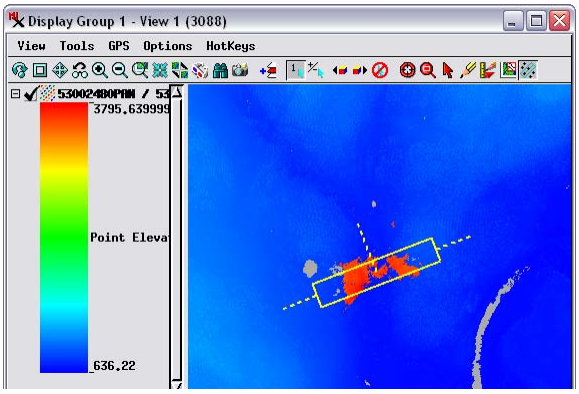
Automatically Classify Noise in LAS Point Clouds

LIDAR point clouds may include *noise* points, which have anomalously high or low elevations in comparison to the elevations expected for ground, vegetation, and structures in the survey area. Points with anomalously high elevations can be caused by laser pulse returns from thin clouds and haze, birds, or low-flying aircraft. Multiple reflections from structures and trees also may result in returns with excessively long travel times and thus point elevations that are anomalously low. When point clouds are displayed with points colored by elevation, noise points expand the apparent elevation range and therefore limit the range of colors assigned to the valid elevation points (see illustrations to the right).

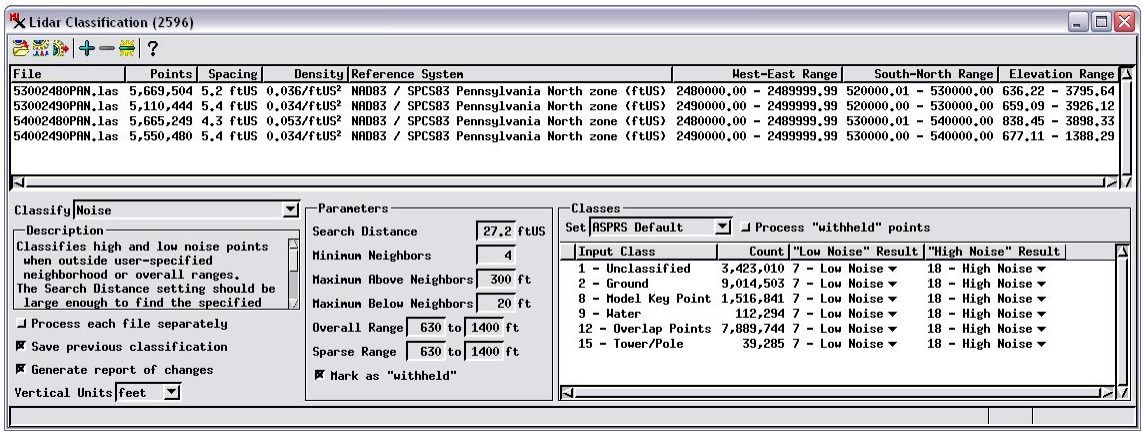


2D View (above) and Point Profile (below) of LIDAR point cloud (points colored by elevation) with patch of high noise points (red) that are more than 2500 feet higher than corresponding ground and structures. Because of these high points, all other points with valid elevations are only shown in shades of blue.

You can automatically reclassify noise points in one or more LAS point cloud files using the Lidar Classification process in TNTmips (Terrain / Lidar Classification) by choosing the Noise option from the Classify menu. You can choose to process points in all input classes or exclude certain classes. Points that meet the noise criteria you specify are reassigned to the high noise or low noise classes. You also have the option to mark points as "withheld", which means that they will be excluded by default from further processing. Files are processed "in place", but you have the option to save the previous classification information along with the new classification (see the Technical Guide entitled *LIDAR: Automatically Classify LAS Point Clouds*).

Noise Classification Strategy

The noise classifier takes a two-tiered approach to identifying noise points. It first compares each point's elevation to an expected overall elevation range that you specify, and if the elevation is outside of that range the point is reclassified to the high or low noise class. If the point elevation is within the expected range, it is then evaluated based on its elevation above or below the surrounding points and assigned to a noise class if its deviation from the neighborhood elevation exceeds your specified threshold values. In order to set appropriate values for the noise classifier's parameters, you should first display and examine the LAS files to ascertain the expected overall range of ground and structure elevations and determine an approximate maximum height of vegetation and structures. If you are processing multiple files at the same time, they should be contiguous files from the same project area, as the same set of classification parameters are applied to all input files.



Noise classifier set to process four LAS files as a group. All input classes (Unclassified, Ground, Model Key Point, Water, Overlap Points, and Tower/Pole) are set to be included in the process. The option to also mark output noise points as "withheld" is turned on.

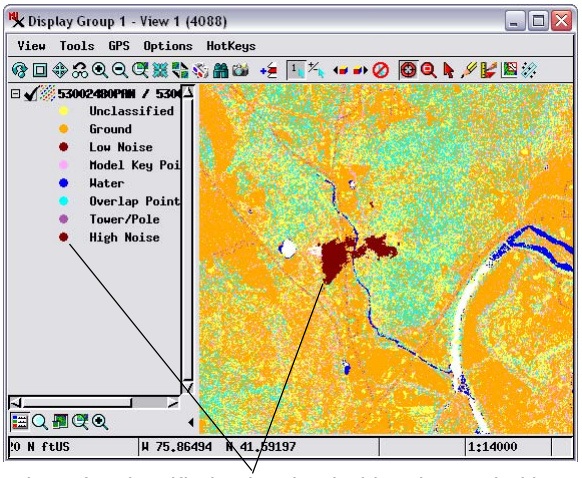
Noise Classification Parameters

Enter your expected overall minimum and maximum elevation values in the Overall Range fields in the Parameters panel. The settings in the upper part of this panel pertain to the neighborhood-based classification. The Search Distance value should be large enough so that the number of neighboring points you specify in the Minimum Neighbors field can be found for most points. A typical value would be at least 5 times the nominal point spacing (shown in the Spacing column for each file in the input file list).

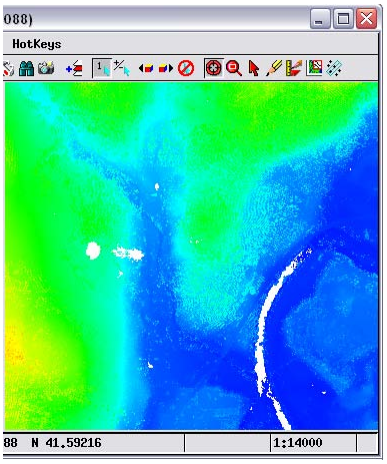
(over)

The values in the Maximum Above Neighbors and Maximum Below Neighbors fields set the maximum allowed deviations from the neighborhood elevation; a point whose deviation exceeds one of these thresholds is reclassified as noise.

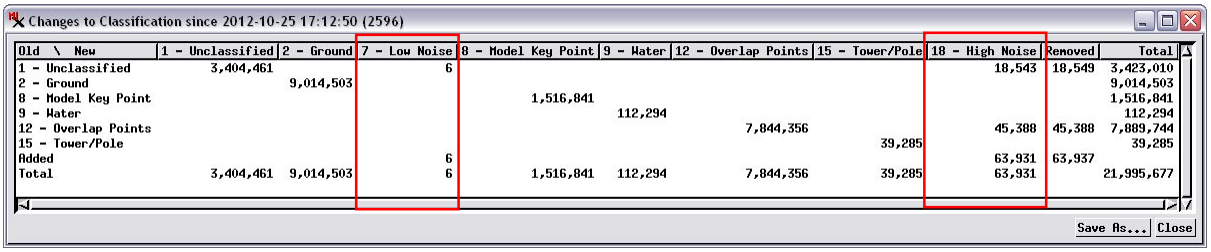
In some LIDAR files the spatial density of points may vary, with local areas having very sparse points, such that the Minimum Neighbors criterion cannot be met in the sparse areas. For example, large areas of open water typically have very few and scattered returns because most laser pulses are absorbed or reflected away from the sensor. If your input point clouds include a large open-water area with sparse points and a known elevation, you can set minimum and maximum allowed elevations for these sparse point areas in the Sparse Range fields in the Parameters panel (for example, a narrow elevation range above and below sea level for point clouds in a coastal area). Sparse area points that have insufficient neighbors for the neighborhood evaluation have their elevations compared to the specified Sparse Range and are reassigned as noise if their elevations fall outside this range.



View of reclassified point cloud with points styled by class, showing cluster of anomalously high points now assigned to the High Noise class (brown).



View of reclassified point cloud styled by elevation, with noise points omitted to show expaned color range for valid elevation points.



Old \ New	1 - Unclassified	2 - Ground	7 - Low Noise	8 - Model Key Point	9 - Water	12 - Overlap Points	15 - Tower/Pole	18 - High Noise	Removed	Total
1 - Unclassified	3,404,461		6					18,543	18,549	3,423,010
2 - Ground		9,014,503								9,014,503
8 - Model Key Point				1,516,841						1,516,841
9 - Water					112,294					112,294
12 - Overlap Points						7,844,356		45,388	45,388	7,889,744
15 - Tower/Pole							39,285			39,285
Added			6					63,931	63,937	
Total	3,404,461	9,014,503	6	1,516,841	112,294	7,844,356	39,285	63,931		21,995,677

Noise classification report for the block of 4 LAS files shown on the previous page. The Low Noise column shows that 6 unclassified points were reclassified as low noise. The High Noise column shows that 18, 543 unclassified points and 45,388 overlap points were reclassified as High Noise.