

Ground Control Point Survey Report

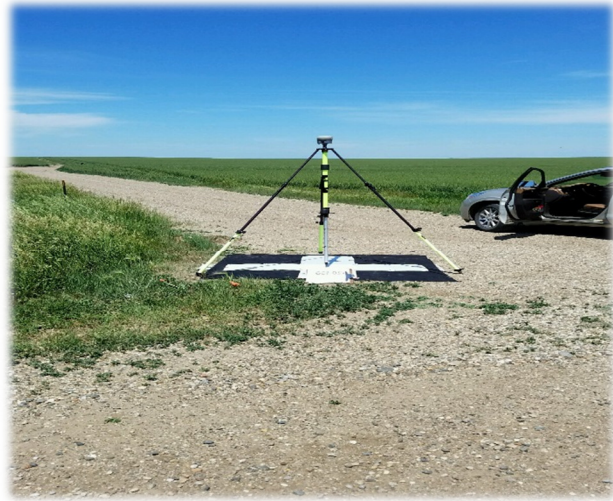
“South Dakota - Missouri River LiDAR FY 2016”

USGS Contract: G16PC00020

Task Order Number: G16PD00482

Prepared for:

United States Geological Survey (USGS)



Prepared By:

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	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 Consultants LLC is under contract to the United States Geological Survey to provide 161 Ground Control Points in the State of South Dakota. 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 May 13 thru May 26, 2016.

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 UTM, Zone 14, NAD83 (2011) in meters. Final Vertical elevations are referenced to NAVD88 in meters using Geoid model 2012B (Geoid12B).

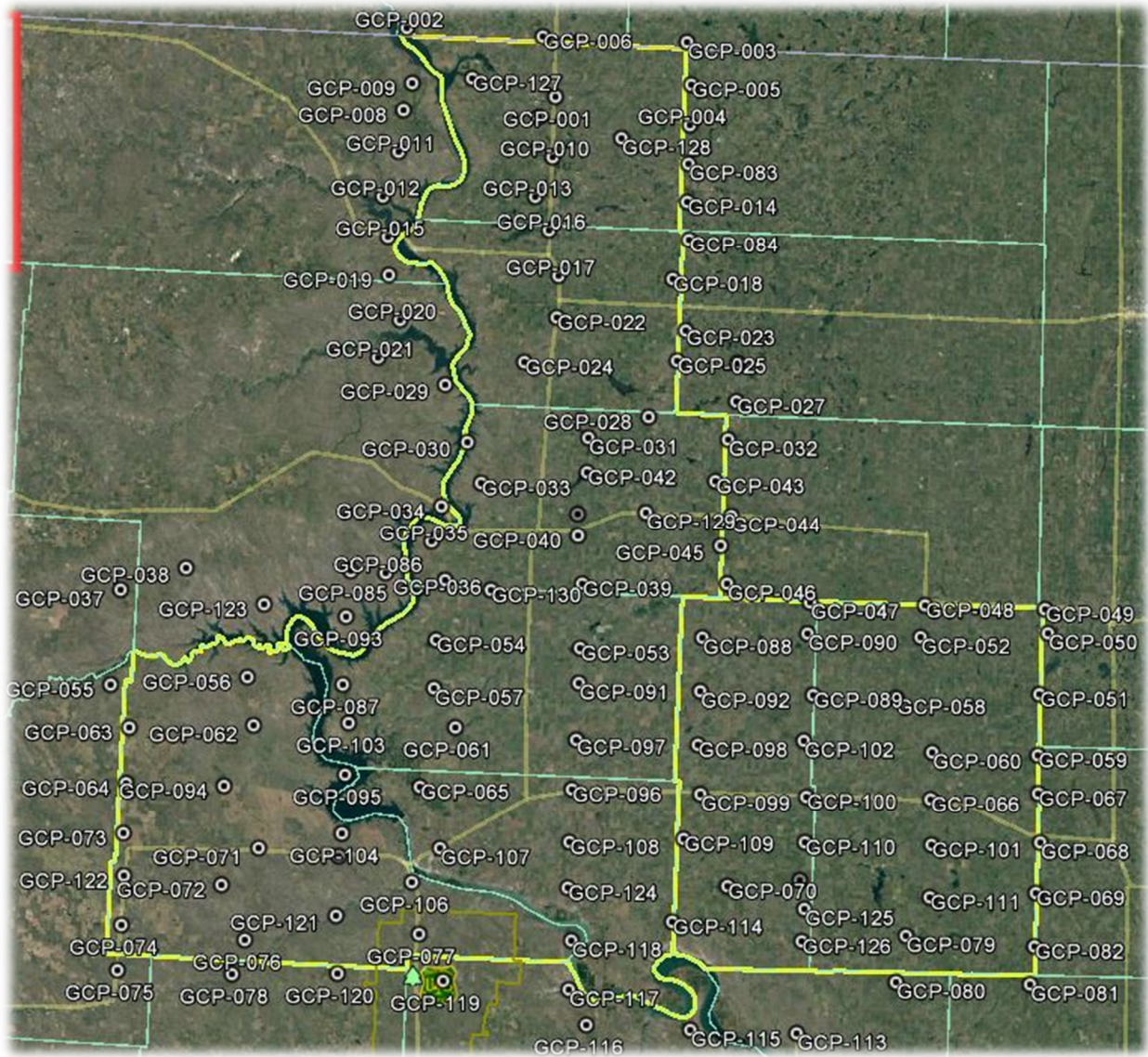
1.2 *Points of Contact*

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 TSC3 Data Collector to collect GPS raw data were used to perform the field surveys.

2.2 *Survey Point Detail*

The 161 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 “Check Point Documentation Report” sheets attached to this report.

2.3 *Network Design*

The GPS survey performed by Dewberry Consultants LLC office located in Lanham, MD was tied to a Real Time Network operated by Midstates VRS. 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 ± 5 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.

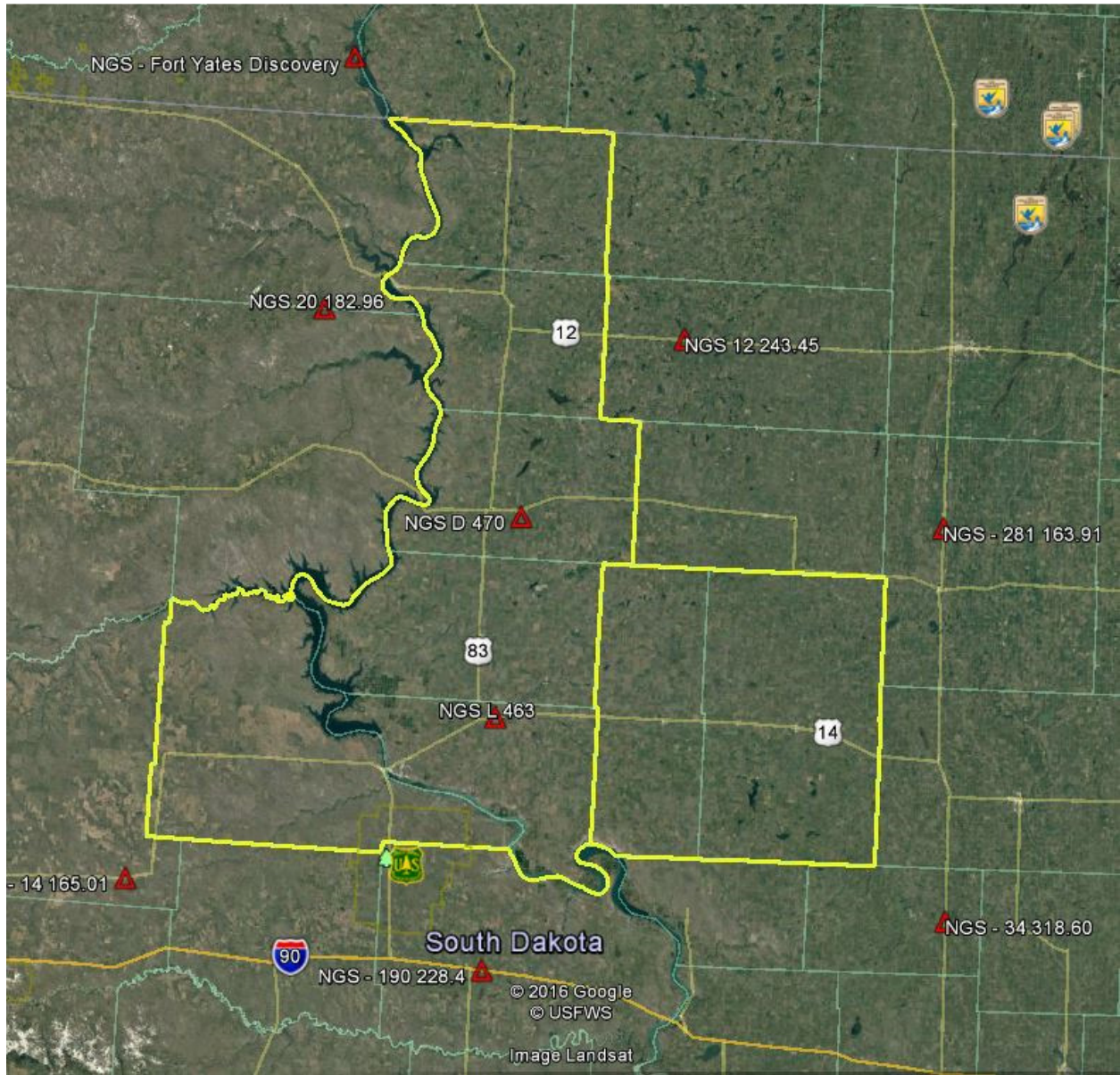
Each occupation which utilized OPUS (if used) was occupied between 20 and 30 minutes.

Field GPS observations are detailed on the “Control Point Documentation Reports” submitted as part of this report.

Nine (9) existing NGS monument listed in the NSRS database were located 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 AC7947, OS0803, AB9017, AC7878, AE4105, AD8931, AE9763, AC7917 and AC7971. The results are as follows:

PT. #	Observed Values			Data Sheet Values			ΔX	ΔY	ΔZ
	NORTHING	EASTING	ELEVS.	NORTHING	EASTING	ELEVS.			
14 165.01	4881254.318	321650.493	585.643	4,881,254.368	321,650.511	585.6	0.050	0.018	-0.043
I90 228.4	4860915.485	419142.545	545.163	4,860,915.570	419,142.568	545.129	0.085	0.023	-0.034
L 463	4929245.929	419778.082	530.351	4,929,245.943	419,778.089	530.355	0.014	0.007	0.004
34 318.6	4879486.026	543858.237	425.944	4,879,486.019	543,858.243	426.0	-0.007	0.006	0.056
D 470	4983284.107	424333.706	628.889	4,983,284.109	424,333.714	628.871	0.002	0.008	-0.018
281 163.91	4985349.570	538346.019	394.481	4,985,349.582	538,346.032	394.483	0.012	0.013	0.002
12 243.45	5032877.015	466136.295	557.683	5,032,876.977	466,136.255	557.717	-0.038	-0.040	0.034
20 182.96	5036951.738	368669.234	660.554	5,036,951.763	368,669.251	660.558	0.025	0.017	0.004
FORT YATES DISCOVERY II	5105263.498	373675.687	495.974	5,105,263.551	373,675.682	496.0	0.053	-0.005	0.026

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



NGS Monuments Utilized for this Project

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 Midstates VRS system 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 2014) 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*

SOUTH DAKOTA - LiDAR POINTS (Initial GCP Collection)			
POINT ID	NORTHING (m)	EASTING (m)	ELEV. (m)
GCP POINTS			
GCP-001	5076959.320	417119.182	515.494
GCP-002	5090754.738	385142.827	503.825
GCP-003	5089348.241	444729.154	600.996
GCP-004	5071788.685	445801.604	572.224
GCP-005	5080350.266	445865.826	559.156
GCP-006	5089685.872	414098.981	530.093
GCP-007	5072556.284	413700.592	515.868
GCP-008	5073332.065	385015.939	618.543
GCP-008R	5073336.270	385013.056	618.501
GCP-009	5079078.604	386652.895	608.477
GCP-010	5064201.859	416918.698	524.002
GCP-011	5064477.835	384232.298	568.022
GCP-012	5054914.530	381216.279	498.538
GCP-012R	5054878.002	380825.548	498.368
GCP-013	5055703.611	413478.192	538.686
GCP-014	5055514.232	445711.524	542.934
GCP-015	5046417.739	382561.723	544.197
GCP-016	5048707.795	416599.943	526.638
GCP-017	5039010.530	418924.560	572.445
GCP-018	5038966.898	443091.581	623.256
GCP-018R	5037878.316	443076.823	614.544
GCP-019	5038176.082	382969.746	569.992
GCP-020	5028747.216	385601.415	555.740
GCP-020R	5028747.439	385600.816	555.736
GCP-021	5020727.622	381188.889	521.784
GCP-021R	5020727.227	381189.270	522.483
GCP-022	5030174.728	418770.548	608.873
GCP-023	5028175.554	446225.369	594.840
GCP-024	5020592.395	412197.569	544.122
GCP-025	5021776.626	444527.624	592.003
GCP-026	5021645.630	457342.111	575.818
GCP-027	5013600.202	457265.871	583.551
GCP-028	5009769.608	438826.668	580.073
GCP-029	5015354.494	395592.076	561.764

GCP-030	5003390.201	400623.535	499.357
GCP-031	5005021.875	426210.611	595.978
GCP-031R	5005014.605	426212.461	595.775
GCP-032	5005500.589	455759.749	583.007
GCP-033	4994911.718	403812.534	569.471
GCP-033R	4994911.996	403811.639	569.406
GCP-034	4989716.687	395554.663	542.521
GCP-034R	4989720.988	395555.048	542.346
GCP-035	4982212.969	393678.936	570.087
GCP-036	4974082.051	396769.464	551.481
GCP-037	4970113.208	327952.982	615.828
GCP-038	4975110.343	341762.970	559.587
GCP-039	4974161.886	425794.113	598.412
GCP-040	4984256.841	424616.488	627.901
GCP-041	4988919.061	424410.632	667.843
GCP-041R	4988927.606	424414.385	667.478
GCP-042	4997773.043	426128.983	599.218
GCP-042R	4997777.337	426052.033	597.042
GCP-043	4996676.277	453331.614	592.751
GCP-043R	4996676.984	453331.688	592.723
GCP-044	4989405.616	456904.327	588.727
GCP-045	4982965.648	454869.015	609.556
GCP-046	4975019.303	456403.502	601.681
GCP-047	4971566.651	474137.136	596.405
GCP-048	4971655.933	498492.352	460.539
GCP-048R	4971522.809	499848.971	454.714
GCP-049	4971549.076	523993.503	409.386
GCP-050	4966512.266	524792.290	409.453
GCP-051	4953620.341	523313.597	415.962
GCP-052	4964931.325	497733.064	460.121
GCP-053	4960618.219	425713.354	568.674
GCP-054	4961444.658	395218.130	569.240
GCP-055	4950020.593	326387.510	522.480
GCP-056	4952447.913	355439.266	607.980
GCP-057	4951278.639	395078.489	565.245
GCP-058	4952030.054	492936.529	479.793
GCP-059	4940753.454	523348.043	419.743
GCP-060	4940746.726	500900.949	455.997
GCP-061	4943141.595	399832.424	554.866

GCP-062	4942361.800	357023.707	627.892
GCP-063	4941113.731	330586.476	623.889
GCP-064	4929330.535	330238.377	679.348
GCP-065	4930426.845	392663.900	535.317
GCP-066	4930790.225	500820.947	479.790
GCP-067	4932664.876	523722.199	428.722
GCP-068	4922185.141	524448.606	433.423
GCP-069	4911482.605	523815.748	447.652
GCP-070	4911229.581	458350.994	632.753
GCP-071	4916333.448	358811.657	604.779
GCP-072	4908326.961	351126.849	608.639
GCP-073	4918646.146	329966.796	642.400
GCP-074	4899194.209	330048.370	674.407
GCP-075	4889582.823	329424.106	652.048
GCP-076	4896865.483	356387.636	600.183
GCP-077	4899200.093	393328.545	556.860
GCP-078	4889543.520	353846.007	525.919
GCP-079	4901760.916	496470.533	553.639
GCP-080	4891878.136	494680.714	543.832
GCP-081	4892173.638	523202.764	557.731
GCP-082	4900210.509	523865.136	506.398
GCP-083	5063582.790	445748.792	557.271
GCP-084	5047497.784	446319.145	556.428
GCP-085	4978136.767	377318.804	561.618
GCP-086	4975203.306	384138.380	571.349
GCP-087	4951497.618	375728.373	545.471
GCP-088	4963518.221	451535.744	568.570
GCP-089	4952085.058	475268.763	509.593
GCP-090	4964996.545	473744.405	564.019
GCP-090R	4965807.320	473751.726	575.994
GCP-091	4953239.872	425686.495	573.343
GCP-091R	4953240.873	425685.700	573.219
GCP-092	4952248.366	451380.399	547.412
GCP-092R	4952248.768	451379.372	547.292
GCP-093	4965785.710	376003.882	574.460
GCP-094	4929399.602	351101.761	662.694
GCP-095	4932524.086	376726.156	529.665
GCP-096	4930795.828	424800.798	501.594
GCP-096R	4930821.630	424770.241	499.405

GCP-097	4941257.623	425467.997	533.088
GCP-098	4940970.075	451216.081	543.657
GCP-098R	4940971.612	451215.998	543.558
GCP-099	4930559.025	452048.951	547.665
GCP-100	4930621.584	474512.967	544.419
GCP-101	4921093.003	501327.582	523.535
GCP-102	4942442.779	470805.837	508.159
GCP-103	4943429.154	377185.247	546.512
GCP-104	4919962.997	376412.074	561.814
GCP-105	4915141.387	375851.861	581.088
GCP-106	4910114.998	391514.044	450.130
GCP-107	4917485.547	397316.090	533.627
GCP-108	4919551.278	424633.441	541.952
GCP-109	4920915.437	448771.904	606.516
GCP-110	4920918.014	474477.293	598.563
GCP-111	4910011.333	501302.880	580.028
GCP-112	4912900.456	473629.467	631.105
GCP-113	4880525.826	473927.299	519.110
GCP-114	4903354.728	446880.599	626.888
GCP-115	4880640.786	451369.134	544.271
GCP-116	4881059.282	429304.180	545.260
GCP-117	4888421.137	425379.241	438.392
GCP-118	4898771.350	425630.005	455.055
GCP-119	4889479.880	398718.338	578.704
GCP-120	4890152.242	374755.141	615.646
GCP-121	4902524.478	375626.234	469.859
GCP-122	4909643.372	330304.509	623.636
GCP-123	4967903.875	358554.942	605.431
GCP-124	4909907.947	424539.917	507.291
GCP-125	4906860.716	474870.240	542.683
GCP-126	4900013.775	474412.326	574.286
GCP-127	5080401.691	399371.189	519.815
GCP-128	5068589.316	431391.359	552.508
GCP-129	4989611.133	438827.693	596.816
GCP-130	4972275.277	406528.827	575.682
GCP-130R	4972265.045	406526.166	574.833
GCP-131	4908142.673	386796.345	452.440
GCP-132	4907400.500	414840.457	445.013
GCP-133	4894155.068	407558.687	544.270

GCP-134	4901881.612	367773.452	486.185
GCP-135	4898416.608	346548.185	620.309
GCP-136	4938018.747	352536.408	575.741
GCP-137	4918986.906	379315.605	553.247
GCP-138	4894229.868	464704.077	523.713
GCP-139	4891381.924	442820.707	437.473
GCP-140	4920912.112	404169.051	530.538
GCP-141	4931852.923	364349.480	539.501
GCP-142	4941856.557	377293.977	547.340
GCP-143	4964633.353	426422.602	557.511

SOUTH DAKOTA - LiDAR POINTS (GCP Re-collection)			
POINT #	NORTHING (m)	EASTING (m)	ELEV. (m)
GCP POINTS			
GCP-001	5076989.673	417169.201	517.903
GCP-002	5090456.561	385300.308	502.473
GCP-003	5087715.886	446909.055	600.814
GCP-004	5070773.655	445860.415	572.777
GCP-005	5080277.107	445870.163	557.747
GCP-006	5091199.207	414028.814	555.705
GCP-007	5073898.221	413825.714	511.577
GCP-008	5072406.008	384995.969	614.041
GCP-009	5079059.806	386693.876	608.655
GCP-010	5064190.871	416853.436	525.325
GCP-011	5064513.813	384288.421	566.824
GCP-012	5054925.805	381108.382	498.013
GCP-013	5055710.891	416703.790	520.101
GCP-014	5058689.196	443685.126	542.860
GCP-015	5046363.334	382598.409	543.356
GCP-016	5049473.802	418205.764	521.793
GCP-017	5038980.497	418907.680	569.252
GCP-018	5037452.689	443153.146	616.102
GCP-019	5037635.269	382957.179	549.188
GCP-020	5026396.745	386812.335	494.898
GCP-021	5020876.247	380596.476	501.434
GCP-022	5029675.258	418762.368	600.817
GCP-023	5033092.443	446892.416	604.666

GCP-024	5020588.592	412176.571	544.768
GCP-025	5020365.144	444711.057	581.522
GCP-026	5019971.980	458959.281	559.117
GCP-027	5013604.864	457260.954	583.960
GCP-030	5003315.856	400557.436	499.731
GCP-031	5005816.770	426263.377	595.725
GCP-032	5005529.067	458191.291	577.583
GCP-033	4993622.703	403577.699	554.326
GCP-034	4986600.552	397857.037	498.747
GCP-036	4974018.114	398395.706	546.934
GCP-037	4970165.361	325910.334	603.997
GCP-038	4974710.660	341546.355	538.379
GCP-039	4974164.356	425880.579	601.112
GCP-041	4988470.502	424316.027	668.736
GCP-042	4997764.043	426144.498	597.934
GCP-043	4995864.421	453062.598	589.026
GCP-044	4989439.791	453291.745	598.575
GCP-045	4982949.248	459591.895	582.585
GCP-046	4974828.845	456841.125	604.210
GCP-047	4971526.633	475369.740	598.446
GCP-048	4964916.018	497109.245	461.111
GCP-049	4971559.870	526663.852	399.718
GCP-050	4960500.772	525730.254	402.908
GCP-051	4953632.674	523299.142	413.941
GCP-052	4971529.425	500446.323	451.257
GCP-053	4957783.887	425676.105	564.882
GCP-054	4959759.099	395186.619	557.569
GCP-055	4951141.477	324554.534	505.768
GCP-056	4952478.948	355483.253	608.819
GCP-057	4951262.842	395946.086	560.574
GCP-058	4952680.058	492908.134	478.620
GCP-059	4940731.095	524856.275	420.474
GCP-060	4940721.951	500867.376	455.242
GCP-061	4941651.030	401304.495	538.857
GCP-062	4942680.061	356887.430	621.248
GCP-063	4941910.749	330610.100	624.069
GCP-064	4928443.763	330239.692	688.079
GCP-065	4928874.314	392624.453	519.954
GCP-066	4930755.789	500608.031	476.587

GCP-067	4932719.613	523358.957	429.209
GCP-069	4911466.934	523792.666	447.428
GCP-070	4911211.157	458514.587	631.650
GCP-072	4908401.551	348665.439	601.484
GCP-073	4919235.989	329954.646	635.517
GCP-074	4901649.559	330124.887	631.317
GCP-075	4888181.258	329386.948	630.901
GCP-077	4899190.347	393328.829	556.219
GCP-077A	4899190.199	393329.006	556.213
GCP-077B	4899173.391	393329.114	555.566
GCP-078	4890801.901	355744.506	511.104
GCP-079	4901807.727	496454.848	552.236
GCP-080	4891915.317	496679.573	522.024
GCP-081	4891944.575	515711.818	575.467
GCP-082	4900216.737	524965.980	481.523
GCP-083	5062003.264	445755.122	570.304
GCP-084	5047493.526	446841.477	548.909
GCP-085	4977983.011	378018.611	530.509
GCP-087	4951501.546	375633.014	540.695
GCP-088	4966798.772	443820.539	575.236
GCP-089	4950884.521	476784.749	503.799
GCP-090	4965534.734	473754.529	564.514
GCP-091	4950919.962	426685.540	550.670
GCP-092	4954585.001	452957.529	551.990
GCP-093	4958274.493	370054.373	498.206
GCP-094	4915292.175	353801.715	573.520
GCP-095	4931693.903	384593.577	493.373
GCP-096	4930793.804	427875.311	505.207
GCP-097	4941213.807	431609.643	527.913
GCP-098	4942437.066	451240.601	532.411
GCP-099	4930576.539	451616.017	543.169
GCP-100	4930635.054	475608.064	538.520
GCP-101	4921072.453	501342.146	523.328
GCP-102	4943351.513	470404.843	507.394
GCP-106	4911811.673	390597.798	440.179
GCP-108	4922816.299	422550.259	496.877
GCP-109	4919368.225	442616.865	591.606
GCP-110	4920891.312	472851.407	590.530
GCP-111	4909858.020	501288.954	578.176

GCP-112	4912028.760	471211.831	600.795
GCP-113	4880552.356	469448.282	445.004
GCP-114	4903973.822	449398.585	604.716
GCP-115	4880672.059	451384.552	545.120
GCP-116	4880302.320	430648.033	529.421
GCP-117	4888354.193	425416.561	438.071
GCP-118	4897405.497	425714.361	448.249
GCP-119	4889624.593	392099.982	611.471
GCP-120	4890195.575	373371.777	596.833
GCP-121	4903175.595	377421.684	468.664
GCP-122	4911100.937	330382.532	621.284
GCP-123	4968717.300	358219.521	603.135
GCP-124	4904317.684	425733.853	447.431
GCP-126	4899999.573	476091.562	567.013
GCP-127	4989032.280	382880.904	496.917
GCP-128	5013812.027	394087.069	562.303
GCP-129	4951094.181	414391.691	568.921
GCP-130	4957265.847	349185.942	498.496
GCP-131	4908142.673	386796.345	452.440
GCP-132	4907400.500	414840.457	445.013
GCP-133	4894155.068	407558.687	544.270
GCP-134	4901881.612	367773.452	486.185
GCP-135	4898416.608	346548.185	620.309
GCP-136	4938018.747	352536.408	575.741
GCP-137	4918986.906	379315.605	553.247
GCP-138	4894229.868	464704.077	523.713
GCP-139	4891381.924	442820.707	437.473
GCP-140	4920912.112	404169.051	530.538
GCP-141	4931852.923	364349.480	539.501
GCP-142	4941856.557	377293.977	547.340
GCP-143	4964633.353	426422.602	557.511

4. GPS OBSERVATIONS – Initial GCP Collection

POINT ID	OBSERV. DATE	JULIAN DATE	TIME OF DAY (AST)	RE-OBSERV. DATE	RE-OBSERV. TIME
GCP-001	5/23/2016	144	11:07	N/A	N/A
GCP-002	5/23/2016	144	15:52	5/24/2016	12:09
GCP-003	5/23/2016	144	19:31	5/24/2016	11:10
GCP-004	5/24/2016	145	16:45	5/25/2016	14:30
GCP-005	5/24/2016	145	16:15	5/25/2016	14:01
GCP-006	5/23/2016	144	14:14	5/24/2016	11:56
GCP-007	5/23/2016	144	10:35	5/24/2016	15:11
GCP-008	5/22/2016	143	10:34	N/A	N/A
GCP-009	5/22/2016	143	11:00	N/A	N/A
GCP-010	5/23/2016	144	8:46	5/24/2016	8:31
GCP-011	5/22/2016	143	10:06	N/A	N/A
GCP-012	5/21/2016	142	13:22	N/A	N/A
GCP-013	5/24/2016	145	17:52	N/A	N/A
GCP-014	5/24/2016	145	12:00	5/25/2016	15:41
GCP-015	5/21/2016	142	11:50	N/A	N/A
GCP-016	5/24/2016	145	7:45	N/A	N/A
GCP-017	5/21/2016	142	9:40	5/24/2016	5:16
GCP-018	5/21/2016	142	11:20	N/A	N/A
GCP-019	5/21/2016	142	12:29	N/A	N/A
GCP-020	5/20/2016	141	17:20	N/A	N/A
GCP-021	5/20/2016	141	16:21	N/A	N/A
GCP-022	5/19/2016	140	7:50	5/20/2016	17:46
GCP-023	5/20/2016	141	10:41	N/A	N/A
GCP-024	5/19/2016	140	10:40	5/20/2016	15:16
GCP-025	5/20/2016	141	13:05	5/23/2016	11:41
GCP-026	5/20/2016	141	11:36	N/A	N/A
GCP-027	5/20/2016	141	12:25	5/23/2016	11:01
GCP-028	5/20/2016	141	15:55	N/A	N/A
GCP-029	5/20/2016	141	15:01	N/A	N/A
GCP-030	5/19/2016	140	13:30	N/A	N/A
GCP-031	5/23/2016	144	9:24	N/A	N/A
GCP-032	5/22/2016	143	15:22	5/25/2016	8:20
GCP-033	5/19/2016	140	15:16	N/A	N/A
GCP-034	5/20/2016	141	13:45	N/A	N/A
GCP-035	5/21/2016	142	15:35	N/A	N/A
GCP-036	5/23/2016	144	14:35	N/A	N/A

GCP-037	5/19/2016	140	16:05	N/A	N/A
GCP-038	5/19/2016	140	15:29	N/A	N/A
GCP-039	5/21/2016	141	12:53	5/23/2016	8:46
GCP-040	5/22/2016	143	12:30	N/A	N/A
GCP-041	5/22/2016	143	18:45	5/25/2016	6:18
GCP-042	5/23/2016	144	8:47	N/A	N/A
GCP-043	5/22/2016	143	14:50	N/A	N/A
GCP-044	5/21/2016	142	9:26	5/23/2016	9:36
GCP-045	5/21/2016	142	9:57	5/23/2016	9:21
GCP-046	5/21/2016	142	10:35	5/22/2016	17:10
GCP-047	5/20/2016	141	11:07	N/A	N/A
GCP-048	5/19/2016	140	15:50	N/A	N/A
GCP-049	5/19/2016	140	13:47	5/22/2016	11:56
GCP-050	5/19/2016	140	14:09	N/A	N/A
GCP-051	5/19/2016	140	14:40	N/A	N/A
GCP-052	5/19/2016	140	16:46	5/22/2016	13:08
GCP-053	5/24/2016	145	13:24	N/A	N/A
GCP-054	5/19/2016	140	9:31	5/20/2016	10:16
GCP-055	5/19/2016	140	16:45	N/A	N/A
GCP-056	5/20/2016	141	9:23	N/A	N/A
GCP-057	5/19/2016	140	8:52	5/23/2016	5:31
GCP-058	5/19/2016	140	18:01	N/A	N/A
GCP-059	5/19/2016	140	11:16	N/A	N/A
GCP-060	5/19/2016	140	19:05	N/A	N/A
GCP-061	5/18/2016	139	13:03	N/A	N/A
GCP-062	5/16/2016	137	15:32	N/A	N/A
GCP-063	5/16/2016	137	17:08	N/A	N/A
GCP-064	5/17/2016	138	12:03	5/19/2016	13:50
GCP-065	5/18/2016	139	15:08	N/A	N/A
GCP-066	5/16/2016	137	9:29	5/19/2016	9:24
GCP-067	5/19/2016	140	10:53	5/22/2016	10:19
GCP-068	5/16/2016	137	10:12	5/19/2016	5:18
GCP-069	5/16/2016	137	8:23	5/19/2016	6:06
GCP-070	5/31/2016	152	17:04	N/A	N/A
GCP-071	5/17/2016	138	8:08	N/A	N/A
GCP-072	5/17/2016	138	16:28	5/19/2016	12:53
GCP-073	5/17/2016	138	11:38	N/A	N/A
GCP-074	5/17/2016	138	14:37	N/A	N/A
GCP-075	5/17/2016	138	13:14	N/A	N/A

GCP-076	5/17/2016	138	17:40	N/A	N/A
GCP-077	5/18/2016	139	11:57	5/19/2016	18:13
GCP-078	5/17/2016	138	18:25	5/19/2016	11:38
GCP-079	5/16/2016	137	13:52	N/A	N/A
GCP-080	5/16/2016	137	12:56	N/A	N/A
GCP-081	5/16/2016	137	7:48	N/A	N/A
GCP-082	5/16/2016	137	7:22	5/19/2016	6:51
GCP-083	5/24/2016	145	12:35	N/A	N/A
GCP-084	5/21/2016	142	12:50	N/A	N/A
GCP-085	5/20/2016	141	12:58	N/A	N/A
GCP-086	5/24/2016	145	8:30	N/A	N/A
GCP-087	5/18/2016	139	11:13	N/A	N/A
GCP-088	5/20/2016	141	16:12	N/A	N/A
GCP-089	5/20/2016	141	12:19	N/A	N/A
GCP-090	5/20/2016	141	11:32	N/A	N/A
GCP-091	5/24/2016	145	11:47	N/A	N/A
GCP-092	5/20/2016	141	17:12	N/A	N/A
GCP-093	5/19/2016	140	13:09	N/A	N/A
GCP-094	5/16/2016	137	17:53	N/A	N/A
GCP-095	5/16/2016	137	13:38	N/A	N/A
GCP-096	5/18/2016	139	12:08	5/19/2016	7:59
GCP-097	5/18/2016	139	14:25	5/19/2016	8:30
GCP-098	5/20/2016	141	17:36	5/22/2016	5:55
GCP-099	5/17/2016	138	16:58	N/A	N/A
GCP-100	5/17/2016	138	8:23	N/A	N/A
GCP-101	5/16/2016	137	15:03	N/A	N/A
GCP-102	5/20/2016	141	13:05	5/22/2016	6:56
GCP-103	5/18/2016	139	11:50	N/A	N/A
GCP-104	5/16/2016	137	9:42	N/A	N/A
GCP-105	5/17/2016	138	7:10	N/A	N/A
GCP-106	5/18/2016	139	8:33	N/A	N/A
GCP-107	5/24/2016	145	10:54	N/A	N/A
GCP-108	5/18/2016	139	10:53	N/A	N/A
GCP-109	5/31/2016	152	16:09	N/A	N/A
GCP-110	5/16/2016	137	19:35	5/19/2016	9:51
GCP-111	5/16/2016	137	14:16	5/19/2016	10:15
GCP-112	5/16/2016	137	19:58	5/19/2016	10:41
GCP-113	5/17/2016	138	11:45	N/A	N/A
GCP-114	5/17/2016	138	12:38	5/19/2016	11:49

GCP-115	5/17/2016	138	18:33	N/A	N/A
GCP-116	5/17/2016	138	19:01	N/A	N/A
GCP-117	5/17/2016	138	19:21	5/19/2016	17:41
GCP-118	5/18/2016	139	16:11	N/A	N/A
GCP-119	5/18/2016	139	14:42	5/19/2016	16:59
GCP-120	5/18/2016	139	13:29	5/19/2016	10:18
GCP-121	5/18/2016	139	9:39	5/19/2016	10:46
GCP-122	5/17/2016	138	12:43	N/A	N/A
GCP-123	5/19/2016	140	14:39	N/A	N/A
GCP-124	5/18/2016	139	10:07	N/A	N/A
GCP-125	5/16/2016	137	17:29	5/19/2016	10:56
GCP-126	5/16/2016	137	16:53	5/19/2016	11:10
GCP-127	5/22/2016	143	17:25	N/A	N/A
GCP-128	5/24/2016	145	14:08	5/25/2016	13:10
GCP-129	5/22/2016	143	13:37	5/25/2016	9:16
GCP-130	5/21/2016	142	14:24	5/23/2016	7:03
GCP-131	7/21/2016	202	8:03	7/21/2016	8:08
GCP-132	7/21/2016	202	10:05	7/21/2016	10:13
GCP-133	7/21/2016	202	17:51	7/21/2016	17:59
GCP-134	7/21/2016	202	8:34	7/21/2016	8:41
GCP-135	7/21/2016	202	9:35	N/A	N/A
GCP-136	7/24/2016	205	8:30	N/A	N/A
GCP-137	7/21/2016	202	13:04	7/21/2016	13:10
GCP-138	7/23/2016	204	11:50	7/23/2016	11:58
GCP-139	7/24/2016	205	9:18	7/24/2016	9:26
GCP-140	7/22/2016	203	7:15	7/22/2016	7:23
GCP-141	7/24/2016	205	8:06	7/24/2016	8:11
GCP-142	7/24/2016	205	16:00	7/24/2016	16:08
GCP-143	7/25/2016	206	11:45	7/25/2016	11:52

5. *POINT COMPARISON – Initial GCP Collection*

POINT ID	POINT CK	DELTA NORTH (m)	DELTA EAST (m)	VERT. DIFF (m)
GCP-002	GCP-002CK	0.001	-0.010	-0.007
GCP-003	GCP-003CK	-0.005	-0.006	-0.015
GCP-004	GCP-004CK	-0.003	0.001	-0.005
GCP-005	GCP-005CK	0.016	-0.006	-0.020
GCP-006	GCP-006CK	0.003	-0.002	-0.001
GCP-007	GCP-007CK	0.003	0.000	-0.003
GCP-010	GCP-010CK	-0.003	0.003	0.013
GCP-014	GCP-014CK	-0.002	-0.002	-0.001
GCP-017	GCP-017CK	-0.001	0.006	0.000
GCP-022	GCP-022CK	0.010	-0.002	-0.002
GCP-024	GCP-024CK	-0.003	-0.005	-0.011
GCP-025	GCP-025CK	-0.001	-0.001	-0.005
GCP-027	GCP-027CK	0.002	0.000	-0.009
GCP-032	GCP-032CK	0.001	0.002	0.005
GCP-039	GCP-039CK	0.003	0.002	-0.002
GCP-041	GCP-041CK	-0.008	0.000	0.001
GCP-044	GCP-044CK	0.006	-0.001	0.007
GCP-045	GCP-045CK	0.003	-0.001	0.011
GCP-046	GCP-046CK	-0.002	0.001	-0.002
GCP-049	GCP-049CK	0.010	0.006	-0.013
GCP-052	GCP-052CK	-0.003	0.002	0.005
GCP-054	GCP-054CK	0.000	-0.004	0.006
GCP-057	GCP-057CK	0.006	0.005	-0.006
GCP-064	GCP-064CK	-0.005	-0.005	-0.003
GCP-066	GCP-066CK	0.007	0.005	0.000
GCP-067	GCP-067CK	0.002	-0.003	-0.007
GCP-068	GCP-068CK	0.004	-0.001	0.008
GCP-069	GCP-069CK	0.000	0.000	-0.004
GCP-072	GCP-072CK	0.003	-0.003	0.004
GCP-077	GCP-077CK	-0.001	-0.001	-0.007
GCP-078	GCP-078CK	0.006	0.007	0.007
GCP-082	GCP-082CK	0.011	0.006	0.005
GCP-096	GCP-096CK	-0.001	0.011	0.035
GCP-097	GCP-097CK	-0.004	0.003	-0.010
GCP-098	GCP-098CK	-0.003	0.001	0.002
GCP-102	GCP-102CK	0.001	0.000	-0.006

GCP-110	GCP-110CK	0.004	-0.001	0.000
GCP-111	GCP-111CK	0.011	-0.001	0.001
GCP-112	GCP-112CK	0.002	0.003	0.002
GCP-114	GCP-114CK	-0.007	0.005	0.007
GCP-117	GCP-117CK	0.005	-0.003	0.000
GCP-119	GCP-119CK	0.000	-0.001	-0.003
GCP-120	GCP-120CK	0.000	0.000	0.001
GCP-121	GCP-121CK	-0.003	0.001	0.015
GCP-125	GCP-125CK	-0.001	0.003	0.009
GCP-126	GCP-126CK	-0.002	0.002	-0.007
GCP-128	GCP-128CK	-0.003	0.008	0.003
GCP-129	GCP-129CK	-0.006	-0.005	0.002
GCP-130	GCP-130CK	-0.002	0.002	0.003

LiDAR QA - Re-collection				
POINT ID	POINT CK	DELTA NORTH (m)	DELTA EAST (m)	VERT. DIFF (m)
GCP-001	GCP-001CK	-0.001	0.005	-0.004
GCP-005	GCP-005CK	0.002	0.000	-0.010
GCP-007	GCP-007CK	0.021	-0.009	-0.008
GCP-008	GCP-008CK	0.002	-0.004	-0.002
GCP-009	GCP-009CK	0.003	0.002	0.007
GCP-010	GCP-010CK	0.001	0.009	0.010
GCP-011	GCP-011CK	0.001	-0.007	0.014
GCP-013	GCP-013CK	0.000	0.000	-0.003
GCP-014	GCP-014CK	-0.001	-0.005	0.004
GCP-015	GCP-015CK	0.002	0.002	-0.004
GCP-019	GCP-019CK	0.006	0.002	0.007
GCP-020	GCP-020CK	0.006	0.001	-0.006
GCP-021	GCP-021CK	-0.003	0.006	0.006
GCP-022	GCP-022CK	0.002	-0.002	0.003
GCP-023	GCP-023CK	0.000	-0.001	0.001
GCP-024	GCP-024CK	0.011	0.017	0.012
GCP-025	GCP-025CK	0.000	-0.003	-0.013
GCP-026	GCP-026CK	0.000	0.000	0.000
GCP-027	GCP-027CK	-0.001	0.001	0.000
GCP-030	GCP-030CK	-0.003	0.002	-0.001
GCP-031	GCP-031CK	0.009	0.001	0.008
GCP-032	GCP-032CK	0.002	0.000	-0.006

GCP-033	GCP-033CK	-0.009	-0.004	0.015
GCP-034	GCP-034CK	-0.010	0.006	-0.005
GCP-036	GCP-036CK	-0.001	-0.003	-0.013
GCP-037	GCP-037CK	0.011	0.000	-0.009
GCP-039	GCP-039CK	0.001	0.007	-0.001
GCP-042	GCP-042CK	-0.003	0.002	0.011
GCP-043	GCP-043CK	0.002	-0.001	-0.009
GCP-044	GCP-044CK	0.011	-0.003	-0.002
GCP-045	GCP-045CK	0.008	0.012	-0.008
GCP-046	GCP-046CK	-0.003	-0.001	-0.004
GCP-047	GCP-047CK	0.011	-0.005	-0.017
GCP-048	GCP-048CK	-0.005	0.002	0.000
GCP-049	GCP-049CK	-0.006	0.000	0.023
GCP-050	GCP-050CK	-0.003	0.003	-0.010
GCP-052	GCP-052CK	-0.001	0.001	-0.008
GCP-053	GCP-053CK	0.001	-0.004	0.007
GCP-054	GCP-054CK	0.009	-0.009	0.008
GCP-055	GCP-055CK	0.006	0.009	-0.004
GCP-056	GCP-056CK	0.004	0.005	-0.013
GCP-057	GCP-057CK	-0.003	-0.005	-0.011
GCP-059	GCP-059CK	0.007	-0.001	-0.111
GCP-060	GCP-060CK	0.001	0.000	-0.007
GCP-062	GCP-062CK	0.006	0.005	-0.012
GCP-064	GCP-064CK	-0.021	-0.004	-0.003
GCP-065	GCP-065CK	0.010	-0.006	-0.018
GCP-066	GCP-066CK	-0.003	0.004	-0.007
GCP-067	GCP-067CK	0.001	-0.003	-0.006
GCP-070	GCP-070CK	-0.002	0.004	-0.010
GCP-072	GCP-072CK	-0.033	0.016	0.019
GCP-074	GCP-074CK	-0.019	0.007	0.052
GCP-075	GCP-075CK	-0.005	0.002	-0.041
GCP-077B	GCP-077BCK	-0.001	0.003	-0.004
GCP-078	GCP-078CK	-0.006	0.002	0.005
GCP-079	GCP-079CK	-0.005	0.000	-0.004
GCP-080	GCP-080CK	0.009	-0.003	0.006
GCP-082	GCP-082CK	-0.004	0.000	-0.001
GCP-083	GCP-083CK	-0.006	-0.002	0.013
GCP-084	GCP-084CK	-0.003	0.004	0.010
GCP-085	GCP-085CK	-0.012	0.007	-0.025

GCP-087	GCP-087CK	0.001	0.000	-0.014
GCP-088	GCP-088CK	-0.008	0.004	0.002
GCP-089	GCP-089CK	0.007	0.003	-0.015
GCP-090	GCP-090CK	0.001	0.004	-0.003
GCP-091	GCP-091CK	-0.002	-0.001	-0.002
GCP-092	GCP-092CK	-0.006	0.002	0.015
GCP-094	GCP-094CK	-0.001	0.002	-0.006
GCP-095	GCP-095CK	0.003	-0.002	-0.004
GCP-096	GCP-096CK	0.001	0.008	-0.008
GCP-097	GCP-097CK	0.000	0.003	-0.003
GCP-098	GCP-098CK	0.005	0.003	0.002
GCP-099	GCP-099CK	0.001	0.001	0.006
GCP-100	GCP-100CK	0.002	0.005	-0.007
GCP-101	GCP-101CK	0.002	0.002	0.000
GCP-102	GCP-102CK	-0.003	0.000	0.002
GCP-106	GCP-106CK	0.002	-0.009	-0.014
GCP-108	GCP-108CK	-0.006	-0.003	0.014
GCP-109	GCP-109CK	-0.008	-0.003	0.009
GCP-110	GCP-110CK	-0.009	-0.021	0.069
GCP-111	GCP-111CK	-0.011	0.000	0.002
GCP-112	GCP-112CK	0.000	-0.001	0.023
GCP-113	GCP-113CK	0.002	0.000	-0.011
GCP-114	GCP-114CK	0.001	0.002	0.007
GCP-116	GCP-116CK	0.001	-0.001	-0.007
GCP-118	GCP-118CK	-0.009	0.015	-0.010
GCP-119	GCP-119CK	0.015	0.001	0.016
GCP-120	GCP-120CK	-0.015	0.004	-0.008
GCP-122	GCP-122CK	0.000	0.017	0.039
GCP-126	GCP-126CK	-0.011	-0.012	-0.001
GCP-128	GCP-128CK	0.001	0.009	0.016
GCP-130	GCP-130CK	0.005	0.008	0.006
GCP-131	GCP-131CK	0.001	-0.006	0.000
GCP-132	GCP-132CK	0.000	0.002	0.001
GCP-133	GCP-133CK	0.000	0.000	-0.017
GCP-134	GCP-134CK	0.000	-0.001	-0.016
GCP-137	GCP-137CK	0.004	0.001	-0.010
GCP-138	GCP-138CK	0.000	-0.008	0.018
GCP-139	GCP-139CK	0.004	-0.001	-0.006
GCP-140	GCP-140CK	0.003	0.001	-0.007

GCP-141	GCP-141CK	0.004	0.001	-0.007
GCP-142	GCP-142CK	-0.001	0.001	0.015
GCP-143	GCP-143CK	0.009	-0.009	0.017