Tools, Tips, and Workflows

LP360/Topolyst Feature Analyst
LP360, versions 2014.1 and above

B S A T | A W G

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Feature Analyst is an exciting new tool that will appear in LP360/Topolyst 2016.2. To motivate this discussion, I will provide a synopsis of a few use cases for Feature Analyst here. A detailed look at these cases is presented at the end of this article. Examples of tests you will be able to perform with the 2016.2 release include:

- Water body flatness (Flat Feature)
- Monotonic Hydro Drainage (Downhill/Uphill)
- "Fudge Factor" in creating drains (M Value tests)
- Contour flatness test
- Stockpile toes deviating from the surface
- Unintentional holes (CW/CCW)
- Too much polygon detail (Minimum Polygon Area)
- Many other examples….

We have been working with a small group of customers (primarily from the US Government) who do a lot of feature collection from LIDAR-based data sets. This work is primarily in support of hydrological modeling but can also encompass planimetric mapping operations. The group forms what I call the "LP360 Advisory Group" or "LAG." This group advises us on capabilities for our software that will make a significant positive impact on their work.

We have been adding a lot of new feature collection tools to the standalone version of LP360 (Topolyst being the same as this albeit with a different licensing model) in support of these needs. The first batch of these tools appeared in the 2016.1 release of the products this past June. The rest of this article applies to the standalone version of LP360 (Standard licensing level) and Topolyst. Recall that LP360 licenses include both a license for the standalone version as well as the ArcGIS® extension. Topolyst is available as a Windows® standalone product only.

The LAG has been in discussions regarding the time it takes to validate features under different scenarios. Most of these features form LIDAR breakline models although they can serve other purposes as well. Often questions such as "are all my flat water polygons really flat?" require either a tedious interactive inspection or the writing of test-specific code.

In response to these analysis needs, we have added a new Feature Analyst tool to LP360. This tool is part of new Feature Edit suite in LP360 Standalone (as well as Topolyst). Feature Analyst replaces the Attribute Editor tool that appeared in 2015 LP360/Topolyst release. The very efficient aspect of Feature Analyst is that it links analysis directly to editing - find a problem with Analyst and then immediately correct with the editing tools.

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Tools
LP360/Topolyst Feature Analyst

In 2016.2, LP360 reaches parity with LP360 for ArcGIS® in terms of feature edit tools, especially the breakline creation and edit tools. This includes full support for Measure values ("M" values) on 2D and 3D features. Our users are finding LP360 (standalone) to be an extremely efficient environment for collecting, analyzing and repairing features not only because of the startup time (seconds as opposed to minutes) but also because it is a native 64 bit Windows® application. Thus in 2016.2, you can use LP360 (standalone) for all of your feature collection and analysis needs.

The remainder of this article provides a detailed overview of the current state of Feature Analyst. Open Feature Analyst by pressing the Feature Analyst tool on the Feature Edit toolbar (see Figure 1) or by right clicking a feature layer in the table of contents (TOC) and selecting *Feature Analyst…*
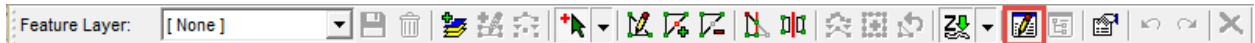

Figure 1: Invoking Feature Analyst

With Feature Analyst open (Figure 2), particular layers are loaded by a variety of actions:
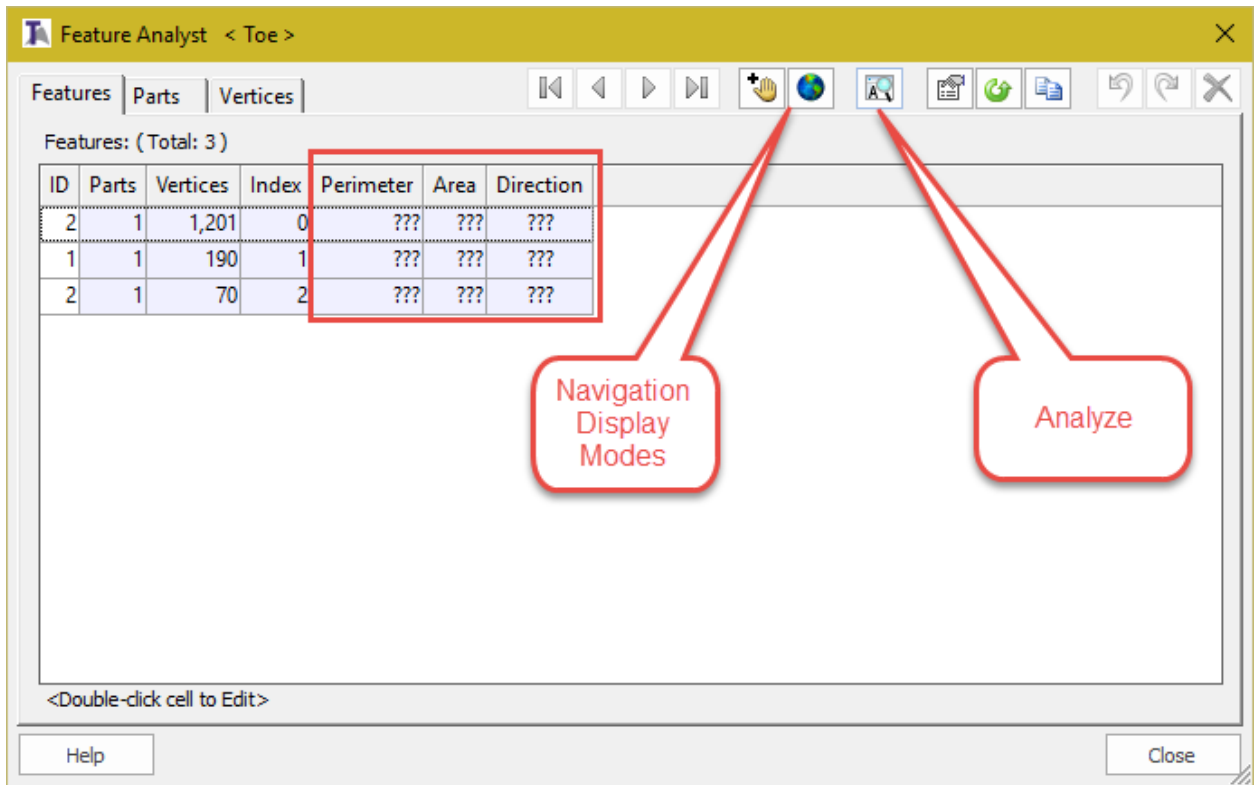

Figure 2: Feature Analyst dialog

- Open via the Right Click Menu on the TOC with a layer selected. That layer will load into Feature Analyst
- With Feature Analyst open, select a feature using either the Feature Edit tool or one of the Vertex Edit tools on the Feature Edit toolbar. The associated layer will load into Feature Analyst.

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Once Feature Analyst is open, you can navigate to the listed features (on the feature tab) by using the "VCR" buttons at the top of the dialog, by using the keyboard arrow keys while the Feature Analyst window has focus or by selecting features in the Map View using the Select/Edit Features tool.

Note that when Feature Analyst is first invoked (with no analysis tasks activated – more on this below), you may see some question marks in some columns. For example, in Figure 2 the columns Perimeter, Area and Direction are filled with question marks. These appear when a particular field is not directly readable from the Feature file but rather must be computed. It saves load time to not do this computation unless you areinterested in the results. Simply press the Analyze button (illustrated in Figure 2) to run analysis computations. Sometimes these computations can take some time (for example, running the "Flat" test on a dense layer of contours). In this case, a progress bar will display at the bottom of the Feature Analyst dialog. Figure 3 shows the dialog after pressing Analyze.
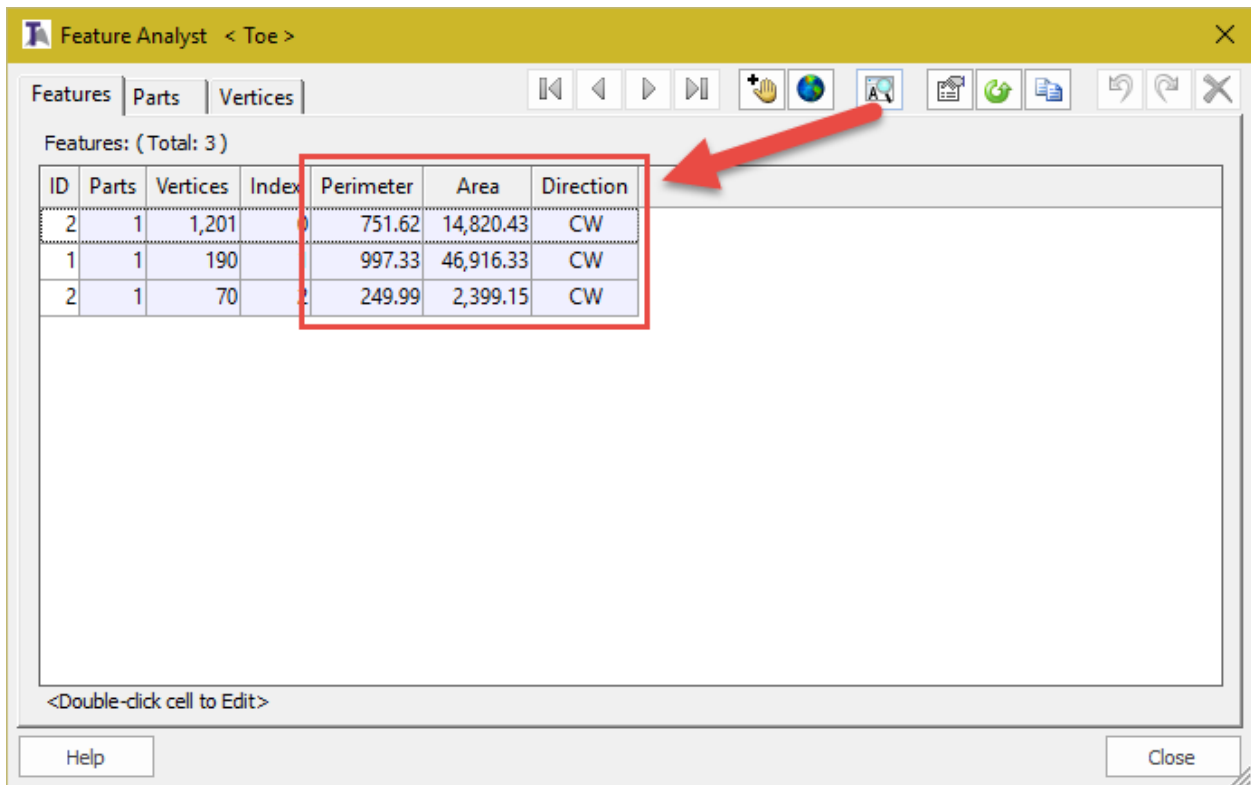

Figure 3: Previously uncomputed columns after pressing Analyze

As you select a row or rows in the Feature Table, the Map View, Profile and 3D views will update based on the settings pressed in the Navigation Display options; none (no action is taken), fit or window center (see Figure 2 for the location of these mode buttons).

If you select a single row in the Feature (or Part) list and switch to the Vertex tab, the vertices of the selected feature (or part) will be listed. You can also move to this mode by selecting a feature in the Map View using one of the Vertex edit tools. As with the Feature tab, you can navigate through the vertices by pressing the keyboard arrow keys (while the Feature Analyst window has focus) or by using

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the VCR style buttons at the top of the Feature Analyst dialog. A future article will be devoted to vertex editing.

Columns can be sorted in ascending order by pressing the column header (see Figure 4). You can reverse the sort order by pressing the column header a second time. You can sort by additional columns by holding down the *shift* key while pressing a column header. For example, to sort by segment length and then by X value, first press the column header for Segment Length and then, while holding down *shift*, press the column header for X.
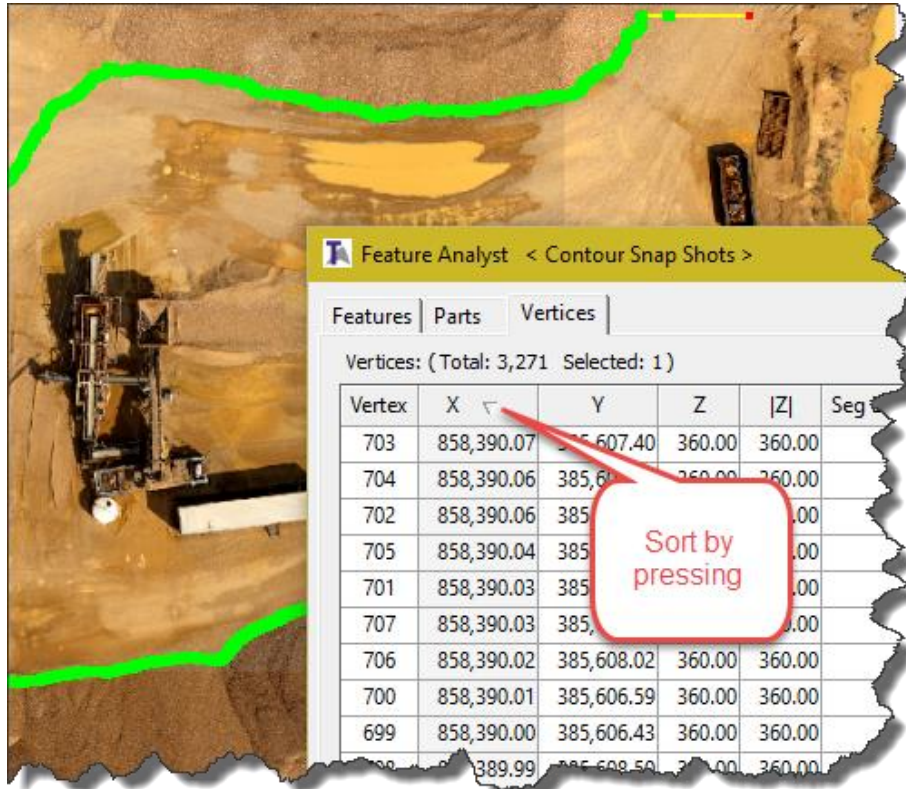

Figure 4: Sorting columns

You can quickly navigate to any row in the vertex table by enabling the display modes of window center and/or fit.

So those are the preliminaries for using the navigation tools of Feature Analyst. Let's now focus on analysis.

First of all, you can do a tremendous amount of analysis just using the sorting and navigation commands. For example, a standard column in the vertex table is Slope. This column is the value, for each vertex, of the elevation slope from the current vertex to the next vertex. If the slope is positive, the segment is pointed uphill. If negative, the segment slopes down. Thus to inspect a line to ensure it conforms to a downstream constraint, you can simply sort on slope. This will reorganize the vertices in descending order of slope. You immediately know that if any segments have positive slope, the line

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violates the downstream constraint. Furthermore, you can immediately drive to the offending segment by setting the Fit mode on the navigation options and select the row with the offending uphill slope. The map will center on this segment with the first vertex of the offending segment *selected.* This is illustrated in Figure 5 where I have selected the start vertex of the segment with maximum positive slope for this feature. Note that we can even exam the nature of the erroneous segment by viewing in the synchronized profile view - we can clearly see the uphill slope of the segment beginning with the selected vertex (selection color in the illustration is purple).
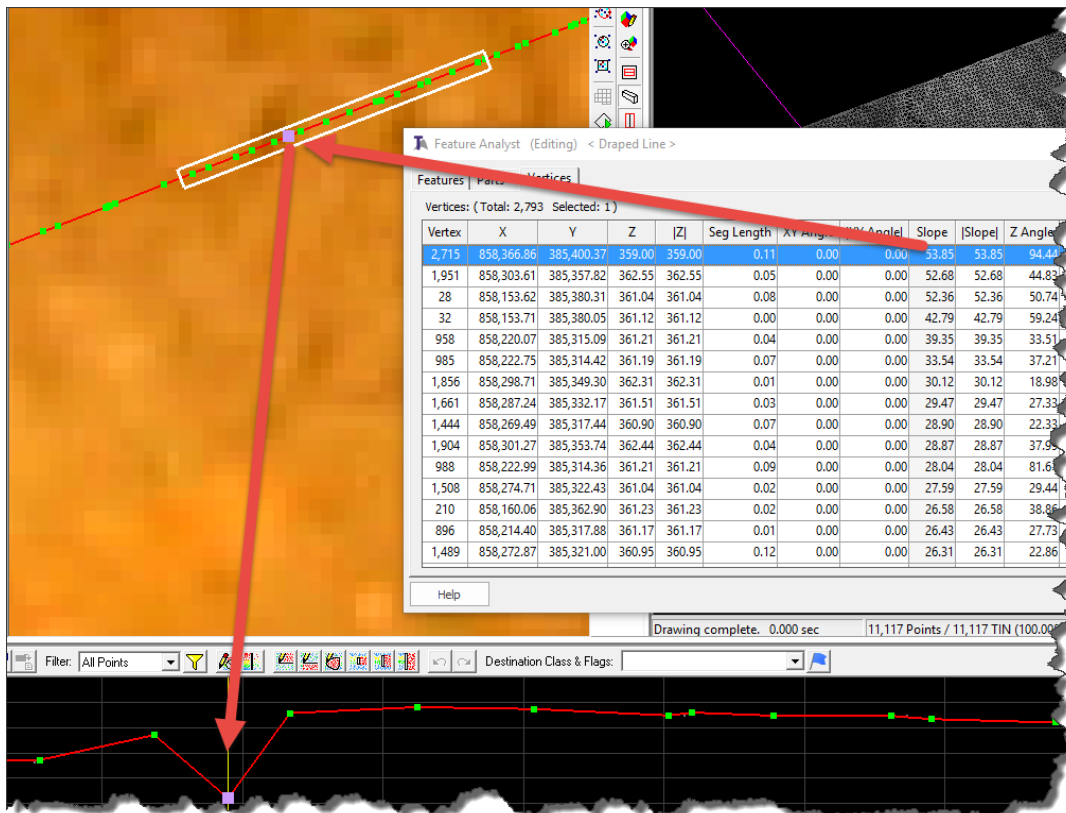

Figure 5: Using sorting to locate problems

Of course, it would be completely impractical to inspect every feature in a dense data set by sorting each on the parameters of interest! Looking at the QC needs of our LP360 Advisory Group resulted in the design of efficient methods to do a variety of constraint checks.

The Options dialog of Feature Analyst contains (as of 2016.2) five tabs devoted to various tests. The tabs include test groups for:

- General
- Planar
- Vertical
- Size
- Measure ("M") Values

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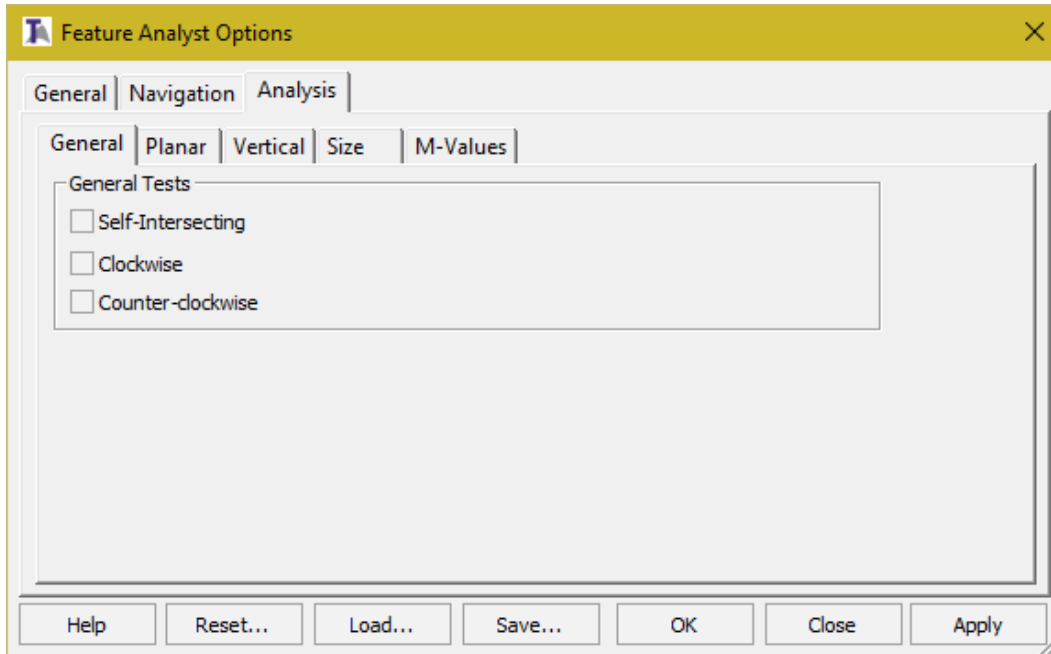The Analysis tab with the General subtab selected is illustrated in Figure 6.

Figure 6: The Analyze tab of Feature Analyst showing the General tests

Figure 6 through Figure 10 show the tabs of the tests that are currently available. I will not describe each of these tests since their action is self-evident from their names. Note that we will be adding to these tests as we receive feedback from you and other users.
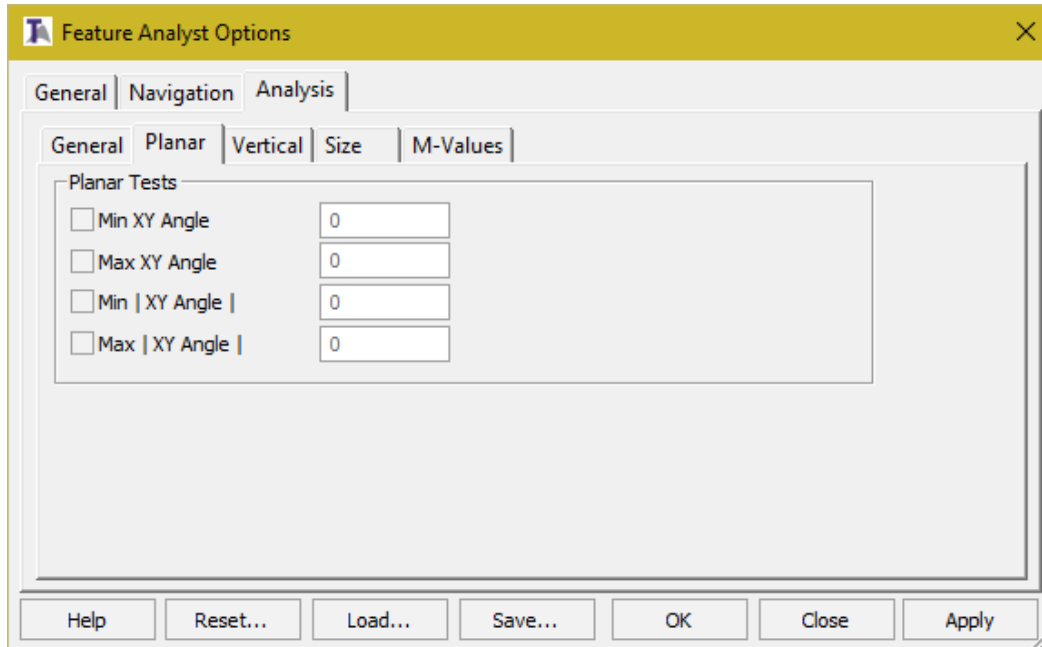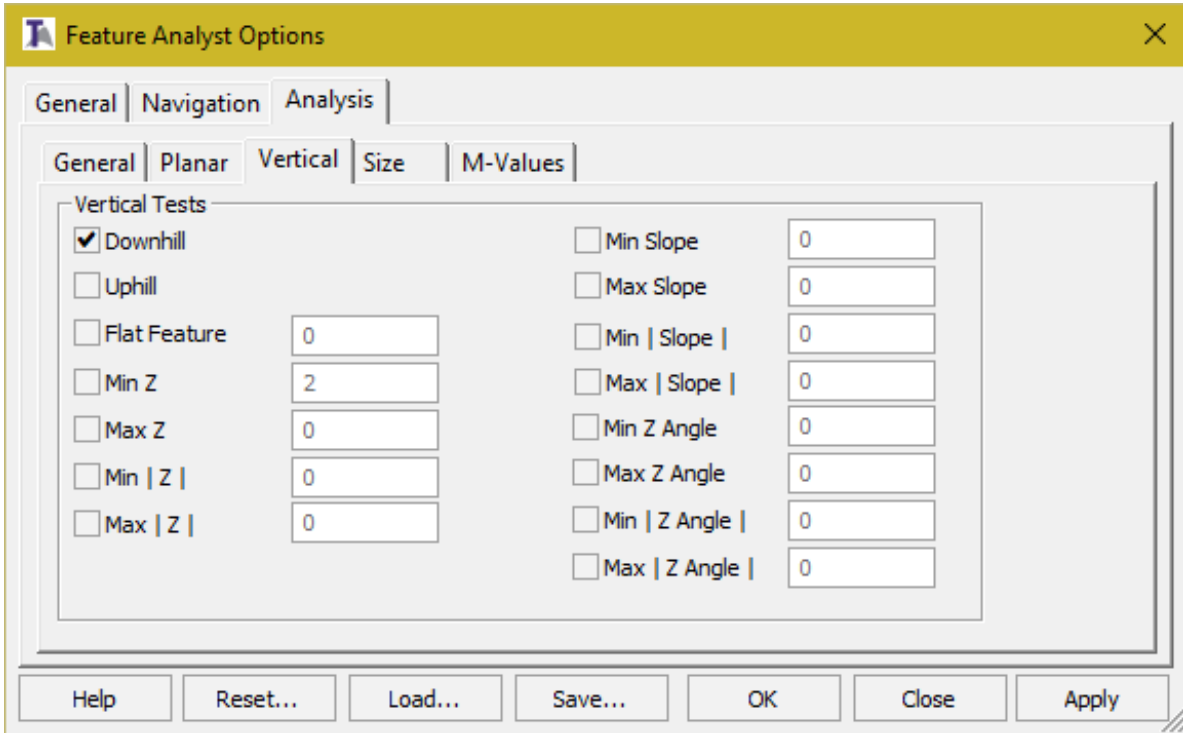

Figure 7: Feature Analyst planar tests

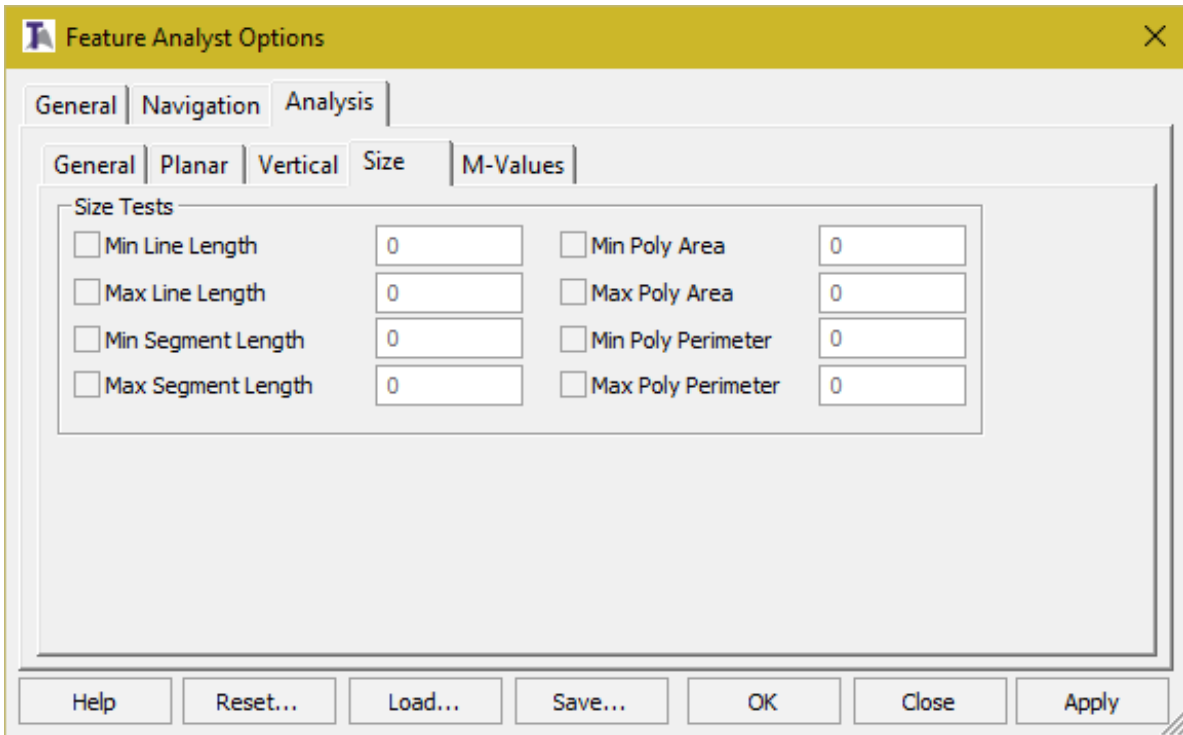**Lewis Graham**   Page **6** of **11**   GeoCue Group
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Figure 8: Feature Analyst vertical tests

Figure 9: Feature Analyst size tests

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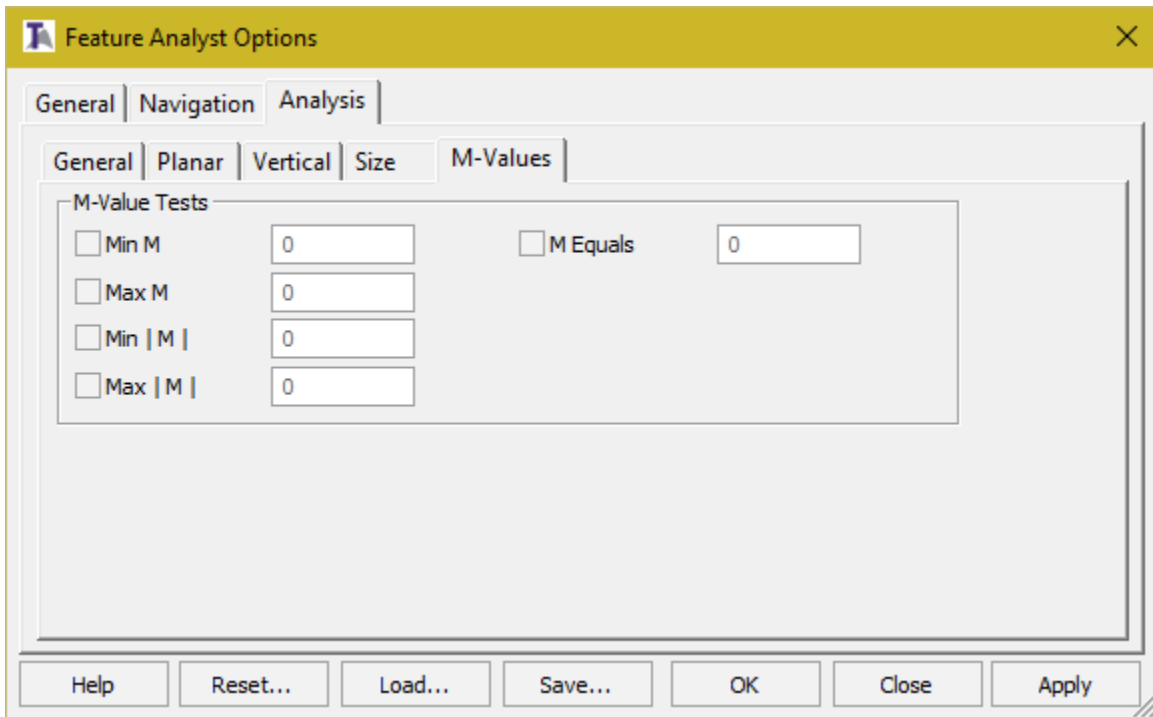GeoCue Group
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Figure 10: Feature Analyst M Value tests

All of the tests are applied in isolation. For example, if (in Figure 10) you set both a Min M and a Max M test, these tests are individually applied. The value of parameters (if needed for a test) are always inclusive of the set value. For example, if you set the Min M test to 1.0 then any feature with an M value of 1.0 or above will pass the test. Any feature containing a vertex with an M value strictly less than your keyed in value of 1.0 will fail the test (we use machine epsilon as the threshold for these tests).

For each test that is enabled via the test tabs, a column is added to the Feature table in Feature Analyst. Hovering over a column will reveal, via a tool tip (the Feature Analyst dialog must have focus) the name and value of the test. An example where I have set up four tests is shown in Figure 11. Note the name and parameter value shown for the Max XY angle test by the tool tip. Notice also that the question marks are shown in columns for which the test has not yet been executed. Tests are executed by pressing the Analyze button on the Feature Analyst tool bar.

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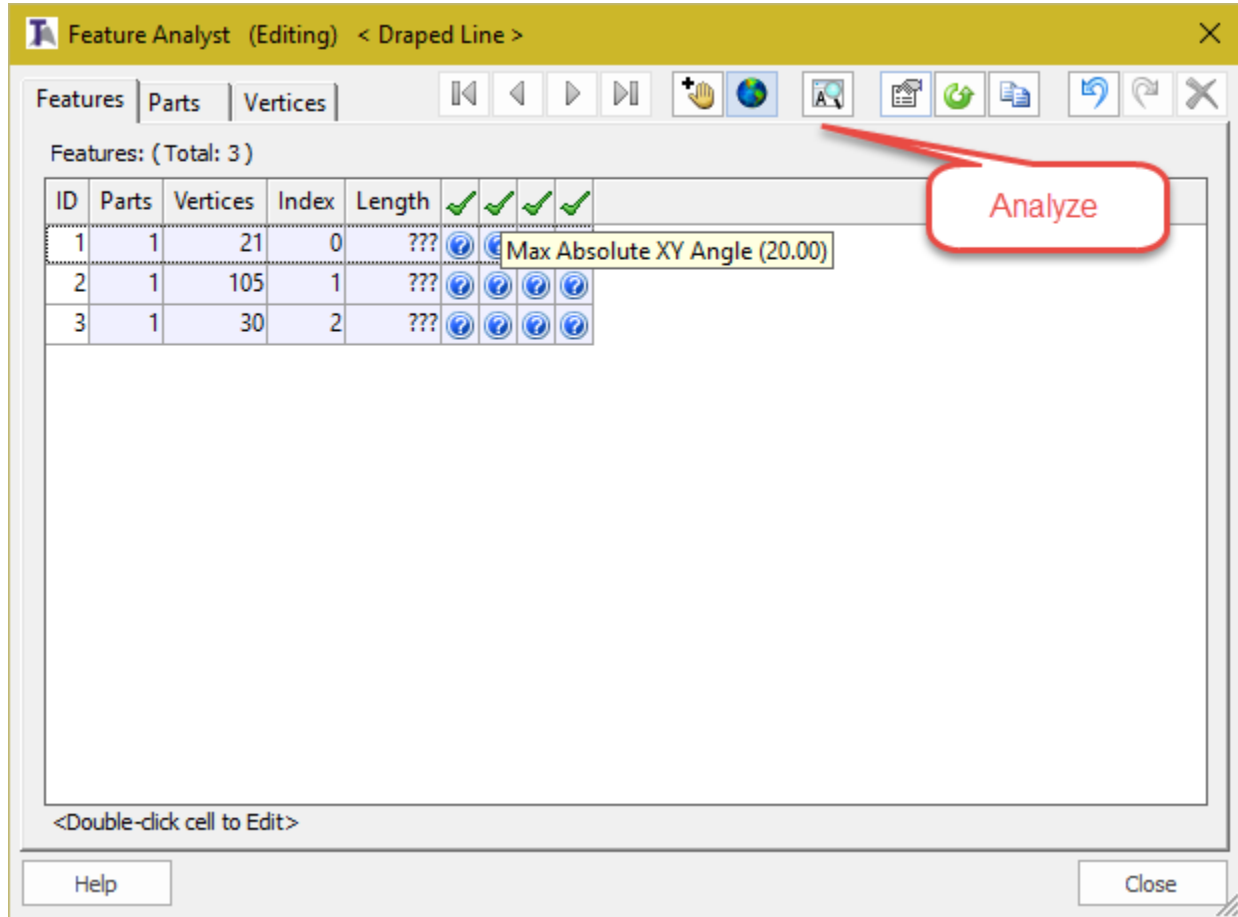
Figure 11: A test setup prior to application of the Analyze button

Figure 11 shows the Feature Analyst dialog immediately after pressing the *Analyze* tool. Note that passed tests are indicated as a green check mark whereas failed tests are signaled by a red x. Hovering over any check or x will provide a tool tip indicating the test and the parameters (if any) associated with that test. The column header will indicate a failure for that column if any feature failed the test. This makes quick work of seeing if *any* features failed a particular test. Like other columns, the test columns can also be sorted by pressing the column header. This allows you to group all of the failed features at the top of the dialog.

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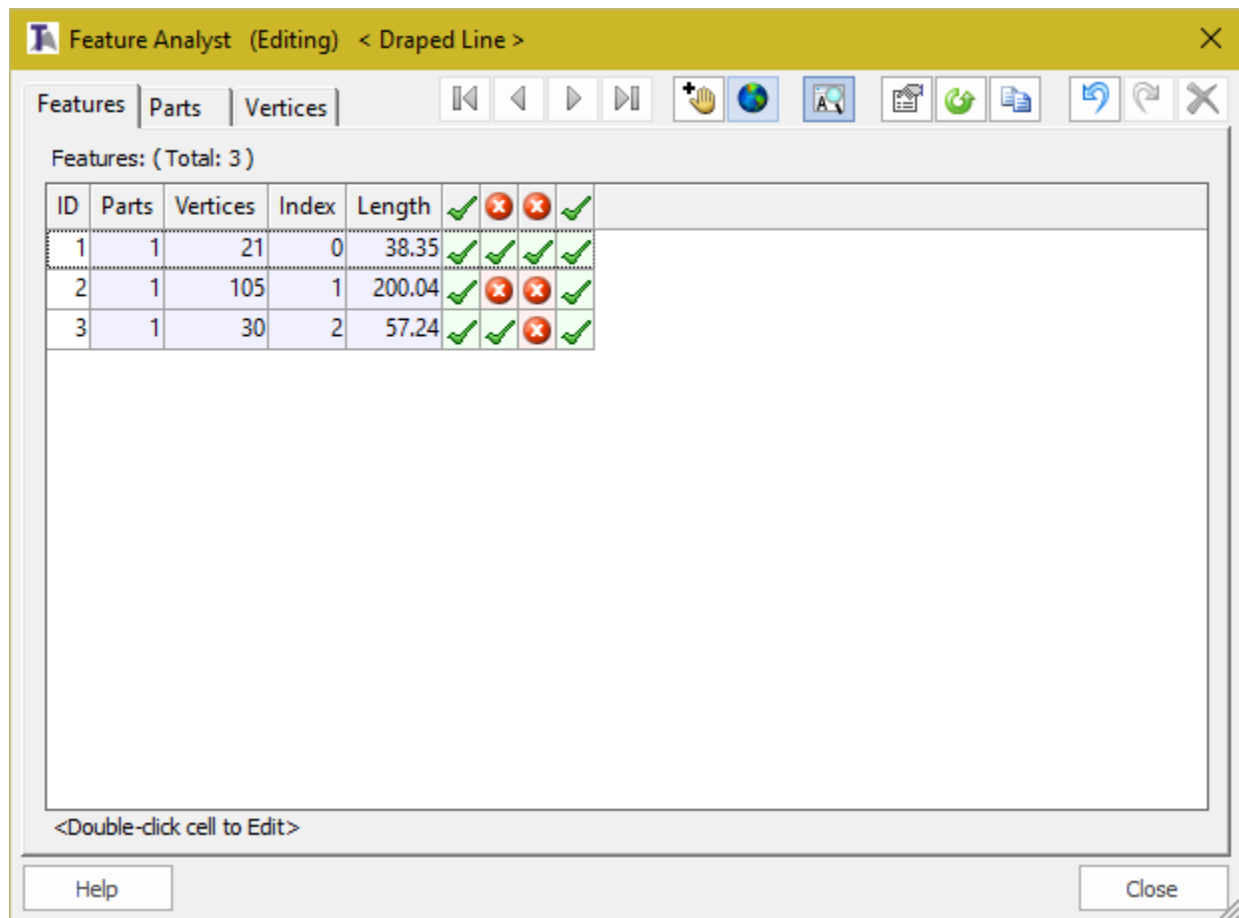GeoCue Group
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Figure 12: Feature Analyst immediately after pressing the Analyze tool

We will eventually put together a document containing use cases for some of the analysis tests. However, I expect that you and other users will employ these tools in ways that we have not yet imagined! To get you started, here are a few cases we had in mind when designing the tests:

- Water body flatness (Flat Feature) – This one is on the vertical tab and is used for testing how closely a polyline or polygon conforms to a horizontal plane. The obvious use for this test is checking to ensure that water body polygons that are supposed to represent flat water bodies actually do so. The parameter specifies how much you will allow the vertices to deviate from flatness in the vertical direction. For example, if your vertical units are feet and you key in 1.0 for the flatness parameter, any feature with the difference between the highest vertex and lowest vertex less than or equal to 1 foot will pass the test.

- Monotonic Hydro Drainage (Downhill/Uphill) – Again, these tests are vertical. They will flag any feature containing a positive (for downstream) or negative (for upstream) segment slope. These tests are used primarily for hydrographic conformance testing.

- "Fudge Factor" in creating drains (M Value tests) – Our downstream/upstream constraint breakline digitizing tools (now available in LP360 Standalone/Topolyst) force the desired vertical monotonic geometry by moving vertices in the vertical direction from where they would

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normally drape on the point cloud surface. The amount that a vertex has to be moved is stored in the Measure Value (M Value) for that vertex. If the vertex does not move at all, the M Value is 0. This test allows you to set the maximum permissible M Value criteria. For example, if you are using LIDAR data with an expected vertical precision of 15 cm (meaning 15 cm of vertical noise at a 95% confidence interval), you would expect some violation of downstream constraint just due to noise. The M Value test allows you to quantify this.

- Contour flatness test (Flat with tolerance value zero) - Sometimes we are provided *a priori* contours for use in a mapping project. Occasionally we find errant vertices within a contour (e.g. vertices that do not have the value of 460 in a contour that is to represent the 460 meter elevation). Applying the Flatness test with an acceptable range of zero to this contour layer will quickly validate all of the contours in one fell swoop.

- Stockpile toes deviating from the surface (Maximum | Z Angle|) - When creating stockpile toes, large changes in the vertical angle can be an indication of a toe that has made a dramatic excursion to something other than the true stockpile toe. A classic example is the toe vectoring up to an overhead conveyor. This test will locate these types of issues.

- Unintentional holes (CW/CCW) – The clockwise and counter-clockwise tests allow you to very quickly sort the polygons on a layer based on direction ("sense"). When creating breaklines, a counter-clockwise polygon is used to indicate a hole. Quite often, the direction of a polygon was the result of a mistake on the part of the user creating the breakline rather than an intentional indication of a hole. This test followed by selecting the offending polygons (by simply selecting their rows in the Feature Analyst table) and pressing the Reverse Geometry button on the Feature Edit tool bar immediately corrects this problem.

- Too much polygon detail (Minimum Polygon Area) – Some feature collection standards require digitizing water bodies larger than a particular size. This test might be used to see if features that are too small for inclusion in the data set have been collected. Unfortunately, it cannot show you the water bodies that simply have not been collected!

Feature Analyst is bringing the concept of "Queued Edit" to LP360/Topolyst. The idea is to locate problems and then be able to drive immediately to the offending issue with edit tools at the ready. By the release of 2016.2 (a few weeks from when I am writing this article), the test columns that are applicable at the vertex level will be shown in the vertex table columns. This will allow scenarios such as driving directly to the vertices that are violating the maximum M Value criteria.

Note that all of our current tests are intra-feature tests. As we extend our analysis tools in 2017, we will be adding inter-feature tests. Most of these tests will be aimed at topology corrections such as line crossings at different elevations. Of course, these tests will be paired with Feature Edit tools that can be used to correct the issues.

I think you will find these new tools amazingly effective for very quickly finding a wide variety of problems with feature data sets. Within the past year, LP360 (standalone)/Topolyst has become the "go to" tool for rapidly creating features in the context of a point cloud. As usual, I would very much appreciate any feedback you have on ways to improve this overall experience.

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