Michigan Geological Survey

ArcGIS Pro Custom Tools Training

Mapping Projects

Basic Requirements:

ArcGIS Pro with all extensions
ArcGIS Online Organizational account
Access to Microsoft Teams (Off Campus) & DEQ Drive (On Campus & Off Campus)

- Link to Mapping Team channel with the custom Python scripts

Understanding of Excel data summaries

****IMPORTANT NOTE: These tools were tested with ArcGIS Pro 3.3.0. Issues may be present in other versions.****

Quick Note for Data and Layers:

It is important to consider data quality before data collection. For example, widely used databases can often be incomplete or inaccurate. We don't want to use this data in our calculations because the accuracy of the data will be in question and may not yield the correct interpretation. We will want to make sure we clean up the data before we use it (more to discuss further in the document). The same goes for the DEM data and any other data that we download.

The processing time for all tools is directly tied to the size of the input datasets. Very large datasets (state-wide or larger) can take days to finish processing. For the quickest results clip your data down to only what you need.

Final note: Each project is unique and should be treated as such. There is a standard workflow for each project but should be noted that each project will have its own data needs that should be addressed from project to project that may not follow the standard workflow.

Setting Up the Workspace & Project

Each project that is given will be assigned by the current Project Manager. Project details will be outlined before the work begins, which includes the name of the project, the general location information (latitude and longitude), and what the scope of the project is. These will all be parameters needed to begin creating the project files and extent for the analysis.

If you do not have the custom Python tools downloaded, be sure to download them to your local computer before continuing. If you are working off Microsoft Teams, you can sync files from the Mapping Channel to your local computer in order to access the tools. If you do not have the ability to synchronize with the Mapping Channel, contact the project manager to gain access to the tools before continuing.

Once the scope of the project has been determined, the users will load the MGS_Tools toolbox into a new map document and run the MGS – Project Creation tool that is found in the Data Formatting Tools toolset. This process for this custom Python script is described below in **Figure 1**:

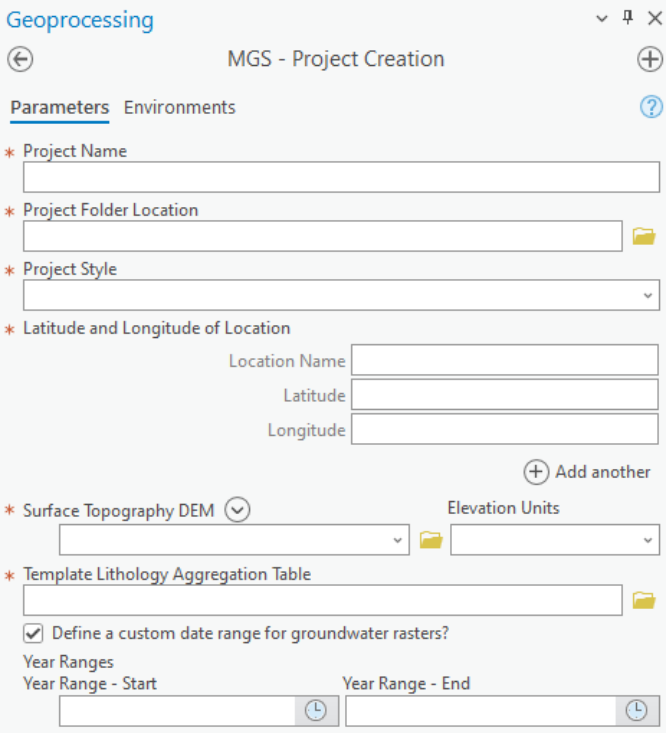


***Figure 1**: Screenshot of the MGS - Project Creation custom Python script in the ArcGIS Pro software.*

1. Give the project a name to be used for naming the subsequent files through the Python script. Keep the name simple, concise and without any spaces involved.
2. Indicate the file location of where you want the datasets to be downloaded and sent to in your local computer. This should be the folder where you have the map document saved.
3. State the style of the project. There are only two options, a standard 2–5-mile project area or a non-standard project area.
    a. Standard 2-5-mile project areas create an area around a point around a point or set of points (see next step for context). This project style is consistent formatted with a 2-mile extent from the location(s) as the main focus with data points up to 5 miles away from the location(s).
    b. Non-standard project areas are dominated by the extent of the DEM provided by the user (see DEM section for context). This project style is for generally larger areas than the 2-5-mile projects or is a grander scope than the standard style.
4. Provide the location information for your project.
    a. This can support multiple locations in a project. Simply click on “Add Another” to include more locations in the project setup.
5. Provide the surface topography DEM raster(s).
    a. The parameter supports adding as many rasters as are needed for the project area. Each raster needs to also be provided with the elevation units that the raster represents. The final raster for the project will be displayed in feet. To download rasters beforehand, visit the USGS The National Map website to collect the rasters needed for the project.
6. Provide the Microsoft Excel template for the lithology aggregate classification.
    a. This Excel table provides the script to transform the lithology terms in Wellogic to a set of 8 terms, which is defined in the LITH_AGG field for the final lithology tables.
7. Check the box marked “Define a custom date range for groundwater rasters?” if you would like to set a range for the rasters. Otherwise, leave unchecked for the default ranges.

a. If this option is unchecked, the script will create standard groundwater surfaces based on validated water wells (meaning that someone has checked the well for the correct location). The standard format will be a groundwater surface containing all points, all points pre-2000's, and 5-year increments after 2000 to the current year.
b. If this option is checked, the user can define the beginning and ending date to analyze. This will tell the script to run from the beginning to the end in a set interval, which is also defined by the user.

The processing time for this and all other tools from this toolbox will depend on both the scale of your project and the capabilities of your computer. Typically, project creation time is roughly around 15-30 minutes on good hardware for an area less than 50 square miles.

Validating Datasets Produced

If some of these datasets need to be reconstructed, there are some other tools we can use to format the data correctly. For example, if there is a groundwater raster that needs to be re-run, then a groundwater reclassification script can be used. This tool is named in the Data Formatting Tools toolset as MGS – GWL Raster Creation. This process for this custom Python script is described below in **Figure 2**:

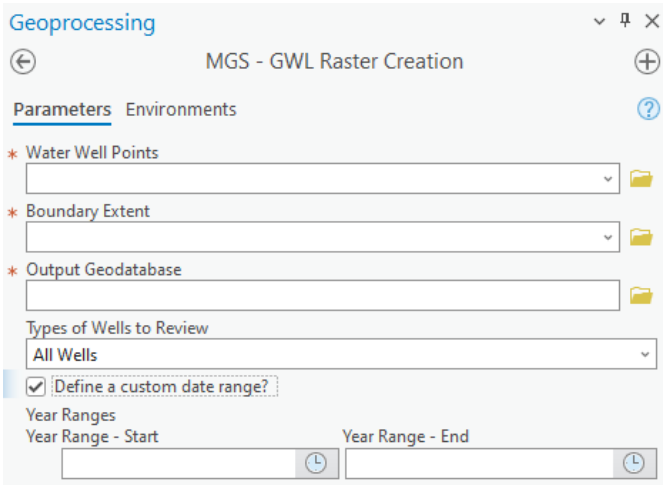


Figure 2: *Screenshot of the MGS - GWL Raster Creation custom Python script in the ArcGIS Pro software.*

1. Define the wells to be used in the analysis. These features must have gone through the Project Creation tool or the Data Formatting tool (see discussion of Data Formatting tool).
2. Define the boundary of the dataset. For the 2-5-mile area, this will be the 5-mile extent feature class. For the non-standard project, this will be the extent of the DEM or the project area if defined later by the user.
3. Define where the resulting rasters will be created. This will likely be the Raster geodatabase created in the Project Creation tool. If it is not, define a geodatabase to save the rasters in.
4. Provide the types of wells to be reviewed to generate the groundwater rasters.
    a. All Wells – Every well will be considered for the generation. This is the default.
    b. Drift Wells – All of the wells designated as "Drift Wells" will be processed through this tool.
    c. Bedrock Wells – All of the wells designated as "Bedrock Wells" will be processed through this tool.

5. Check the box marked "Define a custom date?" if you would like to set a range for the rasters. Otherwise, leave unchecked for the default ranges.

If the project has been created already and the Wellogic data just needs to be reformatted, there is a separate tool to just create the water wells feature and reformat the lithology table for usage in all other MGS custom tools. This tool is named the MGS – Data Formatting tool in the Data Formatting Tools toolset. This process for this custom Python script is described below in **Figure 3**:

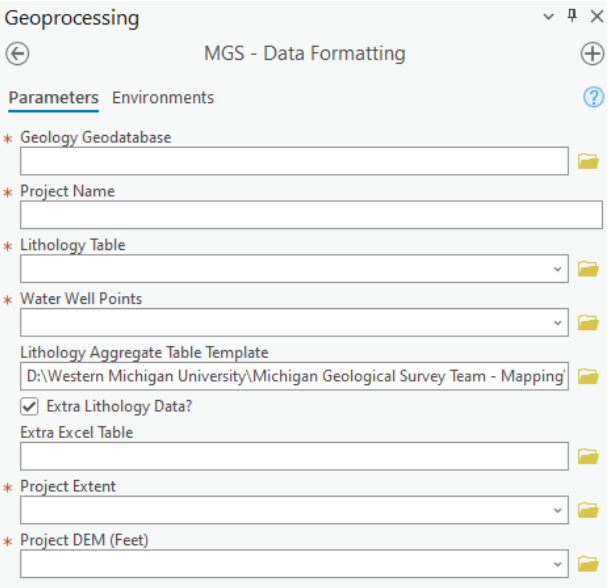


Figure 3: *Screenshot of MGS - Data Formatting custom Python script in the ArcGIS Pro software.*

1. Define the database location to store the geology information once it has been reformatted.
2. Define the name of the project. This can be the same name that was given in the Project Creation tool, or it can be something different.
3. Define the lithology table that needs to be reformatted. This is the table that comes from Wellogic. If the table does not match the same format, then the tool will not work.
4. Define the water well points feature class that needs to be reformatted. This is also from Wellogic, so the feature class needs to have the same fields as Wellogic.
5. Define the Excel template for the lithology aggregate units. This is the same as the project creation tool parameter.
6. Check the box marked "Extra Lithology Data?" if you have extra data to add to the lithology table.
    a. This will not be a parameter that not many people will use. Wellogic contains other fields that are not exported in the shapefile and lithology tables, which includes a third description field for the lithology table. This allows for a custom Excel table to import the third lithology term which contains fields WELLID, SEQ_NUM, COLOR, LITH_PRIM, SEC_LITH, FORMATION, THICKNESS, DEPTH, and GEO_COMMENTS.
7. Define the project extent for the new datasets. If the project style is the 2-5-mile area, then you will want to use the 5-mile extent. If it is a non-standard project, this will likely be the extent of the DEM, but it can also be a user-generated area of interest.
8. Define the project DEM to be used. A few notes:

a. This raster must be in feet units to complement the Wellogic datasets, which are all in feet measurements.
b. The DEM must also encompass either **the full area of the project extent** or a **vast majority of the project extent**. This is really important because the Wellogic water well points are going to extract the elevation data from the DEM, and if there are too many points outside of the DEM, the tool will generate an error and will not continue the script. It is an error produced by the Extract Values to Points tool in ArcGIS Pro.

Just as with the Project Creation tool and the GWL Raster Creation tool, the Data Formatting tool can be left on in the background. Other tasks can be performed while the script is running and formatting the data to MGS standards.

The files produced are the same from the Project Creation tool to the Data Formatting tool and will have the same fields and calculations as each other.

Data Formatting (Cross-Section Only) - Optional

If you decide to skip the project creation or have no use for its outputs, then you can move directly to creating the cross-sections after formatting the Wellogic data.

Step 1: Setup the workspace and prepare the DEM

8. Begin by opening a new map in ArcGIS Pro.
9. Obtain the appropriate elevation data and place it into the map (1-meter-resolution DEMs are recommended for areas less than 10 mi^2 in size). Merge DEMs as necessary to make a single raster file. **Make sure the elevation unit for the DEM is in feet for the next step.**
10. Next, ensure you have a proper polygon to encase your project area. Existing township or county boundaries work well, or you can make a custom polygon to suit the project's needs.
11. Acquire the Wellogic water well data for the project. Download all the counties that are needed for the extent of the project area. If there are multiple counties in the project area, merge the water well points together into one shapefile as well as the lithology tables.
    a. Note: The tools are designed to only work with well data in this specific format.
12. Add the *MGS_XSEC_TOOLS_v2.atbx* toolbox to your project by right clicking on *Toolboxes* in the catalog, navigating to where you stored the downloaded tools, and selecting the toolbox.

Step 2: Data Formatting

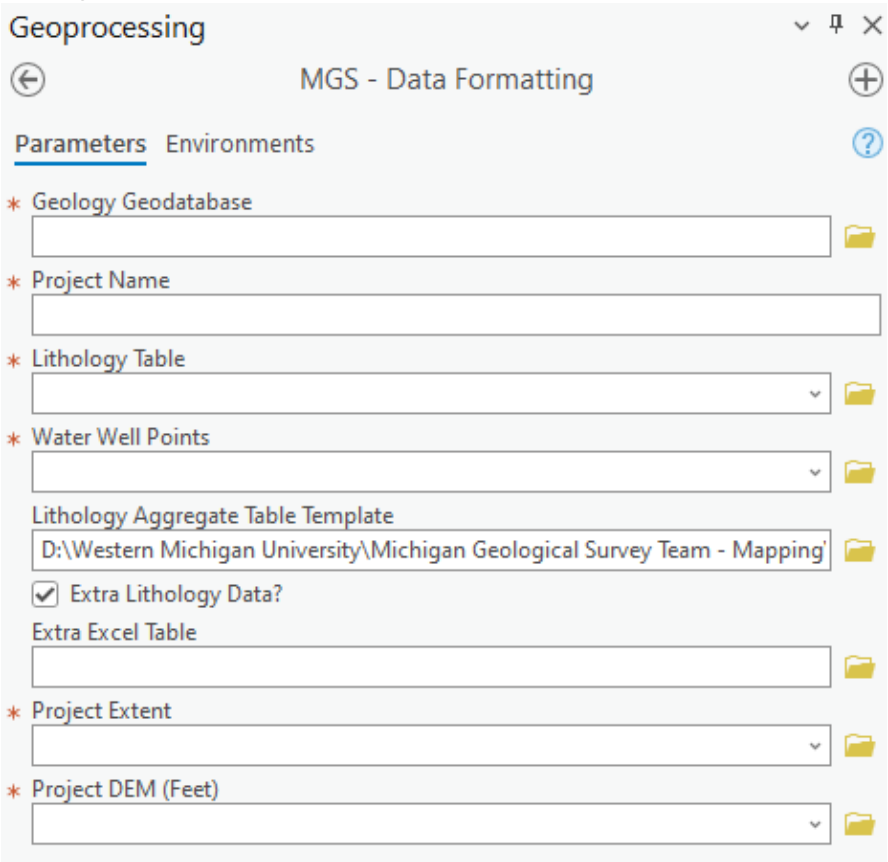


Figure 4: *Screenshot of MGS - Data Formatting custom Python script in the ArcGIS Pro software.*

6. Open the Data Formatting Tools inside the MGS toolbox and select the "MGS – Data Formatting" tool. See in **Figure 1.**
7. Create/Select a geology geodatabase for the project. ****IMPORTANT NOTE: This should be separate from your default geodatabase.****
8. Provide the name of the project. *No special characters or spaces except for underscores and cannot begin with a number.*
9. Select the Wellogic lithology table and water well points.
10. Provide the lithology aggregate Excel spreadsheet.
    a. Provided in the cross-section tools package.
11. Select the polygon used for the project's extent.
    a. Note: Projects larger than one county will take significantly longer to process.
12. Select the project DEM.

Step 3: Groundwater Level Raster Creation (Optional)

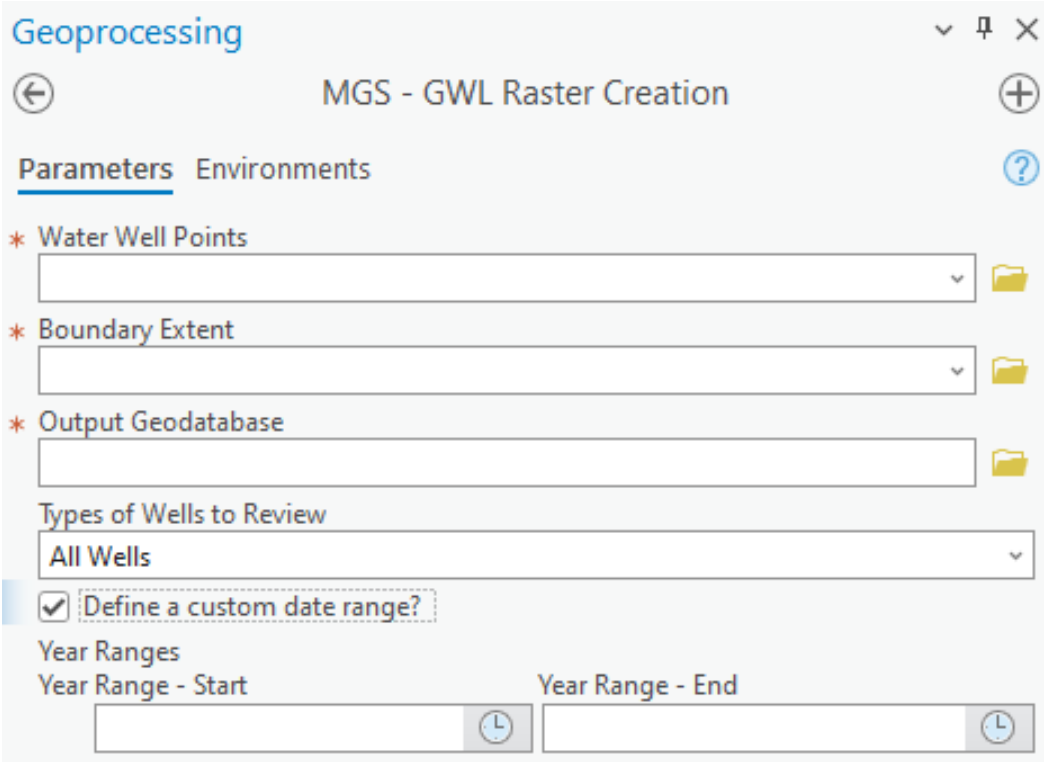


***Figure 5**: Screenshot of MGS – GWL Raster Creation custom Python script in the ArcGIS Pro software.*

This tool is used to generate groundwater rasters across several year increments to see how it changes over time. This can also be used to delineate between bedrock and drift aquifer systems if the need arises. These are later used in the cross-section tool to predict water levels along the cross-section.

9. Select "**MGS – Raster Creation**" tool below the Data Formatting tool seen in *Figure 2*.
10. Once the tool is open, define the wells to be used in the analysis. These features must have gone through the Project Creation* tool or the Data Formatting tool (see discussion of Data Formatting tool). **For more information on the Project Creation Tool, review the Wellogic Data training document - ArcGIS_Pro_TrainingDocument_WellogicData_20240507**
11. Define the desired boundary of the rasters. You can use the previously defined project extent or choose a new one.
12. Select the geodatabase where you would like to store the output rasters.
13. Select the types of wells to review.
    a. **All Wells** = Every well in the feature class.
    b. **Bedrock Wells** = All the wells designated as "Bedrock Aquifers"
    c. **Drift Wells** = All the wells designated as "Glacial Drift Aquifers"
14. Define a custom date range if needed.
    a. Note: The standard format will be a groundwater surface encompassing all wells drilled in the area, all wells drilled before 2000, and 5-year increments after 2000 to the current year.

Step 4: Drawing Cross-Section Lines

1. Before using the cross-section tool, you must create cross-section lines on your map. Start by creating a new Polyline feature class in your default geodatabase.
2. Create two text string fields within the feature class called **"XSEC"** and **"DIRECTION"** (case sensitive).
3. Use the **"XSEC"** to name the cross-section(s).
4. In the **"DIRECTION"** field, you must specify the quadrant you would like the cross-section to start analyzing (or drawing) from. You must use one of the following codes below in order to define the drawing direction:
    a. If the direction is labeled as W-E, NW-SE, or E-W, the script will be reading the cross-section from the **Northwest quadrant.**
    b. If the direction is labeled SW-NE, S-N, or N-S, the script will be reading the cross-section from the **Southwest quadrant.**
    c. If the direction is labeled as NE-SW, the script will be reading the cross-section from the **Northeast quadrant.**
    d. If the direction is labeled as SE-NW, the script will be reading the cross-section from the **Southeast quadrant.**

    ****IMPORTANT NOTE: Without the addition of these fields the tool will fail.****
5. Draw all necessary cross-section lines and fill out the required information in the attribute table. ***DISCLAIMER*** The number of wells will determine the length of time needed to process the cross-section lines. The length of the line will also increase the processing time.

Step 5: Cross-Section Tool (All Steps)

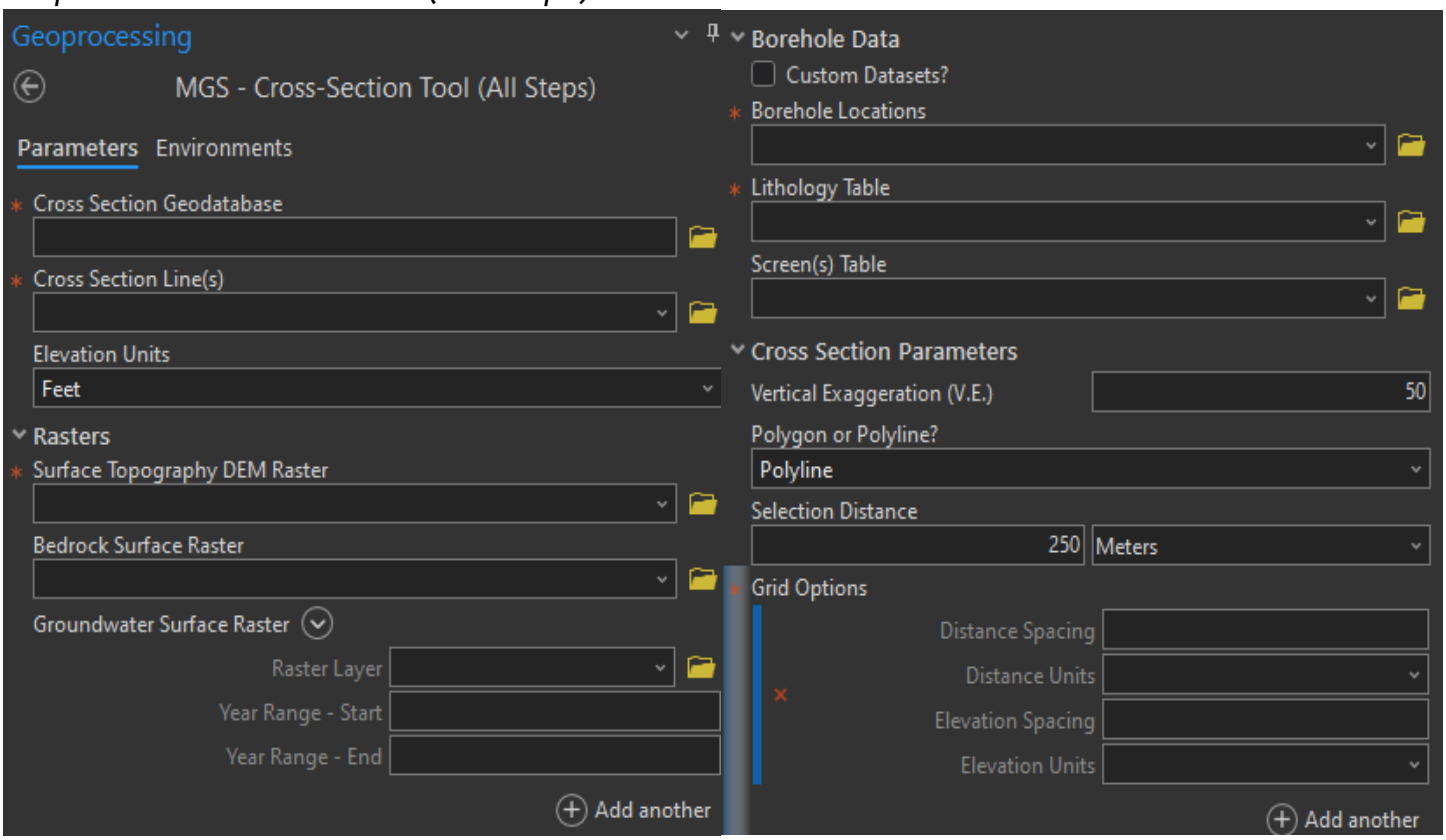
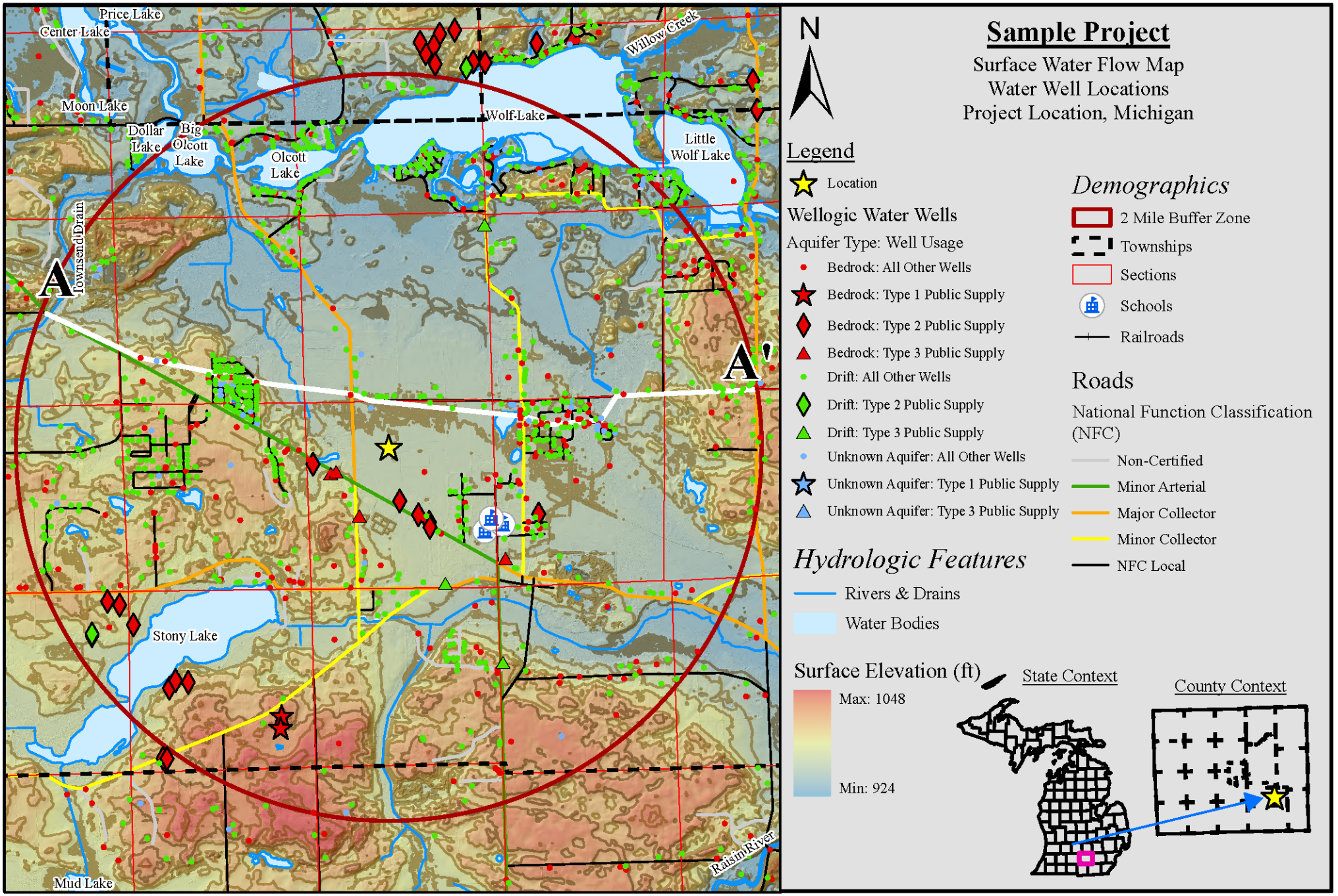


Figure 6: *Screenshot of MGS – Cross-Section Tool (All Steps) custom Python script in the ArcGIS Pro software for Wellogic input.*

1. Create a cross-section geodatabase for the cross-section files.
    a. Warning: Files may be erased if the files are placed in an existing geodatabase or if the tool is run again in the same geodatabase.
    b. ****IMPORTANT NOTE: This geodatabase must be separate from your default geodatabase or the tool may fail.****
2. Open the "MGS – Cross-Section Tool (All Steps) under the Cross Section Tools Toolset
    a. Several of the steps have been separated out of the "All Steps" script to be repeated upon changes made to other datasets. These include "Borehole Only", "Segment Profiles Only", and "Grid Line Creation Only". Remember, default names will be overwritten when running these tools. If you wish to keep any of your original outputs then you must rename them.
3. Select the newly created cross-section geodatabase.
4. Select the cross-section feature class.
5. Select the elevation units for **all your features.** The default is set to feet units.
6. Select the surface DEM used for the project.
7. Select the bedrock surface raster and the groundwater surface raster(s) (Optional)
    a. Note for Cross-Sections: These surfaces are generated in sections of confidence (solid line) and inferred (dashed lines). Anomalies in the groundwater levels often come from areas where there are no wells drilled within the selected time interval to support the predicted groundwater level.

   b. For groundwater levels, input the years you would like included in the analysis for the confidence of the surface. These years should match the years of the wells that were selected to create the groundwater raster. If left blank this will include all years.
8. Select the reformatted water well points.
9. Select the reformatted Wellogic lithology table.
10. Select the screen table created by the data formatting tool *(Optional)*
11. Choose your vertical exaggeration (V.E.).
    a. 50 – 100x Recommended. Default is 50.
12. Choose whether you would like the borehole lithologies to be represented by polylines or polygons.
    a. Note: Polylines are easier to read on dense cross-sections.
13. Choose how far away from the cross-section line wells should be selected to be included in the cross-section.
    a. 250 Meters is recommended and is the default.
14. Choose your grid spacing for the cross-section frame.
    a. Recommendation if Elevation Units are in Feet = Distance: 2000 feet and Elevation: 50 feet.
15. Run the tool.
16. Complete your layout. See completed cross-section in **Figure 4**.

Figure 7: Example of surface flow map. (Credit: Garrett Ringle)



While looking **Figure 4**, there are a few key notes to keep in mind while creating the "finalized" maps, which are outlined below:

1. We are presenting the data to people under the assumption that the audience does not know anything of the data itself. So, it is important to make sure that everything is outlined in a very clear way to the audience as to what the map is trying to tell the story of.
2. Not everything on the map needs to be included in the symbology, but make sure that everything is explained clearly (i.e. the LiDAR DEM data does not toe be included in the legend, but should be noted in the description).
3. Some areas may need the actual surface raster of the groundwater surface in order to see the gentler hydraulic gradients.
4. A few housekeeping items that need to be included in the maps:
    a. All of the water wells in the area should be shown in the map (don't leave out the wells that you didn't use in the analysis. People still want to know they exist)
        i. The wells should already be symbolized, but incase they are not symbolized, there is a layer symbology in the Mapping Team folder labeled ***INSERT FILE NAME***.
    b. The central location of interest (Marked by a yellow star)
        i. If the project does not have a specific location of interest, this does not need to be included.
    c. The hydrologic features, such as rivers, drains, lakes, and ponds
    d. The groundwater surface raster
    e. The demographic features:
        i. Road segments
        ii. Township and city boundaries
        iii. Public Land Survey System (PLSS) Section lines
        iv. Schools in the area
            1. K-12 Schools
            2. Colleges
    f. DEM features for the background information
        i. The surface DEM with the Prediction color scheme and a 50 percent transparency
        ii. Hillshade behind the DEM
        iii. Elevation contours
            1. The custom tool can sometimes glitch and not symbolize this layer. The Index versus Intermediate contours are defined in the data table but may need to be symbolized later.
    g. A scale bar for the map (keep it in miles); one subsection and set to 1-mile increments.
    h. A north-arrow indicator (any north arrow style should be fine)
    i. A title for the project (NOTE: This should be the working title from the Manager and Director for both the maps and cross sections, so keep it consistent)
        i. This will likely be the name of the site or name given for the project by MPART or EGLE.
    j. The title of the map itself, what it shows, and the location.
        i. Example: Groundwater Flow Map; Water Well Locations; Northville, Michigan
    k. An **observational** description and data description

        i. This is not meant to be an interpretive piece; this is only meant to direct the audience to features that we would like people to be aware of. For example, we want people to know that the location of the water wells have been validated for their correct location. This is not interpretive, but factual.
    l. A couple of context maps to show where the location is in relation to:
        i. The State of Michigan
            1. Indicate which county(s) the audience is looking at with a red fill (or something similar). This should be symbolized for you already, but just in case there was an error in the code that prevented the symbol from finishing.
        ii. The county(s) the location is found in within a 2-to-5-mile radius (or the extent of the project area)
    m. Include a note for the contour intervals and what each interval shows.
    n. Include what the coordinate system is for the map itself to help the audience understand the projection of the map in geographic space.
    o. Include the MGS logo somewhere in the map document. Typically, it is good to have it in the bottom right corner.
    p. Include a date for each exported text somewhere on the document, to track changed documents.
        i. This can be added in through Dynamic Texts in the layout view.
    q. When the timing is right, include the cross-section lines with labels for the ends of the lines.
5. Remember that the maps may not be final and should be taken with a grain of salt for revisions and adaptations. Not every project will look exactly the same, but the maps within a project should look almost identical from one map to another.
6. Typically, a legal paper size (11”x14”) should give just enough room for the map document. Some things may need to be shrunk to include more information than what is outlined previously.

Once satisfied, submit the maps to Management to undergo review. Management may ask for some revisions to the appearance or the data quality for second drafts. Be sure to label the file name of the documents to reflect a common theme: the project name, what the document is, and the date and time it was created (Ex: Anderson_GWL_20211120_1234.pdf)

Cross Section Creation and Presentation

Once all the maps have been created and analyzed, it is time to begin considering making cross-section lines through the project area. A couple of notes before going into the cross-section creation tool:

6. Make note of the density of wells in the surrounding area. We want to capture as many wells as possible to get the full picture. At the direction of the Project Manager and Director, place as many cross-sections as needed to gain a full 3D picture of the area.
7. If you used the Project Creation tool to generate the workspace, there is a feature class generated for you that is named XSEC_Lines. This is where you will be creating new cross-section lines for your area. You must define the **name of the line** (AA, BB, etc.) and the **direction** of the line **MUST** be defined for the cross-section tool to work.
    a. The directions are defined in a domain-controlled scheme, but in-case the line was not generated, or the Project Creation tool was not run, the following terms are listed that the script is looking for:
        i. Field Name: DIRECTION; Terms in Field: W-E, NW-SE, E-W, SW-NE, S-N, N-S, NE-SW, SE-NW
        ii. If the direction is labeled as W-E, NW-SE, or E-W, the script will be reading the cross-section from the **Northwest quadrant.**
        iii. If the direction is labeled SW-NE, S-N, or N-S, the script will be reading the cross-section from the **Southwest quadrant.**
        iv. If the direction is labeled as NE-SW, the script will be reading the cross-section from the **Northeast quadrant.**
        v. If the direction is labeled as SE-NW, the script will be reading the cross-section from the **Southeast quadrant.**
8. It is recommended that the lines contain the full segment of the topography raster, but the script will continue if there is a blank spot in the line or if the raster ends sooner than the line does.
9. ***DISCLAIMER*** Be careful of how many vertices you add to a cross-section line. The more vertices on a line segment, the longer it will take for the borehole portion of the cross-section tool to run. The number of wells will also determine the length of time needed to process the cross-section lines. The length of the line will also increase the processing time.

With all the above being stated, we are now ready to produce new cross-section maps. There are a couple of options, but a good starting point for a new project would be to use the tool named MGS – Cross-Section Tool (All Steps), which is found in the Cross Section Tools toolset. The process is described below in **Figure 5**:

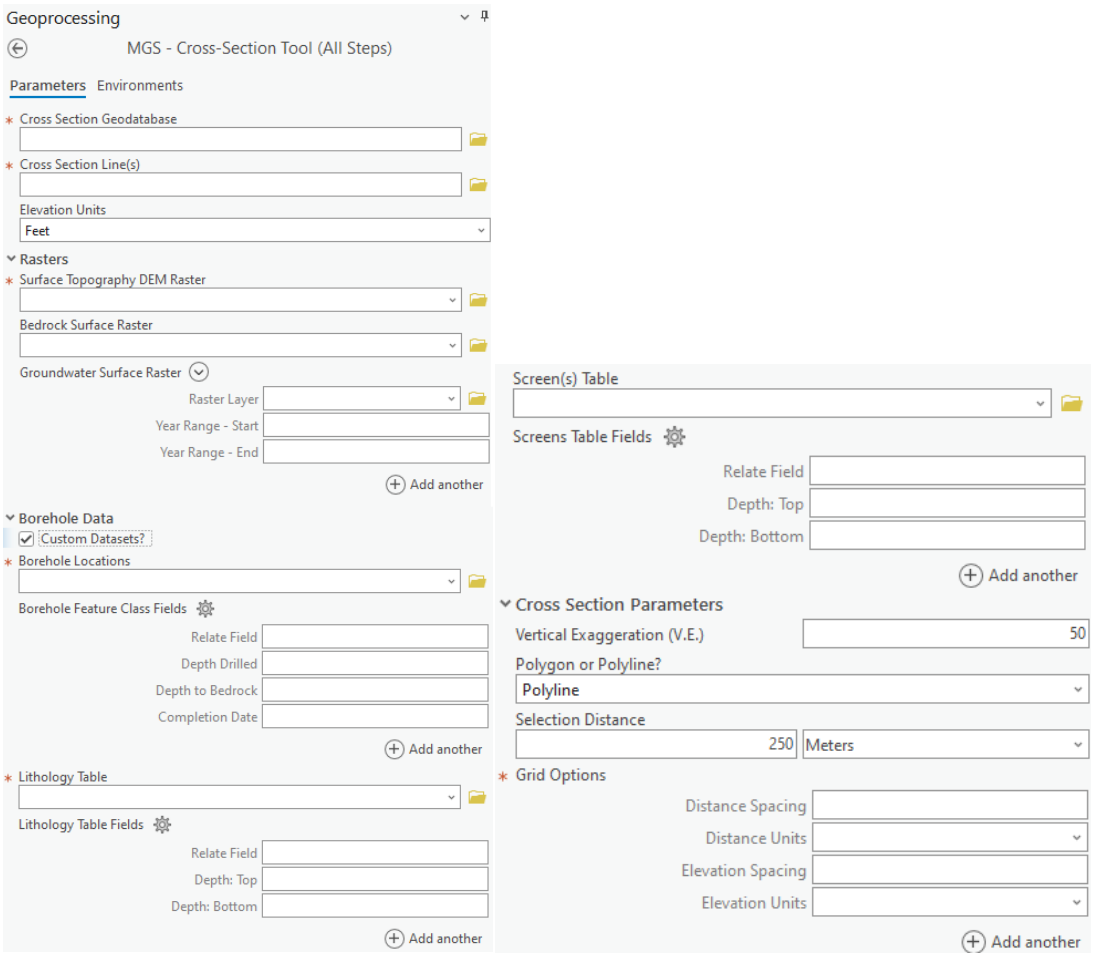


Figure 8: *Screenshot of MGS - Cross-Section Tool (All Steps) custom Python script in the ArcGIS Pro software.*

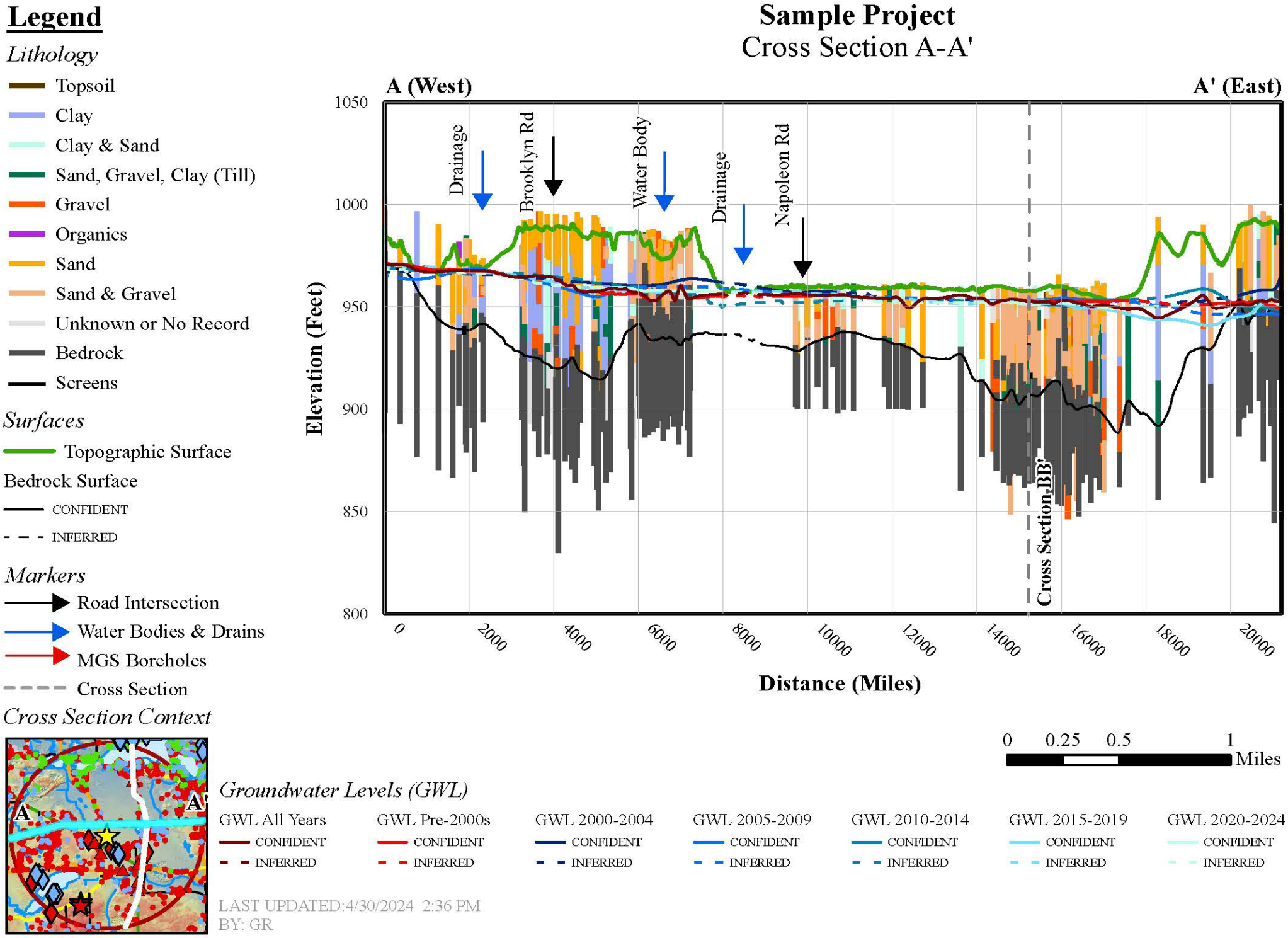
17. Define the location of the cross-section geodatabase. All files will be saved in this geodatabase. There will also be associated datasets that are created for each line that is saved in this geodatabase. ****IMPORTANT NOTE: The selected geodatabase must be separate from your default geodatabase.****
18. Define the cross-section lines layer. The feature class can contain more than one cross-section line, but they must all be labeled correctly (see previous comments for context).
19. Define the elevation units for **all your features.** The default is set to feet units.
    a. This includes the elevation units for:
        i. The surface DEM
        ii. Bedrock surface DEM
        iii. Groundwater surface DEM(s)
        iv. Borehole locations elevation and total depth
        v. The lithology table and screen interval depths
20. Define the surface topography DEM raster.
21. Define the bedrock surface DEM raster. This is not a required parameter, so it does not need to be filled out. Add the data if it is acceptable to use, but the tool will pass the step if it is not applicable.
22. Define the groundwater surface DEM raster(s). This is the same as the bedrock surface. The script will skip this step if there are no groundwater rasters to analyze. The user can also add as many surfaces as they wish. There is no limit to how many groundwater surfaces can be analyzed.

   a. The user must also define the year ranges for each groundwater raster that has been added. If the rasters have been processed through the GWL Raster Creation tool, they will have years at the end of the file name to aid in defining the year ranges. For All Years, the year ranges can be left blank. For the Pre-2000's rasters, mark the end year as 1999 and the beginning year as 1800. The Wellogic data does not go back any farther than the 1800's, so this will provide the full range of the Pre-2000's water wells.

23. Check the box marked "Custom Dataset?" to provide if the user is using a custom feature dataset for the borehole data or if it is the standard datasets.
    a. The default is unchecked, meaning that the borehole data has been generated by either the Project Creation tool or the Data Formatting tool.
    b. Checking this box will provide tables to define the necessary fields that are used to project the boreholes on the cross section.
        i. Relate ID Field = The borehole identification field. ***THIS MUST BE THE SAME FOR ALL THREE TABLES.***
        ii. Depth Drilled = The total depth field that the borehole was drilled. This can only accept numeric fields, such as long, float, double, etc.
        iii. Depth to Bedrock = The depth to the first encountered bedrock unit for each borehole. This is only necessary if there is a bedrock surface elevation raster to tie confident bedrock surfaces to known bedrock wells. This must also be a numeric field.
        iv. Construction Date = The final date of construction field for the well. This must be in a date field format.
        v. Depth: Top = The field that contains the top depth of the unit. This must be a numeric field. This applies to both the lithology table and the screens table.
        vi. Depth: Bottom = The field that contains the bottom depth of the unit. This must be a numeric field. This applies to both the lithology table and the screens table.
24. Define the borehole locations feature class. This should be formatted using either the Project Creation tool or the Data Formatting tool.
25. Define the lithology table. As with the borehole locations, this should be formatted using either the Project Creation tool or the Data Formatting tool.
26. Define the screens table. This should be in a similar format as the lithology table.
    ****IMPORTANT NOTE: The borehole locations, lithology table, and screens table must all be separate files for the tool to function correctly. If the information for one or more of the inputs is found within a single file, make additional copies as many times as needed to ensure the files are separated.****
27. Define the vertical exaggeration for the cross-section. The units in the elevation field will be adjusted to reflect the vertical exaggeration for all the features. The default is set to 50x for optimal view.
28. Define the format of the well diagrams and screens. Polylines just allow for color differences where the polygons support color and graphic differences. If the lines are long and contain lots of wells, it is recommended to run the polylines. Polylines are the default option.
29. Define the selection distance for the cross-sections. This gives the script a search radius away from the cross-section lines to look for water wells to include in the cross-section profile. The default is 250 meters.
30. Define the parameters for the profile grid.
    a. The units for the distance and elevation marks will be provided based on what the user has chosen as the elevation units.
        i. If the user chose "feet" as the elevation units, then the user can only select miles and feet for distance units and feet for elevation units.

   ii. If the user chose “meters” as the elevation units, then the user can only select kilometers and meters for distance units and meters for elevation units.
b. The default values are 2,000 feet distance intervals and 50 feet elevation intervals.
c. The script can support running multiple grids if the user defines a second set.

Figure 9: Example cross-section for the sample project from Figure 4. (Credit: Garrett Ringle)



While looking at **Figure 6**, there are a few key notes to keep in mind while creating the "finalized" cross-section documents, which are outlined below:

1. As stated in the Groundwater and Surficial maps, we are presenting the data as it is, not interpreting the data. If the data does not make sense, that is alright. Sometimes the drillers will not put in relevant information, or the geology information is not correct for the area. Therefore, there may be times where the cross-sections need to be revised to exclude points or add points that either help or hurt (depending on the context) the story of the area. The most important thing is that were not data manipulators, but rather data presenters.
2. Depending on the project there may be multiple lines that cross each other at various places. So, keep everything labeled correctly as you build these cross-sections.
3. A few other key notes about the presentation of the cross-sections and what to include:
    a. The legend. Separate out the legends into the geology components, the groundwater surface(s), and the generic surface(s)
        i. Include borehole lithologies and screen information. The default symbology will be the aquifer types of the lithologies, but contains the lithology information as well (sand, gravel, clay, etc.). The lithologies will need to be re-symbolized if you the project does not require aquifer types.
            1. ***NOTE*** If a lithology is observed in one line and is not observed in another, include the unit in the legend anyway. We want all the cross-sections and legends to have the same look from one line to another.
        ii. Include the groundwater surface(s). The style of the surfaces will be already made, but colors will need to be adjusted for each interval.
        iii. Include any other surfaces in the cross-section. This includes the bedrock surface (if there is one) and the topographic surface.
        iv. This is not able to be generated, but for any cross-section indicator markers (i.e. if a road crosses the line, or a river, etc.) it is important to include those as graphics in the legend area as well.
    b. Include the cross-section context map. Only label the line of interest and add a cyan blue thick line behind the cross-section being analyzed. This is a minimalistic context map since it is small, so be sure to not include too much background information to avoid clutter.
    c. Label the axis for distance and elevation. Keep track of what your units are from running the cross-section tool (see running the Cross-Section Tool – All Steps for context).
    d. Include dynamic texts to include the date in which the layout was exported to a PDF.
    e. Make sure to include the title for the cross-section. The main title will be the project name (which is the same as the surficial maps) and the secondary title will be the cross-section name.
    f. Make sure to label the direction of the line on either side of the grid in the layout view. Label both the cardinal direction and the end-point label name (Ex: A (South) → (North) A').
    g. Make sure to include the MGS logo somewhere on the document. It doesn't need to be big, but enough for people to see it.
4. Be prepared to re-run any of the cross-section tools if the information does not seem geologically sound. We want to be clear with our products of the story of the area, which means making modifications when the situation arises.