

Ground Control Point Survey Report

Montana Highline Completion Wibaux LiDAR Project

USGS Contract: G16PC0020

Task Order Number: 140G0221F0248

Prepared for:

United States Geological Survey (USGS)



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6.	Deliverables	Sent via Electronic Transfer
	Including: a) Point Documentation Report & Photos of Survey Points	
	b) Final Coordinate List in Excel Format	
	c) NGS Data Sheets for Project Controls	

1. INTRODUCTION

1.1 *Project Summary*

Dewberry Engineers Inc. is under contract to the United States Geological Survey to provide 73 Ground Control Points in the State of Montana. Under the above referenced USGS Task Order, Dewberry is tasked to complete the quality assurance of LiDAR products. As part of this work Dewberry staff will complete Ground Control Point surveys that will be used to evaluate vertical and horizontal accuracy. The ground survey was conducted October 3, 2021 thru November 6, 2021.

Existing NGS Control Points were located and surveyed to check the accuracy of the RTK/GPS survey equipment with the results shown in Section 2.4 of this Report.

As an internal QA/QC procedure and to verify that the Ground Control Points meet the 95% confidence level approximately 50% of the points were re-observed and are shown in Section 5 of this report.

Final horizontal coordinates are referenced to Montana State Plane, NAD83 (2011) in meters. Final Vertical elevations are referenced to NAVD88 in meters using Geoid model 2018B (Geoid18B).

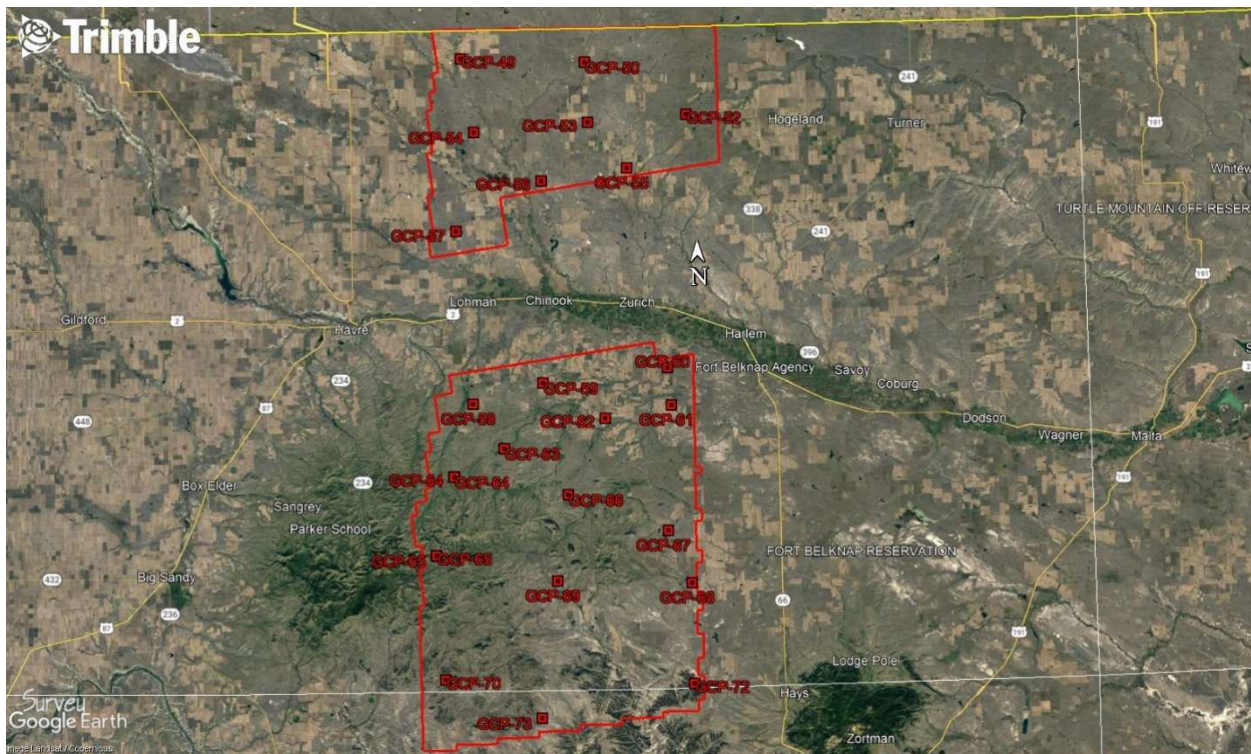
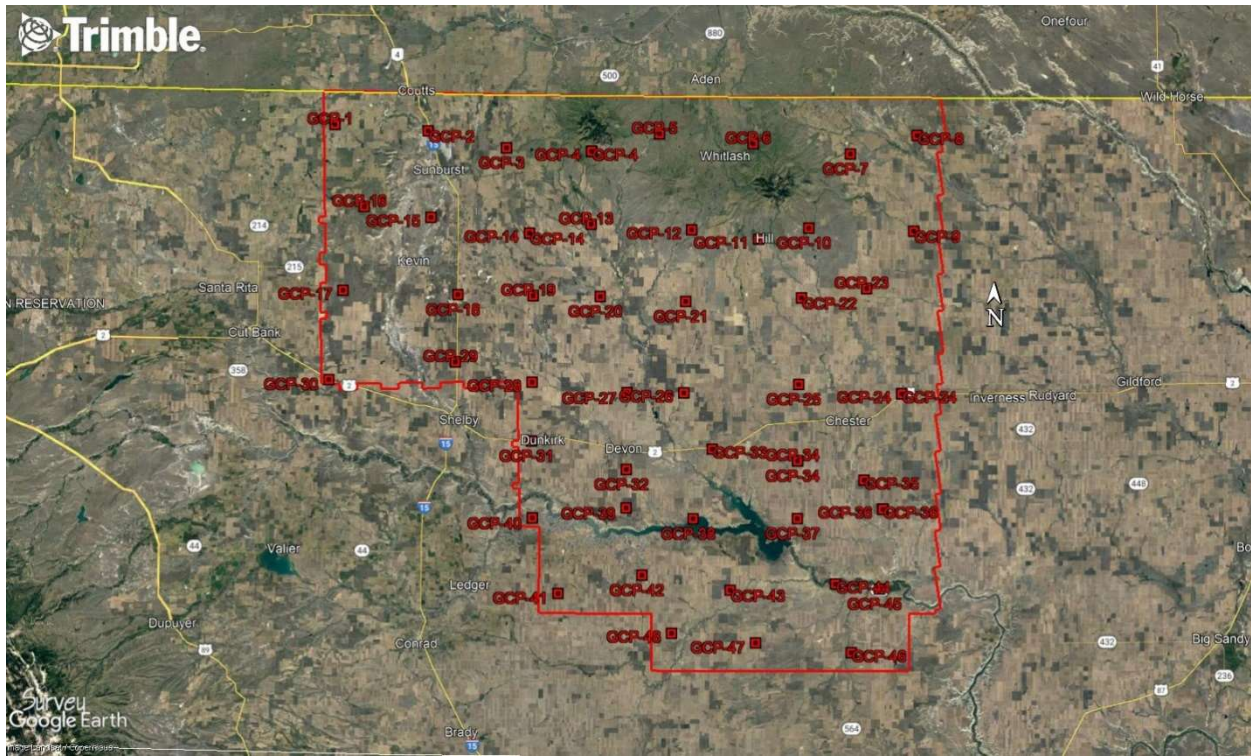
1.2 *Points of Contact*

Questions regarding the technical aspects of this report should be addressed to:

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1.3 Project Area



PROJECT DETAILS

2.1 *Survey Equipment*

In performing the GPS observations Trimble R-10 GNSS receiver/antenna attached to a two-meter fixed height pole with a Trimble TSC7 Data Collector to collect GPS raw data were used to perform the field surveys.

2.2 *Survey Point Detail*

The 73 Ground Control Points were well distributed throughout the project area.

A sketch was made for each location and a nail was set at the point where possible or at an identifiable point. The Ground Control Point locations are detailed on the “Control Point Documentation Report” sheets attached to this report.

2.3 *Network Design*

The GPS survey performed by Dewberry Engineers Inc. office located in Lanham, MD was tied to a Real Time Network operated by Trimble RTX. The network is a series of “real-time” continuously operating, high precision GPS reference stations. All of the reference stations have been linked together using Trimble GPSNet software, creating a Virtual Reference Station System (VRS).

The Trimble NetR5 Reference Station is a multi-channel, multi-frequency GNSS (Global Navigation Satellite System) receiver designed for use as a stand-alone reference station or as part of a GNSS infrastructure solution. Trimble R-Track technology in the NetR5 receiver supports the modernized GPS L2C and L5 signals as well as GLONASS L1/L2 signals.

2.4 Field Survey Procedures and Analysis

Dewberry field surveyors used Trimble R-10 GNSS receivers, which is a geodetic quality dual frequency GPS receiver, to collect data at each surveyed location.

All locations were occupied once with approximately 50% of the locations being re-observed. All re-observations matched the initially derived station positions within the allowable tolerance of $\pm 5\text{cm}$ or within the 95% confidence level. Each occupation which utilized the VRS network was occupied for approximately three (3) minutes in duration and measured to 180 epochs.

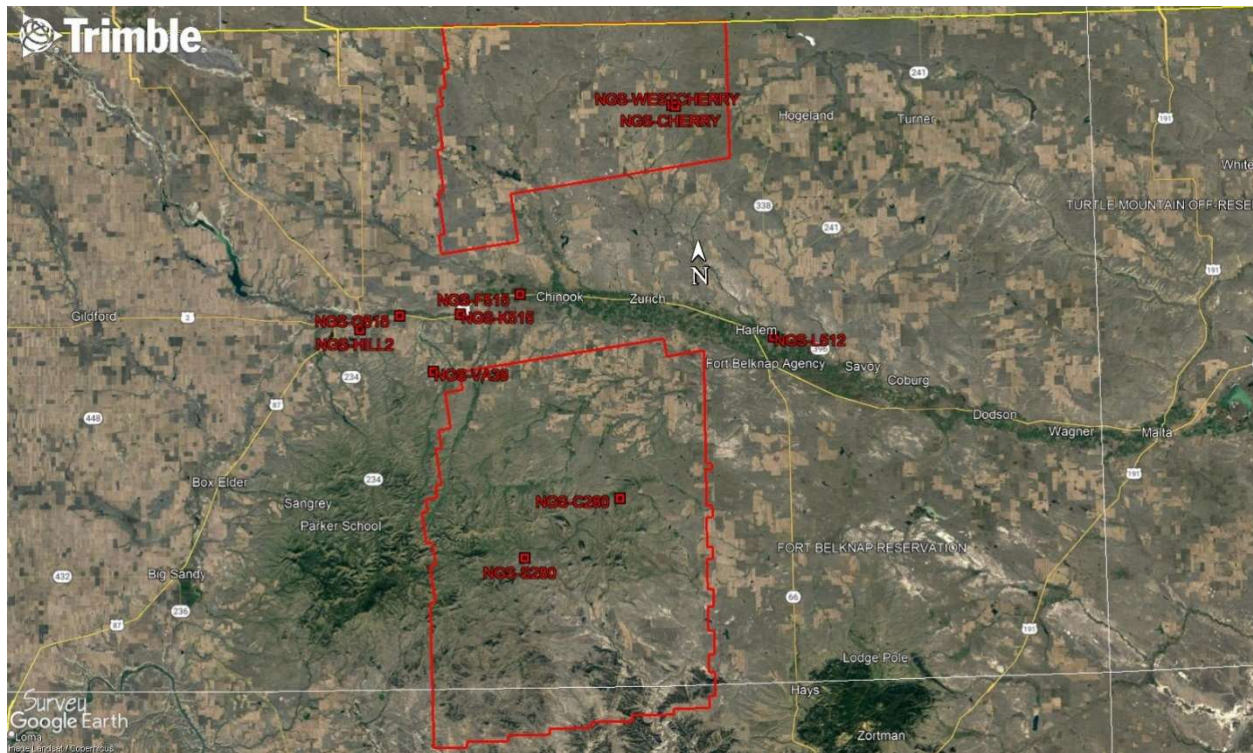
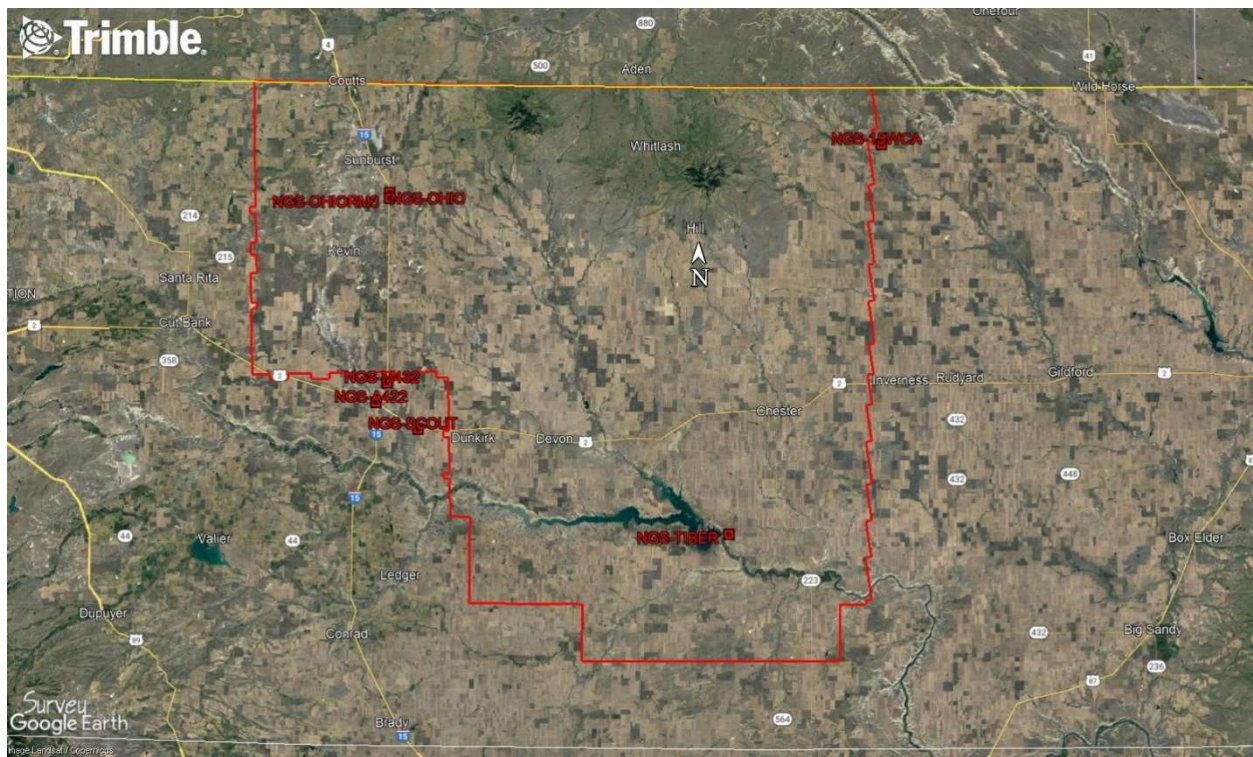
Each occupation which utilized OPUS (if used) was occupied between 20 and 30 minutes. Field GPS observations are detailed on the “Control Point Documentation Reports” submitted as part of this report.

Ten (10) existing NGS monument listed in the NSRS database were located for the Louisiana area as an additional QA/QC method to check the horizontal and vertical accuracy of the VRS network as well as being the primary project control monuments designated as TK0168, TK0183, TK0335, TK0330, TK0356, TK0322, TK0447, TLO297, TLO707, and TLO363. The results are as follows:

PT. #	Observed Values			Data Sheet Values			ΔX	ΔY	ΔZ
	NORTHING	EASTING	ELEVS.	NORTHING	EASTING	ELEVS.			
C280	448560.478	629595.351	1039.313	448560.517	629595.359	1039.271	-0.039	-0.008	0.042
F515	482970.568	613282.223	737.071	N/A	N/A	737.064	N/A	N/A	0.007
K515	479806.238	603176.023	751.349	N/A	N/A	751.331	N/A	N/A	0.018
L512	475196.588	655892.590	717.004	475196.634	655892.602	716.994	-0.046	-0.012	0.010
Q515	479695.820	592926.193	752.370	N/A	N/A	752.337	N/A	N/A	0.033
S280	438859.057	613413.281	1248.913	438859.107	613413.294	1248.922	-0.050	-0.013	0.009
CHERRY	514096.400	639935.058	1088.236	514096.367	639935.025	1088.200	0.033	0.033	0.036
15WCA	519039.057	509699.746	968.012	N/A	N/A	968.004	N/A	N/A	0.008
A422	477080.409	423899.688	1001.399	477080.396	423899.678	1001.356	0.013	0.010	0.043
M432	480316.671	425816.529	1060.535	480316.663	425816.522	1060.514	0.008	0.007	0.021

The above results indicate that the VRS network is providing positional values within the 5cm parameters for this survey.

NGS Monuments



2.5 Adjustment

The survey data was collected using Virtual Reference Stations (VRS) methodology within a Virtual Reference System (VRS).

The system is designed to provide a true Network RTK performance, the RTKNet software enables high-accuracy positioning in real time across a geographic region. The RTKNet software package uses real-time data streams from the Trimble RTX network user and generates correction models for high-accuracy RTK GPS corrections throughout the network. Therefore, corrections were applied to the points as they were being collected, thus negating the need for a post process adjustment.

2.6 Data Processing Procedures

After field data is collected the information is downloaded from the data collectors into the office software. The Software program used is called Trimble Business Center.

Downloaded data is run through the TBC program to obtain the following reports; points report, point comparison report and a point detail report. The reports are reviewed for point accuracy and precision.

After review of the point data an “ASCII” or “txt” file which is the industry standard is created. Point files are loaded into our CADD program (Carlson Survey 2019) to make a visual check of the point data (Pt. #, Coordinates, Elev. and Description). The data can now be imported into the final product.

3. ***FINAL COORDINATES/ELEVATIONS***

POINT ID	NORTHING (m)	EASTING (m)	ELEV. (m)
MONTANA STATE PLANE, NAD83(2011), NAVD 88, Meters, Geoid 18			
GCP			
GCP-1	525624.662	405982.483	1160.892
GCP-2	524302.722	421662.480	1031.762
GCP-3	521229.280	434857.586	1061.039
GCP-4	520368.186	449186.040	1347.172
GCP-5	523185.374	460678.922	1097.723
GCP-6	521264.107	476403.714	1251.002
GCP-7	519341.266	492798.194	1067.755
GCP-8	522331.978	504127.622	983.921
GCP-9	506255.657	503303.438	997.241
GCP-10	507000.088	485560.021	1223.675
GCP-11	505260.536	477105.425	1197.561
GCP-12	507001.741	465831.892	1199.357
GCP-13	508195.856	448927.235	1068.072
GCP-14	506873.882	438513.182	1084.189
GCP-15	509787.613	421943.280	1018.491
GCP-16	511727.972	410770.842	1267.706
GCP-17	497789.396	406923.920	1063.655
GCP-18	496760.826	426298.275	1046.116
GCP-19	496391.753	438989.819	1054.268
GCP-20	496092.113	450283.886	999.768
GCP-21	495041.326	464652.402	1104.016
GCP-22	495340.752	484178.605	1051.144
GCP-23	496743.024	495175.152	1035.540
GCP-24	479018.936	500839.748	1047.037
GCP-25	480852.306	483483.511	1019.813
GCP-26	479729.713	464124.925	1002.746
GCP-27	479919.235	454550.706	991.058
GCP-28	481907.959	438595.138	1016.266
GCP-29	485493.831	425712.567	1086.932
GCP-30	482853.643	404350.961	1093.852
GCP-31	472049.566	438330.715	1011.146
GCP-32	467046.415	454241.686	1007.966
GCP-33	470237.293	468752.387	988.922
GCP-34	468027.097	483116.509	966.785
GCP-35	464637.282	494260.671	962.867

GCP-36	459712.580	497393.026	918.831
GCP-37	458364.818	482934.410	939.725
GCP-38	458606.834	465370.103	918.122
GCP-39	460606.036	454096.203	984.027
GCP-40	459170.610	438282.204	1005.670
GCP-41	446455.591	442411.206	1050.792
GCP-42	449299.757	456595.702	1051.913
GCP-43	446529.490	471426.599	921.636
GCP-44	447288.741	489211.236	850.521
GCP-45	446308.132	496655.718	840.448
GCP-46	435709.072	491703.188	928.396
GCP-47	437621.984	475583.749	941.395
GCP-48	439469.100	461446.764	981.855
GCP-49	523270.709	605594.357	835.829
GCP-50	522373.028	626519.033	840.420
GCP-51	517845.714	636576.679	921.367
GCP-52	513309.466	643476.253	1029.794
GCP-53	512242.274	626872.838	859.802
GCP-54	510853.574	607651.632	806.928
GCP-55	504490.169	633355.178	868.913
GCP-56	502510.112	618902.232	802.708
GCP-57	494284.872	604405.604	827.547
GCP-58	465237.199	606891.336	941.609
GCP-59	468608.555	618697.408	940.014
GCP-60	470881.099	639699.593	775.941
GCP-61	464589.967	640277.637	820.944
GCP-62	462523.875	629091.930	920.955
GCP-63	457708.810	612032.402	1050.460
GCP-64	453061.340	603564.032	1165.051
GCP-65	439954.755	600404.386	1238.675
GCP-66	449816.383	622681.505	1071.458
GCP-67	443576.552	639435.847	994.581
GCP-68	434737.607	643316.325	976.808
GCP-69	435402.142	620693.672	1169.887
GCP-70	419076.101	601571.373	1223.848
GCP-71	424365.395	630507.900	1032.661
GCP-72	417800.636	643458.686	983.124
GCP-73	412373.980	617704.980	1050.563

4. GPS OBSERVATIONS

POINT ID	OBSERV. DATE	JULIAN DATE	TIME OF DAY (AST)	RE-OBSERV. DATE	RE-OBSERV. TIME
GCP-1	10/25/2021	298	14:22	N/A	N/A
GCP-2	10/25/2021	298	15:59	N/A	N/A
GCP-3	10/26/2021	299	15:00	N/A	N/A
GCP-4	10/26/2021	299	17:54	11/1/2021	16:28
GCP-5	11/2/2021	306	13:41	N/A	N/A
GCP-6	11/6/2021	310	13:35	N/A	N/A
GCP-7	11/6/2021	310	16:28	N/A	N/A
GCP-8	11/5/2021	309	17:40	N/A	N/A
GCP-9	11/4/2021	308	16:59	11/5/2021	13:15
GCP-10	11/6/2021	310	15:22	N/A	N/A
GCP-11	10/31/2021	303	16:13	11/2/2021	16:02
GCP-12	11/6/2021	310	11:48	N/A	N/A
GCP-13	10/23/2021	296	15:56	10/31/2021	18:25
GCP-14	10/23/2021	296	17:19	11/1/2021	17:57
GCP-15	10/26/2021	299	13:38	N/A	N/A
GCP-16	10/25/2021	298	12:42	N/A	N/A
GCP-17	10/19/2021	292	11:48	10/20/2021	14:20
GCP-18	10/18/2021	291	12:25	10/19/2021	13:44
GCP-19	10/20/2021	293	16:24	10/22/2021	14:13
GCP-20	10/22/2021	295	14:55	N/A	N/A
GCP-21	11/1/2021	305	13:22	N/A	N/A
GCP-22	11/2/2021	306	16:46	N/A	N/A
GCP-23	11/4/2021	308	15:22	N/A	N/A
GCP-24	10/28/2021	301	14:15	11/4/2021	18:16
GCP-25	11/2/2021	306	17:53	N/A	N/A
GCP-26	10/31/2021	304	13:55	11/1/2021	12:28
GCP-27	10/22/2021	295	18:26	10/23/2021	13:22
GCP-28	10/20/2021	293	17:10	10/22/2021	13:37
GCP-29	10/18/2021	291	11:18	10/19/2021	18:13
GCP-30	10/19/2021	292	10:54	10/20/2021	12:59
GCP-31	10/18/2021	291	13:50	10/22/2021	13:00
GCP-32	10/18/2021	291	18:00	N/A	N/A
GCP-33	10/28/2021	301	11:07	10/28/2021	18:26
GCP-34	10/29/2021	302	13:50	10/30/2021	12:12
GCP-35	10/28/2021	301	17:37	N/A	N/A
GCP-36	10/28/2021	301	16:06	10/31/2021	17:40

GCP-37	10/29/2021	302	14:57	10/30/2021	13:02
GCP-38	10/18/2021	291	16:38	10/27/2021	15:13
GCP-39	10/18/2021	291	17:37	10/27/2021	12:43
GCP-40	10/21/2021	294	12:11	10/27/2021	18:38
GCP-41	10/21/2021	294	13:03	11/3/2021	14:12
GCP-42	10/21/2021	294	14:15	10/27/2021	17:48
GCP-43	10/21/2021	294	17:50	10/27/2021	17:02
GCP-44	10/30/2021	303	13:35	N/A	N/A
GCP-45	10/30/2021	303	16:34	N/A	N/A
GCP-46	10/30/2021	303	15:31	11/3/2021	18:38
GCP-47	11/3/2021	307	17:06	N/A	N/A
GCP-48	11/3/2021	307	15:25	N/A	N/A
GCP-49	10/8/2021	281	15:24	10/10/2021	14:19
GCP-50	10/9/2021	282	16:05	N/A	N/A
GCP-51	10/11/2021	284	15:01	N/A	N/A
GCP-52	10/11/2021	284	13:47	N/A	N/A
GCP-53	10/9/2021	282	17:03	10/10/2021	18:25
GCP-54	10/8/2021	281	16:39	10/10/2021	16:50
GCP-55	10/11/2021	284	10:09	10/11/2021	16:45
GCP-56	10/9/2021	282	14:41	N/A	N/A
GCP-57	10/8/2021	281	11:52	N/A	N/A
GCP-58	10/4/2021	277	11:54	N/A	N/A
GCP-59	10/4/2021	277	12:50	N/A	N/A
GCP-60	10/3/2021	276	17:12	10/12/2021	13:00
GCP-61	10/12/2021	285	13:44	N/A	N/A
GCP-62	10/3/2021	276	18:22	10/6/2021	13:35
GCP-63	10/4/2021	277	13:55	N/A	N/A
GCP-64	10/5/2021	278	12:43	10/15/2021	13:25
GCP-65	10/5/2021	278	13:45	10/15/2021	14:03
GCP-66	10/4/2021	277	17:16	10/5/2021	17:09
GCP-67	10/6/2021	279	14:56	10/12/2021	15:26
GCP-68	10/6/2021	279	18:11	10/14/2021	18:01
GCP-69	10/14/2021	287	13:45	N/A	N/A
GCP-70	10/15/2021	288	16:56	N/A	N/A
GCP-71	10/14/2021	287	15:13	N/A	N/A
GCP-72	10/14/2021	287	17:05	N/A	N/A
GCP-73	10/16/2021	289	16:28	N/A	N/A

5. POINT COMPARISON

Point ID	Point CK	Delta North (M)	Delta East (M)	Vertical Difference (M)
GCP-1	GCP-1 CK	N/A	N/A	N/A
GCP-2	GCP-2 CK	N/A	N/A	N/A
GCP-3	GCP-3 CK	N/A	N/A	N/A
GCP-4	GCP-4 CK	-0.004	-0.009	-0.018
GCP-5	GCP-5 CK	N/A	N/A	N/A
GCP-6	GCP-6 CK	N/A	N/A	N/A
GCP-7	GCP-7 CK	N/A	N/A	N/A
GCP-8	GCP-8 CK	N/A	N/A	N/A
GCP-9	GCP-9 CK	0.015	-0.014	0.014
GCP-10	GCP-10 CK	N/A	N/A	N/A
GCP-11	GCP-11 CK	-0.012	-0.011	0.001
GCP-12	GCP-12 CK	N/A	N/A	N/A
GCP-13	GCP-13 CK	0.003	0.015	0.007
GCP-14	GCP-14 CK	0.009	0.006	-0.012
GCP-15	GCP-15 CK	N/A	N/A	N/A
GCP-16	GCP-16 CK	N/A	N/A	N/A
GCP-17	GCP-17 CK	-0.005	-0.008	0.030
GCP-18	GCP-18 CK	0.010	-0.005	-0.003
GCP-19	GCP-19 CK	-0.003	0.011	-0.017
GCP-20	GCP-20 CK	N/A	N/A	N/A
GCP-21	GCP-21 CK	N/A	N/A	N/A
GCP-22	GCP-22 CK	N/A	N/A	N/A
GCP-23	GCP-23 CK	N/A	N/A	N/A
GCP-24	GCP-24 CK	-0.011	-0.010	0.026
GCP-25	GCP-25 CK	N/A	N/A	N/A
GCP-26	GCP-26 CK	-0.007	-0.003	0.036
GCP-27	GCP-27 CK	0.013	-0.006	-0.022
GCP-28	GCP-28 CK	0.001	-0.006	0.017
GCP-29	GCP-29 CK	0.007	0.001	-0.007
GCP-30	GCP-30 CK	-0.021	-0.002	-0.016
GCP-31	GCP-31 CK	0.003	0.002	0.007
GCP-32	GCP-32 CK	N/A	N/A	N/A
GCP-33	GCP-33 CK	0.001	0.013	0.033
GCP-34	GCP-34 CK	0.002	0.010	0.014
GCP-35	GCP-35 CK	N/A	N/A	N/A
GCP-36	GCP-36 CK	-0.005	-0.003	0.011
GCP-37	GCP-37 CK	-0.015	-0.007	0.017
GCP-38	GCP-38 CK	-0.002	0.014	0.014
GCP-39	GCP-39 CK	-0.001	0.002	-0.019

GCP-40	GCP-40 CK	0.011	0.016	0.016
GCP-41	GCP-41 CK	0.025	-0.006	0.036
GCP-42	GCP-42 CK	0.002	0.007	-0.006
GCP-43	GCP-43 CK	-0.013	0.002	0.010
GCP-44	GCP-44 CK	N/A	N/A	N/A
GCP-45	GCP-45 CK	N/A	N/A	N/A
GCP-46	GCP-46 CK	-0.005	0.010	-0.028
GCP-47	GCP-47 CK	N/A	N/A	N/A
GCP-48	GCP-48 CK	N/A	N/A	N/A
GCP-49	GCP-49 CK	0.000	0.015	-0.009
GCP-50	GCP-50 CK	N/A	N/A	N/A
GCP-51	GCP-51 CK	N/A	N/A	N/A
GCP-52	GCP-52 CK	N/A	N/A	N/A
GCP-53	GCP-53 CK	-0.002	-0.007	0.001
GCP-54	GCP-54 CK	0.001	-0.015	0.019
GCP-55	GCP-55 CK	0.011	-0.014	-0.031
GCP-56	GCP-56 CK	N/A	N/A	N/A
GCP-57	GCP-57 CK	N/A	N/A	N/A
GCP-58	GCP-58 CK	N/A	N/A	N/A
GCP-59	GCP-59 CK	N/A	N/A	N/A
GCP-60	GCP-60 CK	-0.004	0.021	-0.009
GCP-61	GCP-61 CK	N/A	N/A	N/A
GCP-62	GCP-62 CK	-0.027	0.009	0.026
GCP-63	GCP-63 CK	N/A	N/A	N/A
GCP-64	GCP-64 CK	0.010	0.000	-0.024
GCP-65	GCP-65 CK	-0.005	0.004	-0.014
GCP-66	GCP-66 CK	-0.010	-0.010	0.012
GCP-67	GCP-67 CK	-0.002	0.003	0.001
GCP-68	GCP-68 CK	-0.014	0.004	-0.022
GCP-69	GCP-69 CK	N/A	N/A	N/A
GCP-70	GCP-70 CK	N/A	N/A	N/A
GCP-71	GCP-71 CK	N/A	N/A	N/A
GCP-72	GCP-72 CK	N/A	N/A	N/A
GCP-73	GCP-73 CK	N/A	N/A	N/A