UAF Light Detection and Ranging (LiDAR) and Ortho-Imagery Data Project Report Hoonah Corridor

Tetra Tech was contracted by the University of Alaska Fairbanks (UAF) to provide LiDAR and ortho-imagery data for the Road to Resources in Alaska Program. Tetra Tech collected LIDAR data and aerial imagery during the fall of 2013 and the spring/summer of 2014. Included within this document are the various reports required by the contract.

Collection Report

LiDAR data for the Hoonah corridor project area was acquired with a Cessna 401 aircraft. The tail number of this aircraft is N34MM.

LiDAR Sensor:
Optech Orion H300

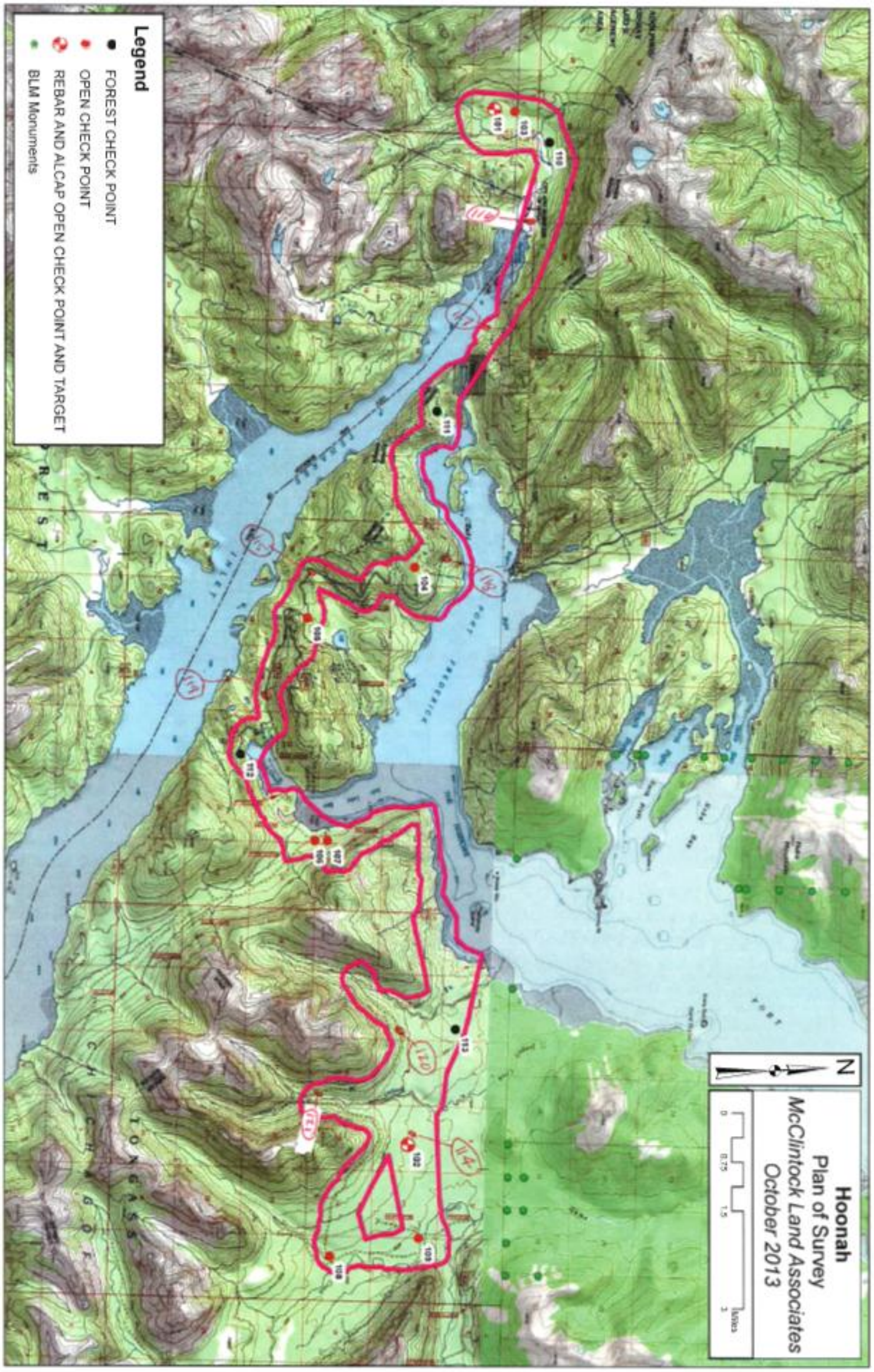
Imagery for the Revilla corridor project area was acquired with a Cessna 401 aircraft. The tail number of this aircraft is N34MM.

Imagery Camera:
Intergraph DMC01 Digital Mapping Camera

Survey Report

Each polygon area contains calibration points as well as independent check points. Check points have been withheld from Tetra Tech. The coordinates with field notes for each area will be provided to GINA directly by the surveyor, McClintock Land Associates.

The Hoonah area contains 3 calibration points and 19 independent check points as shown in the diagram below.


Legend
FOREST CHECK POINT
OPEN CHECK POINT
REBAR AND ALCAP OPEN CHECK POINT AND TARGET
BLM Monuments
N
Hoonah
Plan of Survey
McClintock Land Associates
October 2013
0
0.75
1.5
3
Miles

TETRA TECH

Certification from Surveyor

Hoonah

QUALITY CONTROL REVIEW SUMMARY

Max. High Elev. Deviation:	0.39	feet
Max. Low Elev. Deviation:	-1.67	feet
Elevation Deviation Range:	2.06	feet
Elevation Deviation Mean:	-0.43	feet
Elevation Deviation RMSE	**0.60**	**feet**

(RMSE = Root Mean Square Error)

Number of Check Points Used:	19.00
Number of Check Points Excluded	0.00
Total Number of Check Points:	19.00

CHECK POINTS			SURVEYED Elevation			LiDAR Elevation	Deviation
Point Number	Northing (Feet)	Easting (Feet)	(Feet)	CATEGORY	TIN File Name	(Feet)	(Feet)
103	2257754.06	2244068.15	189.90	Open	L22425_22575	190.06	0.16
104	2251031.83	2281154.33	930.89	Open	L22800_22500	930.74	-0.15
105	2242196.43	2285492.36	373.60	Open	L22850_22400	373.15	-0.45
108	2244681.93	2337208.54	267.52	Open	L23350_22425	266.93	-0.59
109	2251426.12	2336271.91	204.43	Open	L23350_22500	204.00	-0.43
110	2260908.84	2247401.24	94.86	Forest	L22450_22600	93.19	-1.67
111	2253049.68	2268623.99	144.24	Forest	L22675_22525	143.26	-0.98
112	2236699.70	2296511.15	257.00	Forest	L22950_22350	256.72	-0.28
113	2253111.22	2317955.73	347.24	Forest	L23175_22525	346.96	-0.28
114	2251348.56	2326549.72	379.18	Open	L23250_22500	379.14	-0.04
115	2242585.66	2282263.37	425.15	Open	L22800_22425	424.85	-0.30
116	2257355.85	2244276.77	218.27	Open	L22425_22550	217.91	-0.36
117	2256050.88	2262565.13	14.99	Open	L22625_22550	14.21	-0.78
118	2253729.04	2282865.14	257.27	Open	L22825_22525	256.76	-0.51
119	2238801.67	2291032.80	205.55	Open	L22900_22375	205.47	-0.07
120	2250155.08	2319606.35	608.11	Open	L23175_22500	607.48	-0.63
121	2247450.40	2325696.86	723.38	Open	L23250_22450	722.83	-0.55
123	2242325.03	2302074.42	15.22	Open	L23000_22400	15.61	0.39
124	2250107.90	2326943.77	437.47	Open	L23250_22500	436.90	-0.57

TIN CERTIFICATION

Date Prepared: 2/16/2015

Roads to Resources – HOONAH
TIN Surface Model

Prepared by: McClintock Land Associates, Inc.
Prepared for: Tetra Tech, Inc.

I hereby certify that an independent ground survey was performed under my supervision to obtain sampling data to be used to test the reliability of the electronic Triangular Irregular Network (TIN) surface model for Hoonah, Alaska. This TIN is based on the Model Key Points Method. For ease of manipulation the surface model was divided into 156 cells as defined by the .dwg files shown on the attached listing.

These files were produced by Tetra Tech, Inc. from a LiDAR survey. The LiDAR data was acquired and calibrated by Aerial Surveys International flown on July 16, July 18, and July 21, 2014 and processed by Tetra Tech, Inc. between December 8, 2014 and February 6, 2015.

The independent ground survey was performed by McClintock Land Associates, Inc. May 8 - 10, 2014 using Static and RTK GPS methods as well as conventional optical methods. Topcon Data Collectors, along with Topcon HiPer GA and GR-3 GNSS receivers were used as well as a Topcon GPT-3005LW Reflectorless Electronic Total Station. Topcon Magnet Field v2.0.1 data collection software was used for the field data collection and Topcon Magnet Office Tools v2.0.1 office software was used for post-processing and adjustments.

The survey data was collected in Alaska State Plane Coordinates, Zone 1 (NAD83) in US Survey Feet. The vertical datum is NAVD88 in feet and elevations were determined as approximate orthometric heights using Geoid Model 2012A. Ties to the NSRS were made using the NGS OPUS Utility. A more detailed description of the methods and control will be contained in the Survey Report for this project.

This TIN was checked using independent QC check points which had been withheld from the TIN producer. The RMS error standard for ASPRS Class 2 Maps for Vertical Accuracy for a 2 foot contour interval map is 2/3 of the contour interval or 1.33 feet. The RMS error between the elevations returned from the TIN and the actual check points was 0.60 feet. This map meets and exceeds that standard.

Professional Land Surveyor
McClintock Land Associates, Inc.

Date: 2/16/2015

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QA/QC Report

Tetra Tech has performed quality control throughout each step of the acquisition and processing for the Revilla corridor project area. The only difficulty encountered was during the acquisition phase of the project, waiting for suitable weather conditions for collection. Difficult weather conditions were a challenge and caused delays and offsets between LiDAR acquisition, image acquisition and ground survey. Our flight teams remained on-site and acquired LiDAR at a lower altitude that enabled collection below cloud deck. The data was immediately checked for quality to determine if the lower flight altitude would affect the data. There was no adverse effect on the data.

Processing Report

Imagery

The imagery was acquired with a DMC01 digital frame camera on October 10, 2014. The flight took place between 11:28 am and 11:54 am and between 12:46 pm and 1:14 pm local time. The camera was equipped with airborne GPS and inertial unit (IMU). The image acquisition was planned in conjunction with survey of ground control points and collection of airborne LiDAR data. An aerotriangulation was performed in the Inpho / Trimble Match-AT version 5.7 software. For orthorectification a digital elevation model with 3ft grid spacing was generated from the LiDAR data. The Orthoimagery was then created in Inpho / Trimble OrthoMaster version 5.7 and mosaicked and color balanced in OrthoVista 5.7. MrSID compressed files were created in Lizardtech Geoexpress 9.

For additional information on the image processing see the AT log file and the camera calibration report and GPS shapefile in the imagery directory. Information regarding the processing is also contained in the xml metadata file accompanying each image (i.e. each individual geotiff tile, the complete MrSID mosaics and the individual unbalanced orthoimages).

Aerotriangulation

The aerotriangulation results are documented in the match-at log file “aat.html”. The AT relies much on the airborne GPS and IMU. In addition we used ground control points 101, 102 and 107 for vertical control and datum shift. Selecting photo-identifiable horizontal control was a challenge in this terrain and identification of the photo ID point was not very satisfying. However, the required accuracy of 8’ rms will be far exceeded based on airborne GPS alone. An additional visual check was performed by overlaying the orthoimagery e.g. with the intensity imagery.

Orthorectification

The imagery was orthorectified in OrthoMaster using a 3ft spacing DEM generated from the LiDAR data, classes 8 and 9.

4 band unbalanced "raw" orthoimages: the raw aerial images were converted from 16 bit to 8 bit, 4-band imagery without any balancing. The imagery was then orthorectified to the full extent of each image. During the orthorectification process images were clipped to the area of interest (AOI) since no DEM is available outside that area.

3 band True Color RGB and Color Infrared CIR mosaics: 8 bit balanced 4 band images were orthorectified. Seamlines (=cut lines) were automatically generated in OrthoVista and manually edited in the Seam Editor. Images were color balanced across the block in OrthoVista and were also clipped to the area of interest in OrthoVista and then written out into two set, 3 band RGB and 3 band CIR geotiff tiles. These tiles were combined to a MrSID mosaic in Lizardtech Geoexpress 9. See Figure 1 for organization of the image data delivery.

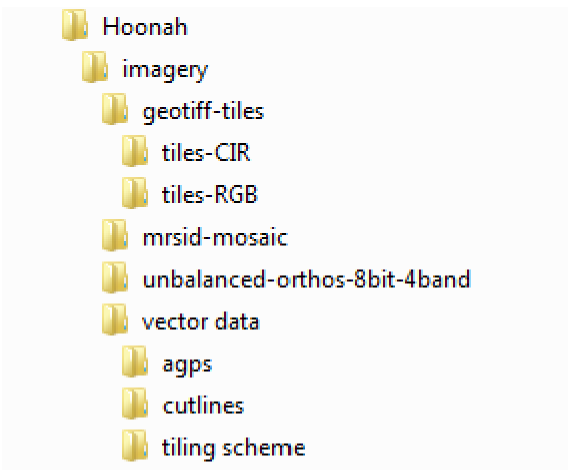

Figure 1: Organization of image data

The LiDAR data for the Hoonah corridor area was acquired July 16, 18 and 21 of 2014. SBET and shapefile of the trajectory are located with the point cloud data (see Figure 2 for the organization of LiDAR and LiDAR derived data). The data was post processed through PosPac, Waypoint's GPS and IMU (inertial measurement unit) post processing software, and LMS, Optech's LiDAR post processing software. PosPac is used to generate the trajectory file which contains the position (X, Y, Z) from differential GPS observations and the plane's attitude (roll, pitch, heading) from the IMU. LMS is used to join the discreet point range information to the trajectory information through a common time stamp and to calibrate the data. The calibration is achieved by first identifying common features in the overlap of adjacent flight lines, and then adjustments are applied to the IMU's angular offsets to align the data. Once finished, LMS refines the calibration further through a bundle adjustment to create the final calibrated data set.

Classification of the calibrated LiDAR data set is achieved through the use of TerraScan, the industry standard software from TerraSolid for classifying LiDAR. Individual macros were defined that derive and refine a ground surface, vegetation, and buildings. These macros are also used to eliminate spurious points below the surface and high point artifacts. The Hoonah area was then manually checked and edited to eliminate low and high points as well as to ensure that points are classified appropriately.

Breaklines were derived from LiDAR and imagery, which are used in the production of contours and help define water classes in the LiDAR data.

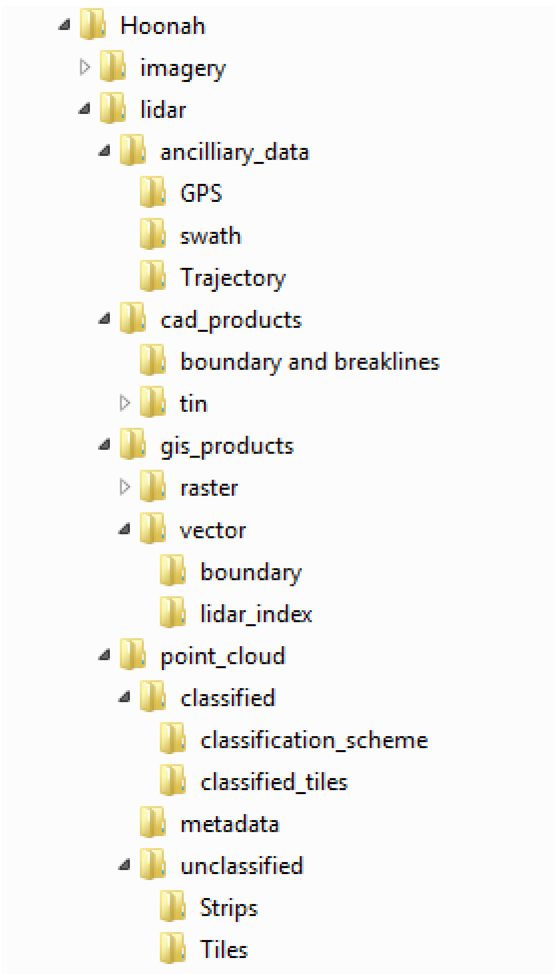

Figure 2: Organization of LiDAR data

DSM

The DSM was created from LiDAR first returns and only-returns. A thinning within 1’ cells was applied to select points that contribute to the DSM. This selection occurred in Terrascan. Points were then imported into a geodatabase. A terrain was created in 3D Analyst from the imported points and subsequently a 3’ spacing grid was generated, using the NATURAL_NEIGHBORS interpolation method.

The ERDAS imagine mosaic tool was then used to clip and tile the DSM at the same time into individual geotiff tiles.

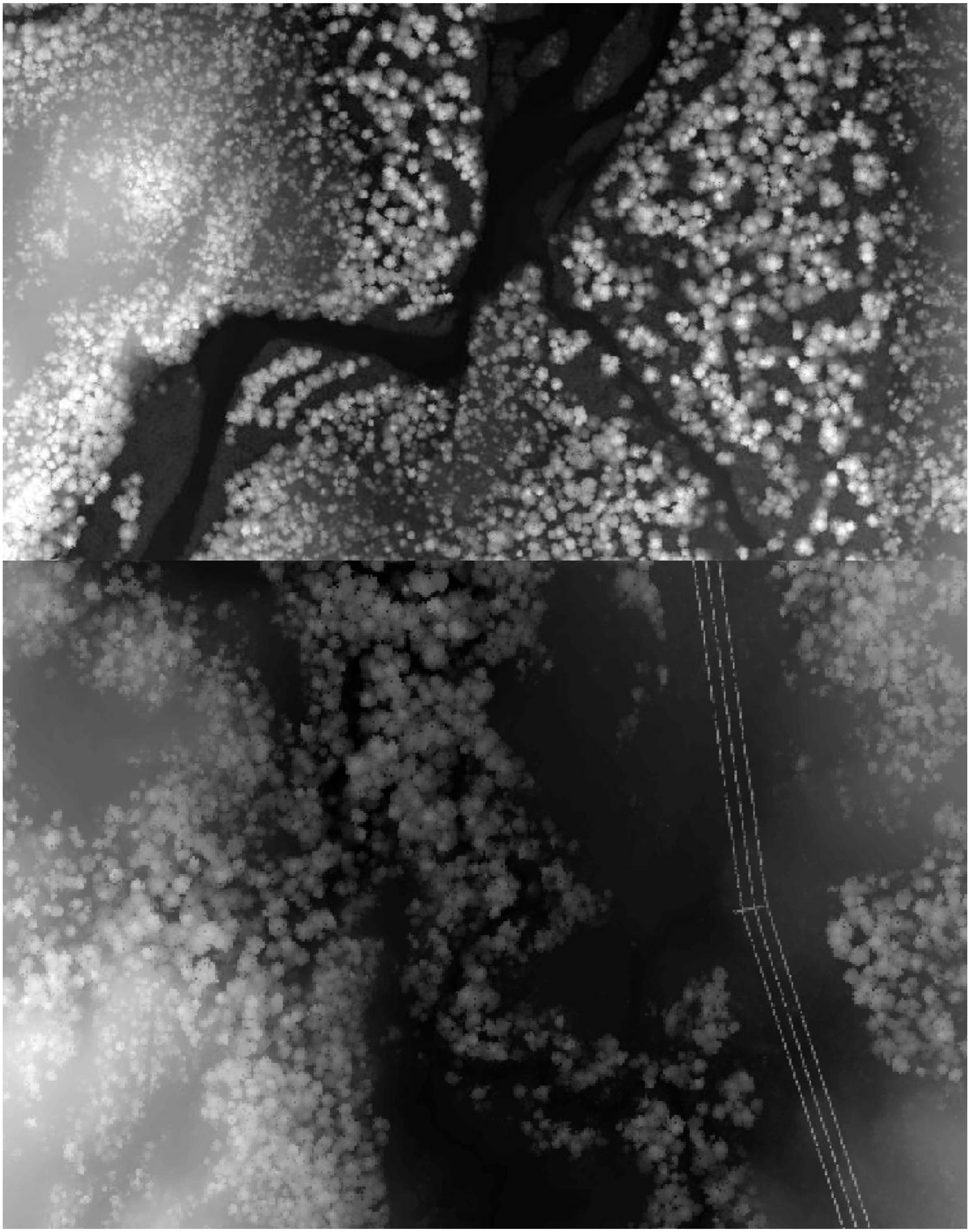

Figure 3: Result, DSM with 3ft grid spacing, tiled and clipped to AOI

DEM

The DEM was created using ESRI 3DAnalyst. The individual steps included:

- Importing all las files into the geodatabase as multipoint, all returns, classes 8 and 9.
- Importing the breaklines as a feature layer.
- Creating a terrain in 3D Analyst from all mass-points.
- Creating a 3' spacing grid, using the NATURAL_NEIGHBORS interpolation method
- The ERDAS Imagine mosaic tool was then used to clip and tile the DEM at the same time into individual geotiff tiles (Figure 4).

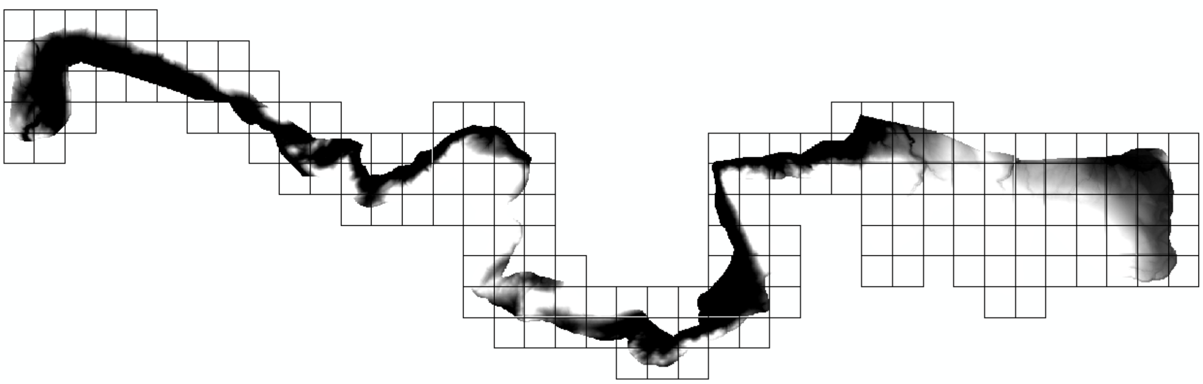

Figure 4: DEM as a shaded relief overlaid with the tiling scheme.

Intensity Image

- The intensities were exported from the LAS files in the LP360 software to one ESRI grid with 3ft. spacing.
- The grid was then exported in ESRI to a geotiff with data type float.
- The geotiff was again clipped to the AOI and tiled to the LiDAR tiling scheme in ERDAS Imagine.

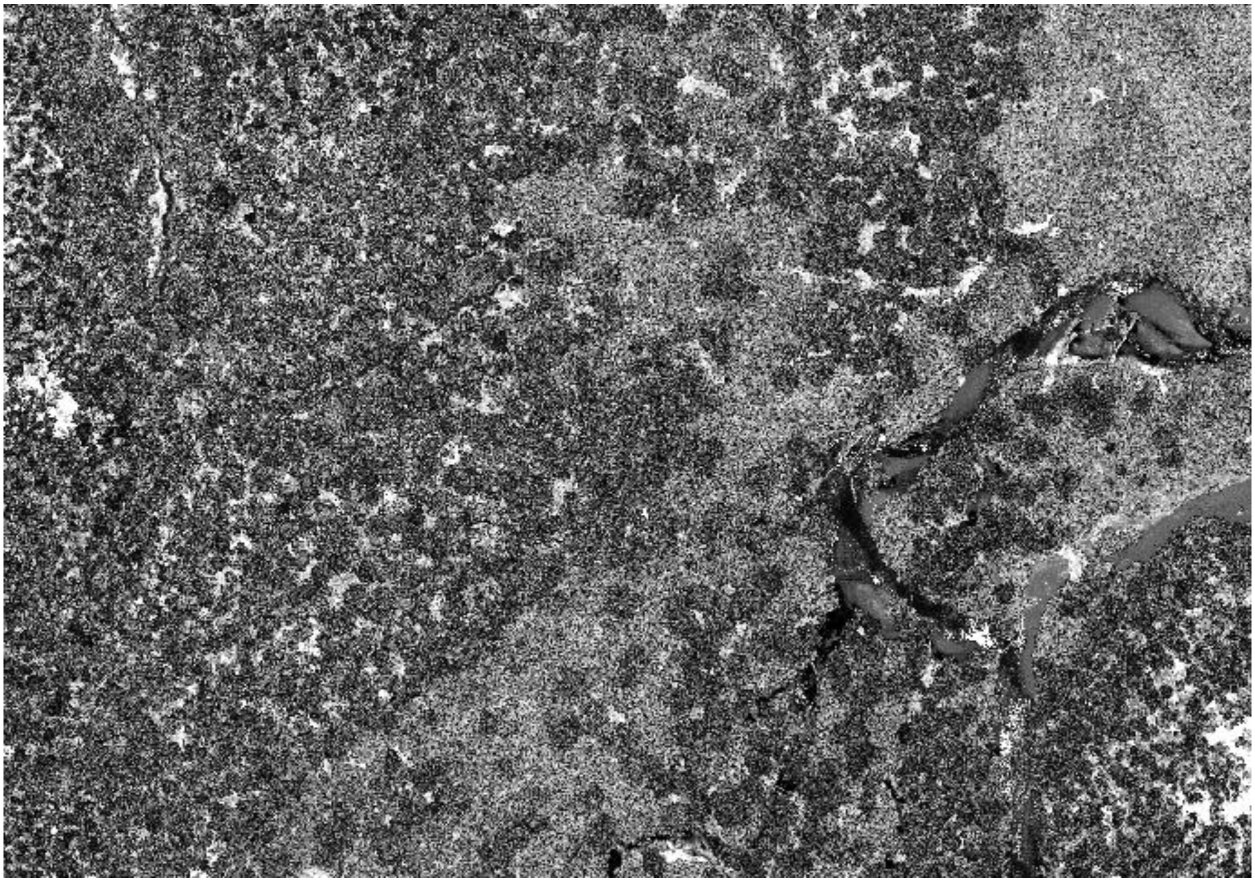

Figure 5: Intensity image, 3ft spacing, float values.

TIN

TIN creation based model key points

In producing a TIN from LiDAR data, it is common practice to use model key points and breaklines. Model key points are thinned from the LiDAR ground points to represent the terrain, and allow for an accurate but less dense data set. Model key points are exported from the las files into csv format, with a 150 ft. over edge beyond the tile boundary. Breaklines are imported directly into the Civil3D file, while the csv is referenced externally to create the TIN.