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FEMA Region V– Branch, MI
Ground Control Project Report for STARR II
Flyer: Continental Mapping

October 2017

Project Information

CDI Project Number:	**FSG5017**
FEMA Task Order Number:	**HSFE05-16-J-0207**
STARR II Project Number:	**400000347**
STARR II Partner Tracking No:	**CD S2 R05 16 T0207**
WO Period of Performance:	**9/30/16 – 3/31/2018**
Task Code:	**R0501.12.G**
Geographic Location:	**Branch, MI**
Number of GCPs Requested:	**80**
Number of GCPs Collected:	**86**

Project Specifications

Precision (Horizontal/Vertical):	**CDI Quality 1 ≤ 6.5 cm H/V**
Coordinate System:	**Michigan South**
Datum:	**NAD83 (2011)**
Altitude Reference:	**NAVD88 (Geoid12B)**
Units:	**International Feet**

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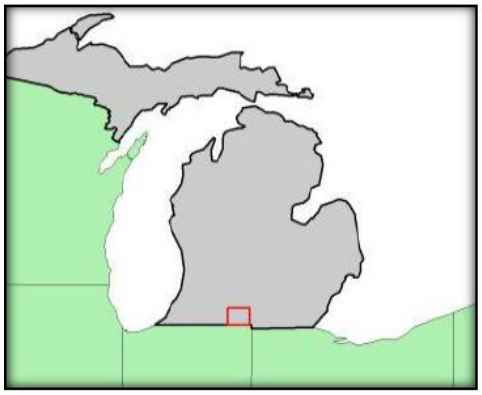
Summary

The purpose of this project was to locate and survey ground control points (GCPs) in multiple areas of interest as defined by FEMA-supplied shape and kml files. The GCP coordinates are to be used to control the vertical aspect of all newly-flown LiDAR data during post-processing and subsequent deliverables creation. CompassData visited the project area, found suitable GCPs, and determined accurate coordinates for each GCP according to the customer's specifications.

Area Specification and Request



The Branch County AOI encompasses ~535 square miles (1384 square kilometers). The flyer has requested 21 ground control points for their processing. In adherence to the USGS v.1.2 quality level 2 requirements, an additional 65 checkpoints will be collected. These numbers are derived from the ASPRS recommended number of check points based on area for project areas between 1251-1500 sq.km. The division of these points will be 35 NVA points and 25 VVA points. Distribution will be determined through discussions with the flier and based on locations of different land classifications.

Equipment

CompassData used a Trimble R10 to perform the control survey. This device is accurate to within 1 cm on a position-by-position basis per Trimble specifications. Operating within the VRS network provided accurate coordinate values at or around 6.5 cm H/V. CompassData has consistently demonstrated this level of accuracy on many GCP collection jobs across North and South America, Europe, Asia and Africa. Specifications for the Trimble R10 are available upon request.

Survey Methodology

CompassData has met the required precision for this project by using a high-quality GPS receiver with differential corrections provided by a RTK and RTN network setup in the area. The GPS antenna used to survey the control and test points sat atop a bubble-leveled, fixed-height range pole that was placed over the center of the desired GCP. At least 180 positions (captured at a rate of one per second) were geometrically averaged to calculate a single coordinate for each GCP. All required field documentation was filled out and the points were identified on web-based imagery. Digital pictures of each GCP location were collected in the field.

Quality Control Procedures

CompassData collects GCPs with an unobstructed view of the sky to ensure proper GPS-operation. CompassData works to avoid potential sources of multipath error such as trees, buildings, and fences that may adversely affect the GPS accuracy. Additional quality control comes from the fact that at least 180 GPS positions are collected for each GCP. While operating within a RTN network, valid solutions are reached within seconds; however, we continue to collect additional data to ensure meeting collection specifications. To ensure project integrity, a GCP will be observed again or moved to a more suitable location if it does not meet project specifications.

In addition to the afore mentioned procedures, CompassData "surveys" existing geodetic control monuments to see if our coordinates match the published coordinates to the required accuracy. These monuments are usually established by the National Geodetic Survey (NGS) in the United States. If it is found that our coordinates are outside the acceptable accuracy, the reason for the difference will be found or the GCPs will be observed again under different GPS constellation constraints. There are certain geodetic considerations that must be taken in account that affect whether a GPS-derived coordinate will line up with a survey monument, especially when these monuments reference local coordinate systems or the systems of another country. Sometimes the published coordinates for a monument are not accurate, although this is very infrequent.

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Deliverables

Deliverables for this project include:

- Coordinates (in spreadsheet format)
- Digital Pictures
- QA/QC Data

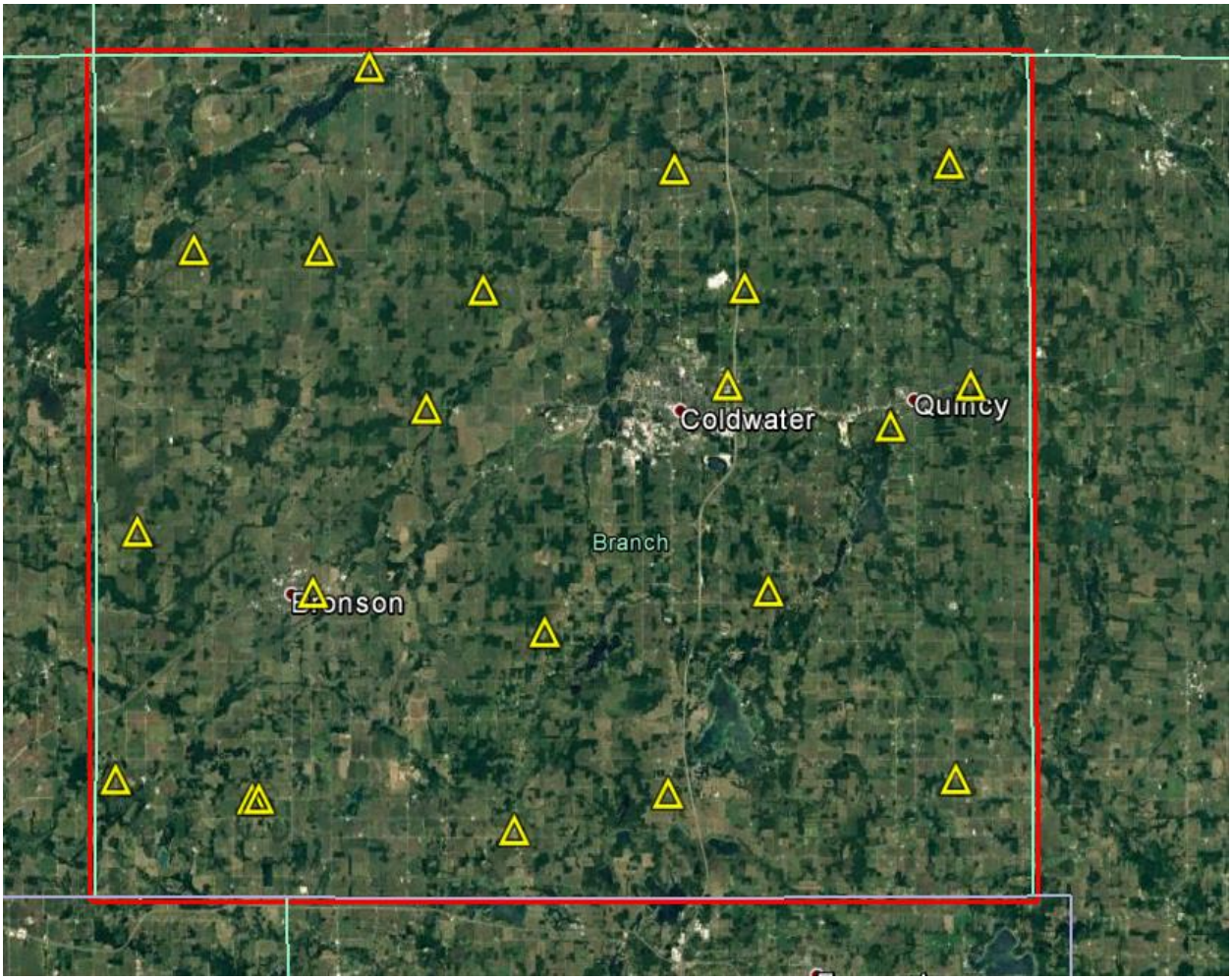
Project Notes

All collected points were retrieved from the Trimble Survey Controller and processed with the Trimble Business Center software. The GPS survey is producing in this step heights above ellipsoid (HAEs).

Geoid12B was then used to generate the geoid separation at every Lat/Long location. NAVD88 orthometric heights were then generated in spreadsheet form using the formula HAE - Geoid = Orthometric Height. Those values were then included into the final delivery coordinate CSV files and have been tested against NGS monuments collected during this survey and are showing millimeter-level agreement.

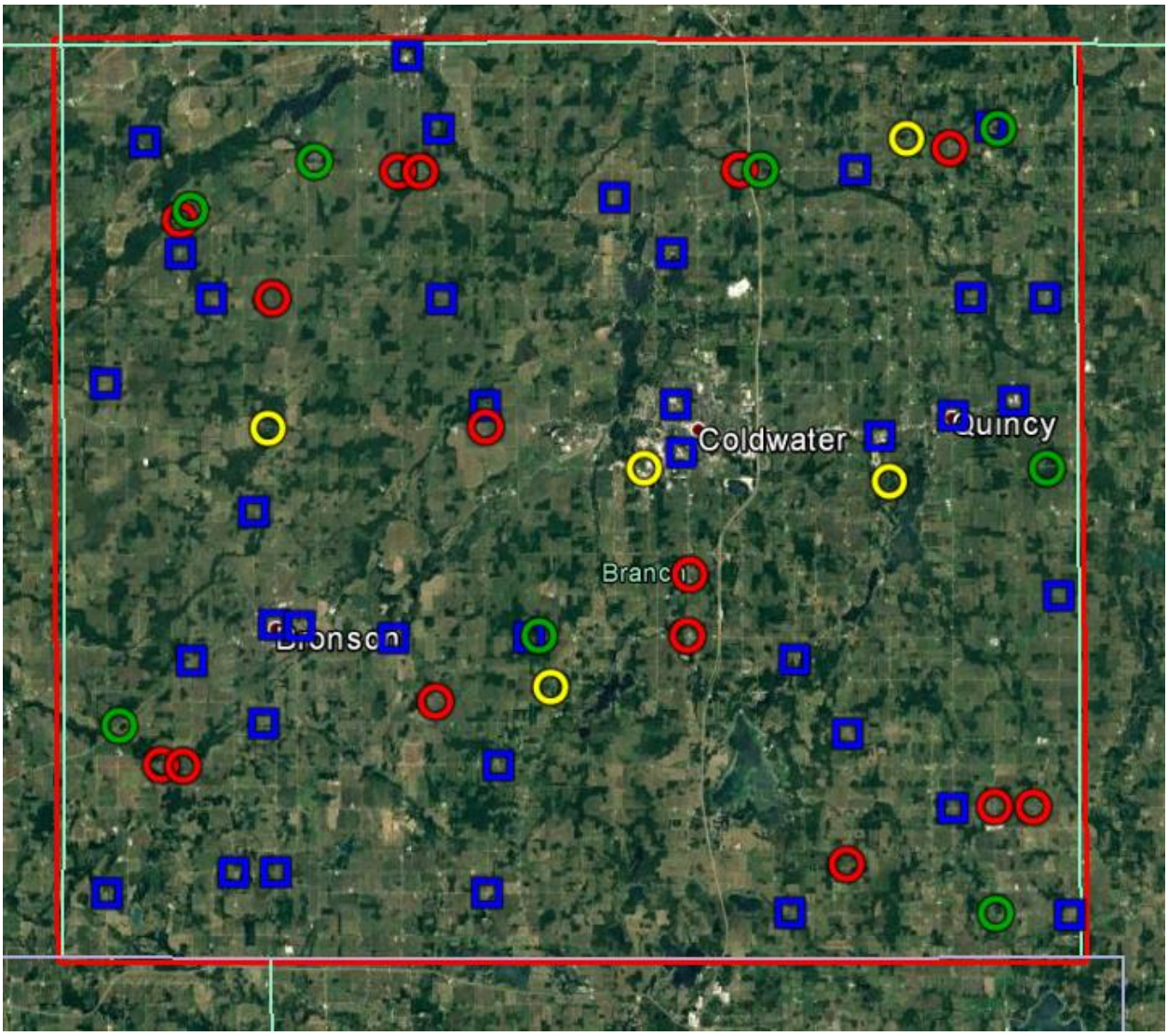
The Horizontal and Vertical accuracies reported in the Final Coordinates file were obtained from field measurements and post-processing. The report contains all points collected during each daily survey deployment, including NVA, VVA and Ground Control.

Area with Ground Control Points



Area with NVA and VVA Test Points

Blue Squares – NVA Test Points
Yellow Circles – VVA Brush
Red Circles – VVA Crop
Green Trees – VVA Forest



Results of NVA

Point ID	Easting Int. Survey Feet	Northing Int. Survey Feet	NAVD88 MSL Int. Survey Feet	LiDAR Elevation Int. Survey Feet	Δ Z Int. Survey Feet	Δ Z^2
NVA200	12876383.286	103986.712	916.657	916.660	-0.003	0.000
NVA201	12923972.658	103650.275	961.027	961.080	-0.053	0.003
NVA202	12961896.662	100875.637	1030.269	1030.180	0.089	0.008
NVA203	12996916.495	100332.600	1090.066	1089.990	0.076	0.006
NVA204	12887240.214	132880.567	908.667	908.640	0.027	0.001
NVA205	12912562.023	135510.135	931.662	931.390	0.272	0.074
NVA206	12929532.543	135449.555	1006.519	1006.470	0.049	0.002
NVA207	12962709.099	132430.175	991.210	991.220	-0.010	0.000
NVA208	12995878.939	140105.916	1066.659	1066.470	0.189	0.036
NVA209	12924246.685	164372.487	939.450	939.350	0.100	0.010
NVA210	12973618.156	160161.765	1016.469	1016.400	0.069	0.005
NVA211	12990419.761	164393.248	1012.444	1012.440	0.004	0.000
NVA212	12994461.658	177213.195	1060.511	1060.450	0.061	0.004
NVA213	12985162.981	177330.241	1005.871	1005.880	-0.009	0.000
NVA214A	12970821.879	193363.426	974.758	974.640	0.118	0.014
NVA215	12925559.243	119562.805	981.755	981.810	-0.055	0.003
NVA216	12890096.088	177989.001	913.111	912.970	0.141	0.020
NVA217A	12897551.408	106465.844	946.868	946.850	0.018	0.000
NVA218	12896186.470	125018.011	913.210	913.200	0.010	0.000
NVA219	12969292.875	123159.906	1011.283	1011.500	-0.217	0.047
NVA220A	12982380.062	113765.874	1051.466	1051.390	0.076	0.006
NVA221	12987811.035	198587.862	995.702	995.450	0.252	0.064
NVA222	12947760.994	183177.095	967.918	967.800	0.118	0.014
NVA223	12940646.477	190153.669	935.470	935.370	0.100	0.010
NVA224	12918729.805	198876.052	932.171	932.090	0.081	0.007
NVA225	12918907.401	177691.470	984.847	984.780	0.067	0.004
NVA226	12881902.491	197577.014	853.680	853.620	0.060	0.004
NVA227	12895178.882	151386.266	932.042	932.020	0.022	0.000
NVA228	12876752.612	167496.031	907.728	907.570	0.158	0.025
NVA250	12892302.647	106491.522	931.455	931.490	-0.035	0.001

NVA400	12897591.004	137292.868	913.271	913.460	-0.189	0.036
NVA401A	12900823.349	137093.445	914.931	915.010	-0.079	0.006
NVA402	12886256.992	183605.454	879.850	879.900	-0.050	0.002
NVA403	12948088.555	164307.270	957.830	957.880	-0.050	0.002
NVA404	12948765.993	158278.767	965.361	965.280	0.081	0.007
NVA405	12982788.052	162625.670	1018.670	1018.620	0.050	0.002
NVA406	12914856.349	208018.849	908.844	908.800	0.044	0.002

Datum: NAD83(2011)
Epoch: 2010
Geoid: 12B
State Plane: Michigan South
Units: International Feet

Summary is in International Feet			**International Feet**	**Meters**
Z Mean	**0.04**	**RMSE:**	**0.109**	**0.033**
Z Min:	**-0.22**	*** 1.9600**	**0.213**	**0.065**
Z Max:	**0.27**			

Results of VVA

Point ID	Easting Int. Survey Feet	Northing Int. Survey Feet	NAVD88 MSL Int. Survey Feet	LiDAR Elevation Int. Survey Feet	Δ Z Int. Survey Feet	ΔZ^2
VVA501	12932220.094	129176.605	1003.646	1003.450	0.196	0.038
VVA502	12897085.975	161681.897	888.236	888.470	-0.234	0.055
VVA503	12944128.309	156315.350	967.094	967.000	0.094	0.009
VVA504	12969067.210	106791.275	1050.690	1050.720	-0.030	0.001
VVA505A	12886087.185	119730.726	894.099	894.330	-0.231	0.053
VVA506	12977325.516	197113.089	993.666	993.720	-0.054	0.003
VVA507	12974805.301	154440.210	982.845	983.820	-0.975	0.951
VVA800	12992502.505	113750.136	1046.190	1045.950	0.240	0.058
VVA801A	12917774.409	127485.390	944.911	944.940	-0.029	0.001
VVA802A	12883330.302	119876.022	896.284	896.290	-0.006	0.000
VVA803	12886274.235	187696.376	870.406	870.330	0.076	0.006
VVA804	12924320.988	161637.503	944.045	943.920	0.125	0.016
VVA805	12897759.428	177852.649	901.586	901.710	-0.124	0.015
VVA806	12956390.460	193383.616	957.188	957.090	0.098	0.010
VVA807A	12982711.265	195877.006	987.570	987.560	0.010	0.000
VVA808	12916399.203	193500.875	950.849	950.850	-0.001	0.000
VVA809	12949709.803	143047.871	1003.547	1003.290	0.257	0.066
VVA810	12949372.411	135422.044	999.283	999.300	-0.017	0.000
VVA850	12987671.020	113841.724	1061.865	1061.810	0.055	0.003
VVA851	12913633.739	193574.565	934.344	934.110	0.234	0.055
VVA900A	12988784.119	198274.937	994.920	994.950	-0.030	0.001
VVA901AA	12878156.927	124806.228	904.705	904.780	-0.075	0.006
VVA902A	12930806.696	135562.022	1021.813	1021.890	-0.077	0.006
VVA903A	12994553.341	155906.177	1026.289	1025.910	0.379	0.144
VVA904A	12887574.957	188933.515	879.108	879.530	-0.422	0.178
VVA905A	12903178.665	194866.840	896.441	896.250	0.191	0.036
VVA906B	12959004.005	193341.857	952.185	951.980	0.205	0.042
VVA907A	12987706.739	100527.532	1088.413	1088.600	-0.187	0.035

Datum: NAD83(2011)
Epoch:
2010

Geoid: 12B
State Plane: Michigan South
Units: International Feet

Summary is in International Feet			International Feet	Meters
Z Average	0.01	RMSE:	0.257	0.078
Z Min:	-0.98	* 1.9600	0.504	0.154
Z Max:	0.38	95th Percentile	0.251	0.077

Contact Information

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