LiDAR Production Report

for

Androscoggin County, Maine LiDAR Enhancement

USGS Contract Number: G10PC00026
USGS Task Order: G10PD01737

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Project Description

Photo Science was issued Task Order G10PD01737 entitled “Androscoggin LiDAR Data Enhancement” dated 07/13/2010 requiring a limited amount of processing of an existing LiDAR data set covering Androscoggin County, Maine. This data set was provided to Photo Science as GFP by FEMA. Photo Science performed the LiDAR acquisition and processing of said dataset for FEMA Region 1 as a subconsultant working for the Region’s assigned RiskMap Contractor, STARR. Photo Science possessed a complete copy of all intermediate and final data sets and deliverables provided to STARR. The existing GFP bare earth surface was developed by Photo Science to achieve a vertical RMSE(z) of 15cm in open terrain.

In general, the acquisition and processing approach used by Photo Science in support of the Androscoggin County project adhered to “U.S. Geological Survey National Geospatial Program Base LiDAR Specification, Version 12”, specifications and included the delivery of classified point cloud in .las format, version 1.1 with corresponding product level metadata. However, raw point cloud deliverable, bare earth surface DEM deliverable and corresponding metadata files were not a required deliverable by FEMA/STARR.

Therefore, the primary task(s) associated with Task Order G10PD01737 was to provide enhanced datasets using the existing FEMA GFP for eventual ingestion into the NED.

Project Boundary

It was determined that the county based production boundary used by Photo Science for the FEMA/STARR project was not perfectly coincident with the County Boundary shape file supplied by USGS in Attachment B of the Task Order G10PD01737. This resulted in the additional processing of the existing raw point cloud necessary to develop both classified, hydro flattened .las tile(s) as well as corresponding DEM tile(s) deliverables completing coverage of the USGS supplied boundary.

Based on existing LiDAR coverage, Photo Science included a buffer of 200m*NPS beyond (or as much as possible) the USGS supplied county boundary for any modified and/or new classified .las file added to the dataset, as well as, added the same buffer to any new DEM files provided that existing classified .las data was available to support this buffer distance. It should be noted that existing LiDAR coverage were insufficient in covering portions of the USGS supplied county shape file. See “Problems/Issues Encountered” Section of the Report for specific information on this issue.

Data Processing

Utilizing the post processed LiDAR point cloud data from the FEMA/STARR project, Photo Science performed additional analysis, classification, and filtering to generate bare earth surface models for any new and/or modified data tiles needed to cover the project boundary.

GeoCue was used in the creation of selective files needed in downstream processing, as well as in the additional tiling (as needed) of the dataset into more manageable file sizes. The TerraScan and TerraModeler software packages were then used for the automated data classification, manual cleanup, and bare earth generation from this data. Project specific macros were used to classify the ground and to remove the side overlap between parallel flight lines. All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. QT Modeler was used as a final check of the bare earth dataset. GeoCue was then used to create the deliverable LAS 1.1 files for the classified. In-house software was then used to perform final statistical analysis of the classes in the LAS files.

Point Cloud Classification

In order to maintain consistency with the previously produced FEMA/STARR data set, each new/modified LAS file was classified as bare-ground or not bare-ground according to the American Society of Photogrammetry and Remote Sensing (ASPRS) LAS format classification table:

- Unclassified (non-ground) – Class 1
- Ground (bare-earth extra points) – Class 2
- Low Vegetation – Class 3
- Medium Vegetation – Class 4
- High Vegetation – Class 5
- Buildings – Class 6
- Noise (low or high, manually identified, if needed) – Class 7
- Water- Class 9
- Overlap – Class 12

It should also be noted that minor differences existed between the classification codes used by Photo Science in the processing of the FEMA/STARR deliverables and the Version 12 specification. Code 10, Ignored Ground, was not used by Photo Science, USGS has indicated that reclassification of LiDAR returns in order to meet Version 12 requirements is not required.

Hydro Flattening

As needed to extend or supplement additional classified, hydro flattened surface to meet USGS county limits, Photo Science developed 2-dimensional breaklines from the intensity images. In order to maintain consistency across the entire data set, Photo Science utilized the same breakline collection criteria (see collection specifications below) that were established for the original FEMA/STARR project. The breaklines are topologically correct and maintain monotonicity to ensure the downward flow of water. These breaklines were then used to classify and hydro enforce water features in the LAS data.

HYDROGRAPHIC FLATTENING BREAKLINES

Double_Line_Drain

Description Definition	Collection Rules	Classification Rule
Linear hydrographic features such as streams, shorelines, canals, swales, etc. with an average width greater than **40 feet**.	Capture features showing dual line (one on each side of the feature) with the water feature to the **LEFT**. Average width shall be greater than **40 feet** to show as a double line. Each vertex placed should maintain vertical integrity. Monotonicity must be maintained throughout entirety of feature. Opposite sides of banks should be of equal value. Line intersections must be at nodes. Double Line hydrographic features should be carried through all bridges.	Ground points should be classified inside all Double Line Drain features and a **3 foot buffer** shall be used around each feature. **Class 2 points will be moved to Class 9 (Water)**

Double_Line_Drain_Island

Description Definition	Collection Rules	Classification Rule
Land/Water boundary of varying elevation, depicting a land mass found inside of a double line drain. Features shall be defined as closed polygons and contain an elevation value that reflects the best estimate of the water elevation at the time of data capture. Land Mass will be captured for any feature of **1 acre (43,560 sq ft) or greater** in size.	Land mass shall be captured as closed polygons with the water feature to the **LEFT**. The compiler shall take care to ensure that the z-values for all vertices placed on the water body are equal to the surrounding Double Line Drain Feature (DGN Level 399). Each vertex placed should maintain vertical integrity. Monotonicity must be maintained throughout entirety of feature. Opposite sides of banks should be of equal value. Line intersections must be at nodes. Double Line hydrographic features should be carried through all bridges.	Ground points should be classified between all Double Line Drain and Double Line Drain Island features and a **3 foot buffer** shall be used around each feature. **Class 2 points will be moved to Class 9 (Water)**

Closed Water Body Features

Description Definition	Collection Rules	Classification Rule
Land/Water boundaries of constant elevation such as lakes, reservoirs, ponds, etc. Features shall be defined as closed polygons and contain an elevation value that reflects the best estimate of the water elevation at the time of data capture. Water body features will be captured for features **2 acres (87,120 sq ft) or greater** in size.	Water bodies shall be captured as closed polygons with the water feature to the **RIGHT**. The compiler shall take care to ensure that the z-value remains constant for all vertices placed on the water body.	Ground points should be classified inside all Closed Water Body features and a **3 foot buffer** shall be used around each feature. **Class 2 points will be moved to Class 9 (Water)**

Closed Water Body Island

Description Definition	Collection Rules	Classification Rule
Land/Water boundaries of constant elevation found inside a Closed Water Body Feature (DGN Level 302). Features shall be defined as closed polygons and contain an elevation value that reflects the best estimate of the water elevation at the time of data capture. Land mass features will be captured for features **1 acre (43,560 sq ft) or greater** in size.	Land mass shall be captured as closed polygons with the water feature to the **RIGHT**. The compiler shall take care to ensure that the z-value remains constant for all vertices placed on the water body and is equal to the surrounding Closed Water Body Feature (DGN Level 302).	Ground points should be classified between all Closed Water Body and Closed Water Body Island features and a **3 foot buffer** around each feature. **Class 2 points will be moved to Class 9 (Water)**

File Information

The tile schema (5,000' x 5,000') used by Photo Science was the same dimension, position and orientation as the original FEMA GFP. A total of 648, 5,000' x 5,000' tiles were developed by Photo Science to cover the USGS supplied project boundary.

Tiles were produced and delivered for both the classified LAS and gridded DEM datasets. The file naming schema was based on the truncated coordinate grid values (first three coordinate values of the easting and northing) of the lower left hand corner of each tile. The deliverable formats for the files are in the table below:

- LAS (648 – LAS Version 1.1 files)
- Raster DEM (648 – 2.5 foot cell size in ERDAS IMG format)
- Hydro Flattened Breaklines (1 – ArcGIS Shape file format)
- Raw Flight Line Source (119 – LAS Version 1.0 files)

Projection / Datum

All data for this project was reduced to Maine SPCS, West, NAD83, US Survey Feet and the vertical datum is referenced to the North American Vertical Datum of 1988 (NAVD 88), US Survey Feet.

Metadata

Photo Science developed and provided FGDC compliant metadata at a project level basis.

Problems / Issues Encountered

1. Existing FEMA GFP LiDAR coverage was insufficient in covering portions of the USGS supplied county shape file in the following tiles:

    - 920E585N
    - 920E550N
    - 915E515N
    - 985E425N
    - 990E450N
    - 995E485N

In these instances, Photo Science was not required by USGS to supplement these coverage gaps with new LiDAR acquisition efforts.

2. Due to the dense post spacing (~ 1m NPS) of the GFP LIDAR data, the unusually large number of classified ground points present in many tiles and the requirement for larger tile sizes (5k x 5k), Photo Science encountered DEM processing delays for approximately 20% of the 648 gridded DEM tiles. The extended time necessary to correctly process these DEM tiles required additional, unanticipated, time resulting in a modest delivery delay to USGS.