

Final Report

For project:

Lake Simcoe LiDAR

Prepared for:

**Ontario Ministry of Agriculture, Food and Rural Affairs
1 Stone Road West, Guelph, Ontario, N1G 4Y2**

Prepared by:



**Airborne Imaging
2700 – 61 Avenue SE
Calgary, AB T2C 4V2**

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Introduction

The Ontario Ministry of Agriculture, Food and Rural Affairs contracted Airborne Imaging in the spring of 2022 to acquire and deliver digital elevation data derived from airborne LiDAR (Light Detection and Ranging) to cover two regions in Ontario: Lake Huron and Lake Simcoe.

This report covers the Lake Simcoe area, collected in the spring of 2022. It focuses on LiDAR acquisition details, such as flight parameters, project control, ground truthing results, data processing technique and deliverables.

The contracted area for Lake Simcoe is 2,088 km².

Project Schedule & Personnel

The ground control and Lidar acquisition occurred in May 2022. The Lidar data for Lake Simcoe area was collected in three missions on May 5, 6 and 7. Jeffrey Thompson and Andrew Power were the operators on site responsible for collecting the Lidar data and Chris Johnson was the surveyor collecting ground truth points.

A typical Lidar acquisition crew consisted of one Lidar Operator and one Pilot. The project management was done remotely by Allyson Fox.

LiDAR System & Flight Parameters

A Riegl VQ-1560ii was installed in KASI Aviation's Piper Navajo C-GMEC.

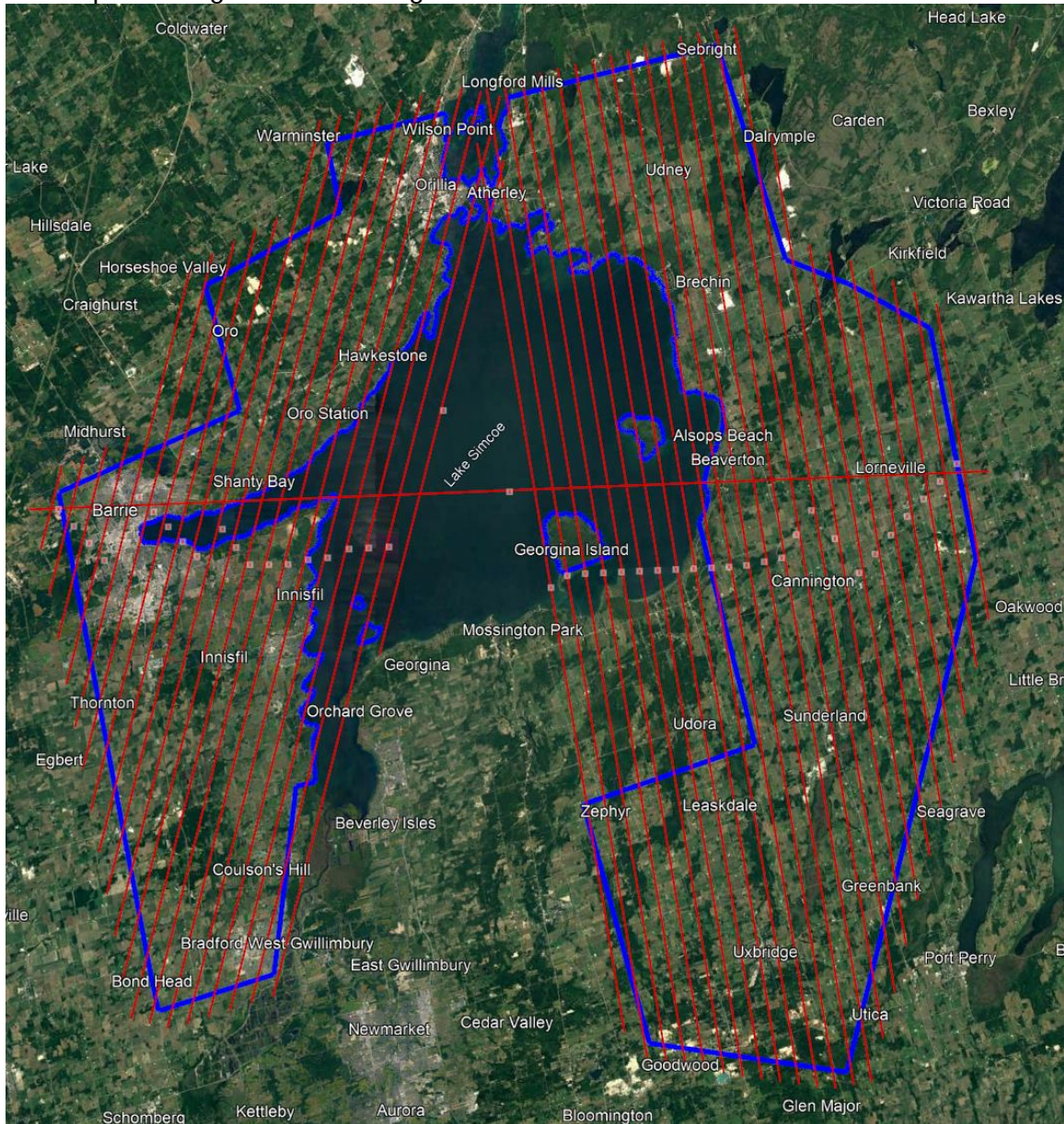
Below is a table of the lifts with their flight parameters.

Flight Date	Julian Day	Lift	Flt Hours	System	AGL_m	Speed kts	Pulse kHz	ScanRate Hz	FOV deg	Project Manager	Operator	Aircraft Co	Aircraft	Deliv.
05/05/2022	125a	3822125a	5.1	VQ-1560ii	1600	160	2100	346	60	A. Fox	J. Thompson	KASI	C-GMEC	2
05/06/2022	126a	3822126a	6.0	VQ-1560ii	1600	160	2100	346	60	A. Fox	J. Thompson	KASI	C-GMEC	2
05/07/2022	127a	3822127a	3.1	VQ-1560ii	1600	160	2100	346	60	A. Fox	A. Power	KASI	C-GMEC	2

Table 1: Project Parameters for the Lake Simcoe areas.

	Riegl VQ-1560-ii
Altitude	1600m AGL
Field of View (FOV)	60°
Air Speed	160 Kts
Pulse Rate	2100 kHz
Sidelap	20%
Point Density	> 8 pts/m ²

The flight lines were designed optimally to maximize time online versus time in turn. Below is a map of the flight lines including cross-ties.



Project Control / Datum

Several baselines were measured by GPS static occupation between the Cannet stations and existing NRCan, cosine points as well as newly established points by Airborne Imaging. The existing control used consisted of four NRCan Cannet stations, two NRCan passive stations and nine Cosine points.

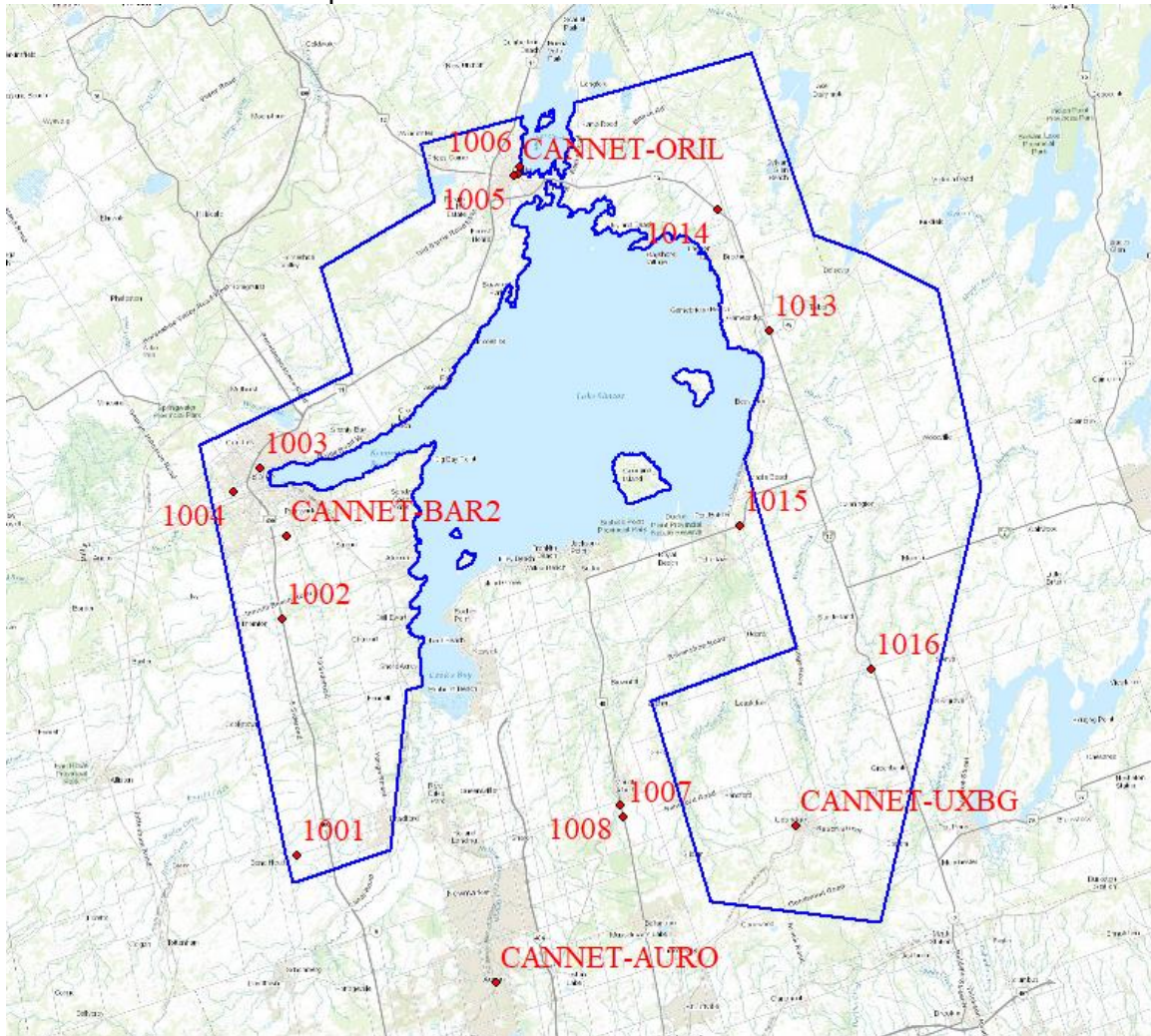
Appendix A contains a list of Control Points and their published coordinates.

Appendix B shows the checks performed between Cannet stations and passive stations with redundant checks.

Appendix C shows the published station coordinate sheets.

The datum used and therefore all subsequent Lidar data are based on the Nad83 CSRS (epoch 2010.0) horizontal datum and the CGVD2013 vertical datum (CGG2013 undulation model).

Below is an overview map of the control stations.



Check Points

Control check points were surveyed from different methods to use as vertical check and accuracy assessment. The kinematic method was used for calibration purposes and the RTK method for Non-Vegetated Vertical Accuracy Assessment (NVA) and Vegetated Vertical Accuracy Assessment (VVA).

Kinematic GPS

The first method called kinematic are profiles surveyed on open roads from a truck-mounted GPS receiver while driving. The post-processed kinematic coordinates, collected at an interval of one second are derived from a base station that is part of our control

network.

Whenever possible, we try to select roads that are perpendicular to the flight line azimuth so the control points intersect as many Lidar strips as possible. Kinematic points were collected along the roads following the red dots on the map below. Note that a kinematic session was collected on the east side of Lake Simcoe but the Can-net data is not available to download for station UXBG on that day and could not be used for accuracy reporting.

The output coordinates are analyzed and filtered to ensure only very reliable positions are kept. All points collected while moving slower than 2 meters per second are rejected. This removes all points when the truck was stationary that could skew the statistics.

The following points are also rejected:

- Points with a Quality Level worse than 1.
- Points with a forward/reverse vertical separation worse than 3 cm.
- Points with less than two solutions (forward & reverse).
- Points with a standard deviation worse than 2sigma.

Many sections of road were surveyed throughout the project giving us more than 2,000 surveyed points on the road. We estimate that the vertical accuracy of these points is better than 5 cm.

During the calibration of the Lidar strips, the Lidar strips are matched vertically to these reliable kinematic points. These points are not used for the vertical accuracy assessment of the Lidar point cloud, but rather just for calibration monitoring and shifting.

RTK GPS

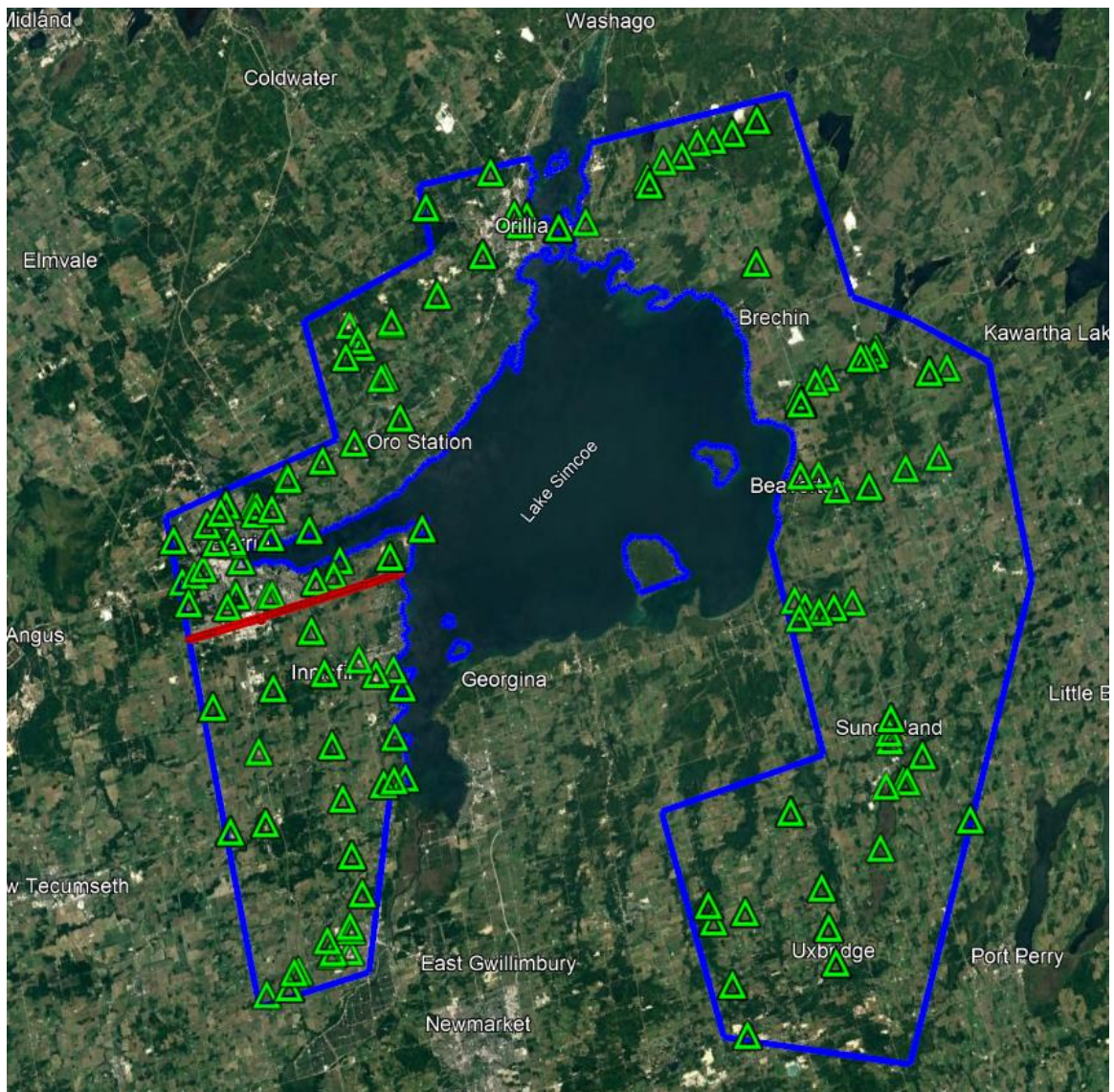
In order to meet the recommended ASPRS minimum number of points for a 2,088 square kilometer project, RTK points were surveyed in areas distributed throughout the project.

The second method called Real Time Kinematic are individual points surveyed on open terrain. Our surveyor collected GPS data mounted on a pole while receiving real time differential corrections from the GPS receiver positioned over a nearby control point. 216 points were surveyed on the Lake Simcoe project. Of these, 122 points were over non-vegetated ground conditions for NVA accuracy reporting and 94 of them were over vegetated areas for VVA accuracy reporting.

Pictures of these RTK points (as well as the existing control) are provided with this report in a folder called "LakeSimcoe\Control_Point_Pictures".

These points are used just for the vertical accuracy assessment of the Lidar point cloud and were not used to determine any vertical shift applied to the point cloud.

See the green triangles on the map below.



Blue = project outline
Green = Fast Static (NVA & VVA)
Red = Kinematic

Trajectory Processing

The aircraft trajectory positioning for the missions over the Lake Simcoe area were processed using the Precise Point Positioning (PPP) technique.

PPP is a positioning technique that removes and models GNSS system errors via precise satellite orbit data and clock corrections that are applied to the trajectory post mission, providing centimeter level positional accuracy without the use of ground base stations.

The TerraPOS software by Terratec was used to postprocess the PPP solutions to produce final kinematic trajectories accurate to 5 centimeters for each flight mission.

The horizontal datum used is Nad83 CSRS UTM zone 17 with the CGVD2013 vertical datum (CGG2013 undulation model).

LiDAR Data Processing

Calibration Procedures

After each mission, the field project manager creates the preliminary calibrated point cloud with each sensor's set boresight values for each mission. Proprietary QC tools using the Lastools software are run on each mission to check for coverage, relative accuracy, point density, etc... If any data is found to be not meeting specifications, or coverage missing, the field crew is immediately notified and the areas affected reflight as soon as possible.

This preliminary calibrated point cloud is inspected in conjunction with the kinematic ground truth points to apply bulk shifts if necessary and further refine the calibration by applying corrections to the preliminary calibrated strips. The refined calibration is done using Bayesmap's StripAlign software. Intensity values are also normalized by mission to be 16 bits (0 to 65535).

Data Tiling and Classification

The raw LiDAR data is processed into calibrated point cloud strips corresponding to flight lines. For ease of data manipulation, the strips are combined and saved in tiles of 1 km by 1 km. The format the strips and tiles are saved in is .Laz version 1.4. The tiling scheme is based on the UTM17 projection at the even kilometers.

The tiled point cloud is then processed with a series of algorithms to separate the "most-likely" ground returns from other returns. The point classification is done using a product by the TerraSolid software running on MicroStation Connect called TerraScan and TerraModeler.

In addition to our regular field QC and calibration procedures, we also generate various raster products using the Lastools software to assess coverage and calibration accuracy.

Point Cloud Manipulation

The TerraScan software uses macros that are set-up to measure the angles and distances between points to determine what classification a point should be: ground, vegetation, noise, other. The angle and distance values in the macros can be adjusted to be more or less aggressive with the classification of points by varying the incidence angles and estimated distances among neighboring points. The lower points are generally classified as ground returns, with the points above classified as undefined (class 1). Outliers and noise described in the table below are normally clouds, outliers or atmospheric noise in the data that are separated into above or below the ground level (high point or low points).

After the automated macro is run to determine classes, a systematic visual inspection is performed to fine tune the ground definition. To better understand areas for improvement for the ground surface, the points that are classified as ground are used to create viewable TINs and grid surfaces. These surfaces are inspected for areas that appear rough, artificially flattened or truncated, no data areas, or have other viewable errors.

In cleaning up ground points, the focus is concentrated in areas where few ground points have been left in the bare earth model and the ground appears rough or lower and flatter than it may be in reality. The scarcity of ground points may be a result from no penetration through a dense vegetation layer, water bodies, low reflectivity objects, or too aggressive values with the macro. A manual/visual inspection of these areas plays a major role in resolving any issues or irregularities with the bare earth model.

Once the first edits are completed, a one-meter grid of the ground surface is re-exported and hill shade images produced to QC the edited ground surface. This QC step is done iteratively as many times as necessary. Once the point cloud data has reached a satisfactory level of classification accuracy, the final deliverables are produced.

Water Classification & Hydro-Flattening

Once the ground class has reached the final level of classification accuracy, the water delineation process is initiated. The rivers and water bodies are digitized as break lines according to USGS specifications of a minimum of 8000 m² for water bodies and 30 m nominal width for streams and rivers. Ponds and lakes have their elevations set constant to just below ground. Stream and river hydro lines are collected using the downstream method. Once all hydro lines have been collected for an area, the ground points inside the hydro lines are classified to class 9 – Water. The ground points outside of the hydro lines but within 35 cm are classified to class 20 – Ignored ground (near breaklines). Using the TIN of class 2 (ground points), the hydro lines are used as constraints to generate the final 50 cm hydro-flattened DEMs in ESRI Ascii format, then converted to 32bit Geotiff format with the Global Mapper software.

Class definitions

The classification follows the ASPRS classification codes. The table below shows the classes for the delivered point cloud.

Table 2: ASPRS Point Classes

Classification Value	Description
1	Unclassified
2	Ground
7	Low Points
9	Water
17	Bridge Decks
18	High Points
20	Ignored Ground (breakline proximity)
21	Snow
22	Temporal exclusion

Deliverables

See below for a table of the folder structure and description of each deliverables.

2022_LAKESIMCOE_EPSG2958

DTM

Hydro-flattened 50cm Bare Earth DEMs, 1 X 1 km tiles in 32bit Geotiff format
e.g. 1km175980491502022LLAKESIMCOE_DTM.tif

METADATA

Metadata files for Breaklines, DEM, LAS and Project in .XML format
e.g. LakeSimcoe_Lidar_metadata_LAS.xml

POINTCLOUD

Point cloud data, 1 X 1 km tiles in .LAZ format 1.4
e.g. 1km175980491502022LLAKESIMCOE.laz

PROJECT_POLYGON

Shape files of: Lift_metadata, Hydro_breaklines, Project_extent & Tile_index
e.g. 3821127a_Lift_metadata.shp

Vertical Accuracy Assessment

Kinematic

Below is a summary of the statistics between the point cloud TIN from the ground class and the kinematic points surveyed on the road:

Number of points:	2009	
Average dz:	+0.007	m
Minimum dz:	-0.120	m
Maximum dz:	+0.094	m
Average magnitude:	0.025	m
Root mean square:	0.031	m
Std deviation:	0.031	m

Kinematic Vertical
Accuracy (95%): 0.061 m

For a complete listing of the kinematic points and their differences, please refer to the spreadsheet named "LakeSimcoe_NVA_Kinematic_comparisons_Final.xlsx" provided with the report.

This Kinematic vertical accuracy assessment is provided only as a reference. It is biased because during calibration, the point cloud was vertically shifted to these points. It should not be used as an independent check for accuracy assessments.

The independent assessment of vertical accuracy is made against the "Non-Vegetated" points surveyed (RTK).

RTK

Below is a summary of the statistics between the point cloud TIN from the ground class and the RTK points surveyed on flat hard surfaces:

Number of points:	122	
Average dz:	-0.005	m
Minimum dz:	-0.085	m
Maximum dz:	+0.095	m
Average magnitude:	0.020	m
Root mean square:	0.026	m
Std deviation:	0.026	m

RTK Vertical Accuracy (95%): 0.051 m

For a complete listing of the RTK points and their differences, please refer to the spreadsheet named "LakeSimcoe_NVA_RTK_comparisons_Final.xlsx" provided with the deliverables.

This RTK vertical accuracy assessment can be used as an independent check for the Non-Vegetated Accuracy (NVA).

As seen in the RTK NVA comparison above, the accuracy observed of 0.051 m meets the project requirement of QLO NVA vertical accuracy of 9.8 cm (95%).

Geodetic Control Points

As an extra check, the control points were compared with the Lidar ground surface. Only two cosine points had elevations at ground level and were deemed reliable.

For a listing of the six control points and their differences, please refer to the spreadsheet named "LakeSimcoe_Control_comparisons_Final.xlsx" provided with the deliverables.

RTK (VVA)

The elevations of the points surveyed in various vegetated land cover types were compared to the Lidar ground surface. Since the elevation differences for this type of accuracy does not follow a normal distribution, the percentile method is used and not the 95% confidence level. For the 94 VVA points surveyed, sorting the absolute differences from the smallest to the largest gives the accuracy at the 95th percentile (using the linear interpolation between closest ranks method). For this sample, the 89th and 90th largest difference are respectively 14.7 and 15.4 cm.

For this project, the VVA accuracy is therefore 14.95 cm.

This is slightly below the required specifications of 15.0 cm (the QL0 VVA specification).

For a complete listing of the kinematic points and their differences, please refer to the spreadsheet named "LakeSimcoe_VVA_RTK_comparisons_Final.xlsx" provided with the deliverables.

Conclusion

This is the final report covering the Lake Simcoe Lidar project. Topics such as field operations, control, data processing and final accuracy results were explained. The acquisition for this leaf off, snow off project was acquired fast thanks to good weather and the processing went as expected. Vertical accuracies of non-vegetated surfaces and vegetated surfaces meet the QL0 requirement for this project.

Appendix A - Control Points – Published Coordinates

Lake Simcoe Existing Control used						
Station	Easting	Northing	h	H (CGVD2013)	Status	Comments
CANNET-AURO	623879.328	4872129.553	241.807	277.641	Published	Can-Net
CANNET-BAR2	606039.360	4910049.139	252.634	288.262	Published	Can-Net
CANNET-UXBG	649365.163	4885492.468	259.723	295.269	Published	Can-Net
CANNET-ORIL	625681.385	4940970.863	195.767	231.065	Published	Can-Net
NRCAN 883046 - BRASS CAP	606905.484	4882983.600	209.07	244.894	Published	1001
NRCAN 84U123 - DEEP BENCH MARK	605620.602	4902995.758	259.554	295.233	Published	1002
Cosine - 0011931U455S				228.735	Published	1003
Cosine - 0011979U186				234.254	Published	1005
Cosine - 0011979U187				220.221	Published	1006
Cosine - 00819708607				235.387	Published	1004
Cosine - 00819718419	642687.507	4937944.563	185.611	220.913	Published	1014
Cosine - 00819768517				245.932	Published	1015
Cosine - 00820130004	655853.141	4898807.935			Published	1016
Cosine - 13120210008	647153.300	4927572.610	187.014	222.372	Published	1013
Cosine - 00819768498				256.209	Published	1007

Nad83 CSRS epoch 2010.0, CGVD2013 (CGG2013)

Appendix B – RTK Survey & Control Check

Lake Simcoe RTK Summary									
Station	Easting	Northing	h	H (CGVD2013)	Comments	Julian Day	E tie	N tie	H Tie
ON_Aurora	623879.328	4872129.553	241.806	277.640	Can-Net	94			
1001	606905.501	4882983.584	209.063	244.887	NRCAN 883046 - BRASS CAP	94	-0.004	0.005	0.003
1001_R8	606905.504	4882983.583	209.051	244.875	NRCAN 883046 - BRASS CAP	94	-0.001	0.004	-0.009
2001	605973.496	4882225.336	225.300	261.125	PAVED ROAD	94			
2002	605997.537	4882456.651	220.611	256.435	PAVED PARKING LOT	94			
3001	605924.960	4882505.393	218.231	254.055	HIGH BRUSH	94			
2003	607039.974	4881564.283	228.713	264.544	PAVED ROAD	94			
2004	608779.458	4882125.275	212.722	248.554	PAVED ROAD	94			
3002	608736.153	4882120.910	211.733	247.565	LOW BRUSH	94			
2005	609451.565	4883374.350	204.116	239.942	PAVED ROAD	94			
3003	609112.538	4883280.680	206.443	242.269	TALL GRASS	94			
2006	611935.109	4884709.949	218.456	254.275	PAVED PARKING LOT	94			
3004	612075.701	4884899.146	224.307	260.126	TALL GRASS	94			
2007	611615.635	4885791.477	228.845	264.657	PAVED PARKING LOT	94			
ON_Aurora	623879.328	4872129.553	241.806	277.640	Can-Net	94			
2008	614223.818	4889434.697	225.428	261.219	GRAVEL ROAD	94			
3005	614230.064	4889427.677	225.654	261.445	UNDER CANOPY	94			
ON_Aurora	623879.328	4872129.553	241.806	277.640	Can-Net	95			
1885_CHK1	626217.875	4880835.689	246.401	282.178	Set Control - SCRIBE ON TOP OF CURB	95			
1885_CHK1_R8	626217.882	4880835.684	246.413	282.190	Aii Control - SCRIBE ON TOP OF CURB	95	0.007	-0.005	0.012
2009	615625.948	4885666.205	184.731	220.546	PAVED PARKING LOT	95			
3006	615495.880	4885886.663	183.841	219.655	HIGH BRUSH	95			
3007	615462.259	4887236.186	191.359	227.165	UNDER CANOPY	95			
2010	613456.385	4886600.600	224.523	260.332	PAVED PARKING LOT	95			
3008	613332.265	4886917.330	225.786	261.593	TALL GRASS	95			
ON_Barrie	606039.360	4910049.139	252.634	288.262	Can-Net	95			
1002	605620.641	4902995.746	259.514	295.193	NRCAN 84U123 - DEEP BENCH MARK	95	0.019	0.011	-0.033
1002_R8	605620.641	4902995.756	259.542	295.221	NRCAN 84U123 - DEEP BENCH MARK	95	0.019	0.021	-0.005

2011	606079.712	4900117.629	257.094	292.799	CONCRETE SLAB PARKING LOT	95			
2012	604000.170	4893989.928	213.979	249.736	PAVED PARKING LOT	95			
3009	604014.169	4893945.952	213.391	249.148	UNDER CANOPY	95			
2013	606709.878	4894663.255	190.373	226.132	PAVED PARKING LOT	95			
3010	606705.594	4894626.216	190.077	225.836	UNDER CANOPY	95			
2014	612609.762	4896642.503	266.516	302.256	PAVED ROAD	95			
3011	612583.038	4896635.098	266.220	301.960	LOW GRASS	95			
3012	615701.401	4897809.421	195.993	231.718	UNDER CANOPY	95			
2015	615690.863	4897774.299	195.417	231.143	GRAVEL PARKING LOT	95			
2016	616487.852	4898118.390	188.976	224.698	PAVED ROAD	95			
2017	617367.748	4898333.950	183.524	219.245	PAVED ROAD	95			
2018	616471.597	4901415.431	184.834	220.531	PAVED ROAD	95			
2019	616982.759	4905223.914	185.644	221.309	PAVED ROAD	95			
3013	616992.798	4905206.083	184.963	220.628	UNDER CANOPY	95			
3014	616284.832	4906589.951	185.639	221.293	UNDER CANOPY	95			
3015	614962.472	4906195.284	203.165	238.824	HIGH BRUSH	95			
2020	614946.652	4906228.542	201.919	237.577	PAVED ROAD	95			
2021	613615.178	4907288.590	228.598	264.246	PAVED PARKING LOT	95			
2022	611000.477	4906210.629	247.599	283.257	PAVED PARKING LOT	95			
3016	611070.306	4906123.652	247.351	283.010	UNDER CANOPY	95			
3017	607111.513	4904987.738	229.355	265.022	HIGH BRUSH-Set Check point-Nail	95			
2023	607089.681	4904963.697	233.993	269.660	PAVED ROAD	95			
2024	602498.724	4903453.281	261.460	297.126	GRAVEL ROAD	95			
3018	602475.442	4903451.502	261.340	297.006	LOW GRASS	95			
3007.1	615462.235	4887236.180	191.359	227.165	UNDER CANOPY - NAIL	95	-0.024	-0.006	0.000
1885_CHK1.1	626217.855	4880835.688	246.396	282.173	Aii Control - SCRIBE ON CURB	95	-0.020	-0.001	-0.017
1885_CHK1.1_R8	626217.871	4880835.685	246.403	282.180	Aii Control - SCRIBE ON CURB	95	-0.004	-0.004	0.002
ON_Aurora	623879.328	4872129.553	241.806	277.640	Can-Net	96			
1885_CHK1	626217.873	4880835.699	246.413	282.190	Aii Control - SCRIBE ON CURB	96	-0.002	-0.001	-0.017
1885_CHK2	614522.023	4887230.226	217.606	253.412	Aii Control - Nail	96	-0.014	-0.007	-0.005
On_Barrie	606039.360	4910049.139	252.634	288.262	Can-Net	96			
2025	618270.720	4917382.782	185.962	221.526	PAVED ROAD	96			
3019	618276.961	4917398.413	186.041	221.605	LOW GRASS	96			
3020	615849.112	4915184.855	208.881	244.463	LOW GRASS	96			
3021	615884.533	4915184.068	208.480	244.062	TALL GRASS	96			
2026	615854.458	4915177.945	208.723	244.305	PAVED ROAD	96			
2027	611997.527	4914839.567	191.453	227.043	PAVED ROAD	96			
3022	611559.571	4913687.589	230.421	266.022	UNDER CANOPY	96			
3023	610181.598	4913189.242	225.243	260.848	LOW GRASS	96			
2028	610234.313	4913163.433	224.971	260.577	PAVED PARKING LOT	96			
3024	606855.378	4912099.066	222.268	257.883	LOW GRASS	96			
2029	606573.741	4912060.744	219.261	254.876	PAVED ROAD	96			
2030	603433.365	4911140.871	276.616	312.234	PAVED ROAD	96			
3025	603459.072	4911123.918	275.899	311.518	HIGH BRUSH	96			
3026	600465.832	4911318.822	202.547	238.167	LOW GRASS	96			
2031	600446.171	4911330.755	202.228	237.848	PAVED ROAD	96			
2032	604126.725	4911982.515	253.391	289.005	PAVED ROAD	96			
3027	604007.749	4912091.641	248.783	284.396	LOW BRUSH	96			
3028	604444.271	4914657.586	185.366	220.963	LOW GRASS	96			
2033	604418.600	4914651.931	185.096	220.693	PAVED PARKING LOT	96			
1003	603783.759	4915890.768	193.087	228.674	Cosine - 0011931U4555	96	N/A	N/A	-0.061
3029	603792.802	4915921.112	193.094	228.680	LOW GRASS	96			
2034	603758.536	4916133.620	199.343	234.927	PAVED PARKING LOT	96			
2035	602476.180	4915972.032	239.308	274.893	PAVED ROAD	96			
3030	602499.314	4916027.968	245.942	281.527	LOW GRASS	96			
1004.1	601458.472	4913858.133	199.746	235.347	Cosine - 00819708607	96	N/A	N/A	-0.040
1004	601458.467	4913858.135	199.770	235.371	Cosine - 00819708607	96	N/A	N/A	-0.017
3031	601526.085	4913993.341	199.814	235.414	LOW GRASS	96			
2036	600865.550	4913485.427	199.980	235.584	PAVED ROAD	96			
2037	599945.784	4912947.031	197.407	233.017	PAVED PARKING LOT	96			
4001	599219.124	4916105.994	266.092	301.677	NW CORNER PAINT LINE	96			
3032	599229.400	4916109.813	266.077	301.662	LOW GRASS	96			
3033	601749.384	4917348.816	245.502	281.074	LOW GRASS	96			
2038	601763.945	4917357.312	244.510	280.082	PAVED PARKING LOT	96			
4002	602762.247	4918260.176	254.622	290.185	NW CORNER PAINT MARK	96			
3034	602794.542	4918282.309	255.000	290.563	UNDER CANOPY	96			
4003	603182.598	4918865.258	237.719	273.276	NW CORNER PAINT MARK	96			

3035	603182.015	4918993.135	237.482	273.038	LOW GRASS	96			
2039	603193.901	4918990.016	237.748	273.304	PAVED AREA	96			
4004	605251.124	4918835.528	215.708	251.265	NW CORNER PAINT MARK	96			
4005	605548.448	4918853.928	216.251	251.808	NW CORNER PAINT MARK	96			
3036	605602.186	4918854.349	216.697	252.254	LOW GRASS	96			
1885_CHK2.1	614522.016	4887230.210	217.610	253.416	Aii Control - Nail	96	-0.021	-0.012	-0.001
1885_CHK1.1	626217.873	4880835.695	246.422	282.199	Aii Control - SCRIBE ON CURB	96	-0.002	0.006	0.021
ON_Aurora	623879.328	4872129.553	241.806	277.640	Can-Net	97			
1885_CHK1	626217.880	4880835.704	246.399	282.176	Aii Control - SCRIBE ON CURB	97	0.005	0.015	-0.002
1885_CHK1_R8	626217.880	4880835.686	246.396	282.173	Aii Control - SCRIBE ON CURB	97	0.005	-0.003	-0.005
4006	613355.430	4884992.730	216.700	252.519	NE CORNER PAINT MARK	97			
1885_CHK2	614522.025	4887230.217	217.627	253.433	Aii Control - Nail	97	-0.012	-0.016	0.016
1885_CHK2_R8	614522.028	4887230.220	217.615	253.421	Aii Control - Nail	97	-0.009	-0.013	0.004
ON_Barrie	606039.360	4910049.139	252.634	288.262	Can-Net	97			
2040	606662.830	4916490.455	191.512	227.094	PAVED ROAD	97			
3037	606632.143	4916483.872	190.959	226.541	LOW GRASS	97			
ON_Barrie	606039.360	4910049.139	252.634	288.262	Can-Net	97			
4007	605449.376	4918257.291	239.834	275.397	NE CORNER PAINT LINE	97			
3038	605481.677	4918284.543	239.581	275.144	LOW GRASS	97			
2041	606722.090	4918676.027	224.352	259.910	PAVED ROAD	97			
3039	606709.057	4918647.105	222.887	258.446	HIGH BRUSH	97			
3040	607902.893	4920965.591	221.116	256.648	LOW GRASS	97			
4008	607829.353	4921121.782	221.210	256.740	NW CORNER PAINT LINE	97			
4009	610520.591	4922384.182	203.539	239.049	NE CORNER PAINT LINE	97			
3041	610529.945	4922425.148	203.284	238.793	LOW GRASS	97			
3042	612935.012	4923845.490	250.276	285.763	LOW GRASS	97			
4010	612960.545	4923830.594	249.378	284.865	NW CORNER PAINT MARK	97			
2042	616411.044	4925815.430	247.257	282.720	PAVED ROAD	97			
3043	616412.883	4925779.287	246.944	282.407	TALL GRASS	97			
3044	614899.508	4928796.093	268.931	304.353	LOW GRASS	97			
2043	615164.210	4928934.459	269.671	305.092	PAVED ROAD	97			
2044	613378.409	4931156.484	285.706	321.097	PAVED ROAD	97			
ON_Orrilla	625681.385	4940970.863	195.767	231.065	Can-Net	97			
3045	613078.452	4931672.522	312.526	347.911	UNDER CANOPY	97			
2045	612380.644	4932804.692	325.055	360.426	PAVED ROAD	97			
2046	612155.127	4930327.715	278.903	314.304	GRAVEL ROAD	97			
3046	612150.896	4930353.484	279.899	315.300	LOW GRASS	97			
4011	615605.704	4933129.703	286.723	322.092	NW CORNER PAINT LINE	97			
3047	615621.258	4932949.146	286.728	322.099	LOW GRASS	97			
3048	619004.971	4935192.167	237.621	272.973	LOW GRASS	97			
2047	619096.820	4935246.006	236.103	271.455	PAVED ROAD	97			
3049	622495.388	4938347.177	227.596	262.920	LOW GRASS	97			
4012	622468.586	4938409.186	227.562	262.885	SW CORNER PAINT LINE	97			
4013	622518.105	4938446.976	227.573	262.896	NE CORNER PAINT LINE	97			
2048	618265.335	4941836.807	227.387	262.682	PAVED ROAD	97			
4014	618035.992	4941924.862	232.472	267.766	NE CORNER PAINT MARK	97			
3050	618064.612	4941911.274	231.751	267.045	LOW GRASS	97			
3051	622976.813	4944702.998	196.541	231.808	LOW GRASS	97			
2049	622933.289	4944744.976	195.035	230.302	GRAVEL PARKING LOT	97			
4015	624848.684	4941511.416	234.271	269.563	SW CORNER PAINT MARK	97			
3052	624866.460	4941484.489	235.121	270.413	UNDER CANOPY	97			
1005	625321.344	4940757.582	198.934	234.234	Cosine - 0011979U186	97	N/A	N/A	-0.020
1005_R8	625321.347	4940757.581	198.969	234.269	Cosine - 0011979U186	97	N/A	N/A	0.015
3053	625318.632	4940759.373	199.271	234.571	UNDER CANOPY	97			
2050	625323.961	4940735.567	197.994	233.294	PARKING LOT	97			
1006	625895.020	4941599.135	184.905	220.196	Cosine - 0011979U187	97	N/A	N/A	-0.025
1006_R8	625895.019	4941599.121	184.916	220.207	Cosine - 0011979U187	97	N/A	N/A	-0.014
2051	625897.044	4941569.246	185.361	220.652	BITUMEN PATH	97			
3054	625816.731	4941433.666	184.210	219.503	LOW GRASS	97			
2052	625828.070	4941382.369	184.356	219.649	PAVED PARKING LOT	97			
1885_CHK2.1	614522.023	4887230.231	217.610	253.416	Aii Control - Nail	97	-0.014	-0.002	-0.001
1885_CHK2.1_R8	614522.033	4887230.223	217.617	253.423	Aii Control - Nail	97	-0.004	-0.010	0.006
ON_Aurora	623879.328	4872129.553	241.806	277.640	Can-Net	98			
1885_CHK1	626217.879	4880835.683	246.418	282.195	Aii Control - SCRIBE ON CURB	98	0.004	-0.006	0.018
ON_Uxbridge	649365.163	4885492.468	259.723	295.269	Can-Net	98			
1885_CHK3	641213.755	4887826.363	248.812	284.411	Aii Control - Nail	98	0.009	-0.002	0.006

1885_CHK2	614522.044	4887230.233	217.612	253.418	Aii Control - Nail	98	0.007	0.000	0.000
ON_BARRIE	606039.360	4910049.139	252.634	282.262	Can-Net	98			
4016	613362.945	4892322.186	257.092	292.862	NW CORNER PAINT MARK	98			
3055	613357.973	4892297.382	258.025	293.796	LOW GRASS	98			
4017	613350.446	4892312.374	257.410	293.181	NW CORNER PAINT MARK	98			
2053	611700.630	4900686.498	242.499	278.204	PAVED ROAD	98			
3056	611687.721	4900692.915	244.307	280.012	LOW GRASS	98			
3057	609930.831	4909402.725	236.491	272.124	LOW GRASS	98			
4018	609935.642	4909386.207	236.327	271.960	SE CORNER PAINT MARK	98			
2054	609602.637	4917096.184	204.142	239.714	PAVED ROAD	98			
3058	609656.456	4917106.488	204.631	240.203	LOW GRASS	98			
1885_CHK2.1	641522.060	4887230.211	217.624	253.430	Aii Control - Nail	98	0.023	-0.022	0.012
1885_CHK3.1	641213.742	4887826.365	248.794	284.394	Aii Control - Nail	98	-0.004	0.000	-0.012
1885_CHK1.1	626217.879	4880835.677	246.416	282.193	Aii Control - SCRIBE ON CURB	98	0.004	-0.012	0.015
ON_Aurora	623879.328	4872129.553	241.806	277.640	Can-Net	115			
CHK-01	626261.066	4880874.540	246.754	282.531	Set Aii Check point	115			
CHK-01	626261.073	4880874.528	246.772	282.548	Aii Check point	115	0.007	-0.012	0.017
ON_Uxbridge	649365.163	4885492.468	259.723	295.269	Can-Net	115			
CHK-03	641213.732	4887826.380	248.799	284.398	Aii Control - Nail	115	-0.014	0.015	-0.007
2055	641228.426	4887810.959	249.550	285.150	PAVED ROAD	115			
2056	640791.263	4889061.412	208.968	244.566	PAVED ROAD	115			
2057	650681.377	4884867.034	237.134	272.679	PAVED SIDEWALK	115			
3059	641208.440	4887831.507	249.255	284.854	LOW GRASS	115			
3060	640797.824	4889073.454	209.107	244.704	UNDER CANOPY	115			
3061	650682.808	4884875.074	236.853	272.398	UNDER CANOPY	115			
3062	650678.364	4884855.339	236.942	272.487	LOW GRASS	115			
ON_Uxbridge	649365.163	4885492.468	259.723	295.269	Can-Net	116			
3063	642743.892	4883027.644	254.340	289.949	UNDER CANOPY	116			
2058	642759.883	4883030.755	254.909	290.518	PAVED ROAD	116			
4019	644000.953	4879238.976	300.803	336.426	CORNER PAINT LINE	116			
3064	643986.364	4879207.495	301.143	336.766	LOW GRASS	116			
1007	634668.986	4886264.27	220.546	256.214	Cosine - 00819768498	116	N/A	N/A	0.005
1008	634448.972	4887213.316	208.507	244.173	Cosine - 819830109	116	-0.006	0.016	-0.002
1009	641213.729	4887826.370	248.807	284.406	Aii Control - 1885_CHK3	116	-0.017	0.005	0.001
1010	641213.728	4887826.373	248.813	284.413	Aii Control - 1885_CHK4	116	-0.018	0.008	0.008
4020	643631.355	4888581.624	260.965	296.537	CORNER HANDI-PARK	116			
4021	643638.265	4888584.606	260.836	296.409	CORNER PAINT LINE	116			
3066	649464.515	4890570.020	216.936	252.452	TALL GRASS	116			
2059	649462.176	4890581.177	217.505	253.021	PACKED GRAVEL ROAD	116			
4022	650032.720	4887518.093	224.434	259.965	TIP PAINTED ARROW	116			
3068	650022.432	4887554.354	223.904	259.434	LOW GRASS	116			
3067	650074.074	4887513.238	224.014	259.544	UNDER CANOPY	116			
2060	658099.042	4881324.110	246.714	282.271	PAVED DRIVEWAY	116			
4023	658102.503	4881333.226	246.909	282.466	CORNER PAINT LINE	116			
2061	660583.482	4889797.281	218.672	254.137	PACKED GRAVEL ROAD	116			
3069	660595.546	4889797.382	218.136	253.601	TALL GRASS	116			
2062	660773.721	4895976.348	222.490	257.899	PAVED ROAD	116			
3070	660766.838	4895987.544	221.464	256.873	TALL GRASS	116			
2063	653907.535	4893697.216	225.055	260.518	PACKED GRAVEL ROAD	116			
ON_Orrilla	625681.385	4940970.863	195.767	231.065	Can-Net	116			
4024	647177.313	4927619.096	186.994	222.371	CORNER OF BLACK GRATE	116			
ON_Aurora	623879.328	4872129.553	241.806	277.640	Can-Net	116			
1011	626217.883	4880835.678	246.406	282.183	1885_CHK1 - Aii Control	116	0.008	-0.011	0.005
1012	626261.036	4880874.529	246.749	282.526	CHK-01 - Aii Control	116	-0.030	-0.011	-0.005
ON_Uxbridge	649365.163	4885492.468	259.723	295.269	Can-Net	117			
3061	650682.811	4884875.085	236.876	272.420	Aii Under Canopy check shot	117	0.003	0.011	0.022
ON_Orrilla	625681.385	4940970.863	195.767	231.065	Can-Net	117			
1013	647153.307	4927572.618	186.981	222.358	Cosine - 13120210008	117	0.007	0.008	-0.014
2063A	628277.556	4940587.180	184.369	219.670	PAINT LINE	117			
3071	628290.731	4940600.176	184.069	219.371	LOW GRASS	117			
2064	628277.331	4940597.506	184.266	219.567	PAVED PARKING LOT	117			
3072	628209.238	4940560.578	185.370	220.672	UNDER CANOPY	117			
2065	630347.647	4941044.145	187.606	222.898	PAINT LINE	117			
3073	635176.469	4944074.577	185.773	221.019	UNDER CANOPY	117			
2066	635183.533	4944022.033	187.399	222.645	PACKED GRAVEL ROAD	117			

3074	635224.190	4944084.160	186.366	221.611	HIGH BRUSH	117			
3075	635176.193	4944004.721	186.727	221.973	HIGH BRUSH	117			
3076	636184.885	4945815.808	196.687	231.910	TALL GRASS	117			
4025	635018.371	4944510.371	186.618	221.859	PAINT LINE	117			
3077	643360.009	4949127.644	215.295	250.451	LOW BRUSH	117			
3078	643364.053	4949137.987	214.991	250.147	UNDER CANOPY	117			
2067	643328.602	4949109.728	215.642	250.798	PAVED ROAD	117			
2068	641452.345	4948072.885	213.768	248.945	PAVED ROAD	117			
3079	641450.262	4948082.222	213.012	248.189	TALL GRASS	117			
2069	639978.201	4947521.540	214.831	250.020	PAVED ROAD	117			
2070	638813.113	4947326.077	211.822	247.018	PACKED GRAVEL ROAD	117			
2071	637618.675	4946249.973	212.349	247.562	PACKED GRAVEL ROAD	117			
3080	637628.846	4946252.128	211.633	246.845	TALL GRASS	117			
ON_Orrilla	625681.385	4940970.863	195.767	231.065	Can-Net	125			
1014	642687.516	4937944.571	185.623	220.917	Cosine - 00819718419	125	0.009	0.008	0.012
2073	643508.280	4938212.363	186.143	221.430	PACKED GRAVEL ROAD	125			
3082	643507.015	4938202.606	185.773	221.060	TALL GRASS	125			
4027	647113.135	4927611.306	186.595	221.971	PAINT LINE	125			
3083	647117.121	4927636.640	185.449	220.826	UNDER CANOPY	125			
1013	647153.310	4927572.622	187.007	222.384	Cosine - 13120210008	125	0.010	0.012	-0.007
3085	647134.640	4927526.769	184.959	220.337	TALL GRASS	125			
3086	647158.079	4927539.796	185.197	220.574	LOW GRASS	125			
3084	647149.476	4927612.711	186.926	222.302	HIGH BRUSH	125			
2074	647168.803	4927612.228	187.049	222.425	CORNER PAVEMENT	125			
4028	646982.768	4928070.541	186.673	222.047	PAINT LINE	125			
4029	648217.281	4929176.810	194.442	229.798	PAINT LINE	125			
4030	649062.597	4929548.166	195.924	231.273	PAINT LINE	125			
2075	652057.536	4931070.703	206.918	242.234	PAVED ROAD	125			
3087	652729.382	4931413.031	211.835	247.144	UNDER CANOPY	125			
3088	652723.393	4931388.694	208.259	243.568	LOW GRASS	125			
2076	652718.508	4931390.247	208.555	243.864	PACKED GRAVEL ROAD	125			
2077	652796.987	4931836.104	209.490	244.795	PACKED GRAVEL ROAD	125			
2078	651631.700	4931075.341	204.094	239.413	PAVED ROAD	125			
3089	651640.091	4931083.259	203.530	238.850	TALL GRASS	125			
4031	655426.027	4934287.421	238.726	273.992	PAINT LINE	125			
3091	656948.162	4930121.828	233.213	268.503	TALL GRASS	125			
3090	656949.394	4930127.531	233.136	268.426	STANDING CROP	125			
2079	656943.210	4930099.758	233.416	268.706	PACKED GRAVEL ROAD	125			
2080	658293.083	4930485.280	232.297	267.574	PACKED GRAVEL ROAD	125			
1015	644605.417	4911024.170	210.450	245.922	Cosine - 00819768517	125	N/A	N/A	-0.010
2081	646942.041	4912499.537	224.449	259.898	PACKED GRAVEL ROAD	125			
2082	647766.676	4912006.945	207.200	242.643	PAVED ROAD	125			
4032	651384.587	4912451.218	222.391	257.804	PAINT LINE	125			
2083	649968.754	4911995.710	211.848	247.272	PAVED ROAD	125			
3092	649965.982	4912002.552	210.925	246.350	TALL GRASS	125			
2084	648848.362	4911626.905	210.070	245.505	PAVED ROAD	125			
2085	647342.177	4911136.452	206.293	241.743	PACKED GRAVEL ROAD	125			
2086	645792.487	4910635.514	219.610	255.074	PACKED GRAVEL ROAD	125			
3093	645793.183	4910641.171	219.752	255.215	TALL GRASS	125			
4033	644818.200	4910279.355	205.768	241.241	PAINT LINE	125			
1016	655853.142	4898807.950	250.730	286.148	Cosine - 00820130004	125	0.001	0.015	0.004
2087	654470.750	4901921.132	229.783	265.203	PAVED ROAD	125			
4034	654385.319	4902511.339	236.954	272.372	PAINT LINE	125			
ON_Uxbridge	649365.163	4885492.468	259.723	295.269	Can-Net	125			
3094	654503.109	4903613.582	235.870	271.283	UNDER CANOPY	125			
3095	654537.118	4903608.787	234.268	269.681	UNDER CANOPY	125			
2088	654533.792	4903604.664	234.433	269.845	PACKED GRAVEL ROAD	125			
2089	656988.205	4900826.170	252.946	288.349	PAVED ROAD	125			
3096	656982.787	4900831.179	252.690	288.093	TALL GRASS	125			
2090	655575.930	4898874.943	232.507	267.927	PACKED GRAVEL ROAD	125			
3097	655592.815	4898846.503	233.552	268.972	UNDER CANOPY	125			
2091	654244.457	4898438.112	225.449	260.884	PAVED ROAD	125			
2092	646943.827	4896286.007	219.437	254.943	PAVED ROAD	125			
3098	646983.367	4896329.155	219.054	254.560	UNDER CANOPY	125			
3099	646974.280	4896342.351	219.433	254.938	LOW GRASS	125			
3100	655849.650	4898804.620	250.538	285.956	LOW GRASS	125			

Cosine - 820130004	655853.141	4898807.935	250.726	286.144	Cosine Monument	126			
3100 - check	655849.655	4898804.586	250.584	286.002	Check from JD 125 - Can-Net	126	0.005	-0.034	0.046
2090 - check	655575.960	4898874.938	232.524	267.944	Check from JD 125 - Can-Net	126	0.030	-0.005	-0.017
Cosine - 13120210008	647153.300	4927572.610	187.014	222.391	Cosine Monument	126			
2074 - check	647168.802	4927612.219	187.015	222.391	Check from JD 125 - Can-Net	126	-0.001	-0.009	-0.034
3086 - check	647158.075	4927539.803	185.187	220.564	Check from JD 125 - Can-Net	126	-0.004	0.007	-0.010
ON_Orillia	625681.385	4940970.863	195.767	231.065	Can-Net	126			
2093	647209.994	4922020.452	195.220	230.632	PAVED PARKING LOT	126			
3101	647205.844	4922010.376	195.273	230.684	LOW GRASS	126			
2094	648600.143	4922126.800	200.595	235.995	PAVED ROAD	126			
2095	650040.238	4921006.726	204.590	239.984	PACKED GRAVEL ROAD	126			
2096	652493.554	4921292.646	207.794	243.168	PAVED ROAD	126			
3102	652480.362	4921294.226	206.876	242.250	TALL GRASS	126			
2097	655262.398	4922723.793	237.372	272.716	PAVED ROAD	126			
2098	657794.594	4923672.483	233.462	268.779	PACKED GRAVEL ROAD	126			

Appendix C – Published Station Coordinate Sheets



Government
of Canada

Gouvernement
du Canada

Natural Resources Canada

Station Report - CAUR

Station 1 of 1

Site Identification					
Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
CANNET-AURO	Ontario	030M14	CAUR		CANNET

Station Coordinates				
Coordinates	Reference Frame	Vertical Datum	Geoid	Epoch
plan	NAD83(CSRS)	CGVD2013	CGG2013a	2010

Zone: UTM17

Easting (metres)	Northing (metres)	h (metres)
623879.328	4872129.553	241.807
Scale	Combined	Convergence
0.99978874	0.99975084	-1° 04' 23.39"
N (metres)	H (metres)	Published date and project ID
-35.834 ± 0.011	277.641	2015-09-24 M15-703

Vertical Data

Use the value of H from the coordinates above.



Station Marker				
Marker Type	Inspected in	Established by	Status	Comments
Unknown		Cannet		None



Station Report - CBA2

Station 1 of 1

Site Identification					
Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
CANNET-BAR2	Ontario	031D05	CBA2		CANNET

Station Coordinates				
Coordinates	Reference Frame	Vertical Datum	Geoid	Epoch
plan	NAD83(CSRs)	CGVD2013	CGG2013a	2010

Zone: UTM17

Easting (metres)	Northing (metres)	h (metres)
606039.360	4910049.139	252.634
Scale	Combined	Convergence
0.99973828	0.99969868	-0° 55' 46.82"
N (metres)	H (metres)	Published date and project ID
-35.628 ± 0.011	288.262	2015-09-24 M15-703

Vertical Data

Use the value of H from the coordinates above.



Station Marker				
Marker Type	Inspected in	Established by	Status	Comments
Unknown		Cannet		None



Station Report - CUXB

Station 1 of 1

Site Identification					
Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
CANNET-UXBG	Ontario	031D03	CUXB		CANNET

Station Coordinates				
Coordinates	Reference Frame	Vertical Datum	Geoid	Epoch
plan	NAD83(CSRS)	CGVD2013	CGG2013a	2010

Zone: UTM17

Easting (metres)	Northing (metres)	h (metres)
649365.163	4885492.468	259.723
Scale	Combined	Convergence
0.99987439	0.99983367	-1° 17' 57.27"
N (metres)	H (metres)	Published date and project ID
-35.546 ± 0.010	295.269	2015-09-24 M15-703

Vertical Data

Use the value of H from the coordinates above.



Station Marker				
Marker Type	Inspected in	Established by	Status	Comments
Unknown		Cannet		None



Station Report - CORI

Station 1 of 1

Site Identification					
Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
CANNET-ORIL	Ontario	031D11	CORI		CANNET

Station Coordinates				
Coordinates	Reference Frame	Vertical Datum	Geoid	Epoch
plan	NAD83(CSRs)	CGVD2013	CGG2013a	2010

Zone: UTM17

Easting (metres)	Northing (metres)	h (metres)
625681.385	4940970.863	195.767
Scale	Combined	Convergence
0.99979425	0.99976356	-1° 06' 45.14"
N (metres)	H (metres)	Published date and project ID
-35.298 ± 0.009	231.065	2015-09-24 M15-703

Vertical Data

Use the value of H from the coordinates above.

Station Marker				
Marker Type	Inspected in	Established by	Status	Comments
Unknown		Cannet		None



Station Report - 883046

Station 1 of 1

Site Identification					
Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
883046	Ontario	031D04	883046		GPS

Station Coordinates				
Coordinates	Reference Frame	Vertical Datum	Geoid	Epoch
plan	NAD83(CSRs)	CGVD2013	CGG2013a	1997.0

Zone: UTM17

Easting (metres)	Northing (metres)	h (metres)
606905.484	4882983.600	209.070
Scale	Combined	Convergence
0.99974056	0.99970779	-0° 55' 45.61"
N (metres)	H (metres)	Published date and project ID
-35.824 ± 0.009	244.894	2001-01-01 M01707

Vertical Data

Use the value of H from the coordinates above.



Station Marker

Marker Type	Inspected in	Established by	Status	Comments
Brass/bronze tablet or cap	1988	Canadian geodetic survey - nrcan	Good	None

Location

Accessible by passenger car or light truck and a walk of less than 50 m.

Mkr type d setting code 02 from the inter of hwy #88 and hwy #27 in bondhead drive 1.0 km e to conc culvert under hwy #88. Mkd by a gsc br tab on top of culvert, 12.5 m n of c/l of hwy #88, 1.91 m s of n end of culvert and 0.21 m w of e side. An orange cyl witness was nailed to a guard rail post 6.4 m away, at a mag brg of 354 deg to the sta.

Location

MKR TYPE D SETTING CODE 02 FROM THE INTER OF HWY #88 AND HWY #27 IN BONDHEAD DRIVE 1.0 KM E TO CONC CULVERT UNDER HWY #88. MKD BY A GSC BR TAB ON TOP OF CULVERT, 12.5 M N OF C/L OF HWY #88, 1.91 M S OF N END OF CULVERT AND 0.21 M W OF E SIDE. AN ORANGE CYL WITNESS WAS NAILED TO A GUARD RAIL POST 6.4 M AWAY, AT A MAG BRG OF 354 DEG TO THE STA.



Station Report - 84U123

Station 1 of 1

Site Identification					
Name	Province	NTS map sheet	Unique Number	Provincial Identifier	Network
84U123	Ontario	031D05	84U123		44079

Station Coordinates				
Coordinates	Reference Frame	Vertical Datum	Geoid	Epoch
plan	NAD83(CSRs)	CGVD2013	CGG2013a	1997.0

Zone: UTM17

Easting (metres)	Northing (metres)	h (metres)
605620.602	4902995.758	259.554
Scale	Combined	Convergence
0.99973720	0.99969651	-0° 55' 26.24"
N (metres)	H (metres)	Published date and project ID
-35.679 ± 0.011	295.233	2001-01-01 M01707

Vertical Data					
Vertical Datum	Elevation (m)	Order	Gravity (mGal)	Published	Project ID
CGVD2013 (2010.0)	295.236	1st	980438.84	2013	H13ML1311
CGVD28	295.602	1st	980551.33	1985	VA2U85
IGLD85	295.655	1st	980619.90	1992	IGLD85AP92



Station Marker

Marker Type	Inspected in	Established by	Status	Comments
Permanent agency marker	1985	Canadian geodetic survey - nrcan	Good	None

Location

Accessible by passenger car or light truck and a walk of less than 50 m.

Provisional description/description provisionnel cookstown deep bench mark in manhole along highway no. 400, 8.4 km north of intersection with highway no. 89 (cookstown road), 1.4 km south of innisfil beach road, on west shoulder, 29.3 m south of south end of concrete culvert, 70 km south and 2.2 m west of south post of west guardrail fence, at road level.

Location

PROVISIONAL DESCRIPTION/DESCRIPTION PROVISIONNEL COOKSTOWN DEEP BENCH MARK IN MANHOLE ALONG HIGHWAY NO. 400, 8.4 KM NORTH OF INTERSECTION WITH HIGHWAY NO. 89 (COOKSTOWN ROAD), 1.4 KM SOUTH OF INNISFIL BEACH ROAD, ON WEST SHOULDER, 29.3 M SOUTH OF SOUTH END OF CONCRETE CULVERT, 70 KM SOUTH AND 2.2 M WEST OF SOUTH POST OF WEST GUARDRAIL FENCE, AT ROAD LEVEL.

	Ontario Ministry of Natural Resources and Forestry	COSINE Station Report Retrieval Date: 2022-Oct-04
	Control Survey Information Exchange AKA Names: 0011931U455S, 31U455S, 455S, VA2U85 Number of Ref Sketches: 0 Networks [usage]: 0250V [FREE], 0251V [FIX]	Station: 0011931U455S Known Status: Existing Last Reported Visit: Monument Type: - Station Type: GPS

Location Description:

Township: BARRIE FUNDAMENTAL BENCH-MARK IN QUEENS PARK, 12.2 M NORTHEAST OF CURB AT NORTHEAST SIDE OF PARKSIDE DRIVE, 1.8 M NORTHEAST OF BOUNDARY BETWEEN PARK AND DRILL HALL GROUNDS, TABLET IN TOP.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1927:SCAL	Horiz order: Unclassified	Ellipsoidal order: Unclassified
Latitude: N44° 23' 20.0xxxxx"	Longitude: W79° 41' 49.0xxxxx"	Ellipsoidal elev: 230.xxx
*UTM Zone: 17 E: E603789.xxx	N: N4915676.xxx	c. s. f.: 0.99969642
		Mrdl Conv: 0° 54' 41.8"
*MTM Zone: 10 E: E289108.xxx	N: N4916344.xxx	c. s. f.: 0.99986696
		Mrdl Conv: -0° 08' 16.0"

Datum: NAD-1983:ORIG	Horiz Order: Unclassified	Ellipsoidal Order:
Latitude: N44° 23' 20.1xxxxx"	Longitude: W79° 41' 48.9xxxxx"	Ellipsoidal elev:
*UTM Zone: 17 E: E603788.xxx	N: N4915896.xxx	c. s. f.: 0.99973247
		Mrdl Conv: 0° 54' 41.8"
*MTM Zone: 10 E: E289111.xxx	N: N4916564.xxx	c. s. f.: 0.99990302
		Mrdl Conv: -0° 08' 15.9"

Vertical (Geoidal) Control Data

Datum: CGVD2013	Vert order: First Order	Elevation: 228.735
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Datum: CGVD28:78	Vert order: First Order	Elevation: 229.099
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Maintenance / History

Date	Description
2019-Mar-20	GSC; last inspected: 1985

Reference Sketches

Reference sketch for 0011931U4555 is not available.

	Ontario Ministry of Natural Resources and Forestry	COSINE Station Report
		Retrieval Date: 2022-Oct-04
Control Survey Information Exchange		Station: 0011979U186
AKA Names: 00179U186, 79U186, CP85209 Number of Ref Sketches: 0 Networks [usage]:		Known Status: Existing Last Reported Visit: Monument Type: - Station Type: SPIR

Location Description: Township: ORILLIA ORILLIA TOWN ADMINISTRATION BUILDING AT SW COR OF INTERSECTION OF COLDWATER ST AND "WEST ST NORTH". MKD BY DEEP BENCH MARK IN MANHOLE IN LAWN IN FRONT OF BUILDING AND BESIDE A FLAGPOLE. LOC 30.0 M NE OF NE COR OF BUILDING 13.5 M SE OF CENTRE OF MAIN ENTRANCE, 4.2 M SW OF CENTRE OF SW SIDEWALK ALONG "WEST ST NORTH" AND 70 CM NW OF FLAGPOLE. Township: ORILLIA ORILLIA TOWN ADMINISTRATION BUILDING AT SW COR OF INTERSECTION OF COLDWATER ST AND "WEST ST NORTH". MKD BY DEEP BENCH MARK IN MANHOLE IN LAWN IN FRONT OF BUILDING AND BESIDE A FLAGPOLE. LOC 30.0 M NE OF NE COR OF BUILDING 13.5 M SE OF CENTRE OF MAIN ENTRANCE, 4.2 M SW OF CENTRE OF SW SIDEWALK ALONG "WEST ST NORTH" AND 70 CM NW OF FLAGPOLE.	No Photo
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Horizontal (Ellipsoidal) Control Data

Datum: NAD-1927:SCAL	Horiz order: Unclassified	Ellipsoidal order: Unclassified
Latitude: N44° 36' 33.0xxxxx"	Longitude: W79° 25' 14.0xxxxx"	Ellipsoidal elev: 235.xxx
*UTM Zone: 17 E: E625331.xxx	N: N4940531.xxx	c. s. f.: 0.99975632
		Mrdl convg: 1° 06' 33.6"
*MTM Zone: 10 E: E311105.xxx	N: N4940803.xxx	c. s. f.: 0.99986364
		Mrdl convg: 0° 03' 20.8"

Datum: NAD-1983:ORIG	Horiz order: Unclassified	Ellipsoidal order: Unclassified
Latitude: N44° 36' 33.3xxxxx"	Longitude: W79° 25' 14.2xxxxx"	Ellipsoidal elev: 199.xxx
*UTM Zone: 17 E: E625321.xxx	N: N4940757.xxx	c. s. f.: 0.99976194
		Mrdl convg: 1° 06' 33.4"
*MTM Zone: 10 E: E311099.xxx	N: N4941030.xxx	c. s. f.: 0.99986928
		Mrdl convg: 0° 03' 20.6"

Vertical (Geoidal) Control Data

Datum: CGVD2013	Vert order: First Order	Elevation: 234.254
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Datum: CGVD28:78	Vert order: First Order	Elevation: 234.610
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Maintenance / History

Date	Description
2019-Mar-20	GSC; last inspected: 1988

Reference Sketches

Reference sketch for 0011979U186 is not available.

	Ontario Ministry of Natural Resources and Forestry	COSINE Station Report
		Retrieval Date: 2022-Oct-04
Control Survey Information Exchange		Station: 0011979U187
AKA Names: 00179U187, 79U187, VA154 Number of Ref Sketches: 0 Networks [usage]:		Known Status: Existing Last Reported Visit: Monument Type: - Station Type: SPIR

Location Description:

Township: ORILLIA COUCHICHIING PARK IMMEDIATELY SOUTH OF FILTRATION PLANT, DEEP BENCH MARK IN MANHOLE IN LAWN IN FRONT AND AT CENTRE OF SAMUEL DE CHAMPLAIN MONUMENT, OPPOSITE A POINT ON CIRCULAR STREET IN FRONT OF MONUMENT, 40.7 M NORTH OF CENTRE LINE OF ENTRANCE TO GOVERNMENT WHARF, 17.2 M EAST OF FIRST STEP TO MONUMENT, 17.2 M WEST OF CENTRE LINE OF WESTERLY PART OF CIRCULAR STREET IN PARK, 1.1 M EAST OF FLOWERS SQUARE.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1927:SCAL	Horiz Order: Unclassified	Ellipsoidal order: Unclassified
Latitude: N44° 37' 01.0xxxxx"	Longitude: W79° 25' 01.0xxxxx"	Ellipsoidal elev: 221.xxx
*UTM Zone: 17 E: E625601.xxx	N: N4941401.xxx	c. s. f.: 0.99975935
		Mrdl Conv: 1° 06' 43.3"
*MTM Zone: 10 E: E311391.xxx	N: N4941668.xxx	c. s. f.: 0.99986588
		Mrdl Conv: 0° 03' 30.0"

Vertical (Geoidal) Control Data

Datum: CGVD2013	Vert order: First Order	Elevation: 220.221
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Datum: CGVD28:78	Vert order: First Order	Elevation: 220.578
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Maintenance / History

Date	Description
2019-Mar-20	GSC; last inspected: 1988

Reference Sketches

Reference sketch for 0011979U187 is not available.

 AKA Names: 607-70 Number of Ref Sketches: 0 Networks [usage]:	Ontario Ministry of Natural Resources and Forestry	COSINE Station Report Retrieval Date: 2022-Oct-04
	Control Survey Information Exchange	Station: 00819708607 Known Status: Existing Last Reported Visit: Monument Type: BM Station Type: SPIR

Location Description:

607-70: STEEL ROD WITH BRASS CAP BENCH ON NORTH SIDE OF HWY 90, 1.7 KM WEST OF BRIDGE CARRYING HWY 90 (DUNLOP ST) OVER HWY 400 IN THE CITY OF BARRIE, 170.7 M WEST OF HYDRO HIGH TENSION LINE AND 30.6 M NORTH OF CENTERLINE OF HWY 90. BENCH MARK IS SET 27 CM SOUTH OF NORTH RIGHT-OF-WAY FENCE AND IS MARKED BY A MARKER POST SET 40 CM SOUTH OF BENCH MARK.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1927:SCAL	Horiz Order: Unclassified	Ellipsoidal order: Unclassified
Latitude: N44° 22' 30.0xxxxx"	Longitude: W79° 43' 24.0xxxxx"	Ellipsoidal elev: 236.xxx
*UTM zone: 17 E: E601711.xxx	N: N4914100.xxx	C. S. F.: 0.99969023
		Mrdl Conv: 0° 53' 34.5"
*MTM zone: 10 E: E287001.xxx	N: N4914806.xxx	C. S. F.: 0.99986689
		Mrdl Conv: -0° 09' 22.3"

Vertical (Geoidal) Control Data

Datum: CGVD2013	Vert Order: First Order	Elevation: 235.387
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Datum: CGVD28:78	Vert order: First Order	Elevation: 235.756
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Maintenance / History

Date	Description
2019-Mar-20	MTO

Reference Sketches

Reference sketch for 00819708607 is not available.

 AKA Names: 419-71 Number of Ref Sketches: 0 Networks [usage]: 3311CS [FREE]	Ontario Ministry of Natural Resources and Forestry Control Survey Information Exchange	COSINE Station Report Retrieval Date: 2022-Oct-04 Station: 00819718419 Known Status: Existing Last Reported Visit: Monument Type: CAP Station Type: GPS
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Location Description:

419-71: STEEL ROD WITH BRASS CAP BENCH MARK ON EAST SIDE OF HWY 12, 4.5 KM NORTH OF JCT OF HWY 12 AND SIMCOE ROAD 47 IN THE HAMLET OF BRECHIN 8.5 M NORTH OF MARA TWP.CON.RD.7 AND 90.8 M EAST OF CENTRE LINE OF HWY 12. BENCH MARK IS ET 30 CM SOUTH OF NORTH RIGHT-OF-WAY FENCE ALONG MARA TWP.CON.RD.7, 5.2 M EAST OF A FIELD ENTRANCE AND IS MARKED BY A MARKER POST SET 30 CM SOUTH OF BENCH MARK.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1983:CSRS:CBNV6-2010.0	Horiz Order: CSRS Class C	Ellipsoidal order: Fourth Order
Latitude: N44° 34' 50.526718"	Longitude: W79° 12' 09.581429"	Ellipsoidal elev: 185.611
*UTM zone: 17	E: E642687.507	N: N4937944.563
	c. s. f.: 0.99982127	Mrdl Conv: 1° 15' 42.4"
*MTM zone: 10	E: E328412.197	N: N4937897.918
	c. s. f.: 0.99987775	Mrdl Conv: 0° 12' 31.3"

Vertical (Geoidal) Control Data

Datum: CGVD2013	Vert Order: First Order	Elevation: 220.913
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Datum: CGVD28:78	Vert order: First Order	Elevation: 221.260
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Maintenance / History

Date	Description
2019-Mar-20	MTO

Reference Sketches

Reference sketch for 00819718419 is not available.

	Ontario Ministry of Natural Resources and Forestry	COSINE Station Report
		Retrieval Date: 2022-Oct-04
Control Survey Information Exchange		Station: 00819768517
AKA Names: 768517 Number of Ref Sketches: 0 Networks [usage]: MTO [FREE]	Known Status: Existing Last Reported Visit: Monument Type: CAP Station Type: GPS	

Location Description:

768517: STEEL ROD WITH BRASS CAP BENCH MARK ON THE NORTH SIDE OF HWY 48, 243.8 M EAST OF THE CENTERLINE OF PORT BOLSTER RD (DURHAM 23 RD), 1.1 KM WEST OF THE JCT OF HWY 48 AND BROCK TWP 14TH CON AND 20.3 M NORTH OF CENTERLINE OF HWY 48. BENCH MARK IS LOCATED 11.9 M EAST OF CENTERLINE OF GRAVEL ENTRANCE TO HYDRO RIGHT-OF-WAY, 58 CM SOUTH OF NORTH RIGHT-OF-WAY FENCELINE AND 79 CM WEST OF A BLACK AND YELLOW MARKER POST.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1927:SCAL	Horiz order: Unclassified	Ellipsoidal order: Unclassified
Latitude: N44° 20' 18.0xxxxx"	Longitude: W79° 11' 12.0xxxxx"	Ellipsoidal elev: 246.xxx
*UTM zone: 17 E: E644558.xxx	N: N4910834.xxx	c. s. f.: 0.99981842
		Mrdl Conv: 1° 16' 03.2"
*MTM zone: 10 E: E329786.xxx	N: N4910756.xxx	c. s. f.: 0.99986910
		Mrdl Conv: 0° 13' 08.4"

Datum: NAD-1983:ORIG	Horiz order: Unclassified	Ellipsoidal order:
Latitude: N44° 20' 17.0xxxxx"	Longitude: W79° 11' 09.7xxxxx"	Ellipsoidal elev:
*UTM zone: 17 E: E644605.xxx	N: N4911024.xxx	c. s. f.: 0.99985716
		Mrdl Conv: 1° 16' 04.7"
*MTM zone: 10 E: E329836.xxx	N: N4910945.xxx	c. s. f.: 0.99990770
		Mrdl Conv: 0° 13' 09.9"

Vertical (Geoidal) Control Data

Datum: CGVD2013	Vert order: First Order	Elevation: 245.932
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Datum: CGVD28:78	Vert order: First Order	Elevation: 246.301
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Maintenance / History

Date	Description
2020-Jan-07	Located by OLS March 2019 - Stable

Reference Sketches

Reference sketch for 00819768517 is not available.

	Ontario Ministry of Natural Resources and Forestry	COSINE Station Report
		Retrieval Date: 2022-Oct-04
Control Survey Information Exchange		Station: 00820130004
AKA Names:		Known Status: Existing
Number of Ref Sketches: 1		Last Reported Visit:
Networks [usage]: 3311CS [FREE]		Monument Type: CAP
		Station Type: GPS

Location Description:

RIB & cap, 20 cm below ground. - Monument is located on west side of Hwy 12 approx 0.10 km south of Durham Rd 13.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1983:CSRS:CBNV6-2010.0	Horiz Order: CSRS Class C	Ellipsoidal order: Fourth Order
Latitude: N44° 13' 33.010017"	Longitude: W79° 2' 55.177268"	Ellipsoidal elev: 250.726
*UTM zone: 17 E: E655853.141	N: N4898807.935	C. S. F.: 0.99985942
		Mrdl Conv: 1° 21' 40.7"
*MTM zone: 10 E: E340859.045	N: N4898525.194	C. S. F.: 0.99987667
		Mrdl Conv: 0° 18' 53.3"

Vertical (Geoidal) Control Data

No vertical data found.

Maintenance / History

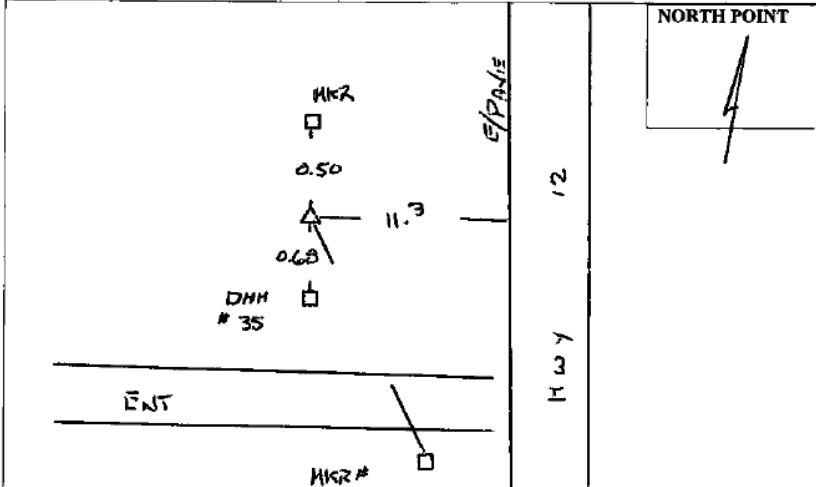
Date	Description
2019-Mar-20	Set by MTO April 2013.

Reference Sketches

Sketch 1 of 1

MONUMENT POSITION SKETCH				
DATE:	Work Order	2012-104	MTM ZONE	10
APRIL 2013	MONUMENT	00820130004	UTM ZONE	17
UPDATED:	HWY	12	SET BY	EVEREST GEODETICS

TYPE OF MONUMENT RIB & CAP	RELATIONSHIP TO GROUND - 20 CMS
INTERVISIBLE WITH	
LOCATION: MONUMENT IS LOCATED ON WEST SIDE OF HWY 12 APPROX 0.10 KMS SOUTH OF DURHAM RD 13.	

PURPOSE:	LOCATE: X	PRECISE REFERENCE
		NORTH POINT MONUMENT NUMBER 00820130004

	Ontario Ministry of Natural Resources and Forestry	COSINE Station Report
		Retrieval Date: 2022-Oct-04
Control Survey Information Exchange		Station: 13120210008
AKA Names: Number of Ref Sketches: 2 Networks [usage]: 2135CS [FREE], 2135V [FREE], 2135V13 [FREE]		Known Status: Existing Last Reported Visit: Monument Type: CAP Station Type: GPS

Location Description:
 Brass Tablet set vertically in Lock Structure on the Trent-Severn Waterway at Lock 41. Tablet is set South West Corner of the Lock. Tablet is set 1.90m North of Top of the stairs and 0.70m East of the West Edge of the Lock Structure

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1983:CSRS:CBNV6-2010.0	Horiz order: CSRS Class C	Ellipsoidal order: Third Order
Latitude: N44° 29' 11.315694"	Longitude: W79° 8' 57.828163"	Ellipsoidal elev: 187.014
*UTM zone: 17	E: E647153.300	N: N4927572.610
	c. s. f.: 0.99983698	Mrdl Conv: 1° 17' 49.3"
*MTM zone: 10	E: E332686.984	N: N4927445.185
	c. s. f.: 0.99988024	Mrdl Conv: 0° 14' 44.5"

Vertical (Geoidal) Control Data

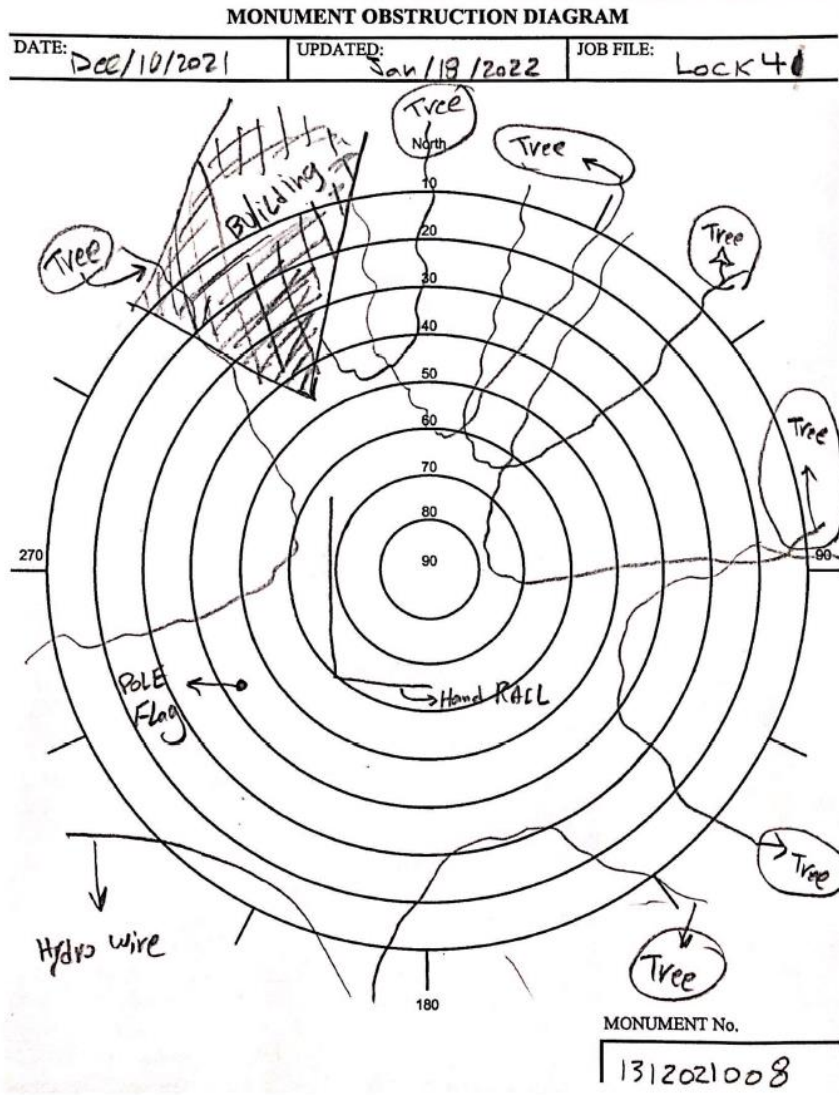
Datum: CGVD2013	Vert order: First Order	Elevation: 222.372
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Datum: CGVD28:78	Vert order: First Order	Elevation: 222.723
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Maintenance / History

No maintenance data found.

Sketch 2 of 2



Scanned with CamScanner

	Ontario Ministry of Natural Resources and Forestry	COSINE Station Report
		Retrieval Date: 2022-Oct-11
Control Survey Information Exchange		Station: 00819768498
AKA Names: 768498 Number of Ref Sketches: 0 Networks [usage]: MTO [FREE]	Known Status: Existing Last Reported Visit: Monument Type: CAP Station Type: SPIR	

Location Description:

768498: CONCRETE CULVERT (1.52 M X 1.52 M) ON WEST SIDE OF HWY 48, 1.4 KM SOUTH OF JCT OF HWY 48 AND YORK REG RD 13 AT MOUNT ALBERT, 2.7 KM NORTH OF YORK REG RD 31, 0.6 KM NORTH OF HERALD RD AND 13.1 M WEST OF CENTERLINE OF HWY 48. TABLET IS SET VERTICALLY IN TOP OF CONCRETE CULVERT IN THE N.W. CORNER, 24 CM EAST OF WEST END OF CULVERT AND 15 CM SOUTH OF NORTH SIDE OF CULVERT.

No Photo

Horizontal (Ellipsoidal) Control Data

Datum: NAD-1983:ORIG	Horiz Order: Unclassified	Ellipsoidal Order:
Latitude: N44° 7' 01.8xxxxx"	Longitude: W79° 19' 01.1xxxxx"	Ellipsoidal elev:
*UTM Zone: 17 E: E634669.xxx	N: N4886264.xxx	c. s. f.: 0.99982304
*MTM Zone: 10 E: E319448.xxx	N: N4886369.xxx	c. s. f.: 0.99990263
		Mrdl convg: 1° 10' 18.4"
		Mrdl convg: 0° 07' 38.6"

Vertical (Geoidal) Control Data

Datum: CGVD2013	Vert order: First Order	Elevation: 256.209
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Datum: CGVD28:78	Vert order: First Order	Elevation: 256.589
Geoid:	Meridional defl:	Prime vert defl:
		Undulation:

Maintenance / History

Date	Description
2019-Mar-20	Established by MTO 1976. Inspected by private OLS April 2018 - stable.

Reference Sketches

Reference sketch for 00819768498 is not available.
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