PAMAP
LiDAR Visual QA/QC
Lidar Block 2006 Land Air Woolpert
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Submitted to:
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QA/QC REPORT

1 Introduction

LiDAR data gives access to precise elevation measurements at a very high resolution, resulting in a detailed definition of the earth's surface topography. Dewberry provided an independent verification of the LiDAR data for PAMAP using a vertical accuracy assessment, a completeness validation of the LiDAR mass points, and a qualitative review of the derived bare earth surface. This report concerned one Lidar acquisition block surveyed in 2006 by Land Air Woolpert. It includes Elk, Cameron, Clearfield, Centre, Cambria, and Blair Counties.

The first step in the quality assurance/quality control (QA/QC) process was the completeness verification, to include a file inventory and a validation of conformity to format, projection, and georeference specifications, using a Geocue project management process that streamlines the deliveries and allows automated inventory and geospatial conformance. URS, as part of Dewberry's QA/QC team, was responsible for this part of the process.

Dewberry's vertical accuracy assessment report was previously delivered for Lidar Block 2006 Land Air Woolpert. The Lidar dataset met all accuracy specifications.

To fully assess the data for overall quality and usability, a qualitative review for horizontal accuracy, data anomalies, duplicate points, and data artifacts was conducted by Dewberry. Because no automatic method exists, Dewberry performed a manual visual review of all data, compared with acceptance criteria in the PAMAP QA/QC Work Plan. This visual review process included the creation of pseudo image products such as 3-dimensional models. By creating multiple images and using overlay techniques, not only could potential errors be found, but Dewberry could also determine where the data met and/or exceeded expectations.

All steps relevant to the production, data delivery, and quality control of the LiDAR data were tracked within a master Geocue project; consequently PennState has a centralized database with documentation of whether each tile meets the quality requirement or not during various stages of inspections and re-inspections. Furthermore, this report provides additional comments concerning the overall quality of the data, and lists minor issues that might be helpful for the improvement of the processing, if desired, for future applications.

Within this QA/QC process, two fundamental questions were addressed:

- Did the LiDAR system perform to specifications?
- Did the ground classification process yield desirable results for the intended bare-earth terrain product?

2 Quality Assurance

2.1 Tracking of LiDAR deliverables

This report is for the 2006 Land Air Woolpert Lidar block which contains Mercer, Venango, Forest, Lawrence, Butler, Clarion, Jefferson, Armstrong and Indiana Counties as shown on Figure 1. As mentioned in the introduction, this project utilizes Geocue to track and log the data processing, the QA/QC steps, and the deliveries. Each partner sends and receives DPMS deliveries (Distributed Production Management System) which allows the automatic validation of delivery completeness. For Lidar Block 2006 Land Air Woolpert, the required tiles are correctly populated, as illustrated with the map at Figure 2 with the corresponding checklist.

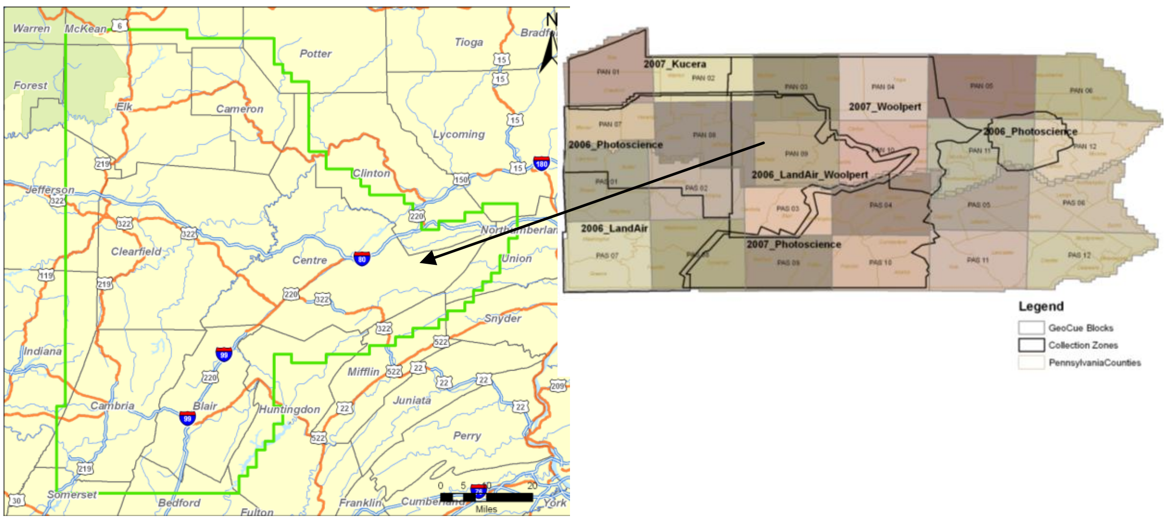
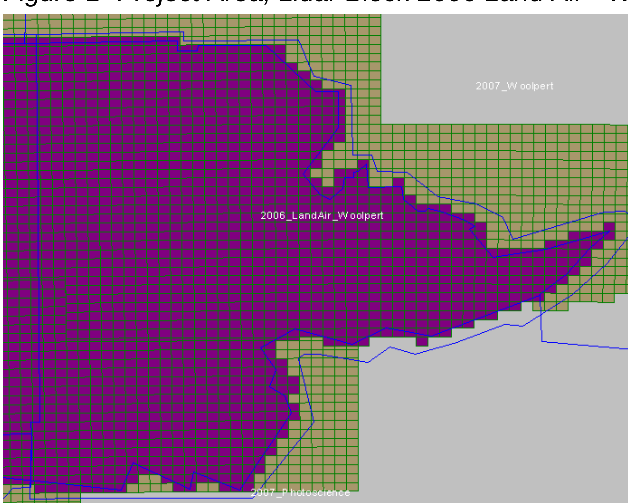


Figure 1- Project Area, Lidar Block 2006 Land Air - Woolpert



A	1	Initialization	Initialize the item.
I	2	d DEWS Received Lidar	Lidar has been received (y/n)?
I	3	d DEWS QC: Qualitative Analysis Pass?	Has the data passed 'Qual' QA checks?
I	4	d DEWS QC: Quantitative Analysis Pass?	Has this tile's group/area passed the vertical accuracy check? (Yes/No)
I	5	DEWS QC: Write report	Write report
I	6	d DEWS QC: Send report	Send report and all associated files

Figure 2 – Received LAS and Geocue checklist status for LiDAR QA/QC at Dewberry

To verify the content of the data and to validate the data integrity, a statistical analysis was performed on all the data. This process allows us to statistically review 100% of the data to identify any gross outliers concerning the classes and the min and max coordinates. No anomaly was found.

2.2 Qualitative assessment

2.2.1 Protocol

The goal of this qualitative review is to assess the continuity and the level of cleanliness of the bare earth topographic product. The acceptance criteria reviewed are as follows:

- If the density of LiDAR mass points is homogeneous, correctly supported by flightline overlap and sufficient to meet the user needs.
- If the ground points have been correctly classified (no manmade structures or vegetation remains, no gaps or data voids except over water bodies),
- If the ground surface model exhibits a correct definition (no aggressive classification, no over-smoothing, no inconsistency in the post-processing)
- If no obvious anomalies are present due to sensor malfunction or systematic processing artifacts (e.g., data holidays, spikes, divots, ridges between tiles, cornrows…).

In this project the LiDAR points were classified in 6 LAS classes:

1 – Unclassified (which includes the buildings)
2 – Ground
8 – Model key points (ground points that are key to define a ground surface)
9 – Water
12 – Non Ground (which includes vegetation)
15 – Road edges

In order to evaluate the cleanliness of a bare-earth model we combined classes 2, 8 and 15 to build a digital elevation model.

Dewberry QA/QC analysts, experienced in evaluating LiDAR data, performed a visual inspection of the bare-earth terrain. LiDAR mass points were first gridded with a grid distance of 2x the full point cloud resolution. Then, a triangulated irregular network (TIN) was built based on this gridded surface and displayed as a 3D surface. A shaded relief effect was applied which enhances 3D rendering. The software used for visualization allows the user to navigate, zoom and rotate models and to display elevation information with an adaptive color coding in order to better identify anomalies.

One of the variables established when creating the models is the threshold for missing data (data voids) or low point density. For each individual triangle, the point density information is stored; if it meets the threshold, the corresponding surface will be displayed in green, if not it will be displayed in red (see Figure 3).

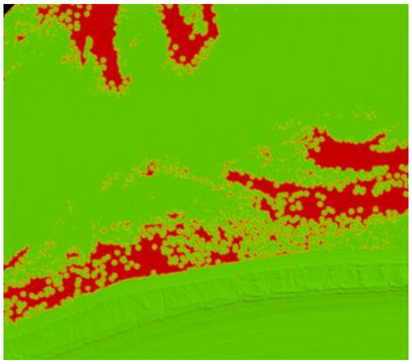


Figure 3 – Ground model with density information (red means no data)

The first step of Dewberry's qualitative workflow was to verify the point distribution by systematically loading a percentage of the tiles as mass points colored by class or by flightline. The particular types of displays, as shown at Figure 4 and Figure 5, help the QA/QC analysts to visualize and better understand the scan pattern, the flight line orientation and coverage, and give additional confirmation that all classes are present and appear to logically represent the terrain. Figure 5 also shows two examples of cross-sections cut through the LiDAR full point cloud to depict the six different LAS classes.

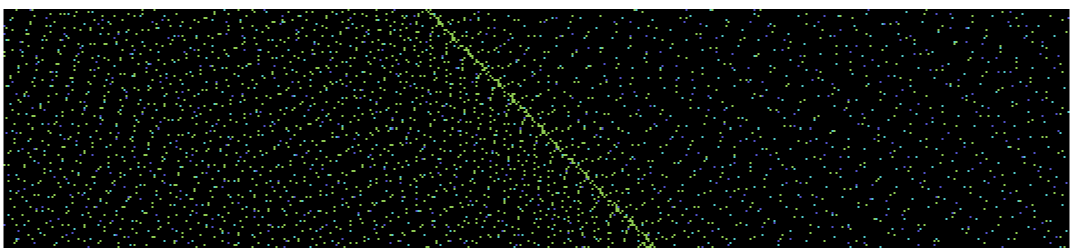


*Figure **4** – LiDAR points colored by flightline. Detail of the point distribution. Note the variations in the scan pattern*

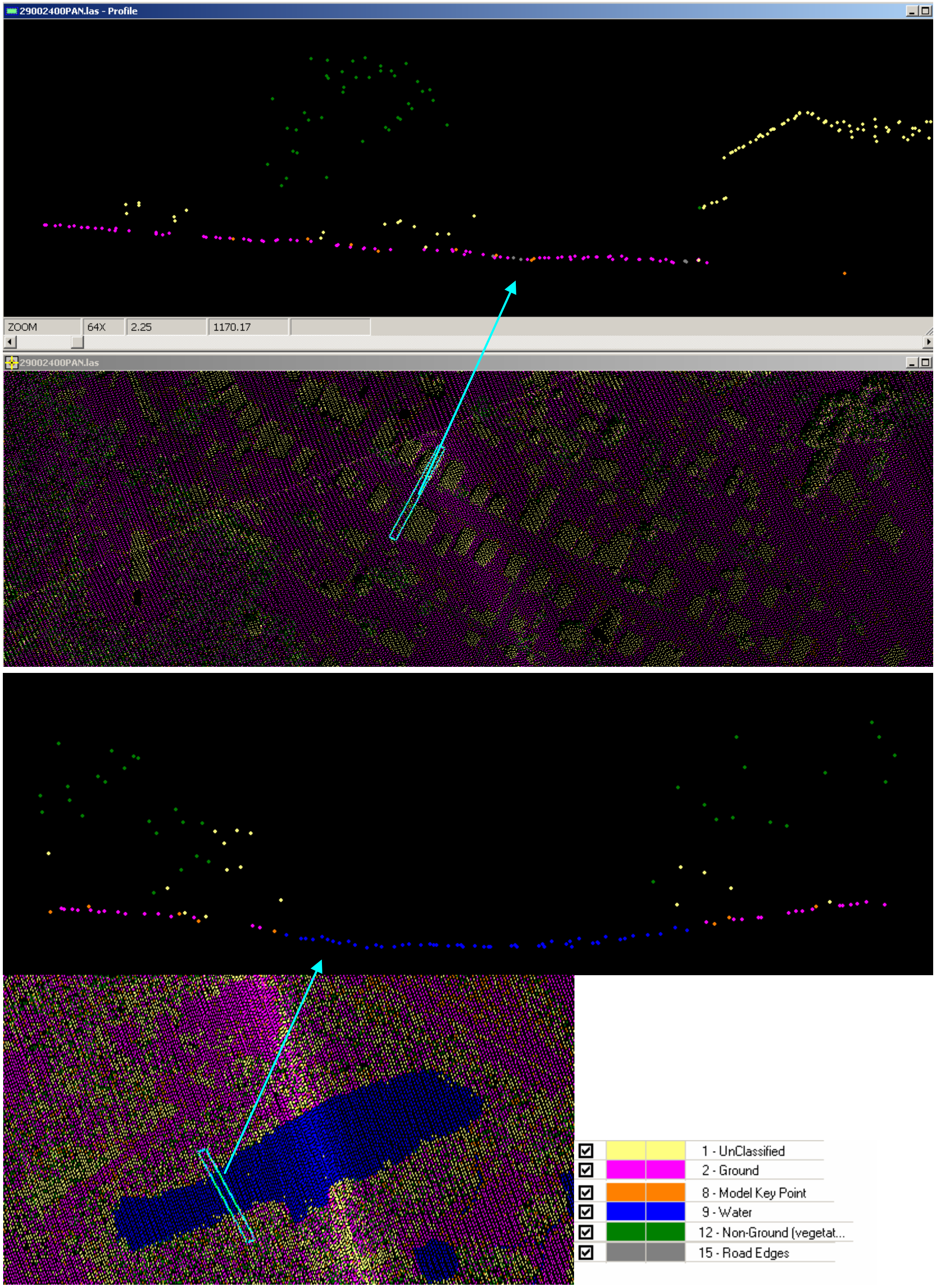


Figure 5 – Full point cloud colored by class

The second step was to verify data completeness, continuity and cleanliness using the bare-earth terrain with density information, displayed at a macro level for 100% of the tiles. If, during this macro review of the ground models, Dewberry found potential artifacts or large voids, then the digital surface model (DSM) based on the full point cloud was used, including vegetation and buildings, to help better pinpoint the extent and the cause of the issue. Moreover, the intensity information stored in the LiDAR data could be visualized over this surface model, helping in interpretation of the terrain.
Finally, in case the analyst suspected a systematic error relating to data collection, a visualization of the 3D raw mass points was performed, rather than visualizing as a surface.
The process of importing, comparing and analyzing these two later types of models (DSM with intensity and raw mass point), along with cross section extraction, surface measurements, and density evaluation, constituted Dewberry's micro level of review, performed as needed.

2.2.2 Quality Report

Dewberry's qualitative review included a macro visual inspection of all tiles. Our professional judgment is that the bare earth model is of decent quality. Generally speaking no remote sensing data void or significant anomalies were found in the data. The nominal point spacing of the ground mass points is approximately 3.5 ft.

Aggressive classification

A few occurrences of minor misclassification of ground were encountered in the data (see Figure 6). A section of the surface is aggressively removed from the ground class leaving gaps in the bare earth surface; however the general surface profile is fairly unaffected. Therefore, Dewberry does not consider this as a critical issue.

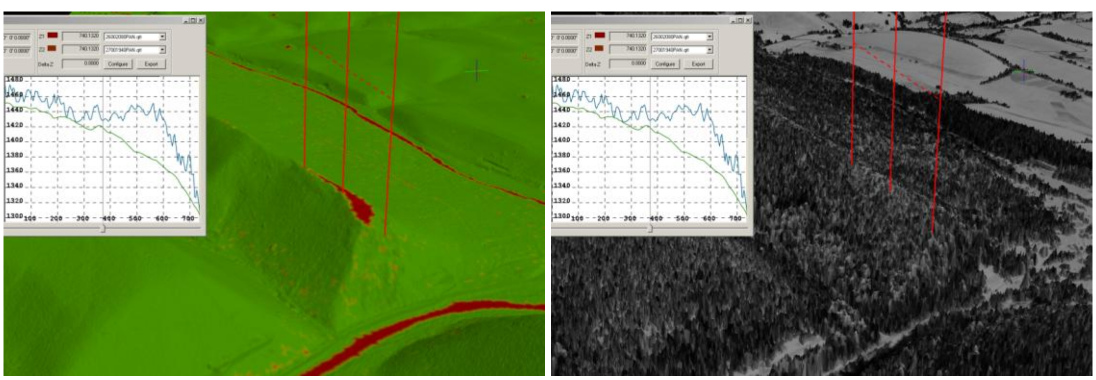
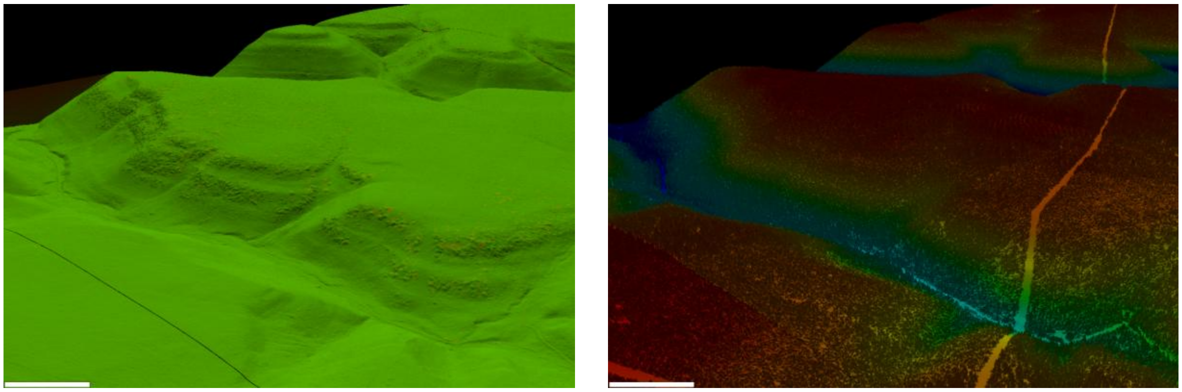


Figure 6 – Minor issue: 26002040PAN aggressive classification of the ground

Noise

Dewberry found some patches of ground which appeared rougher than the surrounding area. This occurs often when the vegetation is very dense, and the LiDAR may not penetrate the canopy all the way to the ground. Nevertheless, as soon as a few points are present, a 3D model can be built with a good reliability, especially in flat areas. This is illustrated at Figure 7.



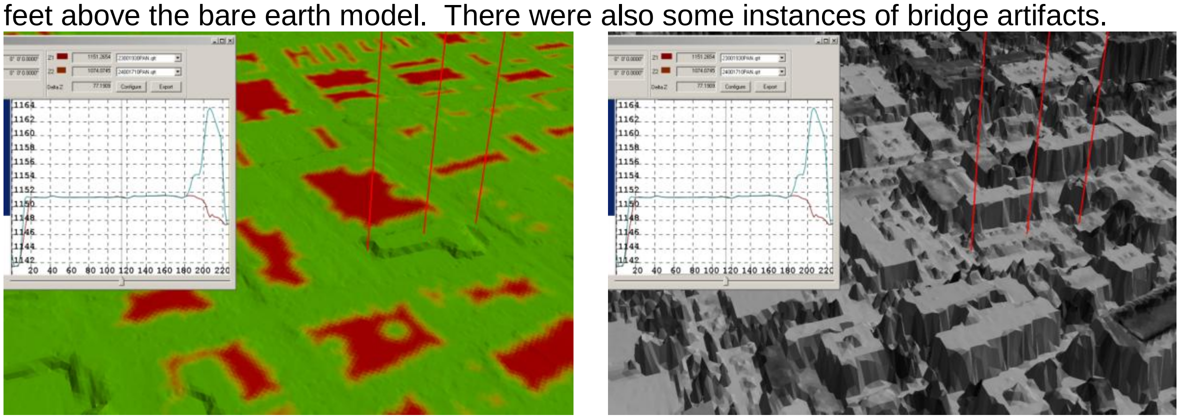
Bare-earth (class 2 + class 8 + class15) model with density information (red = sparse data)

Surface model with intensity (all classes)

Figure 7 – tile 39001780PAN - Noise

Building artifacts

Another classification issue that Dewberry encountered involved the presence of potential building artifacts (see Figure 8). These artifacts range in height from 10 to 20 feet above the bare earth model. There were also some instances of bridge artifacts.



Bare-earth (class 2+ class 8+class15) model with density information (red = sparse data)

Surface model with intensity (all classes);

Figure 8 – Tile 23001930PAN; Possible building artifacts

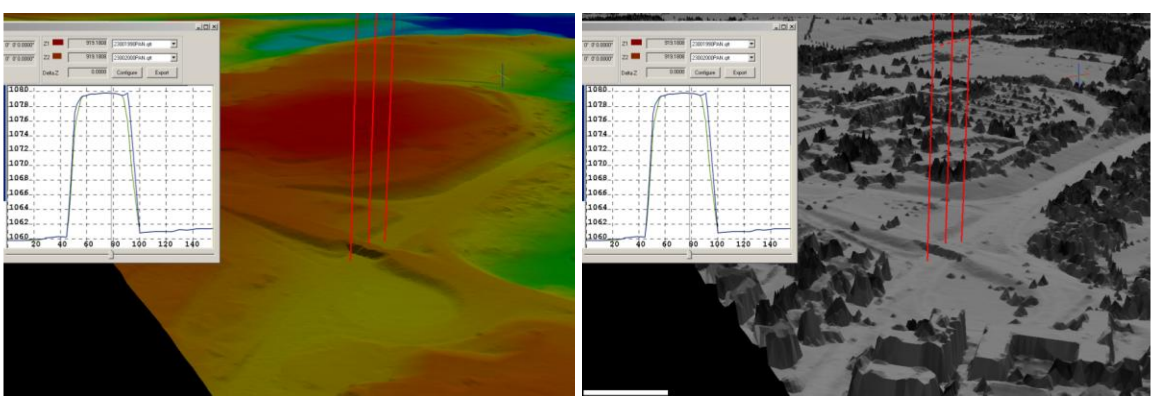
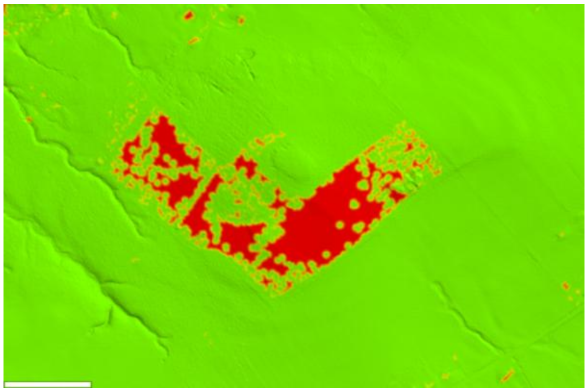


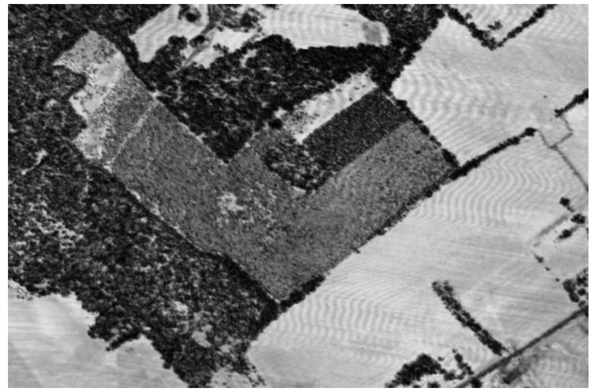
Figure 9 – Tile 24001940PAN; bridge artifact

Poor LiDAR penetration

Dewberry found many patches with lower density of ground points. When the vegetation is very dense, the LiDAR may not penetrate the canopy all the way to the ground; therefore only a few ground points remain after classification of the vegetation. Nevertheless, as soon as a few points are present, a 3D model can be built with a good reliability, especially in flat areas. This is illustrated at Figure 7.



Bare-earth (class 2 + class 8 + class15) model with density information (red = sparse data)



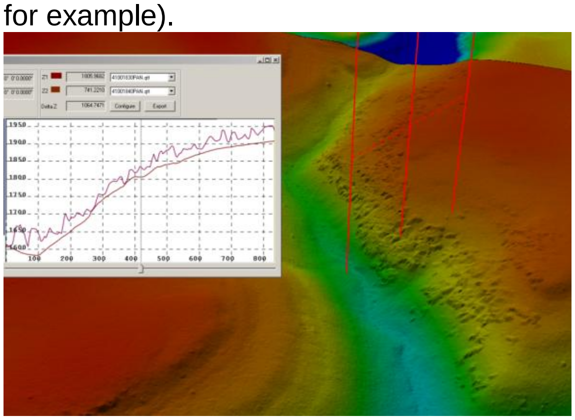
Surface model with intensity (all classes)

Figure 10 – tile 38001690PAS - Poor LiDAR penetration in dense vegetation

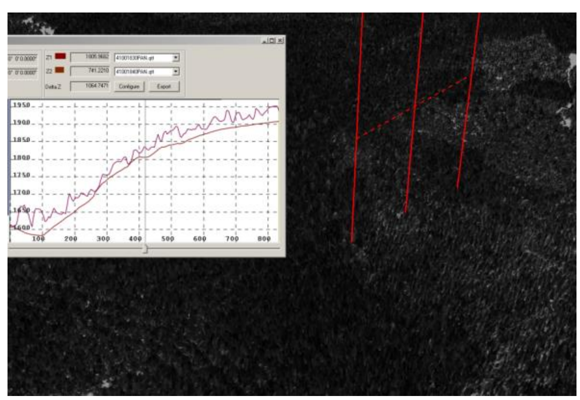
Based on the settings used by Dewberry to build the bare earth model, red zones in density colored images will correspond to a distance of over 32 feet between adjacent points; however the average density of the concerned zone may be better.

Vegetation artifact

Another classification issue that Dewberry encountered was the presence of potential vegetation artifacts (see Figure 8). Although it is conceivable that the soil exhibits natural small relief, we believe that they are vegetation remains. These artifacts are limited in height and appear as noise in the bare earth model. However, attempts to smooth such noise could result in over-smoothing of the terrain surface elsewhere, where small variations in relief need to remain to correctly depict the true surface (of stream banks, for example).



Bare-earth (class 2+ class 8+class15) model with elevation information

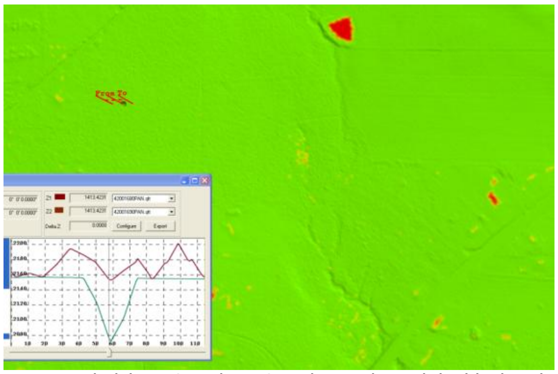


Surface model with intensity (all classes);

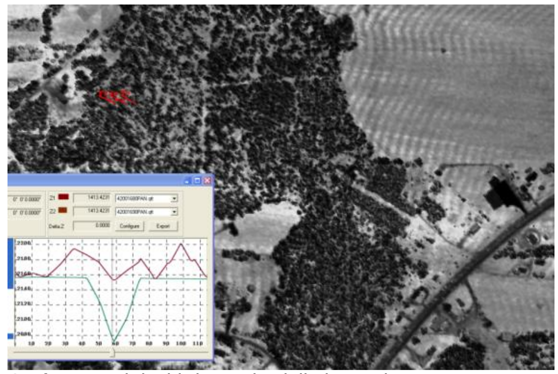
Figure 11 – Tile 41001830PAN; Possible vegetation artifacts

Divots

There were several divots varying in size within the project area. These can be seen in total in Appendix A. The elevation of a LiDAR point is set by the time it takes the pulse to return to the sensor. The divot in Figure 13 was likely to be created by a pulse bouncing off of an object (house wall) and taking longer to return to the sensor and thus having a lower elevation.



Bare-earth (class 2 + class 8 + class15) model with density information (red = sparse data)

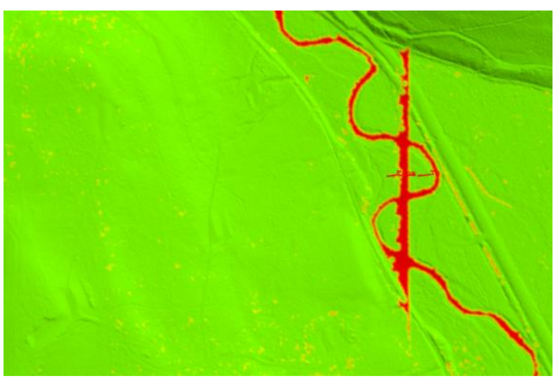


Surface model with intensity (all classes)

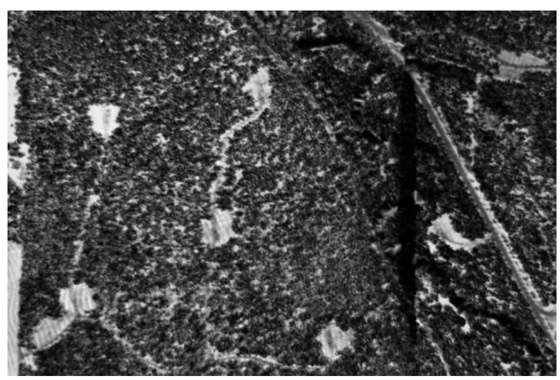
Figure 12 – Tile 44001700PAN; Divot

Special Missing Ground Issues

There was one tile on which we had a special issue which caused a portion of the ground to be removed. It seems as though the Lidar beam was able to penetrate the canopy at one angle, but unable to do so while collecting the same area from another angle. This created a linear shaped area of missing data. (See Figure 13)



Bare-earth (class 2 + class 8 + class15) model with density information (red = sparse data)



Surface model with intensity (all classes)

Figure 13 – Tile 26001700PAN – Missing ground

Figure 14 shows the tiles, which has the more frequently encountered issues. The errors on these tiles can be seen in Appendix A.

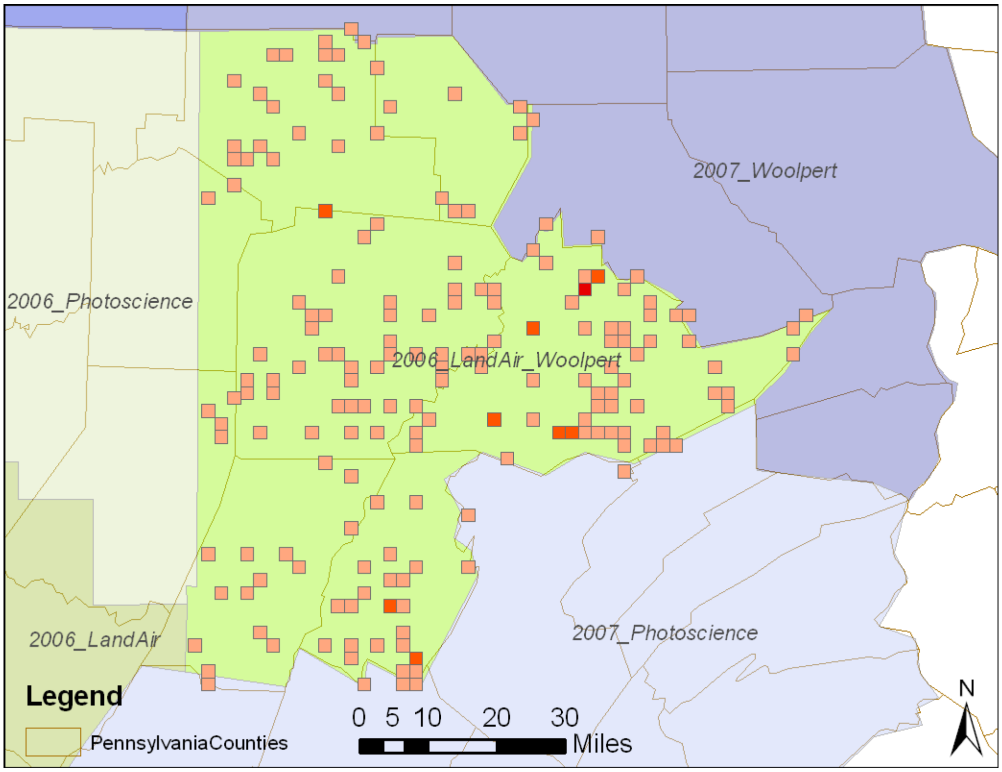


Figure 14 – 2006 Land Air Woolpert Issues

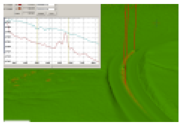
3 Conclusion

This review was performed by Dewberry to assess the quality of the LiDAR data and LAS classification of data. The quantitative vertical accuracy is reported separately.

Overall the data exhibits adequate detail even though some areas have lower point density. The level of cleanliness for the bare-earth terrain is of acceptable quality and no major anomalies were found. The figures highlighted above are samples of the minor issues that were encountered and are not representative of the majority of the data. Dewberry considers this dataset to pass the qualitative acceptance criteria in the PAMAP QA/QC Work Plan. This data will meet the needs of the general users of elevations data.

Appendix A Qualitative issues contact sheets

Aggressive Classification



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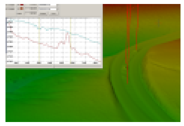

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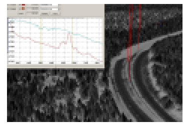

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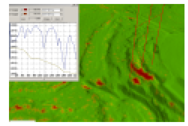

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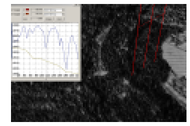

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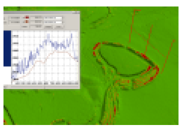

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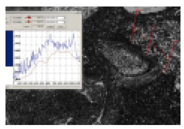

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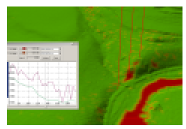

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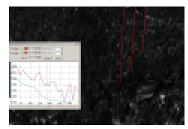

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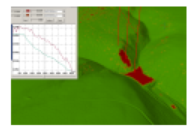

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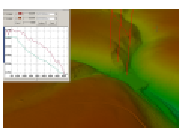

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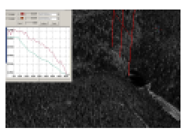

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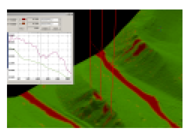

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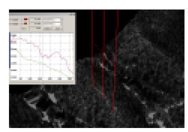

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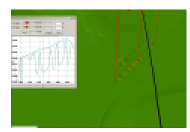

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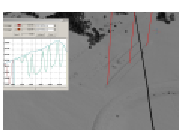

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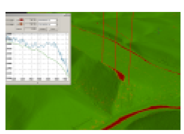

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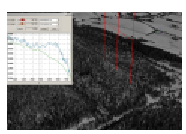

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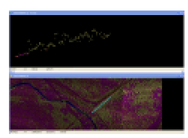

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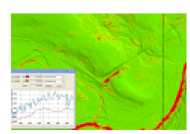

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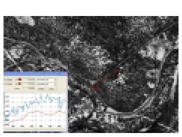

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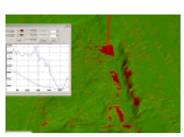

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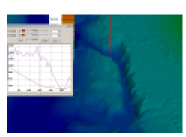

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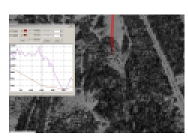

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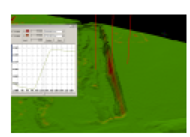

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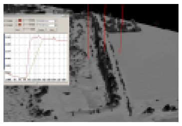
Aggressive Classification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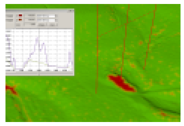
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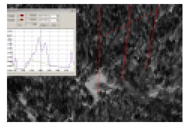
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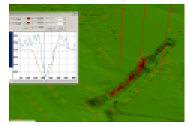
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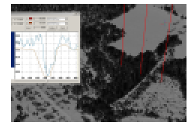
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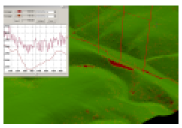
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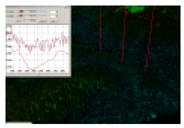
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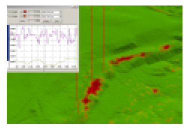
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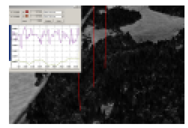
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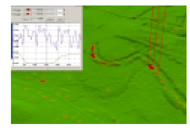
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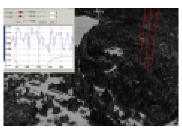
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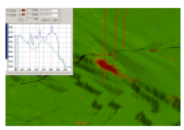
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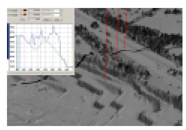
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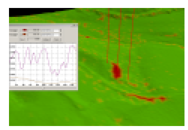
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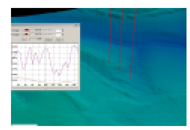
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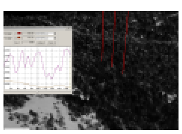
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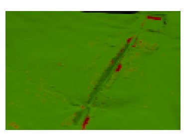
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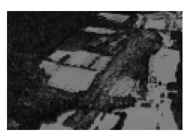
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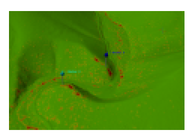
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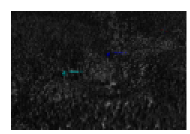
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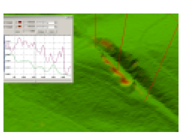
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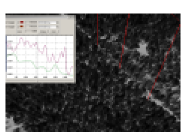
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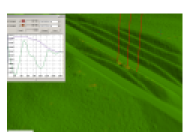
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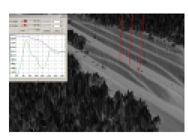
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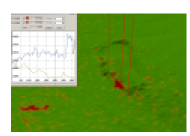
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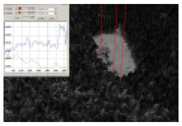
Aggressive Classification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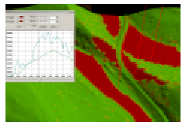
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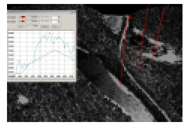
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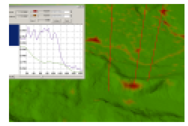
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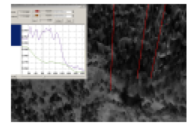
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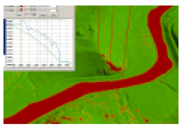
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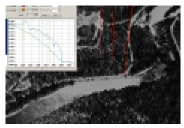
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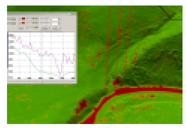
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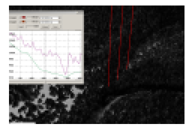
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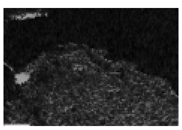
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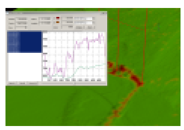
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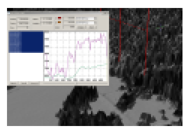
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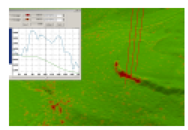
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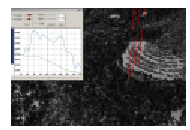
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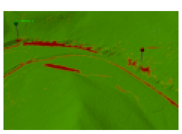
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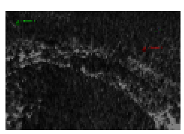
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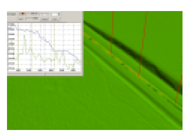
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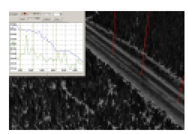
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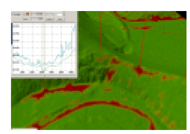
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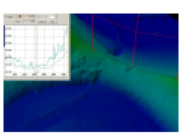
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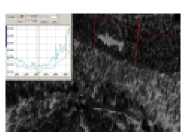
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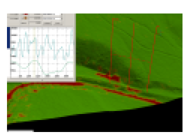
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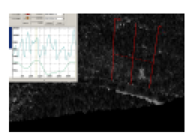
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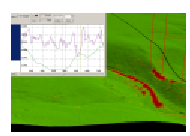
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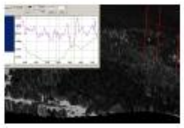
Aggressive Classification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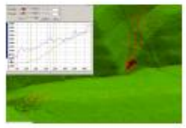
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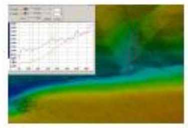
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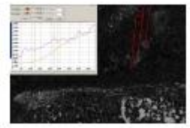
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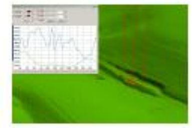
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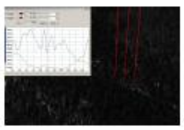
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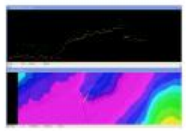
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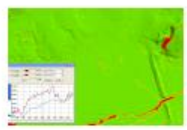
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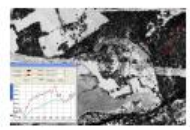
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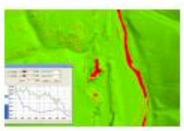
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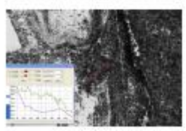
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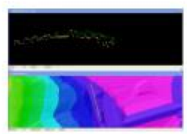
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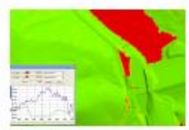
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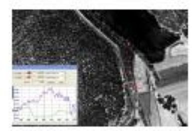
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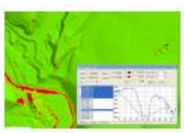
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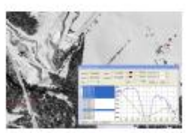
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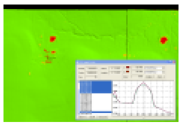
Building Artifacts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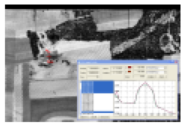
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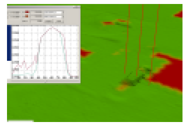
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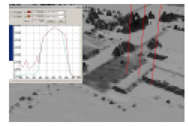
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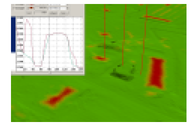
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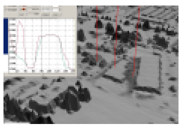
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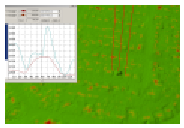
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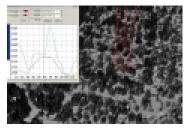
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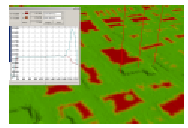
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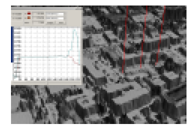
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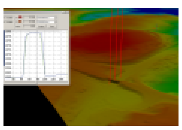
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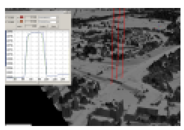
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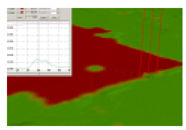
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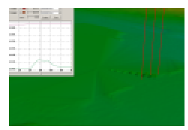
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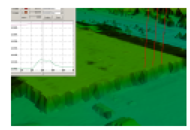
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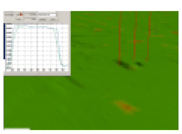
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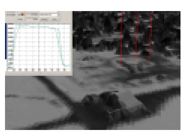
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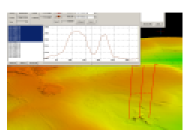
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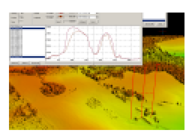
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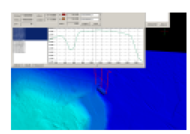
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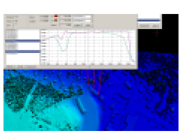
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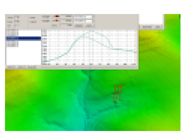
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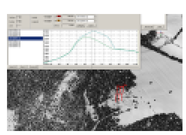
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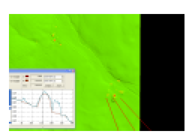
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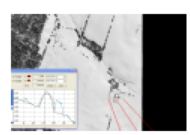
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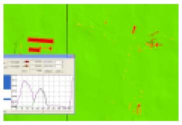
Building Artifacts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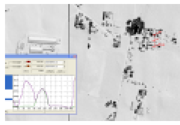
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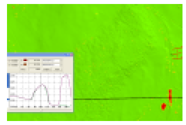
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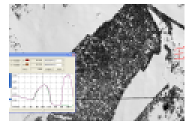
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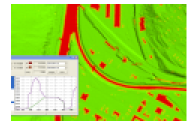
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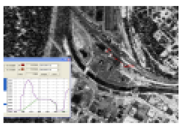
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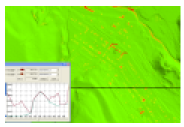
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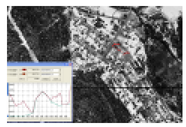
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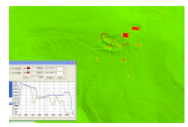
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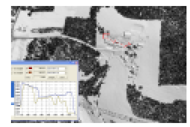
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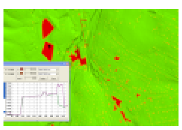
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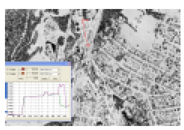
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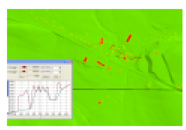
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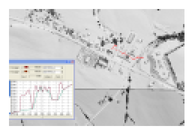
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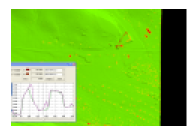
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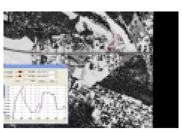
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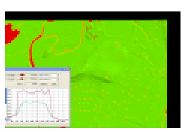
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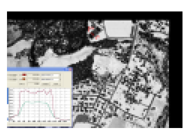
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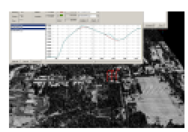
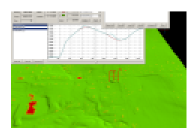

41001660PAS_buildingartifact_fpc_PAS02.png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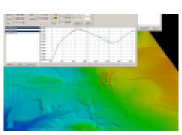
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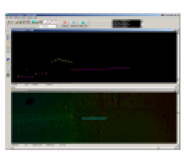
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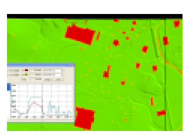
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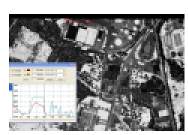
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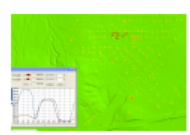
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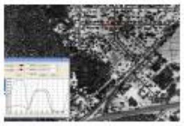
Building Artifacts



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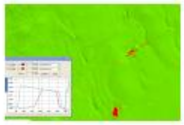

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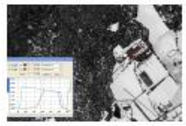

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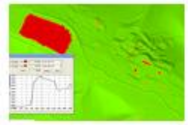
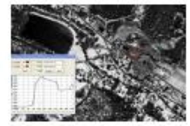


43001770PAS_BuildingArtifact_qttGnd_PAS03.png



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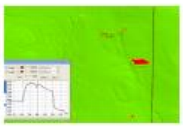

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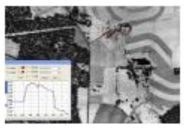

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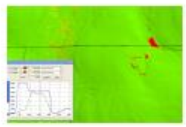

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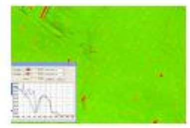
44001710PAS_BuildingArtifact_qttInt_PAS03.png



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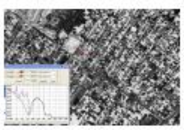

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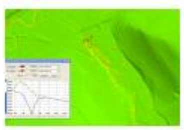
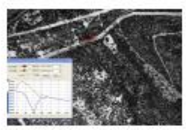


46001720PAN_PartialBridgeArtifact_qttGnd_PAN03.png



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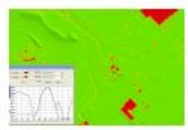

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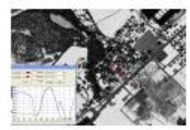

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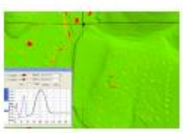
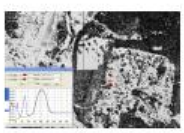


49001840PAN_BuildingArtifact_qttGnd_PAN03.png



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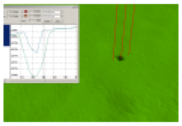
Divots



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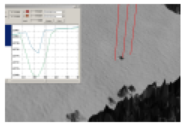

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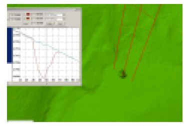

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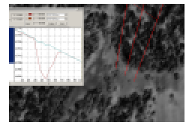

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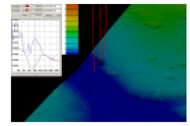

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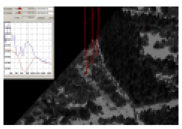

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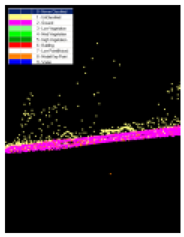

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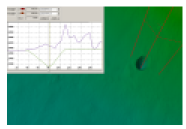

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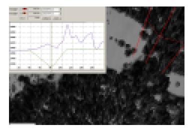

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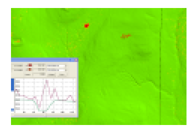

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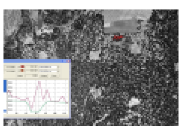

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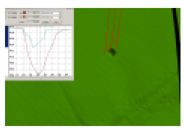

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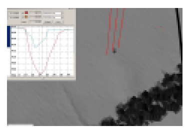

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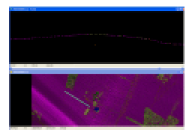
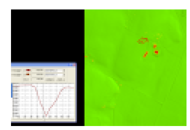


34001800PAS_Divot_Las_PAS03.png



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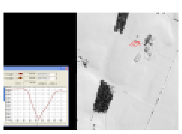

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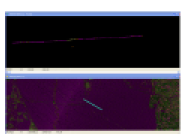

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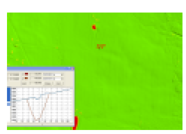

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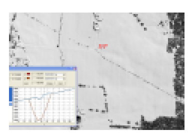

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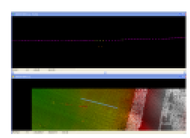

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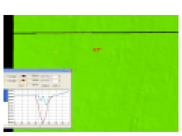

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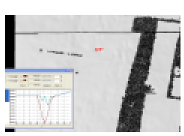

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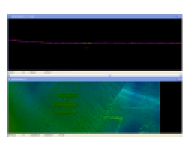

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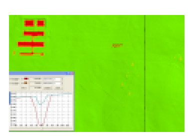

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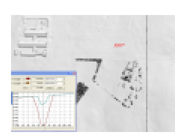

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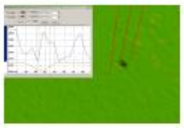
Divots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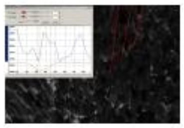
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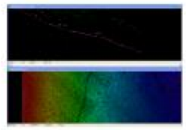
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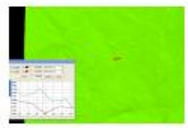
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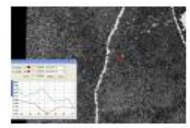
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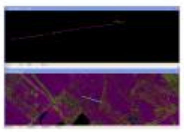
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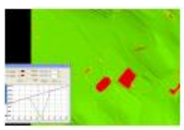
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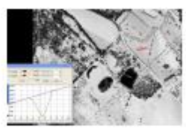
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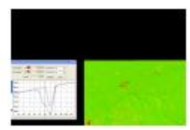
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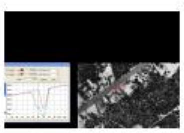
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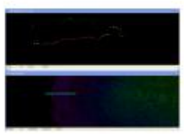
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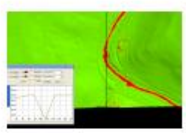
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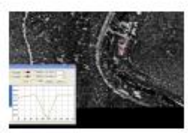
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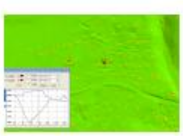
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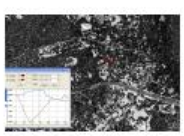
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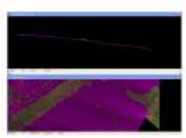
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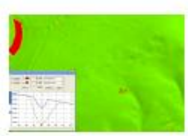
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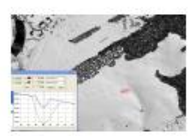
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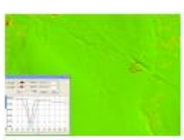
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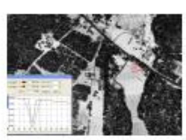
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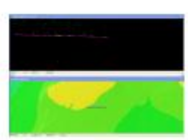
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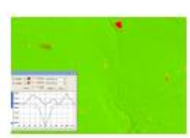
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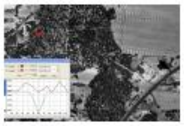
Divots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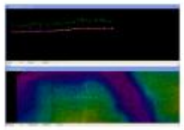
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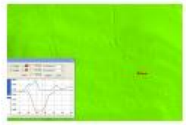
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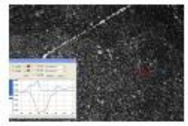
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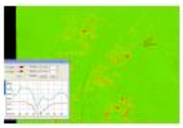
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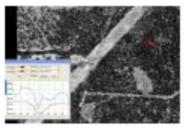
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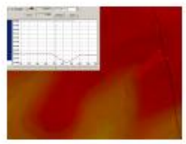
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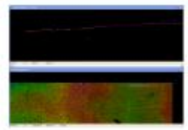
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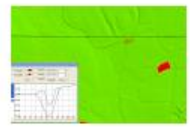
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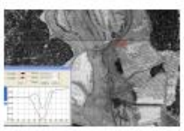
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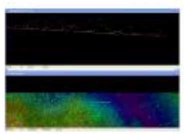
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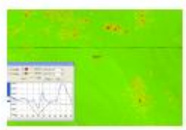
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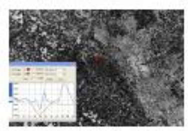
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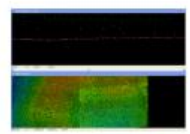
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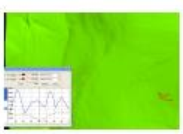
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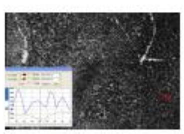
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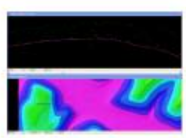
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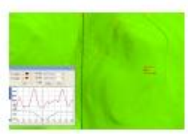
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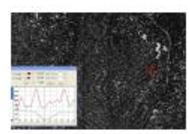
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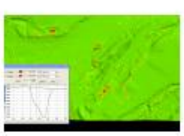
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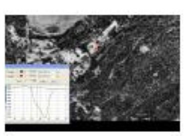
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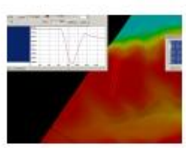
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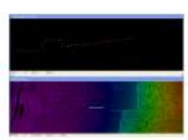
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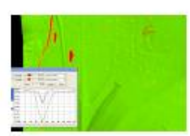
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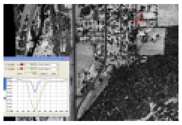
Divots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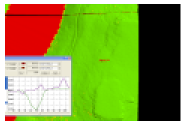
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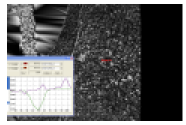
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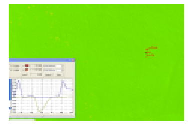
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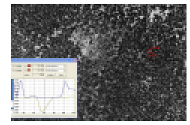
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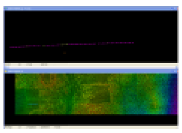
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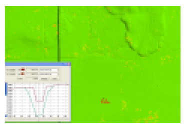
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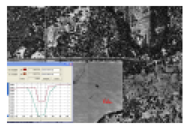
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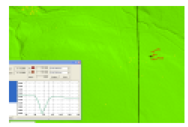
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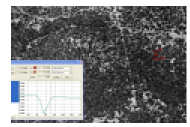
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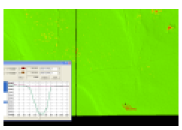
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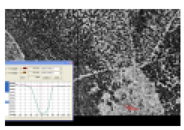
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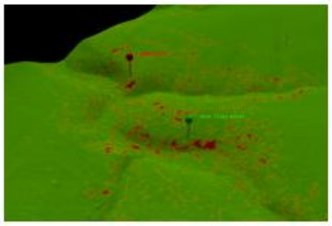
Poor Lidar Penetration



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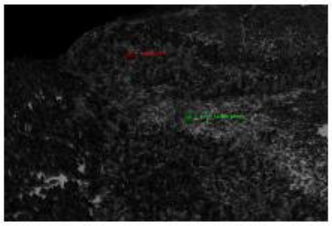

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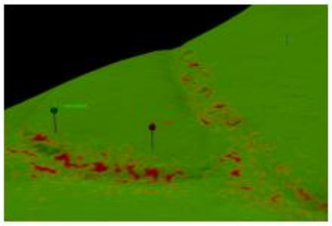

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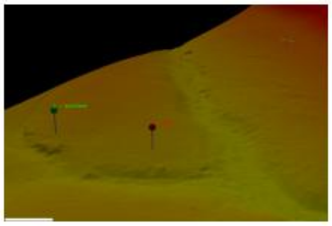

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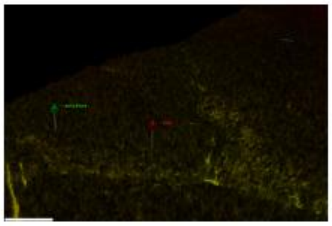

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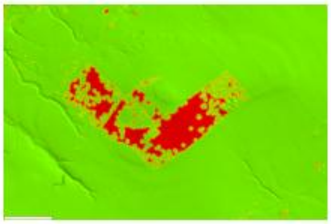

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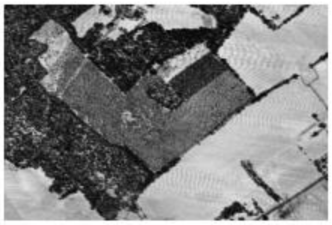

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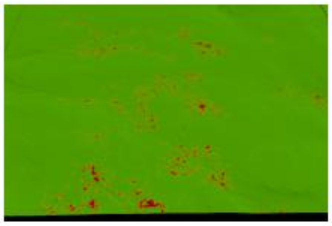

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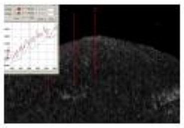
Vegetation Artifacts



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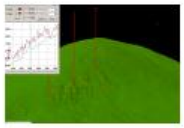

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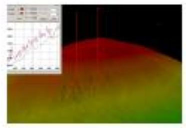

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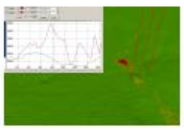

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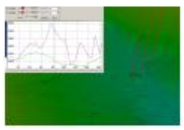

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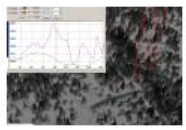

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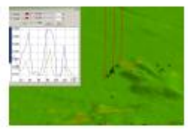

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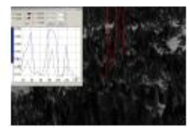

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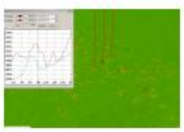

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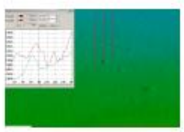

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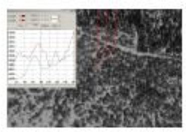

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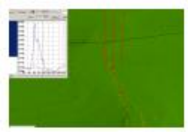

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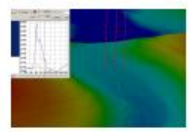

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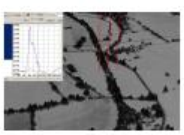

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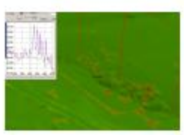

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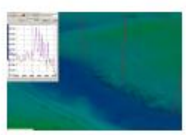

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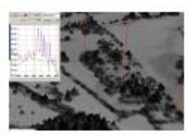

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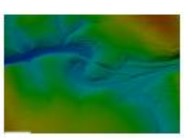

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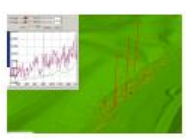

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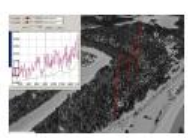

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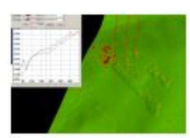

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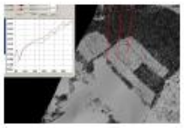
Vegetation Artifacts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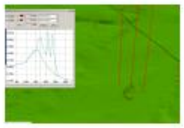
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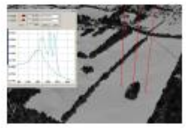
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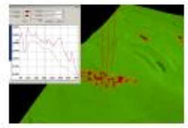
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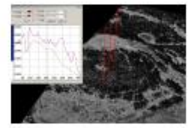
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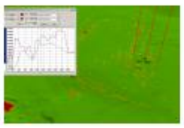
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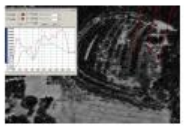
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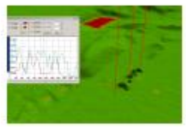
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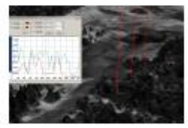
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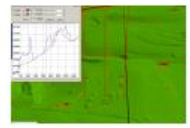
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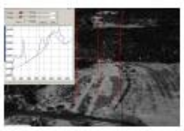
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26001680PAN_Noise_qttGnd_PAN08.png


26001680PAN_Noise_qttInt_PAN08.png


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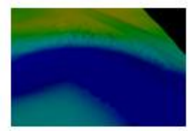
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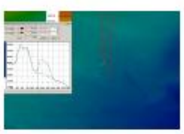
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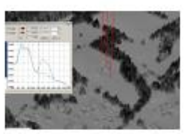
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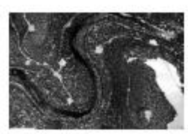
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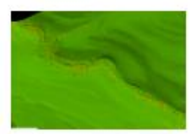
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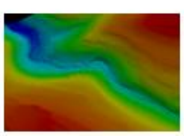
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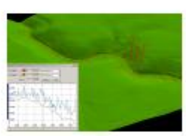
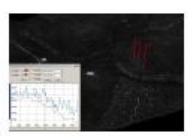
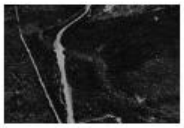
28001780PAN_noise_qttINT_PAN09.png


28001860PAN_noise_qttground_PAN09.png


28001860PAN_noise_qttINT_PAN09.png


29001790PAN_noise_qttground_PAN09.png

Vegetation Artifacts



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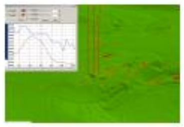

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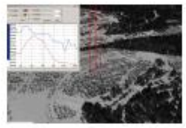

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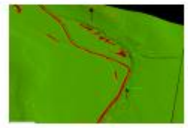

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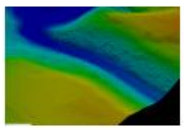

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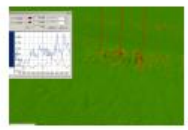
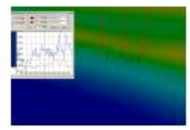
29001860PAN_noise_qttINT_PAN09.png



29002100PAN_artifact_qttground_PAN10.png



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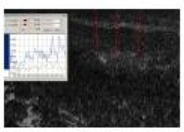

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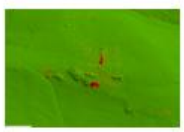

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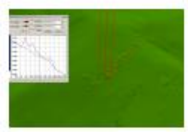

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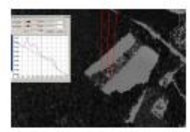

30001960PAN_artifacts_qttINT_PAN10.png

30001970PAN_vegartifact_qttground_PAN10.png

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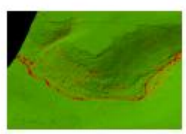

31001730PAN_noise_qttground_PAN09.png

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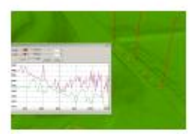

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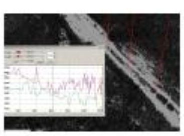

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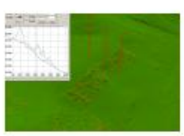

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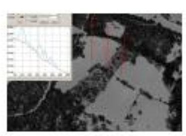

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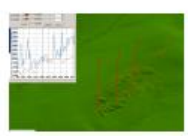

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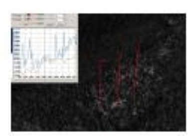

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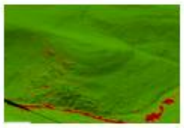
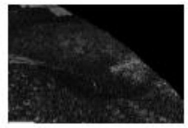
Vegetation Artifacts


32001730PAN_noise_qttground_PAN09.png


32001730PAN_noise_qttINT_PAN09.png


32001740PAN_noise_qttground_PAN09.png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32001820PAN_noise_qttground_PAN09.png


32001820PAN_noise_qttINT_PAN09.png


32002020PAN_noise_qttground_PAN10.png


32002020PAN_noise_qttINT_PAN10.png


33001720PAN_noise_qttground_PAN09.png


33001720PAN_noise_qttINT_PAN09.png


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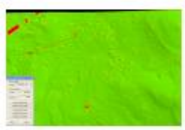
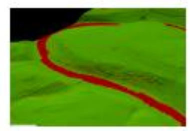

34001650PAS_Extensive-Noise_qttGnd_PAS08.png


34001650PAS_Extensive-Noise_qttInt_PAS08.png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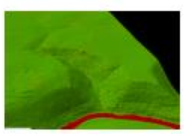
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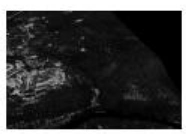
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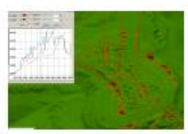
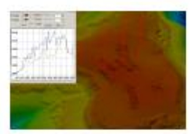

34001940PAN_artifact_qttground_PAN10.png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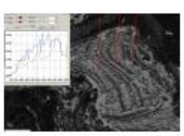
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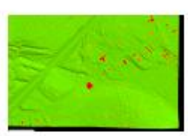
34001970PAN_noise_qttground_PAN10.png


34001970PAN_noise_qttINT_PAN10.png

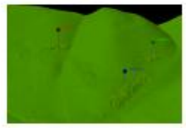

35001650PAS_Noise_qttGnd_PAS08.png


35001650PAS_Noise_qttInt_PAS08.png

Vegetation Artifacts


35001940PAN_noise_qttground_PAN10.png


35001940PAN_noise_qttINT_PAN10.png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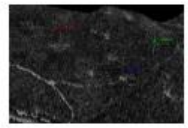
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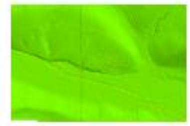
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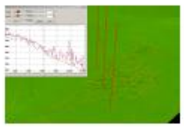
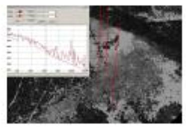
36001760PAS_Noise_qttInt_PAS03.png


36001910PAN_vegartifact_qttground_PAN09.png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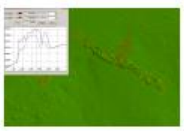
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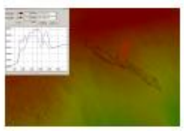
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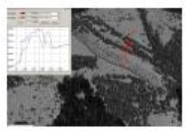
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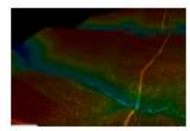
39001780PAN_noise_qttground_PAN09.png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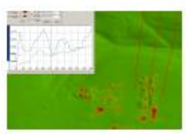
39001910PAN_noise_qttground_PAN09.png


39001910PAN_noise_qttINT_PAN09.png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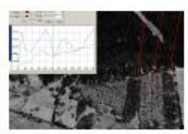

40001740PAN_vegartifact_qttINT_PAN09.png


40001750PAS_Noise_qttGnd_PAS03.png


40001750PAS_Noise_qttInt_PAS03.png

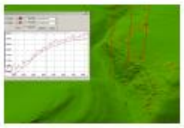

40001850PAN_noise_qttground_PAN09.png


40001850PAN_noise_qttINT_PAN09.png


41001650PAN_Artifact_qttGnd_PAN08.png


41001650PAN_Artifact_qttInt_PAN08.png

Vegetation Artifacts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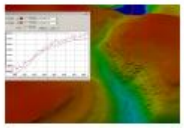
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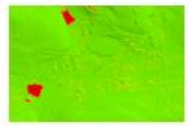
41001830PAN_vegartifact_qttINT_PAN09.png


43001720PAS_Noise_qttGnd_PAS03.png

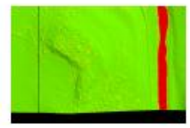

43001720PAS_Noise_qttInt_PAS03.png


44001670PAN_Noise_qttGnd_PAN08.png


44001670PAN_Noise_qttInt_PAN08.png


44001680PAN_Noise_qttGnd_PAN08.png

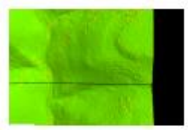

44001680PAN_Noise_qttInt_PAN08.png


45001670PAN_Noise_qttGnd_PAN08.png


45001670PAN_Noise_qttInt_PAN08.png


46001760PAS_Noise_qttGnd_PAS03.png


46001760PAS_Noise_qttInt_PAS03.png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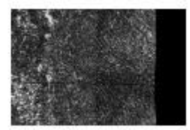
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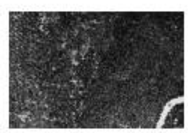
48001780PAS_Noise_qttGnd_PAS03.png


48001780PAS_Noise_qttInt_PAS03.png


48001790PAN_Noise_qttGnd_PAN03.png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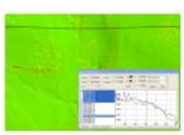
48001890PAN_Noise_qttGnd_PAN03.png


48001890PAN_Noise_qttInt_PAN03.png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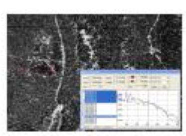
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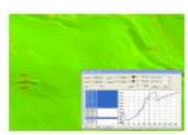
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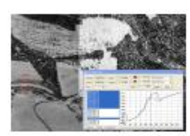
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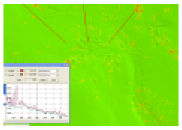
Vegetation Artifacts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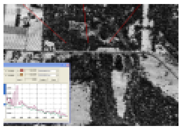
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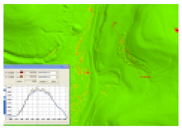
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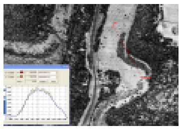
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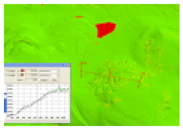
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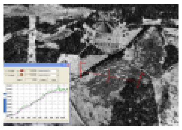
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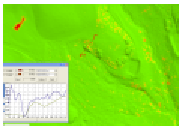
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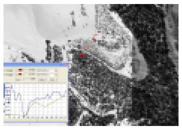
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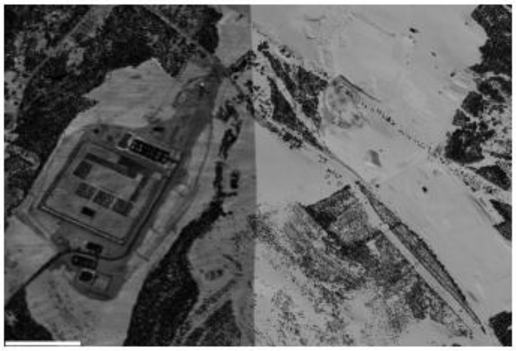
Intensity



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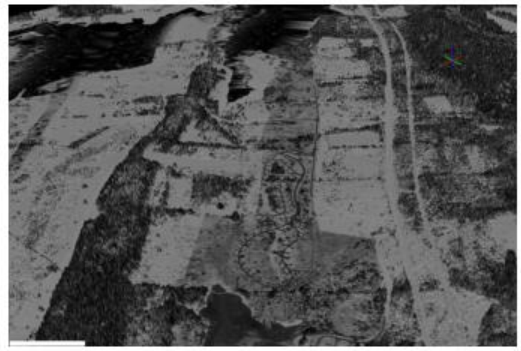

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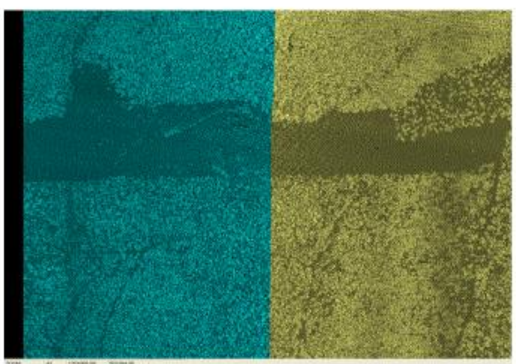
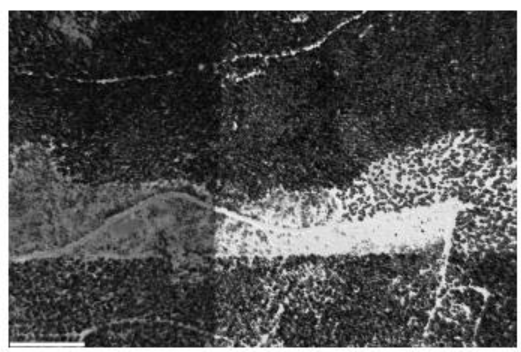


51001780PAN_IntensitySaturation_Las_PAN03.png



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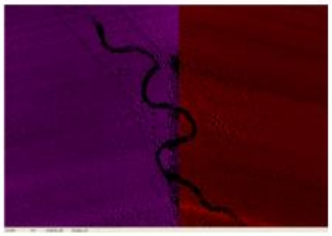
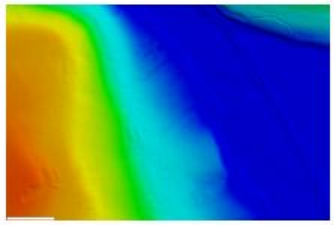
Others



26001700PAN_SpecialMissGrnd_Las_PAN08.png



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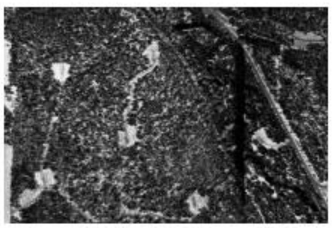

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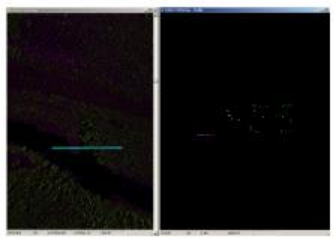

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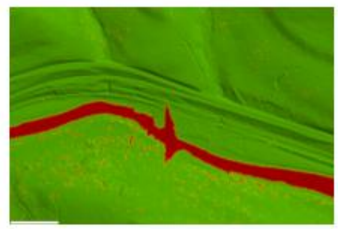
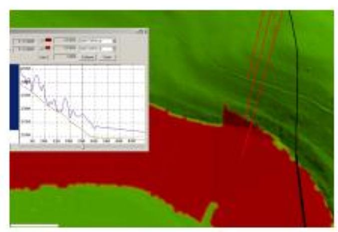


28001720PAN_SpecialMissGrnd_qttground._PAN09.png

28001720PAN_SpecialMissGrnd_qttINT_PAN09.png

29001740PAN_SpecialMissGrnd_FPC_PAN09.png



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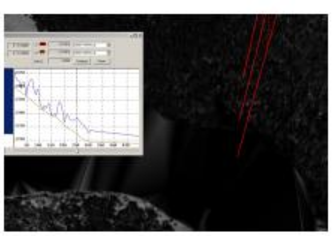

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