

## Tools, Tips, and Workflows

# Breaklines, Part 4 — Applying Breaklines to Enforce Constant Elevation



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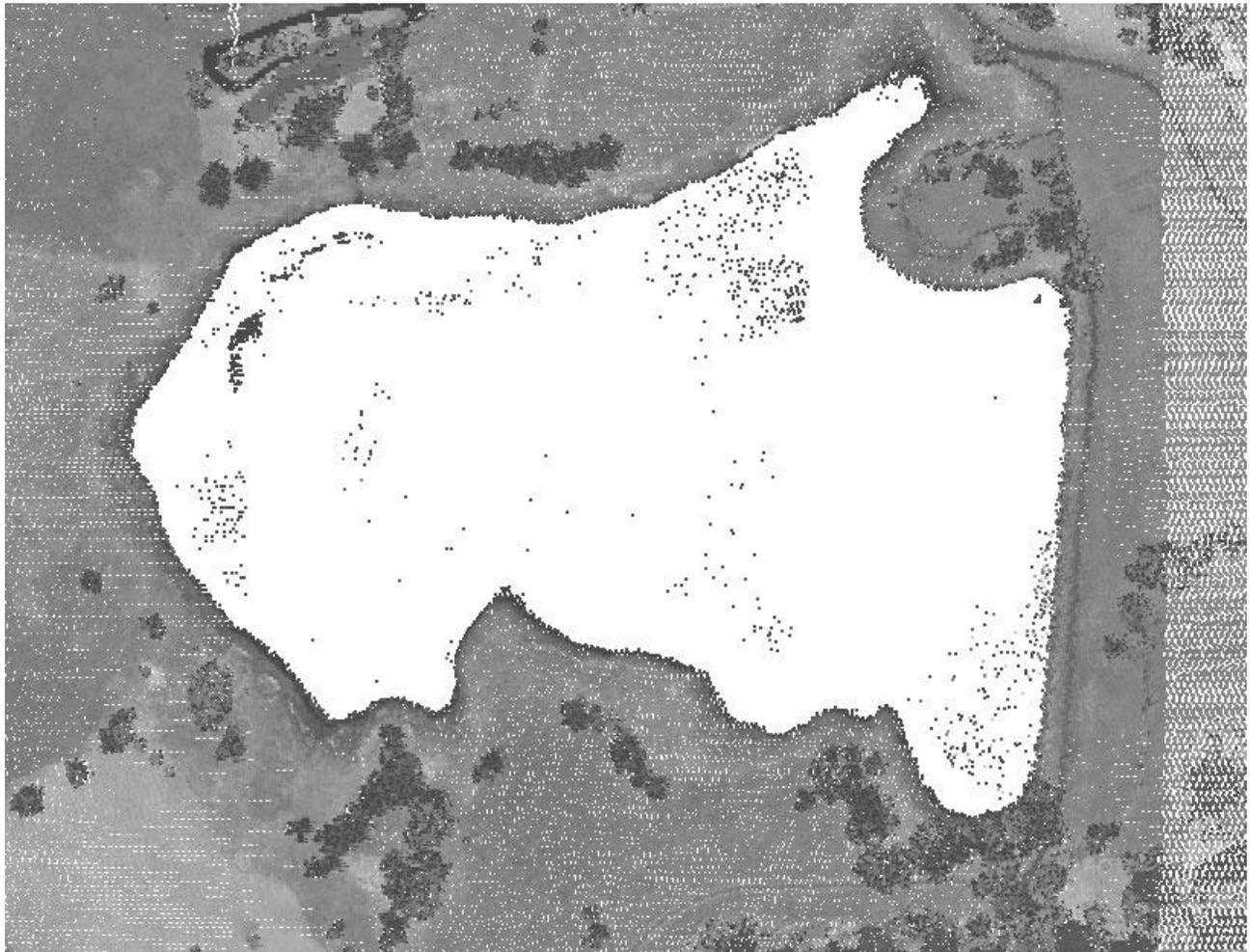
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In the last edition of LP360 News, we discussed the creation of **3D breaklines**. Recall that, for our purposes, a **3D breakline** is a vector that has an elevation value (Z) associated with each vertex. Generally, **3D breaklines** can be divided into two categories – those with the same elevation for each vertex (used for flat water bodies, for example) and those with the ability to store a different elevation value for each vertex (a down-stream flow polyline, for example).

In this edition, let's look at a constant Z example such as a flat water body. A common method of collecting flat water bodies is to use heads-up digitizing from an orthophoto for the X, Y (planimetric) aspects of the construction and to store the desired (and single-valued) elevation in an attribute table. I like this storage approach as compared to using a pure 3D vector (where Z is stored on each vertex) since it saves 1/3 of the storage. Why store a Z value at each polygon vertex when all Zs are the same?

In Figure 1 is depicted a water body in the Boulder, Colorado area. This figure is rendered as points, colored in gray by the LIDAR return intensity. These data have not been classified, yet it is obvious that this is a water body.



*Figure 1: A water body shown rendered by intensity*

In Figure 2 is depicted the lake rendered as an elevation color-coded triangulated irregular network (TIN), modulated by intensity. Notice several features of this water body. First of all, the water body is not “flat” as is evident by the shaded relief triangle facets that appear on the lake surface. Secondly, note the water points that are showing in the profile view. Due to vertical noise in the LIDAR and potentially wave action on the water body, these water points will not exhibit the same vertical values and hence will distort a TIN rendering of the surface. Finally, note (from the profile graticule) that the elevation of this lake is about 1,872 meters above the datum. Thus, while we expect a water body to be flat, we do not (at least in general) expect the elevation to be at zero.

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## Breaklines, Part IV — Applying Breaklines to Enforce Constant Elevation

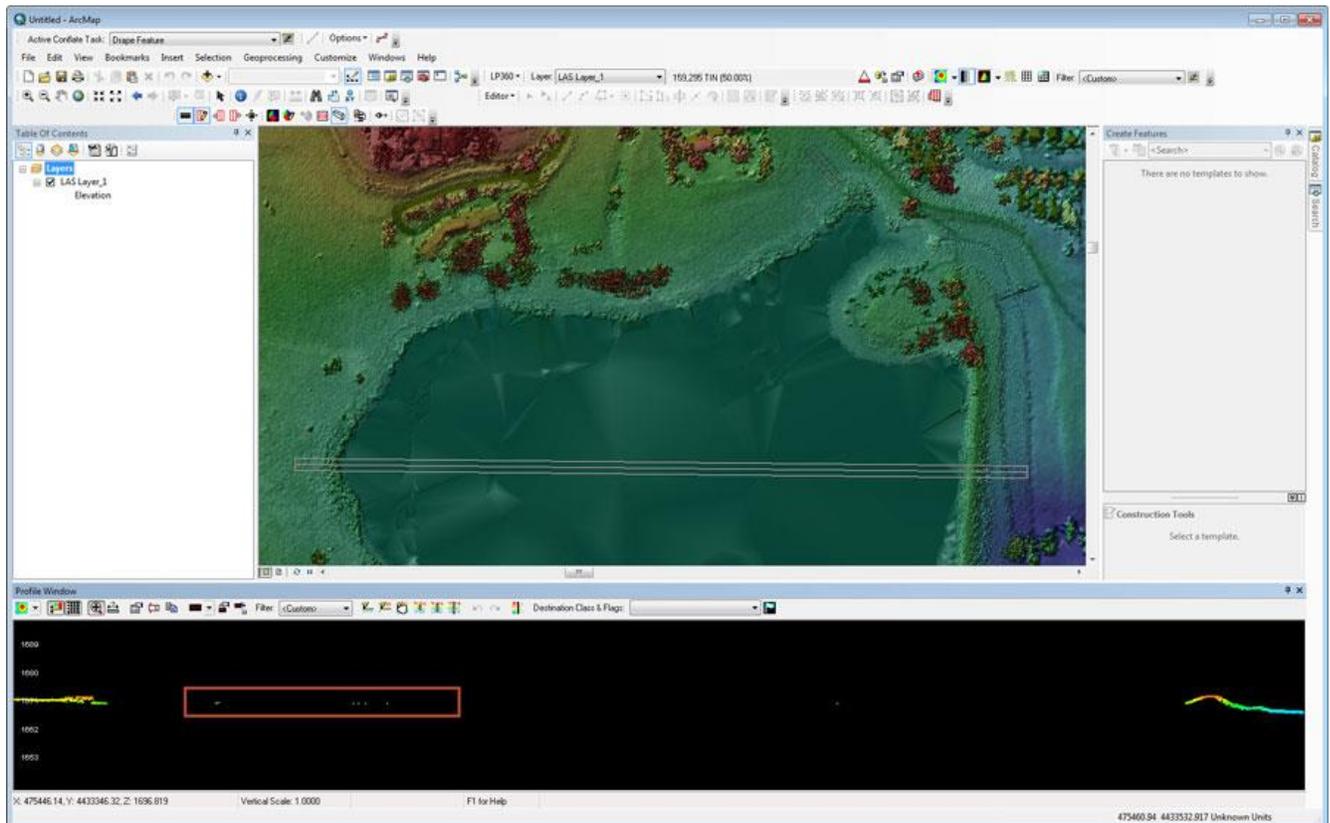


Figure 2: Lake rendered as a TIN with water points shown in the profile window

To flatten this water body, we must do several things:

- Construct a polygon that denotes the land-water boundary
- Provide a single elevation value to be used for designating the elevation of the water body
- Either remove all interior points from inclusion in the TIN or set their elevation values to the chosen water body elevation

When following best practices in LIDAR data processing, the values of X, Y and/or Z coordinates are never changed once past the rigorous geometric correction phase. Therefore, we will eliminate the use of the interior water points rather than change their coordinate values (in fact, there is not a tool in LP360 that will allow you to change point coordinates!).

The polygon (for LP360 for ArcGIS) will be either a 2D or 3D ArcMap feature. As previously mentioned, there is no need to use a 3D feature for a flat surface since each vertex Z will be set to the same value. I will provide an example of extracting the Z value from the LIDAR as the method of resolving the elevation value to use for the lake surface. The Summarize Z method of conflation is used for this task (see Figure 3).

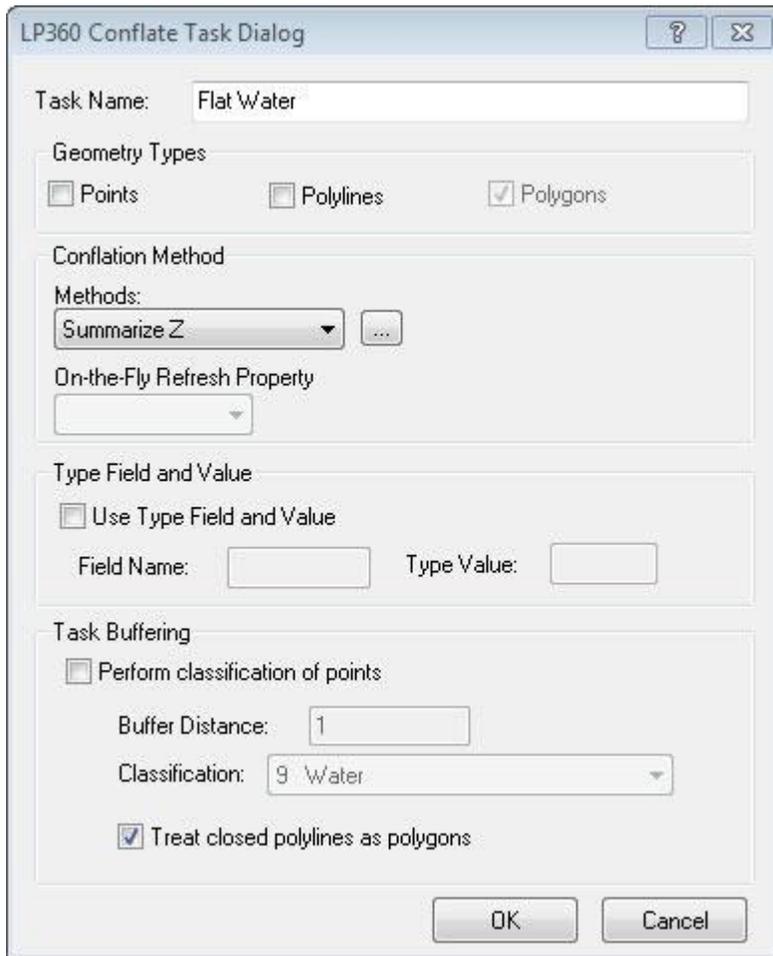


Figure 3: The Summarize Z dialog

Note in Figure 4 that there are a number of methods of computing the Z value. If you know the value that you would like to use, you can simply check the Constant Z option and key in this value. You can also use statistics of points either within a range of the vertices or completely within the polygon that is to be drawn. I have set the method to use points completely within the polygon that I will draw. I chose this method since a visual inspection of the lake revealed that the interior points were relatively flat and should provide a reasonable estimate of the water surface level. Note that other methods are available that allow you to set a radius around each point and compute the statistics by including all points within the circle.

Note that I have elected to compute a single set of values and store these in the attribute table. This means that I must add the attributes to the attribute table prior to running the conflation method. I have chosen to compute Mean, Min, Max and Standard Deviation since, by examining the results, I can quickly detect if I have anomalies in the data that will affect the result.

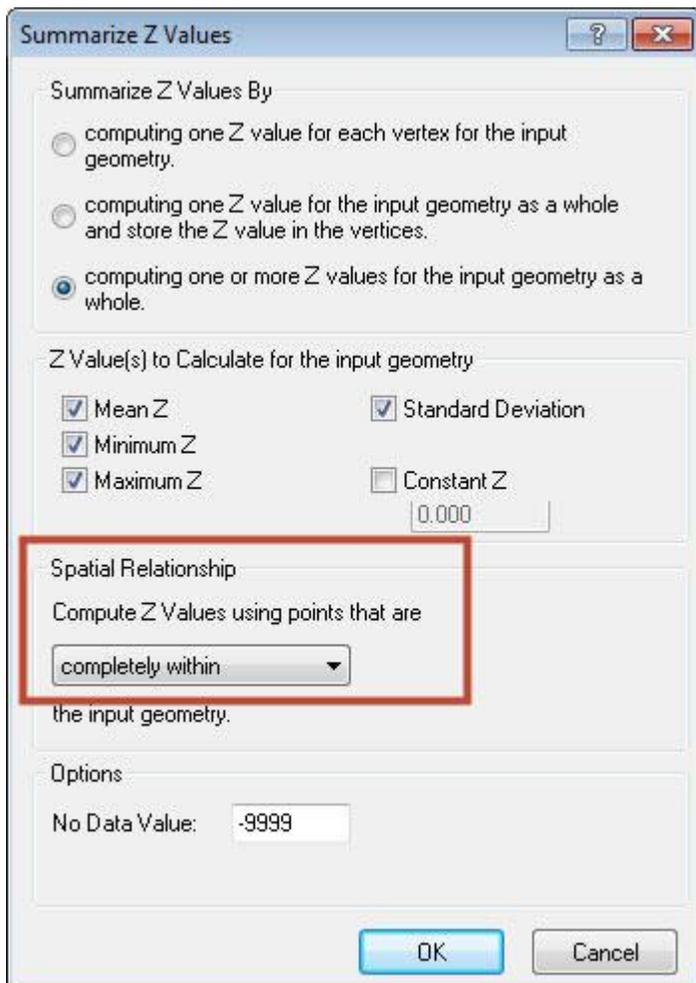


Figure 4: Computing the Z value

I now simply digitize the lake shore from the LIDAR TIN rendering. Note that LP360 combines the profile view with the Map View to allow you to easily see the true shore line. This is activated by pressing the “P” key while digitizing a breakline. A white vertical line is displayed in the profile view at the location where a point will be digitized in the Map View (see Figure 5).

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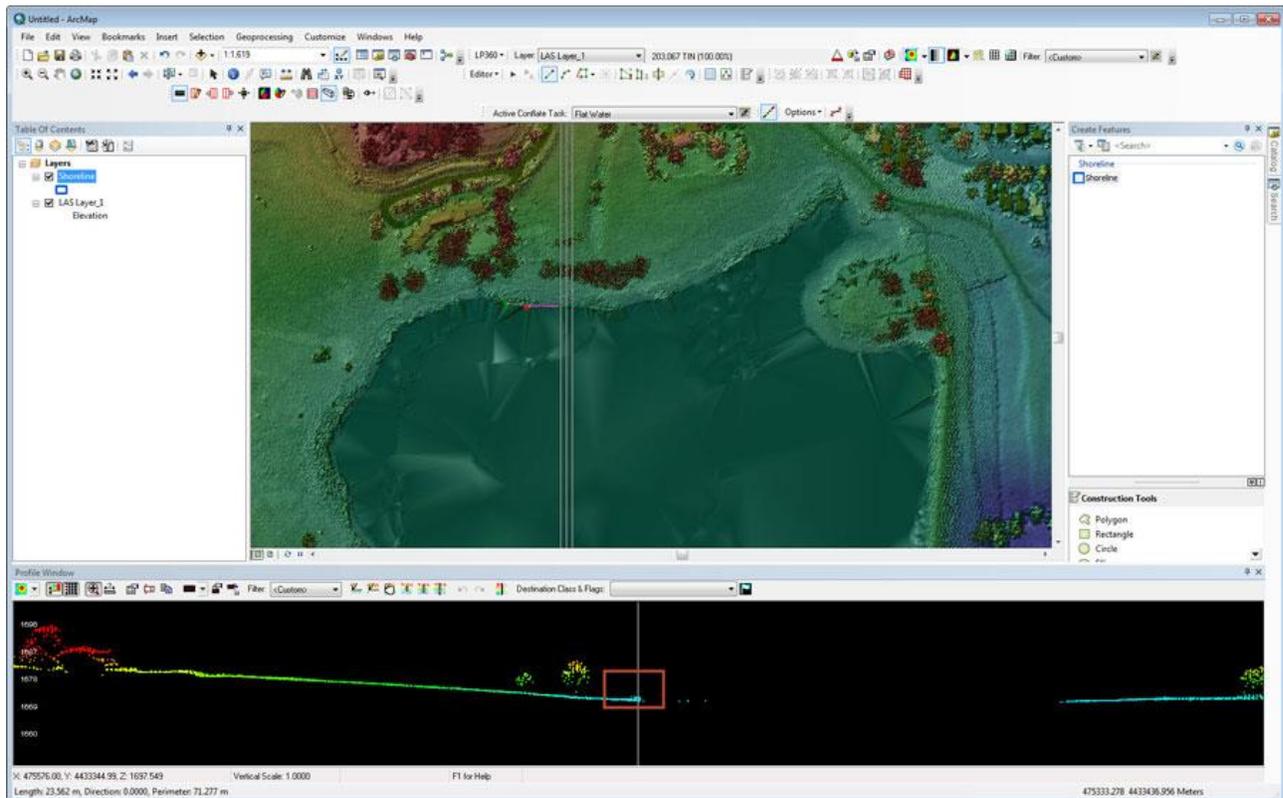


Figure 5: Digitizing the shoreline (note the vertical white line in the profile view)

The resultant breakline and collected statistics are depicted in Figure 6. Note that the system computed a mean Z value of 1,671.96 m with a standard deviation of 0.291 m. Due to the relatively small standard deviation, I am satisfied with this result and will apply the Mean Z as the elevation to use for the flattening operation.

The next step is to classify all of the interior points as Water points. Note that I could have done this concurrently with digitizing the breakline. However, I like to keep this as a separate “Classify by Feature” step in case I make a mistake in breakline digitizing and have to modify the feature.

The interior points are reclassified to Water by using the “Classify by Feature” tool in LP360. I set the source class to All and the destination class to Water (see the LP360 online help for details on this and the other operations in this article).

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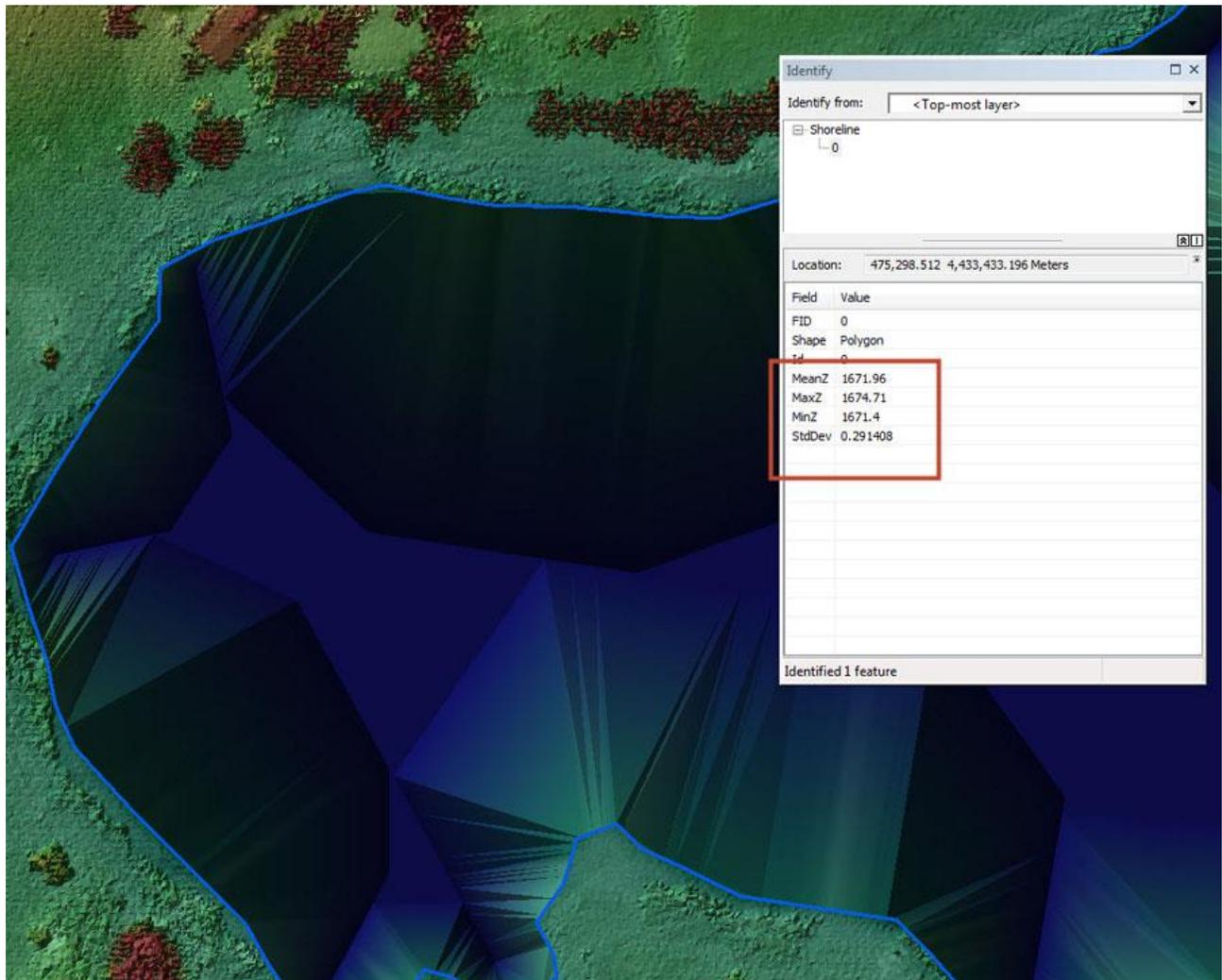


Figure 6: Breakline with collected statistics

I am now ready to enforce my new breakline. In the breakline enforcement dialog, I set the “Buffer Class” to Water so that the water points are not included in the TIN surface. The result is depicted in Figure 7. Notice that the water surface is perfectly flat (in the TIN rendering) and that none of the contours cross the breakline.

To create a Digital Elevation Model (DEM) with the breaklines enforced, I simply use the Export Wizard in LP360, setting the breakline option the same as I have in this exercise. The result will be a gridded elevation model with flat water surfaces.

In the next edition of LP360 News, we will examine breaklines where the Z component varies from vertex to vertex. If you have any problems with breakline concepts, just post a note to our new Google Group, “LP360.”

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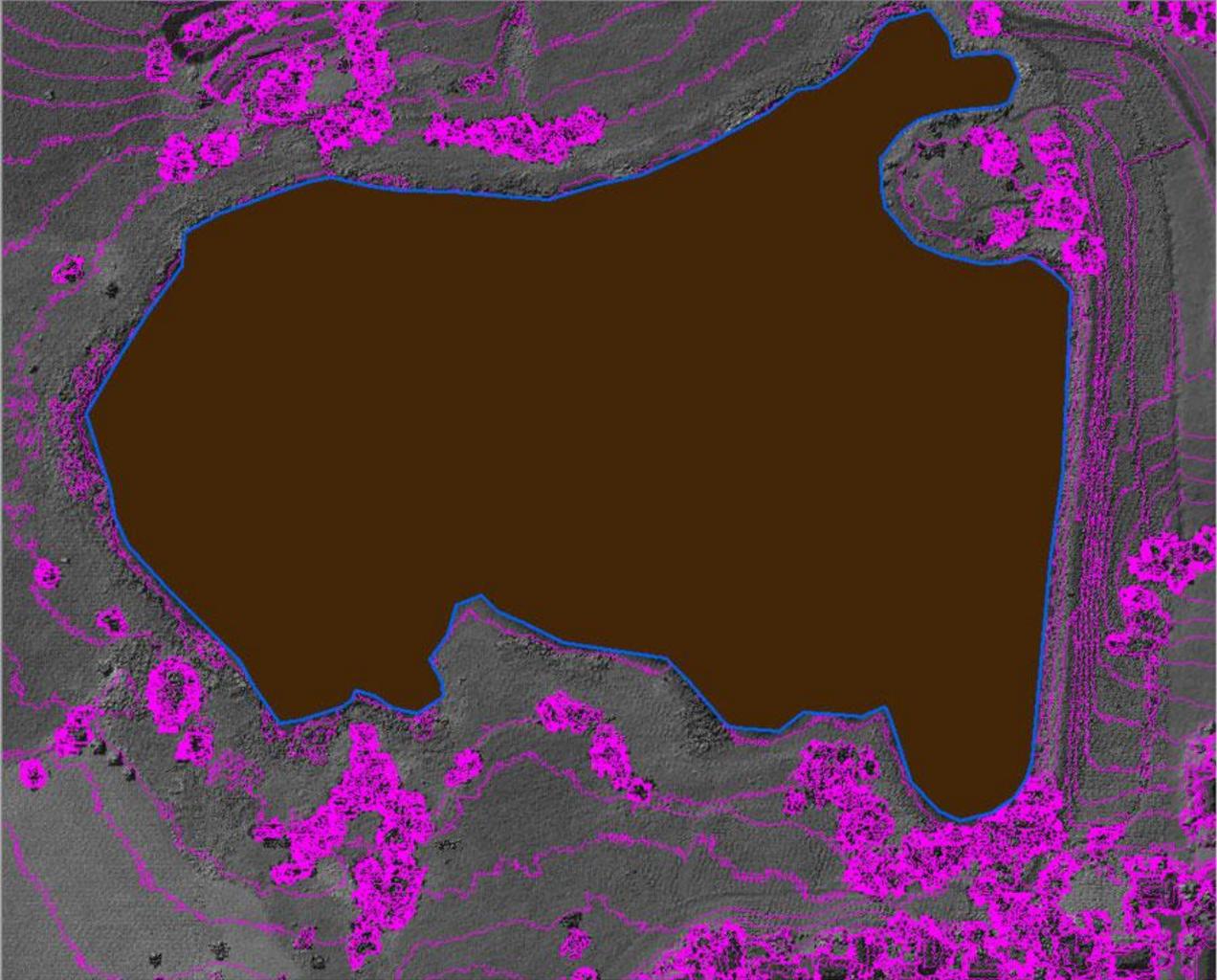


Figure 7: The enforced breakline