

Drone photogrammetry in surveying

Zach Hoover, Ph.D, B.Sc., B.GeoM., Candidate Member—ANSLS

Spring seminar, May 30, 2025

Inn on Prince Hotel and Conference Centre, 437 Prince Street, Truro

Overview

- Photogrammetry drones
- Basic workflow
- Best practices
- Examples
- Regulations

Photogrammetry drones

- Fixed Wing
 - Pros—cover large areas quickly and efficiently, long run times
 - Cons—may require runway, cost
- Multi-rotor
 - Pros—maneuverability, ease of use, cost
 - Cons—shorter flights, lower speed



<https://aeromao.com/products/vtnaut/>



<https://store.dji.com/ca/product/dji-mavic-3e-and-dji-care-enterprise-basic?vid=120171>



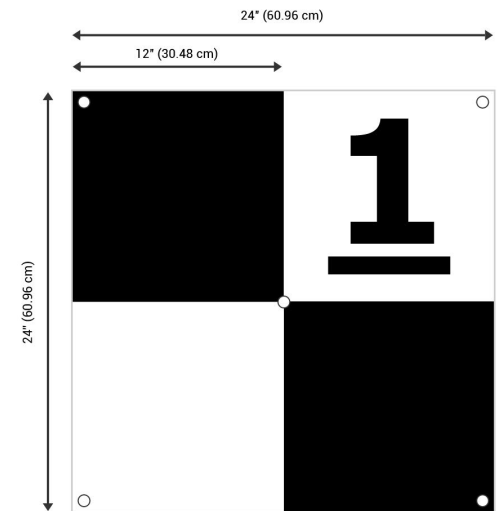
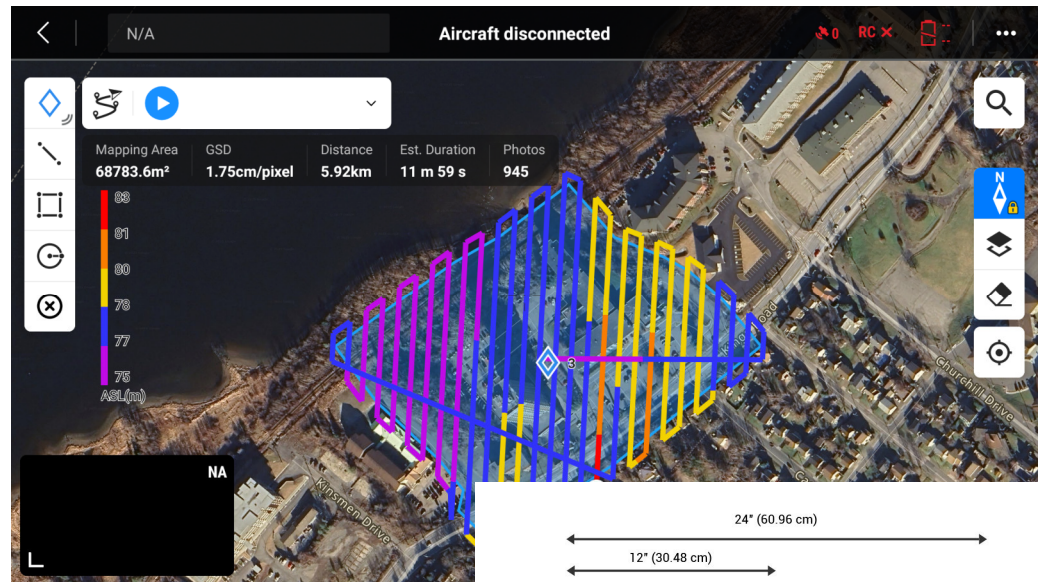
<https://www.pegasusaero.ca/g15-sentinel>

Photogrammetry drones cont.

- Recommended equipment
 - RTK/PPK
 - Mechanical shutter
- Examples
 - DJI Mavic 3E
 - \$4805.00 (drdrone.ca, drone only)
 - DJI Matrice 300
 - \$13393.00 (drone w/ RTK)
 - \$9099.00 (P1 camera)
 - Many others

Basic workflow

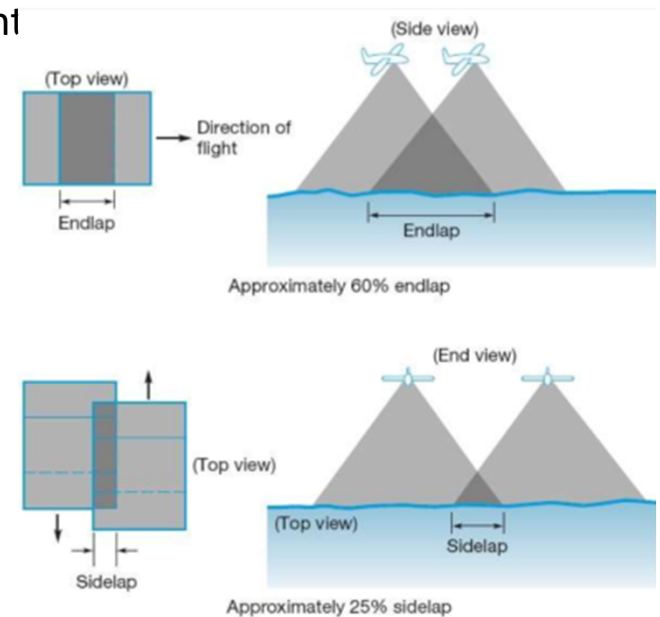
- Mission planning
- GCPs
 - RTK/PPK vs GCPs only
- Flying
- Processing
 - Buy once, cry once
 - Agisoft Metashape, Pix4D (some), DJI Terra
 - Pay per use/recurring
 - Carlson PhotoCapture, DroneDeploy, VirtualSurveyor
 - Free
 - WebODM, Reality Capture
- CAD import



<https://a.co/d/aiPrLcY>

Best practices

- Mission planning
 - GSD (ground sample distance)
 - Linear distance on the ground covered by one pixel
 - Related to camera focal length, pixel size, and flight height
 - $H = f \frac{GSD}{pixel\ size}$
 - Very generally,
 - Horizontal relative accuracy = 1-2 * GSD
 - Vertical relative accuracy = 1-3 * GSD
 - Flight height is a trade-off
 - Flight line overlap
 - ~80% endlap
 - ~50% sidelap



Best practices

- Environmental
 - Time of day
 - Weather
 - Space weather
 - Time of year
- Safety



<https://www.shutterstock.com/image-vector/unstable-cliff-edge-warning-sign-vector-1997779286>



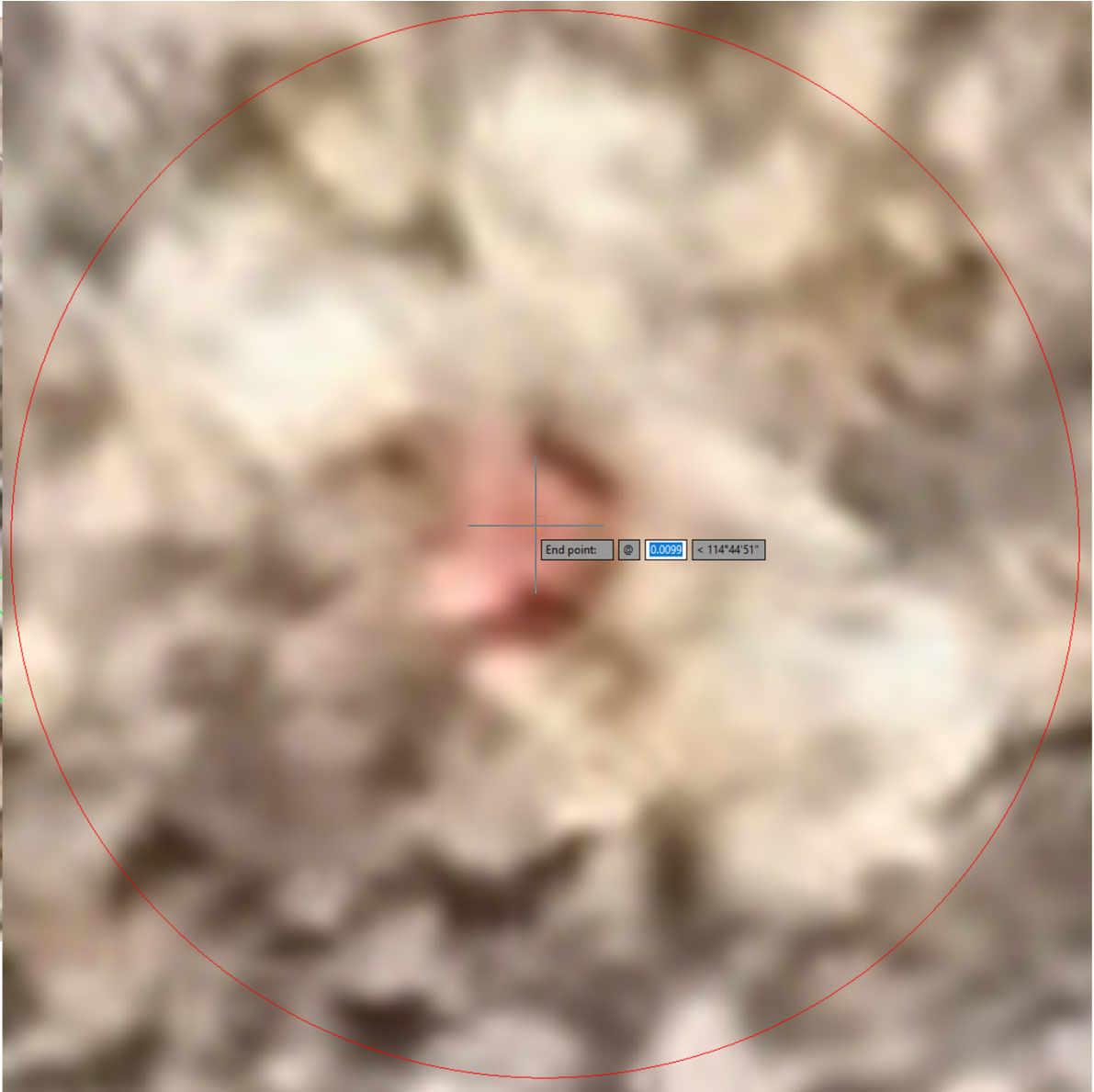
<https://www.coverdrone.com/10-tips-for-preventing-drone-crashes/>

Examples





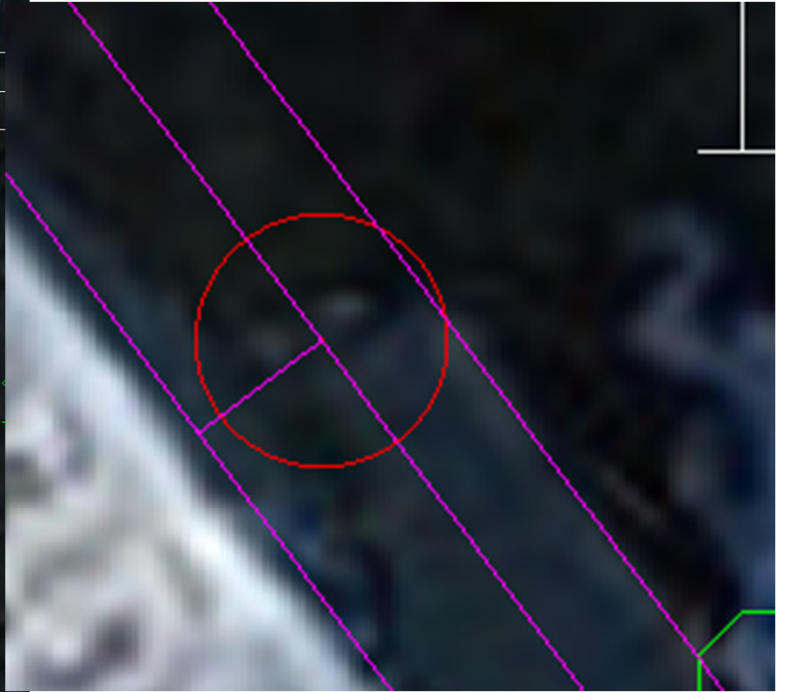






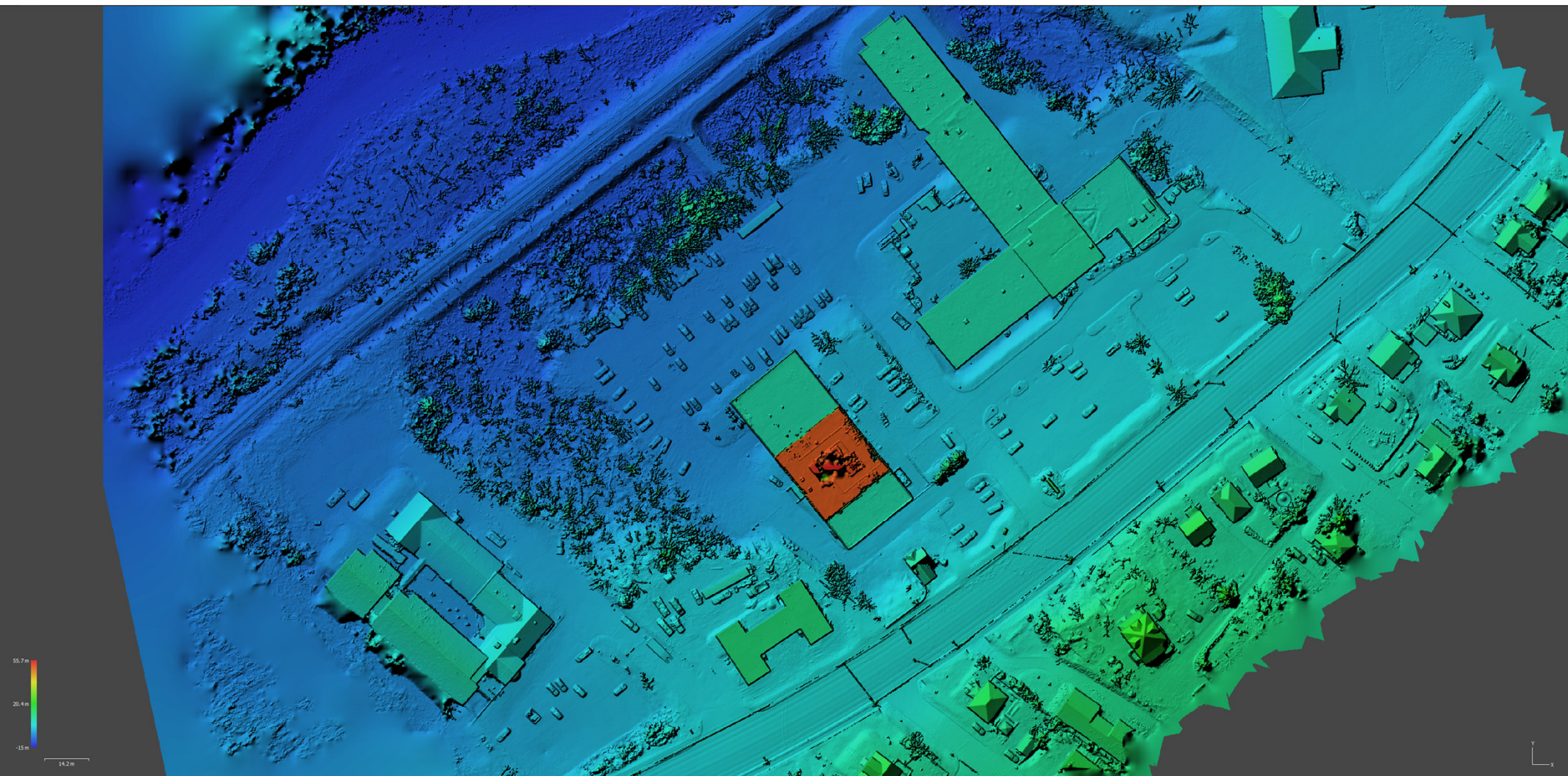


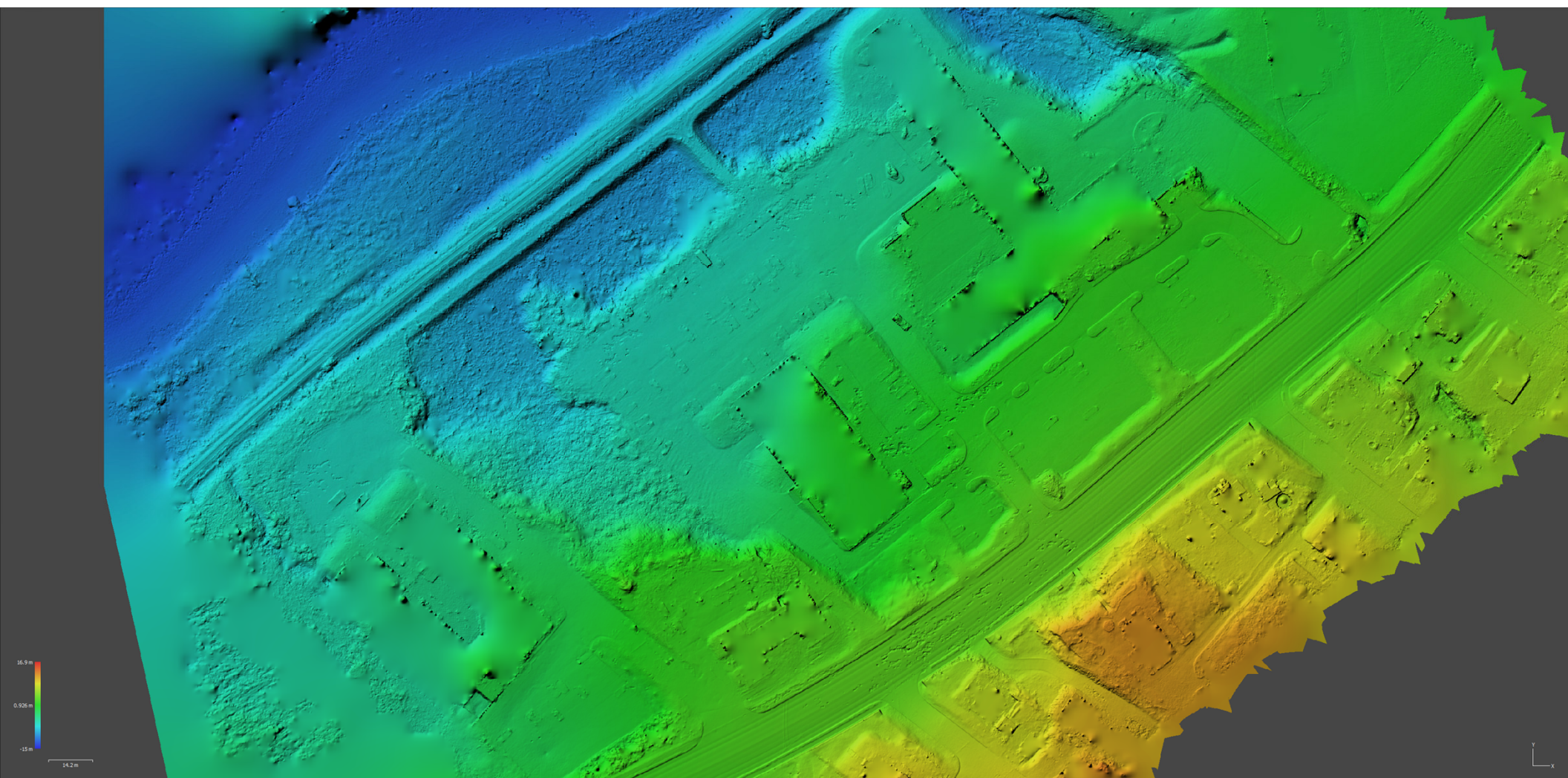


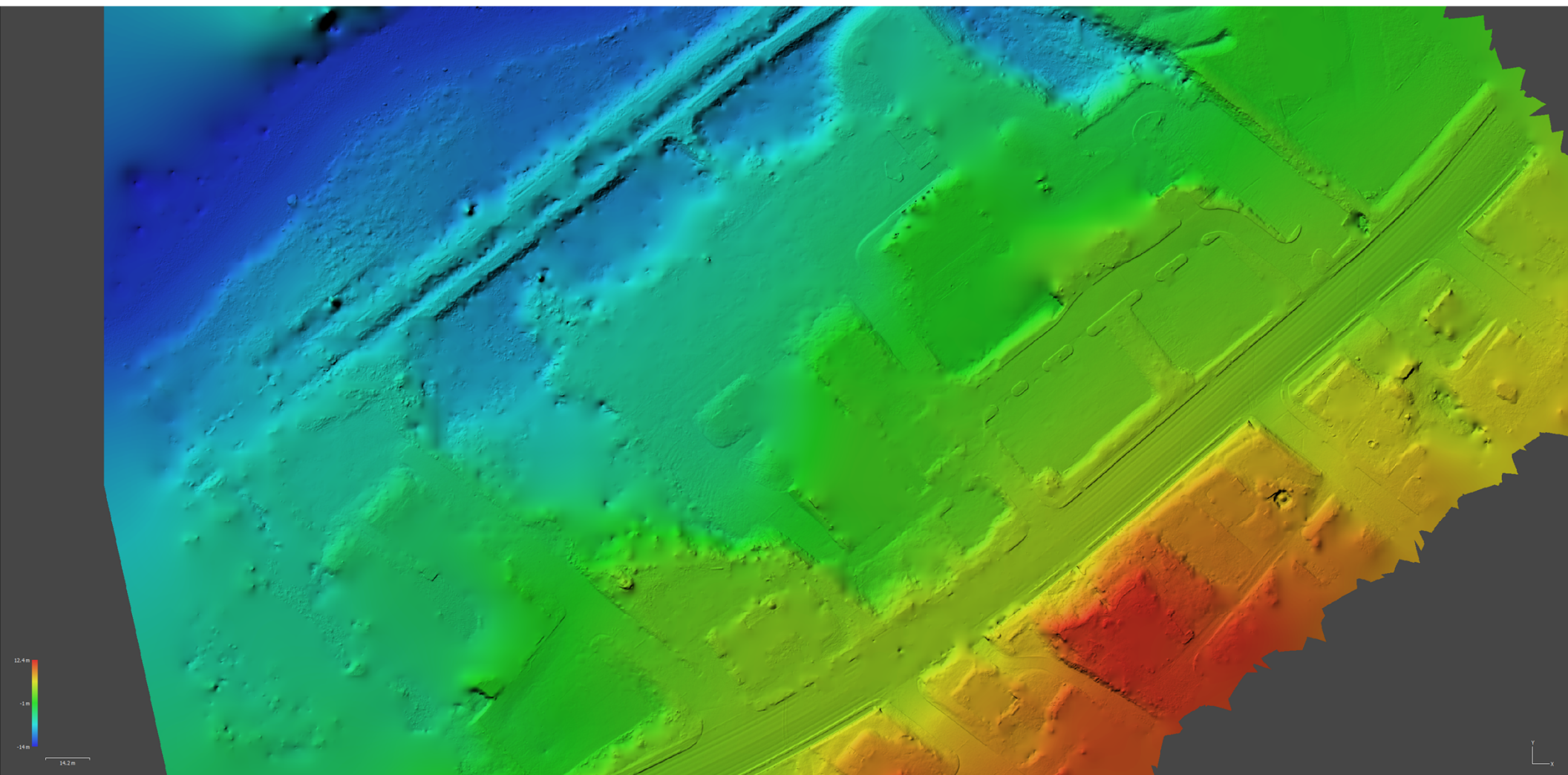


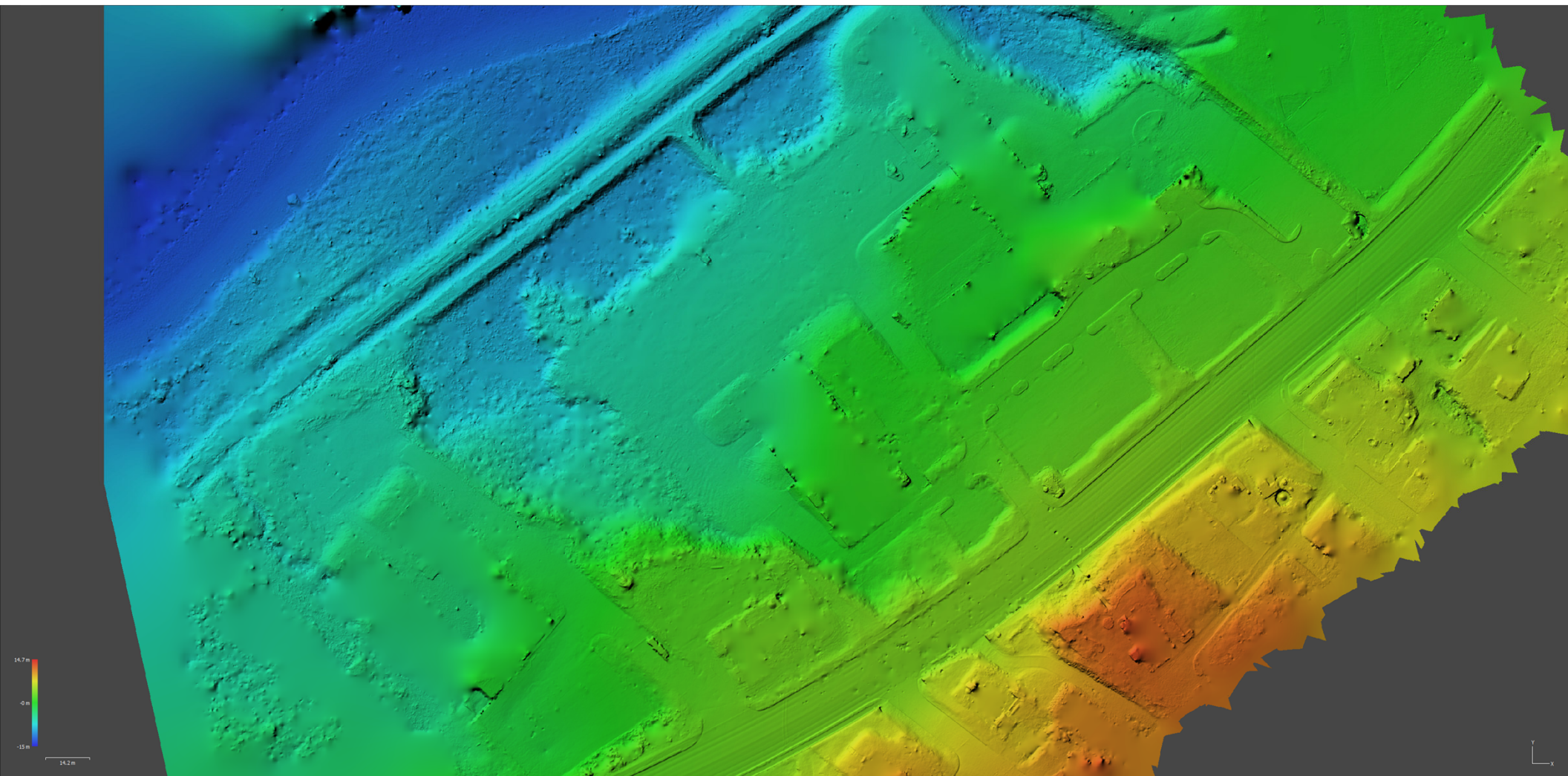










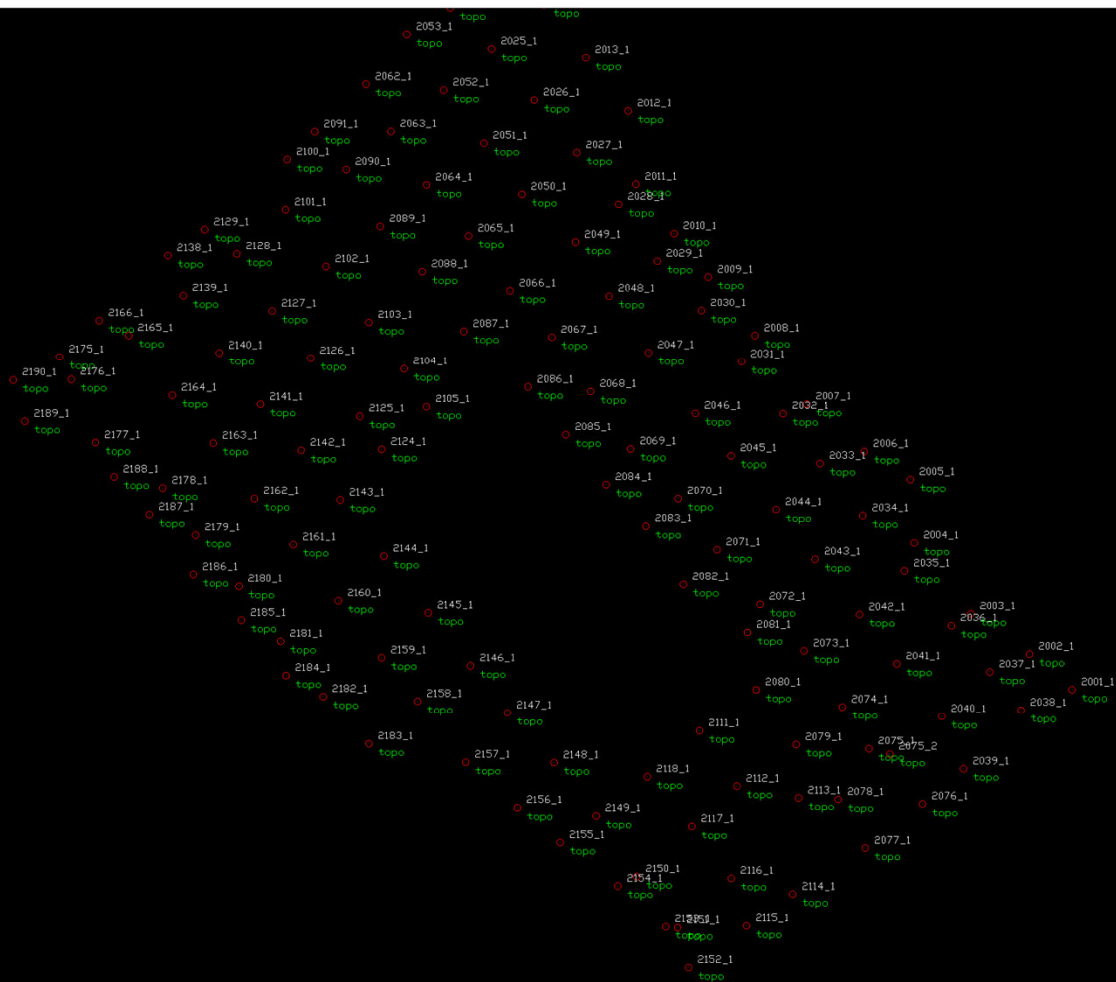


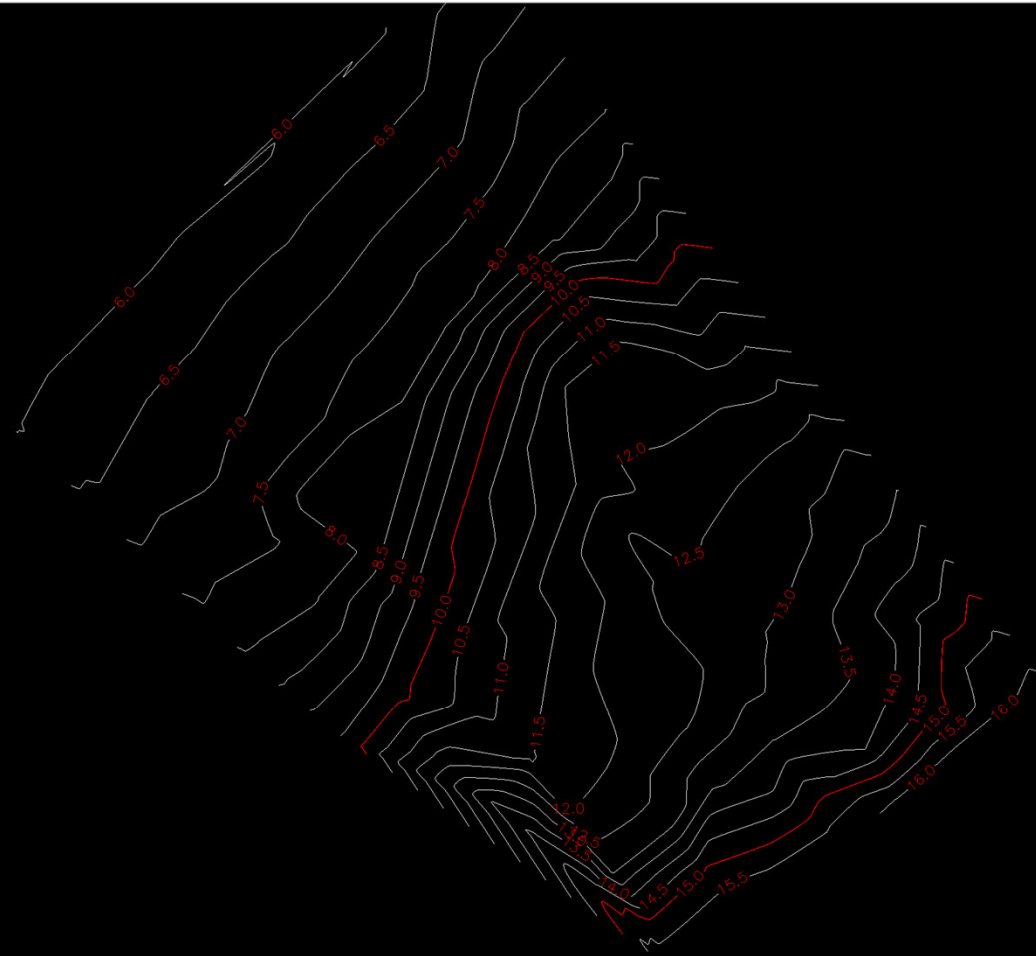


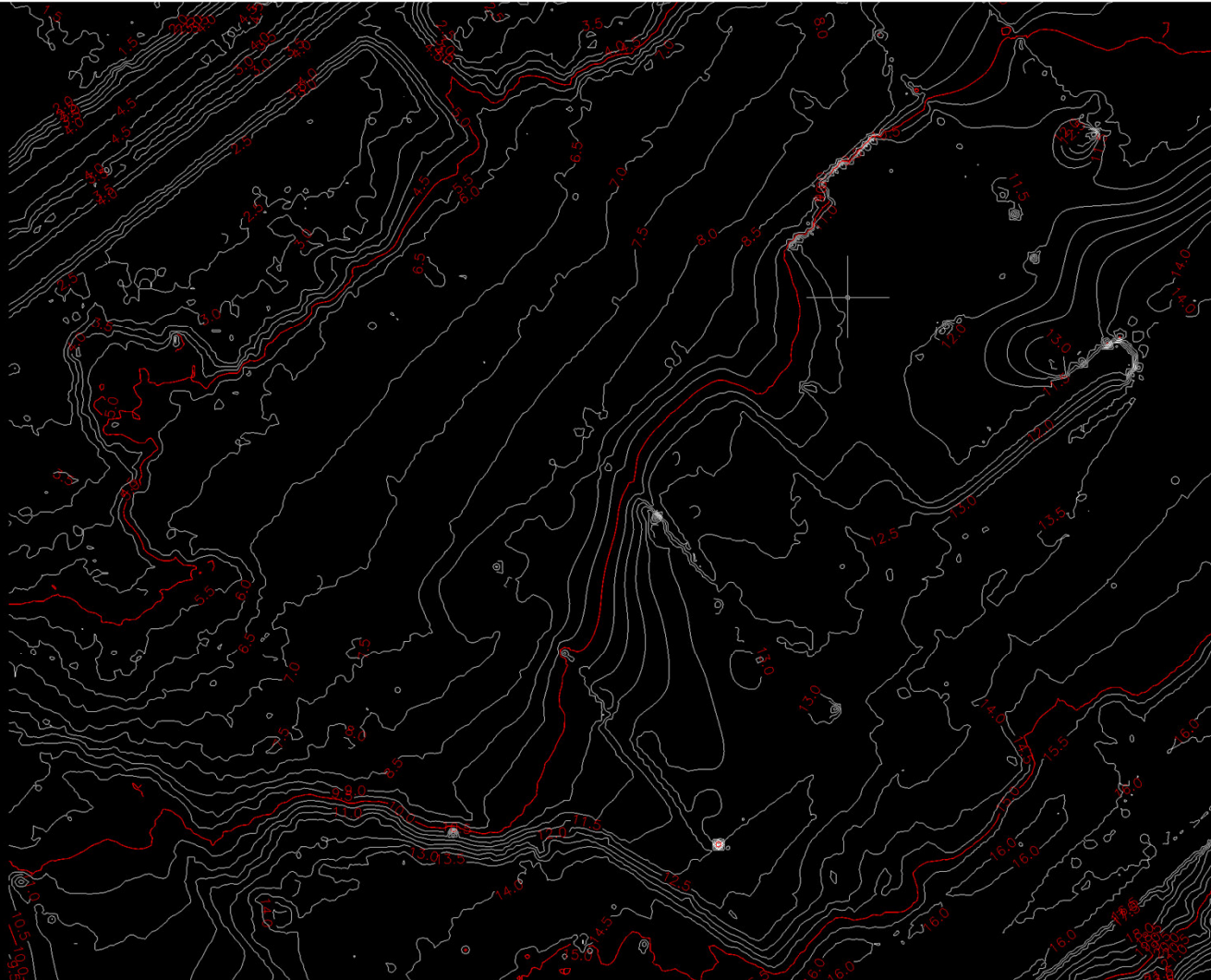


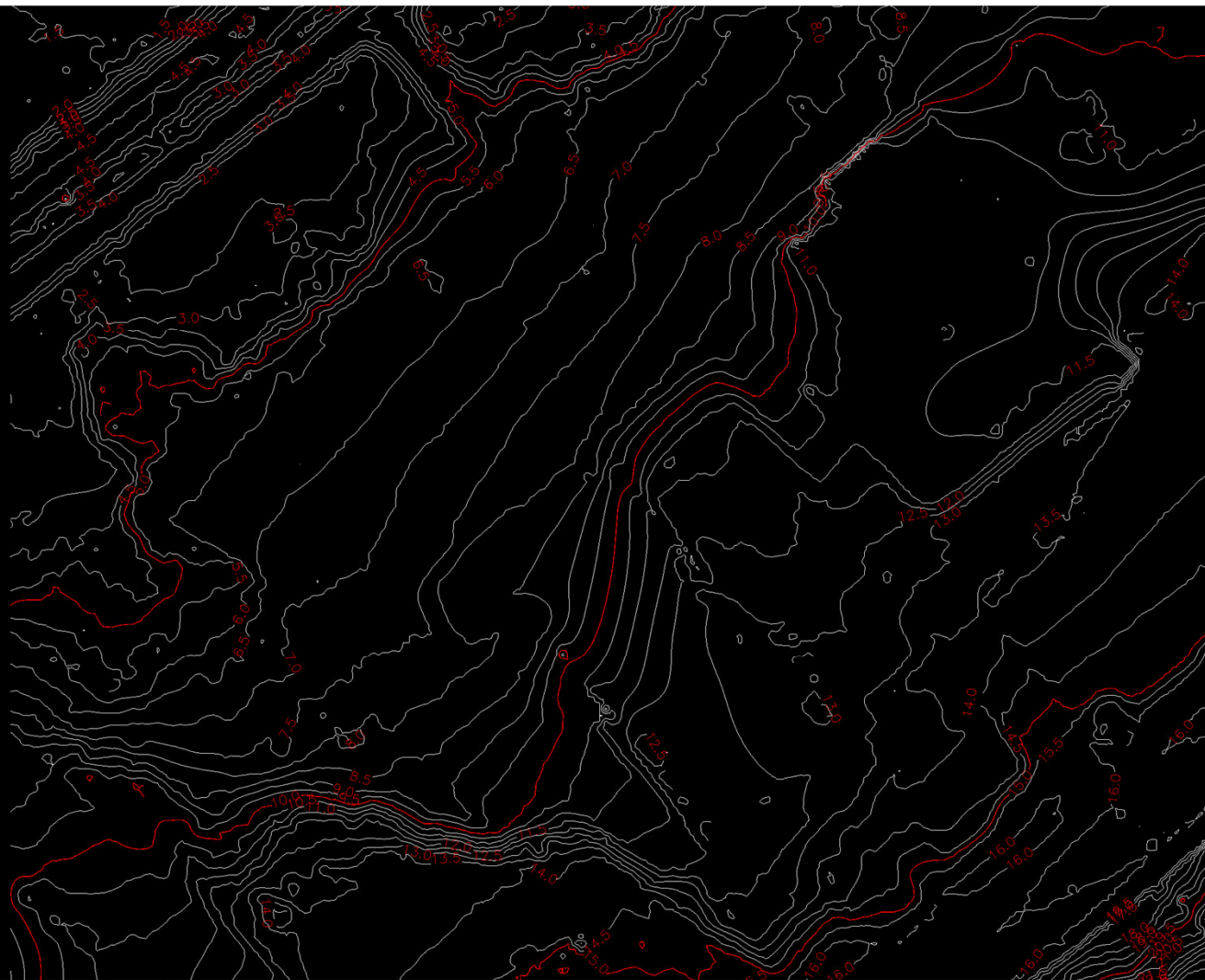
TOP

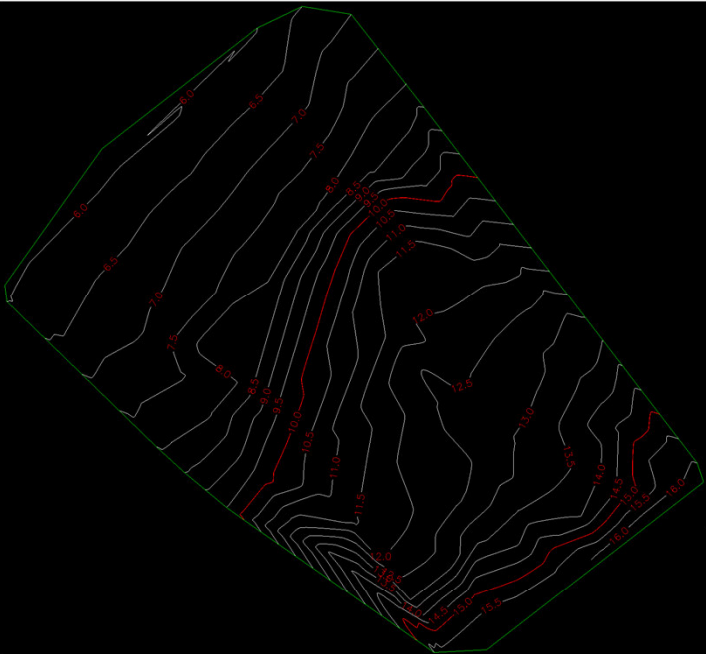
WCS



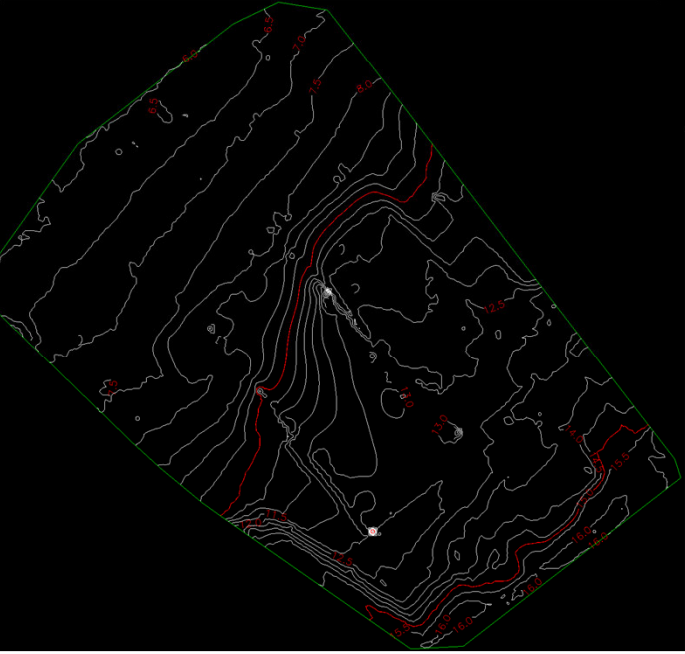








Surface from field measurements



DTM1, drone



DTM2, drone



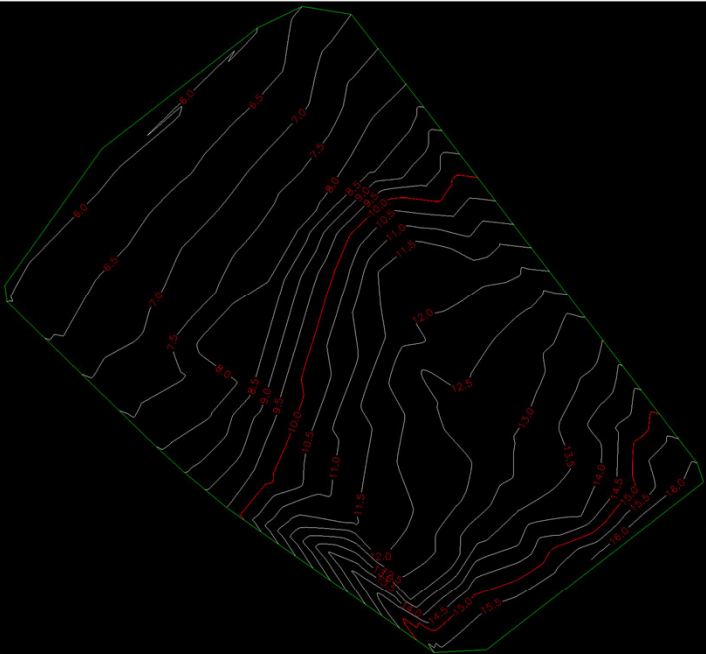
Measurements (m)								Height comparisons (m)		
point	E	N	H_field	H_dtm1	H_dtm2	description		dtm1 v field	dtm2 v field	dtm1 v dtm2
1	24600060.710	5109971.172	6.341	6.395	6.366	parking lot		0.055	0.026	0.029
2	24600108.530	5110010.210	6.876	6.838	6.857	parking lot		-0.038	-0.019	-0.019
3	24600097.220	5109925.129	9.462	9.512	9.512	parking lot		0.049	0.049	0.000
4	24600141.680	5109952.960	12.185	12.102	12.104	parking lot		-0.083	-0.081	-0.002
5	24600160.760	5109905.681	14.779	14.963	14.963	slope--paved		0.184	0.184	0.000
6	24600116.490	5109906.163	13.120	12.298	12.298	slope		-0.822	-0.822	0.000
7	24600142.640	5109900.276	13.704	13.212	13.212	slope		-0.493	-0.493	0.000
8	24600172.910	5109911.022	14.947	15.365	15.365	slope		0.418	0.418	0.000
9	24600116.500	5109976.581	9.626	9.613	9.609	slope		-0.013	-0.018	0.005
10	24600158.790	5109933.087	13.148	13.538	13.408	tree cover		0.390	0.260	0.131



Measurements (m)								Height comparisons (m)		
point	E	N	H_as_measured	H_field	H_dtm1	H_dtm2	description	dtm1 v measured	dtm2 v measured	dtm1 v dtm2
101	24600061.997	5109967.208	6.471	6.471	6.531	6.541	pl	0.060	0.070	-0.011
102	24600108.687	5110005.013	6.964	6.964	6.995	7.004	pl	0.031	0.039	-0.008
103	24600086.865	5109936.521	7.916	7.916	8.000	8.000	pl	0.084	0.084	0.000
104	24600106.684	5109926.822	10.379	10.379	10.400	10.400	pl	0.021	0.021	0.000
105	24600161.769	5109906.666	14.836	14.836	14.897	14.897	slope--paved	0.061	0.061	0.000
106	24600113.703	5109905.460	13.549	13.549	13.709	13.674	slope	0.160	0.125	0.035
107	24600139.840	5109902.657	12.760	12.760	12.858	12.858	topo	0.098	0.098	0.000
108	24600177.276	5109919.191	14.496	14.496	14.648	14.669	slope	0.152	0.173	-0.021
109	24600118.871	5109975.955	10.099	10.099	10.192	10.209	topo	0.093	0.110	-0.017
110	24600138.577	5109938.973	12.558	12.558	12.652	12.644	building_edge	0.094	0.086	0.008

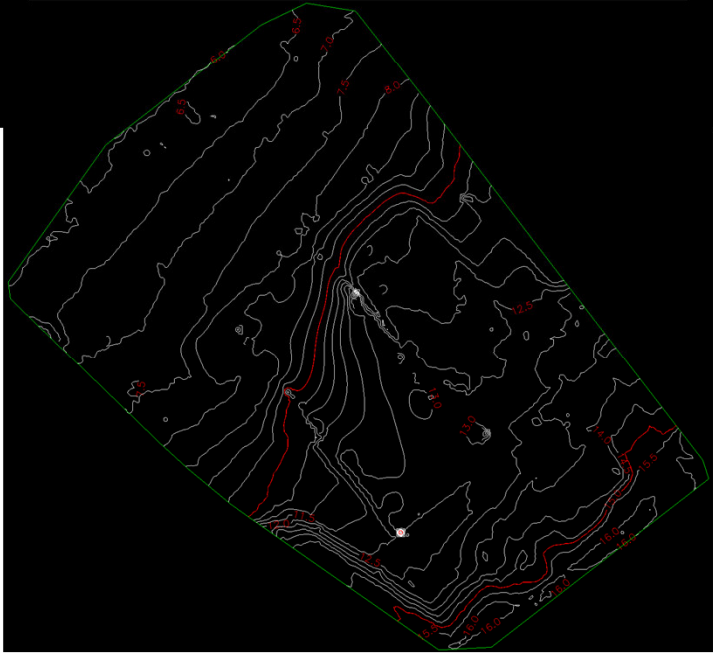


Measurements (m)								Height comparisons (m)				
point	E	N	H_as_measured	H_field	H_dtm1	H_dtm2	description	field v measured	dtm1 v measured	dtm2 v measured	dtm1 v dtm2	closest to measured
501	24600107.491	5109975.704	7.874	8.231	7.964	7.977	pl	0.357	0.090	0.103	-0.013	drone
502	24600087.024	5109941.144	7.726	7.803	7.793	7.793	pl	0.077	0.067	0.067	0.000	drone
503	24600093.457	5109935.489	8.173	8.631	8.312	8.312	pl	0.458	0.139	0.139	0.000	drone
504	24600101.666	5109928.751	9.651	9.777	9.741	9.741	pl	0.126	0.090	0.090	0.000	drone
505	24600121.563	5109962.907	11.630	11.219	11.716	11.716	pl	-0.411	0.086	0.085	0.001	drone
506	24600134.949	5109975.628	11.575	11.292	11.675	11.678	pl	-0.283	0.100	0.103	-0.004	drone
507	24600157.895	5109964.069	12.214	12.248	12.247	12.287	storm	0.034	0.033	0.073	-0.040	field
508	24600154.260	5109928.985	13.201	12.974	12.793	12.948	boc	-0.227	-0.408	-0.253	-0.155	none
509	24600184.053	5109931.749	15.103	15.045	15.105	15.114	foc	-0.059	0.002	0.011	-0.009	drone
510	24600165.424	5109908.842	14.050	14.671	14.213	14.213	pl	0.621	0.163	0.163	0.000	drone



Surface from field measurements

DTM1, drone



DTM2, drone

Regulations

- Transport Canada
 - <https://tc.canada.ca/en/aviation/drone-safety/learn-rules-you-fly-your-drone/flying-your-drone-safely-legally>
 - Updated regulations: November 4, 2025
- Microdrones (under 250g)
- Most photogrammetry drones (250g – 25kg)
 - Registration required
 - Pilot certificate required
- Drones over 25kg
 - Special permission required from TC
- Fines for non-compliance

Regulations—licenses

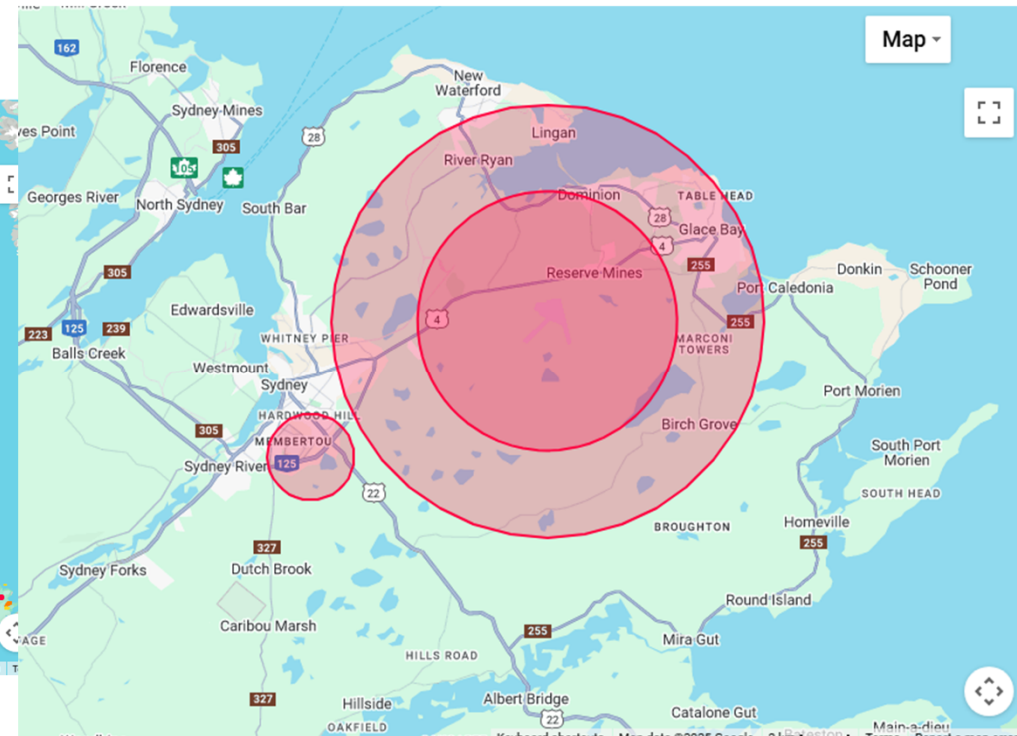
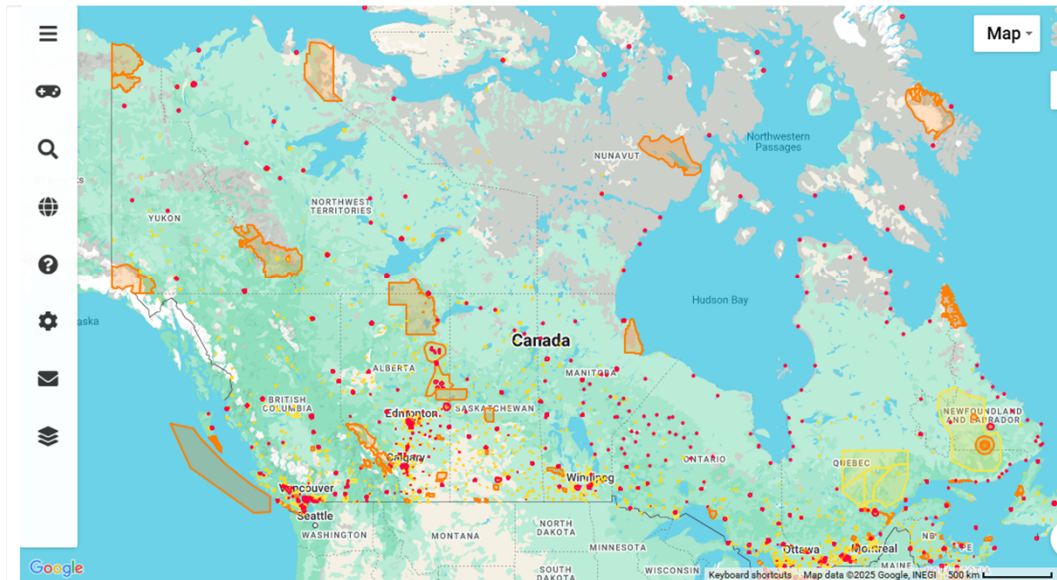
- Basic operations
 - Uncontrolled airspace
 - > 100' horizontally from bystanders
 - > 3 nautical miles from airports/aerodromes
 - > 1 nautical mile from helipads
 - Drone must remain in VLOS
 - Requirements for
 - Recency (24 months)
 - SOP
 - Flight logs
 - Online test

Regulations—licenses

- Advanced operations
 - Assuming approved RPAS model and permission, where required
 - Within controlled airspace
 - Within 3 nautical miles of airports
 - Within 1 nautical mile of heliports
 - Within 5m of bystanders
 - BVLOS with permission
 - Online test + In-person flight review test

Regulations—locations

- Drone site selection tool
 - <https://nrc.canada.ca/en/drone-tool/>



Questions?

