AUTODESK **UNIVERSITY** 2014

Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM

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CV5674-L

In this class we are going to look at how we can create and model geological data with the Geotechnical Module in AutoCAD Civil 3D software. The class will cover how to import and generate boring holes and surfaces in AutoCAD Civil 3D software, and then we'll go on to cover the essential techniques in modeling the subsurface data. The class will see how to use Feature Lines and Break Lines to mold and manipulate AutoCAD Civil 3D software surfaces to model geotechnical features. We will then learn how to convert the AutoCAD Civil 3D surfaces into AutoCAD software 3D solids ready for use in other software systems like Revit software and InfraWorks software. This class is designed to assist you in your understanding of the techniques used to model and visualize substrata in order to better understand and present information

Learning Objectives

At the end of this class, you will be able to:

- Learn how to import and create boring holes and surfaces
- Understand the principles of modeling geology surfaces
- Comprehend the use and role of Feature Lines and Break Lines in modeling geology
- Learn how to convert the subsurface data in AutoCAD software 3D solids ready for export

About the Speaker

Gary Morin, originally trained as a civil engineer and has over 30 years experience working in the production and support of a range of geographic information systems and CAD software systems. As the technical director of Keynetix, which he co-founded in 2000 to specialize in geotechnical data management software, Gary heads up the geotechnical Building Information Modeling (BIM) development and is responsible for the design and support services for a range of products designed to manage geotechnical data in the BIM process, including the HoleBASE SI extension, the Geotechnical Module from Autodesk, and advance HoleBASE SI extension for AutoCAD Civil 3D software.

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Rules

Always open drawings from within AutoCAD Civil 3D, DO NOT open drawings from File Explorer, as the Geotechnical Module will not start up correctly.

Learn How to Import and Create Boring Holes and Surfaces

In this session we are going to look at the CSV format for importing boring locations and geology strata.

To enable this it is essential that the two files required are in the correct format and have the correct data.

File format

The file should be true CSV (Comma separated Values), the Geotechnical Module does allow different delimiters, but this needs to be specified within the **Import** dialog.

Delimiters supported:

- Comma (,)
- Semicolon (;)
- Colon (:)
- Vertical Bar (|)
- Tab

In the UK and USA we use a dot (.) to represent the decimal point, if in your language you use a different character, ensure you have the correct operating system language specified for the corresponding point character, otherwise errors will occur.

Text does not need to be quoted.

The two files can be of any name, but should have the .CSV extension.

The two files contain:

- Boring Locations
- Boring Strata

Boring Locations

This file contains the information relating to the location of each of the boring.

The file should include a row for each boring location, containing the following information. The file must use the precise column headings specified.

Column Heading	Description	Mandatory	Example
LocationID	Location unique ID	Yes	BH0001
LocationType	Type of activity at location	Yes	RC
Easting	Easting or longitude of the location of hole	Yes	123456.4
Northing	Northing or latitude of the location	Yes	232467.3
GroundLevel	Ground level relative to datum of location or start of traverse	Yes	35.43
FinalDepth	Final Depth		8.37
Orientation	Orientation of hole (degrees Clockwise from north)		87
Inclination	Inclination of hole (measured positively down from horizontal in deg)		56.3

Example location file:

LocationID,LocationType,Easting,Northing,Ground Level,FinalDepth,Orientation,Inclination
BH13,RC,348810.69,312280.95,57.33,,,
BH9,RC,348801.13,312224.73,51.98,,,
BH8,RC,348776.3,312250.22,53.06,,,
BH11,RC,348749.43,312520.97,62.99,,,
BH1,RC,348743.68,312482.79,61.64,,,
BH19,RC,348740.94,312224.17,50.68,,,
BH3,RC,348731.53,312327.8,57.33,,,

Boring Strata

The Boring Strata file contains all of the strata readings from down individual borings.

Column Heading	Description	Mandatory	Example
LocationID	Location identifier	Yes	BH001
DepthTop	Depth to the TOP of stratum	Yes	7.43
DepthBase	Depth to the BASE of description	Yes	8.12
GeologyCode	Geology code	At least one of these fields must exist	LC
GeologyCode2	Second geology code		SAND
LegCode	Legend code		102

The strata banded in the geotechnical module is made on one of the three columns GeologyCode, GeologyCode2 or LegCode. The strata names contained within the three columns should be consistent throughout the project, but the actual values are entirely up to you, although if you have render materials based on strata name they should match your materials.

However it is best to use GeologyCode column as the default strata as this is used to segment/band the 3D boreholes.

Example

LocationID,DepthTop,DepthBase,LegCode,GeologyCode,GeologyCode2
BH1,0,0.5,101,TOPSOIL,
BH1,0.5,1.5,102,MADE,
BH1,1.5,3,803,SANDSTONE,
BH1,3,4.5,801,SANDSTONE,
BH1,4.5,8,803,SANDSTONE,
BH1,8,12,803,SANDSTONE,
BH10,0,0.6,101,TOPSOIL,
BH10,0.6,1.4,102,MADE,
BH10,1.4,3.1,201,CLAY,
BH10,3.1,5.8,501,GRAVEL,
BH10,5.8,8.6,803,SANDSTONE,

Data entry rules for strata

1. Each record must contain a valid location ID
2. Depth top and depth base must be specified for each record.
3. The strata bands should not overlap down an individual hole

4. Use consistent stratum names.

Exercise 1: Creating and validating the CSV files

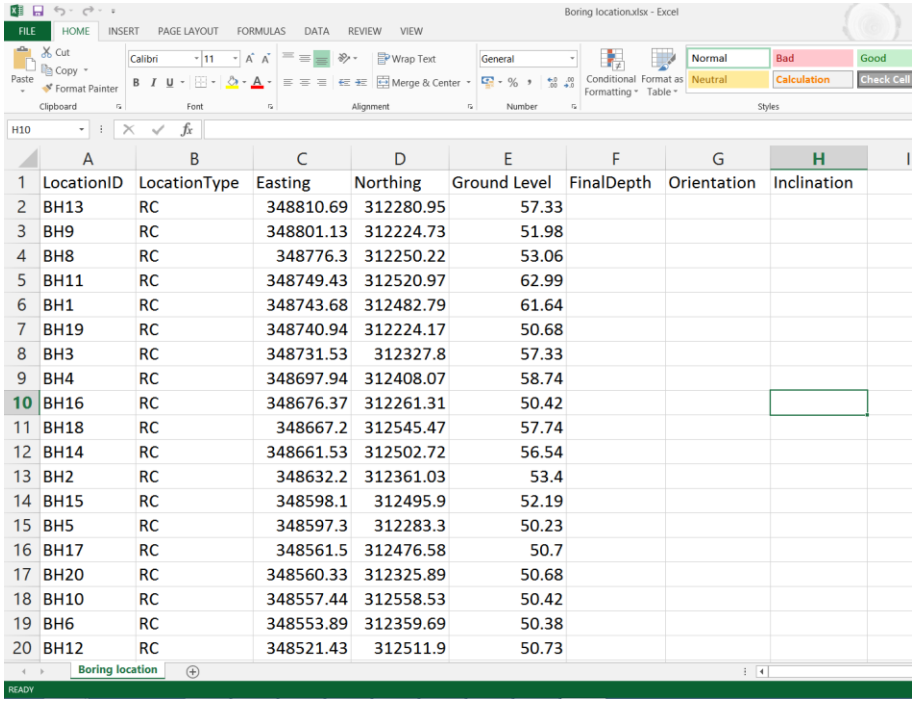
In this exercise we are going to create the two CSV files from existing Microsoft Excel workbooks and validate them using notepad.

1. Navigate to folder:

   C:\datasets\Hands–On–Labs\CV5674-L Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM

2. Double click on the *boring locations.xlsx* file

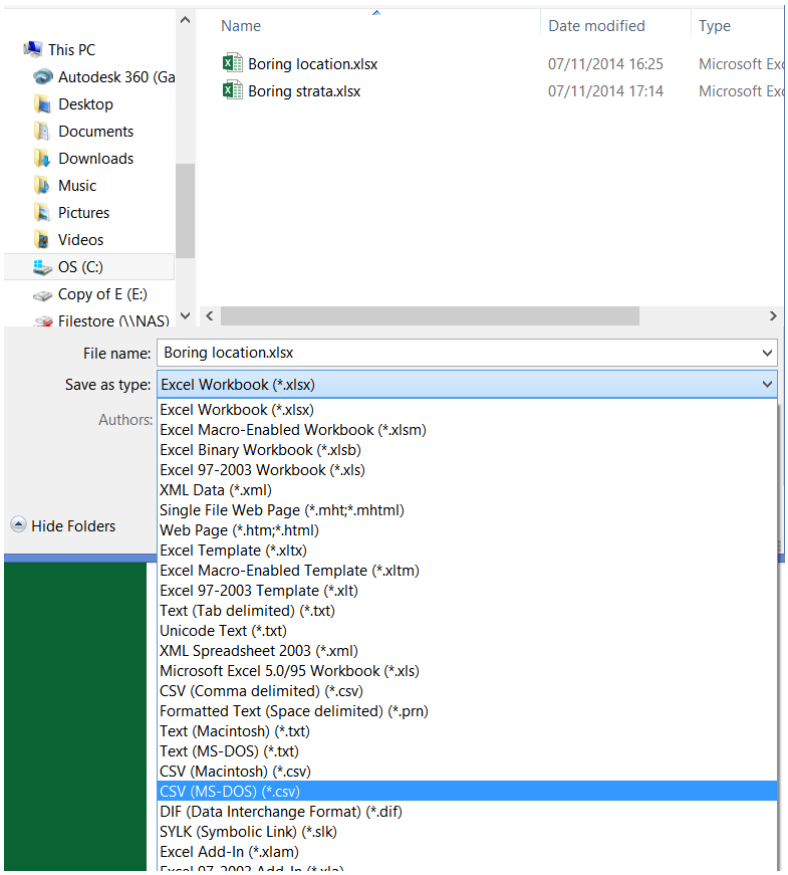
   The file will open in Microsoft Excel



	A	B	C	D	E	F	G	H
1	LocationID	LocationType	Easting	Northing	Ground Level	FinalDepth	Orientation	Inclination
2	BH13	RC	348810.69	312280.95	57.33			
3	BH9	RC	348801.13	312224.73	51.98			
4	BH8	RC	348776.3	312250.22	53.06			
5	BH11	RC	348749.43	312520.97	62.99			
6	BH1	RC	348743.68	312482.79	61.64			
7	BH19	RC	348740.94	312224.17	50.68			
8	BH3	RC	348731.53	312327.8	57.33			
9	BH4	RC	348697.94	312408.07	58.74			
10	BH16	RC	348676.37	312261.31	50.42			
11	BH18	RC	348667.2	312545.47	57.74			
12	BH14	RC	348661.53	312502.72	56.54			
13	BH2	RC	348632.2	312361.03	53.4			
14	BH15	RC	348598.1	312495.9	52.19			
15	BH5	RC	348597.3	312283.3	50.23			
16	BH17	RC	348561.5	312476.58	50.7			
17	BH20	RC	348560.33	312325.89	50.68			
18	BH10	RC	348557.44	312558.53	50.42			
19	BH6	RC	348553.89	312359.69	50.38			
20	BH12	RC	348521.43	312511.9	50.73			

3. From the **File** tab select **Save As**

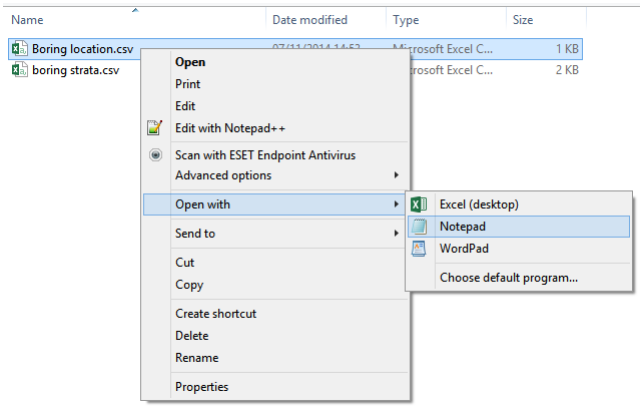
4. From the **Save as type** list pick CSV (MS-DOS) (*.csv)

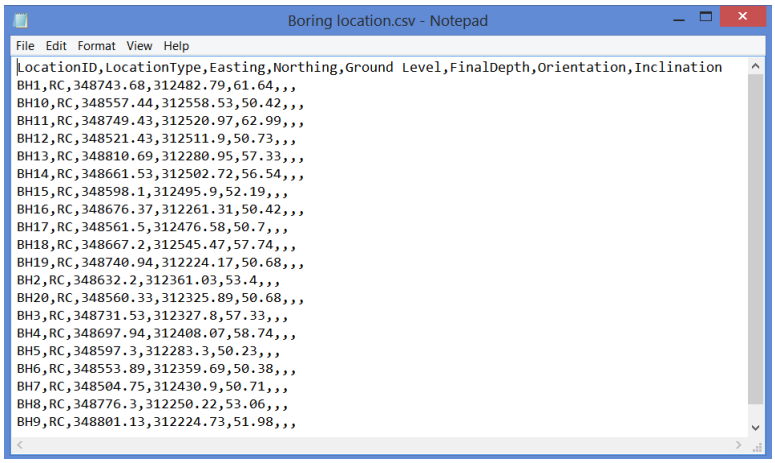


5. Press **Save** to save the CSV file

6. From within the folder **Right click** on the boring location.csv file and select **Notepad** from the **Open with** command.

7. From within notepad check that the file format is correct and that it has the correct comma (,) delimiters





8. Once the file has been validated close Notepad.

9. Repeat steps 2 – 8 for Boring Strata.xlsx

You should now have two files in the correct format ready for import into the Geotechnical Module.

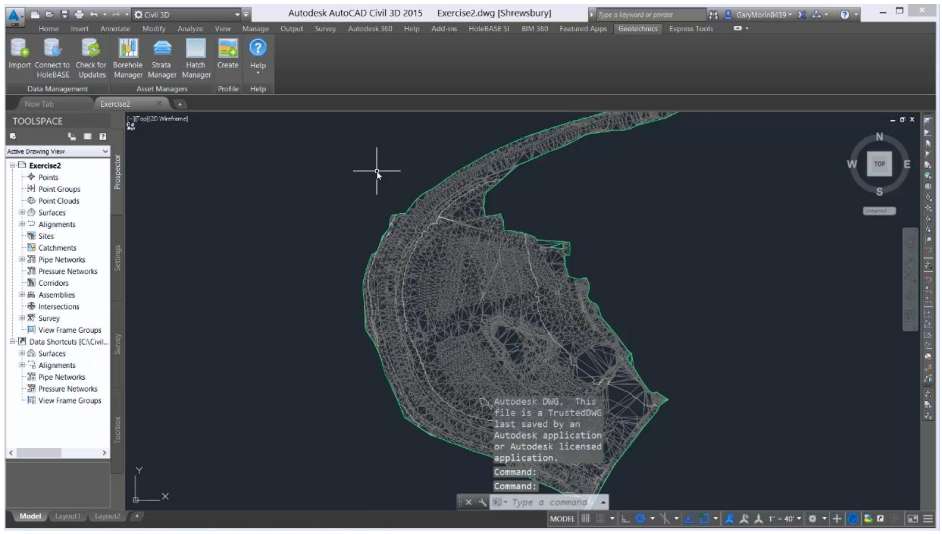
Exercise 2: Importing CSV files into the Geotechnical Module

In this exercise we are going to take the two CSV files just created and import them into the Geotechnical Module to create the 3D boreholes in AutoCAD Civil 3D.

1. Run AutoCAD Civil 3D 2015

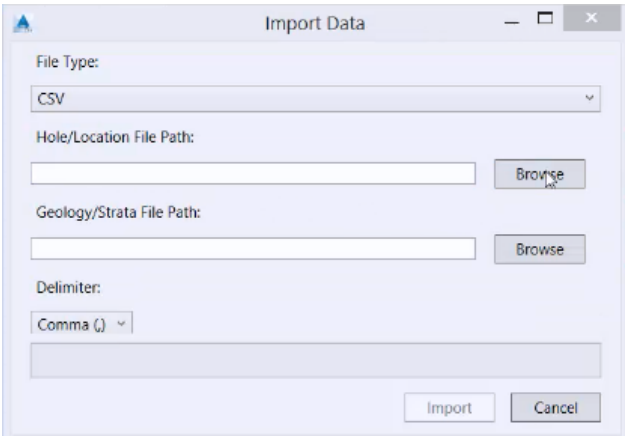
2. Open ***exercise 2.dwg*** in the folder:

   C:\Datasets\Hands–On–Labs\CV5674-L Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM



3. From the Geotechnical tab **click *Import.***

4. The Geotechnical Module **Import** dialog will be displayed.



5. From the **File Type** drop-down pick *CSV*

6. For the **Hole/Location File Path**

   Click the **Browse** button and select the ***Boring location.csv*** file, in folder C:\Datasets\Hands–On–Labs\CV5674-L Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM

   Press **Open**

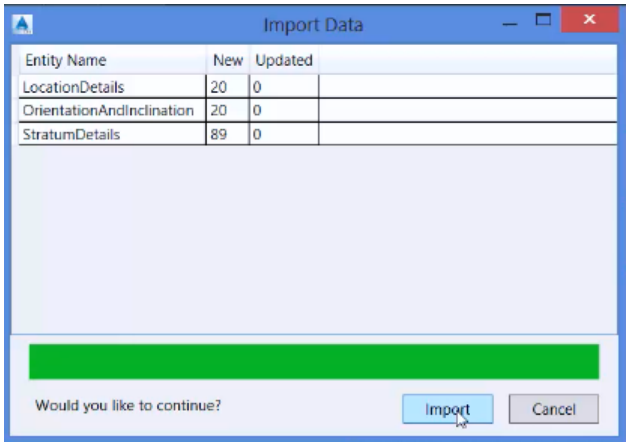
7. For the **Geology/Strata File Path**

   Click the **Browse** button and select the ***Boring strata csv*** file, in folder C:\Datasets\Hands–On–Labs\CV5674-L Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM

   Press **Open**

8. From the **Delimiter** drop-down ensure ***Comma (,)*** is selected

9. Press **Import** to start the process.



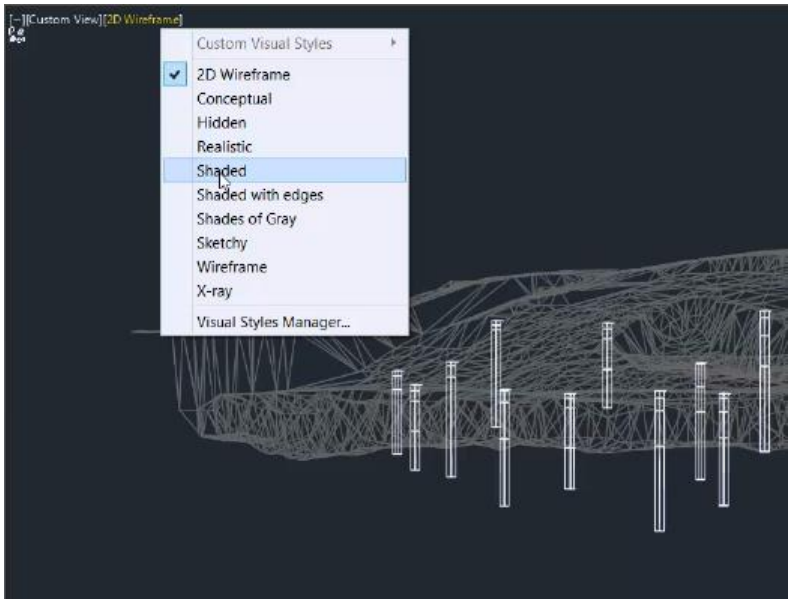
The Import dialog will be updated to display the number of locations and strata details being imported.

10. Press **Import** to continue.

The import process will be completed with the display of the boring locations in plan.

11. Press **Shift** and **Wheel** button to perform a constrained orbit of the 3D model.

12. Click ***2D Wireframe*** and change the visual style to ***Shaded***



A shaded view is created showing the 3D boreholes in contexts with the survey ground model.

Understand the Principles of Modelling Geology Surfaces

In this section we will look at some of the basic fundamentals in modeling geology with the Geotechnical Module.

It is essential you understand your data and especially the order of the strata.

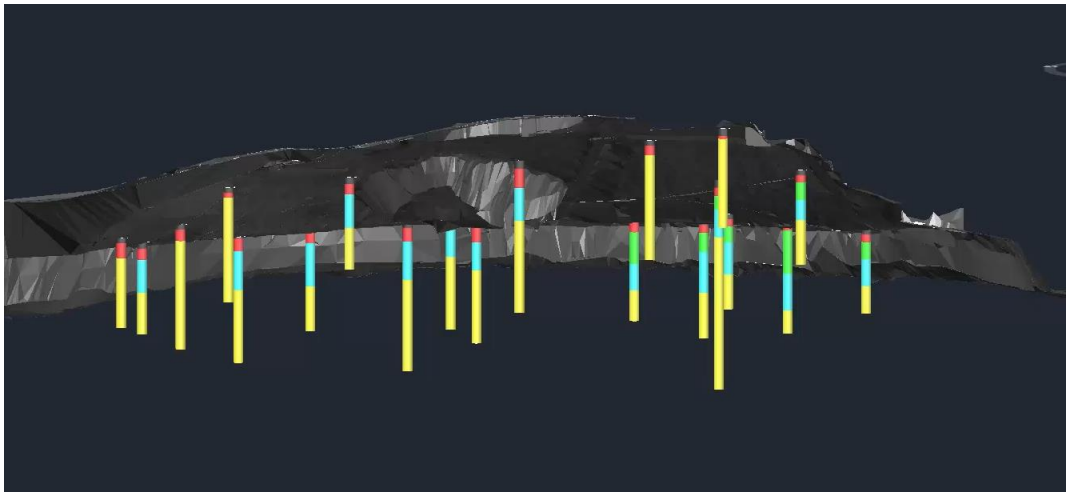
- Take time to review the geology in the data.
    - Look for where geologies appear and don't appear
    - Look for the extents of a particular geology
    - Look for anomalies in the data
- Use the 3D Boreholes to look at where the different geology appears around the site.
- Use the Plan log strips as an aid to the extents of geology when working in plan.
- Use profiles to highlight problems and discrepancies in the model.

Exercise 3: Using 3D Boreholes and Plan Log Strips

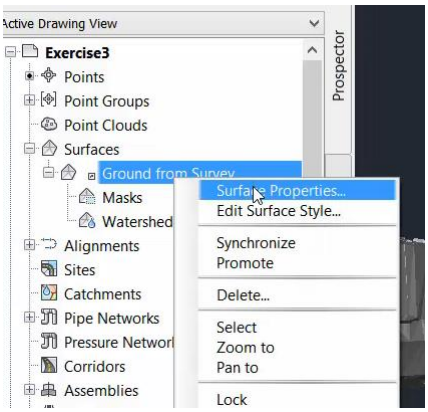
In this exercise we are going to review the extents of the imported geological data and then create log strips on plan for reference.

1. Open ***exercise 3.dwg*** in the folder:

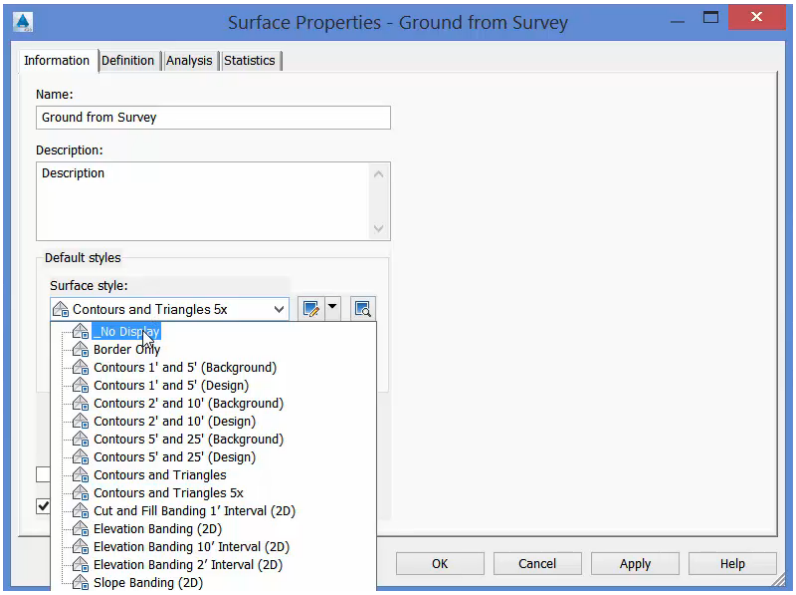
   C:\Datasets\Hands–On–Labs\CV5674-L Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM



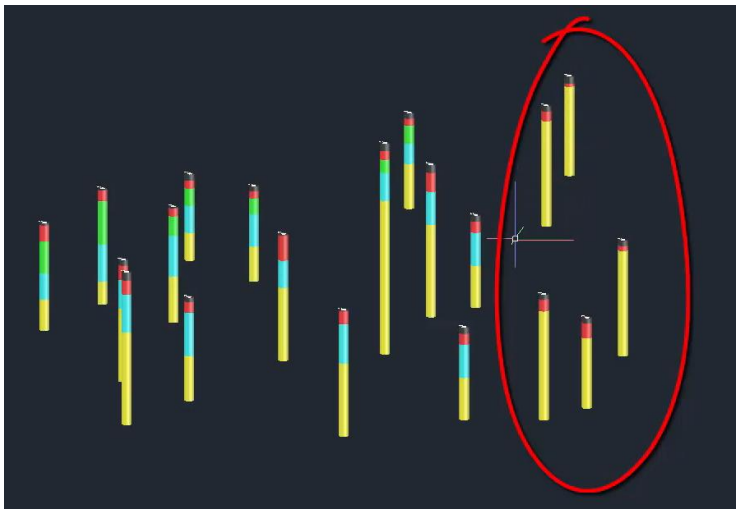
2. Now hide the ***Ground from Survey*** surface. From the **Tool Space Prospector** right click on the Ground from Survey surface and pick **Surface Properties…**



3. In the Surface Properties dialog box, select ***_No Display*** from the **Surface Style** list box and press okay.

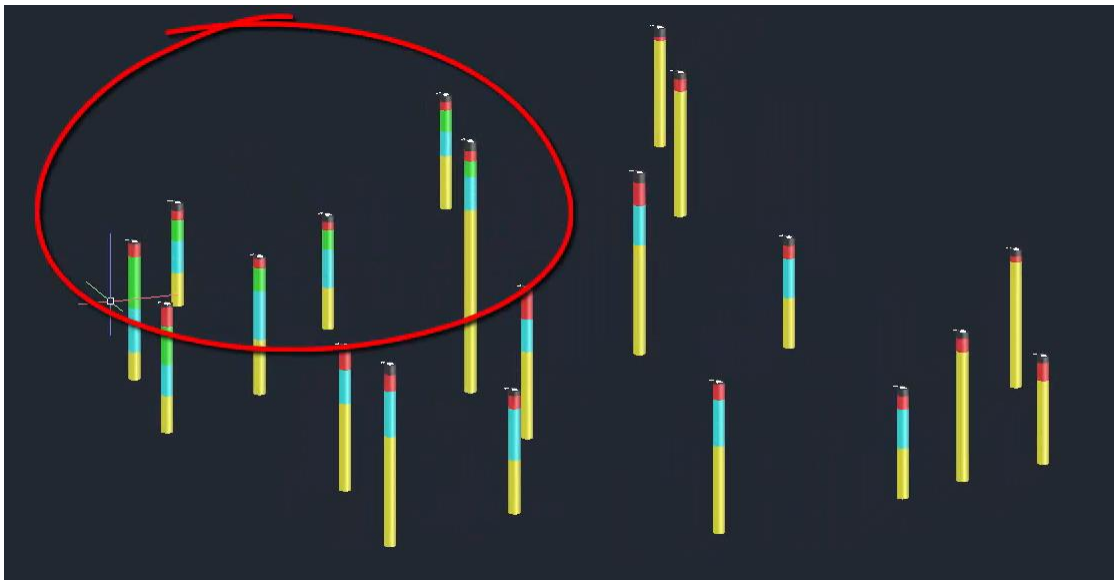


4. Explore the 3D data, use **shift and middle button** to do a constrained orbit to better understand the position and layout of the boring information.

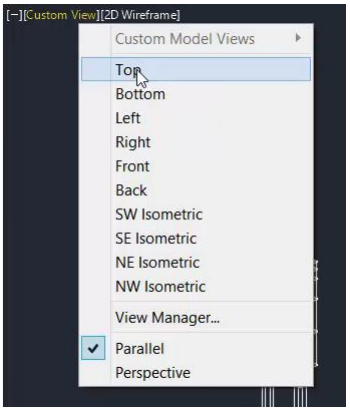


Note: the area circled, there is no cyan indicating the lack of gravel in this area.

In the area to the top left there are some green segments indicating the extents of clay, but they do not appear in any other part of the site.

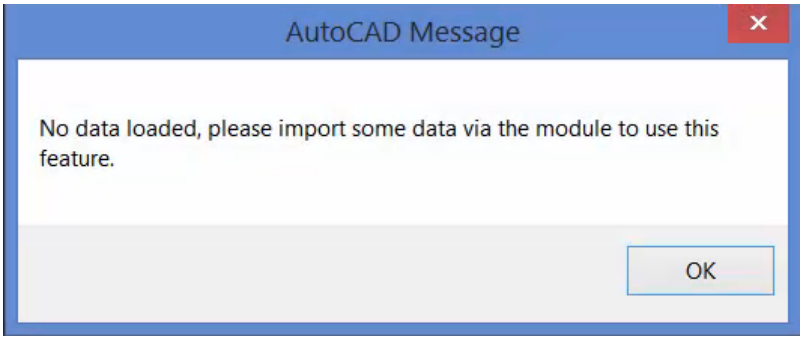


5. Revert back to **Top View** and change the **Visual Style** back to **2D wireframe**.



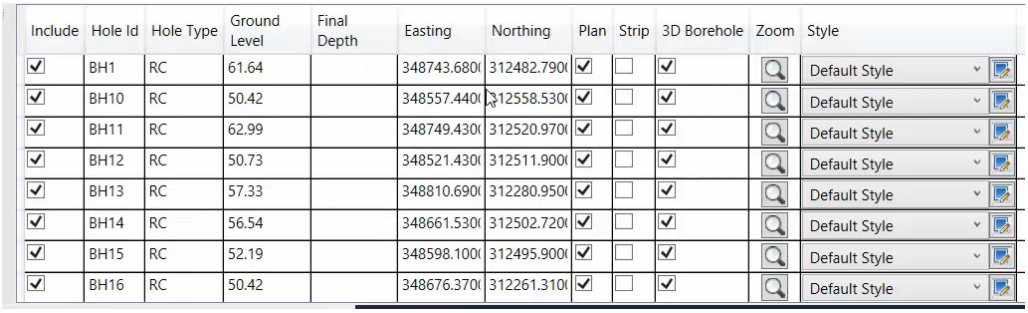
6. From the **Geotechnical** tab pick **Borehole Manager** to display the dialog.

Note: if the following message is displayed:



Click **Okay**, then click **Check for Updates** in the **Geotechnical** tab, click **Okay** and then try the **Borehole Manager** again.

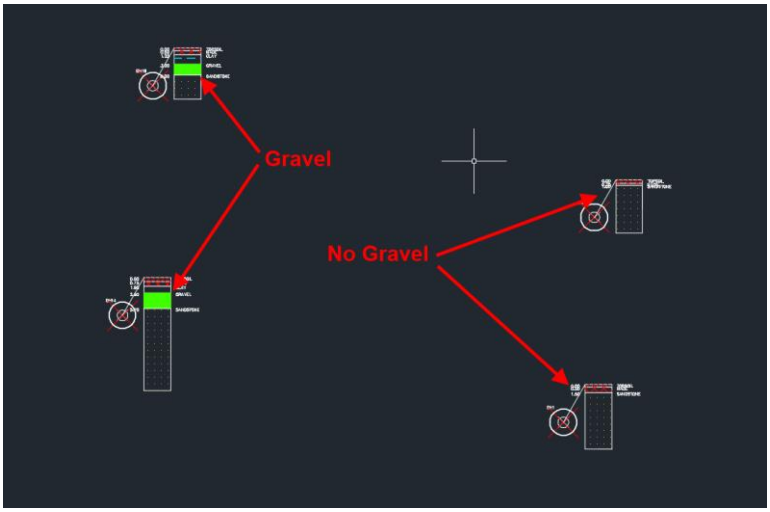
7. The **Borehole Manager** displays all boring locations in the import and gives control on what elements are displayed.



Include	Hole Id	Hole Type	Ground Level	Final Depth	Easting	Northing	Plan	Strip	3D Borehole	Zoom	Style
☑	BH1	RC	61.64		348743.680(	312482.790(	☑	☐	☑		Default Style
☑	BH10	RC	50.42		348557.440(	312558.530(	☑	☐	☑		Default Style
☑	BH11	RC	62.99		348749.430(	312520.970(	☑	☐	☑		Default Style
☑	BH12	RC	50.73		348521.430(	312511.900(	☑	☐	☑		Default Style
☑	BH13	RC	57.33		348810.690(	312280.950(	☑	☐	☑		Default Style
☑	BH14	RC	56.54		348661.530(	312502.720(	☑	☐	☑		Default Style
☑	BH15	RC	52.19		348598.100(	312495.900(	☑	☐	☑		Default Style
☑	BH16	RC	50.42		348676.370(	312261.310(	☑	☐	☑		Default Style

8. Toggle on the **Strip** Check box for borings BH1, BH10, BH14 and BH18.

   Log strips are created and displayed against each of the corresponding boring locations. These can be a great aid in understanding location of geology and the order of the strata. Notice the logs on the left show gravel but the ones on the right do not.



Exercise 4: Using Geotechnical Profiles to Check Data

In this exercise we will look at another technique for understanding geotechnical data in AutoCAD Civil 3D. The Geotechnical Module allows the quick creation of geotechnical profiles which include both log strips and hatched stratum bands. These are ideal for giving a quick visual indication of the location of geology, they also work as an aid in displaying updates to the geological model as it is altered.

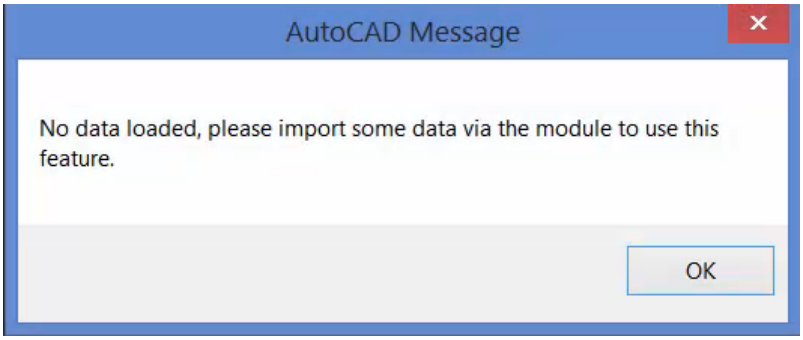
However it should be pointed out when creating geotechnical profiles on the initial un-interpreted data many inaccuracies are likely. It is through the modeling process, using feature lines and break lines we can attempt to do a more accurate model of the data and improve the look of the geotechnical profile.

1. Open ***exercise 4.dwg*** in the folder:

   C:\Datasets\Hands–On–Labs\CV5674-L Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM

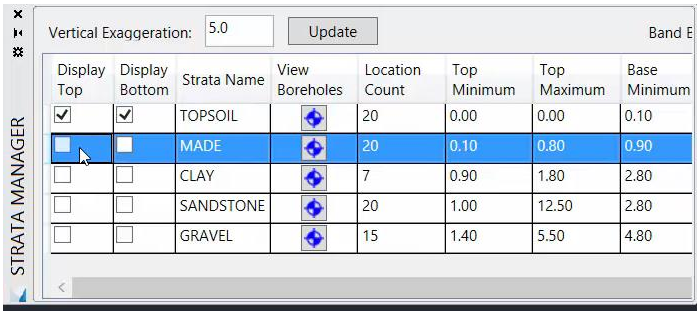
2. From the **Geotechnical** tab click **Strata Manager**

   Note: If the following message is displayed:

   Click **Okay**, then click **Check for Updates** in the **Geotechnical** tab, click **Okay** and then try the **Strata Manager** again.

3. The Strata Manager dialog is displayed, this lists a row for each Stratum in the imported data.

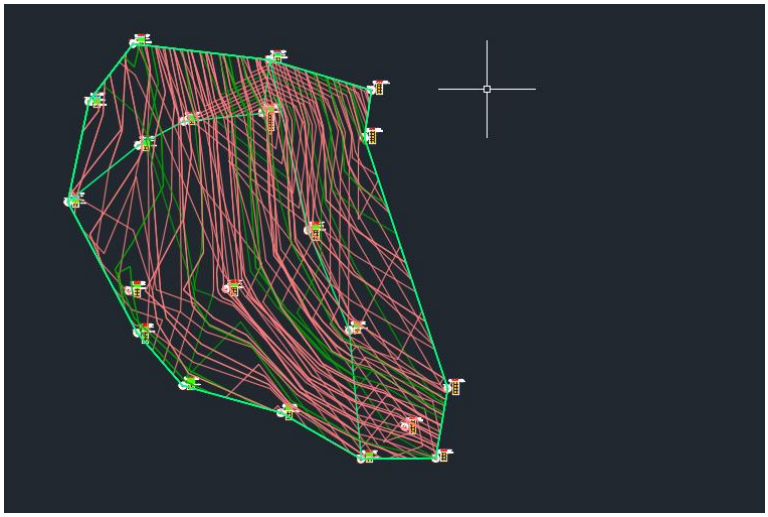
   

   Toggling on the **Display Top** and **Display Bottom** checkboxes will create and display AutoCAD Civil 3D surfaces for the top and base of the stratum. When toggled off the surface will be hidden but

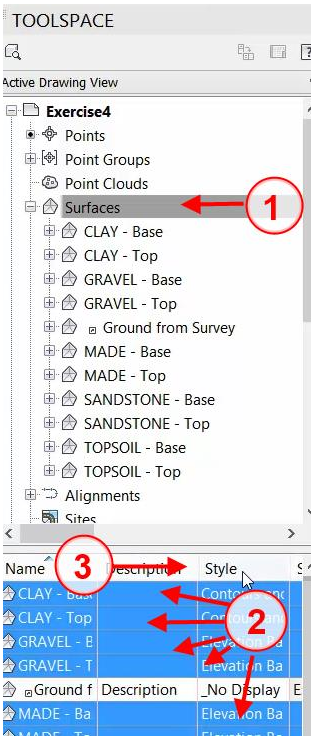
not deleted, toggling on the surface will just redisplay it. This way edits and modifications to the surface are maintained.

Note: the surfaces created are not interpreted surfaces, they are just triangulation, joining the dots between identical geology codes in each boring.

4. Toggle on **all** geology surfaces in the **Strata Manager.**



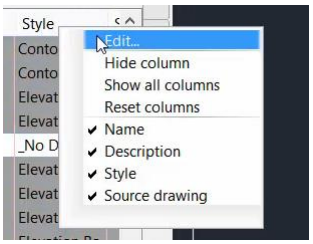
5. You may find you will need to set the surface styles of the newly created surfaces, if so follow these steps:



1. In the Tool Space Prospector click ***Surfaces.***

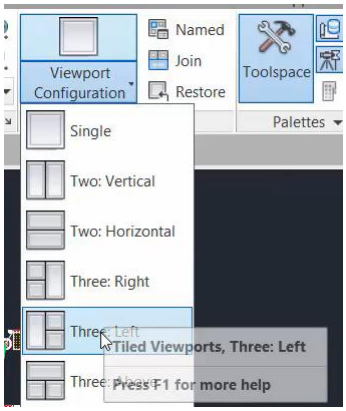
2. In the list of surfaces, select all stratum surfaces, by Pressing **Ctrl** and **left** clicking all the required surfaces.

3. Right click on the Style column heading and click **Edit**…

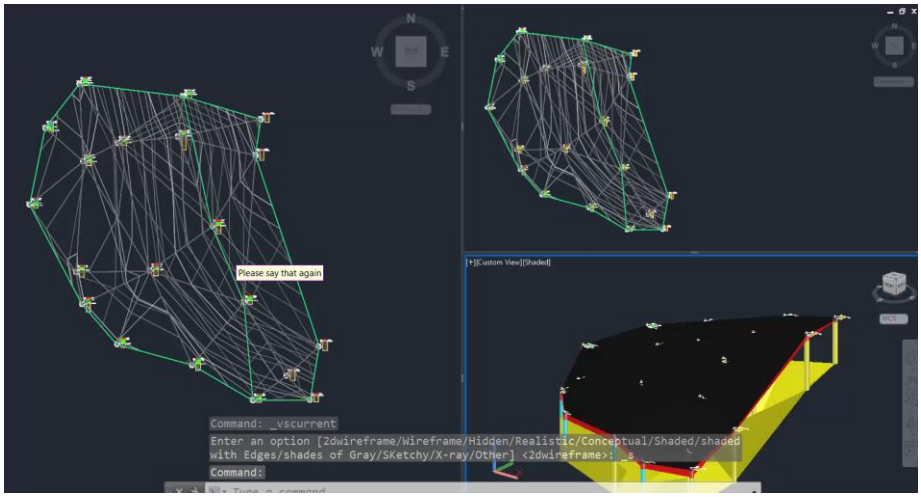


From the style list select ***Contours and Triangles 5x*** and press **Okay.**

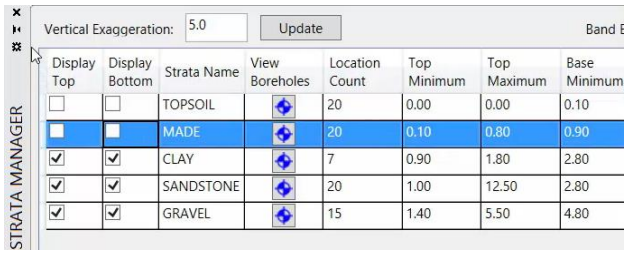
6. From the **View** Tab click **Viewport Configuration** and select **Three: Left** viewport screen.



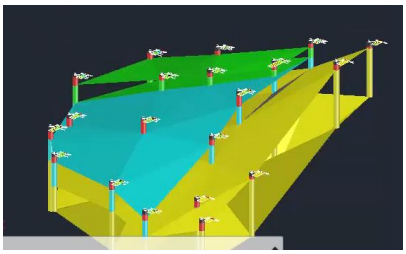
7. Then arrange the views as below:



8. From the **Strata Manager**, toggle off the display of the **Topsoil top** and **bottom** surfaces and also repeat for **Made.** This will give a better view of the underlying strata.



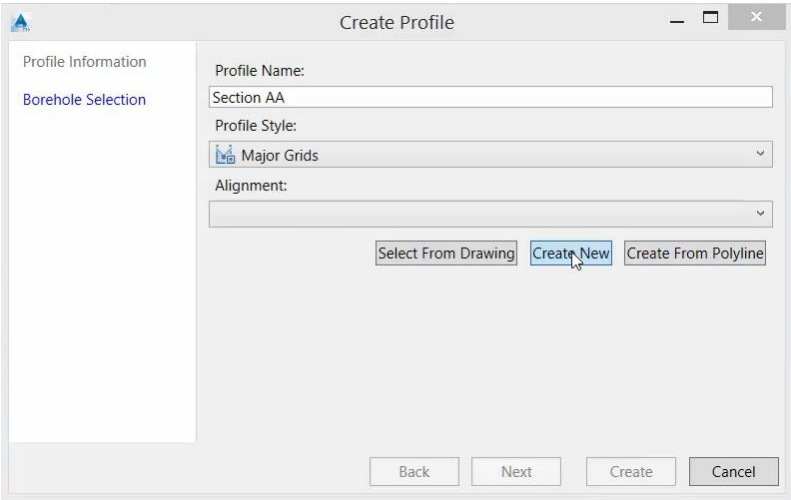
Display Top	Display Bottom	Strata Name	View Boreholes	Location Count	Top Minimum	Top Maximum	Base Minimum
☐	☐	TOPSOIL		20	0.00	0.00	0.10
☐	☐	MADE		20	0.10	0.80	0.90
☑	☑	CLAY		7	0.90	1.80	2.80
☑	☑	SANDSTONE		20	1.00	12.50	2.80
☑	☑	GRAVEL		15	1.40	5.50	4.80



9. From the Geotechnical tab click **Create,** the create Geotechnical Profile dialog will be displayed.

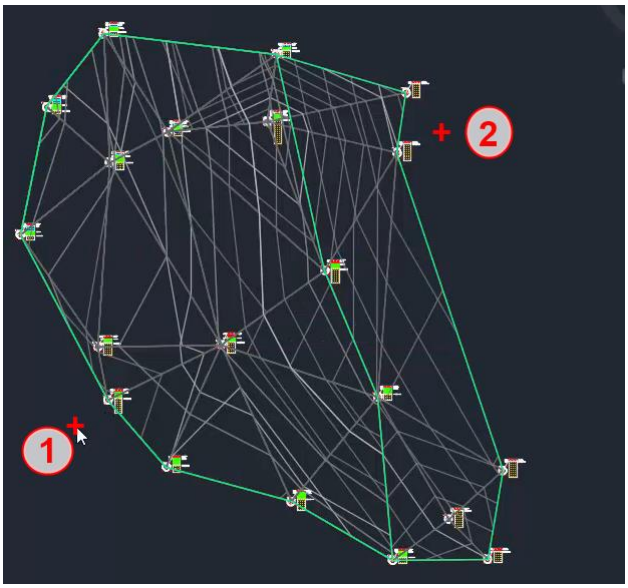
10. Enter ***Section AA*** for the Profile Name.

11. From the **Profile Style** list ***Select Major Grids***.

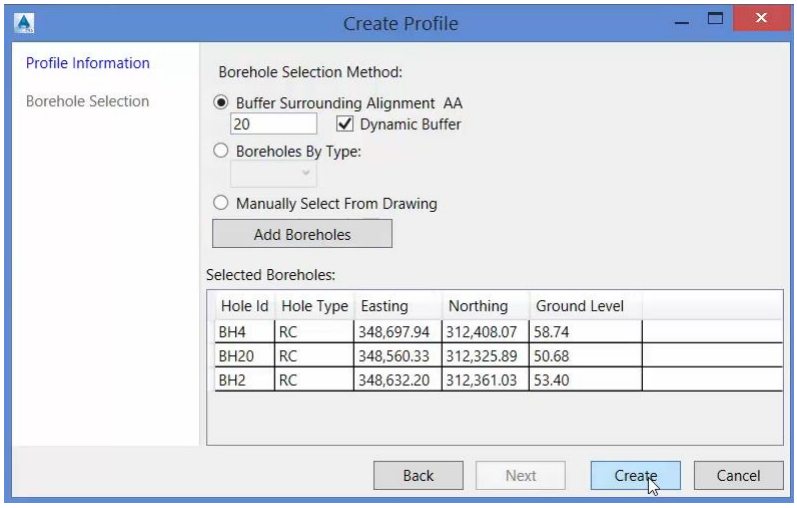


12. Click **Create New** to create a new alignment for the geotechnical profile.

    Click two points as indicated below and enter ***AA*** as the alignment name at the command prompt.



13. Now click **Next,** to display the next screen of the **Create Geotechnical Profile** command.



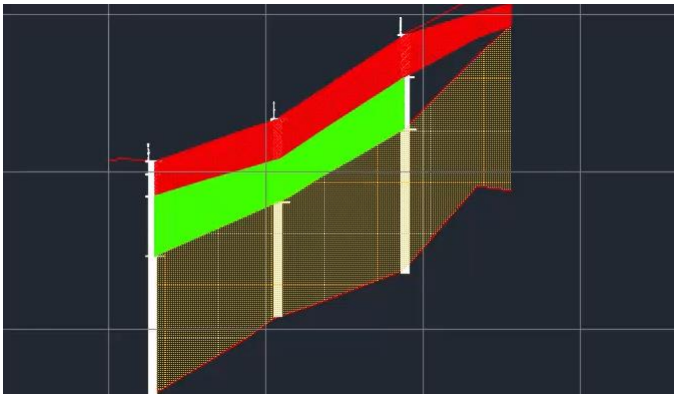
14. Enter 20 for the **Buffer Surrounding Alignment**, any boring within 20 AutoCAD units of the alignment line will be selected when **Add Boreholes** is pressed

15. Ensure **Dynamic Buffer** is checked on, if the alignment is moved any borings within the specified buffer will be projected onto the profile.

16. Click **Add Boreholes**, to list the matching boring locations in the Selected Boreholes grid below.

17. Press **Create**, in the top right viewport click a point to create the geotechnical profile.

    The profile will be created, the strata will be hatched and any matching log strips will be projected onto the profile.

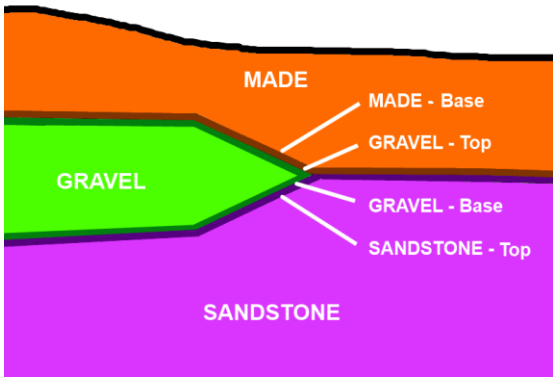


18. The alignment grips can now be used to drag-and-drop to reposition the profile, do this a number of times to get a feel of the current geology.

Comprehend the Use and Role of Feature Lines and Break Lines in Modelling Geology

In this section we are going to look at the role of feature lines and break lines to model geology data. From the available tools in AutoCAD Civil 3D the ability to create 3D feature lines representing a precise location the geology surfaces should pass through is an excellent tool in modelling the data.

There are however, there are a number of considerations.

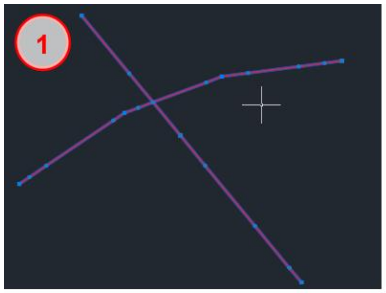


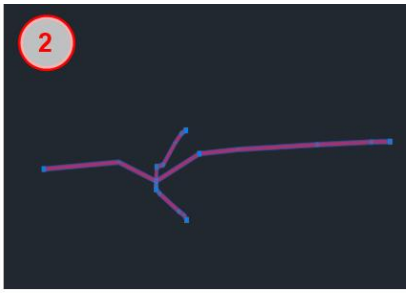
- At any one location there are normally up to 4 surfaces that need to be modified, for instance when modelling the extents of geology, in this example of the gravel extents, **four** surfaces will pass through the same point/line.

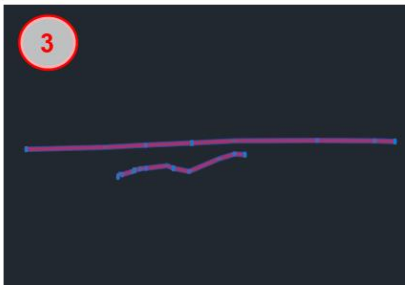
- The feature lines need to have an appropriate elevation, often this is done by moving the feature line to the elevation given by an existing surface, in this example we will use the Sandstone top. Often there is not a suitable site surface to be used, in this case the elevation has to be changed by eye.

- Feature lines can clash, if a feature line overlays another feature line in plan, they will interact with each other and will change elevation, see image 2. Notice how the feature line running from left to right is snapped down onto the other feature line.

  Placing the feature lines on different sites will prevent this from happening, see image 3.







Exercise 5: Using Feature Lines and Break Lines to Model Geology

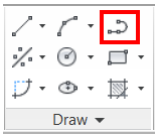
In this exercise we will model the extents of the gravel stratum.

The outline steps are:

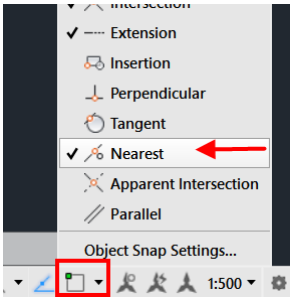
- Draw a polyline representing the extents of the gravel.
- Convert the polyline into a feature line using the Sandstone - top as the elevation
- Add the feature line as break lines to the four surfaces
    - Sandstone - Top
    - Gravel – Base
    - Gravel – Top
    - Made – Base

1. Open ***exercise 5.dwg*** in the folder:

   C:\Datasets\Hands–On–Labs\CV5674-L Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM

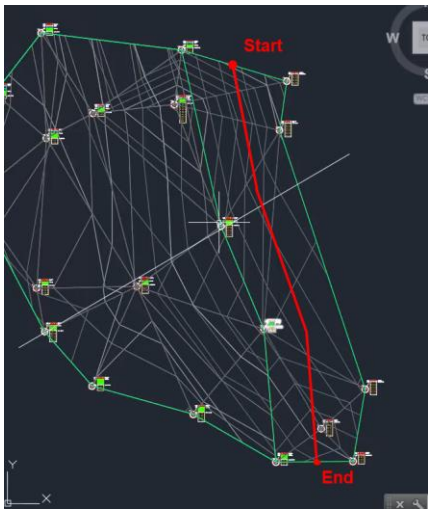
2. From the **Home** tab, pick 

to draw a polyline.

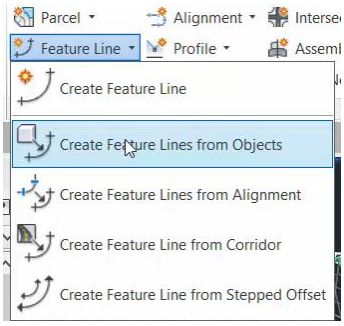


3. It is important that the polyline is snapped to the correct location, ensure the Object Snap Nearest is enabled.

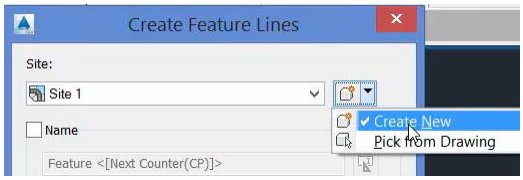
4. Draw the polyline representing the extents of the gravel geology, use nearest snap to the boundary of the surfaces as indicated beside:



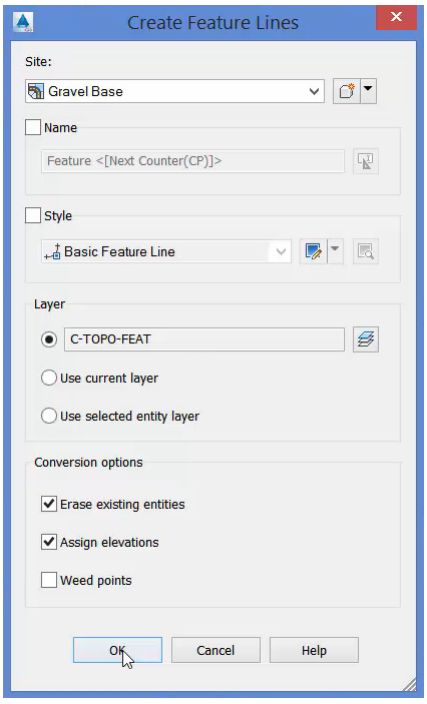
5. From the **Home** tab feature line list pick **Create Feature Line from Objects** and select the polyline just drawn.



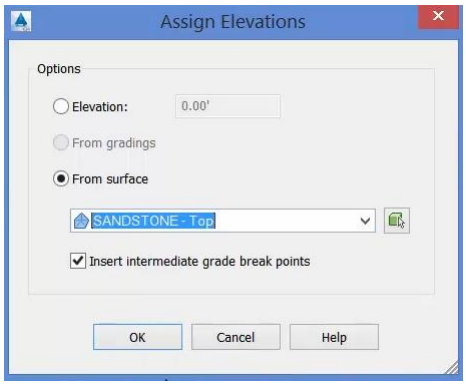
6. In the **Feature Line** dialog box pick **Create New Site.**



7. In the new dialog enter the site name of ***Gravel Base*** and press **Okay** to return to the **Feature Line** dialog.
8. Toggle on **Erase existing entities.**
9. Toggle on **Assign elevation.**
10. Press **Okay** to continue.



11. In the **Assign Elevation** dialog, ensure **From Surface** is selected and from the drop-down list select ***SANDSTONE – Top.***

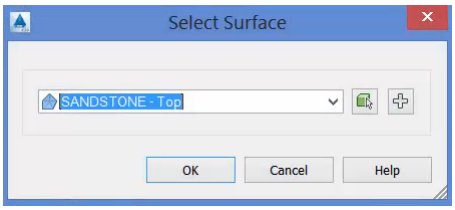


12. Press **Okay** to continue.

    The polyline will be converted into a feature line using the elevation from the SANDSTONE – Top surface.

13. Select the newly created feature line. The ribbon should be updated to display the Feature Line tab.

14. From the **Feature Line** tab select **Add to Surface as Breakline**, in the dialog select surface **SANDSTONE – Top .**



15. Press **Okay** to continue.

16. And press **Okay** again.

    The Sandstone – top surface will be updated incorporating the feature line as a breakline. The surface will now follow the line.

17. Whilst keeping the feature line selected follow steps 14 to 16 for the following three surfaces:

    - Gravel – Base
    - Gravel – Top
    - Made – Base

    The feature line is incorporated as a breakline in all four surfaces, modelling the extents of the gravel.

Because a feature line has been used to model the geology, if the feature line is modified, the elevation changed or the geometry updated, all corresponding surfaces will also be updated reflecting the change. (Note: for modelling geology it is best to have surface **Rebuild Automatically** enabled).

18. In the top right viewport modify the alignment position to check if the gravel has been modelled correctly. Also orbit the model to confirm changes are correct.

Exercise 5a (optional)

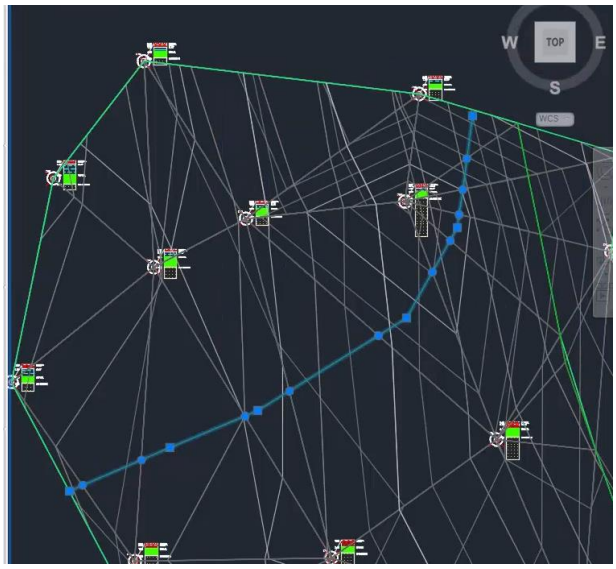
In this exercise we are going to repeat the steps above, but this time to model the Clay.

The process is the same as before, but the stratum surfaces selected will be different.

The outline steps are:

- Draw a polyline representing the extents of the play.
- Convert the polyline into a feature line using the Gravel - top as the elevation
- Add the feature line as break lines to the four surfaces
    - Made - Base
    - Clay - Top
    - Clay – Base
    - Gravel – Top

1. Repeat steps 4 to 18 above using the information below.
2. For Step 4 above, draw a polyline similar to the one to the right.
3. For Step 7 above, specify ***Clay -Base*** as the site name.
4. For Step 11 above, use ***Gravel – Top.***
5. For Steps 14 -17 above repeat for:
    - Gravel – Top
    - Clay – Base
    - Clay – Top
    - Made – Base



The clay geology should now be modeled.

Learn how to convert the subsurface data in AutoCAD software 3D solids ready for export

In this last section we will look at techniques to convert the top and base surfaces created by the Geotechnical Module into solids that can be exported and used by other systems.

The method uses standard AutoCAD 3D commands.

Outline process:

1. Extract triangles from top surface.
2. Extruded all triangles in the same direction.
3. Union all newly created solids into one single solid.
4. Repeat the above three steps for the base surface, triangles must be extruded in the same direction as above.
5. Use the subtraction command and subtract the base solid from the top solid.
6. The result is an Autocad solid representing the stratum.

For the process to work well the top and base surfaces should have identical boundaries in plan, i.e. one surface should not overhang the other.

Exercise 6: Creating a AutoCAD solid

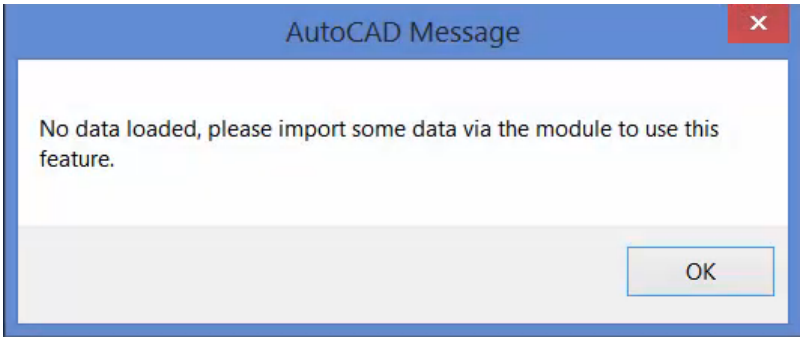
The drawing has been cleaned up so only the Gravel top and base surfaces are displayed.

1. Open ***exercise 6.dwg*** in the folder:

   C:\Datasets\Hands–On–Labs\CV5674-L Modeling and Visualizing Geology Subsurfaces with AutoCAD Civil 3D Ready for BIM

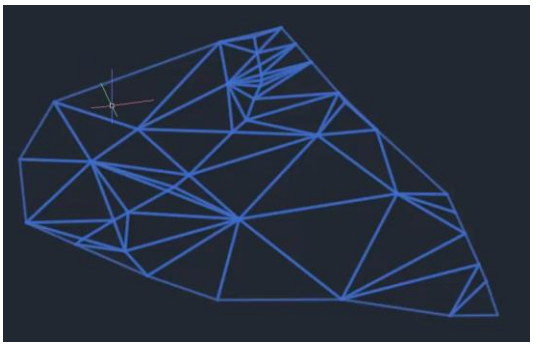
2. From the Geotechnical tab click **Strata Manager**

Note: If the following message is displayed:

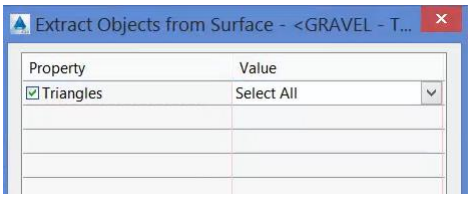


Click **Okay**, then click **Check for Updates** in the **Geotechnical** tab, click **Okay** and then try the **Strata Manager** again.

3. In the **Stratum Manager** toggle off the Gravel bottom surface, so only the top surface is displayed.

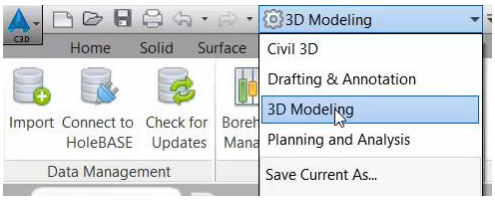


4. From the model space select the surface, the **Surface** context Tab should be displayed for the ***Gravel – Top*** surface.
5. Click **Extract Objects** from the **Surface** tab.
6. In the **Extract Objects from Surface** dialog ensure triangles is toggled on.
7. Press **Okay** to continue.



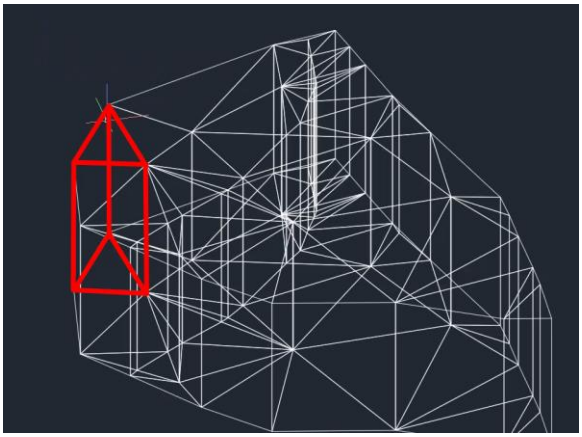
   Individual 3D triangular faces will be created for the surface.

8. Click **Strata Manager** and toggle off the Gravel Top surface so only the newly created triangles are displayed.
9. Now change the workspace to the 3D Modeling, by selecting **3D Modeling** from the workspace list at the top of the page.



10. From the **Home** tab click **Extrude.**
11. Select all of the triangular faces
12. In the command line type: ***MO*** and ensure Solid mode is set
13. In the command line type: ***D*** for the **Direction** option
14. In the command line for the **Extrude specify start point of direction:** type ***0,0,0***
15. In the command line for the **Extrude specify end point of direction:** type ***0,0,-100***

    The individual triangles will all be extruded in the same direction, creating a series of individual prisms.

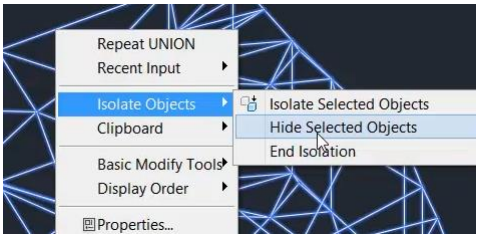


    We now need to use the **Union** command to combine these together.

16. From the **Solid** tab click **Union**.
17. Select all of the newly created prisms and press **Enter.**

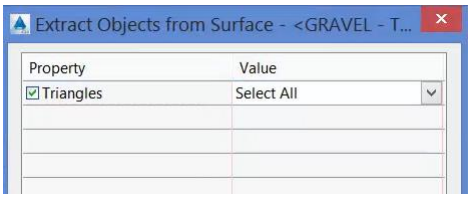
The prisms will be combined into one solid.

18. Right click on the newly created solid to display the context menu, from **Isolate Objects** Pick **Hide Selected Objects.** To temporarily remove the solid from display.



The above steps now need to be repeated to create a solid for the Gravel - base surface.

19. From the **Strata Manager** toggle on the **Gravel – Base** surface
20. From the model space select the surface, the **Surface** context Tab should be displayed for the ***Gravel – Base*** surface.
21. Click **Extract Objects** from the **Surface** tab.
22. In the **Extract Objects from Surface** dialog ensure triangles is toggled on.
23. Press **Okay** to continue.



Individual 3D triangular faces will be created for the surface.

24. Click **Strata Manager** and toggle off the Gravel Base surface so only the newly created triangles are displayed.
25. From the **Home** tab click **Extrude.**
26. Select all of the triangular faces
27. In the command line type: ***D*** for the **Direction** option
28. In the command line for the **Extrude specify start point of direction:** type ***0,0,0***
29. In the command line for the **Extrude specify end point of direction:** type ***0,0,-100***

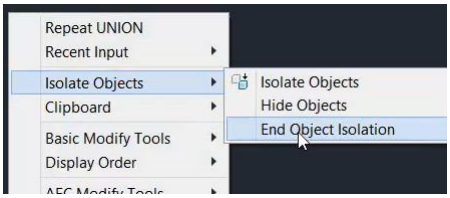
The individual triangles will all be extruded in the same direction created a series of individual prisms.

We now need to use the **Union** command to combine these together.

30. From the **Solid** tab click **Union**.
31. Select all of the newly created prisms and press **Enter.**

The prisms will be combined into one solid.

32. Right click on the model space to display the context menu and from **Isolate Objects** click **End Object Isolation.**

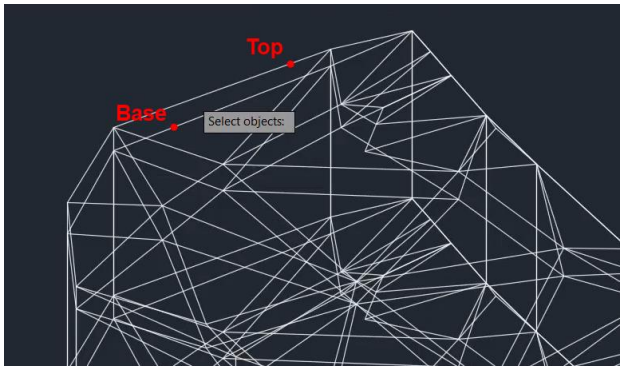


Both solids just created will be displayed.

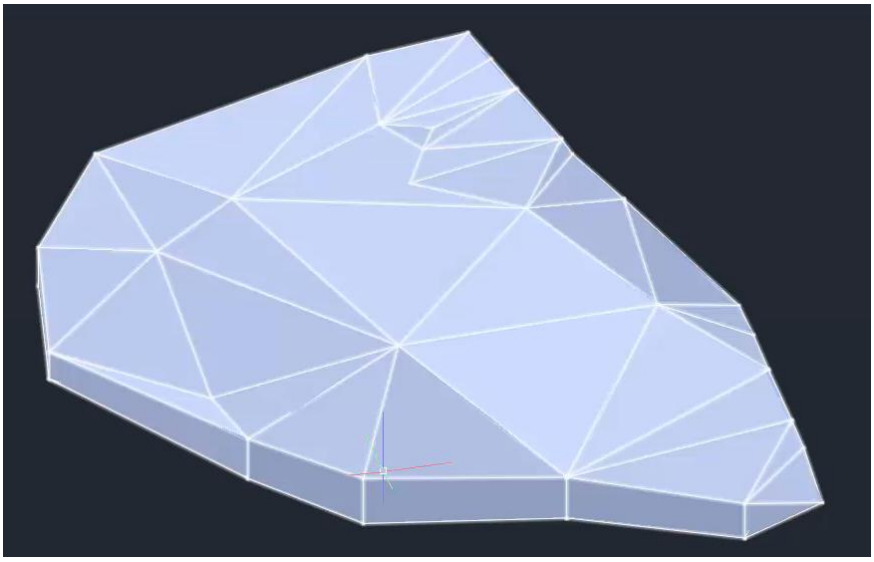
33. From the **Solid** Tab click **Subtract.**

The base solid is going to be subtracted from the top solid to create a solid representing our stratum.

34. Select the *Top* solid:
35. Press **Enter.**
36. Select the *Base* solid.
37. Press **Enter.**



The resultant solid should represent the stratum, this object can then be exported and used in other software.



Exercise 7 (optional)

Repeat the above process for the Clay stratum, before starting, isolate and hide the Gravel solid.