# AutoCAD Civil 3D Tutorial: Importing Survey Points

This tutorial guides you through the *basic* steps required to (1) import survey data into AutoCAD and build a surface, (2) explore representations of a surface, and (3) generate a profile of your surface.

## Part I: Importing Survey Data into AutoCAD

1. For this tutorial, we will use survey data of a short reach of the Provo River from Utah State University. These survey data include a number of cross sections across the river (points taken along the river bed). The original assignment for Utah State University was developed for *ArcGIS*. Here, we will explore the data in *AutoCAD* instead.

   Download the data at this address:

   http://www.gis.usu.edu/~jwheaton/ICRRR/2010/Part_II/ProvoTopoData.zip

   After it has downloaded, unzip the data in a location where you have write permission.

2. Open the folder to look at the data included. The survey data files are saved as ASCII text files. There are two here: "st_reach_topo_nez.txt" and "st_reach_wse_nez.txt". "NEZ" stands for Northing, Easting, Z (elevation). Open the file "st_reach_topo_nez.txt" in a text editor (Notepad++ or Wordpad, or import into Excel).
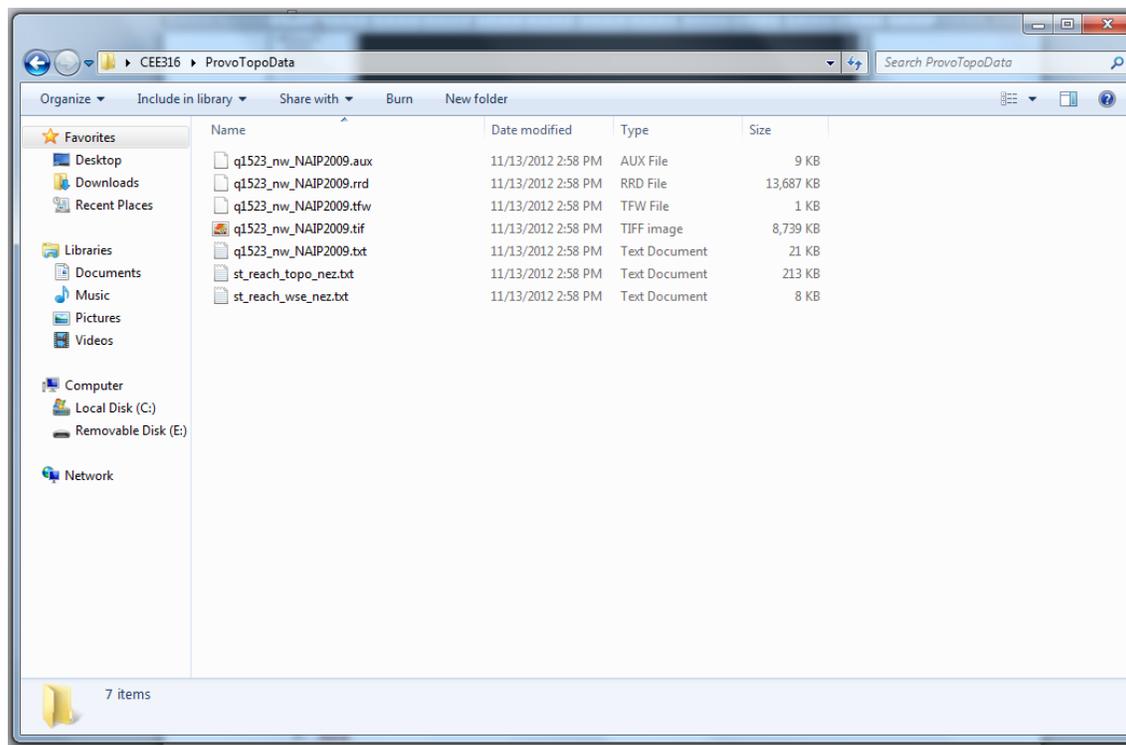
3. You will find that this file has three columns, and these correspond to (1) the Northing, (2) the Easting, and (3) the elevation of each point (row).  This file does not tell us the coordinate system of the points or the units.  In practice, you would consult with your surveying team to obtain the coordinate system and units of these data.  In this example, this information is included in a metadata file ("q1523_nw_NAIP2009.txt") which indicates these are in the Universal Transverse Mercator (UTM) projected coordinate system with units of meters.

```
5182
4482926.189000 461676.963000 1665.359985
4482926.729000 461676.386000 1665.469971
4482927.326000 461675.649000 1665.689941
4482920.672000 461674.512000 1665.469971
4482920.340000 461674.857000 1665.300049
4482877.005002 461684.360000 1665.219971
4482876.927998 461684.069000 1665.119995
4482872.981999 461686.695000 1665.430054
4482872.952000 461686.978000 1665.209961
4482863.647000 461689.292000 1665.180054
4482863.656999 461688.464000 1665.219971
4482863.550000 461687.792000 1665.250000
4482863.601998 461687.075000 1665.189941
4482849.294003 461693.974000 1665.770020
4482849.274999 461693.200000 1665.699951
4482849.079999 461677.637000 1664.479980
4482840.761998 461688.752000 1665.209961
4482840.770001 461688.310000 1665.160034
4482781.168996 461656.855000 1664.819946
4482781.567006 461656.696000 1664.719971
4482780.950002 461627.363002 1664.930054
4482820.092999 461580.649996 1664.439941
4482685.511006 461474.530001 1663.650024
4482680.718999 461434.858996 1663.910034
4482680.455006 461435.466998 1663.599976
4482859.903996 461690.674000 1665.079956
4482859.856999 461689.989000 1665.089966
4482675.015996 461453.125994 1663.420044
4482676.487996 461452.149005 1663.349976
```

4. Close any open text files.  We are now ready to import "st_reach_topo_nez.txt" into AutoCAD Civil 3D.

5. Launch AutoCAD <u>Civil 3D</u> – English Metric (we know the units are in metric for this example) from the Start Menu (as seen below).  Your machine may need to install the software – let it do so.  **Note**: *It is important that you launch AutoCAD <u>Civil 3D</u> and not the original AutoCAD.  Civil 3D has tools that are needed for this exercise that are not found in the original AutoCAD.*

**6.** AutoCAD Civil 3D will start.  Close the welcome screen if it appears.
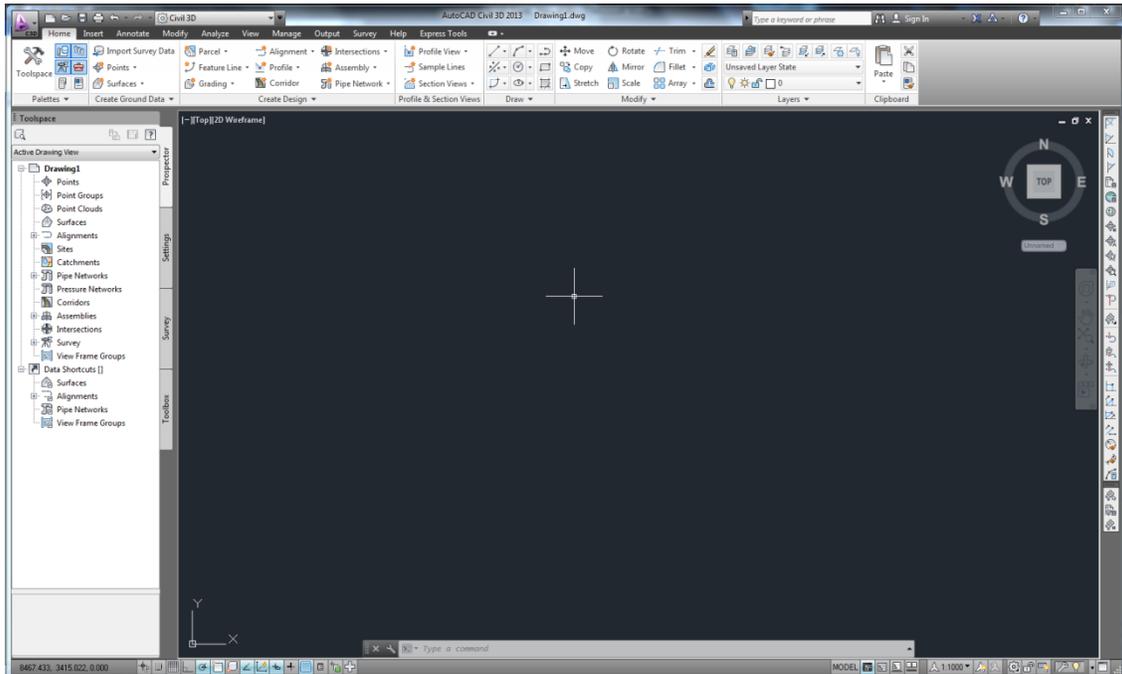


**7.** We will first create a Surface Definition.  This is where the surveyed points will be stored in the database.  On the "Home" ribbon, click Surfaces > Create Surface.
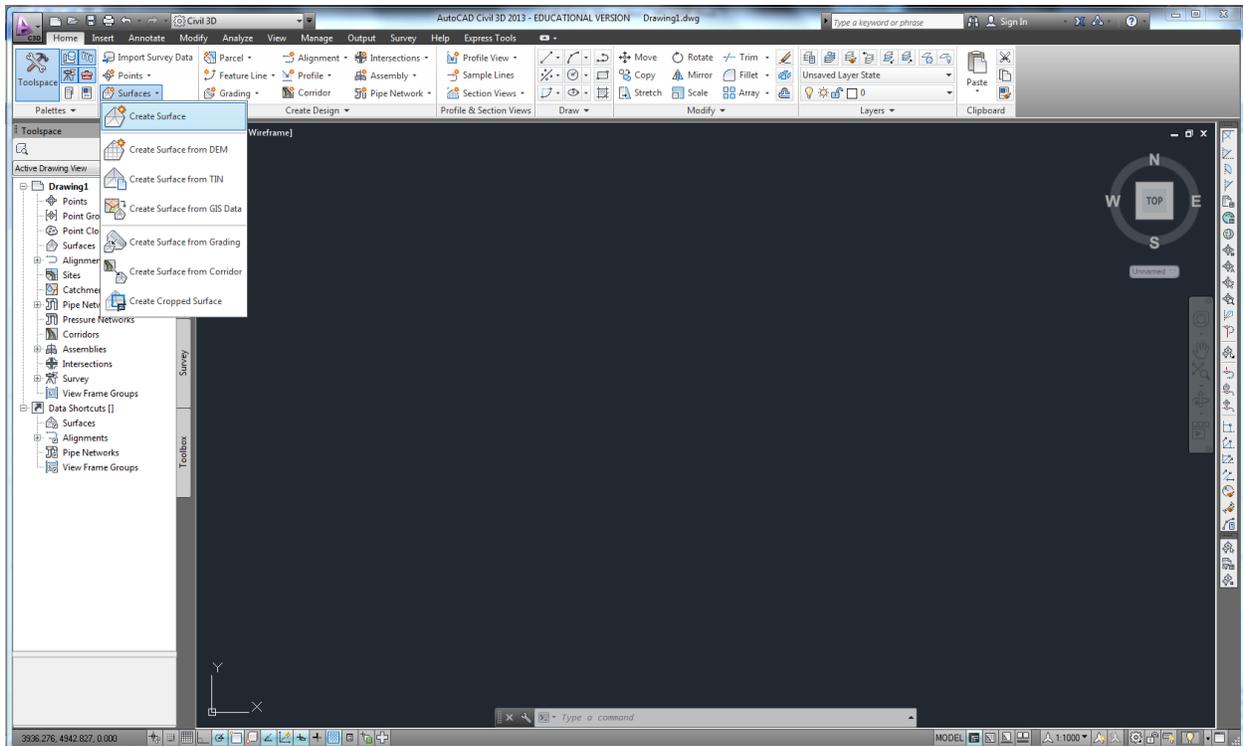
8. The Create Surface dialog appears. Here you can specify the name, description, default contour style, and render material for your surface. You will be able to change the Style and Render material later, so don't worry too much about them right now. Make sure your screen matches the following graphic and click OK.
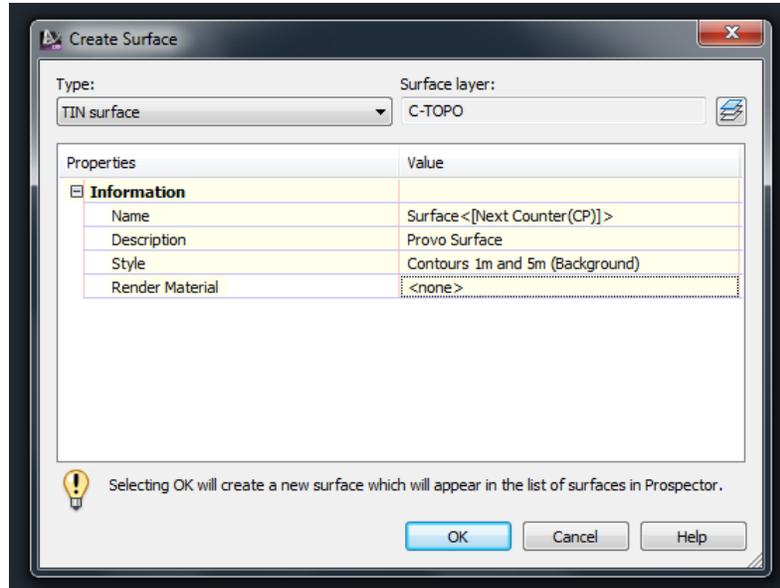


9. Now we have a surface database to store the survey points, but it is currently empty. Let's import the survey points now. Click the Modify Tab > Surface
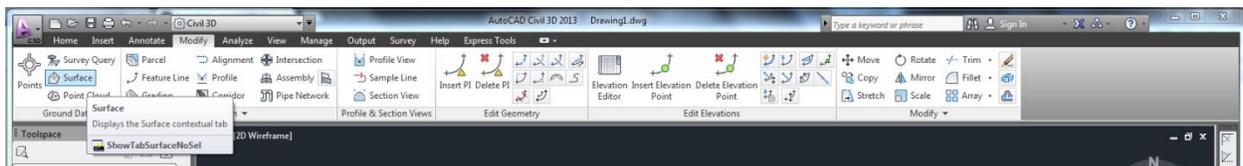


10. The Surface tab now appears. Click Add Data > Point Files
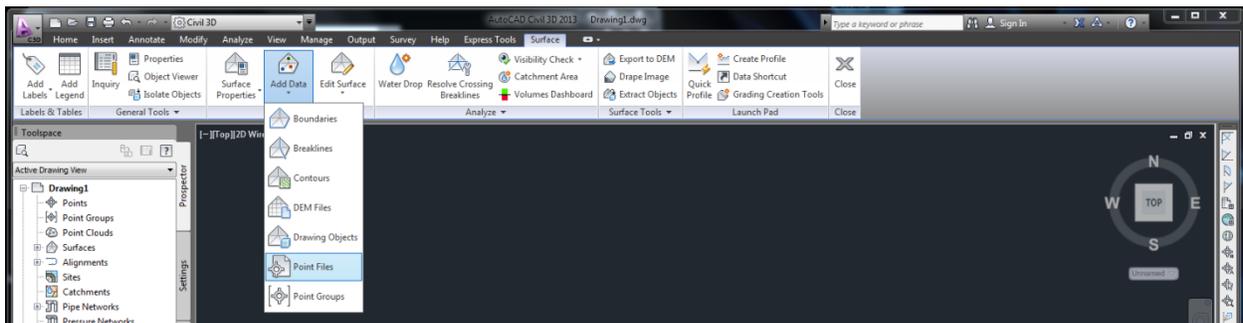
**11.** The Add Point File dialog appears.

You should first note that there are many different format options in the "Specify point file format" window. Many of these are intuitive: P= point number, N = northing, E = easting, Z = elevation, D=description. You will also note that there are different ways to delimit the file, and these include: tab delimited, comma delimited, and space delimited. From Step 3 (above), you should have noted that the format is NEZ, and the columns are separated by a single space.

Hit the plus sign next to the selected files window and browse to "st_reach_topo_nez.txt". **The tool should automatically detect NEZ (space delimited), but if it does not, select it in the file format window.** Make sure your screen matches the options below and click OK.
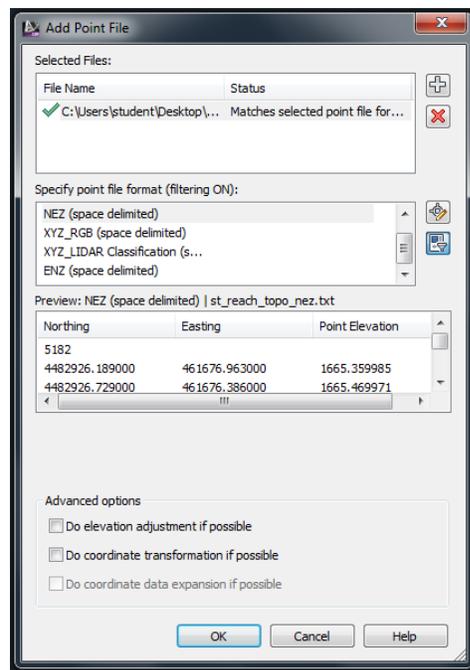
**12.** You may receive a warning that 1 point was outside the elevation extents – this is probably the first row, which has a mysterious value of "5182".  Zoom extents if necessary to see your points.
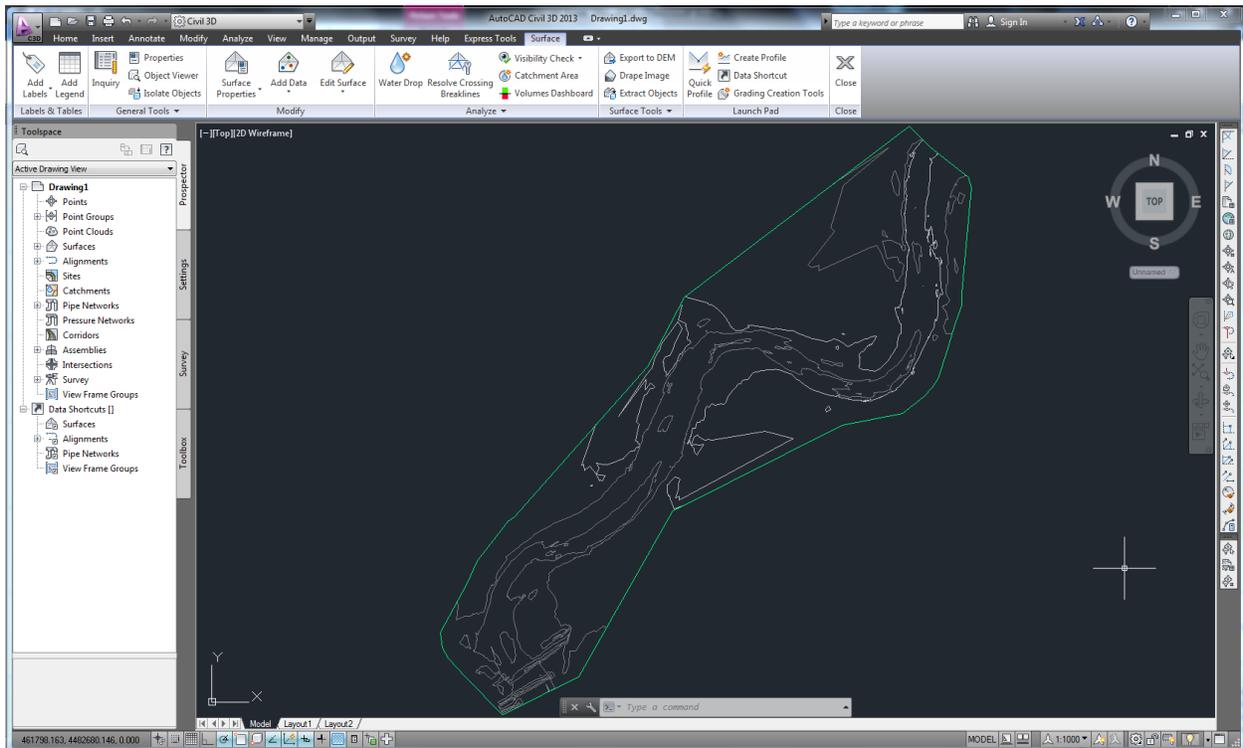


AutoCAD is displaying the contours of your surface (1m minor interval, 5m major interval).  You can see a meandering river!  The green boundary represents the limits of your surface triangulation.  In the next section you will explore ways of visually representing the surface.

### Part II: Representing the Surface

**13.** Now we will examine different ways to represent the surface.  Click Modify > Surface to arrive at the Surface ribbon.  Then click Surface Properties > Surface Properties
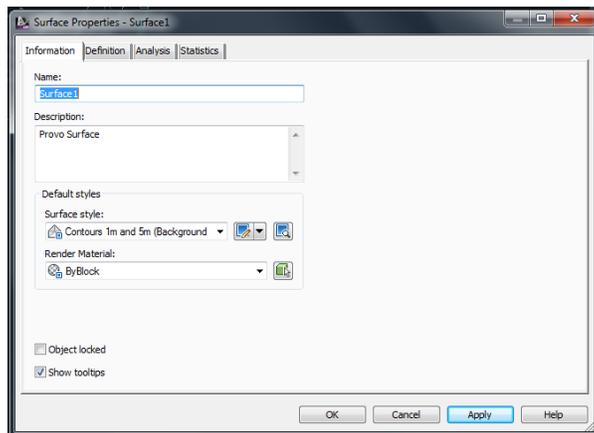
**14.** The "Surface style" dropdown provides several ways of visualizing your surface. We setup the surface to display "Contours 1m and 5m". How else can we visualize the surface? First, let's examine the triangulations used to create the surface. Select "Contours and Triangles" and click Apply.
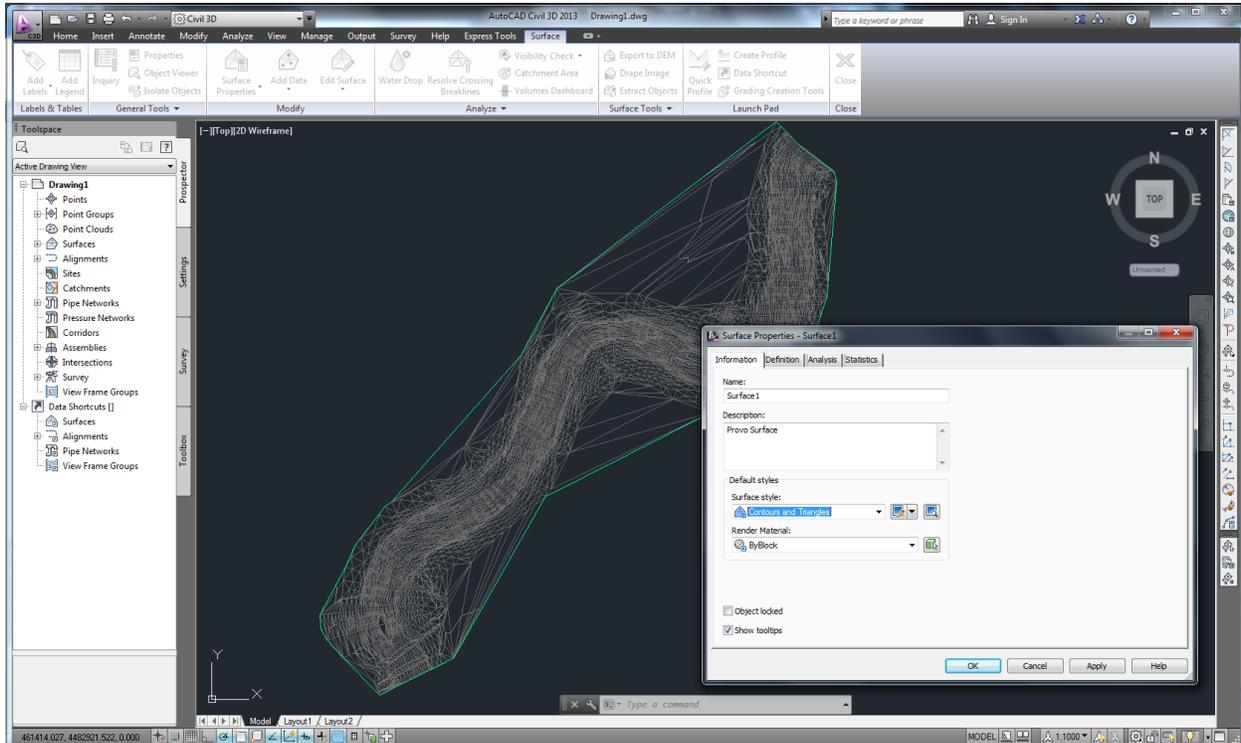


The screen now shows <u>how</u> the surface was created and every triangulation calculation used between the survey points. The more dense the web, the more dense the number of survey points in an area.

Inspecting this triangulated irregular network (TIN) is especially useful if the generated surface shows something unexpected, which may arise due to a surveying error or in areas that are not adequately surveyed. This is an important visualization tool, because it shows the location of your surveyed points (at the vertices of the web). You could surmise that there may be inaccuracies in the locations with less survey points.

You can specify the shape of the boundary used to create this TIN surface. For example, you may want to move the boundary in closer to the river where you have more survey points. This is left for you as a future exercise.

**15.** Now let's look at a raster-type representation of the surface.  In the Surface Properties dialog, select "Elevation Banding (2D)" in the "Surface style" window and click Apply.  AutoCAD should display a colorful representation of your surface, as seen below.  We expect the red areas are the lowest elevations and the blue areas are the higher elevations, but how can we know for sure?
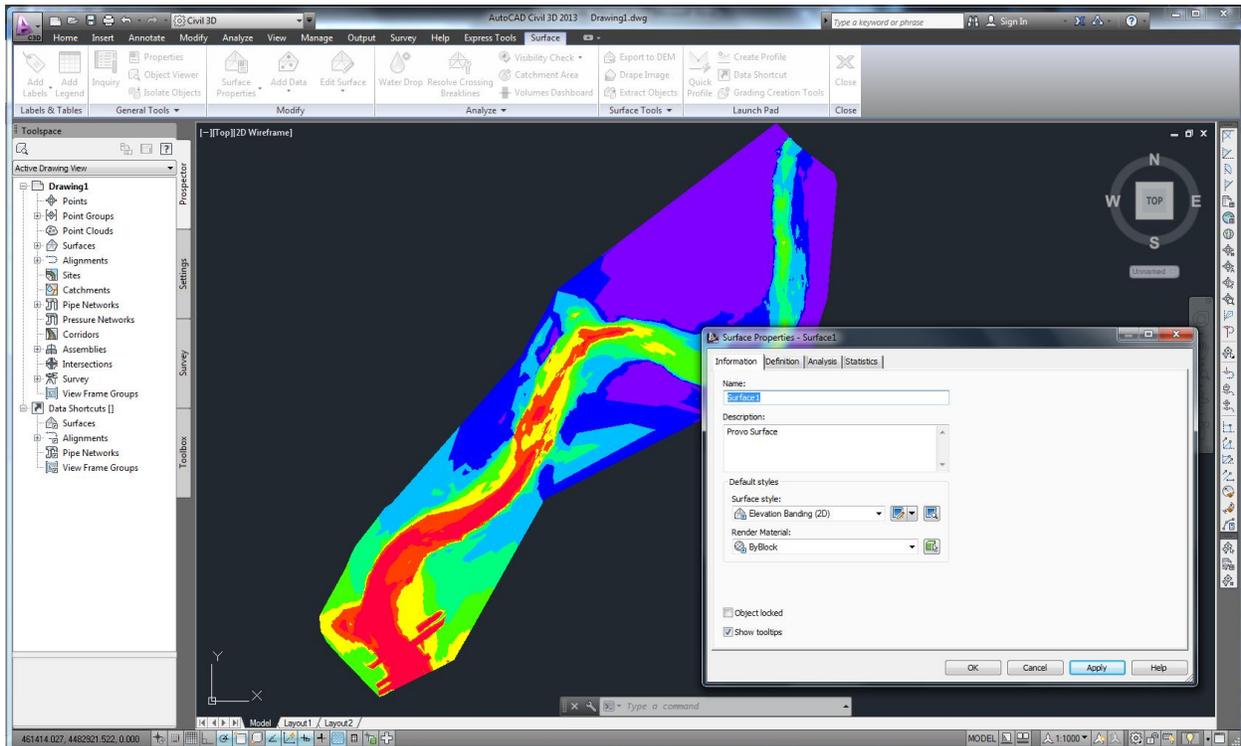


*Note that we can also view a similar map with the slope values ("Slope Banding 2D").*

**16.** To answer that question, let's return to the original representation – select "Contours 1m and 5m (Background)" and hit Apply.  An easy (and intuitive) way to find the highest elevations and lowest elevations is to simply label the contours.  Click Add Labels > Contours – Multiple.  Note that there are several options for labeling your surface here.
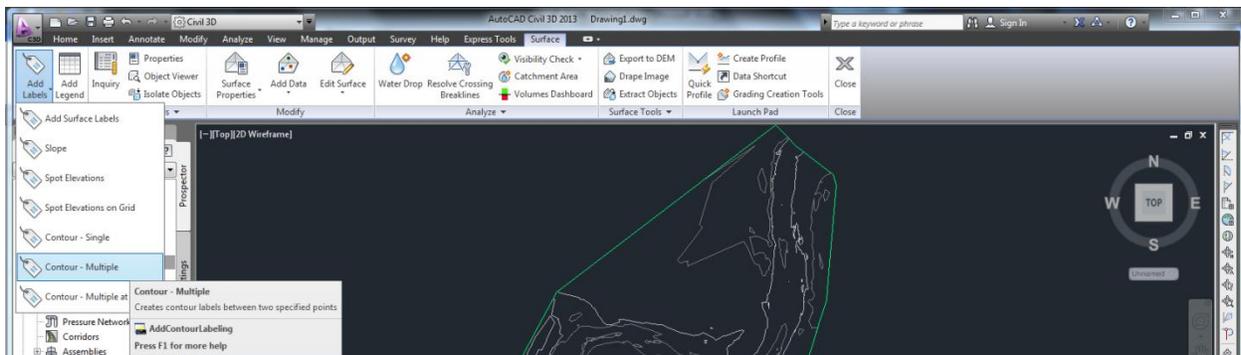
**17.** Click a point in the top right area and move the mouse.  You will see that a line follows your mouse.  All contours that intersect this line will be labeled.
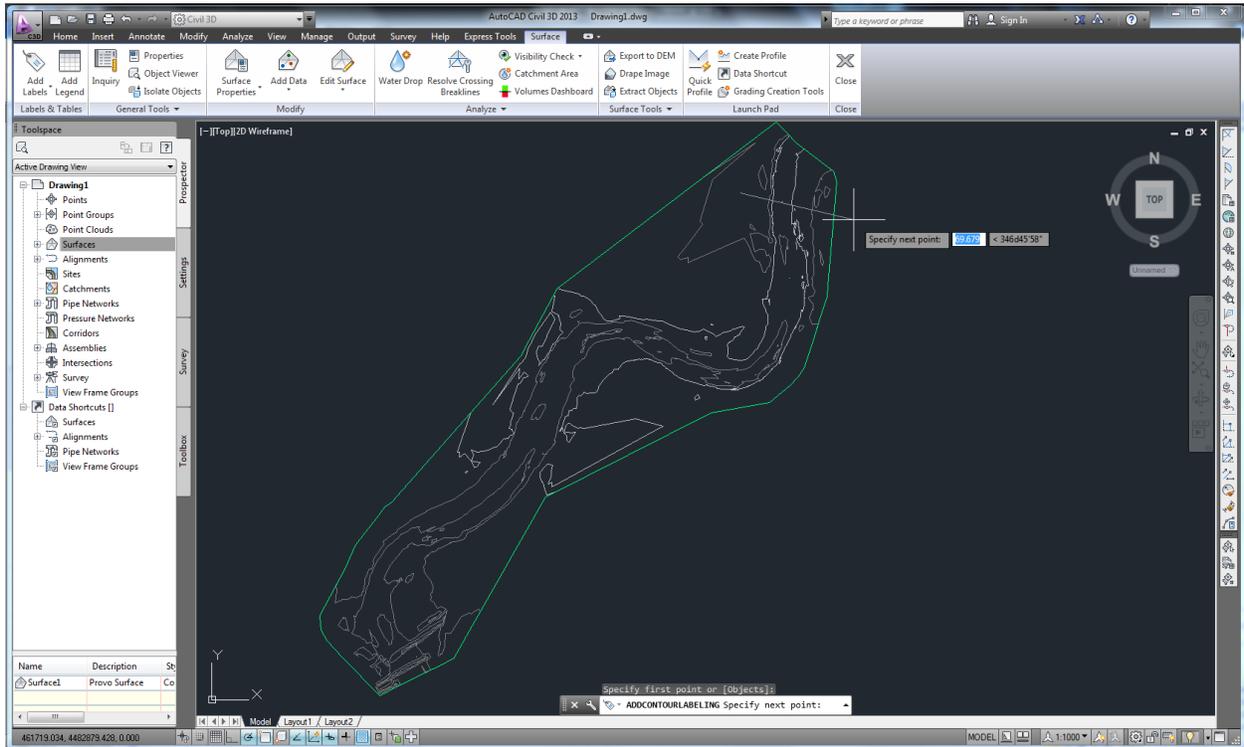


Select a second point (as shown below) and hit enter.  Zooming in, we find the following:



As expected, the slope is draining to the river from both sides (1666 m to 1665 m).

**18.** Now use the contour labeling tool to label the contours in the lower left extent.
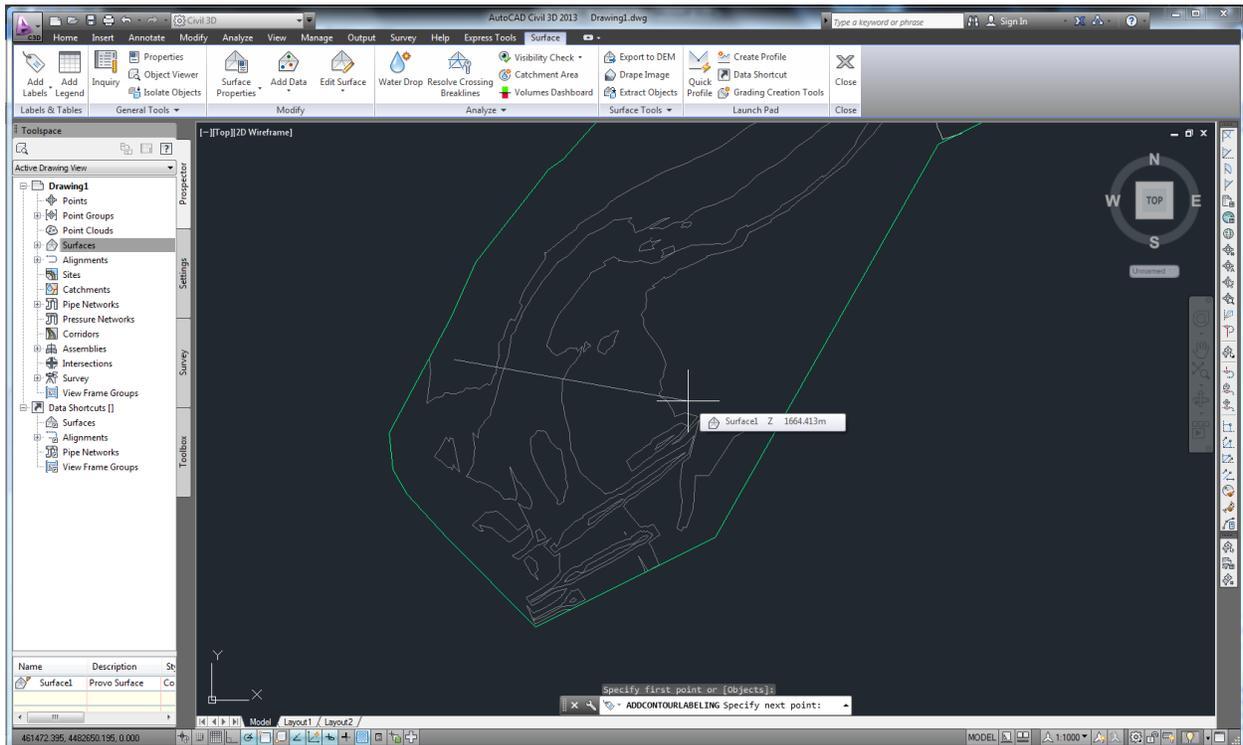


Zoom in after executing this tool, and we find the following:
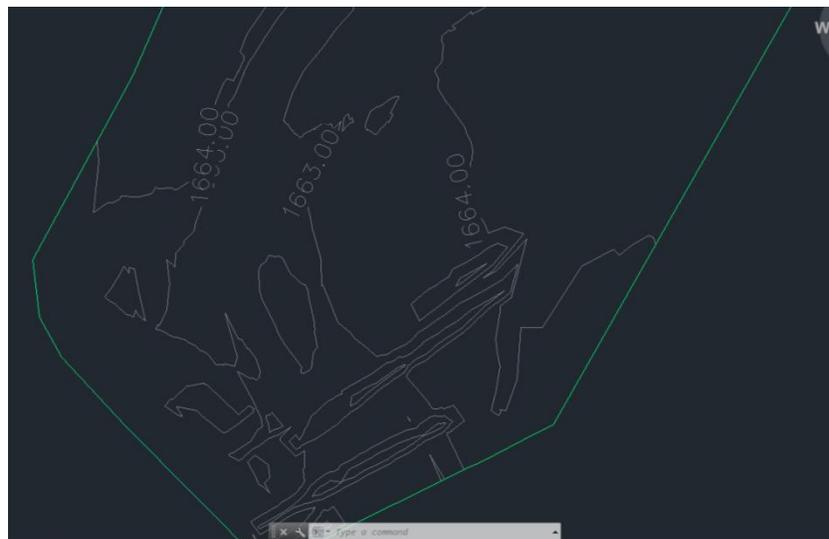


The contours in the lower left are around 1663 m. So this verifies that the river is flowing here from the top right to the bottom left. (of course, you could have easily verified this with a field trip or a discussion with your survey crew)

A final note: the contour intervals here seem too large for this dataset. You can change the contour intervals in the Surface Properties dialogue (you will have to create a new style).

## Part III: Creating a Profile from your Surface

19. Now that you have created a surface from your survey points and explored different ways of representing the surface visually, a useful exercise is to look at profiles (or cross sections) of your surface. This is especially important in design work where you are interested in how the topography varies along some path, which is called an alignment in AutoCAD.

   As an example, we will create a profile of the surface along the approximate route of the Provo River. To do this, we first need an alignment, which can be created from a polyline. Zoom to the upper right part of the surface, and then type the command "pl" to start a new polyline. Click a point in the river to start the line, and then follow the meandering river, clicking along the way to add new vertices (as seen below).
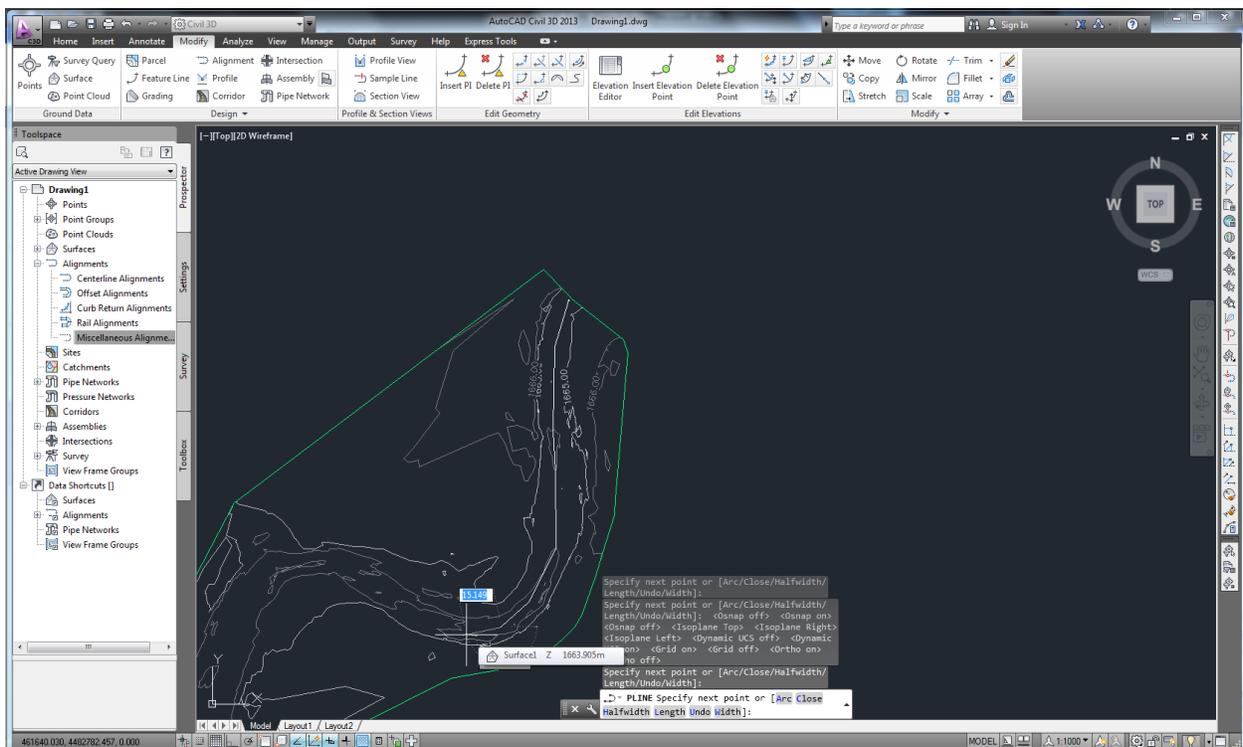


Do your best to follow the low points of the river. In practice, you would probably want to pick a more refined way of tracing the river route, but we will just create the alignment manually here as an example.

**20.** Once you have reached the end of the river, hit ENTER to finish the polyline. Left click on the polyline to select it. *Note*: *if you made a mistake, you can either edit vertices with the polyline edit tool (type "pe") or you can delete the polyline and start over.*
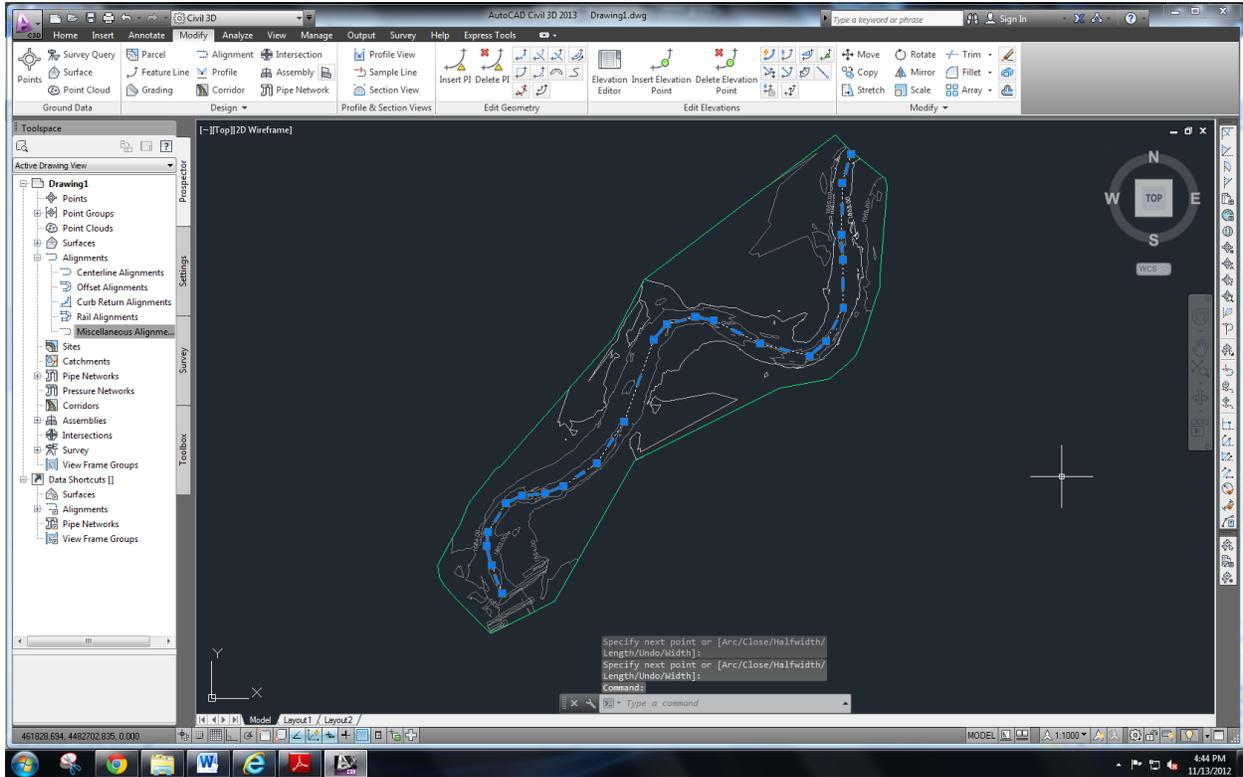


**21.** Make sure you are viewing the "Home" ribbon. With the polyline selected, hit Alignment > Create Alignment from Objects. Hit ENTER if necessary.
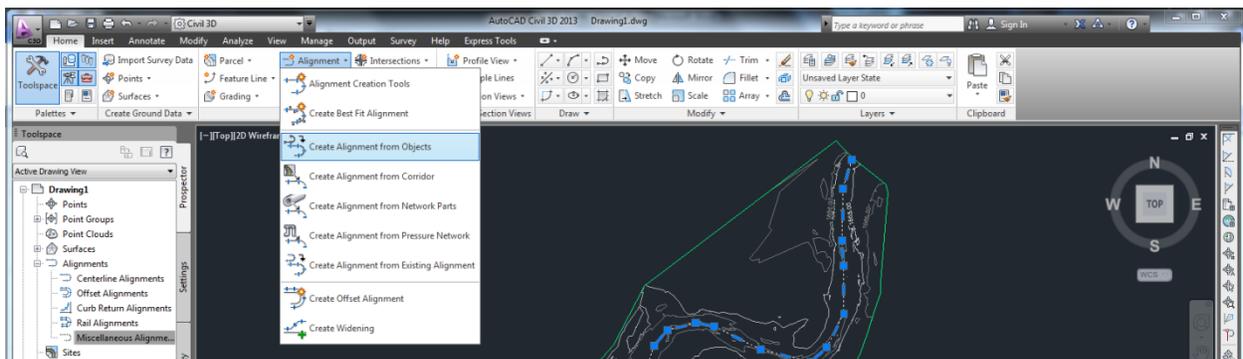
**22.** AutoCAD will ask you to verify the direction of the alignment. As seen below, it will show an arrow pointing in the direction (look at the middle part of the polyline). Because we drew the alignment in the direction of the flow, it should be oriented correctly. Hit ENTER to accept the direction or reverse the direction if necessary.
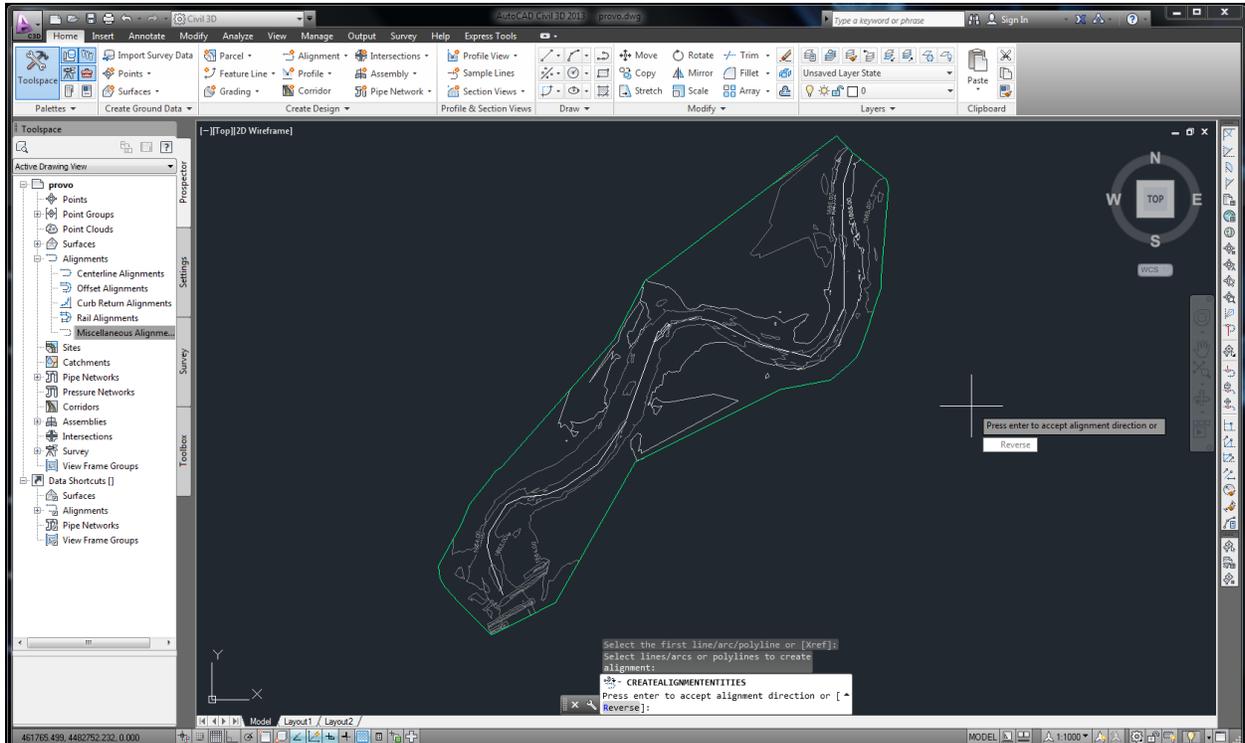


It is important to know the direction of the alignment, as it will help you make sense of the profile. Alignments will have stations, such that the alignment begins at a reference point (usually 0+000 m), and the stations will be numbered based on the distance *along the alignment path* from that reference point. So if we specify 0+000 as the starting point of the alignment, a station of 0+500 signifies a point that is 500 m away from the starting point *along the alignment*. Note that this is *not necessarily* the distance from the starting point as the crow flies; alignments that meander (like our example) or alignments that have curves/bends will have stations that do not correspond to the straight line distance from the starting point of the alignment.

After you have created your alignment, you can label the stations in your plan view to help you remember the orientation. This is left for you as an exercise on your own.

**23.** After you confirm the direction, a dialog entitled "Create Alignment from Objects" will be displayed. Here you can name the alignment, select the type of alignment, provide a description, specify the starting station (we use 0+000.00m here) select the drawing layer and specify other options. Make sure your screen matches the following graphic and hit OK.
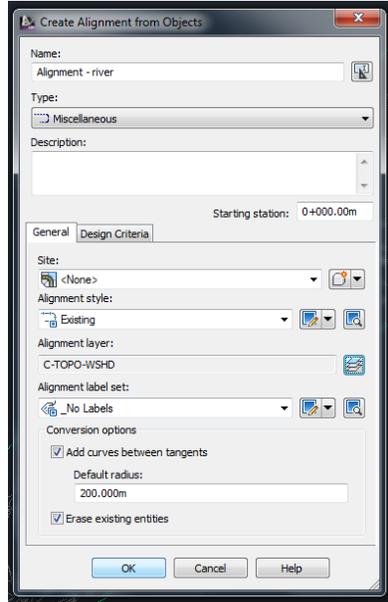


**24.** The alignment is now created. You can confirm this by looking at the "Prospector" tab in your Toolspace. Expand Alignments > Miscellaneous Alignments and find your new alignment.
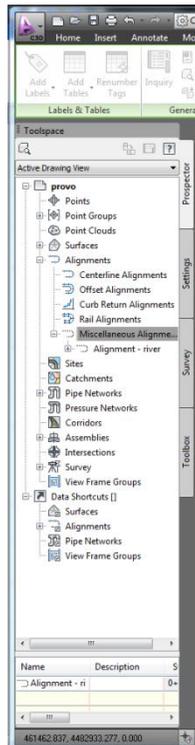
**25.** You now have created a surface and your alignment for the river route. At this stage, the two are disjoint. Let's sample the surface along the river alignment we just created. To do this, select the alignment in your plan view and click "Surface Profile". Here you can select which alignment and which surface you want to use in this operation. In a real project, you would likely have many alignments (e.g., road centerlines, pipe centerlines, channel/river centerlines, etc) and many surface (e.g., existing grade, proposed grade). In this example, there is only one alignment and one surface.

Highlight "Surface1" and hit "Add>>". Then hit OK to sample the surface along your river alignment.
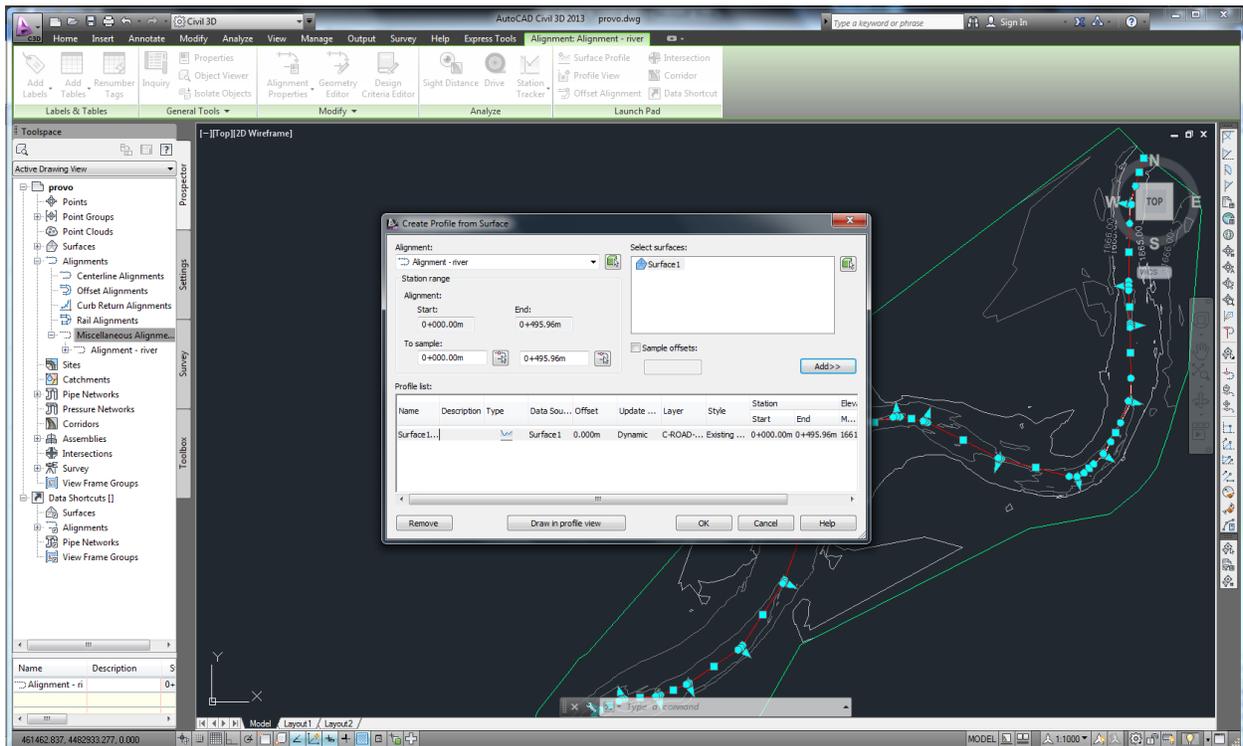
**26.** You have sampled the surface along your alignment and are now ready to generate a surface profile. Select your alignment in the plan view and click "Profile View".
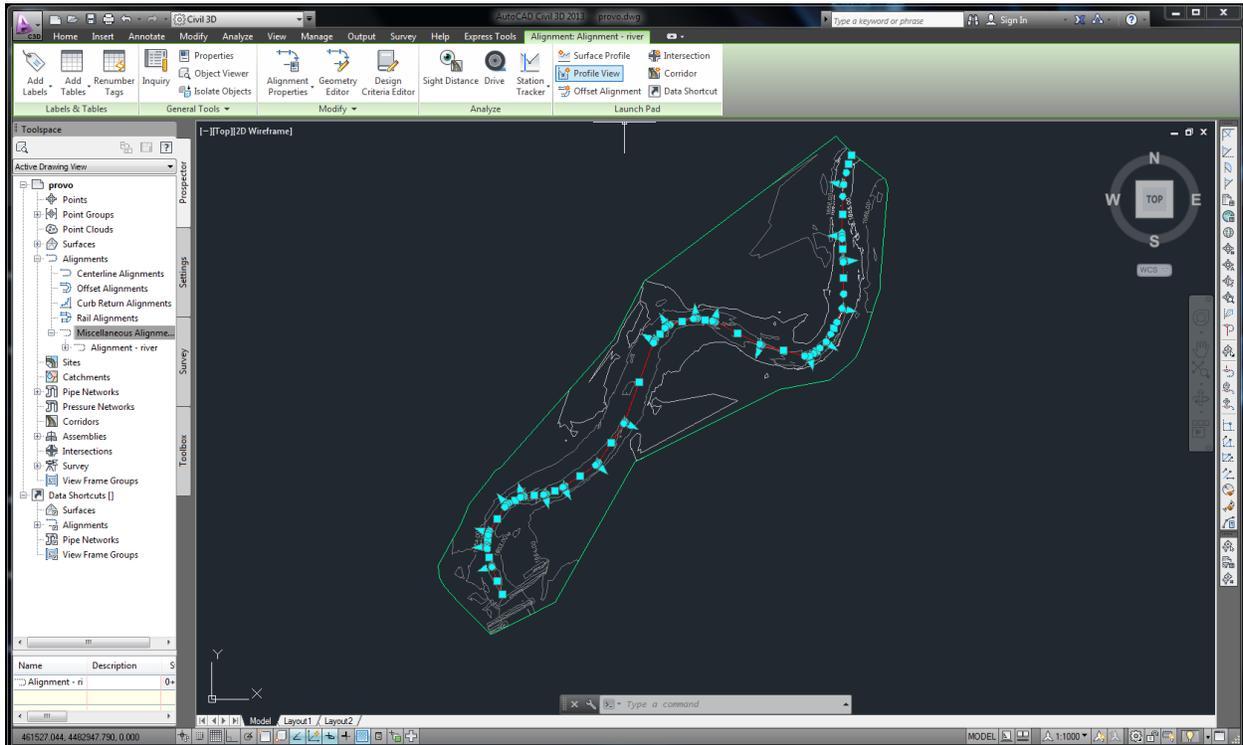


**27.** A "Create Profile View – General" dialogue will be displayed. You will now go through a series of tabs to specify the properties and style of your profile. Make sure you match the following graphic and click "Next >".
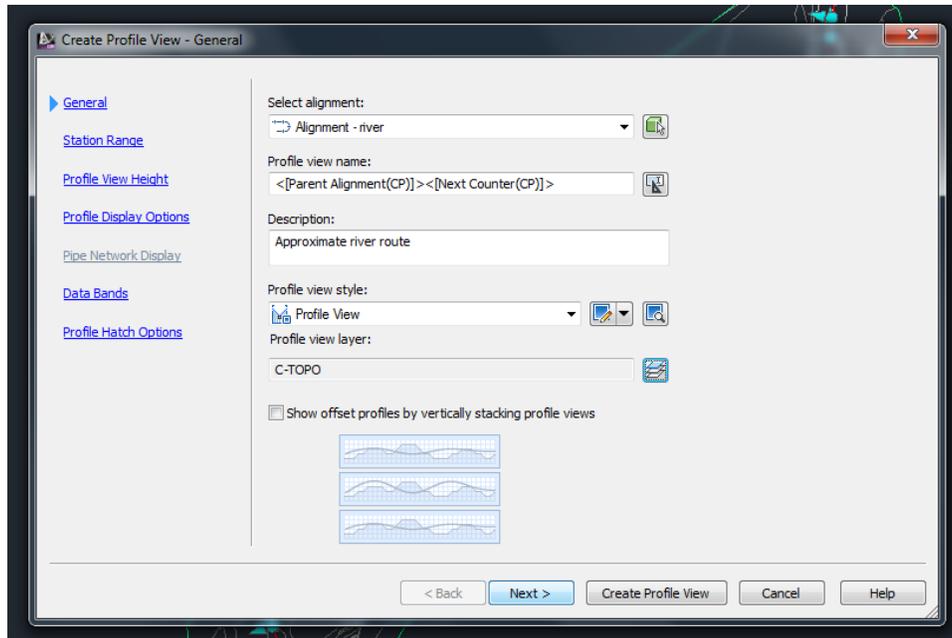
**28.** Once you reach the "Profile View Height" page, ensure that there are values in your minimum and maximum height boxes. If not, then you may not have successfully sampled the surface along your alignment (Step 25) or you did not select the correct alignment (Step 27).
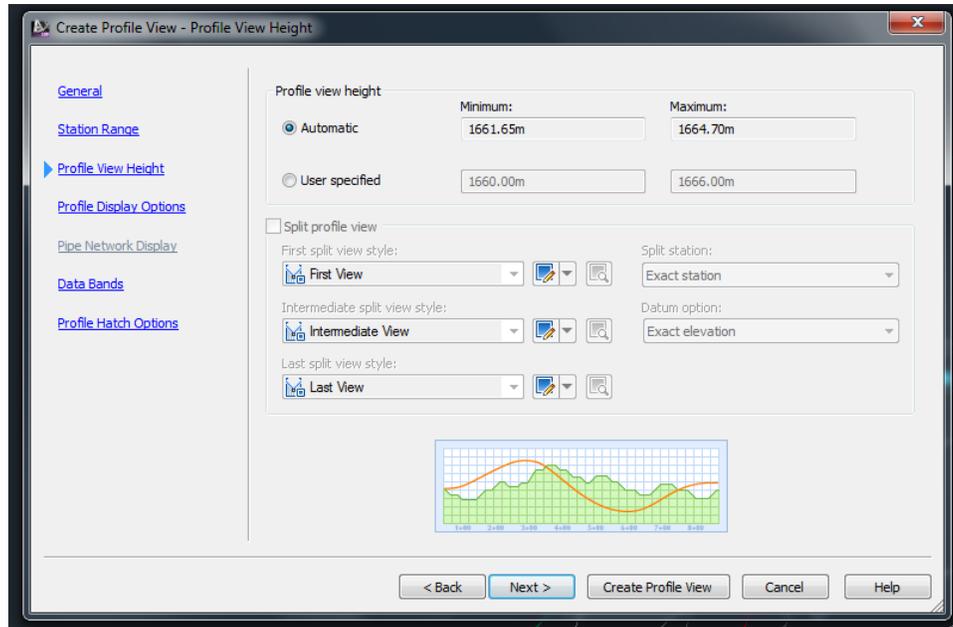


For this exercise, we will not worry about the style of the profile, so we will just continue through with the default values. Keep clicking "Next>" until you reach the "Profile Hatch Options" screen, and then hit "Create Profile View".

**29.** AutoCAD will now prompt you to select a profile view origin.  Zoom out and pan away from your surveyed points, where you will likely not have any points/features drawn in the future.  Click at your desired location to place the profile.
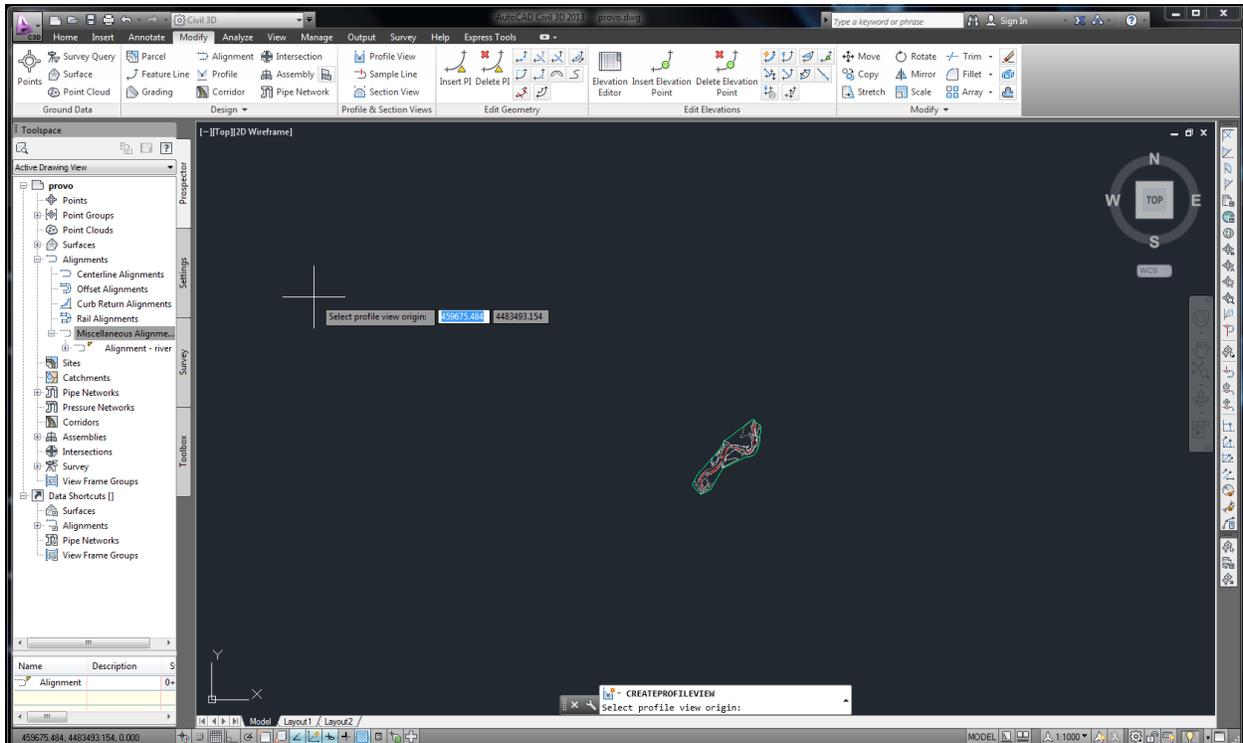


**30.** The profile will be drawn automatically for you, as shown below (red line is your surface). Remember that station 0+000 corresponds to the top right corner of the survey, where we started the alignment, and station 0+500 is in the lower left corner of the survey.  The profile shows the river bed gradually sloping from 0+000 to station 0+500, which meets our expectations.  There are some jagged areas, which may have resulted from a variety of reasons: (1) we eyeballed the alignment, (2) there may be low points or rocks in the river survey, (3) there are locations without many survey points where we are viewing the interpolation.  The profile tool is a useful way of looking at slices of your surface, which should inform your designs.
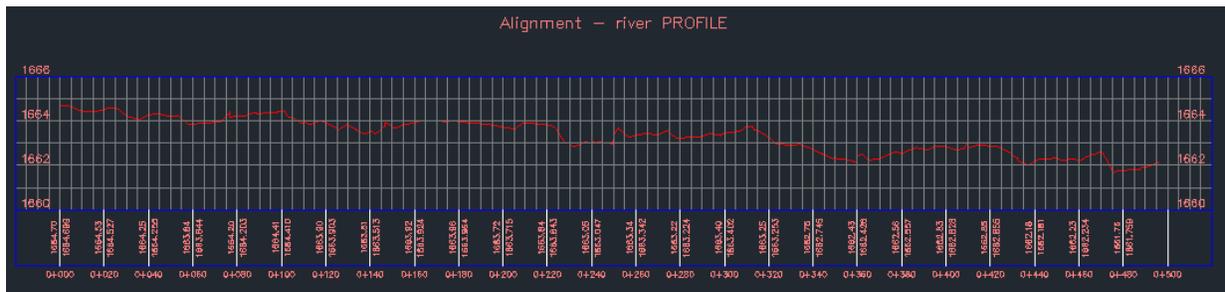


*Note that you can also use this tool to generate cross sections (e.g., profiles that are perpendicular to the direction of flow).  It is left as an exercise for you to create a cross section of the river.*