Arapaho NWR North Area

This report outlines procedures used in Agisoft Metashape Pro to process data captured with a MicSense Rededge-M multispectral sensor and provides error assessments associated with collection and processing.

02 August 2019

Survey Data

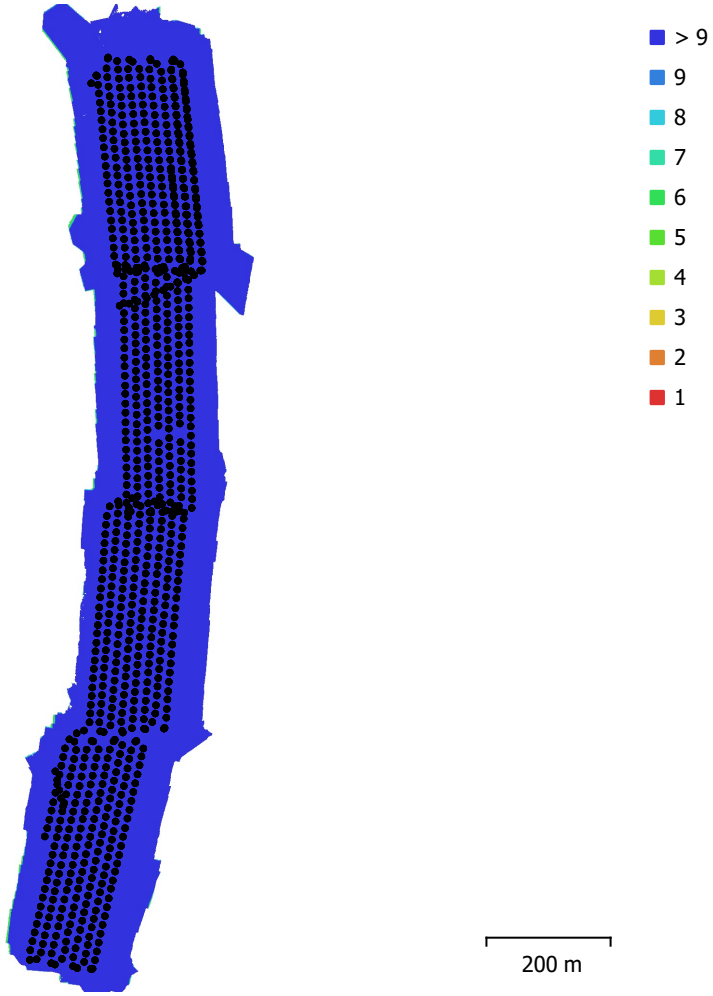

Fig. 1. Camera locations and image overlap.

Number of images:	4,645	Camera stations:	4,570
Flying altitude:	110 m	Tie points:	2,342,959
Ground resolution:	7.32 cm/pix	Projections:	12,719,723
Coverage area:	0.348 km²	Reprojection error:	0.627 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
RedEdge-M, Blue (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes
RedEdge-M, Green (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes
RedEdge-M, Red (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes
RedEdge-M, Red edge (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes
RedEdge-M, NIR (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes

Table 1. Cameras.

Camera Calibration

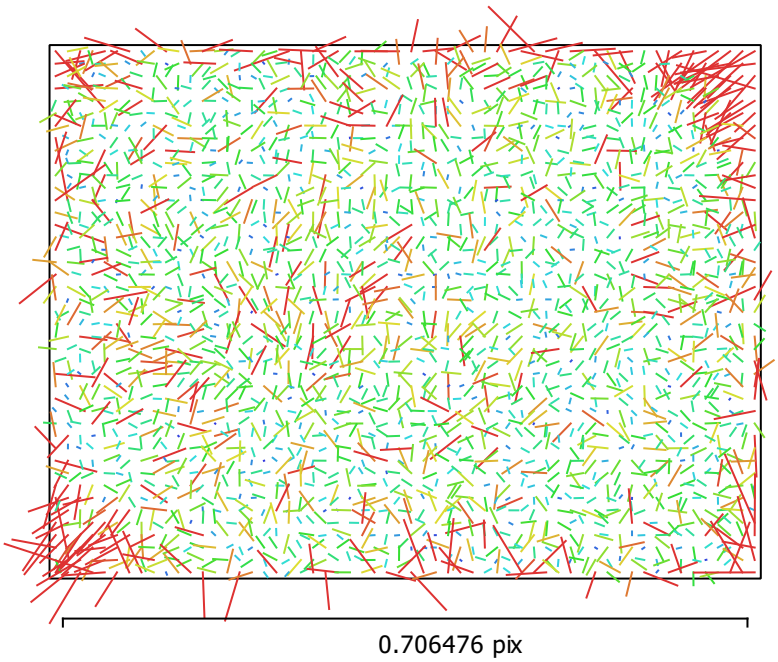

Fig. 2. Image residuals for RedEdge-M, Blue (5.5mm).

RedEdge-M, Blue (5.5mm)

929 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	P1	P2
F	**1452.15**	0.045	1.00	-0.10	-0.30	-0.04	0.04	-0.11	0.14	-0.11	-0.02	-0.09
Cx	**7.64016**	0.017		1.00	0.03	-0.03	0.01	-0.00	0.00	-0.00	0.85	0.01
Cy	**8.39675**	0.014			1.00	0.02	-0.05	-0.02	-0.00	-0.00	0.01	0.70
B1	**0.0382777**	0.0033				1.00	-0.00	0.01	-0.04	0.05	0.02	-0.00
B2	**0.0395048**	0.0031					1.00	0.00	0.00	-0.00	0.02	0.01
K1	**-0.0968742**	0.00011						1.00	-0.97	0.92	-0.01	-0.04
K2	**0.148456**	0.00086							1.00	-0.98	0.00	-0.00
K3	**-0.0390524**	0.002								1.00	-0.00	0.00
P1	**0.000140002**	3.5e-006									1.00	0.02
P2	**-3.67124e-005**	2.9e-006										1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Calibration

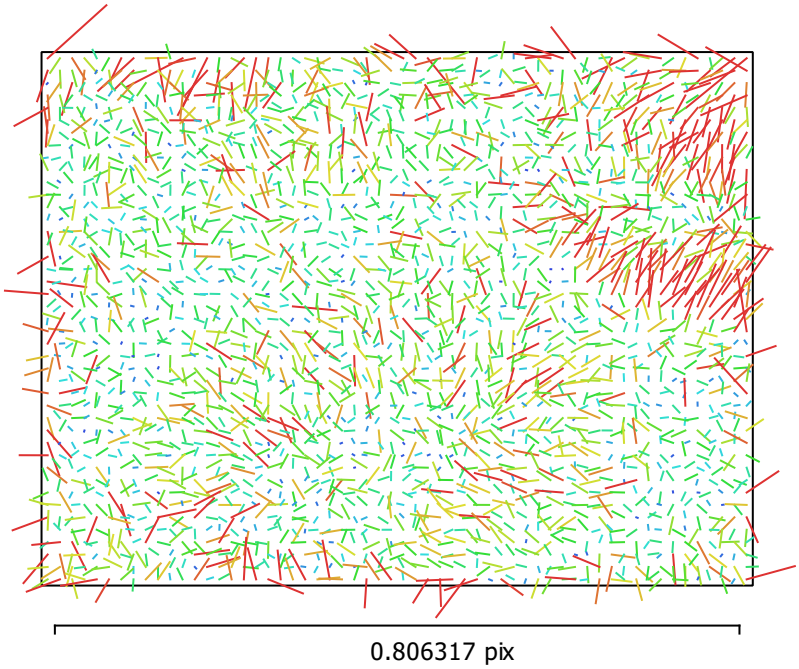

Fig. 3. Image residuals for RedEdge-M, Green (5.5mm).

RedEdge-M, Green (5.5mm)

929 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	P1	P2
F	**1451.4**	0.045	1.00	-0.07	-0.30	-0.04	0.03	-0.11	0.14	-0.12	-0.01	-0.09
Cx	**-8.63508**	0.017		1.00	0.02	-0.05	0.01	-0.00	-0.00	-0.00	0.85	0.01
Cy	**3.98232**	0.014			1.00	0.02	-0.05	-0.02	-0.01	0.00	0.00	0.70
B1	**0.188498**	0.0033				1.00	0.00	0.01	-0.04	0.05	-0.00	0.01
B2	**0.0434727**	0.0032					1.00	0.00	-0.00	0.00	0.01	-0.00
K1	**-0.0981545**	0.00011						1.00	-0.97	0.92	-0.01	-0.04
K2	**0.15204**	0.00086							1.00	-0.98	0.01	0.00
K3	**-0.0425242**	0.002								1.00	-0.01	-0.00
P1	**0.000723352**	3.6e-006									1.00	0.01
P2	**-0.000115702**	3e-006										1.00

Table 3. Calibration coefficients and correlation matrix.

Camera Calibration

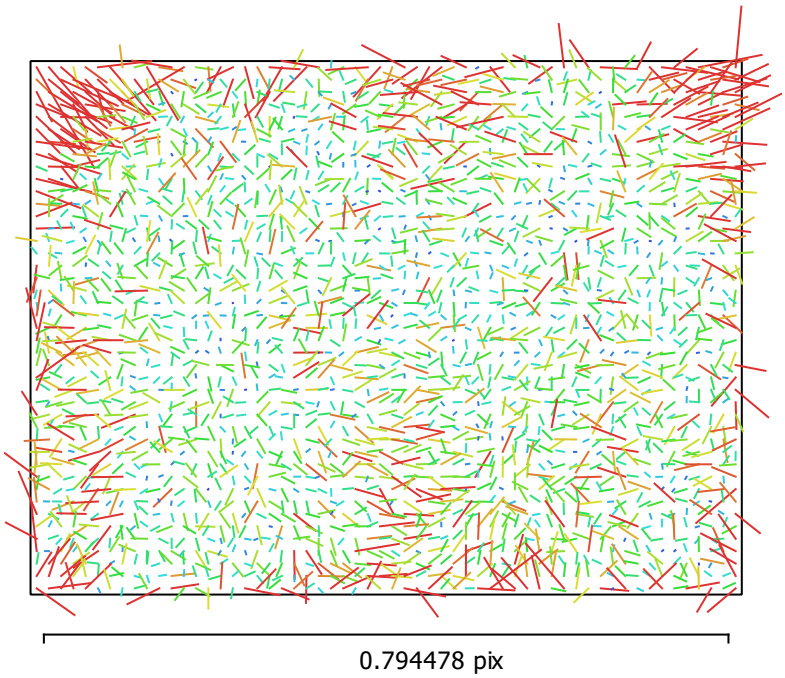

Fig. 4. Image residuals for RedEdge-M, Red (5.5mm).

RedEdge-M, Red (5.5mm)

929 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	P1	P2
F	**1448.62**	0.045	1.00	-0.07	-0.32	-0.03	0.04	-0.10	0.13	-0.10	-0.01	-0.10
Cx	**-17.598**	0.016		1.00	0.02	-0.06	0.02	-0.00	-0.00	-0.00	0.84	0.01
Cy	**16.9658**	0.014			1.00	0.01	-0.07	-0.03	0.00	-0.01	0.01	0.68
B1	**0.189311**	0.0032				1.00	-0.00	0.01	-0.04	0.05	-0.01	-0.01
B2	**0.0153484**	0.0031					1.00	0.00	-0.00	0.00	0.04	-0.01
K1	**-0.102678**	0.0001						1.00	-0.96	0.91	-0.01	-0.04
K2	**0.148371**	0.00079							1.00	-0.98	0.01	-0.00
K3	**-0.0394115**	0.0018								1.00	-0.02	0.00
P1	**0.000125514**	3.3e-006									1.00	0.01
P2	**-8.19877e-005**	2.8e-006										1.00

Table 4. Calibration coefficients and correlation matrix.

Camera Calibration

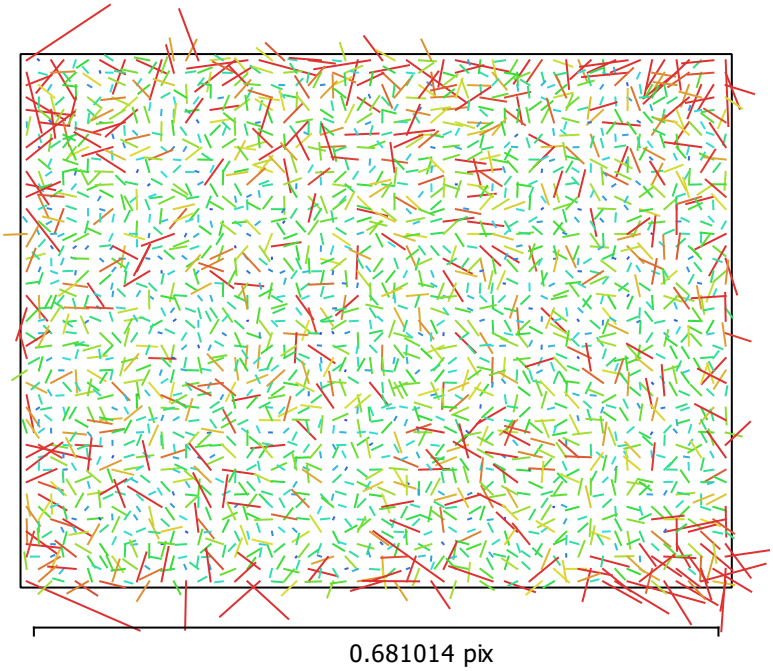

Fig. 5. Image residuals for RedEdge-M, Red edge (5.5mm).

RedEdge-M, Red edge (5.5mm)

929 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	P1	P2
F	**1451.26**	0.045	1.00	-0.10	-0.28	-0.04	0.04	-0.11	0.14	-0.11	-0.02	-0.08
Cx	**-15.7991**	0.017		1.00	0.02	-0.07	0.00	0.00	-0.00	0.00	0.84	0.01
Cy	**2.59365**	0.014			1.00	0.03	-0.07	-0.02	-0.01	0.00	0.01	0.69
B1	**-0.0407032**	0.0033				1.00	0.00	0.01	-0.04	0.05	-0.02	0.01
B2	**-0.091203**	0.0031					1.00	0.00	-0.00	0.00	0.01	-0.02
K1	**-0.102923**	0.00011						1.00	-0.96	0.91	-0.01	-0.04
K2	**0.147016**	0.00082							1.00	-0.98	0.01	0.00
K3	**-0.0301938**	0.0019								1.00	-0.02	0.00
P1	**-0.000290679**	3.4e-006									1.00	0.02
P2	**3.21919e-005**	2.8e-006										1.00

Table 5. Calibration coefficients and correlation matrix.

Camera Calibration

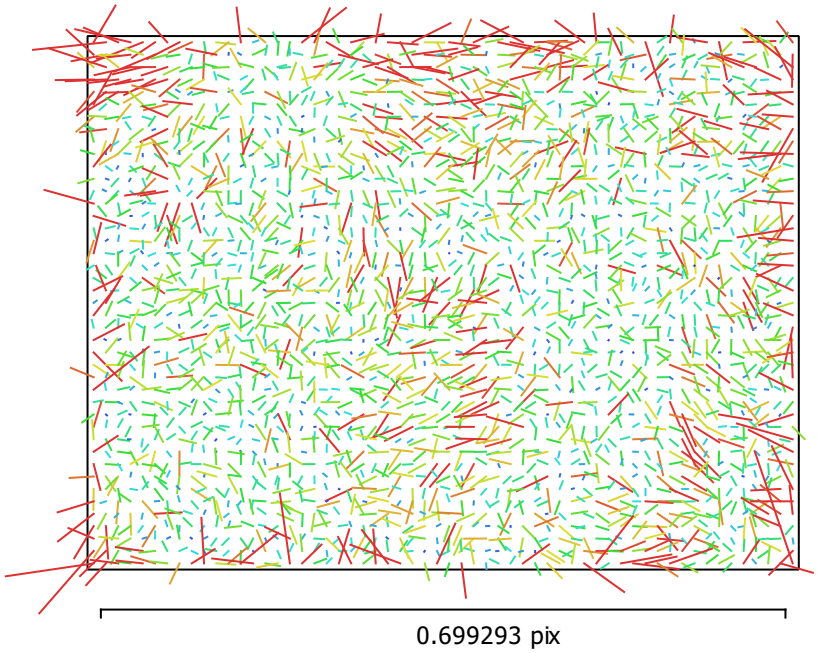

Fig. 6. Image residuals for RedEdge-M, NIR (5.5mm).

RedEdge-M, NIR (5.5mm)

929 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	P1	P2
F	**1454.52**	0.045	1.00	-0.09	-0.32	-0.03	0.03	-0.02	0.19	-0.01	-0.09
Cx	**-17.0328**	0.016		1.00	0.03	-0.04	0.04	-0.00	-0.00	0.82	0.02
Cy	**25.3183**	0.013			1.00	0.01	-0.06	-0.03	-0.06	0.01	0.66
B1	**0.0982407**	0.0031				1.00	0.00	-0.09	0.05	0.01	-0.03
B2	**0.0395939**	0.003					1.00	-0.00	0.01	0.05	-0.00
K1	**-0.102138**	4e-005						1.00	-0.90	0.00	-0.10
K2	**0.13143**	0.00013							1.00	-0.02	-0.00
P1	**0.000658342**	3.1e-006								1.00	0.02
P2	**0.000210043**	2.6e-006									1.00

Table 6. Calibration coefficients and correlation matrix.

Camera Locations

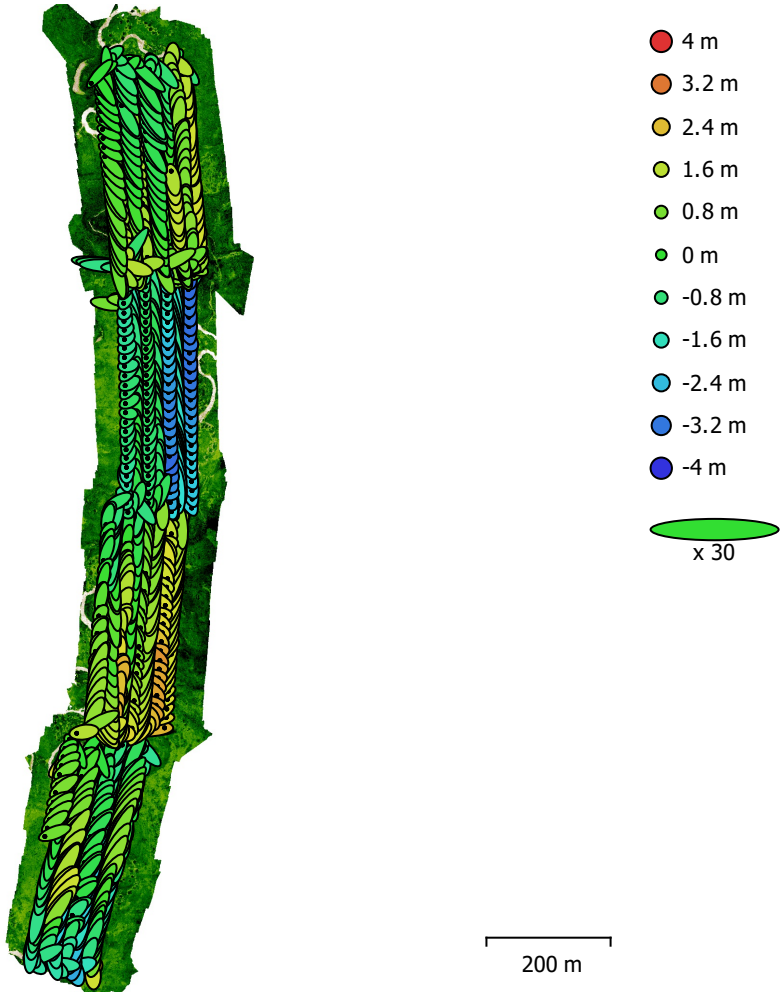

Fig. 7. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
0.570453	1.10192	1.25709	1.24082	1.76633

Table 7. Average camera location error.
X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

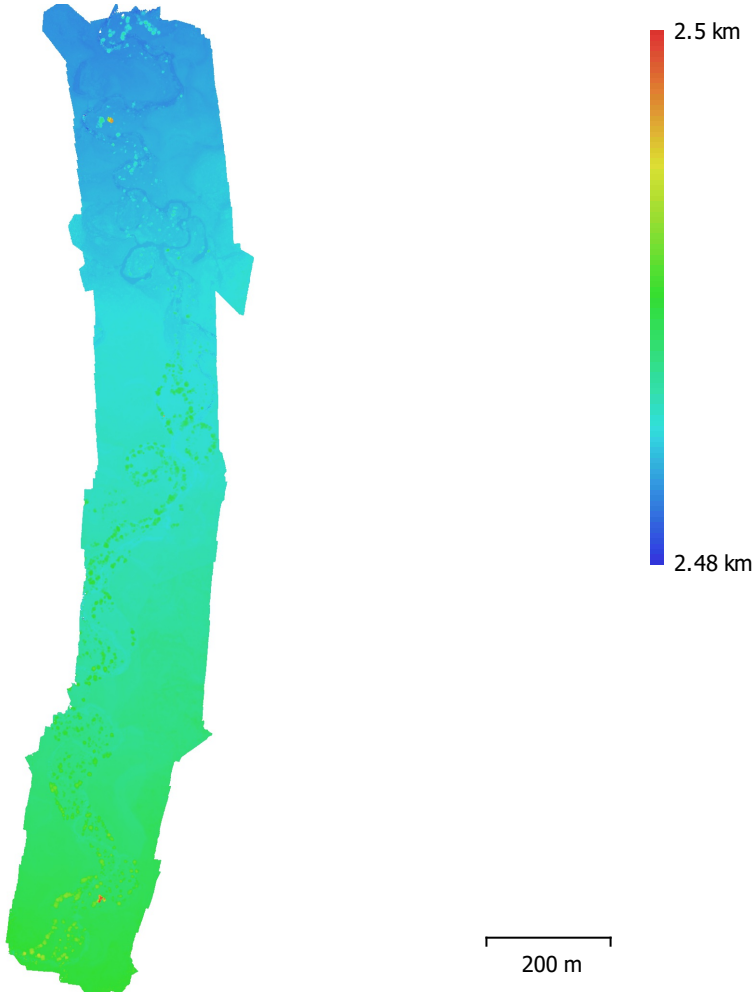

Fig. 8. Reconstructed digital elevation model.

Resolution:	14.6 cm/pix
Point density:	46.7 points/m²

Processing Parameters

General	
Cameras	4645
Aligned cameras	4570
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	2,342,959 of 2,590,119
RMS reprojection error	0.165054 (0.627308 pix)
Max reprojection error	0.598333 (26.9243 pix)
Mean key point size	3.35532 pix
Point colors	1 bands, uint16
Key points	No
Average tie point multiplicity	6.93842
Alignment parameters	
Accuracy	High
Generic preselection	Yes
Reference preselection	Yes
Key point limit	40,000
Tie point limit	4,000
Filter points by mask	No
Mask tie points	No
Adaptive camera model fitting	Yes
Matching time	21 minutes 39 seconds
Alignment time	45 minutes 47 seconds
Optimization parameters	
Parameters	f, b1, b2, cx, cy, k1-k3, p1, p2
Adaptive camera model fitting	Yes
Optimization time	1 minutes 17 seconds
Software version	1.5.2.7838
Depth Maps	
Count	914
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Processing time	59 minutes 27 seconds
Software version	1.5.2.7838
Dense Point Cloud	
Points	17,708,088
Point colors	5 bands, uint16
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Processing time	59 minutes 27 seconds
Dense cloud generation parameters	
Processing time	22 minutes 26 seconds
Software version	1.5.2.7838
DEM	
Size	4,392 x 14,458
Coordinate system	WGS 84 / UTM zone 13N (EPSG::32613)
Reconstruction parameters	

General	
Source data	Dense cloud
Interpolation	Enabled
Processing time	2 minutes 32 seconds
Software version	1.5.2.7838
Orthomosaic	
Size	6,460 x 22,791
Coordinate system	WGS 84 / UTM zone 13N (EPSG::32613)
Colors	5 bands, uint16
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Processing time	10 minutes 2 seconds
Software version	1.5.2.7838
Raster Transform	
Expression	B1 / 32768; B2 / 32768; B3 / 32768; B4 / 32768; B5 / 32768
Software	
Version	1.5.2 build 7838
Platform	Windows 64