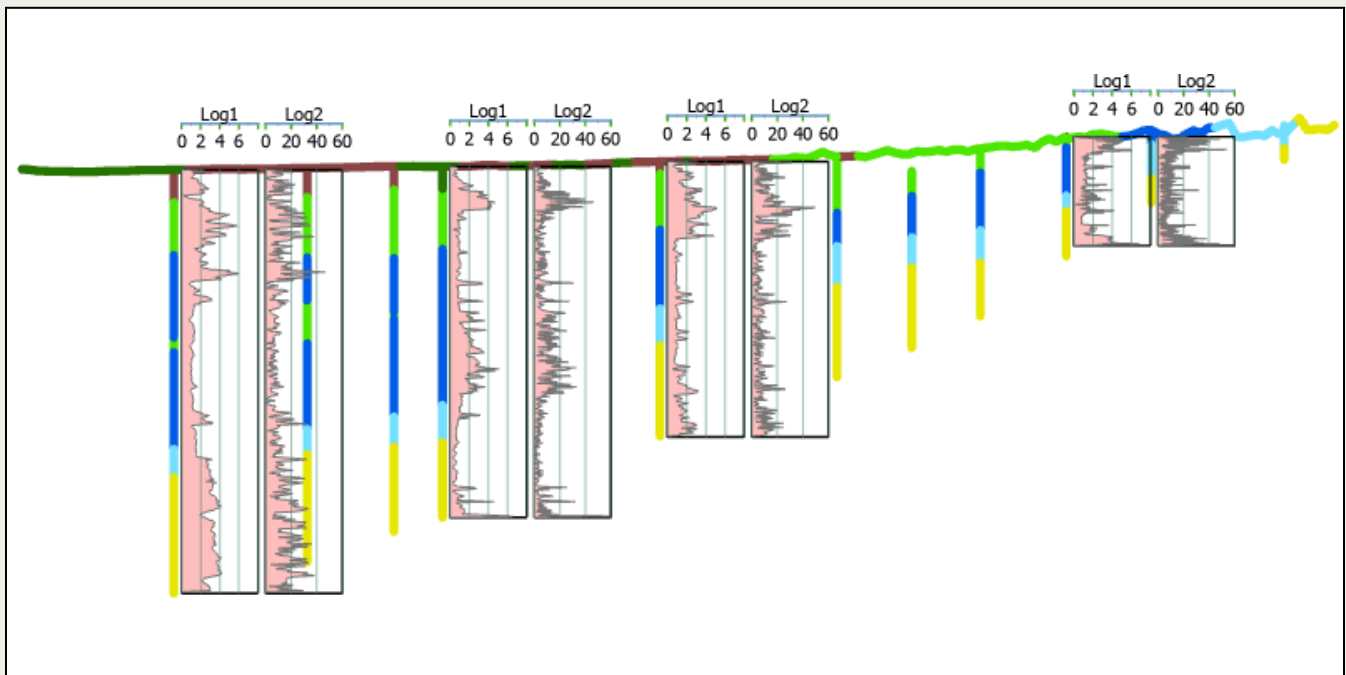*AHGW Pro 1.0 Tutorial*

Subsurface Analyst – Adding Borehole Log Plots to Cross Sections

Create plots of borehole logs in ArcGIS Pro

Objectives

Learn how to use Arc Hydro Groundwater Pro tools to create plots of borehole logs data and add them to a 2D cross section map.

Prerequisite Tutorials

- Subsurface Analyst – Creating 2D Cross Sections

Required Components

- ArcGIS Pro
- Subsurface Analyst

Time

- 10–25 minutes

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1   Introduction

Arc Hydro Groundwater Pro (AHGW Pro) is a geodatabase design for representing groundwater datasets within ArcGIS Pro. 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 Pro Tools* help to import, edit, and manage groundwater data stored in an AHGW Pro geodatabase. *Subsurface Analyst* is a subset of the AHGW Pro 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.

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.
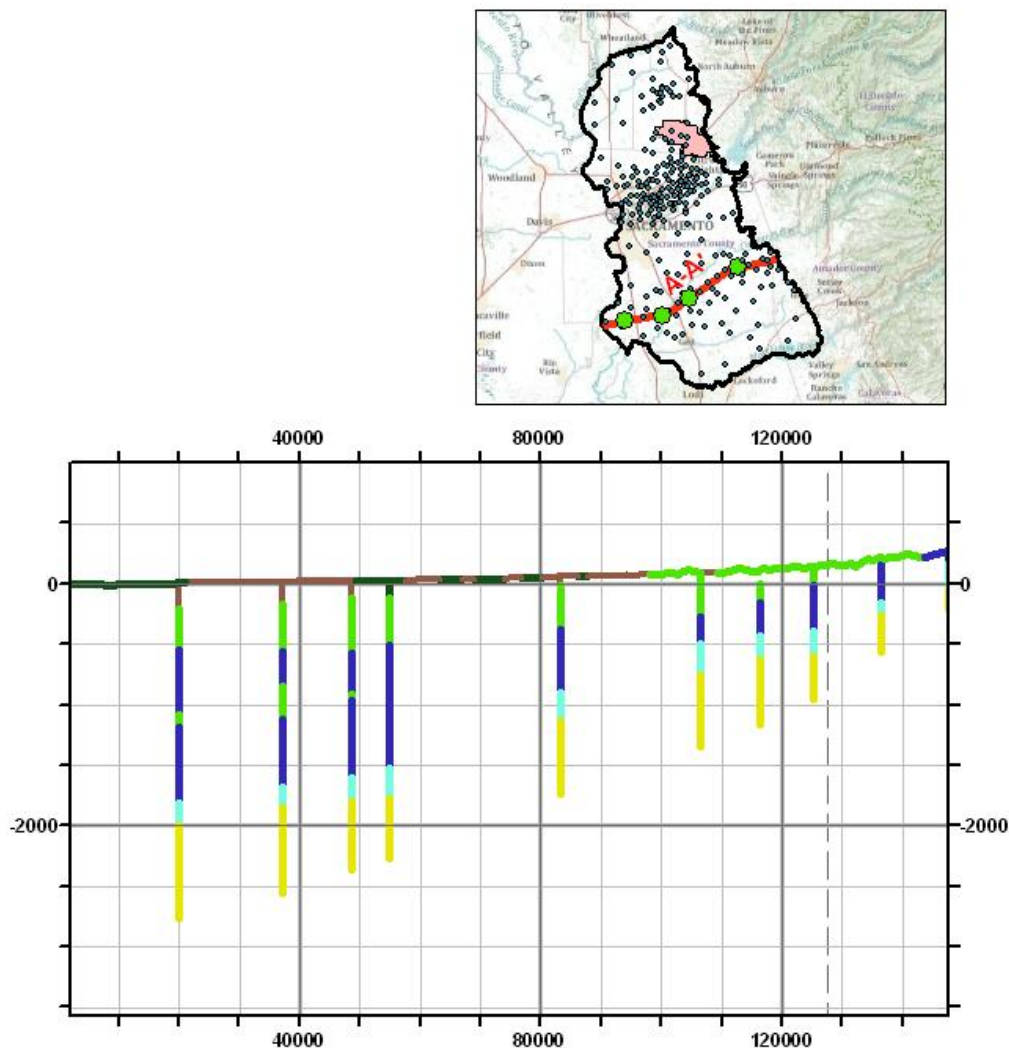
Figure 1   Background map and cross section to which borehole logs will be added

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 Log* tool to add geophysical data onto an existing cross section.

3.   Visualize and symbolize the plots in ArcGIS Pro.

1.3   Required Modules/Interfaces

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

- ArcGIS Pro License

- Arc Hydro Groundwater Pro Tools

- AHGW Pro Tutorial Files

The AHGW Pro Tools require having a compatible ArcGIS Pro service pack installed. Check the AHGW Pro 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

Begin by opening a project containing the data for this tutorial.

1. If necessary, launch *ArcGIS Pro*.

2. If on the ArcGIS Pro start page, select 📁 **Open another project** in the bottom right corner of the window to open the *Open Project* dialog.

3. If already in the user interface, use the 🖼 **Open** macro to open the *Open Project* dialog.

4. Browse to the location with tutorial files for this tutorial.

5. Select the file "XS2D_logplot.aprx" located in the *SubsurfaceAnalystPro/ XS2D_logplot* folder.

6. Click **OK** to import the project.

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*.
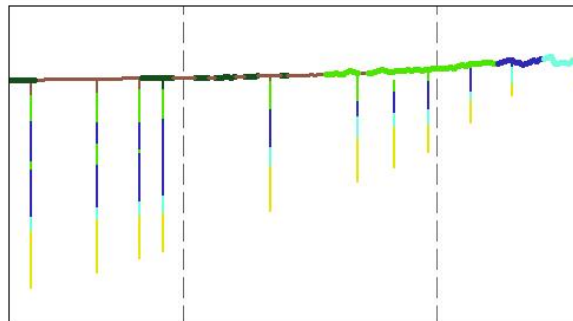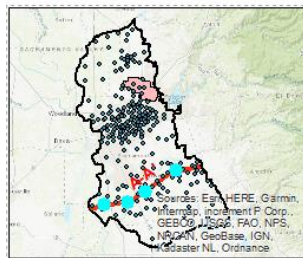

Figure 2   Initial project showing the model boundary and cross section

Before continuing, ensure that the AHGW Pro tools are correctly configured.

1. In the *Catalog* pane, expand the 🧰 *Toolboxes* folder.

The *ArcHydroGroundwater.pyt* toolbox should appear under the list of toolboxes. If toolbox is not visible, complete the following:

2. In the *Catalog* pane, right-click on 📕 *Toolboxes* and use the 🗗 **Add Toolbox** command to open the *Add Toolbox* dialog.

3. Browse to the location of *C:\Program Files\Aquaveo\ AHGW_ArcGIS_Pro_Python_Toolbox* directory and select and open the *ArcHydroGroundwater.pyt* file.

4. Click **OK** to close the *Add Toolbox* dialog.

With the *ArcHydroGroundwater.pyt* toolbox available, access the Groundwater Analyst tool.

5. Expand "🗂 ArcHydroGroundwater.pyt".

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

6. At the top of the *ArcGIS Pro* window, select the *Project* tab. From the list on the left, select **Options** to open the *Options* dialog.

7. Select *Geoprocessing* from the list under *Application* on the left of the dialog.

8. Ensure that *Allow geoprocessing tools to overwrite existing datasets* and *Add output datasets to an open map* are turned on.

9. Select **OK** to exit the *Options* dialog.

10. Using the arrow in the upper left corner, return to the main screen.

3   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.

Figure 3   Log table containing geophysical logs along boreholes

4   Adding Log Plots to a cross section

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

1. Switch to the " Map" view and select the *Map* tab on the ribbon.

This data frame must be active when creating plots because it contains the well features.

2. Using the **Select** tool, 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.*
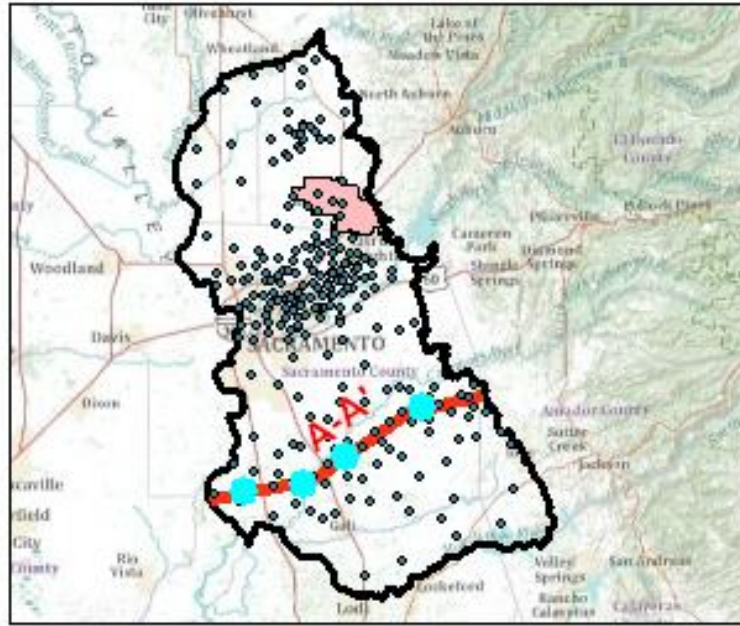
Figure 4   Map showing selected wells that have related log data

3. Select the *Arc Hydro Groundwater* tab in the ribbon.

4. Select the **Create Geophysical Log** to open the *Create Geophysical Log* pane.

5. Using the **Select** tool located in the *SelectLine* section, select the section line A-A' (shown in red).

6. Set the following parameters:

    - *Well Unique ID field* set to "HydroID".

    - *Well elevation field* set to "LandElev".

    - *Number of wells selected* should show "4".

    - *Data Table* set to "LogData".

    - *Well ID field* set to "WellID".

    - *Depth field* set to "Depth".

    - *Data 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".

    - *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".

- *Output Map* set to "Section A-A'".

- *Overwrite option* set to "Overwrite existing features with same data type".

7. Click **Create XS2D Data** to execute the tool.

8. Switch to the " Section A-A'" view.

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. At this point the cross section should be similar to the one shown in Figure 5.
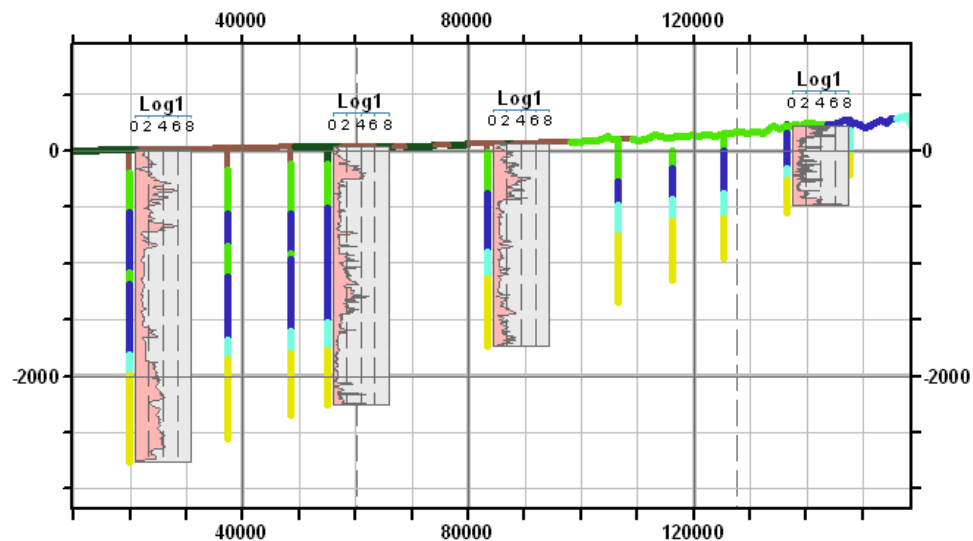

Figure 5   Log plots added to cross section A-A'

5   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 ArcGIS Pro to show labels on the scale bar and tick marks, as shown in Figure 6. If desired, experiment with the plots by toggling on and off the different features in the plot.
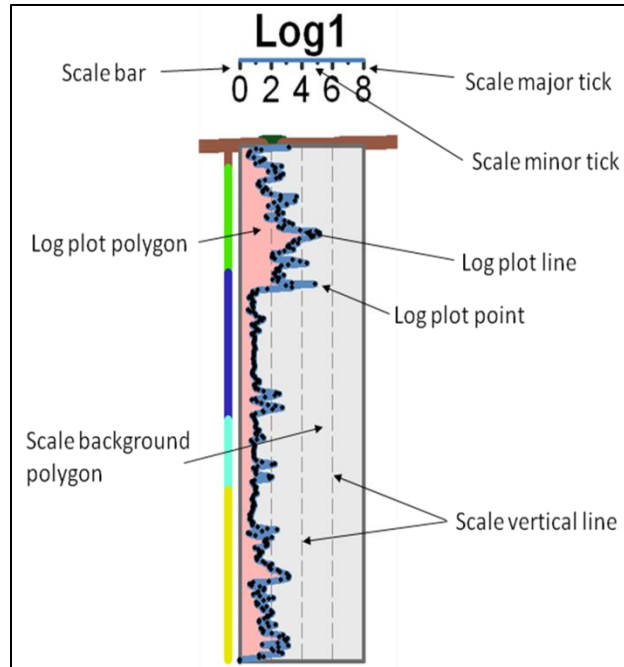
Figure 6   Structure of a log plot

6   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 4). 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. Switch to the " Map" view.

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

3. Return to the *Create Geophysical Log* pane.

4. If it is no longer selected, use the **Select** tool located in the *SelectLine* section, select the section line A-A' (shown in red).

5. Change the following parameters:

    • *Data type value* set to "Log2".

    • *Data type name* enter "Log2".

    • *Plot offset* set to "12,000".

    • *Scale label* enter "Log2".

    • *Maximum scale values* enter "60"

    • *Number of major ticks* enter "4'.

    • *Number of minor ticks* enter "1".

- *Overwrite option* set to "Append". This ensures that the original plots are preserved and are not overwritten.

6. Select **Create XS2D data** to run the tool.

7. Switch to the "⬚ Section A-A'" view.

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 7.
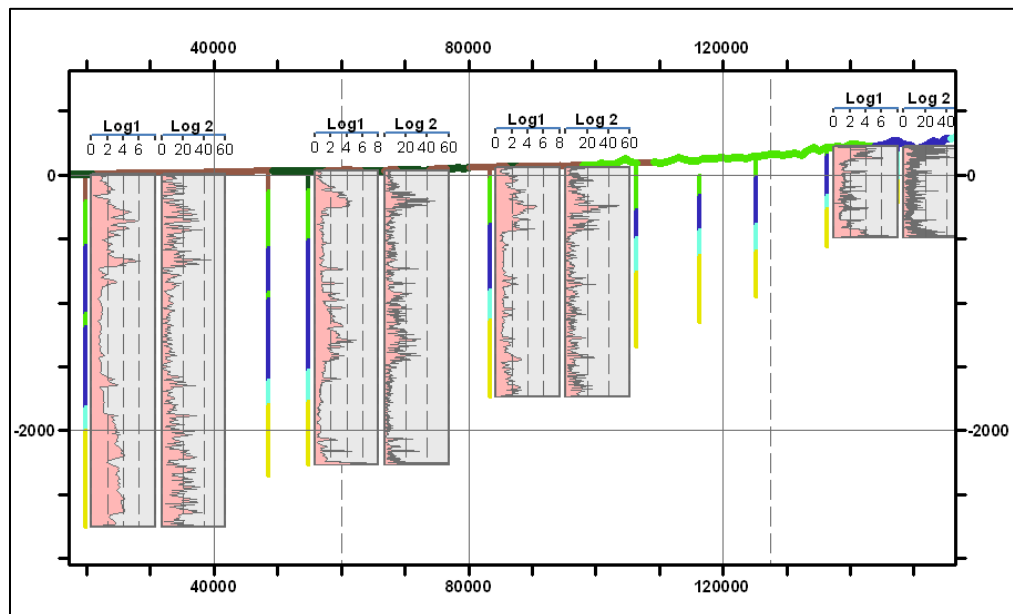

Figure 7   Two sets of log plots added to a cross section

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 8.
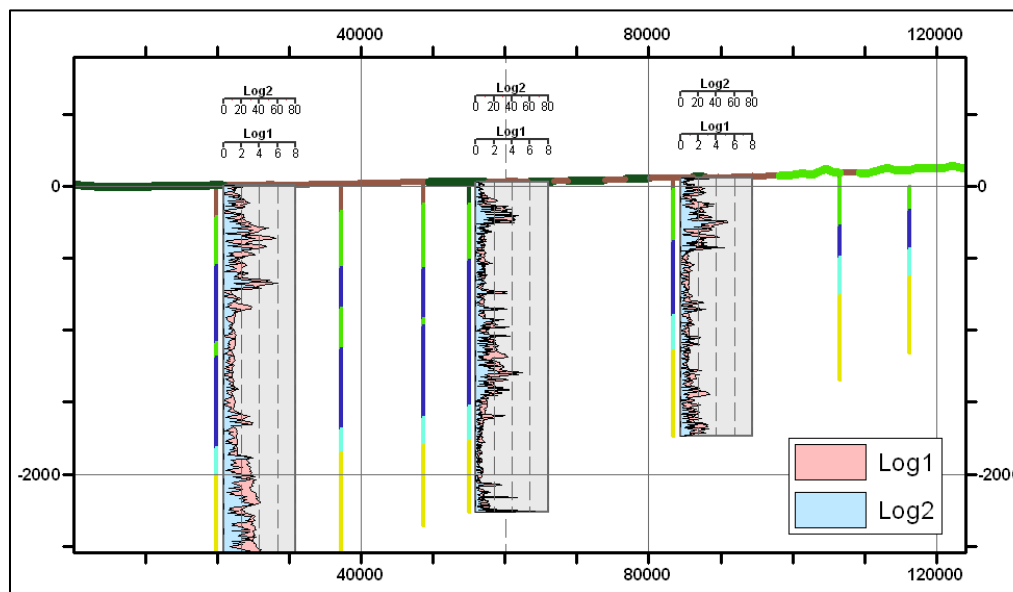

Figure 8   A display of two stacked logs added to a cross section

7   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 ArcGIS Pro.

- The *Create Geophysical Log* tool 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.