
Vertical Accuracy Report

Prepared By: Ayres Associates, LiDAR QA/QC Team
Project Name: St Louis River AOC LIDAR 2016
Sensor Info: Optech Orion H300
Required Nominal Pulse Spacing: 0.7
Consultant: Ayres Associates
Units: Meters

Date of Acquisition: Start: 10/17/2015 Finish: 10/19/2015

Report Information

This report documents the absolute vertical accuracy of the lidar data collected for the St. Louis River AOC in Douglas County, WI. Independent ground control checkpoints were collected by land surveyors using Trimble GNSS equipment connected to WISCORS base stations. The checkpoints were collected in November 2016, shortly after the lidar acquisition.

The checkpoints were collected under various land cover types that are predominant in the AOC. Each land cover type falls into either the Non-vegetated Vertical Accuracy (NVA) or the Vegetated Vertical Accuracy (VVA) group. For this project, there were 25 NVA points and 20 VVA points collected throughout the AOC. The following report provides accuracy statistics, survey photos, and checkpoint locations and elevations collected in each land cover type and NVA/VVA group.

The checkpoints were used to compare against the LiDAR elevations contained in the classified LAS point cloud and the bare earth DEM. Statistics are reported for LAS and DEM by land cover type.

Land Cover types

Bare earth - NVA
Urban - NVA
Swamp - VVA
Tall Weeds - VVA
Forest - VVA

Vertical Accuracy Specifications

LAS:
Non-vegetated vertical accuracy (NVA) is 10 cm RMSEz, which equates to 19.6cm at the 95% confidence level.

DEM:
Non-vegetated vertical accuracy (NVA) is 10 cm RMSEz, which equates to 19.6cm at the 95% confidence level. Vegetated vertical accuracy (VVA) is 29.4cm at the 95th percentile.

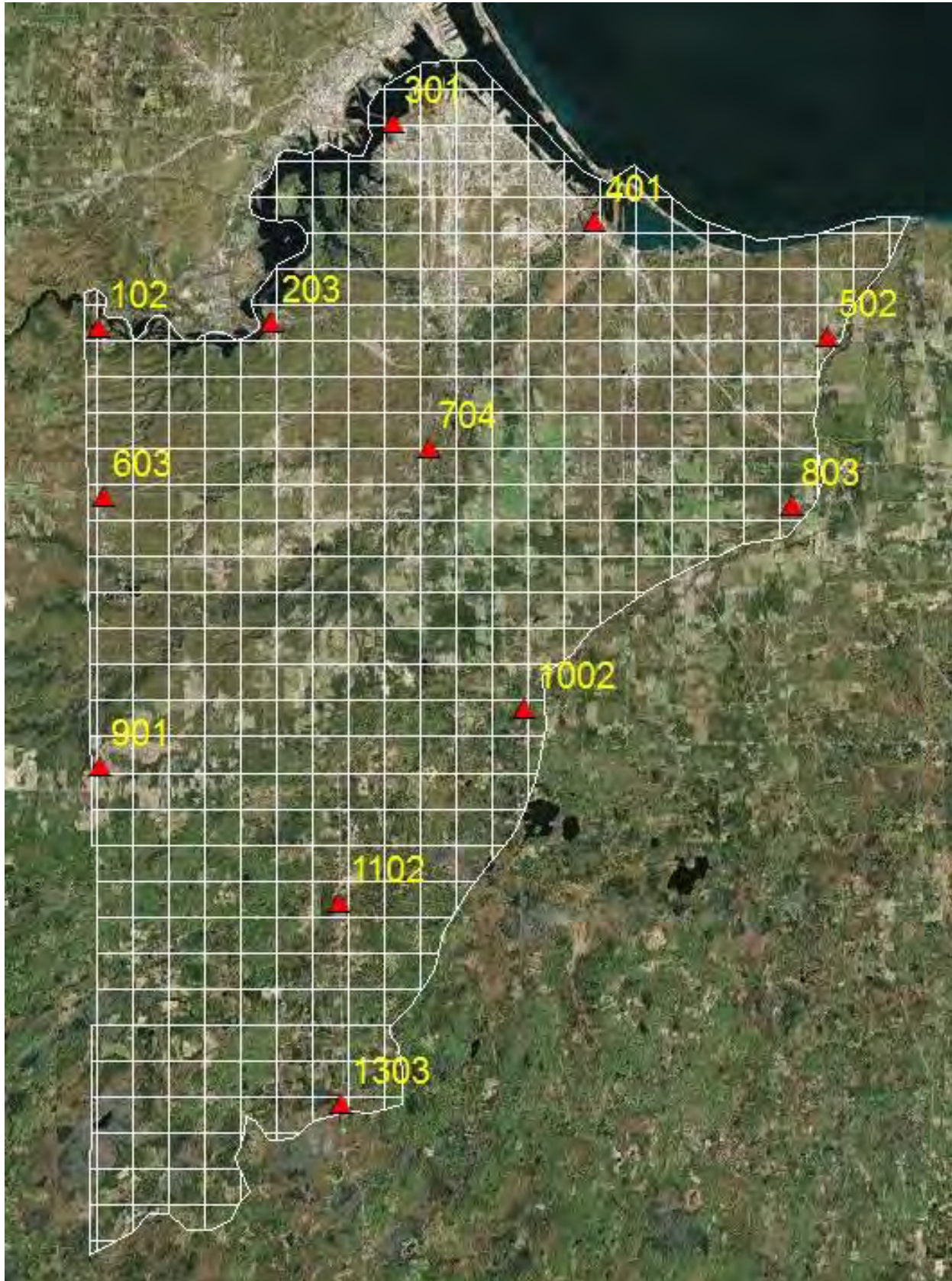
The absolute vertical accuracy for this project is within the stated specifications.

LiDAR Accuracy Assessment Summary

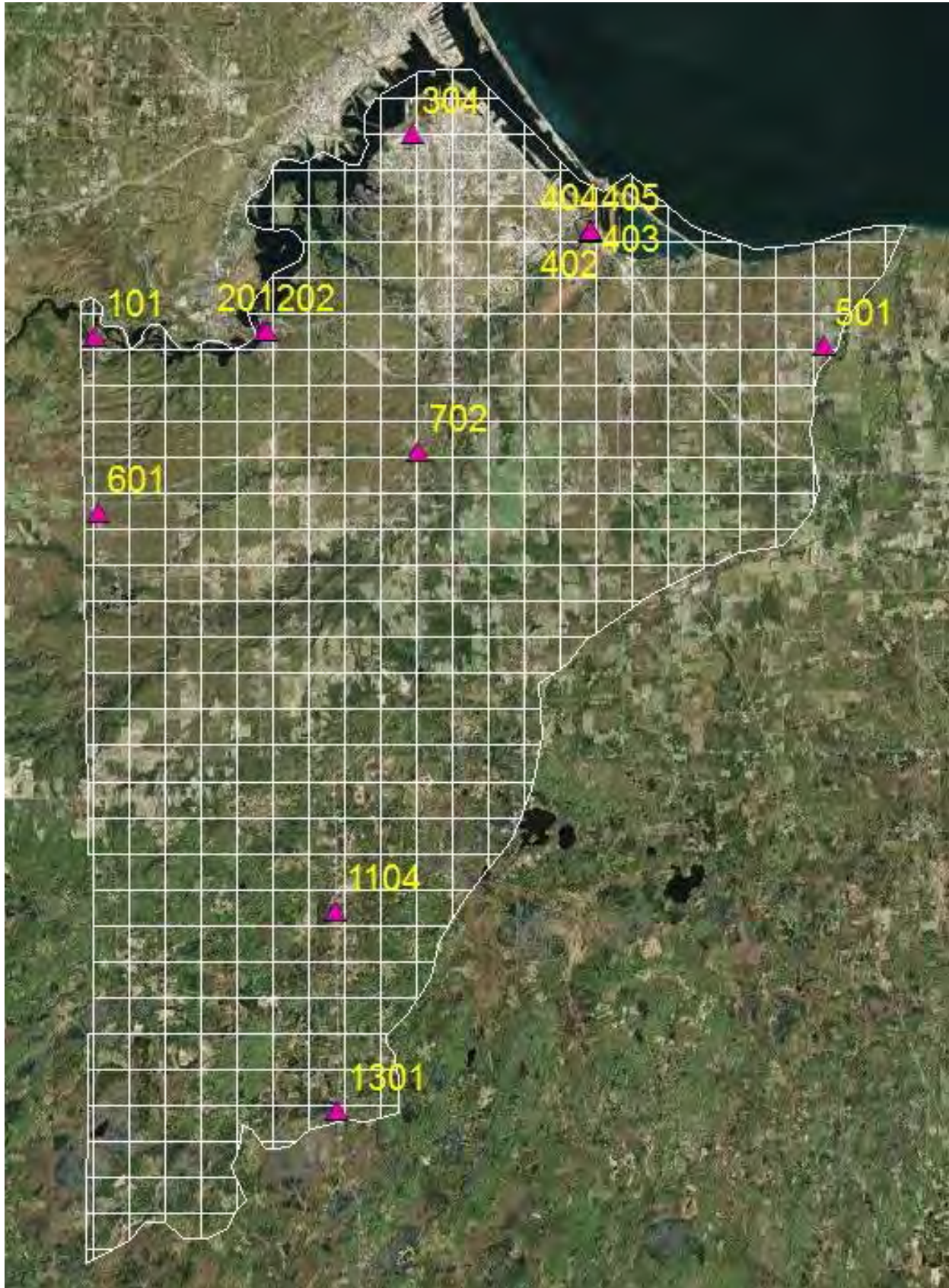
LC Type	# of Points	NVA	VVA	
LAS		95% confidence	95th Percentile	
1 - Bare Earth	12	0.072		
2 - Urban areas	13	0.048		
3 - Tall grass	5			
5 - Forested areas	11			
7 - Swamps	4			
Total	45	0.061	n/a	
DEM				
1 - Bare Earth	12	0.072		
2 - Urban areas	13	0.054		
3 - Tall grass	5		0.274	
5 - Forested areas	11		0.240	
7 - Swamps	4		0.289	
Total	45	0.064	0.281	

Units: Meters

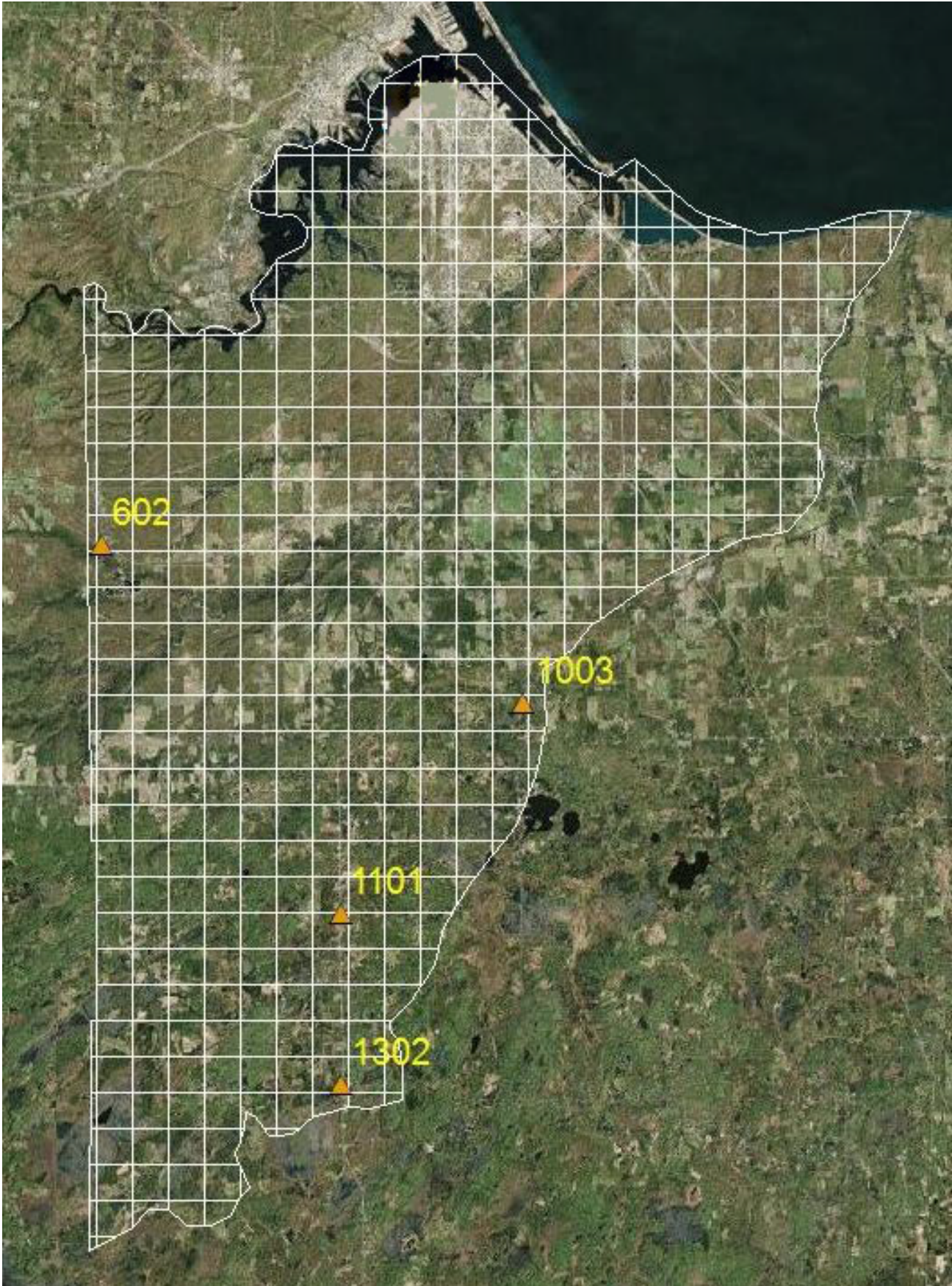
NVA Checkpoint Locations - Bare Earth



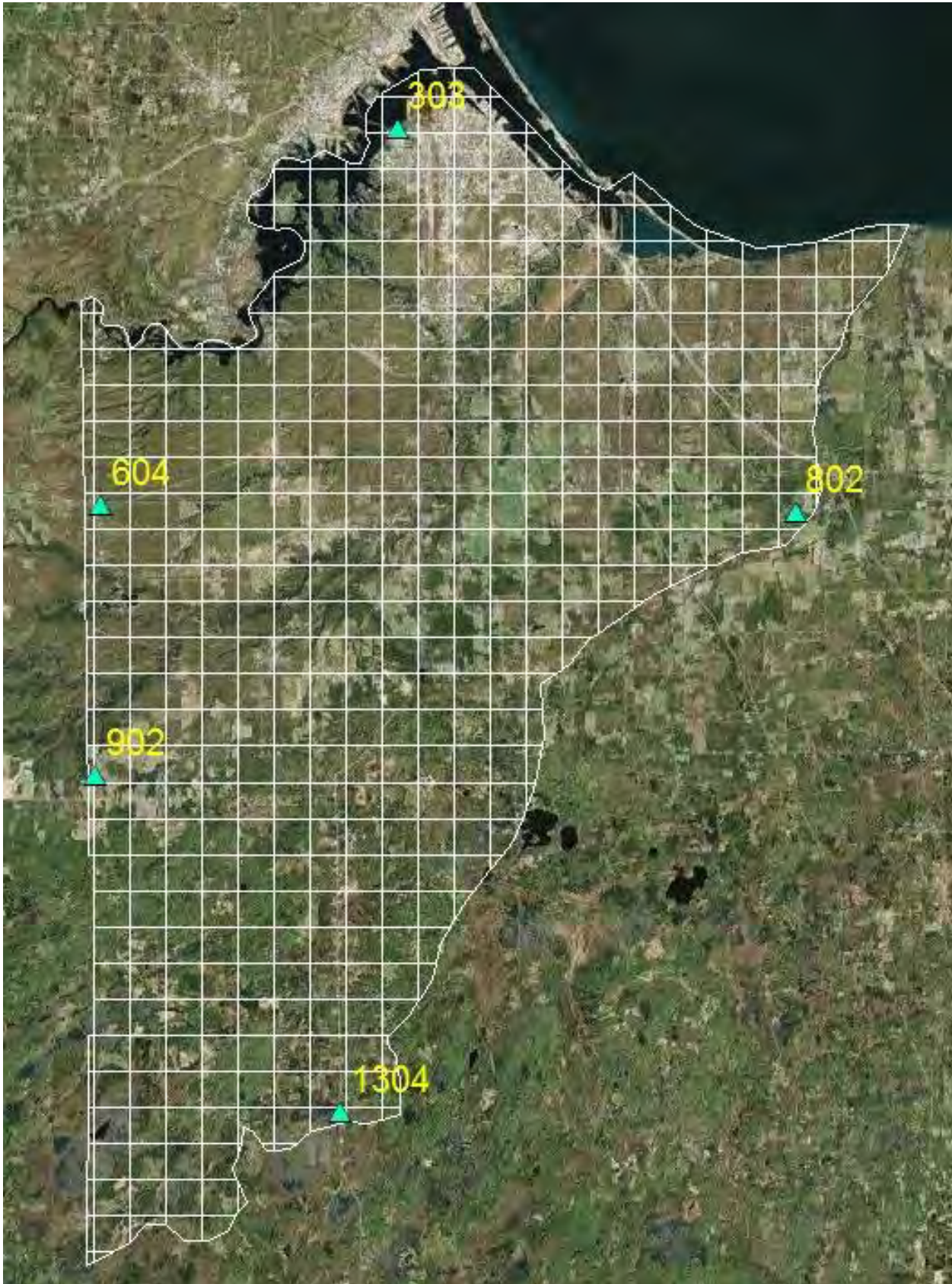
NVA Checkpoint Locations - Urban



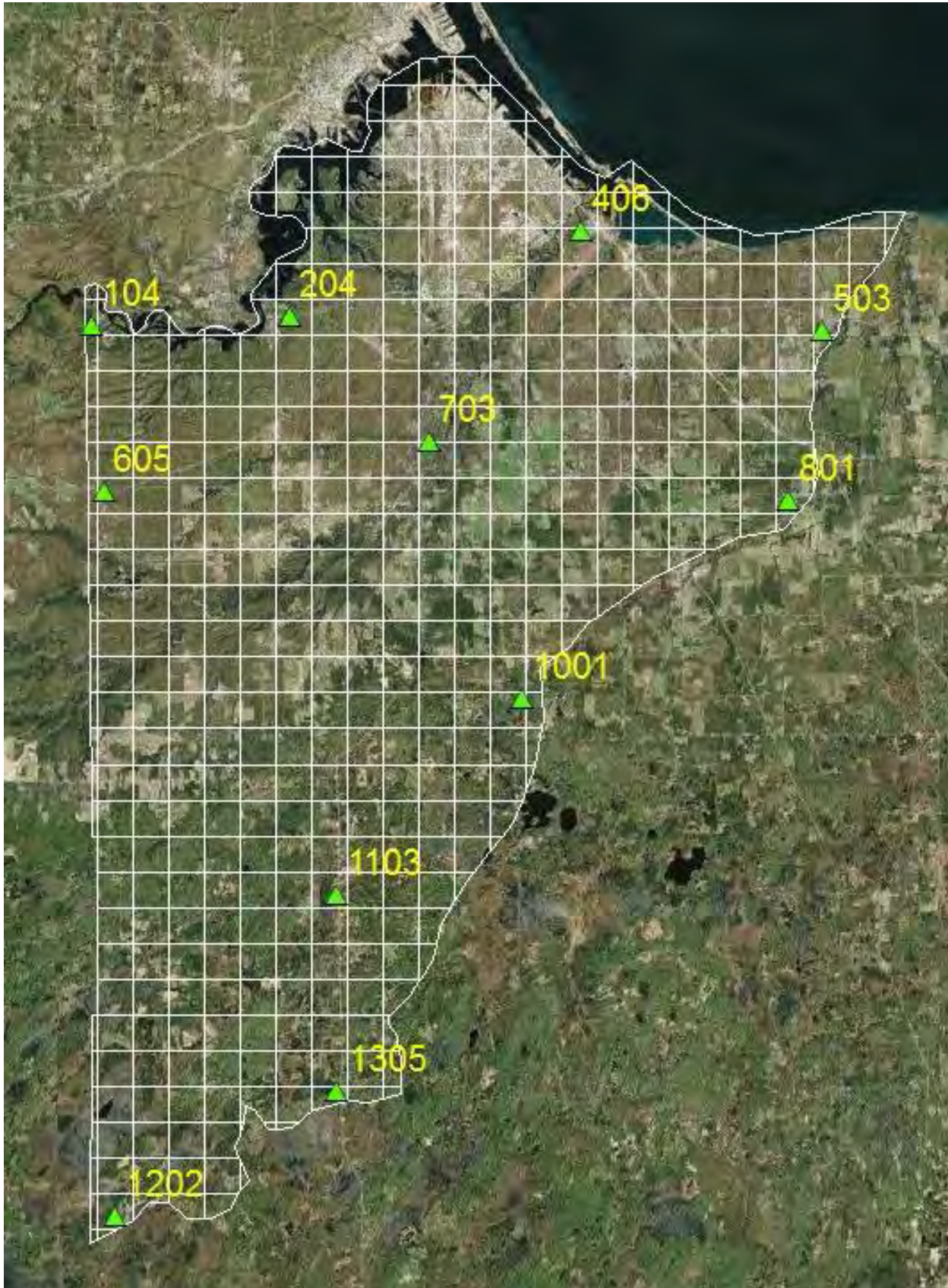
VVA Checkpoint Locations - Swamp



VVA Checkpoint Locations - Tall Grass



VVA Checkpoint Locations - Forest



LAS

Nonvegetated Vertical Accuracy

LandCover Type: 1 - Bare Earth, 2 - Urban areas

Minimum DZ: -0.06

Maximum DZ: 0.077

Mean DZ: 0.004

Mean Magnitude DZ: 0.154

Number Observations: 25

Standard Deviation DZ: 0.031

RMSE Z: 0.031

95% Confidence Level Z: 0.061

Units: Meters

DEM

Nonvegetated Vertical Accuracy

LandCover Type: 1 - Bare Earth, 2 - Urban areas

Minimum DZ: -0.064

Maximum DZ: 0.077

Mean DZ: 0.004

Mean Magnitude DZ: 0.152

Number Observations: 25

Standard Deviation DZ: 0.033

RMSE Z: 0.032

95% Confidence Level Z: 0.064

Units: Meters

DEM

Vegetated Vertical Accuracy

LandCover Type: Swamp, Tall Grass, Forest

Minimum DZ: -0.062

Maximum DZ: 0.289

Mean DZ: 1.106

Number Observations: 20

RMSE Z: 0.156

95th Percentile: 0.281

Units: Meters

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: 3 - Tall grass

Minimum DZ: 0.096

Maximum DZ: 0.274

Mean DZ: 0.178

Mean Magnitude DZ: 0.422

Number Observations: 5

Standard Deviation DZ: 0.065

RMSE Z: 0.187

95th Percentile: 0.274

Units: Meters

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: 5 - Forested areas

Minimum DZ: -0.062

Maximum DZ: 0.24

Mean DZ: 0.028

Mean Magnitude DZ: 0.241

Number Observations: 11

Standard Deviation DZ: 0.084

RMSE Z: 0.085

95th Percentile: 0.24

Units: Meters

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: 7 - Swamps

Minimum DZ: 0.147

Maximum DZ: 0.289

Mean DZ: 0.233

Mean Magnitude DZ: 0.482

Number Observations: 4

Standard Deviation DZ: 0.066

RMSE Z: 0.239

95th Percentile: 0.289

Units: Meters

Point: 101 Urban Area

Survey X: 554507.98, Survey Y: 5167223.41, Z1: 189.46, Z DEM: 189.49, Z LAS: 189.48, LC Type: 2, ΔZ DEM: 0.04, ΔZ LAS: 0.02



North



South



East



West

Point: 102 Bare Earth

Survey X: 554515.94, Survey Y: 5167202.8, Z1: 188.46, Z DEM: 188.46, Z LAS: 188.47, LC Type: 1, ΔZ DEM: 0, ΔZ LAS: 0.02



North



South



East



West

Point: 104 Forest

Survey X: 554225.91, Survey Y: 5167066.79, Z1: 194.11, Z DEM: 194.12, Z LAS: 194.16, LC Type: 5, ΔZ DEM: 0.01, ΔZ LAS: 0.04



North



South



East



West

Point: 201 Urban Area

Survey X: 561227.96, Survey Y: 5167429.77, Z1: 197.41, Z DEM: 197.39, Z LAS: 197.42, LC Type: 2, ΔZ DEM: -0.01, ΔZ LAS: 0.01



North



South



East



West

Point: 202 Urban Area

Survey X: 561376.45, Survey Y: 5167425.98, Z1: 197.55, Z DEM: 197.61, Z LAS: 197.6, LC Type: 2, ΔZ DEM: 0.05, ΔZ LAS: 0.04



North



South



East



West

Point: 203 Bare Earth

Survey X: 561393.12, Survey Y: 5167397.36, Z1: 198.01, Z DEM: 198.09, Z LAS: 198.08, LC Type: 1, ΔZ DEM: 0.08, ΔZ LAS: 0.06



North



South



East



West

Point: 204 Forest

Survey X: 562163.88, Survey Y: 5167462.59, Z1: 200.24, Z DEM: 200.25, Z LAS: 200.25, LC Type: 5, ΔZ DEM: 0.01, ΔZ LAS: 0.01



North



South



East



West

Point: 301 Bare Earth

Survey X: 566300.39, Survey Y: 5175373.66, Z1: 189.63, Z DEM: 189.63, Z LAS: 189.64, LC Type: 1, ΔZ DEM: 0, ΔZ LAS: 0.01



North



South



East



West

Point: 303 Tall Weeds

Survey X: 566554.5, Survey Y: 5175464.69, Z1: 191.89, Z DEM: 192.06, Z LAS: 192.1, LC Type: 3, ΔZ DEM: 0.17, ΔZ LAS: 0.21



North



South



East



West

Point: 304 Urban Area

Survey X: 567185.03, Survey Y: 5175313.81, Z1: 193.19, Z DEM: 193.13, Z LAS: 193.13, LC Type: 2, ΔZ DEM: -0.06, ΔZ LAS: -0.06



North



South



East



West

Point: 401 Bare Earth

Survey X: 574354.06, Survey Y: 5171417.48, Z1: 192.83, Z DEM: 192.85, Z LAS: 192.86, LC Type: 1, ΔZ DEM: 0.02, ΔZ LAS: 0.03



North



South



East



West

Point: 402 Urban Area

Survey X: 574340.78, Survey Y: 5171423.91, Z1: 192.84, Z DEM: 192.83, Z LAS: 192.84, LC Type: 2, ΔZ DEM: -0.01, ΔZ LAS: 0



North



South



East



West

Point: 403 Urban Area

Survey X: 574325.93, Survey Y: 5171405.38, Z1: 192.93, Z DEM: 192.92, Z LAS: 192.92, LC Type: 2, ΔZ DEM: -0.02, ΔZ LAS: -0.01



North



South



East



West

Point: 404 Urban Area

Survey X: 574305.48, Survey Y: 5171421.76, Z1: 192.62, Z DEM: 192.63, Z LAS: 192.62, LC Type: 2, ΔZ DEM: 0.01, ΔZ LAS: 0



North



South



East



West

Point: 405 Urban Area

Survey X: 574320.35, Survey Y: 5171440.28, Z1: 192.66, Z DEM: 192.65, Z LAS: 192.64, LC Type: 2, ΔZ DEM: -0.01, ΔZ LAS: -0.01



North



South



East



West

Point: 406 Forest

Survey X: 573925.09, Survey Y: 5170891.03, Z1: 194.27, Z DEM: 194.21, Z LAS: 194.17, LC Type: 5, ΔZ DEM: -0.06, ΔZ LAS: -0.1



North



South



East



West

Point: 501 Urban Area

Survey X: 583669.39, Survey Y: 5166837.08, Z1: 221.74, Z DEM: 221.72, Z LAS: 221.71, LC Type: 2, ΔZ DEM: -0.02, ΔZ LAS: -0.03



North



South



East



West

Point: 502 Bare Earth

Survey X: 583685.28, Survey Y: 5166828.33, Z1: 221.61, Z DEM: 221.6, Z LAS: 221.59, LC Type: 1, ΔZ DEM: -0.01, ΔZ LAS: -0.01



North



South



East



West

Point: 503 Forest

Survey X: 583612.02, Survey Y: 5166833.75, Z1: 220.59, Z DEM: 220.55, Z LAS: 220.59, LC Type: 5, ΔZ DEM: -0.04, ΔZ LAS: 0



North



South



East



West

Point: 601 Urban Area

Survey X: 554633.43, Survey Y: 5160171.71, Z1: 268.23, Z DEM: 268.22, Z LAS: 268.21, LC Type: 2, ΔZ DEM: -0.01, ΔZ LAS: -0.02



North



South



East



West

Point: 602 Swamp

Survey X: 554655.79, Survey Y: 5158297.6, Z1: 258.7, Z DEM: 258.84, Z LAS: 258.81, LC Type: 7, ΔZ DEM: 0.15, ΔZ LAS: 0.11



North



South



East



West

Point: 603 Bare Earth

Survey X: 554689.05, Survey Y: 5160465.29, Z1: 268.08, Z DEM: 268.02, Z LAS: 268.03, LC Type: 1, ΔZ DEM: -0.06, ΔZ LAS: -0.05



North



South



East



West

Point: 604 Tall Weeds

Survey X: 554719.18, Survey Y: 5160475.8, Z1: 267.52, Z DEM: 267.71, Z LAS: 267.67, LC Type: 3, ΔZ DEM: 0.19, ΔZ LAS: 0.15



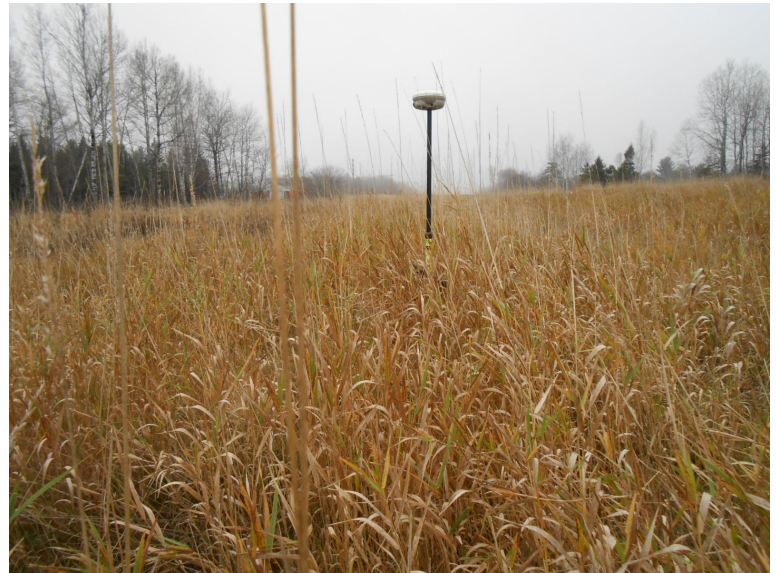
North



South



East



West

Point: 605 Forest

Survey X: 554689.75, Survey Y: 5160416.72, Z1: 265.76, Z DEM: 265.75, Z LAS: 265.74, LC Type: 5, ΔZ DEM: -0.01, ΔZ LAS: -0.02



North



South



East



West

Point: 702 Urban Area

Survey X: 567425.09, Survey Y: 5162616.14, Z1: 211.29, Z DEM: 211.3, Z LAS: 211.28, LC Type: 2, ΔZ DEM: 0.01, ΔZ LAS: -0.01



North



South



East



West

Point: 703 Forest

Survey X: 567774.69, Survey Y: 5162381.58, Z1: 210.37, Z DEM: 210.61, Z LAS: 210.6, LC Type: 5, ΔZ DEM: 0.24, ΔZ LAS: 0.23



North



South



East



West

Point: 704 Bare Earth

Survey X: 567701.57, Survey Y: 5162423.81, Z1: 210.17, Z DEM: 210.25, Z LAS: 210.25, LC Type: 1, ΔZ DEM: 0.07, ΔZ LAS: 0.08



North



South



East



West

Point: 801 Forest

Survey X: 582255.52, Survey Y: 5160019.34, Z1: 322.36, Z DEM: 322.31, Z LAS: 322.29, LC Type: 5, ΔZ DEM: -0.05, ΔZ LAS: -0.06



North



South



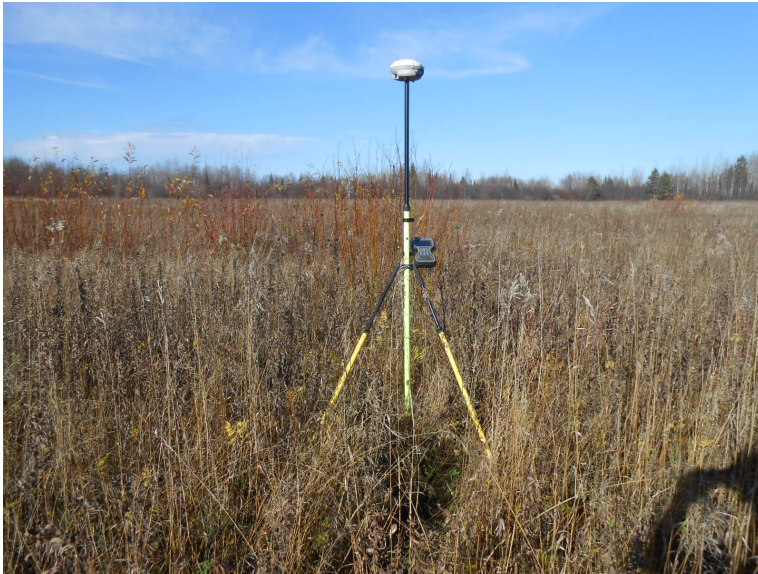
East



West

Point: 802 Tall Weeds

Survey X: 582428.81, Survey Y: 5160146.97, Z1: 321.04, Z DEM: 321.13, Z LAS: 321.13, LC Type: 3, ΔZ DEM: 0.1, ΔZ LAS: 0.09



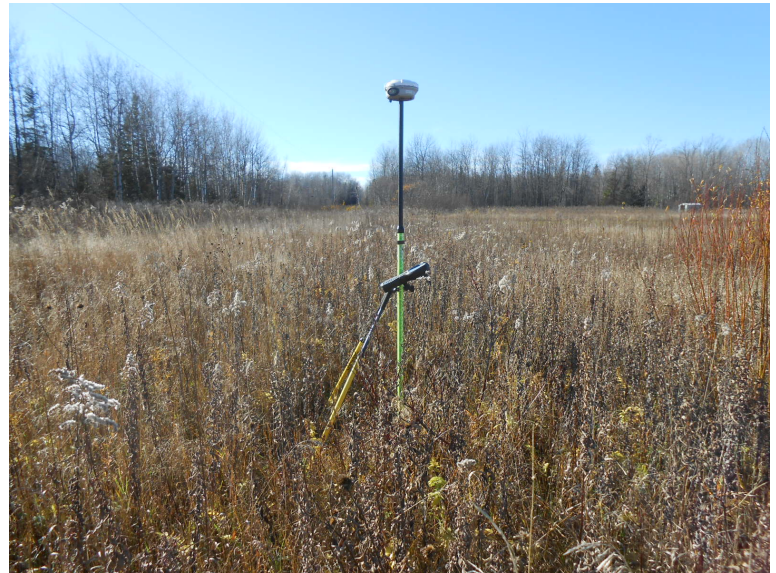
North



South



East



West

Point: 803 Bare Earth

Survey X: 582200.5, Survey Y: 5160127.44, Z1: 322.9, Z DEM: 322.89, Z LAS: 322.89, LC Type: 1, ΔZ DEM: -0.01, ΔZ LAS: -0.01



North



South



East



West

Point: 901 Bare Earth

Survey X: 554594.58, Survey Y: 5149726.03, Z1: 281.57, Z DEM: 281.57, Z LAS: 281.58, LC Type: 1, ΔZ DEM: 0, ΔZ LAS: 0.01



North



South



East



West

Point: 902 Tall Weeds

Survey X: 554541.14, Survey Y: 5149658.32, Z1: 282.65, Z DEM: 282.93, Z LAS: 282.94, LC Type: 3, ΔZ DEM: 0.27, ΔZ LAS: 0.28



North



South



East



West

Point: 1001 Forest

Survey X: 571537.71, Survey Y: 5152051.8, Z1: 349.67, Z DEM: 349.7, Z LAS: 349.68, LC Type: 5, ΔZ DEM: 0.03, ΔZ LAS: 0.01



North



South



East



West

Point: 1002 Bare Earth

Survey X: 571554.07, Survey Y: 5152022.26, Z1: 349.86, Z DEM: 349.85, Z LAS: 349.84, LC Type: 1, ΔZ DEM: -0.01, ΔZ LAS: -0.02



North



South



East



West

Point: 1003 Swamp

Survey X: 571483.13, Survey Y: 5151992.36, Z1: 349.08, Z DEM: 349.36, Z LAS: 349.36, LC Type: 7, ΔZ DEM: 0.28, ΔZ LAS: 0.28



North



South



East



West

Point: 1101 Swamp

Survey X: 564166.62, Survey Y: 5143595.74, Z1: 360.29, Z DEM: 360.58, Z LAS: 360.59, LC Type: 7, ΔZ DEM: 0.29, ΔZ LAS: 0.29



North



South



East



West

Point: 1102 Bare Earth

Survey X: 564162.96, Survey Y: 5144243.55, Z1: 358.15, Z DEM: 358.17, Z LAS: 358.17, LC Type: 1, ΔZ DEM: 0.02, ΔZ LAS: 0.02



North



South



East



West

Point: 1103 Forest

Survey X: 564085.67, Survey Y: 5144191.82, Z1: 357.96, Z DEM: 358.05, Z LAS: 358.05, LC Type: 5, ΔZ DEM: 0.09, ΔZ LAS: 0.1



North



South



East



West

Point: 1104 Urban Area

Survey X: 564132.69, Survey Y: 5144224.9, Z1: 358.42, Z DEM: 358.43, Z LAS: 358.42, LC Type: 2, ΔZ DEM: 0.01, ΔZ LAS: 0.01



North



South



East



West

Point: 1202 Forest

Survey X: 555149.82, Survey Y: 5131208.24, Z1: 389.07, Z DEM: 389.1, Z LAS: 389.11, LC Type: 5, ΔZ DEM: 0.03, ΔZ LAS: 0.04



North



South



East



West

Point: 1301 Urban Area

Survey X: 564214.43, Survey Y: 5136296.99, Z1: 389.23, Z DEM: 389.22, Z LAS: 389.21, LC Type: 2, ΔZ DEM: -0.01, ΔZ LAS: -0.01



North



South



East



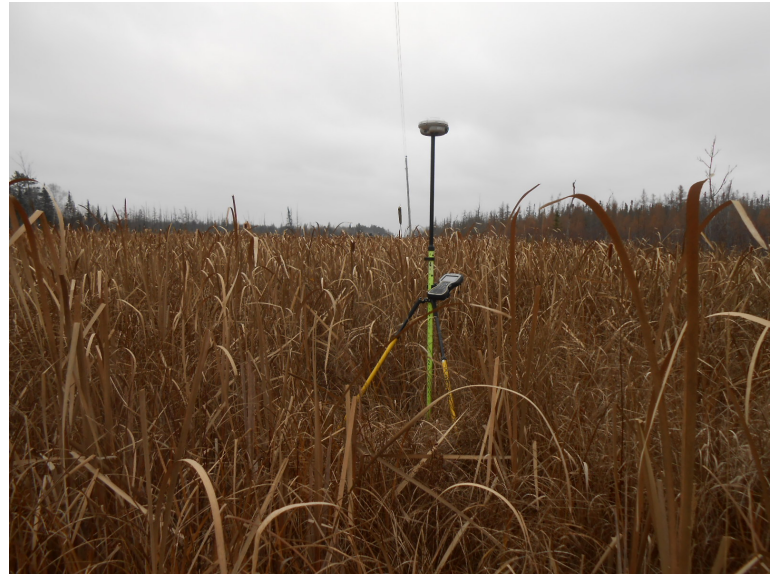
West

Point: 1302 Swamp

Survey X: 564184.92, Survey Y: 5136734.86, Z1: 388.31, Z DEM: 388.53, Z LAS: 388.58, LC Type: 7, ΔZ DEM: 0.21, ΔZ LAS: 0.27



North



South



East



West

Point: 1303 Bare Earth

Survey X: 564204.67, Survey Y: 5136220.75, Z1: 388.9, Z DEM: 388.92, Z LAS: 388.94, LC Type: 1, ΔZ DEM: 0.02, ΔZ LAS: 0.04



North



South



East



West

Point: 1304 Tall Weeds

Survey X: 564262.67, Survey Y: 5136248.13, Z1: 389.84, Z DEM: 390, Z LAS: 390.06, LC Type: 3, ΔZ DEM: 0.16, ΔZ LAS: 0.22



North



South



East



West

Point: 1305 Forest

Survey X: 564090.92, Survey Y: 5136232.94, Z1: 389.53, Z DEM: 389.58, Z LAS: 389.66, LC Type: 5, ΔZ DEM: 0.05, ΔZ LAS: 0.13



North



South



East



West