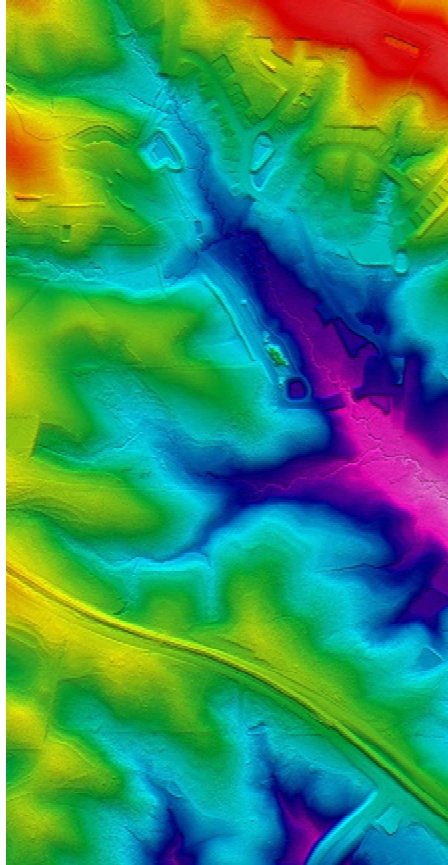
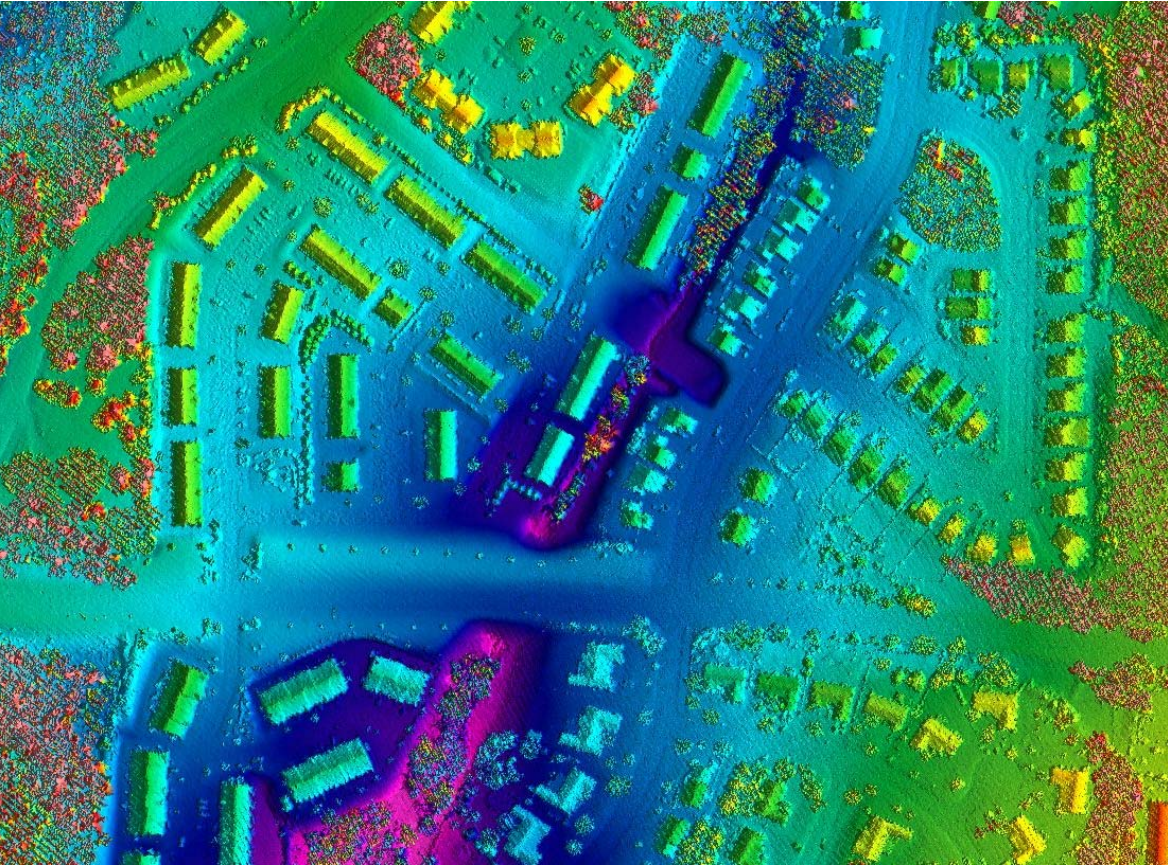


# South Dakota Ground Control Surveys

Survey Report  
01.15.2017



Submitted By:



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Submitted To:



**Harris Corporation**  
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## Acronyms & Abbreviations

CORS	Continuously Operating Reference Stations
ESP	ESP Associates, P.A.
GCP	Ground Control Point
GNSS	Global Navigation Satellite System
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NGS	National Geodetic Survey
NVA	Non-vegetated Vertical Accuracy
OPUS-RS	Online Positioning Users Service – Rapid Static
PLS	Professional Land Surveyor
RTX	Trimble Real-Time eXtended
SFT	US Survey Feet
UTM	Universal Transverse Mercator

## 1.0 – PLS Certification

The following page contains the project narrative certified by the PLS irresponsible charge of this project.

## LIDAR GCP & NVA CHECKPOINT SURVEYS

For

Harris Corporation

### *Introduction*

ESP Associates, P.A. (ESP) was tasked by Harris Corporation to validate the positions provided by others for 43 Light Detection and Ranging (LiDAR) ground control points (GCPs) and to survey 55 new non-vegetated area (NVA) checkpoints throughout east central South Dakota. Of the 43 points to validate, five could not be recovered and a new replacement point was surveyed nearby. ESP partnered with Snyder & Associates, Inc. (Snyder) to complete this work. A map book that illustrates the vicinity of the LiDAR checkpoints throughout the designated area of interest is included in this report. The points were surveyed from November 10 - 20, 2016.

### *Survey Procedures*

Static Global Navigation Satellite System (GNSS) procedures were used for this project and National Geodetic Survey (NGS) Continuously Operating Reference Stations were used as primary control. One hour static sessions were performed at each point and the NGS Online Positioning User Service – Rapid Static (OPUS-RS) was used to post-process the data. For a second solution ESP used Trimble CenterPoint Real-Time eXtended (RTX) post-processing service. RTX uses a different source for orbit data and a different engine providing the solution which makes it independent of OPUS-RS. A datasheet for each calibration point is included in this report which contains positional information along with accompanying photographs.

### *GNSS Horizontal Survey Control*

The GNSS derived horizontal coordinates referred to in this report are based on the Universal Transverse Mercator Coordinate System (Zone 14N). The project horizontal datum is NAD83 (2011) Epoch 2010.00. All coordinates are provided in Meters unless otherwise specified.

### *GNSS Derived Orthometric Heights*

Project elevations are based on the NAVD 88 vertical datum and were calculated using the GNSS derived ellipsoid heights from the static solutions and applying geoid heights that were interpolated from the GEOID12B model. All elevations are provided in Meters unless otherwise specified.

***Verification of GNSS Derived Horizontal & Vertical Positions***

In order to verify the GNSS derived ellipsoid heights and interpolated geoid model heights against the local NAVD 88 datum as well as the GNSS derived horizontal positions against the NAD83 (2011) Epoch 2010.00 datum, ESP checked into two NGS horizontal/vertical bench marks in the project area. The following table shows the results of the benchmark checks:

Bench Mark Name	PID	Vertical Order	Published (ft.)			ESP Measured (ft.)			Delta (ESP Minus Published)	
			Northing	Easting	Elevation	Northing	Easting	Elevation	Hor.	Ver.
A464	AB9041	First Class II	745324.27	1973158.59	1779.24	745324.32	1973158.54	1779.26	0.07	0.02
A466	AB9089	First Class II	743495.11	1809022.91	2022.57	743495.13	1809022.90	2022.59	0.02	0.02

***Survey Accuracy***

The LiDAR calibration and QC point surveys meet a 5 cm (0.16 feet) or better horizontal and vertical positional accuracy relative to the NGS CORS. In order to test the accuracy of the surveys the OPUS-RS and RTX solutions were averaged to establish final coordinates and elevations. Positional accuracy was tested using National Standards for Spatial Data Accuracy guidance and reported at the 95% confidence level.

Mike Schulte PLS

Registration Number # 9477

2017-01-10

Date



## 2.0 – Ground Control Point Spreadsheets

The following pages contain the final control point information in spreadsheet format. Positional information is provided in Universal Transverse Mercator Coordinates and NAVD 88 Elevations.

**Project: South Dakota Ground Control**

**Job#: EW10.200.000**

**Survey Date: November 10 - 20, 2016**

**Coordinate System: Universal Transverse Mercator**

**Zone: 14N**

**Horizontal Datum: NAD83 (2011) Epoch 2010.00**

**Vertical Datum NAVD88 (GEOID12B)**

**Horizontal Units: Meters**

**Vertical Units: Meters**

Point	Northing	Easting	Elevation	Description
Name	Y	X	Z	Code
	Meters	Meters	Meters	
ESP_NVA_01	4895948.413	331627.072	641.358	NVA Checkpoint
ESP_NVA_02	4895848.423	401310.886	551.985	NVA Checkpoint
ESP_NVA_03	4897245.901	344583.001	624.786	NVA Checkpoint
ESP_NVA_04	4897546.247	362925.358	494.493	NVA Checkpoint
ESP_NVA_05	4897375.351	385247.541	578.448	NVA Checkpoint
ESP_NVA_06	4898162.275	363813.987	494.676	NVA Checkpoint
ESP_NVA_07	4898929.732	411832.623	543.972	NVA Checkpoint
ESP_NVA_08	4900665.092	334970.864	620.973	NVA Checkpoint
ESP_NVA_09	4902336.996	370280.647	483.944	NVA Checkpoint
ESP_NVA_10	4908228.004	382665.412	537.946	NVA Checkpoint
ESP_NVA_11	4909478.503	406803.288	441.796	NVA Checkpoint
ESP_NVA_12	4908896.576	415337.610	438.626	NVA Checkpoint
ESP_NVA_13	4913708.942	338680.891	614.987	NVA Checkpoint
ESP_NVA_14	4915187.245	356771.908	597.696	NVA Checkpoint
ESP_NVA_15	4915164.638	365180.21	585.440	NVA Checkpoint
ESP_NVA_16	4915827.742	383239.135	535.492	NVA Checkpoint
ESP_NVA_17	4916918.782	334744.361	620.958	NVA Checkpoint
ESP_NVA_18	4917617.751	352435.986	600.043	NVA Checkpoint
ESP_NVA_19	4918210.216	406907.099	527.787	NVA Checkpoint
ESP_NVA_20	4920690.578	392532.367	525.964	NVA Checkpoint
ESP_NVA_21	4921283.478	416587.357	551.342	NVA Checkpoint
ESP_NVA_22	4923454.68	330097.392	650.728	NVA Checkpoint
ESP_NVA_23	4922200.355	383604.361	553.198	NVA Checkpoint
ESP_NVA_24	4924875.256	363588.05	590.484	NVA Checkpoint
ESP_NVA_25	4924270.96	371989.384	594.956	NVA Checkpoint
ESP_NVA_26	4926463.418	338230.091	642.529	NVA Checkpoint
ESP_NVA_27	4929273.592	356474.339	653.374	NVA Checkpoint
ESP_NVA_28	4928893.976	384933.071	526.961	NVA Checkpoint
ESP_NVA_29	4928276.121	415143.229	545.654	NVA Checkpoint
ESP_NVA_30	4930148.129	408643.228	558.852	NVA Checkpoint
ESP_NVA_31	4932746.273	343996.367	595.227	NVA Checkpoint
ESP_NVA_32	4928199.592	366581.358	622.046	NVA Checkpoint
ESP_NVA_33	4933760.479	382650.355	502.506	NVA Checkpoint
ESP_NVA_34	4933529.184	399112.689	546.751	NVA Checkpoint
ESP_NVA_35	4935690.868	361100.287	655.370	NVA Checkpoint



Point Name	Northing Y Meters	Easting X Meters	Elevation Z Meters	Description Code
ESP_NVA_36	4925835.266	440786.907	571.702	NVA Checkpoint
ESP_NVA_37	4902273.657	437338.535	537.595	NVA Checkpoint
ESP_NVA_38	4886170.79	459244.268	470.960	NVA Checkpoint
ESP_NVA_39	4900398.991	464694.131	568.718	NVA Checkpoint
ESP_NVA_40	4900167.46	515844.901	560.288	NVA Checkpoint
ESP_NVA_41	4917849.175	509223.973	534.245	NVA Checkpoint
ESP_NVA_42	4920313.823	483608.551	621.790	NVA Checkpoint
ESP_NVA_43	4920880.792	464925.657	620.269	NVA Checkpoint
ESP_NVA_44	4889000.132	432246.532	462.194	NVA Checkpoint
ESP_NVA_45	4913069.071	431009.913	516.933	NVA Checkpoint
ESP_NVA_46	4914455.041	451942.053	604.365	NVA Checkpoint
ESP_NVA_47	4901765.268	483581.901	595.190	NVA Checkpoint
ESP_NVA_48	4926852.774	515701.872	454.290	NVA Checkpoint
ESP_NVA_49	4930540.292	464820.398	570.373	NVA Checkpoint
ESP_NVA_50	4881583.293	440305.674	481.109	NVA Checkpoint
ESP_NVA_51	4891948.85	507349.041	590.557	NVA Checkpoint
ESP_NVA_52	4913034.805	493258.362	600.671	NVA Checkpoint
ESP_NVA_53	4892144.729	523201.731	556.727	NVA Checkpoint
ESP_NVA_54	4908873.398	476055.336	559.388	NVA Checkpoint
ESP_NVA_55	4888624.465	472406.875	533.209	NVA Checkpoint
GCP-066	4930755.753	500608.052	476.598	GCP Check
GCP-067	4932719.596	523358.923	429.293	GCP Check
GCP-069	4911466.973	523792.697	447.523	GCP Check
GCP-070	4911211.126	458514.563	631.657	GCP Check
GCP-072	4908401.464	348665.439	601.618	GCP Check
GCP-074	4901649.541	330124.279	631.385	GCP Check
GCP-075	4888181.231	329386.955	630.898	GCP Check
GCP-077A	4899190.217	393329.041	556.225	GCP Check
GCP-077B	4899173.429	393329.102	555.569	GCP Check
GCP-078	4890801.863	355744.484	511.145	GCP Check
GCP-079	4901807.658	496454.916	552.183	GCP Check
GCP-080	4891915.326	496679.58	521.959	GCP Check
GCP-081	4891944.541	515711.842	575.400	GCP Check
GCP-082	4900216.676	524966.022	481.594	GCP Check
GCP-096	4930793.79	427875.303	505.177	GCP Check
GCP-099	4930576.514	451616.026	543.216	GCP Check
GCP-100	4930635.019	475608.092	538.470	GCP Check
GCP-101	4921072.395	501342.155	523.404	GCP Check
GCP-106	4911811.654	390597.779	440.175	GCP Check
GCP-109	4919368.19	442616.87	591.606	GCP Check
GCP-110	4920891.334	472851.398	590.560	GCP Check
GCP-111	4909858.027	501288.939	578.198	New GCP
GCP-112	4912020.452	471211.89	600.722	New GCP
GCP-113	4880543.22	469453.524	446.640	GCP Check
GCP-114	4903973.837	449398.629	604.773	GCP Check
GCP-115	4880672.013	451384.604	545.051	GCP Check
GCP-116	4881029.699	430693.511	539.430	New GCP
GCP-117	4888354.216	425416.532	438.026	GCP Check
GCP-118	4897326.412	425765.964	441.738	New GCP

Point	Northing	Easting	Elevation	Description
Name	Y	X	Z	Code
	Meters	Meters	Meters	
GCP-119	4889624.59	392100.041	611.412	GCP Check
GCP-120	4890195.665	373371.819	596.726	GCP Check
GCP-121	4903175.555	377421.734	468.762	GCP Check
GCP-122	4911100.473	330397.67	621.376	GCP Check
GCP-124	4904317.686	425733.858	447.527	GCP Check
GCP-126	4899999.533	476091.573	567.036	GCP Check
GCP-131	4908142.671	386796.38	452.498	GCP Check
GCP-132	4907400.511	414840.478	445.116	GCP Check
GCP-133	4894155.055	407558.682	544.151	GCP Check
GCP-134	4901881.569	367773.415	486.258	GCP Check
GCP-135	4897183.798	346856.829	644.726	New GCP
GCP-138	4894229.854	464704.114	523.672	GCP Check
GCP-139	4891381.944	442820.663	437.462	GCP Check

### 3.0 – Ground Control Point Datasheets

The following pages contain datasheets for each LiDAR calibration point surveyed. Each datasheet contains positional information along with accompanying photographs.

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 01</b>  NVA Checkpoint
Northing: 134688.89 SFT	Northing: 4895948.413 Meters	
Easting: 1678143.34 SFT	Easting: 331627.072 Meters	
Elevation: 2104.19 FT	Ellipsoid Height: 618.636 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 02</b>  NVA Checkpoint
Northing: 137115.85 SFT	Northing: 4895848.423 Meters	
Easting: 1906802.74 SFT	Easting: 401310.886 Meters	
Elevation: 1810.97 FT	Ellipsoid Height: 527.994 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>ESP NVA 03</u></b>  NVA Checkpoint
Northing: 139455.48 SFT	Northing: 4897245.901 Meters	
Easting: 1720600.81 SFT	Easting: 344583.001 Meters	
Elevation: 2049.82 FT	Ellipsoid Height: 601.719 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 04</b>  NVA Checkpoint
Northing: 141164.7 SFT	Northing: 4897546.247 Meters	
Easting: 1780773.74 SFT	Easting: 362925.358 Meters	
Elevation: 1622.35 FT	Ellipsoid Height: 471.048 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 05</b>  NVA Checkpoint
Northing: 141488.12 SFT	Northing: 4897375.351 Meters	
Easting: 1854028.71 SFT	Easting: 385247.541 Meters	
Elevation: 1897.79 FT	Ellipsoid Height: 554.6 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>ESP NVA 06</u></b>  NVA Checkpoint
Northing: 143221.2 SFT	Northing: 4898162.275 Meters	
Easting: 1783665.24 SFT	Easting: 363813.987 Meters	
Elevation: 1622.95 FT	Ellipsoid Height: 471.231 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 07</b>  NVA Checkpoint
Northing: 147647.08 SFT	Northing: 4898929.732 Meters	
Easting: 1941209.03 SFT	Easting: 411832.623 Meters	
Elevation: 1784.68 FT	Ellipsoid Height: 520.087 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>ESP NVA 08</u></b>  NVA Checkpoint
Northing: 150295.45 SFT	Northing: 4900665.092 Meters	
Easting: 1688928.67 SFT	Easting: 334970.864 Meters	
Elevation: 2037.31 FT	Ellipsoid Height: 598.232 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 09</b>  NVA Checkpoint
Northing: 157175.78 SFT	Northing: 4902336.996 Meters	
Easting: 1804719.14 SFT	Easting: 370280.647 Meters	
Elevation: 1587.74 FT	Ellipsoid Height: 460.493 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>ESP NVA 10</u></b>  NVA Checkpoint
Northing: 176998.13 SFT	Northing: 4908228.004 Meters	
Easting: 1845124.32 SFT	Easting: 382665.412 Meters	
Elevation: 1764.91 FT	Ellipsoid Height: 514.394 Meters	

**Photos:**

Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 11</b>  NVA Checkpoint
Northing: 182063.8 SFT	Northing: 4909478.503 Meters	
Easting: 1924283.31 SFT	Easting: 406803.288 Meters	
Elevation: 1449.46 FT	Ellipsoid Height: 418.08 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 12</b>  NVA Checkpoint
Northing: 180495.24 SFT	Northing: 4908896.576 Meters	
Easting: 1952313.15 SFT	Easting: 415337.61 Meters	
Elevation: 1439.06 FT	Ellipsoid Height: 414.824 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 13</b>  NVA Checkpoint
Northing: 193237.59 SFT	Northing: 4913708.942 Meters	
Easting: 1700586.32 SFT	Easting: 338680.891 Meters	
Elevation: 2017.67 FT	Ellipsoid Height: 592.414 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 14</b>  NVA Checkpoint
Northing: 198804.6 SFT	Northing: 4915187.245 Meters	
Easting: 1759884.42 SFT	Easting: 356771.908 Meters	
Elevation: 1960.94 FT	Ellipsoid Height: 574.875 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 15</b>  NVA Checkpoint
Northing: 199064.29 SFT	Northing: 4915164.638 Meters	
Easting: 1787474.23 SFT	Easting: 365180.21 Meters	
Elevation: 1920.73 FT	Ellipsoid Height: 562.455 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 16</b>  NVA Checkpoint
Northing: 201958.71 SFT	Northing: 4915827.742 Meters	
Easting: 1846704.37 SFT	Easting: 383239.135 Meters	
Elevation: 1756.86 FT	Ellipsoid Height: 512.16 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5

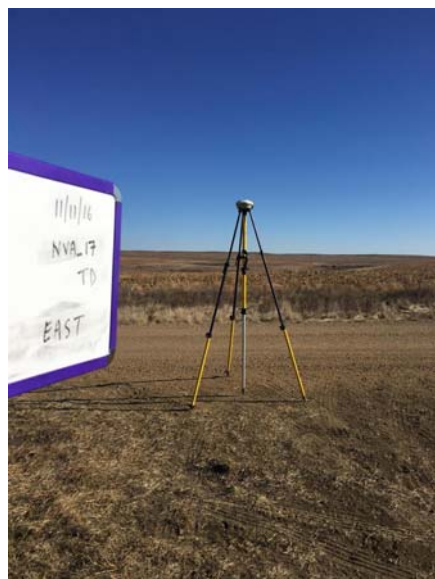


SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 17</b> NVA Checkpoint
Northing: 203612.9 SFT	Northing: 4916918.782 Meters	
Easting: 1687544.14 SFT	Easting: 334744.361 Meters	
Elevation: 2037.26 FT	Ellipsoid Height: 598.543 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/15/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 18</b>  NVA Checkpoint
Northing: 206607.21 SFT	Northing: 4917617.751 Meters	
Easting: 1745561.5 SFT	Easting: 352435.986 Meters	
Elevation: 1968.64 FT	Ellipsoid Height: 577.366 Meters	

**Photos:**



Facing South



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 19</b>  NVA Checkpoint
Northing: 210721.78 SFT	Northing: 4918210.216 Meters	
Easting: 1924274.91 SFT	Easting: 406907.099 Meters	
Elevation: 1731.58 FT	Ellipsoid Height: 504.238 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 20</b>  NVA Checkpoint
Northing: 218286.41 SFT	Northing: 4920690.578 Meters	
Easting: 1877005.17 SFT	Easting: 392532.367 Meters	
Elevation: 1725.6 FT	Ellipsoid Height: 502.683 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 21</b>  NVA Checkpoint
Northing: 221194.61 SFT	Northing: 4921283.478 Meters	
Easting: 1955918.39 SFT	Easting: 416587.357 Meters	
Elevation: 1808.86 FT	Ellipsoid Height: 527.726 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 22</b>  NVA Checkpoint
Northing: 224871.7 SFT	Northing: 4923454.68 Meters	
Easting: 1672039.68 SFT	Easting: 330097.392 Meters	
Elevation: 2134.93 FT	Ellipsoid Height: 628.538 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 23</b>  NVA Checkpoint
Northing: 222884.09 SFT	Northing: 4922200.355 Meters	
Easting: 1847648.67 SFT	Easting: 383604.361 Meters	
Elevation: 1814.95 FT	Ellipsoid Height: 530.045 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 24</b>  NVA Checkpoint
Northing: 230863.05 SFT	Northing: 4924875.256 Meters	
Easting: 1781863.81 SFT	Easting: 363588.05 Meters	
Elevation: 1937.28 FT	Ellipsoid Height: 567.783 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 25</b>  NVA Checkpoint
Northing: 229215.02 SFT	Northing: 4924270.96 Meters	
Easting: 1809454.1 SFT	Easting: 371989.384 Meters	
Elevation: 1951.95 FT	Ellipsoid Height: 572.047 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 26</b>  NVA Checkpoint
Northing: 235065.3 SFT	Northing: 4926463.418 Meters	
Easting: 1698601.84 SFT	Easting: 338230.091 Meters	
Elevation: 2108.03 FT	Ellipsoid Height: 620.272 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 27</b>  NVA Checkpoint
Northing: 245010.95 SFT	Northing: 4929273.592 Meters	
Easting: 1758348 SFT	Easting: 356474.339 Meters	
Elevation: 2143.61 FT	Ellipsoid Height: 630.946 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 28</b>  NVA Checkpoint
Northing: 244901.13 SFT	Northing: 4928893.976 Meters	
Easting: 1851741.23 SFT	Easting: 384933.071 Meters	
Elevation: 1728.87 FT	Ellipsoid Height: 503.945 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 29</b>  NVA Checkpoint
Northing: 244083.63 SFT	Northing: 4928276.121 Meters	
Easting: 1950898.93 SFT	Easting: 415143.229 Meters	
Elevation: 1790.2 FT	Ellipsoid Height: 522.203 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 30</b>  NVA Checkpoint
Northing: 249965.94 SFT	Northing: 4930148.129 Meters	
Easting: 1929493.87 SFT	Easting: 408643.228 Meters	
Elevation: 1833.5 FT	Ellipsoid Height: 535.495 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 31</b>  NVA Checkpoint
Northing: 255907.62 SFT	Northing: 4932746.273 Meters	
Easting: 1717270.2 SFT	Easting: 343996.367 Meters	
Elevation: 1952.84 FT	Ellipsoid Height: 573.031 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 32</b>  NVA Checkpoint
Northing: 241889.93 SFT	Northing: 4928199.592 Meters	
Easting: 1791552.76 SFT	Easting: 366581.358 Meters	
Elevation: 2040.83 FT	Ellipsoid Height: 599.36 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 33</b>  NVA Checkpoint
Northing: 260778.26 SFT	Northing: 4933760.479 Meters	
Easting: 1844056.33 SFT	Easting: 382650.355 Meters	
Elevation: 1648.64 FT	Ellipsoid Height: 479.601 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 34</b>  NVA Checkpoint
Northing: 260678.61 SFT	Northing: 4933529.184 Meters	
Easting: 1898084.21 SFT	Easting: 399112.689 Meters	
Elevation: 1793.8 FT	Ellipsoid Height: 523.58 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 35</b>  NVA Checkpoint
Northing: 266250.76 SFT	Northing: 4935690.868 Meters	
Easting: 1773269.92 SFT	Easting: 361100.287 Meters	
Elevation: 2150.16 FT	Ellipsoid Height: 632.97 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 36</b>  NVA Checkpoint
Northing: 237104.01 SFT	Northing: 4925835.266 Meters	
Easting: 2035150.41 SFT	Easting: 440786.907 Meters	
Elevation: 1875.66 FT	Ellipsoid Height: 548.041 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/20/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 37</b>  NVA Checkpoint
Northing: 159641.51 SFT	Northing: 4902273.657 Meters	
Easting: 2024780.18 SFT	Easting: 437338.535 Meters	
Elevation: 1763.76 FT	Ellipsoid Height: 513.601 Meters	

**Photos:**



Facing North



Facing West



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 38</b>  NVA Checkpoint
Northing: 107672.25 SFT	Northing: 4886170.79 Meters	
Easting: 2097320.31 SFT	Easting: 459244.268 Meters	
Elevation: 1545.14 FT	Ellipsoid Height: 446.42 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/20/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 39</b>  NVA Checkpoint
Northing: 154588.68 SFT	Northing: 4900398.991 Meters	
Easting: 2114634.1 SFT	Easting: 464694.131 Meters	
Elevation: 1865.87 FT	Ellipsoid Height: 544.462 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000

Date of Survey: 11/19/2016

Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 40</b>  NVA Checkpoint
Northing: 155899.05 SFT	Northing: 4900167.46 Meters	
Easting: 2282520.2 SFT	Easting: 515844.901 Meters	
Elevation: 1838.21 FT	Ellipsoid Height: 535.391 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 41</b>  NVA Checkpoint
Northing: 213660.5 SFT	Northing: 4917849.175 Meters	
Easting: 2260072.4 SFT	Easting: 509223.973 Meters	
Elevation: 1752.77 FT	Ellipsoid Height: 509.557 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/20/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 42</b>  NVA Checkpoint
Northing: 220711.22 SFT	Northing: 4920313.823 Meters	
Easting: 2175905.58 SFT	Easting: 483608.551 Meters	
Elevation: 2039.99 FT	Ellipsoid Height: 597.549 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 43</b>  NVA Checkpoint
Northing: 221817.14 SFT	Northing: 4920880.792 Meters	
Easting: 2114568.1 SFT	Easting: 464925.657 Meters	
Elevation: 2035 FT	Ellipsoid Height: 596.254 Meters	

**Photos:**



Facing South



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/20/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 44</b>  NVA Checkpoint
Northing: 115875.43 SFT	Northing: 4889000.132 Meters	
Easting: 2008600.49 SFT	Easting: 432246.532 Meters	
Elevation: 1516.38 FT	Ellipsoid Height: 438.017 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/20/2016  
Acquisition Block: 6



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>ESP NVA 45</u></b>  NVA Checkpoint
Northing: 194815.96 SFT	Northing: 4913069.071 Meters	
Easting: 2003577.93 SFT	Easting: 431009.913 Meters	
Elevation: 1695.97 FT	Ellipsoid Height: 493.058 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/20/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 46</b>  NVA Checkpoint
Northing: 200205.63 SFT	Northing: 4914455.041 Meters	
Easting: 2072217.07 SFT	Easting: 451942.053 Meters	
Elevation: 1982.82 FT	Ellipsoid Height: 580.423 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000

Date of Survey: 11/18/2016

Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 47</b>  NVA Checkpoint
Northing: 159835.09 SFT	Northing: 4901765.268 Meters	
Easting: 2176568.21 SFT	Easting: 483581.901 Meters	
Elevation: 1952.72 FT	Ellipsoid Height: 570.645 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 48</b>  NVA Checkpoint
Northing: 243472.15 SFT	Northing: 4926852.774 Meters	
Easting: 2280966.39 SFT	Easting: 515701.872 Meters	
Elevation: 1490.45 FT	Ellipsoid Height: 429.501 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 49</b>  NVA Checkpoint
Northing: 253513.52 SFT	Northing: 4930540.292 Meters	
Easting: 2113832.78 SFT	Easting: 464820.398 Meters	
Elevation: 1871.3 FT	Ellipsoid Height: 546.52 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 50</b>  NVA Checkpoint
Northing: 91856.07 SFT	Northing: 4881583.293 Meters	
Easting: 2035347.13 SFT	Easting: 440305.674 Meters	
Elevation: 1578.44 FT	Ellipsoid Height: 456.616 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 51</b>  NVA Checkpoint
Northing: 128580.12 SFT	Northing: 4891948.85 Meters	
Easting: 2254970.41 SFT	Easting: 507349.041 Meters	
Elevation: 1937.52 FT	Ellipsoid Height: 565.643 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>ESP NVA 52</u></b>  NVA Checkpoint
Northing: 197212.79 SFT	Northing: 4913034.805 Meters	
Easting: 2207869.91 SFT	Easting: 493258.362 Meters	
Elevation: 1970.7 FT	Ellipsoid Height: 576.195 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>ESP NVA 53</u></b>  NVA Checkpoint
Northing: 129867.6 SFT	Northing: 4892144.729 Meters	
Easting: 2306991.91 SFT	Easting: 523201.731 Meters	
Elevation: 1826.53 FT	Ellipsoid Height: 531.67 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/18/2016  
Acquisition Block: 6



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>ESP NVA 54</u></b>  NVA Checkpoint
Northing: 182859.56 SFT	Northing: 4908873.398 Meters	
Easting: 2151579.1 SFT	Easting: 476055.336 Meters	
Elevation: 1835.26 FT	Ellipsoid Height: 535.047 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/18/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b>ESP NVA 55</b>  NVA Checkpoint
Northing: 116255.37 SFT	Northing: 4888624.465 Meters	
Easting: 2140422.03 SFT	Easting: 472406.875 Meters	
Elevation: 1749.37 FT	Ellipsoid Height: 508.602 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-066</u></b>  GCP Check
Northing: 255668.58 SFT	Northing: 4930755.753 Meters	
Easting: 2231272.56 SFT	Easting: 500608.052 Meters	
Elevation: 1563.64 FT	Ellipsoid Height: 452.132 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/18/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-067</u></b>  GCP Check
Northing: 263037.12 SFT	Northing: 4932719.596 Meters	
Easting: 2305857.06 SFT	Easting: 523358.923 Meters	
Elevation: 1408.44 FT	Ellipsoid Height: 404.498 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-069</u></b>  GCP Check
Northing: 193306.8 SFT	Northing: 4911466.973 Meters	
Easting: 2308144.92 SFT	Easting: 523792.697 Meters	
Elevation: 1468.25 FT	Ellipsoid Height: 422.576 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>GCP-070</u></b>  GCP Check
Northing: 189824.25 SFT	Northing: 4911211.126 Meters	
Easting: 2093917.69 SFT	Easting: 458514.563 Meters	
Elevation: 2072.36 FT	Ellipsoid Height: 607.489 Meters	

**Photos:**

Facing North

Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/15/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-072</u></b>  GCP Check
Northing: 176218.77 SFT	Northing: 4908401.464 Meters	
Easting: 1733555.28 SFT	Easting: 348665.439 Meters	
Elevation: 1973.81 FT	Ellipsoid Height: 578.737 Meters	

**Photos:**



Facing South



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-074</u></b>  GCP Check
Northing: 153334.64 SFT	Northing: 4901649.541 Meters	
Easting: 1672988.77 SFT	Easting: 330124.279 Meters	
Elevation: 2071.47 FT	Ellipsoid Height: 608.819 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/15/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-075</u></b>  GCP Check
Northing: 109117.37 SFT	Northing: 4888181.231 Meters	
Easting: 1671098.18 SFT	Easting: 329386.955 Meters	
Elevation: 2069.87 FT	Ellipsoid Height: 608.368 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-077A</u></b>  GCP Check
Northing: 147764.78 SFT	Northing: 4899190.217 Meters	
Easting: 1880476.41 SFT	Easting: 393329.041 Meters	
Elevation: 1824.88 FT	Ellipsoid Height: 532.343 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-077B</u></b>  GCP Check
Northing: 147709.69 SFT	Northing: 4899173.429 Meters	
Easting: 1880477.28 SFT	Easting: 393329.102 Meters	
Elevation: 1822.73 FT	Ellipsoid Height: 531.687 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>GCP-078</u></b>  GCP Check
Northing: 118751.11 SFT	Northing: 4890801.863 Meters	
Easting: 1757477.43 SFT	Easting: 355744.484 Meters	
Elevation: 1676.98 FT	Ellipsoid Height: 487.662 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-079</u></b>  GCP Check
Northing: 160495.22 SFT	Northing: 4901807.658 Meters	
Easting: 2218815.67 SFT	Easting: 496454.916 Meters	
Elevation: 1811.62 FT	Ellipsoid Height: 527.518 Meters	

**Photos:**



Facing South



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/18/2016  
Acquisition Block: 6



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>GCP-080</u></b>  GCP Check
Northing: 128037.35 SFT	Northing: 4891915.326 Meters	
Easting: 2219953.84 SFT	Easting: 496679.58 Meters	
Elevation: 1712.46 FT	Ellipsoid Height: 497.072 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-081</u></b>  GCP Check
Northing: 128905.78 SFT	Northing: 4891944.541 Meters	
Easting: 2282417.84 SFT	Easting: 515711.842 Meters	
Elevation: 1887.79 FT	Ellipsoid Height: 550.415 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-082</u></b>  GCP Check
Northing: 156431.69 SFT	Northing: 4900216.676 Meters	
Easting: 2312453.64 SFT	Easting: 524966.022 Meters	
Elevation: 1580.03 FT	Ellipsoid Height: 456.573 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-096</u></b>  GCP Check
Northing: 252856.96 SFT	Northing: 4930793.79 Meters	
Easting: 1992579.31 SFT	Easting: 427875.303 Meters	
Elevation: 1657.4 FT	Ellipsoid Height: 481.673 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/16/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-099</u></b>  GCP Check
Northing: 253099.67 SFT	Northing: 4930576.514 Meters	
Easting: 2070497.69 SFT	Easting: 451616.026 Meters	
Elevation: 1782.2 FT	Ellipsoid Height: 519.527 Meters	

**Photos:**



Facing South



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/16/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-100</u></b>  GCP Check
Northing: 254260.23 SFT	Northing: 4930635.019 Meters	
Easting: 2149231.98 SFT	Easting: 475608.092 Meters	
Elevation: 1766.63 FT	Ellipsoid Height: 514.476 Meters	

**Photos:**



Facing South



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-101</u></b>  GCP Check
Northing: 223918.97 SFT	Northing: 4921072.395 Meters	
Easting: 2234074.4 SFT	Easting: 501342.155 Meters	
Elevation: 1717.2 FT	Ellipsoid Height: 498.855 Meters	

**Photos:**



Facing South



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/11/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-106</u></b>  GCP Check
Northing: 189073.51 SFT	Northing: 4911811.654 Meters	
Easting: 1871011.22 SFT	Easting: 390597.779 Meters	
Elevation: 1444.14 FT	Ellipsoid Height: 416.637 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-109</u></b>  GCP Check
Northing: 215954.37 SFT	Northing: 4919368.19 Meters	
Easting: 2041416.04 SFT	Easting: 442616.87 Meters	
Elevation: 1940.96 FT	Ellipsoid Height: 567.825 Meters	

**Photos:**



Facing South



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/16/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-110</u></b>  GCP Check
Northing: 222171.71 SFT	Northing: 4920891.334 Meters	
Easting: 2140578.72 SFT	Easting: 472851.398 Meters	
Elevation: 1937.53 FT	Ellipsoid Height: 566.454 Meters	

**Photos:**



Facing North



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-111</u></b>  New GCP
Northing: 187112.25 SFT	Northing: 4909858.027 Meters	
Easting: 2234354.48 SFT	Easting: 501288.939 Meters	
Elevation: 1896.97 FT	Ellipsoid Height: 553.6 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/19/2016  
Acquisition Block: 6



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>GCP-112</u></b>  New GCP
Northing: 192992.37 SFT	Northing: 4912020.452 Meters	
Easting: 2135556.25 SFT	Easting: 471211.89 Meters	
Elevation: 1970.87 FT	Ellipsoid Height: 576.496 Meters	

**Photos:**



Facing South



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-113</u></b>  GCP Check
Northing: 89612.89 SFT	Northing: 4880543.22 Meters	
Easting: 2131054.52 SFT	Easting: 469453.524 Meters	
Elevation: 1465.35 FT	Ellipsoid Height: 421.825 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/16/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-114</u></b>  GCP Check
Northing: 165705.51 SFT	Northing: 4903973.837 Meters	
Easting: 2064291.53 SFT	Easting: 449398.629 Meters	
Elevation: 1984.16 FT	Ellipsoid Height: 580.77 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/16/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-115</u></b>  GCP Check
Northing: 89309.21 SFT	Northing: 4880672.013 Meters	
Easting: 2071745.24 SFT	Easting: 451384.604 Meters	
Elevation: 1788.22 FT	Ellipsoid Height: 520.395 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/16/2016  
Acquisition Block: 6



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>GCP-116</u></b>  New GCP
Northing: 89654.81 SFT	Northing: 4881029.699 Meters	
Easting: 2003822.15 SFT	Easting: 430693.511 Meters	
Elevation: 1769.78 FT	Ellipsoid Height: 515.052 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>GCP-117</u></b>  GCP Check
Northing: 113482.6 SFT	Northing: 4888354.216 Meters	
Easting: 1986210.91 SFT	Easting: 425416.532 Meters	
Elevation: 1437.09 FT	Ellipsoid Height: 413.888 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-118</u></b>  New GCP
Northing: 142941.98 SFT	Northing: 4897326.412 Meters	
Easting: 1986999.09 SFT	Easting: 425765.964 Meters	
Elevation: 1449.27 FT	Ellipsoid Height: 417.762 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000

Date of Survey: 11/13/2016

Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-119</u></b>  GCP Check
Northing: 116325.35 SFT	Northing: 4889624.59 Meters	
Easting: 1876823.31 SFT	Easting: 392100.041 Meters	
Elevation: 2005.94 FT	Ellipsoid Height: 587.318 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-120</u></b>  GCP Check
Northing: 117457.61 SFT	Northing: 4890195.665 Meters	
Easting: 1815343.08 SFT	Easting: 373371.819 Meters	
Elevation: 1957.76 FT	Ellipsoid Height: 572.944 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-121</u></b>  GCP Check
Northing: 160210.63 SFT	Northing: 4903175.555 Meters	
Easting: 1828118.42 SFT	Easting: 377421.734 Meters	
Elevation: 1537.93 FT	Ellipsoid Height: 445.179 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/15/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-122</u></b>  GCP Check
Northing: 184352.35 SFT	Northing: 4911100.473 Meters	
Easting: 1673513.37 SFT	Easting: 330397.67 Meters	
Elevation: 2038.63 FT	Ellipsoid Height: 598.954 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-124</u></b>  GCP Check
Northing: 165884.61 SFT	Northing: 4904317.686 Meters	
Easting: 1986613.96 SFT	Easting: 425733.858 Meters	
Elevation: 1468.26 FT	Ellipsoid Height: 423.601 Meters	

**Photos:**



Facing South



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-126</u></b>  GCP Check
Northing: 153737.35 SFT	Northing: 4899999.533 Meters	
Easting: 2152056.36 SFT	Easting: 476091.573 Meters	
Elevation: 1860.35 FT	Ellipsoid Height: 542.56 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/13/2016  
Acquisition Block: 5



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>GCP-131</u></b>  GCP Check
Northing: 176882.48 SFT	Northing: 4908142.671 Meters	
Easting: 1858683.22 SFT	Easting: 386796.38 Meters	
Elevation: 1484.57 FT	Ellipsoid Height: 428.875 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-132</u></b>  GCP Check
Northing: 175565.76 SFT	Northing: 4907400.511 Meters	
Easting: 1950741.55 SFT	Easting: 414840.478 Meters	
Elevation: 1460.35 FT	Ellipsoid Height: 421.301 Meters	

**Photos:**



Facing South



Facing West

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/14/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-133</u></b>  GCP Check
Northing: 131807.52 SFT	Northing: 4894155.055 Meters	
Easting: 1927373.52 SFT	Easting: 407558.682 Meters	
Elevation: 1785.27 FT	Ellipsoid Height: 520.138 Meters	

**Photos:**



Facing North



Facing East



**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/12/2016  
Acquisition Block: 5



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-134</u></b>  GCP Check
Northing: 155582.04 SFT	Northing: 4901881.569 Meters	
Easting: 1796510.14 SFT	Easting: 367773.415 Meters	
Elevation: 1595.33 FT	Ellipsoid Height: 462.838 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/10/2016  
Acquisition Block: 5



<b>SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)</b>	<b>UTM Zone 14N NAD83(2011)</b>	<b>Station Name</b> <b><u>GCP-135</u></b>  New GCP
Northing: 139341.29 SFT	Northing: 4897183.798 Meters	
Easting: 1728063.91 SFT	Easting: 346856.829 Meters	
Elevation: 2115.24 FT	Ellipsoid Height: 621.516 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/17/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-138</u></b>  GCP Check
Northing: 134342.07 SFT	Northing: 4894229.854 Meters	
Easting: 2114915.38 SFT	Easting: 464704.114 Meters	
Elevation: 1718.08 FT	Ellipsoid Height: 499.324 Meters	

**Photos:**



Facing North



Facing East

**Project Name: South Dakota Ground Control Surveys**

ESP Project #: EW10.200.000  
Date of Survey: 11/16/2016  
Acquisition Block: 6



SD North_SPC NAD 83(2011)//NAVD 88(GEOID12B)	UTM Zone 14N NAD83(2011)	Station Name <b><u>GCP-139</u></b>  GCP Check
Northing: 124115.86 SFT	Northing: 4891381.944 Meters	
Easting: 2043208.72 SFT	Easting: 442820.663 Meters	
Elevation: 1435.24 FT	Ellipsoid Height: 413.215 Meters	

**Photos:**



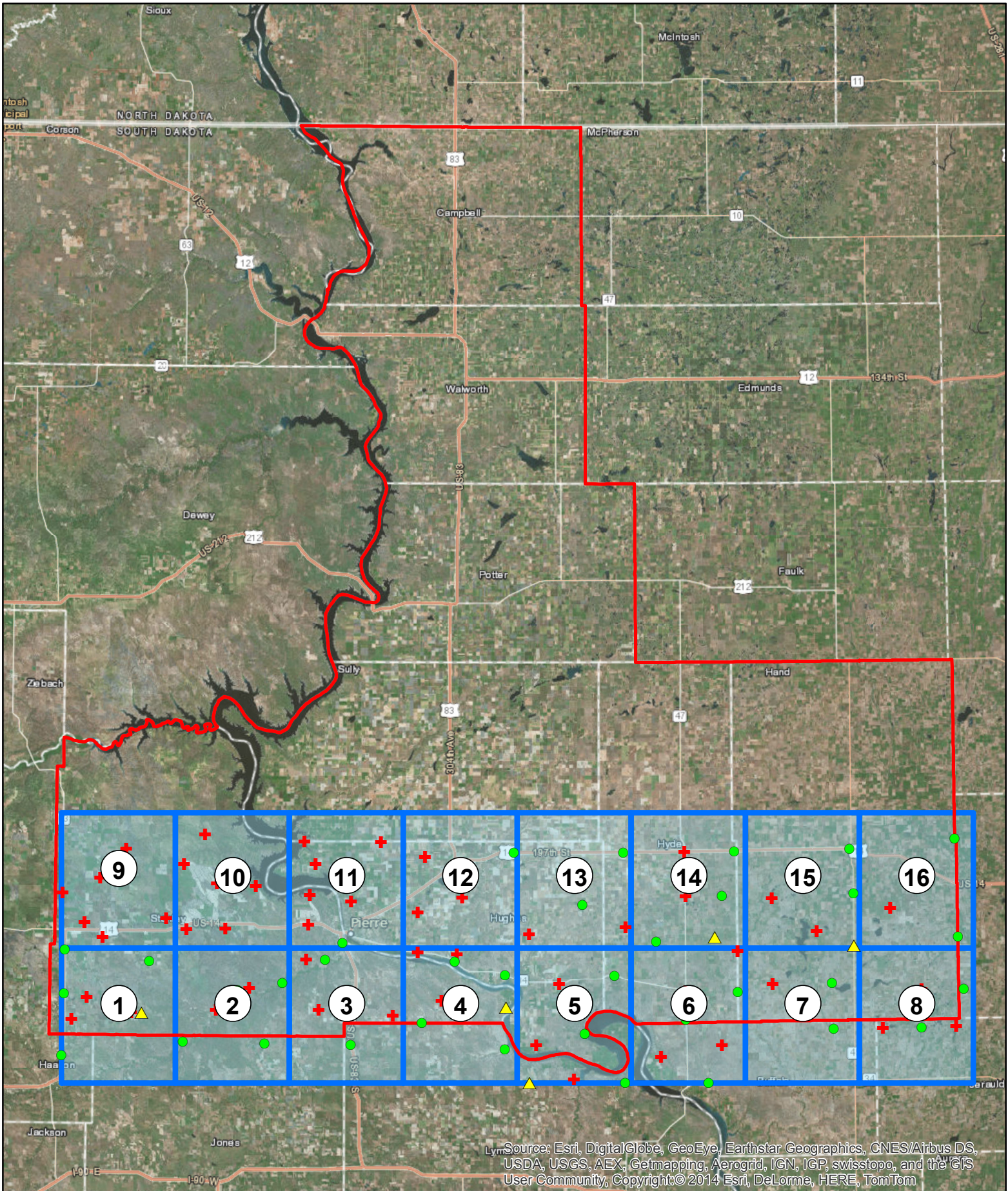
Facing North



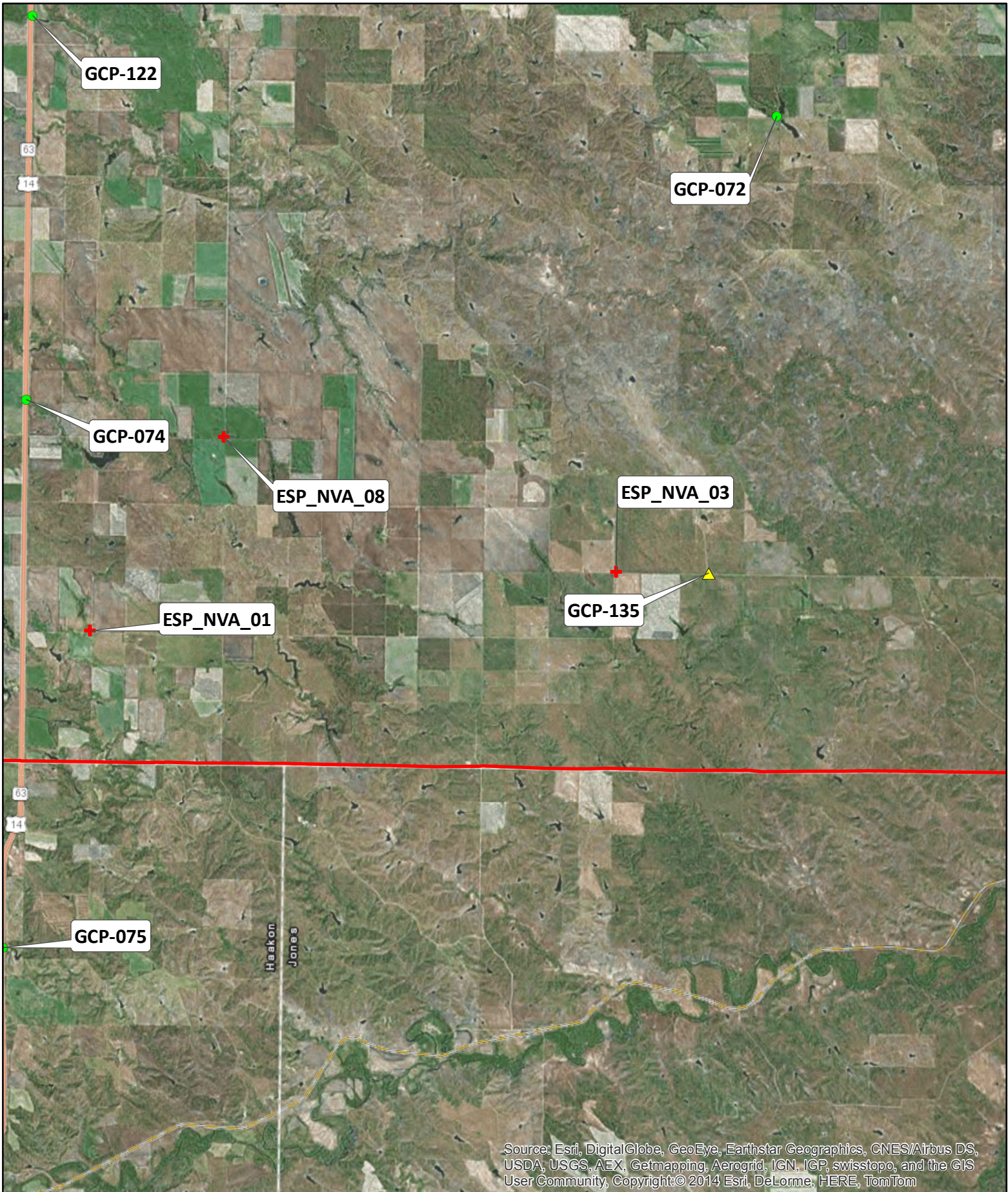
Facing East

## 4.0 – Exhibit Maps

The following pages contain exhibit maps that illustrate the vicinity of ground control points throughout the designated area of interest.

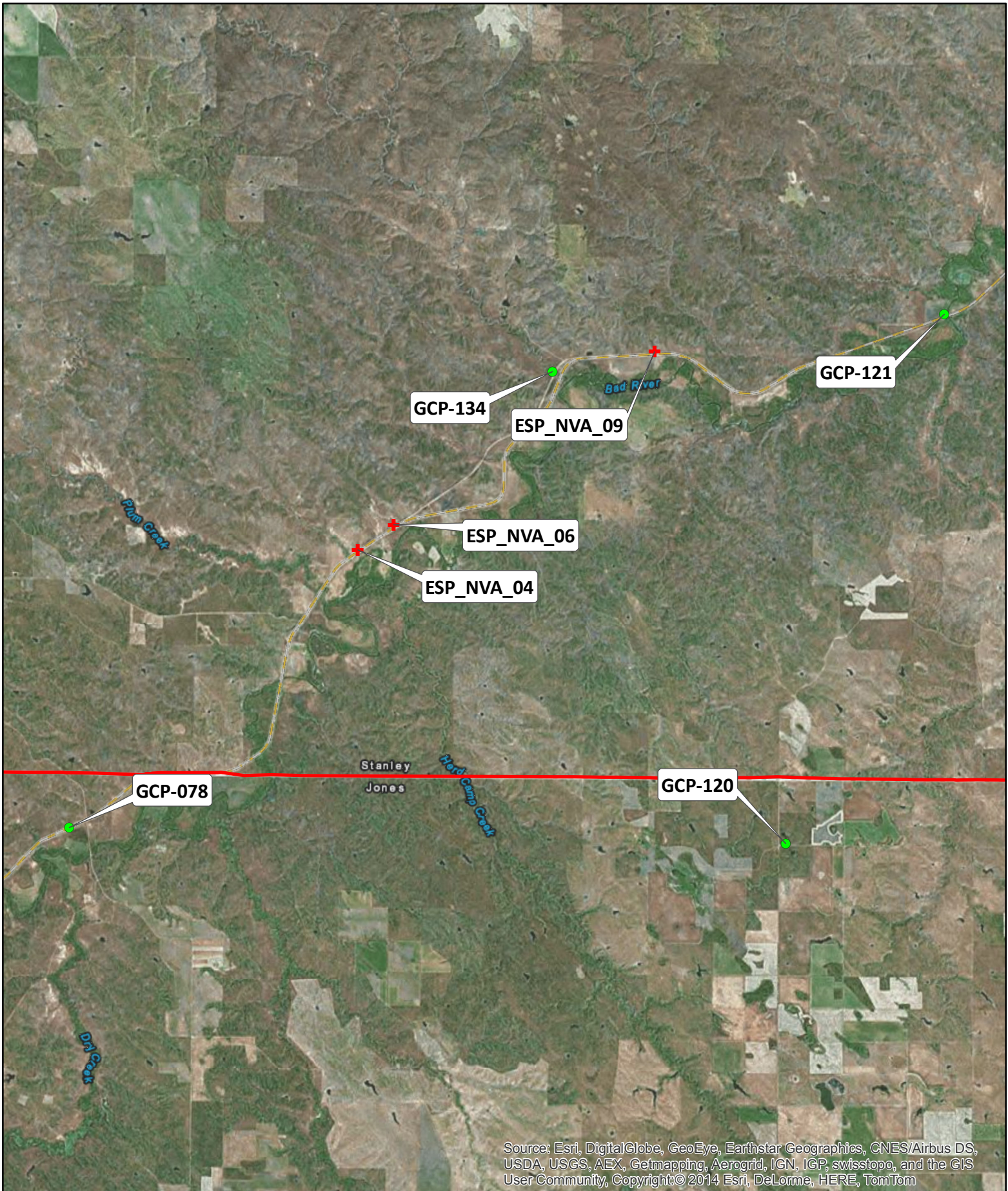


<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI	<b>Date</b> 01/15/2017	<b>Project</b> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
	<b>Scale</b> Not to Scale	<b>Sheet</b> Index Map		



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright:© 2014 Esri, DeLorme, HERE, TomTom

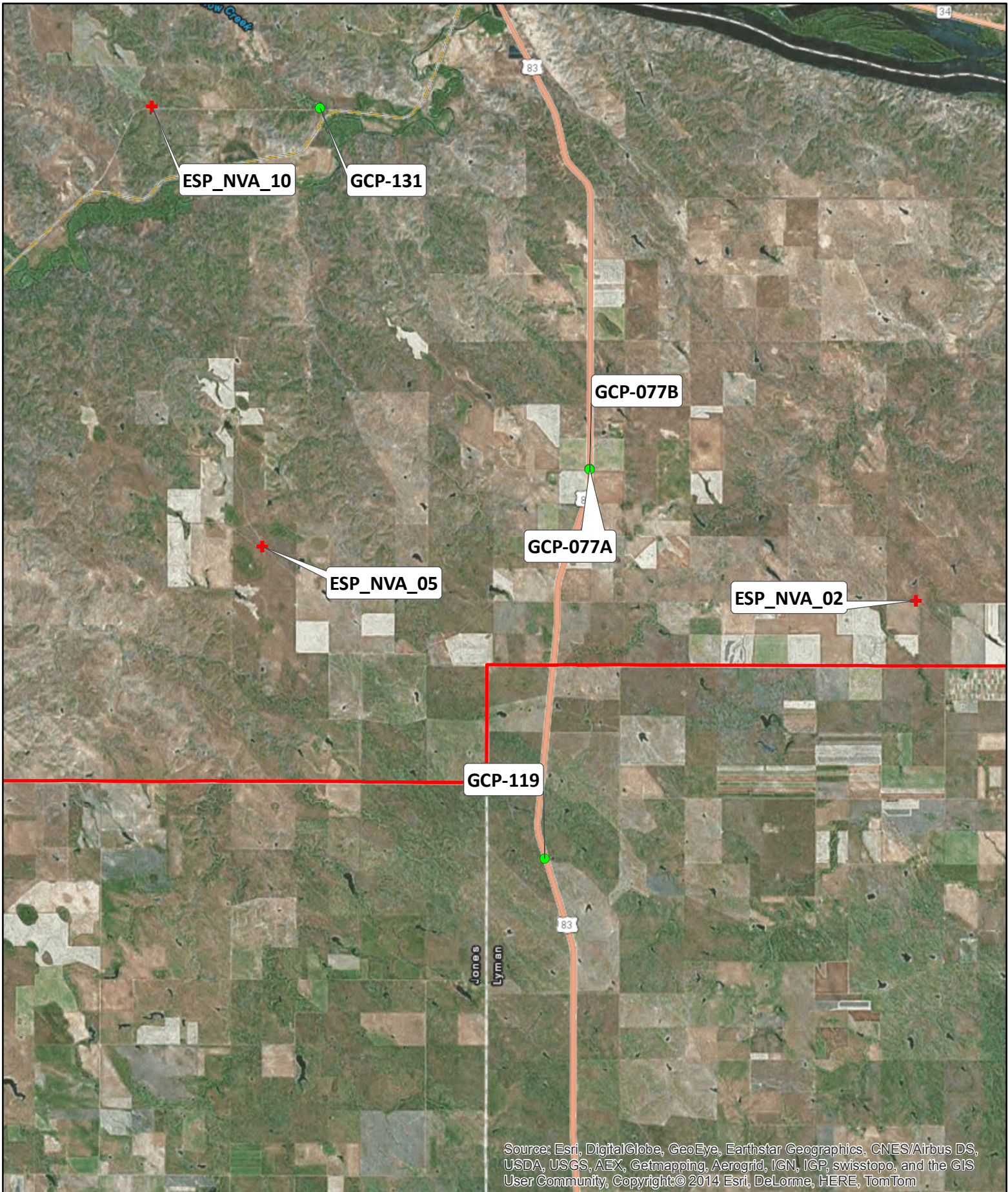
<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		<i>Date</i> 01/15/2017	<i>Project</i> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		<i>Scale</i> 1 in = 10,000 ft	<i>Sheet</i> Sheet #: 1 of 16		



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<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		<i>Date</i> 01/15/2017	<i>Project</i> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		<i>Scale</i> 1 in = 10,000 ft	<i>Sheet</i> Sheet #: 2 of 16		





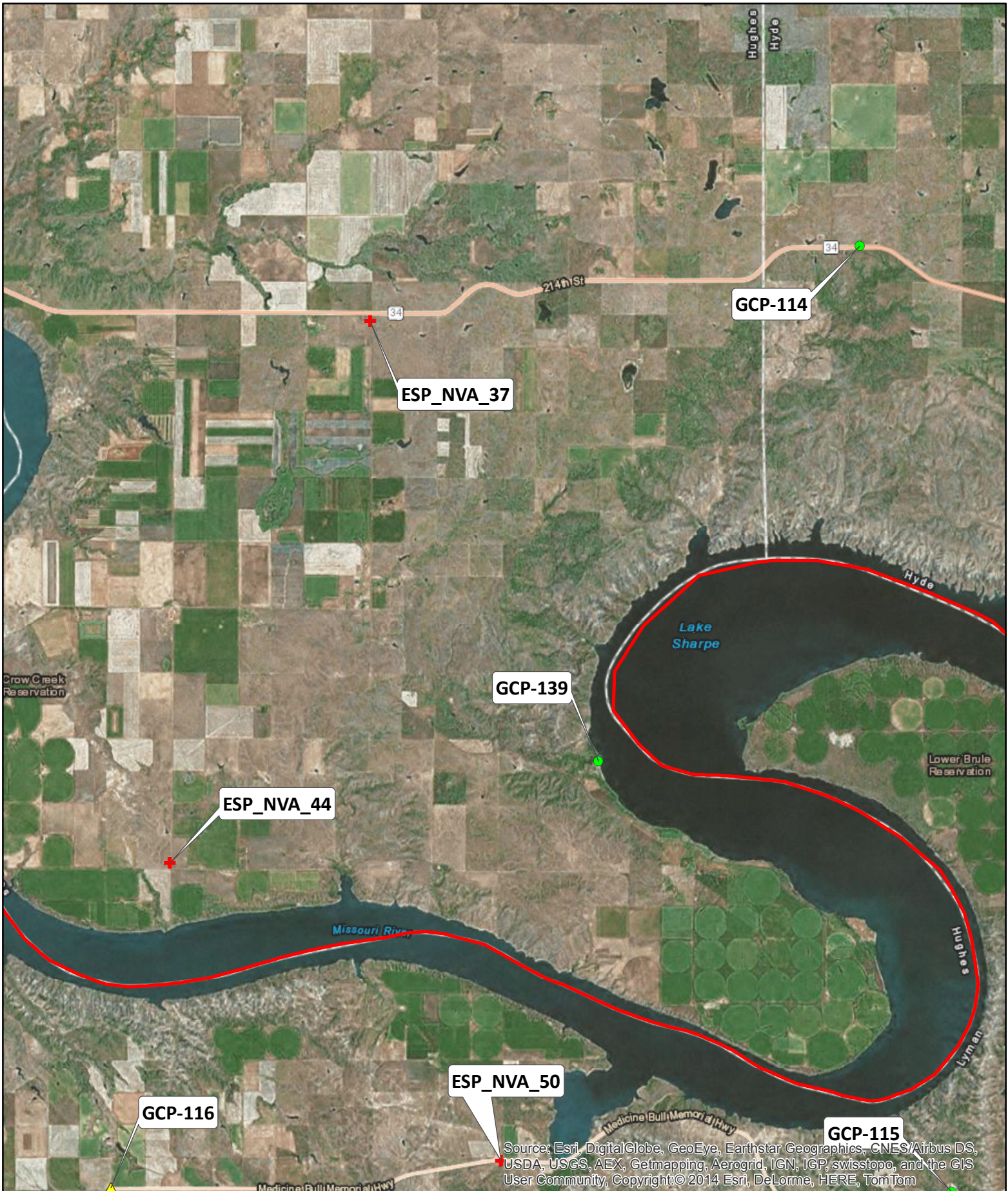
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright:© 2014 Esri, DeLorme, HERE, TomTom

<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		<b>Date</b> 01/15/2017	<b>Project</b> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 3 of 16		



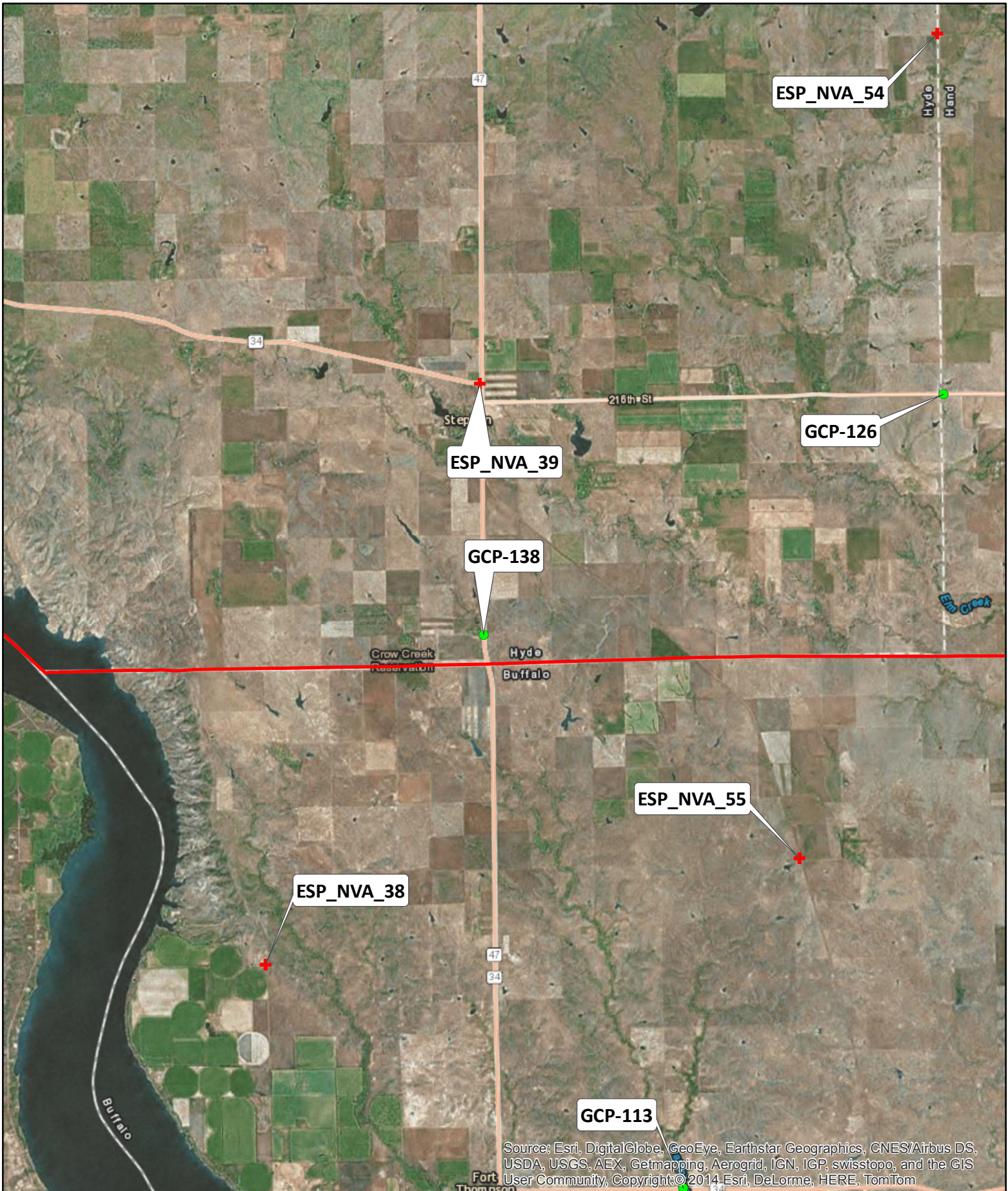
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright © 2014 Esri, DeLorme, HERE, TomTom

<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		<b>Date</b> 01/15/2017	<b>Project</b> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 4 of 16		



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<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI	<b>Date</b> 01/15/2017	<b>Project</b> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
	<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 5 of 16		



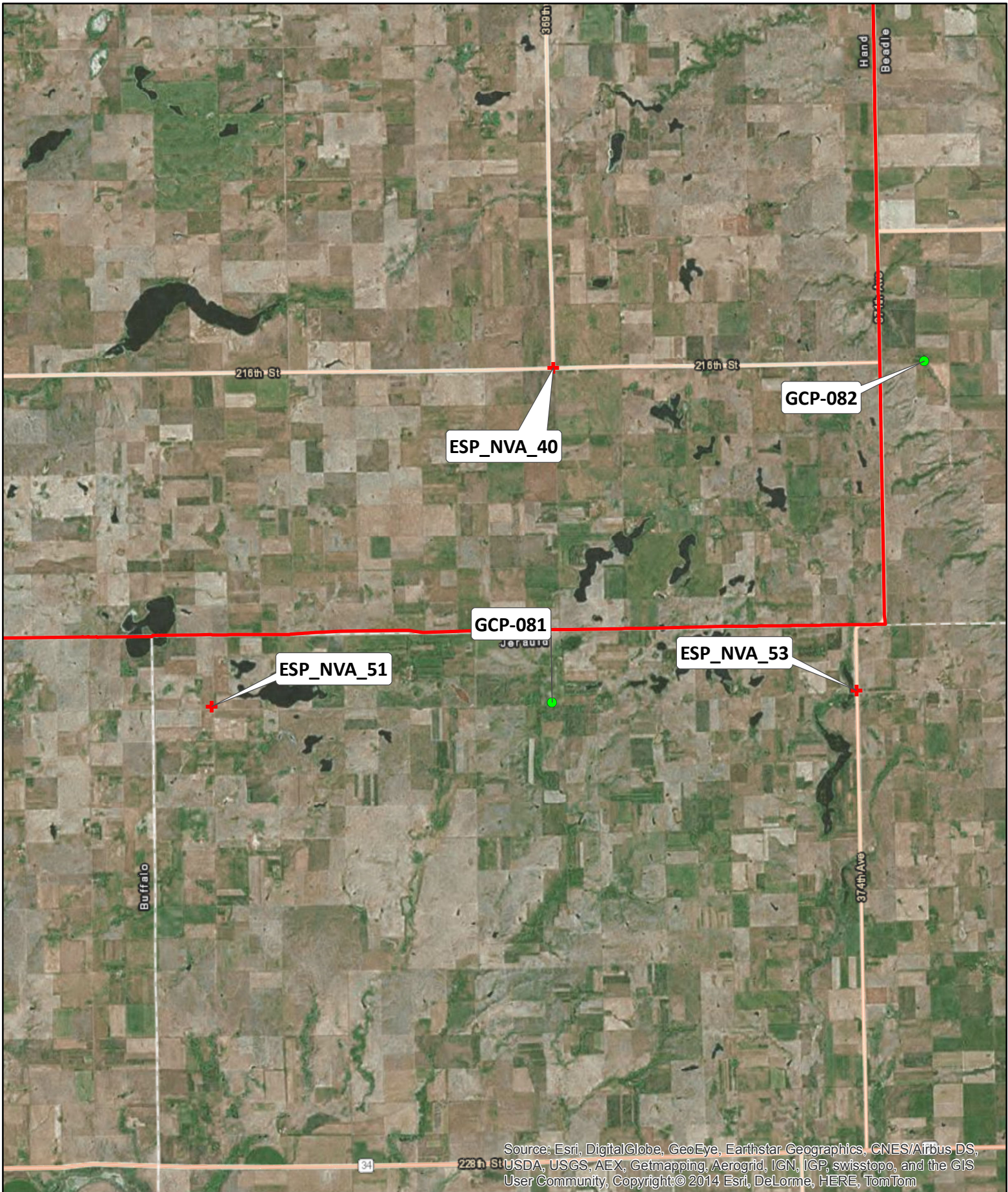
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright:© 2014 Esri, DeLorme, HERE, TomTom

<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		<b>Date</b> 01/15/2017	<b>Project</b> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 6 of 16		



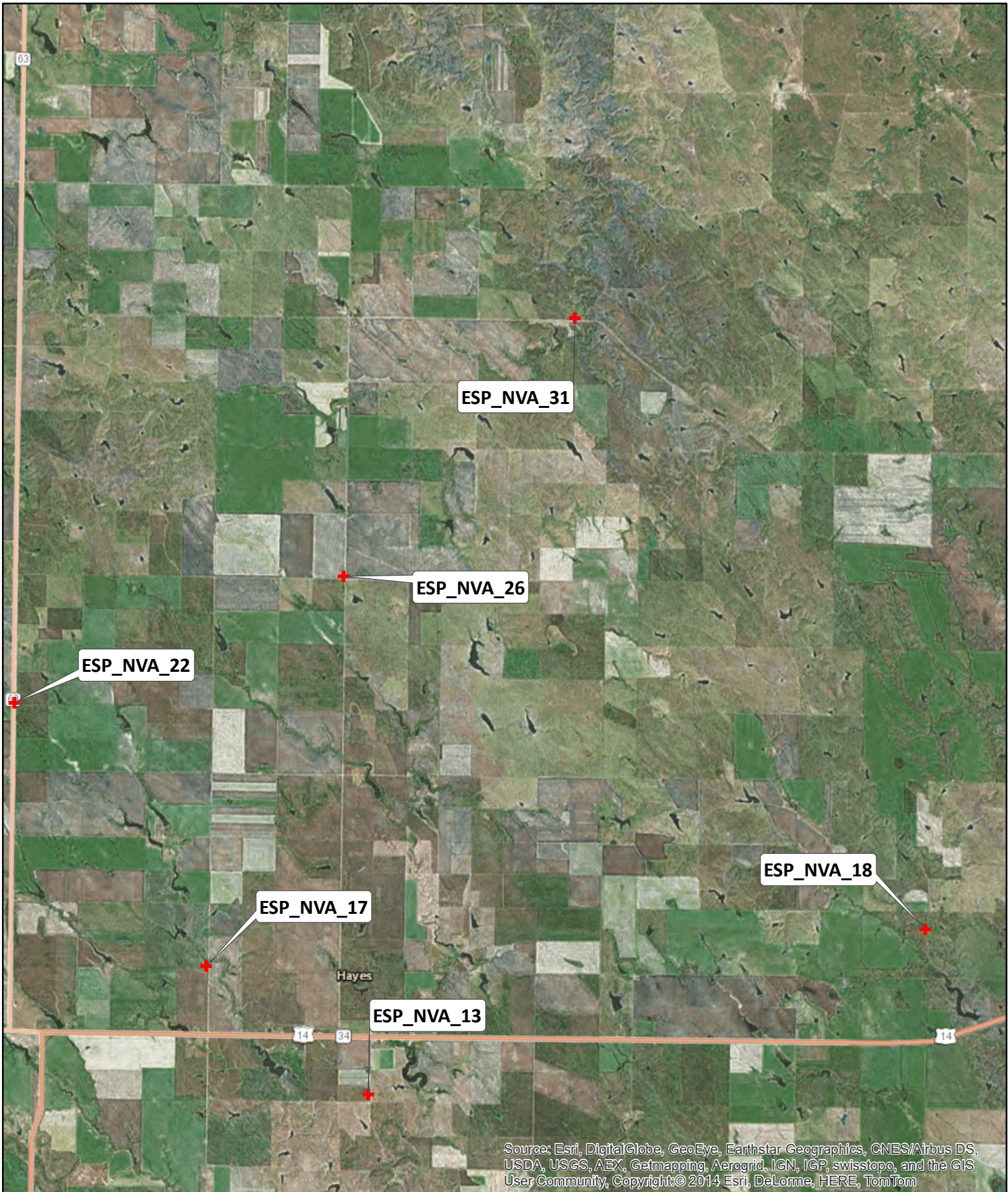
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, JGP, swisstopo, and the GIS User Community, Copyright:© 2014 Esri, DeLorme, HERE, TomTom

<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		<b>Date</b> 01/15/2017	<b>Project</b> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 7 of 16		



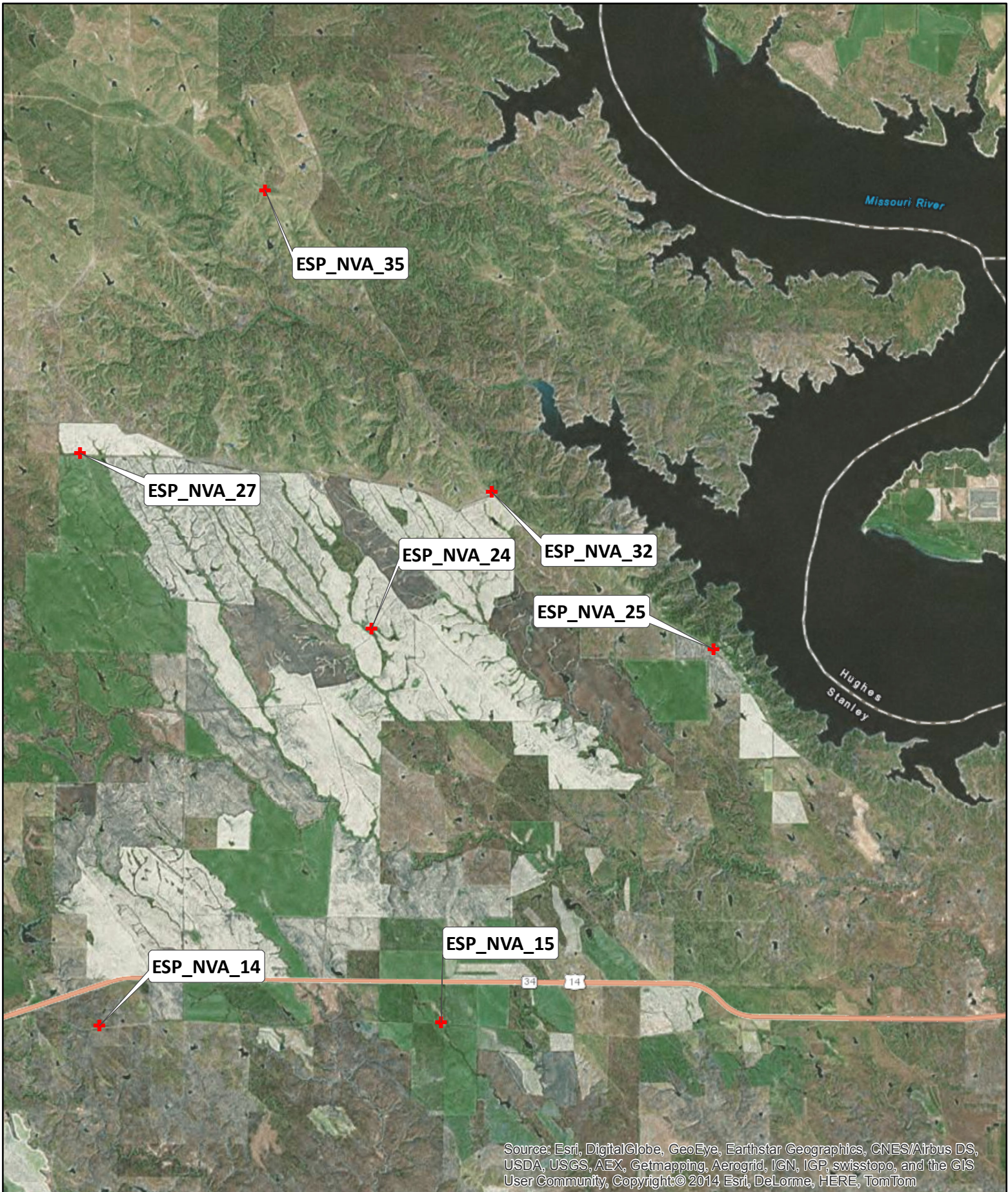
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright © 2014 Esri, DeLorme, HERE, TomTom

<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		Date	01/15/2017	Project	South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		Scale	1 in = 10,000 ft	Sheet	Sheet #: 8 of 16		



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright:© 2014 Esri, DeLorme, HERE, TomTom

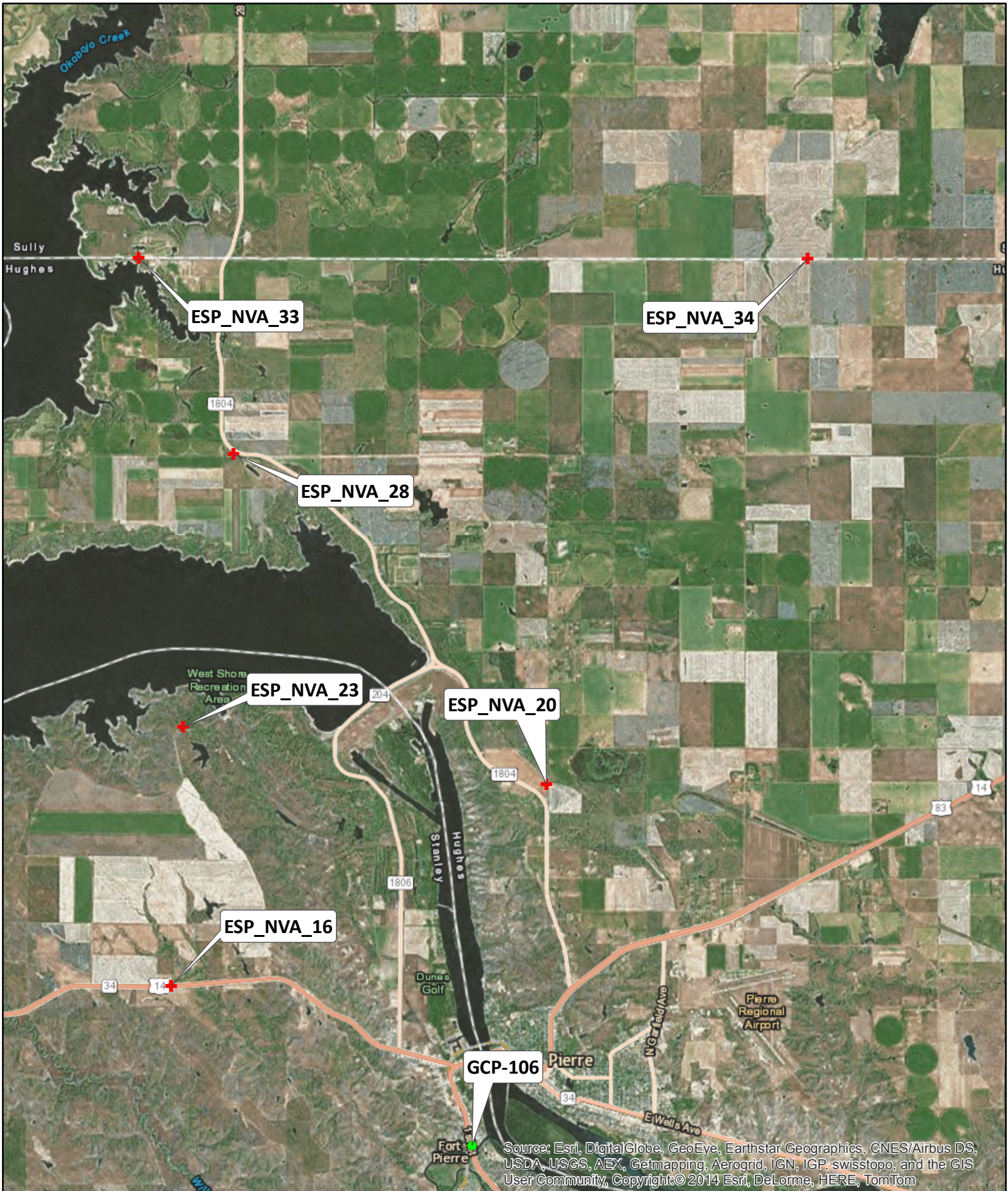
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		<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 9 of 16		



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright:© 2014 Esri, DeLorme, HERE, TomTom

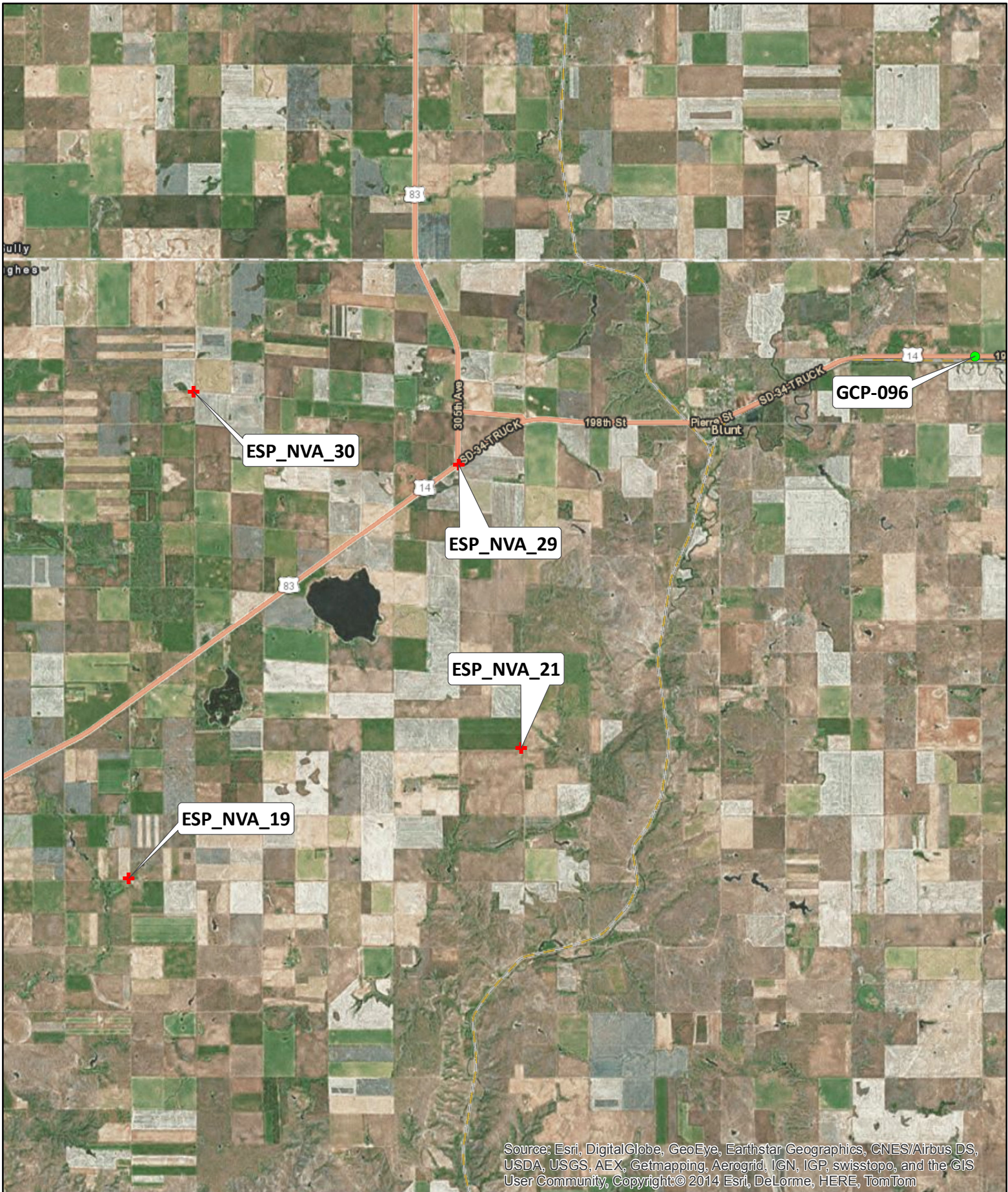
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		<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 10 of 16		





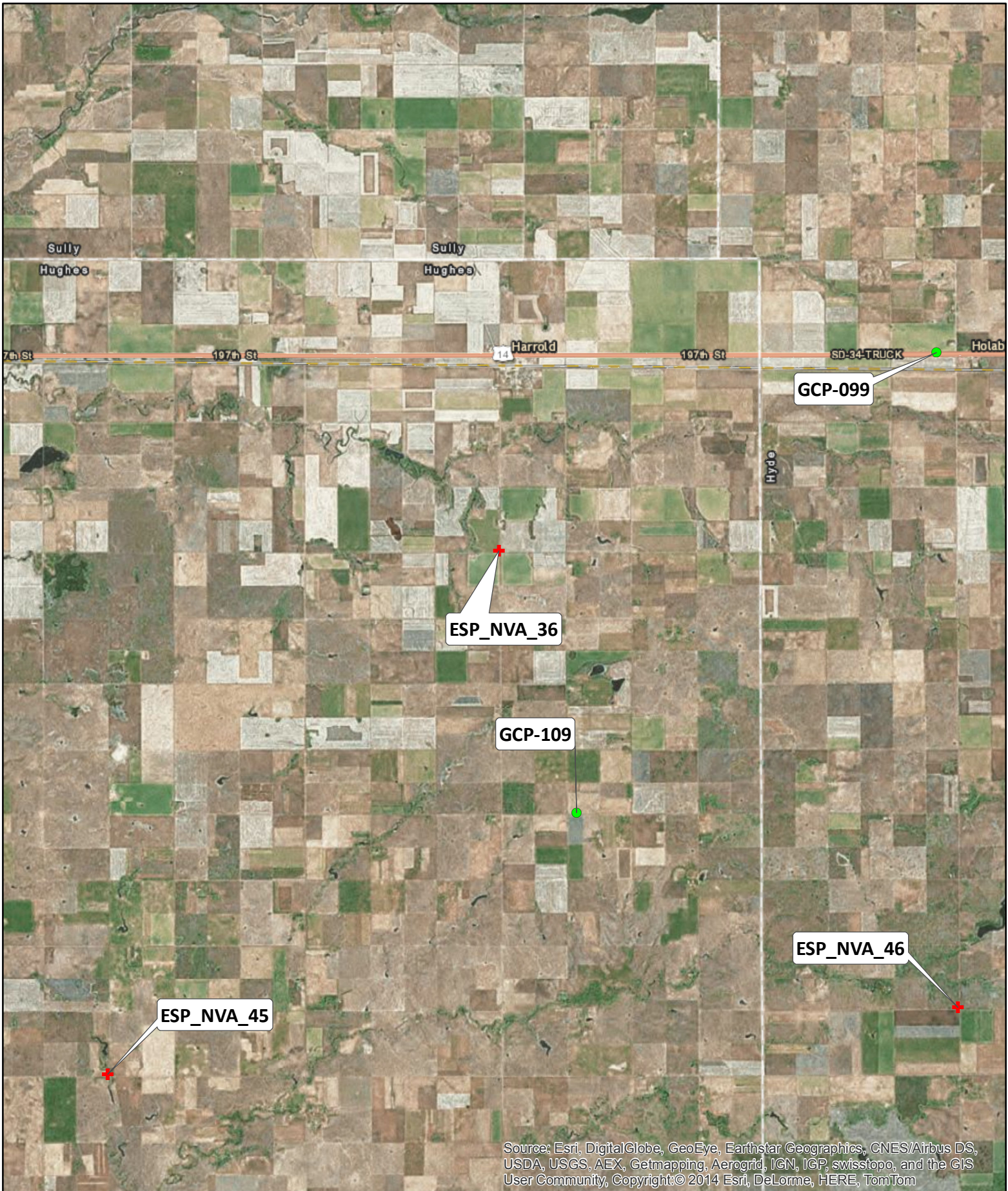
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright © 2014 Esri, DeLorme, HERE, TomTom

<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		Date	01/15/2017	Project	South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		Scale	1 in = 10,000 ft	Sheet	Sheet #: 11 of 16		

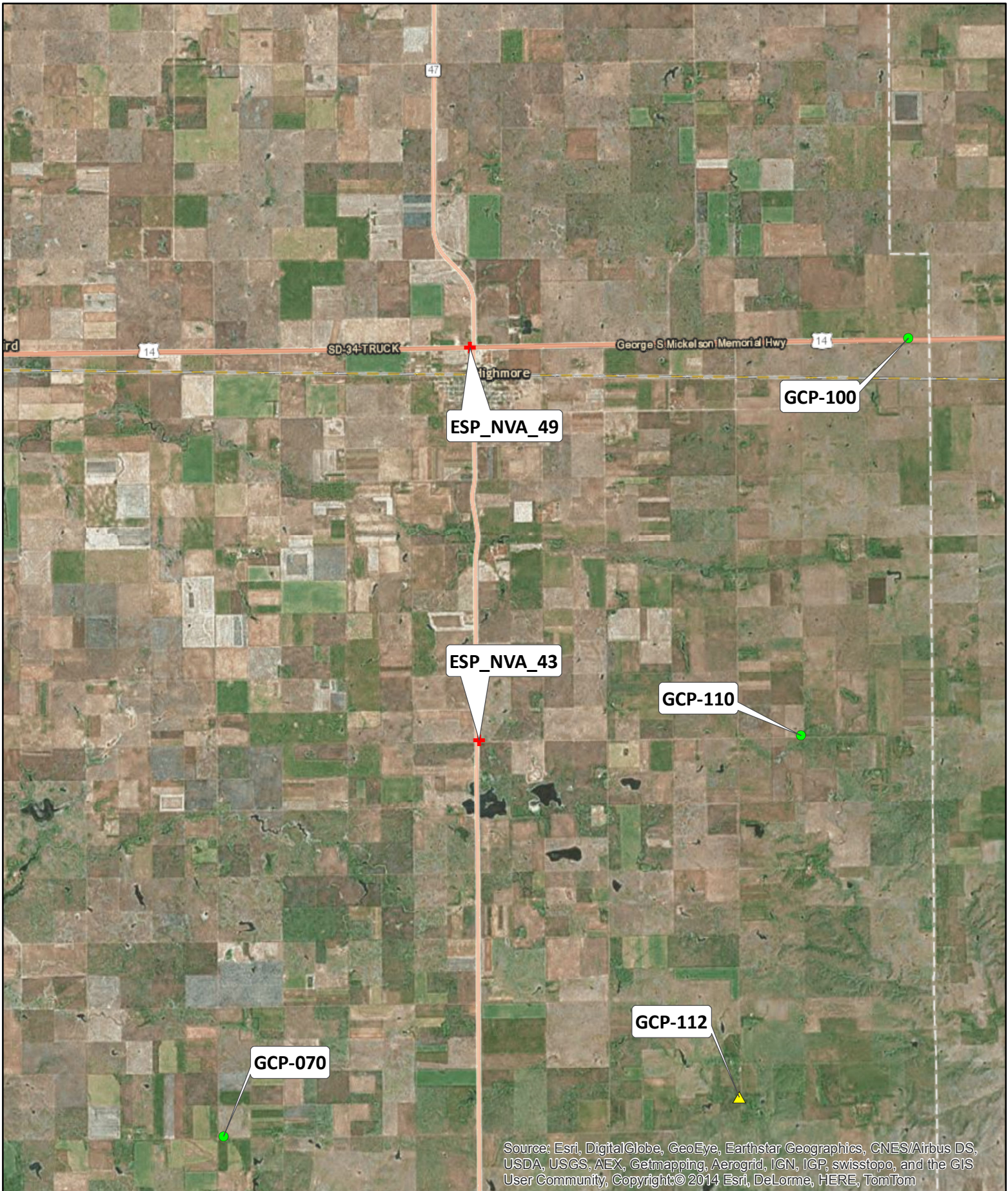


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Copyright:© 2014 Esri, DeLorme, HERE, TomTom

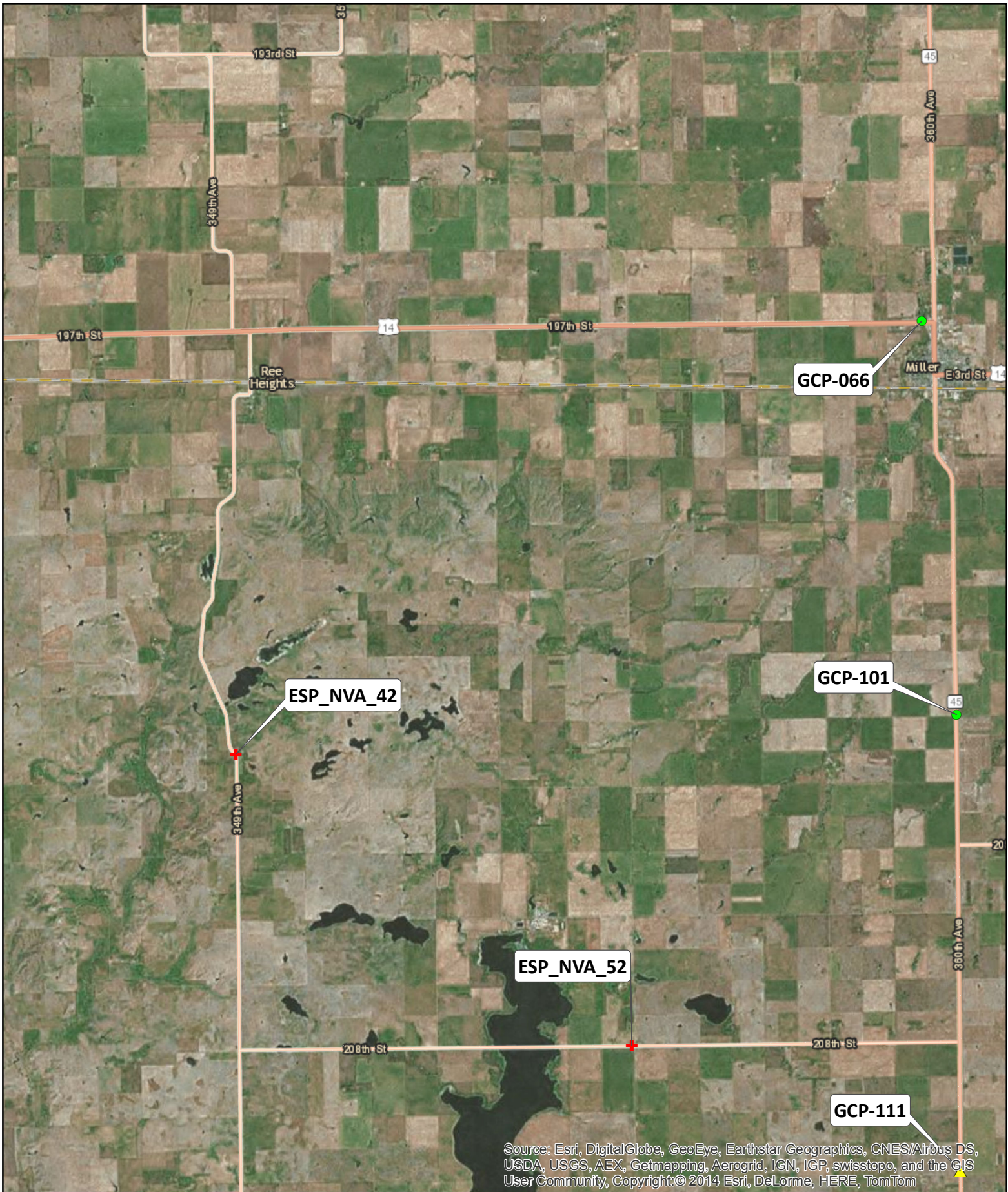
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		Scale	1 in = 10,000 ft	Sheet	Sheet #: 12 of 16		



<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		Date	01/15/2017	Project	South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		Scale	1 in = 10,000 ft	Sheet	Sheet #: 13 of 16		



<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		<b>Date</b> 01/15/2017	<b>Project</b> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 14 of 16		



<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		Date	01/15/2017	Project	South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		Scale	1 in = 10,000 ft	Sheet	Sheet #: 15 of 16		



<b>Type</b> GCP Check NVA Checkpoint New GCP HarrisAOI		<b>Date</b> 01/15/2017	<b>Project</b> South Dakota Ground Control Surveys	 <b>SNYDER &amp; ASSOCIATES</b> Engineers and Planners 501 S.W. Oralabor Rd. Ankeny, IA 50021	 <b>ESP</b> ESP Associates, P.A. PO Box 7030 Charlotte, NC 28241
		<b>Scale</b> 1 in = 10,000 ft	<b>Sheet</b> Sheet #: 16 of 16		

## 5.0 – OPUS-RS and RTX Reports

The following pages contain OPUS-RS and RTX solutions for each LiDAR calibration point surveyed. Each solution contains positional information, accuracy estimates, and elements from the raw static GNSS data.

# OPUS-RS solution : SD\_NVA1\_TD.16o OP1478874296120

opus <opus@ngs.noaa.gov>

Fri 11/11/2016 9:26 AM

Inbox

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_NVA1\_TD.16o OP1478874296120

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 11, 2016  
RINEX FILE: sd\_n315s.16o                  TIME: 14:26:24 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3      START: 2016/11/10 18:51:15  
EPHEMERIS: igu19224.eph [ultra-rapid]      STOP: 2016/11/10 19:51:15  
NAV FILE: brdc3150.16n                  OBS USED: 3290 / 3485 : 94%  
ANT NAME: TRMR8\_GNSS3    NONE                  QUALITY IND. 25.25/ 31.09  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.296

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.86013)

X: -882432.934(m) 0.004(m)      -882433.817(m) 0.004(m)  
Y: -4494861.119(m) 0.011(m)      -4494859.828(m) 0.011(m)  
Z: 4424268.525(m) 0.011(m)      4424268.460(m) 0.011(m)

LAT: 44 11 50.36749 0.004(m)      44 11 50.39075 0.004(m)  
E LON: 258 53 34.53751 0.003(m)      258 53 34.48730 0.003(m)  
W LON: 101 6 25.46249 0.003(m)      101 6 25.51270 0.003(m)  
EL HGT: 618.632(m) 0.015(m)      617.800(m) 0.015(m)  
ORTHO HGT: 641.356(m) 0.017(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4895948.404      41053.247  
Easting (X) [meters]    331627.070      511499.111  
Convergence [degrees]    -1.46925113      -0.78351778  
Point Scale              0.99994867      1.00004924  
Combined Factor          0.99985168      0.99995224

US NATIONAL GRID DESIGNATOR: 14TLP3162795948(NAD 83)



## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	68615.6
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	154091.1
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	170011.8
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	229439.7
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	245161.0

## NEAREST NGS PUBLISHED CONTROL POINT

PT0435	N 73	N441138.	W1010738.	1655.4
--------	------	----------	-----------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4 <CONTRIBUTOR />
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10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
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18 <LAT>0.006</LAT>
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G18 G20 G21 G24 G27 G29 G32 R04 R05 R06 R14 R19 R20 R21</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
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32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.010">-4494859.838</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.012">4424268.458</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>11</MINUTES>
39 <SECONDS>50.39046</SECONDS>
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43 <MINUTES>6</MINUTES>
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78   <ELEMENT_2_2>1.0863E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-6.2202E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.1433E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.3261E-04</ELEMENT_3_3>
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86   <ELEMENT_2_2>2.5091E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>1.4724E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>1.4268E-05</ELEMENT_3_2>
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92 <POINT_ID COORD_TYPE="Local">NVA1</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Tuesday, November 15, 2016 9:37 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_NVA2\_TD.16o OP1479220406580

FILE: SD\_NVA2\_TD.16o OP1479220406580

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 15, 2016  
RINEX FILE: sd\_n319t.16o TIME: 14:36:41 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3 START: 2016/11/14 19:28:00  
EPHEMERIS: igu19231.eph [ultra-rapid] STOP: 2016/11/14 20:27:45  
NAV FILE: brdc3190.16n OBS USED: 4116 / 4320 : 95%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 28.29/ 35.71  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.314

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87113)

X: -813766.419(m) 0.002(m) -813767.302(m) 0.002(m)  
Y: -4506799.109(m) 0.007(m) -4506797.814(m) 0.007(m)  
Z: 4425149.871(m) 0.008(m) 4425149.806(m) 0.008(m)

LAT: 44 12 33.05201 0.003(m) 44 12 33.07575 0.003(m)  
E LON: 259 45 52.99025 0.003(m) 259 45 52.94075 0.003(m)  
W LON: 100 14 7.00975 0.003(m) 100 14 7.05925 0.003(m)  
EL HGT: 527.977(m) 0.010(m) 527.130(m) 0.010(m)  
ORTHO HGT: 551.967(m) 0.013(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4895848.416 41792.988  
Easting (X) [meters] 401310.881 581194.633  
Convergence [degrees] -0.86140563 -0.16651699  
Point Scale 0.99971978 1.00004621  
Combined Factor 0.99963702 0.99996343

US NATIONAL GRID DESIGNATOR: 14TMP0131095848(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	150600.9
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	160059.0
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	200033.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	213617.6
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	239670.6
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	240602.3

NEAREST NGS PUBLISHED CONTROL POINT

PT0113	M 13	N441141.	W1001825.	5949.4
--------	------	----------	-----------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>  
10 <REFERENCE>Bottom of antenna mount</REFERENCE>  
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12 <RECEIVER>  
13 <NAME>TRIMBLE R8 GNSS3</NAME>  
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16 <DATA_QUALITY>  
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19 <LONG>0.005</LONG>  
20 <EL_HEIGHT>0.013</EL_HEIGHT>  
21 </ACCURACY>  
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QZSS_SV="" GLN_SV="R01 R02 R03 R08 R10 R11 R17 R18 R23 R24" GAL_SV=""  
BDS_SV="">G08 G13 G15 G18 G20 G21 G24 G27 G32 R01 R02 R03 R08 R10 R11 R17 R18  
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53     <EPOCH>2010.0</EPOCH>
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55       <RECT_COORD>
56         <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-813766.413</COORDINATE>
57         <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.010">-4506799.124</COORDINATE>
58         <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4425149.907</COORDINATE>
59       </RECT_COORD>
60       <ELLIP_COORD>
61         <LAT>
62           <DEGREES>44</DEGREES>
63           <MINUTES>12</MINUTES>
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65         </LAT>
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68           <MINUTES>14</MINUTES>
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70         </EAST_LONG>
71         <EL_HEIGHT UNIT="m">528.012</EL_HEIGHT>
72       </ELLIP_COORD>
73     </COORD_SET>
74   </POSITION>
75   <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76     <ELEMENT_1_1>2.2929E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>1.1729E-06</ELEMENT_2_1>
78     <ELEMENT_2_2>9.6558E-05</ELEMENT_2_2>
79     <ELEMENT_3_1>-4.2122E-06</ELEMENT_3_1>
80     <ELEMENT_3_2>-7.2915E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.0528E-04</ELEMENT_3_3>
82   </COVARIANCE_MATRIX>
83   <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>2.7630E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-1.8954E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.4844E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>7.3152E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>1.4585E-05</ELEMENT_3_2>
89     <ELEMENT_3_3>1.7229E-04</ELEMENT_3_3>
90   </COVARIANCE_MATRIX>
91   <RETRIEVAL TIME="2016-11-15T13:52:02Z" />
92 <POINT_ID COORD_TYPE="Local">NVA2</POINT_ID></TRIMBLE_RTX_SOLUTION>
93

```

# OPUS-RS solution : SD\_NVA3\_TD.16o OP1478874310368

opus <opus@ngs.noaa.gov>

Fri 11/11/2016 9:27 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_NVA3\_TD.16o OP1478874310368

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 11, 2016  
RINEX FILE: sd\_n315r.16o                  TIME: 14:26:35 UTC

SOFTWARE: rsgps 1.37 RS54.prl 1.99.3      START: 2016/11/10 17:28:15  
EPHEMERIS: igu19224.eph [ultra-rapid]      STOP: 2016/11/10 18:29:45  
NAV FILE: brdc3150.16n                  OBS USED: 4010 / 4010 : 100%  
ANT NAME: TRMR8\_GNSS3    NONE                  QUALITY IND. 21.59/ 41.14  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.308

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.85997)

X: -869531.331(m) 0.004(m)      -869532.214(m) 0.004(m)  
Y: -4496214.198(m) 0.009(m)      -4496212.906(m) 0.009(m)  
Z: 4425415.786(m) 0.012(m)      4425415.721(m) 0.012(m)

LAT: 44 12 42.74648    0.003(m)      44 12 42.76984    0.003(m)  
E LON: 259 3 16.49102    0.003(m)      259 3 16.44092    0.003(m)  
W LON: 100 56 43.50898    0.003(m)      100 56 43.55908    0.003(m)  
EL HGT:    601.713(m) 0.015(m)      600.878(m) 0.015(m)  
ORTHO HGT:    624.782(m) 0.017(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4897245.891      42506.106  
Easting (X) [meters]    344582.996      524440.171  
Convergence [degrees]    -1.35683801      -0.66910924  
Point Scale    0.99989707      1.00004552  
Combined Factor    0.99980274      0.99995118

US NATIONAL GRID DESIGNATOR: 14TLP4458297245(NAD 83)



## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	55958.0
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	152325.4
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	183009.4
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	216421.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	236957.3

## NEAREST NGS PUBLISHED CONTROL POINT

PT1062	SCHIEB	N441129.427	W1005823.816	3175.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```

1 <TRIMBLE_RTX_SOLUTION SID="7786570" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2   <SOLUTION_TIME>2016-11-11T14:43:07Z</SOLUTION_TIME>
3   <OBSERVATION_TIME START="2016-11-10T17:28:15Z" END="2016-11-10T18:29:45Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">SD_NVA3_TD.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
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13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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19      <LONG>0.005</LONG>
20      <EL_HEIGHT>0.015</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="246" PROCESSING_INTERVAL="15.0" USABLE="246"
USED="240">97</PERCENT_OBS_USED>
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QZSS_SV=" " GLN_SV="R03 R04 R05 R06 R18 R19 R20 R21" GAL_SV=" " BDS_SV=" ">G02 G05
G13 G15 G16 G18 G20 G21 G26 G29 R03 R04 R05 R06 R18 R19 R20
R21</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.86</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-869532.211</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4496212.920</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4425415.724</COORDINATE>
34      </RECT_COORD>
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36        <LAT>
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38          <MINUTES>12</MINUTES>
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43          <MINUTES>56</MINUTES>
44          <SECONDS>43.55884</SECONDS>
45        </EAST_LONG>
46        <EL_HEIGHT UNIT="m">600.889</EL_HEIGHT>
47      </ELLIP_COORD>

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48     </COORD_SET>
49 </POSITION>
50 <POSITION TYPE="CUSTOM">
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America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-869531.319</COORDINATE>
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69                 <SECONDS>43.50846</SECONDS>
70             </EAST_LONG>
71             <EL_HEIGHT UNIT="m">601.724</EL_HEIGHT>
72         </ELLIP_COORD>
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74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76     <ELEMENT_1_1>2.8194E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>2.1475E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.1576E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.4108E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.3642E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.1602E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>2.3666E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>5.3283E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.3344E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>3.0884E-07</ELEMENT_3_1>
88     <ELEMENT_3_2>1.5690E-07</ELEMENT_3_2>
89     <ELEMENT_3_3>2.1296E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-11T14:43:07Z" />
92 <POINT_ID COORD_TYPE="Local">NVA3</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:23 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_NVA4\_TD.16o OP1479140352307

FILE: SD\_NVA4\_TD.16o OP1479140352307

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: sd\_n317q.16o TIME: 16:20:42 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3 START: 2016/11/12 16:41:00  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 17:41:00  
NAV FILE: brdc3170.16n OBS USED: 3284 / 3392 : 97%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 18.59/ 44.83  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.323

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86534)

X: -851412.267(m) 0.004(m) -851413.150(m) 0.004(m)  
Y: -4499081.796(m) 0.008(m) -4499080.504(m) 0.008(m)  
Z: 4425832.944(m) 0.011(m) 4425832.879(m) 0.011(m)

LAT: 44 13 5.72059 0.003(m) 44 13 5.74405 0.003(m)  
E LON: 259 17 2.37209 0.004(m) 259 17 2.32218 0.004(m)  
W LON: 100 42 57.62791 0.004(m) 100 42 57.67782 0.004(m)  
EL HGT: 471.041(m) 0.013(m) 470.204(m) 0.013(m)  
ORTHO HGT: 494.489(m) 0.016(m) [NAVD88 (Computed using GEOID12B)]

#### UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4897546.240	43027.079
Easting (X) [meters]	362925.353	542780.916
Convergence [degrees]	-1.19691836	-0.50674603
Point Scale	0.99983108	1.00004392
Combined Factor	0.99975724	0.99997006

US NATIONAL GRID DESIGNATOR: 14TLP6292597546(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	150179.6
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	198109.7
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	201350.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	227467.0

NEAREST NGS PUBLISHED CONTROL POINT

PT0341	1623	N441254.	W1004317.	562.0
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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3   <OBSERVATION_TIME START="2016-11-12T16:41:00Z" END="2016-11-12T17:41:00Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">SD_NVA4_TD.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
17    <ACCURACY UNIT="m" >
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19      <LONG>0.005</LONG>
20      <EL_HEIGHT>0.012</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="241" PROCESSING_INTERVAL="15.0" USABLE="241"
USED="235">97</PERCENT_OBS_USED>
23    <USED_SATELLITES TOTAL="16" GPS_SV="G02 G05 G13 G15 G16 G18 G20 G21 G26 G29"
QZSS_SV=" " GLN_SV="R05 R06 R07 R20 R21 R22" GAL_SV=" " BDS_SV=" ">G02 G05 G13 G15
G16 G18 G20 G21 G26 G29 R05 R06 R07 R20 R21 R22</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.87</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-851413.150</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.009">-4499080.518</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4425832.880</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
37          <DEGREES>44</DEGREES>
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39          <SECONDS>5.74376</SECONDS>
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43          <MINUTES>42</MINUTES>
44          <SECONDS>57.67769</SECONDS>
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47      </ELLIP_COORD>
48    </COORD_SET>

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49 </POSITION>
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53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
55     <RECT_COORD>
56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-851412.258</COORDINATE>
57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.009">-4499081.795</COORDINATE>
58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4425832.964</COORDINATE>
59     </RECT_COORD>
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68         <MINUTES>42</MINUTES>
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73   </COORD_SET>
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77   <ELEMENT_2_1>5.1405E-06</ELEMENT_2_1>
78   <ELEMENT_2_2>7.7925E-05</ELEMENT_2_2>
79   <ELEMENT_3_1>-4.1317E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-5.2436E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>8.3996E-05</ELEMENT_3_3>
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85   <ELEMENT_2_1>5.6032E-07</ELEMENT_2_1>
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87   <ELEMENT_3_1>4.4520E-06</ELEMENT_3_1>
88   <ELEMENT_3_2>7.5837E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>1.3316E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T14:40:02Z" />
92 <POINT_ID COORD_TYPE="Local">NVA4</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:30 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_NVA5\_TD.16o OP1479140581121

FILE: SD\_NVA5\_TD.16o OP1479140581121

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: sd\_n318s.16o TIME: 16:26:14 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3 START: 2016/11/13 18:32:30  
EPHEMERIS: igu19230.eph [ultra-rapid] STOP: 2016/11/13 19:32:30  
NAV FILE: brdc3180.16n OBS USED: 2656 / 2780 : 96%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 26.12/ 34.74  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.273

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86829)

X: -829441.911(m) 0.004(m) -829442.794(m) 0.004(m)  
Y: -4503062.248(m) 0.009(m) -4503060.954(m) 0.009(m)  
Z: 4426075.781(m) 0.006(m) 4426075.716(m) 0.006(m)

LAT: 44 13 14.06343 0.007(m) 44 13 14.08706 0.007(m)  
E LON: 259 33 48.17021 0.006(m) 259 33 48.12053 0.006(m)  
W LON: 100 26 11.82979 0.006(m) 100 26 11.87947 0.006(m)  
EL HGT: 554.598(m) 0.007(m) 553.755(m) 0.007(m)  
ORTHO HGT: 578.445(m) 0.011(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4897375.337 43125.651  
Easting (X) [meters] 385247.537 565109.077  
Convergence [degrees] -1.00203962 -0.30901221  
Point Scale 0.99976195 1.00004333  
Combined Factor 0.99967502 0.99995637



US NATIONAL GRID DESIGNATOR: 14TLP8524797375(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	150040.1
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	210945.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	217949.1
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	223656.6

NEAREST NGS PUBLISHED CONTROL POINT

PT1019	WOOTEN	N441128.562	W1002413.689	4181.4
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">SD_NVA5_TD.t02</OBS_FILE>
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9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
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14    </RECEIVER>
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18      <LAT>0.007</LAT>
19      <LONG>0.005</LONG>
20      <EL_HEIGHT>0.016</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="241" PROCESSING_INTERVAL="15.0" USABLE="241"
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G20 G21 G24 G27 G29 R01 R07 R08 R22 R23 R24</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
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27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28    <EPOCH>2016.87</EPOCH>
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32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4503060.954</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.014">4426075.723</COORDINATE>
34      </RECT_COORD>
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77   <ELEMENT_2_1>5.1047E-06</ELEMENT_2_1>
78   <ELEMENT_2_2>1.2891E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-6.3025E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-1.0932E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>1.8670E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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87   <ELEMENT_3_1>3.2654E-05</ELEMENT_3_1>
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90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T14:42:30Z" />
92 <POINT_ID COORD_TYPE="Local">NVA5</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:21 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_NVA6\_TD.16o OP1479140367487

FILE: SD\_NVA6\_TD.16o OP1479140367487

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: sd\_n317r.16o TIME: 16:20:40 UTC

SOFTWARE: rsgps 1.37 RS53.prl 1.99.3 START: 2016/11/12 17:56:30  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 19:06:15  
NAV FILE: brdc3170.16n OBS USED: 2660 / 2952 : 90%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 21.57/ 73.28  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.306

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86550)

X:	-850469.477(m)	0.005(m)	-850470.360(m)	0.005(m)
Y:	-4498809.845(m)	0.013(m)	-4498808.553(m)	0.013(m)
Z:	4426287.824(m)	0.016(m)	4426287.759(m)	0.016(m)

LAT:	44 13 26.27760	0.004(m)	44 13 26.30107	0.004(m)
E LON:	259 17 41.82677	0.005(m)	259 17 41.77687	0.005(m)
W LON:	100 42 18.17323	0.005(m)	100 42 18.22313	0.005(m)
EL HGT:	471.220(m)	0.020(m)	470.382(m)	0.020(m)
ORTHO HGT:	494.665(m)	0.022(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4898162.268	43653.903
Easting (X) [meters]	363813.983	543662.249
Convergence [degrees]	-1.18939341	-0.49898948
Point Scale	0.99982810	1.00004249
Combined Factor	0.99975423	0.99996860

US NATIONAL GRID DESIGNATOR: 14TLP6381398162(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	150732.1
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	197174.2
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	202262.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	226504.2

NEAREST NGS PUBLISHED CONTROL POINT

PT0342	Q 76	N441337.	W1004123.	1268.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
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G18 G20 G21 G24 G26 G27 G29 R06 R07 R08 R21 R22 R23</USED_SATELLITES>
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26 <REF_FRAME>ITRF2008</REF_FRAME>
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28 <EPOCH>2016.87</EPOCH>
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33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4426287.765</COORDINATE>
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38 <MINUTES>13</MINUTES>
39 <SECONDS>26.30067</SECONDS>
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43 <MINUTES>42</MINUTES>
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79   <ELEMENT_3_1>-1.2377E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-9.2805E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.1810E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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86   <ELEMENT_2_2>2.1118E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-4.8443E-06</ELEMENT_3_1>
88   <ELEMENT_3_2>9.7768E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>2.1914E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
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92 <POINT_ID COORD_TYPE="Local">NVA6</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Tuesday, November 15, 2016 9:39 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_NVA7\_TD.16o OP1479220416293

FILE: SD\_NVA7\_TD.16o OP1479220416293

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.

2005

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

sdhu  
nevn  
sdab  
ndas  
ndel

Your station is 4.8 KM outside the polygon enclosing the reference stations

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 15, 2016  
RINEX FILE: sd\_n319q.16o TIME: 14:36:36 UTC

SOFTWARE: rsgps 1.37 RS52.prl 1.99.3 START: 2016/11/14 16:45:45  
EPHEMERIS: igu19231.eph [ultra-rapid] STOP: 2016/11/14 17:45:45  
NAV FILE: brdc3190.16n OBS USED: 3480 / 4260 : 82%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 30.26/ 58.16  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.322

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87082)

X: -803051.347(m) 0.006(m) -803052.230(m) 0.006(m)



Y: -4506425.264(m) 0.012(m) -4506423.969(m) 0.012(m)  
Z: 4427460.512(m) 0.012(m) 4427460.447(m) 0.012(m)

LAT: 44 14 17.75600 0.002(m) 44 14 17.77981 0.002(m)  
E LON: 259 53 45.14958 0.004(m) 259 53 45.10017 0.004(m)  
W LON: 100 6 14.85042 0.004(m) 100 6 14.89983 0.004(m)  
EL HGT: 520.087(m) 0.018(m) 519.239(m) 0.018(m)  
ORTHO HGT: 543.971(m) 0.020(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4898929.725	45002.912
Easting (X) [meters]	411832.621	591681.693
Convergence [degrees]	-0.77033543	-0.07369332
Point Scale	0.99969560	1.00003895
Combined Factor	0.99961408	0.99995740

US NATIONAL GRID DESIGNATOR: 14TMP1183298929(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	149266.9
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	155856.2
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	190363.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	207482.4
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	232227.9

NEAREST NGS PUBLISHED CONTROL POINT

PT1014	PARK	N441139.685	W1000420.185	5503.0
--------	------	-------------	--------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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7 <ANTENNA>  
8 <NAME>TRM60158.00 NONE</NAME>  
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>  
10 <REFERENCE>Bottom of antenna mount</REFERENCE>  
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12 <RECEIVER>  
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53   <EPOCH>2010.0</EPOCH>
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88   <ELEMENT_3_2>7.9648E-06</ELEMENT_3_2>
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93
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# OPUS-RS solution : SD\_NVA8\_TD.16o OP1478874402685

opus <opus@ngs.noaa.gov>

Fri 11/11/2016 9:28 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_NVA8\_TD.16o OP1478874402685

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 11, 2016  
RINEX FILE: sd\_n315u.16o                  TIME: 14:28:04 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3      START: 2016/11/10 20:10:45  
EPHEMERIS: igu19224.eph [ultra-rapid]      STOP: 2016/11/10 21:11:30  
NAV FILE: brdc3150.16n                  OBS USED: 3590 / 3735 : 96%  
ANT NAME: TRMR8\_GNSS3    NONE                  QUALITY IND. 12.25/ 33.63  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.298

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.86028)

X: -878623.067(m) 0.005(m)      -878623.950(m) 0.005(m)  
Y: -4492180.980(m) 0.016(m)      -4492179.689(m) 0.016(m)  
Z: 4427694.964(m) 0.014(m)      4427694.899(m) 0.014(m)

LAT: 44 14 25.89253    0.003(m)      44 14 25.91582    0.003(m)  
E LON: 258 55 59.73781    0.002(m)      258 55 59.68759    0.002(m)  
W LON: 101 4 0.26219    0.002(m)      101 4 0.31241    0.002(m)  
EL HGT: 598.222(m) 0.022(m)      597.390(m) 0.022(m)  
ORTHO HGT: 620.961(m) 0.023(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES    STATE PLANE COORDINATES  
UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4900665.087      45810.140  
Easting (X) [meters]    334970.858      514786.482  
Convergence [degrees]    -1.44223065      -0.75497228  
Point Scale            0.99993495      1.00003840  
Combined Factor        0.99984116      0.99994460

US NATIONAL GRID DESIGNATOR: 14TLQ3497000665(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	64071.7
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	157774.5
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	173585.9
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	225782.8
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	239379.6

## NEAREST NGS PUBLISHED CONTROL POINT

PT0915	U 432	N441440.	W1010742.	4939.3
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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93
```

## Jamey Gray

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**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:24 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_NVA9\_TD.16o OP1479140436172

FILE: SD\_NVA9\_TD.16o OP1479140436172

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: sd\_n317u.16o TIME: 16:21:50 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3 START: 2016/11/12 20:52:30  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 21:52:30  
NAV FILE: brdc3170.16n OBS USED: 2764 / 2852 : 97%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 25.13/ 57.34  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.306

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86582)

X:	-843639.982(m)	0.005(m)	-843640.866(m)	0.005(m)
Y:	-4497030.947(m)	0.015(m)	-4497029.655(m)	0.015(m)
Z:	4429365.145(m)	0.016(m)	4429365.080(m)	0.016(m)

LAT:	44 15 45.77759	0.003(m)	44 15 45.80111	0.003(m)
E LON:	259 22 29.44938	0.003(m)	259 22 29.39947	0.003(m)
W LON:	100 37 30.55062	0.003(m)	100 37 30.60053	0.003(m)
EL HGT:	460.478(m)	0.022(m)	459.640(m)	0.022(m)
ORTHO HGT:	483.930(m)	0.023(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4902336.993	47907.270
Easting (X) [meters]	370280.641	550079.488
Convergence [degrees]	-1.13443219	-0.44244461
Point Scale	0.99980695	1.00003305
Combined Factor	0.99973477	0.99996085

US NATIONAL GRID DESIGNATOR: 14TLQ7028002336(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	154612.8
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	190431.1
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	208934.8
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	219541.4

NEAREST NGS PUBLISHED CONTROL POINT

PT0345	1566	N441539.98	W1003650.55	905.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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12 <RECEIVER>
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93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:25 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_NVA10\_TD.16o OP1479140527437

FILE: SD\_NVA10\_TD.16o OP1479140527437

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: sd\_n318p.16o TIME: 16:23:56 UTC

SOFTWARE: rsgps 1.37 RS54.prl 1.99.3 START: 2016/11/13 15:44:30  
EPHEMERIS: igu19230.eph [ultra-rapid] STOP: 2016/11/13 16:44:15  
NAV FILE: brdc3180.16n OBS USED: 3438 / 3762 : 91%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 19.22/ 48.85  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.300

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86797)

X: -830796.517(m) 0.009(m) -830797.401(m) 0.009(m)  
Y: -4495110.909(m) 0.009(m) -4495109.617(m) 0.009(m)  
Z: 4433787.433(m) 0.012(m) 4433787.369(m) 0.012(m)

LAT: 44 19 4.21414 0.003(m) 44 19 4.23777 0.003(m)  
E LON: 259 31 43.06588 0.007(m) 259 31 43.01606 0.007(m)  
W LON: 100 28 16.93412 0.007(m) 100 28 16.98394 0.007(m)  
EL HGT: 514.377(m) 0.015(m) 513.539(m) 0.015(m)  
ORTHO HGT: 537.929(m) 0.017(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters]	4908227.991	53949.125
Easting (X) [meters]	382665.410	562395.016
Convergence [degrees]	-1.02807238	-0.33360697
Point Scale	0.99976931	1.00002040
Combined Factor	0.99968868	0.99993975

US NATIONAL GRID DESIGNATOR: 14TLQ8266508227(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	160704.2
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	177787.5
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	206116.3
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	209076.7
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	221714.1
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	241926.4

NEAREST NGS PUBLISHED CONTROL POINT

PT1043	TETON	N441924.854	W1002846.765	918.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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44 <SECONDS>16.98406</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">513.569</EL_HEIGHT>
47 </ELLIP_COORD>

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48     </COORD_SET>
49 </POSITION>
50 <POSITION TYPE="CUSTOM">
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52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-830796.515</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4495110.919</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4433787.469</COORDINATE>
59         </RECT_COORD>
60         <ELLIP_COORD>
61             <LAT>
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63                 <MINUTES>19</MINUTES>
64                 <SECONDS>4.21477</SECONDS>
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67                 <DEGREES>-100</DEGREES>
68                 <MINUTES>28</MINUTES>
69                 <SECONDS>16.93398</SECONDS>
70             </EAST_LONG>
71             <EL_HEIGHT UNIT="m">514.409</EL_HEIGHT>
72         </ELLIP_COORD>
73     </COORD_SET>
74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76     <ELEMENT_1_1>2.6521E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>1.5640E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.5693E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.7081E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.1619E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.1949E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>4.5220E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-6.1820E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.5238E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-1.7135E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>6.1229E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>2.3248E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T14:48:18Z" />
92 <POINT_ID COORD_TYPE="Local">NVA10</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

# OPUS-RS solution : ESP\_NVA\_11.16o OP1479136930272

opus <opus@ngs.noaa.gov>

Mon 11/14/2016 10:25 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_11.16o OP1479136930272

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 14, 2016  
RINEX FILE: esp\_315v.16o                  TIME: 15:24:50 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3      START: 2016/11/10 21:42:00  
EPHEMERIS: igr19224.eph [rapid]          STOP: 2016/11/10 22:50:00  
NAV FILE: brdc3150.16n                  OBS USED: 4851 / 5670 : 86%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 21.37/ 43.11  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.318

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.86046)

X: -806846.501(m) 0.005(m)      -806847.385(m) 0.005(m)  
Y: -4498237.632(m) 0.018(m)      -4498236.338(m) 0.018(m)  
Z: 4434893.043(m) 0.015(m)      4434892.979(m) 0.015(m)

LAT: 44 19 57.32743 0.005(m)      44 19 57.35125 0.005(m)  
E LON: 259 49 51.68296 0.006(m)      259 49 51.63338 0.006(m)  
W LON: 100 10 8.31704 0.006(m)      100 10 8.36662 0.006(m)  
EL HGT: 418.081(m) 0.023(m)      417.237(m) 0.023(m)  
ORTHO HGT: 441.799(m) 0.024(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4909478.498      55493.152  
Easting (X) [meters]    406803.281      586522.719  
Convergence [degrees]    -0.81696573      -0.11959144  
Point Scale            0.99970682      1.00001717  
Combined Factor        0.99964129      0.99995162

US NATIONAL GRID DESIGNATOR: 14TMQ0680309478(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	153615.9
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	165032.5



DP6617 SDAB SDABERDEEN CORS ARP	N452729.471 W0982448.998	186738.2
DP6615 NDAS NDASHLEY CORS ARP	N460200.316 W0992247.944	198939.2
DP6862 NDEL NDELLENDALE CORS ARP	N460010.356 W0983123.166	226265.5
DP6621 SDWE SDWEBSTER CORS ARP	N452116.159 W0973109.815	238267.3
DP1963 SDRS RAPID CITY CORS ARP	N440457.973 W1031332.337	245877.0

## NEAREST NGS PUBLISHED CONTROL POINT

PT0150	D 14	N441943.	W1000912.	1323.8
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```

1 <TRIMBLE_RTX_SOLUTION SID="7786541" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2   <SOLUTION_TIME>2016-11-11T14:33:19Z</SOLUTION_TIME>
3   <OBSERVATION_TIME START="2016-11-10T21:42:00Z" END="2016-11-10T22:50:00Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">ESP_NVA_11.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
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18      <LAT>0.009</LAT>
19      <LONG>0.004</LONG>
20      <EL_HEIGHT>0.015</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="273" PROCESSING_INTERVAL="15.0" USABLE="273"
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23    <USED_SATELLITES TOTAL="21" GPS_SV="G01 G08 G10 G11 G12 G14 G18 G21 G24 G27 G31
G32" QZSS_SV="" GLN_SV="R05 R06 R07 R08 R15 R16 R21 R22 R23" GAL_SV=""
BDS_SV="">G01 G08 G10 G11 G12 G14 G18 G21 G24 G27 G31 G32 R05 R06 R07 R08 R15
R16 R21 R22 R23</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.86</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-806847.380</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.014">-4498236.345</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4434892.967</COORDINATE>
34      </RECT_COORD>
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38          <MINUTES>19</MINUTES>
39          <SECONDS>57.35084</SECONDS>
40        </LAT>
41        <EAST_LONG>
42          <DEGREES>-100</DEGREES>
43          <MINUTES>10</MINUTES>
44          <SECONDS>8.36633</SECONDS>
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47      </ELLIP_COORD>

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58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4434893.050</COORDINATE>
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71             <EL_HEIGHT UNIT="m">418.077</EL_HEIGHT>
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73     </COORD_SET>
74 </POSITION>
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78     <ELEMENT_2_2>2.0992E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.8829E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-7.4802E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.0174E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>7.9266E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-9.3036E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>1.8855E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-5.3945E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>1.8997E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>2.3572E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-11T14:33:19Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_11</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## OPUS-RS solution : ESP\_NVA\_12.16o OP1478876771977

opus <opus@ngs.noaa.gov>

Fri 11/11/2016 10:07 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_12.16o OP1478876771977

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

sdhu  
nevn  
sdab  
ndas  
ndel

Your station is 4.1 KM outside the polygon enclosing the reference stations

#### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 11, 2016  
RINEX FILE: esp\_315r.16o      TIME: 15:07:15 UTC

SOFTWARE: rsgps 1.37 RS52.prl 1.99.3      START: 2016/11/10 17:51:45  
EPHEMERIS: igu19224.eph [ultra-rapid]      STOP: 2016/11/10 18:56:30  
NAV FILE: brdc3150.16n      OBS USED: 3585 / 3865 : 93%  
ANT NAME: TRMR8\_GNSS3      NONE      QUALITY IND. 34.73/ 53.00  
ARP HEIGHT: 2.000      NORMALIZED RMS: 0.334

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.86002)

X: -798491.500(m) 0.004(m)      -798492.384(m) 0.004(m)  
Y: -4500056.573(m) 0.017(m)      -4500055.279(m) 0.017(m)  
Z: 4434557.463(m) 0.022(m)      4434557.399(m) 0.022(m)

LAT: 44 19 42.23286 0.004(m) 44 19 42.25673 0.004(m)  
 E LON: 259 56 17.32338 0.003(m) 259 56 17.27390 0.003(m)  
 W LON: 100 3 42.67662 0.003(m) 100 3 42.72610 0.003(m)  
 EL HGT: 414.817(m) 0.028(m) 413.971(m) 0.028(m)  
 ORTHO HGT: 438.620(m) 0.029(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4908896.567	55015.050
Easting (X) [meters]	415337.605	595066.234
Convergence [degrees]	-0.74203599	-0.04377687
Point Scale	0.99968815	1.00001808
Combined Factor	0.99962313	0.99995304

US NATIONAL GRID DESIGNATOR: 14TMQ1533708896(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	145101.0
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	166381.7
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	180872.0
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	196927.3
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	221952.0

NEAREST NGS PUBLISHED CONTROL POINT

PT0157	Y 314	N442005.	W1000346.	706.6
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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18      <LAT>0.005</LAT>
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21    </ACCURACY>
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QZSS_SV=" " GLN_SV="R03 R04 R05 R06 R18 R19 R20 R21" GAL_SV=" " BDS_SV=" ">G05 G10
G13 G15 G16 G18 G20 G21 G26 G27 G29 R03 R04 R05 R06 R18 R19 R20
R21</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.86</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-798492.382</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4500055.295</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4434557.402</COORDINATE>
34      </RECT_COORD>
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53     <EPOCH>2010.0</EPOCH>
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79     <ELEMENT_3_1>-1.3221E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-7.9649E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>8.7789E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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88     <ELEMENT_3_2>-2.7711E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>1.9058E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-11T14:34:19Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_12</POINT_ID></TRIMBLE_RTX_SOLUTION>
93

```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:18 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : NVA13.16o OP1479140141381

FILE: NVA13.16o OP1479140141381

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: nva1316u.16o TIME: 16:17:45 UTC

SOFTWARE: rsgps 1.37 RS52.prl 1.99.3 START: 2016/11/11 20:26:45  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 21:26:45  
NAV FILE: brdc3160.16n OBS USED: 4104 / 4446 : 92%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 23.25/ 70.89  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.283

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86304)

X: -873543.302(m) 0.004(m) -873544.186(m) 0.004(m)  
Y: -4483821.926(m) 0.024(m) -4483820.636(m) 0.024(m)  
Z: 4437091.215(m) 0.020(m) 4437091.151(m) 0.020(m)

LAT: 44 21 31.38348 0.005(m) 44 21 31.40685 0.005(m)  
E LON: 258 58 32.38973 0.002(m) 258 58 32.33941 0.002(m)  
W LON: 101 1 27.61027 0.002(m) 101 1 27.66059 0.002(m)  
EL HGT: 592.398(m) 0.031(m) 591.569(m) 0.031(m)  
ORTHO HGT: 614.972(m) 0.032(m) [NAVD88 (Computed using GEOID12B)]

#### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters]	4913708.935	58898.928
Easting (X) [meters]	338680.887	518339.743
Convergence [degrees]	-1.41561555	-0.72496183
Point Scale	0.99992005	1.00001161
Combined Factor	0.99982718	0.99991873

US NATIONAL GRID DESIGNATOR: 14TLQ3868013708(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	58311.1
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	169638.5
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	178566.3
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	221691.5
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	226570.4
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	239646.1

NEAREST NGS PUBLISHED CONTROL POINT

AB9092	HAYES AZ MK 2	N442217.	W1010129.	1408.4
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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3 <OBSERVATION_TIME START="2016-11-11T20:26:45Z" END="2016-11-11T21:26:45Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">NVA13.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
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18 <LAT>0.007</LAT>
19 <LONG>0.005</LONG>
20 <EL_HEIGHT>0.014</EL_HEIGHT>
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23 <USED_SATELLITES TOTAL="17" GPS_SV="G08 G14 G15 G18 G20 G21 G24 G27 G32"
QZSS_SV="" GLN_SV="R06 R07 R08 R15 R16 R21 R22 R23" GAL_SV="" BDS_SV="">G08 G14
G15 G18 G20 G21 G24 G27 G32 R06 R07 R08 R15 R16 R21 R22 R23</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
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28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-873544.190</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4483820.667</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4437091.163</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>21</MINUTES>
39 <SECONDS>31.40642</SECONDS>
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42 <DEGREES>-101</DEGREES>
43 <MINUTES>1</MINUTES>
44 <SECONDS>27.66050</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">591.600</EL_HEIGHT>
47 </ELLIP_COORD>
48 </COORD_SET>

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50 <POSITION TYPE="CUSTOM">
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52   <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
    America</TECTONIC_PLATE>
53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
55     <RECT_COORD>
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57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4483821.941</COORDINATE>
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72     </ELLIP_COORD>
73   </COORD_SET>
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76   <ELEMENT_1_1>2.6681E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>8.0272E-06</ELEMENT_2_1>
78   <ELEMENT_2_2>1.5490E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-2.1690E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-7.8676E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.0076E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>4.5052E-05</ELEMENT_1_1>
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86   <ELEMENT_2_2>2.8356E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-2.4405E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>7.5211E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>2.0893E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T14:10:46Z" />
92 <POINT_ID COORD_TYPE="Local">NVA13</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_14.16o OP1479140975125

FILE: ESP\_NVA\_14.16o OP1479140975125

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_318t.16o TIME: 16:34:29 UTC

SOFTWARE: rsgps 1.37 RS51.prl 1.99.3 START: 2016/11/13 19:50:45  
EPHEMERIS: igu19230.eph [ultra-rapid] STOP: 2016/11/13 20:57:45  
NAV FILE: brdc3180.16n OBS USED: 4585 / 4790 : 96%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 3.68/ 55.80  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.298

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86844)

X: -855560.489(m) 0.005(m) -855561.373(m) 0.005(m)  
Y: -4485922.465(m) 0.022(m) -4485921.174(m) 0.022(m)  
Z: 4438437.408(m) 0.023(m) 4438437.344(m) 0.023(m)

LAT: 44 22 32.94240 0.003(m) 44 22 32.96589 0.003(m)  
E LON: 259 12 7.76356 0.004(m) 259 12 7.71341 0.004(m)  
W LON: 100 47 52.23644 0.004(m) 100 47 52.28659 0.004(m)  
EL HGT: 574.856(m) 0.032(m) 574.023(m) 0.032(m)  
ORTHO HGT: 597.675(m) 0.033(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4915187.239 60595.758  
Easting (X) [meters] 356771.904 536413.841  
Convergence [degrees] -1.25755593 -0.56466428  
Point Scale 0.99985229 1.00000808  
Combined Factor 0.99976218 0.99991795

US NATIONAL GRID DESIGNATOR: 14TLQ5677115187(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	168296.7
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	196696.6
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	203604.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	215280.9
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	223396.2

NEAREST NGS PUBLISHED CONTROL POINT

AB9082	14 206.05	N442301.	W1004812.	970.3
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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3   <OBSERVATION_TIME START="2016-11-13T19:50:45Z" END="2016-11-13T20:57:45Z" />
4   <CONTRIBUTOR />
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7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
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20      <EL_HEIGHT>0.014</EL_HEIGHT>
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24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
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33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4438437.360</COORDINATE>
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53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
55     <RECT_COORD>
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57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4485922.486</COORDINATE>
58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4438437.442</COORDINATE>
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79   <ELEMENT_3_1>-1.4867E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-7.6000E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.0144E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85   <ELEMENT_2_1>-2.9811E-06</ELEMENT_2_1>
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87   <ELEMENT_3_1>-1.1794E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>2.5243E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>1.9264E-04</ELEMENT_3_3>
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92 <POINT_ID COORD_TYPE="Local">ESP_NVA_14</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_15.16o OP1479140982219

FILE: ESP\_NVA\_15.16o OP1479140982219

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_318v.16o TIME: 16:34:15 UTC

SOFTWARE: rsgps 1.37 RS50.prl 1.99.3 START: 2016/11/13 21:26:30  
EPHEMERIS: igu19230.eph [ultra-rapid] STOP: 2016/11/13 22:31:45  
NAV FILE: brdc3180.16n OBS USED: 3888 / 4560 : 85%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 17.12/ 31.38  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.314

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86862)

X: -847276.875(m) 0.003(m) -847277.759(m) 0.003(m)  
Y: -4487373.946(m) 0.011(m) -4487372.655(m) 0.011(m)  
Z: 4438540.635(m) 0.007(m) 4438540.571(m) 0.007(m)

LAT: 44 22 38.01421 0.005(m) 44 22 38.03775 0.005(m)  
E LON: 259 18 27.57174 0.004(m) 259 18 27.52169 0.004(m)  
W LON: 100 41 32.42826 0.004(m) 100 41 32.47831 0.004(m)  
EL HGT: 562.448(m) 0.012(m) 561.614(m) 0.012(m)  
ORTHO HGT: 585.435(m) 0.014(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4915164.636 60674.915  
Easting (X) [meters] 365180.205 544823.230  
Convergence [degrees] -1.18376607 -0.48999629  
Point Scale 0.99982354 1.00000779  
Combined Factor 0.99973537 0.99991961



US NATIONAL GRID DESIGNATOR: 14TLQ6518015164(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	167628.2
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	195194.7
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	205035.6
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	210975.1
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	216335.5
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	242389.5

NEAREST NGS PUBLISHED CONTROL POINT

PT0313	1955.8	N442310.	W1004136.	990.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4 <CONTRIBUTOR />
5 <DATA_SOURCES>
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7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
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23 <USED_SATELLITES TOTAL="20" GPS_SV="G01 G08 G10 G11 G12 G14 G18 G21 G24 G27 G31
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24 </DATA_QUALITY>
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26 <REF_FRAME>ITRF2008</REF_FRAME>
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28 <EPOCH>2016.87</EPOCH>
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32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.015">-4487372.680</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4438540.563</COORDINATE>
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35 <ELLIP_COORD>
36 <LAT>
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42 <DEGREES>-100</DEGREES>
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45 </EAST_LONG>
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47 </ELLIP_COORD>

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America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
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55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-847276.865</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.015">-4487373.955</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4438540.645</COORDINATE>
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73     </COORD_SET>
74 </POSITION>
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78     <ELEMENT_2_2>2.1528E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.9145E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-6.0263E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.2266E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>1.0375E-04</ELEMENT_1_1>
85     <ELEMENT_2_1>-2.2704E-05</ELEMENT_2_1>
86     <ELEMENT_2_2>3.7684E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-4.3444E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>1.2292E-05</ELEMENT_3_2>
89     <ELEMENT_3_3>2.3121E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T15:08:57Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_15</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_16.16o OP1479140822690

FILE: ESP\_NVA\_16.16o OP1479140822690

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_317v.16o TIME: 16:34:17 UTC

SOFTWARE: rsgps 1.37 RS53.prl 1.99.3 START: 2016/11/12 21:59:15  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 23:04:45  
NAV FILE: brdc3170.16n OBS USED: 4134 / 4140 : 100%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 26.00/ 25.90  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.315

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86595)

X: -829399.175(m) 0.005(m) -829400.059(m) 0.005(m)  
Y: -4489956.700(m) 0.018(m) -4489955.408(m) 0.018(m)  
Z: 4439228.312(m) 0.015(m) 4439228.248(m) 0.015(m)

LAT: 44 23 10.77886 0.005(m) 44 23 10.80253 0.005(m)  
E LON: 259 32 2.82189 0.005(m) 259 32 2.77201 0.005(m)  
W LON: 100 27 57.17811 0.005(m) 100 27 57.22799 0.005(m)  
EL HGT: 512.152(m) 0.023(m) 511.314(m) 0.023(m)  
ORTHO HGT: 535.482(m) 0.024(m) [NAVD88 (Computed using GEOID12B)]

#### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters]	4915827.739	61557.135
Easting (X) [meters]	383239.129	562876.612
Convergence [degrees]	-1.02548996	-0.32972305
Point Scale	0.99976766	1.00000595
Combined Factor	0.99968738	0.99992565

US NATIONAL GRID DESIGNATOR: 14TLQ8323915827(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	168325.9
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	177138.9
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	201100.6
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	201956.7
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	223045.8
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	235747.2

NEAREST NGS PUBLISHED CONTROL POINT

AB9065	14 223.27	N442312.	W1002740.	382.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```

1 <TRIMBLE_RTX_SOLUTION SID="7799399" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2 <SOLUTION_TIME>2016-11-14T13:32:21Z</SOLUTION_TIME>
3 <OBSERVATION_TIME START="2016-11-12T21:59:15Z" END="2016-11-12T23:04:45Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">ESP_NVA_16.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
17 <ACCURACY UNIT="m">
18 <LAT>0.007</LAT>
19 <LONG>0.004</LONG>
20 <EL_HEIGHT>0.015</EL_HEIGHT>
21 </ACCURACY>
22 <PERCENT_OBS_USED TOTAL="263" PROCESSING_INTERVAL="15.0" USABLE="263"
USED="257">97</PERCENT_OBS_USED>
23 <USED_SATELLITES TOTAL="22" GPS_SV="G01 G08 G10 G11 G12 G14 G18 G21 G22 G24 G25
G27 G31 G32" QZSS_SV="" GLN_SV="R01 R02 R08 R10 R11 R12 R23 R24" GAL_SV=""
BDS_SV="">G01 G08 G10 G11 G12 G14 G18 G21 G22 G24 G25 G27 G31 G32 R01 R02 R08
R10 R11 R12 R23 R24</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-829400.061</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4489955.432</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4439228.249</COORDINATE>
34 </RECT_COORD>
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36 <LAT>
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38 <MINUTES>23</MINUTES>
39 <SECONDS>10.80201</SECONDS>
40 </LAT>
41 <EAST_LONG>
42 <DEGREES>-100</DEGREES>
43 <MINUTES>27</MINUTES>
44 <SECONDS>57.22786</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">511.331</EL_HEIGHT>
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49 </POSITION>
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52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4489956.708</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4439228.331</COORDINATE>
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68                 <MINUTES>27</MINUTES>
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71             <EL_HEIGHT UNIT="m">512.170</EL_HEIGHT>
72         </ELLIP_COORD>
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77     <ELEMENT_2_1>2.6044E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.6680E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.4608E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.1655E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.0481E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>4.4609E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>7.0193E-07</ELEMENT_2_1>
86     <ELEMENT_2_2>1.8609E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-3.1284E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>2.5481E-06</ELEMENT_3_2>
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90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T13:32:21Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_16</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:20 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : NVA17.16o OP1479140151955

FILE: NVA17.16o OP1479140151955

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: nva1316t.16o TIME: 16:18:11 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3 START: 2016/11/11 19:10:00  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 20:10:15  
NAV FILE: brdc3160.16n OBS USED: 3804 / 4242 : 90%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 37.70/ 62.80  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.282

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86289)

X: -877069.003(m) 0.004(m) -877069.887(m) 0.004(m)  
Y: -4480921.315(m) 0.013(m) -4480920.026(m) 0.013(m)  
Z: 4439319.169(m) 0.015(m) 4439319.105(m) 0.015(m)

LAT: 44 23 12.15840 0.004(m) 44 23 12.18173 0.004(m)  
E LON: 258 55 30.99986 0.003(m) 258 55 30.94948 0.003(m)  
W LON: 101 4 29.00014 0.003(m) 101 4 29.05052 0.003(m)  
EL HGT: 598.534(m) 0.020(m) 597.707(m) 0.020(m)  
ORTHO HGT: 620.949(m) 0.021(m) [NAVD88 (Computed using GEOID12B)]

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4916918.774	62061.328
Easting (X) [meters]	334744.358	514364.480
Convergence [degrees]	-1.45159059	-0.76062198
Point Scale	0.99993586	1.00000587
Combined Factor	0.99984203	0.99991203

US NATIONAL GRID DESIGNATOR: 14TLQ3474416918(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	62148.7
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	173624.8
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	175134.5
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	225650.0
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	226309.3
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	241484.4

NEAREST NGS PUBLISHED CONTROL POINT

PT1121	THE LITTLE BROWN METH CH BEL	N442220.556	W1010427.143	1593.3
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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4   <CONTRIBUTOR />
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6     <OBS_FILE TYPE="T02">NVA17.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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18      <LAT>0.008</LAT>
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20      <EL_HEIGHT>0.014</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="242" PROCESSING_INTERVAL="15.0" USABLE="242"
USED="236">97</PERCENT_OBS_USED>
23    <USED_SATELLITES TOTAL="20" GPS_SV="G08 G13 G15 G18 G20 G21 G24 G27 G29 G32"
QZSS_SV="" GLN_SV="R05 R06 R07 R08 R15 R16 R20 R21 R22 R23" GAL_SV=""
BDS_SV="">G08 G13 G15 G18 G20 G21 G24 G27 G29 G32 R05 R06 R07 R08 R15 R16 R20
R21 R22 R23</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.87</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-877069.890</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.010">-4480920.045</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.014">4439319.109</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
37          <DEGREES>44</DEGREES>
38          <MINUTES>23</MINUTES>
39          <SECONDS>12.18138</SECONDS>
40        </LAT>
41        <EAST_LONG>
42          <DEGREES>-101</DEGREES>
43          <MINUTES>4</MINUTES>
44          <SECONDS>29.05049</SECONDS>
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49 </POSITION>
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54     <COORD_SET>
55         <RECT_COORD>
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57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.010">-4480921.319</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.014">4439319.191</COORDINATE>
59         </RECT_COORD>
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78     <ELEMENT_2_2>9.5084E-05</ELEMENT_2_2>
79     <ELEMENT_3_1>9.2456E-06</ELEMENT_3_1>
80     <ELEMENT_3_2>-7.1072E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.8301E-04</ELEMENT_3_3>
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85     <ELEMENT_2_1>7.7772E-06</ELEMENT_2_1>
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87     <ELEMENT_3_1>4.6507E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>2.4543E-05</ELEMENT_3_2>
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93
```

# OPUS-RS solution : ESP\_NVA\_18.16o OP1479315757671

opus <opus@ngs.noaa.gov>

Wed 11/16/2016 12:04 PM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_18.16o OP1479315757671

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 16, 2016  
RINEX FILE: esp\_320n.16o                  TIME: 17:04:03 UTC

SOFTWARE: rsgps 1.37 RS53.prl 1.99.3      START: 2016/11/15 13:13:45  
EPHEMERIS: igu19232.eph [ultra-rapid]      STOP: 2016/11/15 14:23:30  
NAV FILE: brdc3200.16n                  OBS USED: 4296 / 4710 : 91%  
ANT NAME: TRMR8\_GNSS3    NONE                  QUALITY IND. 30.61/ 59.02  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.300

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87316)

X: -859566.117(m) 0.006(m)      -859567.001(m) 0.006(m)  
Y: -4483496.283(m) 0.010(m)      -4483494.993(m) 0.010(m)  
Z: 4440106.992(m) 0.010(m)      4440106.929(m) 0.010(m)

LAT: 44 23 48.54484    0.008(m)      44 23 48.56832    0.008(m)  
E LON: 259 8 49.44690    0.006(m)      259 8 49.39669    0.006(m)  
W LON: 100 51 10.55310    0.006(m)      100 51 10.60331    0.006(m)  
EL HGT:    577.367(m) 0.012(m)      576.537(m) 0.012(m)  
ORTHO HGT:    600.043(m) 0.015(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES    STATE PLANE COORDINATES  
UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4917617.742      62973.995  
Easting (X) [meters]    352435.985      532048.209  
Convergence [degrees]    -1.29658780      -0.60365213  
Point Scale    0.99986779      1.00000386  
Combined Factor    0.99977728      0.99991334

US NATIONAL GRID DESIGNATOR: 14TLQ5243517617(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	215567.5
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	171204.1
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	192733.4
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	225815.8
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	207971.1
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	240822.3

## NEAREST NGS PUBLISHED CONTROL POINT

PT0321	W 74	N442312.	W1005051.	1208.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4 <CONTRIBUTOR />
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6 <OBS_FILE TYPE="T02">ESP_NVA_18.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
17 <ACCURACY UNIT="m">
18 <LAT>0.006</LAT>
19 <LONG>0.004</LONG>
20 <EL_HEIGHT>0.013</EL_HEIGHT>
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22 <PERCENT_OBS_USED TOTAL="280" PROCESSING_INTERVAL="15.0" USABLE="280"
USED="274">97</PERCENT_OBS_USED>
23 <USED_SATELLITES TOTAL="19" GPS_SV="G02 G05 G06 G09 G12 G17 G19 G24 G25 G29"
QZSS_SV="" GLN_SV="R06 R07 R08 R12 R13 R14 R21 R22 R23" GAL_SV="" BDS_SV="">G02
G05 G06 G09 G12 G17 G19 G24 G25 G29 R06 R07 R08 R12 R13 R14 R21 R22
R23</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28 <EPOCH>2016.88</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.004">-859567.006</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4483494.999</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4440106.921</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>23</MINUTES>
39 <SECONDS>48.56799</SECONDS>
40 </LAT>
41 <EAST_LONG>
42 <DEGREES>-100</DEGREES>
43 <MINUTES>51</MINUTES>
44 <SECONDS>10.60346</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">576.536</EL_HEIGHT>
47 </ELLIP_COORD>

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48     </COORD_SET>
49 </POSITION>
50 <POSITION TYPE="CUSTOM">
51     <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.004">-859566.112</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4483496.273</COORDINATE>
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59         </RECT_COORD>
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66             <EAST_LONG>
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68                 <MINUTES>51</MINUTES>
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71             <EL_HEIGHT UNIT="m">577.367</EL_HEIGHT>
72         </ELLIP_COORD>
73     </COORD_SET>
74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76     <ELEMENT_1_1>1.8670E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>1.3176E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.1081E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.0672E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-6.9462E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>9.7744E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>3.4713E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-1.5001E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>1.7063E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-5.8571E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>5.2454E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>1.7545E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-15T19:08:58Z" />
92 <POINT_ID COORD_TYPE="Local">JV_01</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:36 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_19.16o OP1479140811052

FILE: ESP\_NVA\_19.16o OP1479140811052

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_317t.16o TIME: 16:35:29 UTC

SOFTWARE: rsgps 1.37 RS52.prl 1.99.3 START: 2016/11/12 19:59:30  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 21:07:45  
NAV FILE: brdc3170.16n OBS USED: 6482 / 6951 : 93%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 20.61/ 59.02  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.287

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86573)

X:	-805799.308(m)	0.004(m)	-805800.192(m)	0.004(m)
Y:	-4492281.687(m)	0.018(m)	-4492280.394(m)	0.018(m)
Z:	4441197.555(m)	0.015(m)	4441197.492(m)	0.015(m)

LAT:	44 24 40.31568	0.006(m)	44 24 40.33954	0.006(m)
E LON:	259 49 50.74338	0.002(m)	259 49 50.69374	0.002(m)
W LON:	100 10 9.25662	0.002(m)	100 10 9.30626	0.002(m)
EL HGT:	504.223(m)	0.023(m)	503.382(m)	0.023(m)
ORTHO HGT:	527.772(m)	0.024(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4918210.209	64228.120
Easting (X) [meters]	406907.095	586520.163
Convergence [degrees]	-0.81829476	-0.11977616
Point Scale	0.99970658	1.00000105
Combined Factor	0.99962755	0.99992200

US NATIONAL GRID DESIGNATOR: 14TMQ0690718210(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	153517.1
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	173620.6
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	180949.0
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	190653.5
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	219118.9
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	234124.3
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	241180.2

NEAREST NGS PUBLISHED CONTROL POINT

PT1010	TT 14 B	N442347.366	W1000742.043	3644.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="7799403" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2   <SOLUTION_TIME>2016-11-14T13:34:10Z</SOLUTION_TIME>
3   <OBSERVATION_TIME START="2016-11-12T19:59:30Z" END="2016-11-12T21:07:45Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">ESP_NVA_19.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
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18      <LAT>0.006</LAT>
19      <LONG>0.004</LONG>
20      <EL_HEIGHT>0.014</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="274" PROCESSING_INTERVAL="15.0" USABLE="274"
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23    <USED_SATELLITES TOTAL="19" GPS_SV="G08 G10 G13 G14 G15 G18 G20 G21 G24 G27 G32"
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G13 G14 G15 G18 G20 G21 G24 G27 G32 R01 R07 R08 R10 R16 R22 R23
R24</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.87</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-805800.198</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4492280.422</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4441197.502</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
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38          <MINUTES>24</MINUTES>
39          <SECONDS>40.33911</SECONDS>
40        </LAT>
41        <EAST_LONG>
42          <DEGREES>-100</DEGREES>
43          <MINUTES>10</MINUTES>
44          <SECONDS>9.30630</SECONDS>
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46        <EL_HEIGHT UNIT="m">503.409</EL_HEIGHT>
47      </ELLIP_COORD>
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48   </COORD_SET>
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51     <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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53     <EPOCH>2010.0</EPOCH>
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55       <RECT_COORD>
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57         <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4492281.700</COORDINATE>
58         <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4441197.583</COORDINATE>
59       </RECT_COORD>
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72       </ELLIP_COORD>
73     </COORD_SET>
74   </POSITION>
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76     <ELEMENT_1_1>2.4161E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>2.1796E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.3589E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.7286E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-8.4575E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>9.8926E-05</ELEMENT_3_3>
82   </COVARIANCE_MATRIX>
83   <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>3.2753E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-7.7378E-07</ELEMENT_2_1>
86     <ELEMENT_2_2>2.0068E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-1.8751E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>-2.1861E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>2.0616E-04</ELEMENT_3_3>
90   </COVARIANCE_MATRIX>
91   <RETRIEVAL TIME="2016-11-14T13:34:10Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_19</POINT_ID></TRIMBLE_RTX_SOLUTION>
93

```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_20.16o OP1479140799495

FILE: ESP\_NVA\_20.16o OP1479140799495

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_317r.16o TIME: 16:33:53 UTC

SOFTWARE: rsgps 1.37 RS54.prl 1.99.3 START: 2016/11/12 17:36:00  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 18:48:00  
NAV FILE: brdc3170.16n OBS USED: 5586 / 6076 : 92%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 7.72/ 64.56  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.300

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86546)

X:	-819703.214(m)	0.004(m)	-819704.098(m)	0.004(m)
Y:	-4488156.581(m)	0.011(m)	-4488155.289(m)	0.011(m)
Z:	4442810.327(m)	0.014(m)	4442810.264(m)	0.014(m)

LAT:	44 25 53.51632	0.004(m)	44 25 53.54008	0.004(m)
E LON:	259 38 59.09817	0.003(m)	259 38 59.04836	0.003(m)
W LON:	100 21 0.90183	0.003(m)	100 21 0.95164	0.003(m)
EL HGT:	502.659(m)	0.018(m)	501.821(m)	0.018(m)
ORTHO HGT:	525.939(m)	0.020(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4920690.572	66533.824
Easting (X) [meters]	392532.364	572112.317
Convergence [degrees]	-0.94534172	-0.24788566
Point Scale	0.99974203	0.99999719
Combined Factor	0.99966324	0.99991838

US NATIONAL GRID DESIGNATOR: 14TLQ9253220690(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	167974.0
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	173933.1
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	190728.3
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	193652.5
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	226032.2
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	232875.3
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	237256.6

NEAREST NGS PUBLISHED CONTROL POINT

PT0192	W 308	N442623.	W1002101.	910.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="7799410" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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3 <OBSERVATION_TIME START="2016-11-12T17:36:00Z" END="2016-11-12T18:48:00Z" />
4 <CONTRIBUTOR />
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9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
17 <ACCURACY UNIT="m">
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20 <EL_HEIGHT>0.014</EL_HEIGHT>
21 </ACCURACY>
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USED="283">97</PERCENT_OBS_USED>
23 <USED_SATELLITES TOTAL="19" GPS_SV="G05 G10 G13 G15 G16 G18 G20 G21 G26 G27 G29"
QZSS_SV="" GLN_SV="R05 R06 R07 R08 R20 R21 R22 R23" GAL_SV="" BDS_SV="">G05 G10
G13 G15 G16 G18 G20 G21 G26 G27 G29 R05 R06 R07 R08 R20 R21 R22
R23</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
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America</TECTONIC_PLATE>
28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
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31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-819704.104</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4488155.333</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4442810.288</COORDINATE>
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35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>25</MINUTES>
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42 <DEGREES>-100</DEGREES>
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44 <SECONDS>0.95153</SECONDS>
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52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
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55         <RECT_COORD>
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58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4442810.369</COORDINATE>
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66             <EAST_LONG>
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72         </ELLIP_COORD>
73     </COORD_SET>
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76     <ELEMENT_1_1>2.1480E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>1.8372E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.2502E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.1918E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-7.3855E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>8.8077E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85     <ELEMENT_2_1>3.2398E-07</ELEMENT_2_1>
86     <ELEMENT_2_2>1.8328E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-1.8558E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>1.8773E-06</ELEMENT_3_2>
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91 <RETRIEVAL TIME="2016-11-14T13:40:44Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_20</POINT_ID></TRIMBLE_RTX_SOLUTION>
93

```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:30 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_21.16o OP1479140713280

FILE: ESP\_NVA\_21.16o OP1479140713280

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

sdhu  
sdab  
nevn  
ndas  
ndel  
sdwe

Your station is 6.3 KM outside the polygon enclosing the reference stations

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_316t.16o TIME: 16:29:35 UTC

SOFTWARE: rsgps 1.37 RS54.prl 1.99.3 START: 2016/11/11 19:37:00  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 20:42:15  
NAV FILE: brdc3160.16n OBS USED: 5178 / 5550 : 93%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 48.79/ 67.21  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.328

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86295)

X: -795916.669(m) 0.004(m) -795917.553(m) 0.004(m)  
Y: -4491781.579(m) 0.015(m) -4491780.286(m) 0.015(m)  
Z: 4443503.121(m) 0.013(m) 4443503.058(m) 0.013(m)



LAT: 44 26 24.15149 0.003(m) 44 26 24.17541 0.003(m)  
 E LON: 259 57 6.58613 0.003(m) 259 57 6.53657 0.003(m)  
 W LON: 100 2 53.41387 0.003(m) 100 2 53.46343 0.003(m)  
 EL HGT: 527.710(m) 0.020(m) 526.867(m) 0.020(m)  
 ORTHO HGT: 551.324(m) 0.021(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4921283.473	67420.247
Easting (X) [meters]	416587.352	596165.113
Convergence [degrees]	-0.73393185	-0.03409212
Point Scale	0.99968556	0.99999560
Combined Factor	0.99960285	0.99991286

US NATIONAL GRID DESIGNATOR: 14TMQ1658721283(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	143966.1
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	171586.3
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	178704.3
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	184699.5
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	210982.9
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	224099.6

NEAREST NGS PUBLISHED CONTROL POINT

PT1000	MEDICINE	N442826.194	W1000203.319	3926.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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3 <OBSERVATION_TIME START="2016-11-11T19:37:00Z" END="2016-11-11T20:42:15Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">ESP_NVA_21.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
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18 <LAT>0.006</LAT>
19 <LONG>0.005</LONG>
20 <EL_HEIGHT>0.015</EL_HEIGHT>
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BDS_SV="">G08 G10 G13 G15 G18 G20 G21 G24 G27 G32 R05 R06 R07 R08 R15 R16 R20
R21 R22 R23</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
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27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-795917.557</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4491780.320</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4443503.071</COORDINATE>
34 </RECT_COORD>
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42 <DEGREES>-100</DEGREES>
43 <MINUTES>2</MINUTES>
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52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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53     <EPOCH>2010.0</EPOCH>
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71             <EL_HEIGHT UNIT="m">527.744</EL_HEIGHT>
72         </ELLIP_COORD>
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77     <ELEMENT_2_1>1.7434E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.1528E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.4293E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.0659E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.3090E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>3.3081E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>1.8321E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.1619E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>7.9838E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>6.2222E-07</ELEMENT_3_2>
89     <ELEMENT_3_3>2.1633E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T13:43:14Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_21</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:19 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : NVA22.16o OP1479140171971

FILE: NVA22.16o OP1479140171971

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: nva2316q.16o TIME: 16:18:20 UTC

SOFTWARE: rsgps 1.37 RS51.prl 1.99.3 START: 2016/11/11 16:27:15  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 17:27:15  
NAV FILE: brdc3160.16n OBS USED: 4512 / 4746 : 95%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 24.17/ 57.23  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.304

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86259)

X:	-880932.464(m)	0.004(m)	-880933.349(m)	0.004(m)
Y:	-4475609.426(m)	0.011(m)	-4475608.138(m)	0.011(m)
Z:	4443922.445(m)	0.016(m)	4443922.382(m)	0.016(m)

LAT:	44 26 39.97402	0.005(m)	44 26 39.99735	0.005(m)
E LON:	258 51 53.41281	0.003(m)	258 51 53.36230	0.003(m)
W LON:	101 8 6.58719	0.003(m)	101 8 6.63770	0.003(m)
EL HGT:	628.542(m)	0.019(m)	627.718(m)	0.019(m)
ORTHO HGT:	650.732(m)	0.021(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4923454.676	68541.027
Easting (X) [meters]	330097.388	509638.710
Convergence [degrees]	-1.49543450	-0.80339828
Point Scale	0.99995501	0.99999480
Combined Factor	0.99985647	0.99989626

US NATIONAL GRID DESIGNATOR: 14TLQ3009723454(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	67096.1
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	171706.7
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	181066.5
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	224002.1
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	230478.9
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	238242.8

NEAREST NGS PUBLISHED CONTROL POINT

PT0423	A 73	N442628.	W1010808.	370.9
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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10      <REFERENCE>Bottom of antenna mount</REFERENCE>
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13      <NAME>TRIMBLE R8 GNSS3</NAME>
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24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
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33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4443922.366</COORDINATE>
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79   <ELEMENT_3_1>-2.7840E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.1704E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.0991E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
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93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Tuesday, November 15, 2016 9:34 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_23.16o OP1479220208966

FILE: ESP\_NVA\_23.16o OP1479220208966

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 15, 2016  
RINEX FILE: esp\_319n.16o TIME: 14:32:22 UTC

SOFTWARE: rsgps 1.37 RS53.prl 1.99.3 START: 2016/11/14 13:57:15  
EPHEMERIS: igu19231.eph [ultra-rapid] STOP: 2016/11/14 14:59:30  
NAV FILE: brdc3190.16n OBS USED: 3960 / 4086 : 97%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 32.34/ 47.03  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.339

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87050)

X: -828343.442(m) 0.006(m) -828344.327(m) 0.006(m)  
Y: -4485624.027(m) 0.009(m) -4485622.736(m) 0.009(m)  
Z: 4443798.091(m) 0.009(m) 4443798.028(m) 0.009(m)

LAT: 44 26 37.46098 0.007(m) 44 26 37.48467 0.007(m)  
E LON: 259 32 14.17813 0.006(m) 259 32 14.12818 0.006(m)  
W LON: 100 27 45.82187 0.006(m) 100 27 45.87182 0.006(m)  
EL HGT: 530.044(m) 0.011(m) 529.209(m) 0.011(m)  
ORTHO HGT: 553.195(m) 0.014(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4922200.348 67935.199  
Easting (X) [meters] 383604.357 563164.437  
Convergence [degrees] -1.02432947 -0.32749049  
Point Scale 0.99976661 0.99999492  
Combined Factor 0.99968353 0.99991182



US NATIONAL GRID DESIGNATOR: 14TLQ8360422200(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	174710.7
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	176962.8
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	196067.2
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	197119.5
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	224241.5
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	230709.7

NEAREST NGS PUBLISHED CONTROL POINT

PT0239	BROWN HILL RM 2	N442542.64	W1002725.86	1748.8
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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BDS_SV=" ">G02 G05 G06 G09 G12 G17 G19 G20 G25 G29 R05 R06 R07 R08 R11 R12 R13
R21 R22 R23</USED_SATELLITES>
24 </DATA_QUALITY>
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America</TECTONIC_PLATE>
28 <EPOCH>2016.87</EPOCH>
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31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-828344.330</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4485622.747</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.013">4443798.023</COORDINATE>
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52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-828343.436</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4485624.022</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.013">4443798.104</COORDINATE>
59         </RECT_COORD>
60         <ELLIP_COORD>
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63                 <MINUTES>26</MINUTES>
64                 <SECONDS>37.46140</SECONDS>
65             </LAT>
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67                 <DEGREES>-100</DEGREES>
68                 <MINUTES>27</MINUTES>
69                 <SECONDS>45.82164</SECONDS>
70             </EAST_LONG>
71             <EL_HEIGHT UNIT="m">530.049</EL_HEIGHT>
72         </ELLIP_COORD>
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74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76     <ELEMENT_1_1>3.4956E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>2.0798E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.5532E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.7317E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.2495E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.5719E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>3.1978E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>2.5932E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>3.1497E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>1.6523E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>5.4403E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>2.8399E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-15T13:51:44Z" />
92 <POINT_ID COORD_TYPE="Local">JV_01</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:36 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_24.16o OP1479140952812

FILE: ESP\_NVA\_24.16o OP1479140952812

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_318p.16o TIME: 16:33:08 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3 START: 2016/11/13 15:25:45  
EPHEMERIS: igu19230.eph [ultra-rapid] STOP: 2016/11/13 16:31:15  
NAV FILE: brdc3180.16n OBS USED: 3912 / 4332 : 90%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 23.34/ 58.22  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.279

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86794)

X: -847782.664(m) 0.009(m) -847783.549(m) 0.009(m)  
Y: -4480388.482(m) 0.017(m) -4480387.192(m) 0.017(m)  
Z: 4445456.507(m) 0.016(m) 4445456.444(m) 0.016(m)

LAT: 44 27 51.52435 0.004(m) 44 27 51.54792 0.004(m)  
E LON: 259 17 6.46355 0.007(m) 259 17 6.41337 0.007(m)  
W LON: 100 42 53.53645 0.007(m) 100 42 53.58663 0.007(m)  
EL HGT: 567.769(m) 0.023(m) 566.937(m) 0.023(m)  
ORTHO HGT: 590.471(m) 0.025(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4924875.248 70367.190  
Easting (X) [meters] 363588.048 543113.174  
Convergence [degrees] -1.20139165 -0.50594167  
Point Scale 0.99982884 0.99999121  
Combined Factor 0.99973984 0.99990219

US NATIONAL GRID DESIGNATOR: 14TLQ6358824875(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	177413.5
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	197095.2
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	203453.5
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	204894.3
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	212517.7
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	232763.2

NEAREST NGS PUBLISHED CONTROL POINT

PT1065	LACY 2 RESET	N442958.429	W1004515.493	5018.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```

1 <TRIMBLE_RTX_SOLUTION SID="7799419" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2   <SOLUTION_TIME>2016-11-14T13:45:11Z</SOLUTION_TIME>
3   <OBSERVATION_TIME START="2016-11-13T15:25:45Z" END="2016-11-13T16:31:15Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">ESP_NVA_24.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00      NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
17    <ACCURACY UNIT="m" >
18      <LAT>0.006</LAT>
19      <LONG>0.005</LONG>
20      <EL_HEIGHT>0.015</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="263" PROCESSING_INTERVAL="15.0" USABLE="263"
USED="257">97</PERCENT_OBS_USED>
23    <USED_SATELLITES TOTAL="21" GPS_SV="G02 G05 G06 G12 G13 G15 G20 G21 G25 G26 G29"
QZSS_SV=" " GLN_SV="R05 R06 R07 R08 R12 R13 R20 R21 R22 R23" GAL_SV=" "
BDS_SV=" " >G02 G05 G06 G12 G13 G15 G20 G21 G25 G26 G29 R05 R06 R07 R08 R12 R13
R20 R21 R22 R23</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.87</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-847783.555</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4480387.215</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4445456.458</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
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38          <MINUTES>27</MINUTES>
39          <SECONDS>51.54771</SECONDS>
40        </LAT>
41        <EAST_LONG>
42          <DEGREES>-100</DEGREES>
43          <MINUTES>42</MINUTES>
44          <SECONDS>53.58671</SECONDS>
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46        <EL_HEIGHT UNIT="m">566.964</EL_HEIGHT>
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49 </POSITION>
50 <POSITION TYPE="CUSTOM">
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52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
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72         </ELLIP_COORD>
73     </COORD_SET>
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77     <ELEMENT_2_1>2.9933E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.4146E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-2.6782E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.0420E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.0449E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>3.2265E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-1.7548E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.1203E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-2.0238E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>-1.1780E-05</ELEMENT_3_2>
89     <ELEMENT_3_3>2.2070E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T13:45:11Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_24</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_25.16o OP1479140961731

FILE: ESP\_NVA\_25.16o OP1479140961731

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_318r.16o TIME: 16:33:32 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3 START: 2016/11/13 17:18:00  
EPHEMERIS: igu19230.eph [ultra-rapid] STOP: 2016/11/13 18:25:00  
NAV FILE: brdc3180.16n OBS USED: 4710 / 5124 : 92%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 12.57/ 84.75  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.290

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86815)

X: -839570.500(m) 0.003(m) -839571.385(m) 0.003(m)  
Y: -4482246.681(m) 0.007(m) -4482245.391(m) 0.007(m)  
Z: 4445150.051(m) 0.007(m) 4445149.988(m) 0.007(m)

LAT: 44 27 37.47898 0.005(m) 44 27 37.50260 0.005(m)  
E LON: 259 23 27.06277 0.003(m) 259 23 27.01268 0.003(m)  
W LON: 100 36 32.93723 0.003(m) 100 36 32.98732 0.003(m)  
EL HGT: 572.041(m) 0.009(m) 571.208(m) 0.009(m)  
ORTHO HGT: 594.949(m) 0.012(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4924270.953 69864.871  
Easting (X) [meters] 371989.379 551522.708  
Convergence [degrees] -1.12722683 -0.43111817  
Point Scale 0.99980152 0.99999191  
Combined Factor 0.99971185 0.99990222



US NATIONAL GRID DESIGNATOR: 14TLQ7198924270(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	176520.9
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	188672.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	199687.7
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	205676.9
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	213079.1
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	233089.7

NEAREST NGS PUBLISHED CONTROL POINT

PT0277	CHANTIER AZ MK RESET	N442739.	W1003638.	121.4
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="7799422" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">ESP_NVA_25.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
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18      <LAT>0.005</LAT>
19      <LONG>0.004</LONG>
20      <EL_HEIGHT>0.013</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="269" PROCESSING_INTERVAL="15.0" USABLE="269"
USED="263">97</PERCENT_OBS_USED>
23    <USED_SATELLITES TOTAL="19" GPS_SV="G02 G05 G10 G13 G15 G16 G18 G20 G21 G26 G29"
QZSS_SV=" " GLN_SV="R01 R06 R07 R08 R21 R22 R23 R24" GAL_SV=" " BDS_SV=" ">G02 G05
G10 G13 G15 G16 G18 G20 G21 G26 G29 R01 R06 R07 R08 R21 R22 R23
R24</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28    <EPOCH>2016.87</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-839571.385</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.010">-4482245.407</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4445149.987</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
37          <DEGREES>44</DEGREES>
38          <MINUTES>27</MINUTES>
39          <SECONDS>37.50221</SECONDS>
40        </LAT>
41        <EAST_LONG>
42          <DEGREES>-100</DEGREES>
43          <MINUTES>36</MINUTES>
44          <SECONDS>32.98721</SECONDS>
45        </EAST_LONG>
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47      </ELLIP_COORD>

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48     </COORD_SET>
49 </POSITION>
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51     <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-839570.492</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.010">-4482246.682</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4445150.068</COORDINATE>
59         </RECT_COORD>
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66             <EAST_LONG>
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68                 <MINUTES>36</MINUTES>
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70             </EAST_LONG>
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72         </ELLIP_COORD>
73     </COORD_SET>
74 </POSITION>
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78     <ELEMENT_2_2>9.7202E-05</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.5325E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-7.0659E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>8.5144E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85     <ELEMENT_2_1>3.2765E-07</ELEMENT_2_1>
86     <ELEMENT_2_2>1.9843E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-6.5035E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>-3.2666E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>1.6542E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T13:46:36Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_25</POINT_ID></TRIMBLE_RTX_SOLUTION>
93

```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:20 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : NVA26.16o OP1479140195954

FILE: NVA26.16o OP1479140195954

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: nva2316p.16o TIME: 16:18:16 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3 START: 2016/11/11 15:06:45  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 16:07:15  
NAV FILE: brdc3160.16n OBS USED: 2760 / 3186 : 87%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 59.84/ 50.46  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.284

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86243)

X:	-872593.937(m)	0.005(m)	-872594.822(m)	0.005(m)
Y:	-4474942.070(m)	0.011(m)	-4474940.781(m)	0.011(m)
Z:	4446211.754(m)	0.011(m)	4446211.691(m)	0.011(m)

LAT:	44 28 24.13768	0.004(m)	44 28 24.16109	0.004(m)
E LON:	258 57 57.72532	0.005(m)	258 57 57.67486	0.005(m)
W LON:	101 2 2.27468	0.005(m)	101 2 2.32514	0.005(m)
EL HGT:	620.277(m)	0.015(m)	619.451(m)	0.015(m)
ORTHO HGT:	642.534(m)	0.018(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4926463.411	71648.040
Easting (X) [meters]	338230.088	517734.874
Convergence [degrees]	-1.42525863	-0.73177665
Point Scale	0.99992183	0.99998962
Combined Factor	0.99982459	0.99989237

US NATIONAL GRID DESIGNATOR: 14TLQ3823026463(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	59402.3
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	180277.3
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	182223.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	216603.3
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	222505.0
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	233857.6

NEAREST NGS PUBLISHED CONTROL POINT

PT1069	SAN	N442824.136	W1005852.665	4190.7
--------	-----	-------------	--------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4 <CONTRIBUTOR />
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6 <OBS_FILE TYPE="T02">NVA26.t02</OBS_FILE>
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9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
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18 <LAT>0.005</LAT>
19 <LONG>0.006</LONG>
20 <EL_HEIGHT>0.020</EL_HEIGHT>
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23 <USED_SATELLITES TOTAL="16" GPS_SV="G02 G05 G09 G12 G13 G20 G21 G29" QZSS_SV="
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32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.015">-4474940.783</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.014">4446211.677</COORDINATE>
34 </RECT_COORD>
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36 <LAT>
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38 <MINUTES>28</MINUTES>
39 <SECONDS>24.16070</SECONDS>
40 </LAT>
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42 <DEGREES>-101</DEGREES>
43 <MINUTES>2</MINUTES>
44 <SECONDS>2.32527</SECONDS>
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46 <EL_HEIGHT UNIT="m">619.443</EL_HEIGHT>
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48 </COORD_SET>

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49 </POSITION>
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52   <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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53   <EPOCH>2010.0</EPOCH>
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55     <RECT_COORD>
56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.007">-872593.931</COORDINATE>
57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.015">-4474942.056</COORDINATE>
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69         <SECONDS>2.27454</SECONDS>
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76   <ELEMENT_1_1>5.0651E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>5.3178E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>2.3204E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-4.7071E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-1.8848E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>2.0301E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85   <ELEMENT_2_1>3.4275E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>3.7317E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-1.7615E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>-1.7946E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>4.1856E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T14:17:56Z" />
92 <POINT_ID COORD_TYPE="Local">NVA26</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:36 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_27.16o OP1479140942755

FILE: ESP\_NVA\_27.16o OP1479140942755

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_318n.16o TIME: 16:32:57 UTC

SOFTWARE: rsgps 1.37 RS91.prl 1.99.3 START: 2016/11/13 13:59:15  
EPHEMERIS: igu19230.eph [ultra-rapid] STOP: 2016/11/13 15:04:30  
NAV FILE: brdc3180.16n OBS USED: 4056 / 4278 : 95%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 50.81/ 9.56  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.281

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86777)

X: -854317.542(m) 0.007(m) -854318.427(m) 0.007(m)  
Y: -4476164.577(m) 0.011(m) -4476163.288(m) 0.011(m)  
Z: 4448529.560(m) 0.011(m) 4448529.498(m) 0.011(m)

LAT: 44 30 9.04438 0.005(m) 44 30 9.06793 0.005(m)  
E LON: 259 11 40.28193 0.006(m) 259 11 40.23165 0.006(m)  
W LON: 100 48 19.71807 0.006(m) 100 48 19.76835 0.006(m)  
EL HGT: 630.942(m) 0.014(m) 630.114(m) 0.014(m)  
ORTHO HGT: 653.369(m) 0.017(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters]	4929273.585	74679.480
Easting (X) [meters]	356474.335	535945.538
Convergence [degrees]	-1.26574749	-0.57006700
Point Scale	0.99985333	0.99998466
Combined Factor	0.99975443	0.99988574



US NATIONAL GRID DESIGNATOR: 14TLQ5647429273(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	182346.9
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	198716.5
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	203627.0
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	204486.3
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	216489.3
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	228852.3

NEAREST NGS PUBLISHED CONTROL POINT

PT1064	LACY	N442959.390	W1004515.522	4080.0
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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4   <CONTRIBUTOR />
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7     <ANTENNA>
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9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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QZSS_SV=" " GLN_SV="R04 R05 R06 R10 R11 R12 R20 R21 R22" GAL_SV=" " BDS_SV=" ">G02
G05 G06 G09 G12 G17 G19 G20 G25 G29 R04 R05 R06 R10 R11 R12 R20 R21
R22</USED_SATELLITES>
24  </DATA_QUALITY>
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33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4448529.493</COORDINATE>
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58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4448529.574</COORDINATE>
59         </RECT_COORD>
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73     </COORD_SET>
74 </POSITION>
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80     <ELEMENT_3_2>-9.2881E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.2187E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85     <ELEMENT_2_1>-2.2849E-06</ELEMENT_2_1>
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87     <ELEMENT_3_1>-1.7326E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>1.6573E-06</ELEMENT_3_2>
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93

```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_28.16o OP1479140786155

FILE: ESP\_NVA\_28.16o OP1479140786155

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_317p.16o TIME: 16:33:03 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3 START: 2016/11/12 15:48:30  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 17:00:00  
NAV FILE: brdc3170.16n OBS USED: 5502 / 6482 : 85%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 14.01/ 40.63  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.299

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86526)

X:	-826296.255(m)	0.004(m)	-826297.140(m)	0.004(m)
Y:	-4481196.627(m)	0.009(m)	-4481195.336(m)	0.009(m)
Z:	4448573.792(m)	0.013(m)	4448573.730(m)	0.013(m)

LAT:	44 30 15.09677	0.003(m)	44 30 15.12052	0.003(m)
E LON:	259 33 8.91141	0.005(m)	259 33 8.86142	0.005(m)
W LON:	100 26 51.08859	0.005(m)	100 26 51.13858	0.005(m)
EL HGT:	503.940(m)	0.015(m)	503.106(m)	0.015(m)
ORTHO HGT:	526.956(m)	0.017(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4928893.967	74646.004
Easting (X) [meters]	384933.067	564411.852
Convergence [degrees]	-1.01476992	-0.31673025
Point Scale	0.99976283	0.99998438
Combined Factor	0.99968384	0.99990537

US NATIONAL GRID DESIGNATOR: 14TLQ8493328893(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	176083.3
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	181471.8
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	189485.6
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	192284.1
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	224850.9
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	226615.3
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	228633.9

NEAREST NGS PUBLISHED CONTROL POINT

PT0032	G 309	N443015.	W1002702.	241.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
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14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
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19 <LONG>0.005</LONG>
20 <EL_HEIGHT>0.015</EL_HEIGHT>
21 </ACCURACY>
22 <PERCENT_OBS_USED TOTAL="287" PROCESSING_INTERVAL="15.0" USABLE="287"
USED="281">97</PERCENT_OBS_USED>
23 <USED_SATELLITES TOTAL="21" GPS_SV="G02 G05 G12 G13 G15 G18 G20 G21 G25 G26 G29"
QZSS_SV=" " GLN_SV="R04 R05 R06 R07 R11 R12 R19 R20 R21 R22" GAL_SV=" "
BDS_SV=" ">G02 G05 G12 G13 G15 G18 G20 G21 G25 G26 G29 R04 R05 R06 R07 R11 R12
R19 R20 R21 R22</USED_SATELLITES>
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32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4481195.348</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4448573.734</COORDINATE>
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36 <LAT>
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38 <MINUTES>30</MINUTES>
39 <SECONDS>15.12033</SECONDS>
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45 </EAST_LONG>
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52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
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79     <ELEMENT_3_1>-2.0688E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.1956E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.1459E-04</ELEMENT_3_3>
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83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85     <ELEMENT_2_1>-5.5685E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.3754E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-1.9192E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>4.2917E-07</ELEMENT_3_2>
89     <ELEMENT_3_3>2.2994E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T13:54:40Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_28</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:27 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_29.16o OP1479140680082

FILE: ESP\_NVA\_29.16o OP1479140680082

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

sdhu  
sdab  
ndas  
nevn  
ndel  
sdwe

Your station is 9.5 KM outside the polygon enclosing the reference stations

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_316o.16o TIME: 16:26:43 UTC

SOFTWARE: rsgps 1.37 RS54.prl 1.99.3 START: 2016/11/11 14:26:30  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 15:33:00  
NAV FILE: brdc3160.16n OBS USED: 4206 / 4560 : 92%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 34.82/ 55.29  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.309

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86236)

X: -796573.946(m) 0.005(m) -796574.831(m) 0.005(m)  
Y: -4486697.572(m) 0.018(m) -4486696.280(m) 0.018(m)  
Z: 4448477.434(m) 0.017(m) 4448477.372(m) 0.017(m)



LAT: 44 30 10.13871 0.002(m) 44 30 10.16265 0.002(m)  
 E LON: 259 55 57.13959 0.003(m) 259 55 57.08992 0.003(m)  
 W LON: 100 4 2.86041 0.003(m) 100 4 2.91008 0.003(m)  
 EL HGT: 522.203(m) 0.024(m) 521.362(m) 0.024(m)  
 ORTHO HGT: 545.653(m) 0.026(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4928276.117	74396.835
Easting (X) [meters]	415143.226	594635.180
Convergence [degrees]	-0.74827538	-0.04774489
Point Scale	0.99968855	0.99998461
Combined Factor	0.99960670	0.99990274

US NATIONAL GRID DESIGNATOR: 14TMQ1514328276(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	145937.4
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	168192.0
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	178465.6
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	185176.4
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	206127.6
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	222303.3

NEAREST NGS PUBLISHED CONTROL POINT

AB9021	Q 464	N442953.	W1000441.	994.9
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```

1 <TRIMBLE_RTX_SOLUTION SID="7799439" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2   <SOLUTION_TIME>2016-11-14T13:56:15Z</SOLUTION_TIME>
3   <OBSERVATION_TIME START="2016-11-11T14:26:30Z" END="2016-11-11T15:33:00Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">ESP_NVA_29.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
17    <ACCURACY UNIT="m" >
18      <LAT>0.005</LAT>
19      <LONG>0.005</LONG>
20      <EL_HEIGHT>0.023</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="267" PROCESSING_INTERVAL="15.0" USABLE="267"
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23    <USED_SATELLITES TOTAL="17" GPS_SV="G02 G05 G09 G12 G19 G20 G25 G29" QZSS_SV="
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G19 G20 G25 G29 R02 R03 R04 R05 R10 R11 R18 R19 R20</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.86</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.007">-796574.838</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.018">-4486696.289</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.016">4448477.361</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
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38          <MINUTES>30</MINUTES>
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42          <DEGREES>-100</DEGREES>
43          <MINUTES>4</MINUTES>
44          <SECONDS>2.91031</SECONDS>
45        </EAST_LONG>
46        <EL_HEIGHT UNIT="m">521.362</EL_HEIGHT>
47      </ELLIP_COORD>
48    </COORD_SET>

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50 <POSITION TYPE="CUSTOM">
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    America</TECTONIC_PLATE>
53   <EPOCH>2010.0</EPOCH>
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55     <RECT_COORD>
56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.007">-796573.944</COORDINATE>
57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.018">-4486697.566</COORDINATE>
58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.016">4448477.441</COORDINATE>
59     </RECT_COORD>
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64         <SECONDS>10.13902</SECONDS>
65       </LAT>
66       <EAST_LONG>
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68         <MINUTES>4</MINUTES>
69         <SECONDS>2.86038</SECONDS>
70       </EAST_LONG>
71       <EL_HEIGHT UNIT="m">522.203</EL_HEIGHT>
72     </ELLIP_COORD>
73   </COORD_SET>
74 </POSITION>
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77   <ELEMENT_2_1>6.9657E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>3.1057E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-5.8696E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-2.5350E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>2.4890E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>2.7148E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>3.9781E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.7433E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-3.4221E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>-2.3276E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>5.4813E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T13:56:15Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_29</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:31 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_30.16o OP1479140692153

FILE: ESP\_NVA\_30.16o OP1479140692153

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

sdhu  
sdab  
ndas  
nevn  
ndel  
sdwe

Your station is 16.2 KM outside the polygon enclosing the reference stations

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_316p.16o TIME: 16:27:50 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3 START: 2016/11/11 15:51:00  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 16:55:30  
NAV FILE: brdc3160.16n OBS USED: 4500 / 4908 : 92%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 27.03/ 56.64  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.305

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86252)

X: -802782.054(m) 0.005(m) -802782.939(m) 0.005(m)  
Y: -4484329.773(m) 0.007(m) -4484328.481(m) 0.007(m)  
Z: 4449759.205(m) 0.009(m) 4449759.143(m) 0.009(m)

LAT: 44 31 7.94138 0.004(m) 44 31 7.96529 0.004(m)  
 E LON: 259 51 1.64237 0.005(m) 259 51 1.59262 0.005(m)  
 W LON: 100 8 58.35763 0.005(m) 100 8 58.40738 0.005(m)  
 EL HGT: 535.487(m) 0.011(m) 534.648(m) 0.011(m)  
 ORTHO HGT: 558.845(m) 0.014(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4930148.120	76189.762
Easting (X) [meters]	408643.227	588110.906
Convergence [degrees]	-0.80605147	-0.10583785
Point Scale	0.99970264	0.99998199
Combined Factor	0.99961871	0.99989804

US NATIONAL GRID DESIGNATOR: 14TMQ0864330148(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	152598.3
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	172158.3
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	178834.0
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	185675.6
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	208556.4
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	227421.8

NEAREST NGS PUBLISHED CONTROL POINT

AB9023	14 243.55	N442838.	W1000707.	5241.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```

1 <TRIMBLE_RTX_SOLUTION SID="7799444" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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3 <OBSERVATION_TIME START="2016-11-11T15:51:00Z" END="2016-11-11T16:55:30Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">ESP_NVA_30.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
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23 <USED_SATELLITES TOTAL="21" GPS_SV="G02 G05 G12 G13 G15 G18 G20 G21 G25 G26 G29"
QZSS_SV=" " GLN_SV="R03 R04 R05 R06 R10 R11 R18 R19 R20 R21" GAL_SV=" "
BDS_SV=" ">G02 G05 G12 G13 G15 G18 G20 G21 G25 G26 G29 R03 R04 R05 R06 R10 R11
R18 R19 R20 R21</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
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America</TECTONIC_PLATE>
28 <EPOCH>2016.86</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-802782.944</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4484328.496</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4449759.149</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>31</MINUTES>
39 <SECONDS>7.96506</SECONDS>
40 </LAT>
41 <EAST_LONG>
42 <DEGREES>-100</DEGREES>
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```

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53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
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79     <ELEMENT_3_1>-1.8953E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.4266E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.0598E-04</ELEMENT_3_3>
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83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85     <ELEMENT_2_1>8.1888E-07</ELEMENT_2_1>
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87     <ELEMENT_3_1>-1.7264E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>-3.7498E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>2.2129E-04</ELEMENT_3_3>
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91 <RETRIEVAL TIME="2016-11-14T13:57:51Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_30</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Tuesday, November 15, 2016 9:33 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_31.16o OP1479220221538

FILE: ESP\_NVA\_31.16o OP1479220221538

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 15, 2016  
RINEX FILE: esp\_319r.16o TIME: 14:32:22 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3 START: 2016/11/14 17:50:15  
EPHEMERIS: igu19231.eph [ultra-rapid] STOP: 2016/11/14 18:58:15  
NAV FILE: brdc3190.16n OBS USED: 4410 / 4914 : 90%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 19.02/ 41.39  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.320

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87095)

X: -866219.689(m) 0.004(m) -866220.574(m) 0.004(m)  
Y: -4471560.131(m) 0.013(m) -4471558.843(m) 0.013(m)  
Z: 4450759.778(m) 0.010(m) 4450759.716(m) 0.010(m)

LAT: 44 31 52.20821 0.004(m) 44 31 52.23168 0.004(m)  
E LON: 259 2 11.74240 0.004(m) 259 2 11.69196 0.004(m)  
W LON: 100 57 48.25760 0.004(m) 100 57 48.30804 0.004(m)  
EL HGT: 573.023(m) 0.016(m) 572.198(m) 0.016(m)  
ORTHO HGT: 595.220(m) 0.018(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4932746.269 78000.794  
Easting (X) [meters] 343996.361 523424.999  
Convergence [degrees] -1.37720704 -0.68183843  
Point Scale 0.99989929 0.99998003  
Combined Factor 0.99980946 0.99989019



US NATIONAL GRID DESIGNATOR: 14TLQ4399632746(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	55156.2
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	187267.6
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	187384.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	208106.4
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	217206.1
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	225908.5

NEAREST NGS PUBLISHED CONTROL POINT

PT1093	HOPEWELL	N443024.345	W1005434.767	5061.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```

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3 <OBSERVATION_TIME START="2016-11-14T17:50:15Z" END="2016-11-14T18:58:15Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">ESP_NVA_31.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
17 <ACCURACY UNIT="m">
18 <LAT>0.005</LAT>
19 <LONG>0.005</LONG>
20 <EL_HEIGHT>0.015</EL_HEIGHT>
21 </ACCURACY>
22 <PERCENT_OBS_USED TOTAL="273" PROCESSING_INTERVAL="15.0" USABLE="273"
USED="267">97</PERCENT_OBS_USED>
23 <USED_SATELLITES TOTAL="18" GPS_SV="G05 G10 G13 G15 G16 G18 G20 G21 G24 G26 G27
G29" QZSS_SV="" GLN_SV="R01 R02 R08 R17 R23 R24" GAL_SV="" BDS_SV="">G05 G10 G13
G15 G16 G18 G20 G21 G24 G26 G27 G29 R01 R02 R08 R17 R23 R24</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-866220.575</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4471558.867</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4450759.714</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>31</MINUTES>
39 <SECONDS>52.23110</SECONDS>
40 </LAT>
41 <EAST_LONG>
42 <DEGREES>-100</DEGREES>
43 <MINUTES>57</MINUTES>
44 <SECONDS>48.30787</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">572.213</EL_HEIGHT>
47 </ELLIP_COORD>
48 </COORD_SET>

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49 </POSITION>
50 <POSITION TYPE="CUSTOM">
51   <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52   <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
    America</TECTONIC_PLATE>
53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
55     <RECT_COORD>
56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-866219.680</COORDINATE>
57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4471560.140</COORDINATE>
58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4450759.795</COORDINATE>
59     </RECT_COORD>
60     <ELLIP_COORD>
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62         <DEGREES>44</DEGREES>
63         <MINUTES>31</MINUTES>
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67         <DEGREES>-100</DEGREES>
68         <MINUTES>57</MINUTES>
69         <SECONDS>48.25714</SECONDS>
70       </EAST_LONG>
71       <EL_HEIGHT UNIT="m">573.039</EL_HEIGHT>
72     </ELLIP_COORD>
73   </COORD_SET>
74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76   <ELEMENT_1_1>2.4598E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>2.0361E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>1.2868E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-1.7153E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-9.3890E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.1315E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>2.7250E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>3.4194E-07</ELEMENT_2_1>
86   <ELEMENT_2_2>2.0760E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-8.1209E-06</ELEMENT_3_1>
88   <ELEMENT_3_2>1.1013E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>2.1842E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-15T13:51:49Z" />
92 <POINT_ID COORD_TYPE="Local">JV_03</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Tuesday, November 15, 2016 9:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_32.16o OP1479220236763

FILE: ESP\_NVA\_32.16o OP1479220236763

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.

2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 15, 2016  
RINEX FILE: esp\_319t.16o TIME: 14:33:08 UTC

SOFTWARE: rsgps 1.37 RS52.prl 1.99.3 START: 2016/11/14 19:21:15  
EPHEMERIS: igu19231.eph [ultra-rapid] STOP: 2016/11/14 20:27:15  
NAV FILE: brdc3190.16n OBS USED: 5274 / 5550 : 95%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 31.62/ 76.92  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.290

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87112)

X: -844472.771(m) 0.002(m) -844473.656(m) 0.002(m)  
Y: -4478621.786(m) 0.009(m) -4478620.496(m) 0.009(m)  
Z: 4447894.990(m) 0.012(m) 4447894.928(m) 0.012(m)

LAT: 44 29 41.23083 0.003(m) 44 29 41.25445 0.003(m)  
E LON: 259 19 18.78485 0.002(m) 259 19 18.73468 0.002(m)  
W LON: 100 40 41.21515 0.002(m) 100 40 41.26532 0.002(m)  
EL HGT: 599.337(m) 0.015(m) 598.506(m) 0.015(m)  
ORTHO HGT: 622.024(m) 0.017(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4928199.585 73728.191  
Easting (X) [meters] 366581.353 546066.368  
Convergence [degrees] -1.17627055 -0.47992811  
Point Scale 0.99981891 0.99998595  
Combined Factor 0.99972496 0.99989199

US NATIONAL GRID DESIGNATOR: 14TLQ6658128199(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	180587.8
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	194325.4
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	199053.2
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	208245.8
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	208432.1
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	229307.8

NEAREST NGS PUBLISHED CONTROL POINT

PT0267	CLUST J 27	N442820.	W1003756.	4429.0
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

```

1 <TRIMBLE_RTX_SOLUTION SID="7804031" REFERENCE_NUMBER="916482853840"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2 <SOLUTION_TIME>2016-11-15T13:51:51Z</SOLUTION_TIME>
3 <OBSERVATION_TIME START="2016-11-14T19:21:15Z" END="2016-11-14T20:27:15Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">ESP_NVA_32.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
17 <ACCURACY UNIT="m">
18 <LAT>0.005</LAT>
19 <LONG>0.004</LONG>
20 <EL_HEIGHT>0.012</EL_HEIGHT>
21 </ACCURACY>
22 <PERCENT_OBS_USED TOTAL="265" PROCESSING_INTERVAL="15.0" USABLE="265"
USED="259">97</PERCENT_OBS_USED>
23 <USED_SATELLITES TOTAL="21" GPS_SV="G08 G10 G13 G15 G18 G20 G21 G24 G27 G29 G32"
QZSS_SV="" GLN_SV="R01 R02 R03 R08 R10 R11 R17 R18 R23 R24" GAL_SV=""
BDS_SV="">G08 G10 G13 G15 G18 G20 G21 G24 G27 G29 G32 R01 R02 R03 R08 R10 R11
R17 R18 R23 R24</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.004">-844473.661</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.009">-4478620.533</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4447894.951</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>29</MINUTES>
39 <SECONDS>41.25414</SECONDS>
40 </LAT>
41 <EAST_LONG>
42 <DEGREES>-100</DEGREES>
43 <MINUTES>40</MINUTES>
44 <SECONDS>41.26523</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">598.549</EL_HEIGHT>
47 </ELLIP_COORD>

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49 </POSITION>
50 <POSITION TYPE="CUSTOM">
51     <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.004">-844472.767</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.009">-4478621.807</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4447895.032</COORDINATE>
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68                 <MINUTES>40</MINUTES>
69                 <SECONDS>41.21478</SECONDS>
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71             <EL_HEIGHT UNIT="m">599.380</EL_HEIGHT>
72         </ELLIP_COORD>
73     </COORD_SET>
74 </POSITION>
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76     <ELEMENT_1_1>1.9384E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>8.5176E-06</ELEMENT_2_1>
78     <ELEMENT_2_2>8.2758E-05</ELEMENT_2_2>
79     <ELEMENT_3_1>-9.9083E-06</ELEMENT_3_1>
80     <ELEMENT_3_2>-6.3465E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>9.7395E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>2.6468E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-1.0847E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>1.8458E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>7.9864E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>3.9903E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>1.5461E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-15T13:51:51Z" />
92 <POINT_ID COORD_TYPE="Local">JV_04</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_33.16o OP1479140740631

FILE: ESP\_NVA\_33.16o OP1479140740631

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_317o.16o TIME: 16:31:42 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3 START: 2016/11/12 14:11:15  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 15:14:45  
NAV FILE: brdc3170.16n OBS USED: 3648 / 4266 : 86%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 35.31/ 37.90  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.326

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86506)

X:	-828009.314(m)	0.006(m)	-828010.199(m)	0.006(m)
Y:	-4477421.020(m)	0.015(m)	-4477419.730(m)	0.015(m)
Z:	4451997.604(m)	0.012(m)	4451997.542(m)	0.012(m)

LAT:	44 32 51.44308	0.006(m)	44 32 51.46682	0.006(m)
E LON:	259 31 21.58250	0.005(m)	259 31 21.53245	0.005(m)
W LON:	100 28 38.41750	0.005(m)	100 28 38.46755	0.005(m)
EL HGT:	479.598(m)	0.018(m)	478.766(m)	0.018(m)
ORTHO HGT:	502.504(m)	0.020(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4933760.475	79485.369
Easting (X) [meters]	382650.353	562069.491
Convergence [degrees]	-1.03647335	-0.33783047
Point Scale	0.99976935	0.99997749
Combined Factor	0.99969417	0.99990230

US NATIONAL GRID DESIGNATOR: 14TLQ8265033760(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	178836.4
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	186208.6
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	186224.0
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	191606.6
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	222863.6
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	223685.7

NEAREST NGS PUBLISHED CONTROL POINT

PT0044	V 309 RESET	N443251.	W1002705.	2062.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="7799447" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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3   <OBSERVATION_TIME START="2016-11-12T14:11:15Z" END="2016-11-12T15:14:45Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">ESP_NVA_33.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
17    <ACCURACY UNIT="m" >
18      <LAT>0.005</LAT>
19      <LONG>0.005</LONG>
20      <EL_HEIGHT>0.018</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="255" PROCESSING_INTERVAL="15.0" USABLE="255"
USED="249">97</PERCENT_OBS_USED>
23    <USED_SATELLITES TOTAL="18" GPS_SV="G02 G05 G06 G09 G12 G19 G20 G25 G29"
QZSS_SV=" " GLN_SV="R03 R04 R05 R06 R10 R11 R19 R20 R21" GAL_SV=" " BDS_SV=" ">G02
G05 G06 G09 G12 G19 G20 G25 G29 R03 R04 R05 R06 R10 R11 R19 R20
R21</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.87</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-828010.203</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.014">-4477419.742</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.013">4451997.532</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
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39          <SECONDS>51.46630</SECONDS>
40        </LAT>
41        <EAST_LONG>
42          <DEGREES>-100</DEGREES>
43          <MINUTES>28</MINUTES>
44          <SECONDS>38.46762</SECONDS>
45        </EAST_LONG>
46        <EL_HEIGHT UNIT="m">478.768</EL_HEIGHT>
47      </ELLIP_COORD>
```

```

48     </COORD_SET>
49 </POSITION>
50 <POSITION TYPE="CUSTOM">
51     <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-828009.309</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.014">-4477421.017</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.013">4451997.612</COORDINATE>
59         </RECT_COORD>
60         <ELLIP_COORD>
61             <LAT>
62                 <DEGREES>44</DEGREES>
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66             <EAST_LONG>
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69                 <SECONDS>38.41729</SECONDS>
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73     </COORD_SET>
74 </POSITION>
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76     <ELEMENT_1_1>3.6111E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>4.3983E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.8776E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-3.7093E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.4884E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.5999E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>2.5845E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>3.0860E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.5396E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-1.6821E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>-1.6547E-05</ELEMENT_3_2>
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90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T13:59:11Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_33</POINT_ID></TRIMBLE_RTX_SOLUTION>
93

```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:31 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_34.16o OP1479140704899

FILE: ESP\_NVA\_34.16o OP1479140704899

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: esp\_316r.16o TIME: 16:30:10 UTC

SOFTWARE: rsgps 1.37 RS52.prl 1.99.3 START: 2016/11/11 17:18:45  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 18:23:30  
NAV FILE: brdc3160.16n OBS USED: 6020 / 6020 : 100%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 20.84/ 32.06  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.295

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86269)

X: -811809.046(m) 0.003(m) -811809.931(m) 0.003(m)  
Y: -4480385.957(m) 0.009(m) -4480384.666(m) 0.009(m)  
Z: 4452060.987(m) 0.013(m) 4452060.925(m) 0.013(m)

LAT: 44 32 52.92172 0.003(m) 44 32 52.94557 0.003(m)  
E LON: 259 43 47.63929 0.003(m) 259 43 47.58942 0.003(m)  
W LON: 100 16 12.36071 0.003(m) 100 16 12.41058 0.003(m)  
EL HGT: 523.579(m) 0.016(m) 522.743(m) 0.016(m)  
ORTHO HGT: 546.748(m) 0.018(m) [NAVD88 (Computed using GEOID12B)]

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4933529.175	79454.990
Easting (X) [meters]	399112.683	578537.218
Convergence [degrees]	-0.89105903	-0.19116022
Point Scale	0.99972517	0.99997743
Combined Factor	0.99964310	0.99989534

US NATIONAL GRID DESIGNATOR: 14TLQ9911233529(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	162456.2
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	177917.7
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	179249.3
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	187478.7
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	211972.7
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	225046.5
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	234832.1

NEAREST NGS PUBLISHED CONTROL POINT

PT0983	MATTHEIS	N443052.698	W1001503.125	4013.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4 <CONTRIBUTOR />
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9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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12 <RECEIVER>
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14 </RECEIVER>
15 </DATA_SOURCES>
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20 <EL_HEIGHT>0.013</EL_HEIGHT>
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28 <EPOCH>2016.86</EPOCH>
29 <COORD_SET>
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31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-811809.927</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.010">-4480384.675</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4452060.923</COORDINATE>
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41 <EAST_LONG>
42 <DEGREES>-100</DEGREES>
43 <MINUTES>16</MINUTES>
44 <SECONDS>12.41035</SECONDS>
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46 <EL_HEIGHT UNIT="m">522.748</EL_HEIGHT>
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49 </POSITION>
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52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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71             <EL_HEIGHT UNIT="m">523.584</EL_HEIGHT>
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76     <ELEMENT_1_1>2.3925E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>1.7574E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>9.6259E-05</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.1322E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-6.9010E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>9.2723E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
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87     <ELEMENT_3_1>-2.5976E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>-1.8686E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>1.6640E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-14T14:01:09Z" />
92 <POINT_ID COORD_TYPE="Local">ESP_NVA_34</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Tuesday, November 15, 2016 9:33 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : ESP\_NVA\_35.16o OP1479220248551

FILE: ESP\_NVA\_35.16o OP1479220248551

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.

2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 15, 2016  
RINEX FILE: esp\_319p.16o TIME: 14:32:28 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3 START: 2016/11/14 15:27:15  
EPHEMERIS: igu19231.eph [ultra-rapid] STOP: 2016/11/14 16:30:15  
NAV FILE: brdc3190.16n OBS USED: 3660 / 4230 : 87%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 30.82/ 49.62  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.303

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87067)

X: -849055.797(m) 0.008(m) -849056.682(m) 0.008(m)  
Y: -4472514.387(m) 0.011(m) -4472513.098(m) 0.011(m)  
Z: 4453177.440(m) 0.010(m) 4453177.378(m) 0.010(m)

LAT: 44 33 40.18647 0.006(m) 44 33 40.21007 0.006(m)  
E LON: 259 15 3.45387 0.007(m) 259 15 3.40358 0.007(m)  
W LON: 100 44 56.54613 0.007(m) 100 44 56.59642 0.007(m)  
EL HGT: 632.960(m) 0.014(m) 632.132(m) 0.014(m)  
ORTHO HGT: 655.359(m) 0.017(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4935690.861 81153.387  
Easting (X) [meters] 361100.286 540493.751  
Convergence [degrees] -1.22744529 -0.53012463  
Point Scale 0.99983726 0.99997546  
Combined Factor 0.99973804 0.99987623



US NATIONAL GRID DESIGNATOR: 14TLQ6110035690(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	188367.0
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	195718.9
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	200473.6
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	204596.8
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	209361.6
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	222109.7

NEAREST NGS PUBLISHED CONTROL POINT

AC7867	1806 213.39	N443248.803	W1004329.092	2498.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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BDS_SV="">G02 G05 G06 G12 G13 G15 G20 G21 G25 G26 G29 R01 R06 R07 R08 R13 R14
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79     <ELEMENT_3_1>-3.2924E-05</ELEMENT_3_1>
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81     <ELEMENT_3_3>1.2462E-04</ELEMENT_3_3>
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79     <ELEMENT_3_1>-1.4723E-05</ELEMENT_3_1>
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93
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# OPUS-RS solution : ESP\_NVA\_37.16o OP1479823718142

opus <opus@ngs.noaa.gov>

Tue 11/22/2016 9:10 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_37.16o OP1479823718142

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 22, 2016  
RINEX FILE: esp\_325r.16o                  TIME: 14:10:15 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3      START: 2016/11/20 17:09:30  
EPHEMERIS: igr19240.eph [rapid]          STOP: 2016/11/20 18:16:45  
NAV FILE: brdc3250.16n                  OBS USED: 4326 / 4848 : 89%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 58.30/ 3.70  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.312

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88726)

X:    -777518.622(m) 0.006(m)      -777519.506(m) 0.006(m)  
Y:    -4508319.245(m) 0.012(m)      -4508317.949(m) 0.012(m)  
Z:    4430062.148(m) 0.009(m)      4430062.083(m) 0.009(m)

LAT: 44 16 15.63272    0.003(m)      44 16 15.65669    0.003(m)  
E LON: 260 12 53.46212    0.004(m)      260 12 53.41291    0.004(m)  
W LON: 99 47 6.53788    0.004(m)      99 47 6.58709    0.004(m)  
EL HGT:    513.579(m) 0.016(m)      512.727(m) 0.016(m)  
ORTHO HGT:    537.572(m) 0.018(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4902273.651	48658.823
Easting (X) [meters]	437338.530	617154.229
Convergence [degrees]	-0.54809373	0.15205797
Point Scale	0.99964829	1.00003109
Combined Factor	0.99956780	0.99995056

US NATIONAL GRID DESIGNATOR: 14TMQ3733802273(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	123548.5
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	167037.2

11/22/2016

OPUS-RS solution : ESP\_NVA\_37.16o OP1479823718142 - Arry Lazaridis

DP6617 SDAB SDABERDEEN CORS ARP	N452729.471 W0982448.998	170750.1
DP6615 NDAS NDASHLEY CORS ARP	N460200.316 W0992247.944	198448.3
DP6621 SDWE SDWEBSTER CORS ARP	N452116.159 W0973109.815	215911.2
DP6862 NDEL NDELLENDALE CORS ARP	N460010.356 W0983123.166	216561.2

NEAREST NGS PUBLISHED CONTROL POINT

PS0490	N 315	N441834.	W0994705.	4271.0
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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# OPUS-RS solution : ESP\_NVA\_39.16o OP1479823734909

opus <opus@ngs.noaa.gov>

Tue 11/22/2016 9:17 AM

Inbox

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_39.16o OP1479823734909

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 22, 2016  
RINEX FILE: esp\_325s.16o                  TIME: 14:17:11 UTC

SOFTWARE: rsgps 1.37 RS91.prl 1.99.3      START: 2016/11/20 18:43:00  
EPHEMERIS: igr19240.eph [rapid]          STOP: 2016/11/20 19:48:45  
NAV FILE: brdc3250.16n                  OBS USED: 8136 / 8217 : 99%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 36.43/ 52.30  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.302

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88744)

X:    -750720.393(m) 0.007(m)      -750721.277(m) 0.007(m)  
Y:    -4514063.645(m) 0.017(m)      -4514062.348(m) 0.017(m)  
Z:    4428887.129(m) 0.011(m)      4428887.064(m) 0.011(m)

LAT: 44 15 21.50436    0.008(m)    44 15 21.52850    0.008(m)  
E LON: 260 33 27.82533    0.008(m)    260 33 27.77643    0.008(m)  
W LON: 99 26 32.17467    0.008(m)    99 26 32.22357    0.008(m)  
EL HGT:    544.451(m) 0.018(m)      543.593(m) 0.018(m)  
ORTHO HGT:    568.706(m) 0.020(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4900398.981      47118.714  
Easting (X) [meters]    464694.130      644541.761  
Convergence [degrees]    -0.30864851      0.39472629  
Point Scale            0.99961533      1.00003466  
Combined Factor        0.99953000      0.99994929

US NATIONAL GRID DESIGNATOR: 14TMQ6469400398(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	96576.8

DE6268	SFSD SIOUX FALLS COOP CORS ARP	N433419.390	W0964342.615	230832.4
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	177617.6
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	69877.2
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	156401.5
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	195049.5
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	197606.5
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	207172.8
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	240760.1

## NEAREST NGS PUBLISHED CONTROL POINT

PS0369	K 48	N441559.	W0992631.	1157.6
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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## OPUS-RS solution : SD\_NVA40\_TD.16o OP1479742731351

opus &lt;opus@ngs.noaa.gov&gt;

Mon 11/21/2016 10:51 AM

To: Arry Lazaridis &lt;alazaridis@espassociates.com&gt;;

FILE: SD\_NVA40\_TD.16o OP1479742731351

6011 Warning - OPUS-RS was able to find a set of reference stations  
 6011 with data suitable for use with your dataset. However, your  
 6011 position does not fall within the polygon enclosing these reference  
 6011 stations. This means that the geographic interpolation algorithms  
 6011 performed within OPUS-RS must instead perform extrapolation.  
 6011 Extrapolation, especially if your position is far from the  
 6011 reference stations, is prone to error. Use this solution with  
 6011 caution.

mnmr  
 mngr  
 nevn  
 mnms  
 mnhd  
 mnan  
 neha

Your station is 18.5 KM outside the polygon enclosing the reference stations

## NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
 RINEX FILE: sd\_n324p.16o                  TIME: 15:50:38 UTC

SOFTWARE: rsgps 1.37 RS91.prl 1.99.3      START: 2016/11/19 15:11:30  
 EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 16:11:45  
 NAV FILE: brdc3240.16n                  OBS USED: 3822 / 4081 : 94%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 39.26/ 55.88  
 ARP HEIGHT: 2.00                        NORMALIZED RMS:    0.284

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88430)

X: -700208.271(m) 0.008(m)      -700209.154(m) 0.008(m)  
 Y: -4522277.631(m) 0.015(m)      -4522276.331(m) 0.015(m)  
 Z: 4428769.319(m) 0.014(m)      4428769.254(m) 0.014(m)

LAT: 44 15 16.46150    0.005(m)    44 15 16.48598    0.005(m)  
 E LON: 261 11 54.53431    0.009(m)    261 11 54.48602    0.009(m)



W LON: 98 48 5.46569 0.009(m) 98 48 5.51398 0.009(m)  
 EL HGT: 535.400(m) 0.019(m) 534.531(m) 0.019(m)  
 ORTHO HGT: 560.297(m) 0.021(m) [NAVD88 (Computed using GEOID12B)]

## UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4900167.448	47518.113
Easting (X) [meters]	515844.900	695713.548
Convergence [degrees]	0.13851031	0.84821130
Point Scale	0.99960309	1.00003499
Combined Factor	0.99951918	0.99995104

US NATIONAL GRID DESIGNATOR: 14TNQ1584400167(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	202068.1
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	232793.7
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	208304.8
DM2666	MNMS MARSHALL CORS ARP	N442749.382	W0954744.480	240739.7
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	189992.6
DO2875	MNAN APPLETON CORS ARP	N451143.692	W0960117.714	243777.0
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	220281.1

## NEAREST NGS PUBLISHED CONTROL POINT

PS0617	SPIRE A	N441215.698	W0984919.614	5817.0
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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78     <ELEMENT_2_2>1.6031E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.5208E-05</ELEMENT_3_1>
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81     <ELEMENT_3_3>1.3313E-04</ELEMENT_3_3>
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87     <ELEMENT_3_1>-1.2229E-05</ELEMENT_3_1>
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## OPUS-RS solution : ESP\_NVA\_41.16o OP1479741870188

opus &lt;opus@ngs.noaa.gov&gt;

Mon 11/21/2016 10:33 AM

To: Arry Lazaridis &lt;alazaridis@espassociates.com&gt;;

FILE: ESP\_NVA\_41.16o OP1479741870188

6011 Warning - OPUS-RS was able to find a set of reference stations  
 6011 with data suitable for use with your dataset. However, your  
 6011 position does not fall within the polygon enclosing these reference  
 6011 stations. This means that the geographic interpolation algorithms  
 6011 performed within OPUS-RS must instead perform extrapolation.  
 6011 Extrapolation, especially if your position is far from the  
 6011 reference stations, is prone to error. Use this solution with  
 6011 caution.

mnhd  
 neha  
 mnmr  
 mngr  
 mnan  
 mnms  
 nevn

Your station is 35.9 KM outside the polygon enclosing the reference stations

## NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
 RINEX FILE: esp\_324s.16o                  TIME: 15:32:23 UTC

SOFTWARE: rsgps 1.37 RS51.prl 1.99.3      START: 2016/11/19 18:58:45  
 EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 20:05:30  
 NAV FILE: brdc3240.16n                  OBS USED: 5607 / 6489 : 86%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 25.63/ 62.04  
 ARP HEIGHT: 2.000                      NORMALIZED RMS:    0.305

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88474)

X:	-704815.472(m)	0.008(m)	-704816.356(m)	0.008(m)
Y:	-4509021.818(m)	0.010(m)	-4509020.520(m)	0.010(m)
Z:	4441413.695(m)	0.011(m)	4441413.632(m)	0.011(m)

LAT:	44 24 49.94847	0.008(m)	44 24 49.97299	0.008(m)
E LON:	261 6 57.08756	0.009(m)	261 6 57.03902	0.009(m)

W LON: 98 53 2.91244 0.009(m) 98 53 2.96098 0.009(m)  
 EL HGT: 509.557(m) 0.012(m) 508.694(m) 0.012(m)  
 ORTHO HGT: 534.246(m) 0.014(m) [NAVD88 (Computed using GEOID12B)]

## UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4917849.177	65123.852
Easting (X) [meters]	509223.971	688871.444
Convergence [degrees]	0.08108145	0.78973507
Point Scale	0.99960105	1.00000054
Combined Factor	0.99952119	0.99992065

US NATIONAL GRID DESIGNATOR: 14TNQ0922317849(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	195017.0
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	238634.6
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	202142.9
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	227376.4
DO2875	MNAN APPLETON CORS ARP	N451143.692	W0960117.714	242536.9
DM2666	MNMS MARSHALL CORS ARP	N442749.382	W0954744.480	245929.0
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	217389.5

## NEAREST NGS PUBLISHED CONTROL POINT

PS0620	HULBERT	N442534.700	W0984852.150	5716.7
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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89   <ELEMENT_3_3>2.7066E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-21T14:42:47Z" />
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8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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14 </RECEIVER>
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G13 G15 G16 G18 G20 G21 G26 G27 G29 R02 R03 R04 R05 R17 R18 R19
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33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4443577.539</COORDINATE>
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77   <ELEMENT_2_1>8.5348E-06</ELEMENT_2_1>
78   <ELEMENT_2_2>1.2283E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-1.2288E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-9.0501E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.1414E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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86   <ELEMENT_2_2>2.0431E-05</ELEMENT_2_2>
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90 </COVARIANCE_MATRIX>
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92 <POINT_ID COORD_TYPE="Local">ESP_NVA_43</POINT_ID></TRIMBLE_RTX_SOLUTION>
93

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# OPUS-RS solution : ESP\_NVA\_44.16o OP1479823747414

opus <opus@ngs.noaa.gov>

Tue 11/22/2016 9:11 AM

Inbox

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_44.16o OP1479823747414

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 22, 2016  
RINEX FILE: esp\_325o.16o                  TIME: 14:10:49 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3      START: 2016/11/20 14:10:15  
EPHEMERIS: igr19240.eph [rapid]          STOP: 2016/11/20 15:15:15  
NAV FILE: brdc3250.16n                  OBS USED: 3696 / 4236 : 87%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 35.65/ 66.29  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.297

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88692)

X:    -783983.319(m) 0.006(m)      -783984.202(m) 0.006(m)  
Y:    -4516578.252(m) 0.018(m)      -4516576.955(m) 0.018(m)  
Z:    4420455.489(m) 0.017(m)      4420455.423(m) 0.017(m)

LAT: 44 9 3.82315    0.004(m)      44 9 3.84704    0.004(m)  
E LON: 260 9 9.96930    0.004(m)      260 9 9.92017    0.004(m)  
W LON: 99 50 50.03070    0.004(m)      99 50 50.07983    0.004(m)  
EL HGT:    438.015(m) 0.025(m)      437.161(m) 0.025(m)  
ORTHO HGT:    462.192(m) 0.027(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES    STATE PLANE COORDINATES  
UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4889000.125      35318.895  
Easting (X) [meters]    432246.531      612222.652  
Convergence [degrees]    -0.59016308      0.10812063  
Point Scale            0.99965646      1.00006146  
Combined Factor        0.99958781      0.99999278

US NATIONAL GRID DESIGNATOR: 14TMP3224689000(NAD 83)

BASE STATIONS USED  
PID    DESIGNATION                  LATITUDE    LONGITUDE    DISTANCE(m)  
DP6619 SDHU SDHURON CORS ARP                  N442229.102 W0981435.368 130480.3

DP4771 NEVN NDOR VALENTINE CORS ARP	N425220.908 W1003237.144	152818.8
DP6617 SDAB SDABERDEEN CORS ARP	N452729.471 W0982448.998	184291.7
DP6615 NDAS NDASHLEY CORS ARP	N460200.316 W0992247.944	212408.7
DP6621 SDWE SDWEBSTER CORS ARP	N452116.159 W0973109.815	227722.1
DP6862 NDEL NDELLENDALE CORS ARP	N460010.356 W0983123.166	230697.2

NEAREST NGS PUBLISHED CONTROL POINT

PS0447	Y 344	N440901.	W0995202.	1601.7
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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12 <RECEIVER>
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79     <ELEMENT_3_1>-5.3724E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.7016E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.7101E-04</ELEMENT_3_3>
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91 <RETRIEVAL TIME="2016-11-21T14:42:52Z" />
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56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-761779.026</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4502330.308</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4438915.159</COORDINATE>
59         </RECT_COORD>
60         <ELLIP_COORD>
61             <LAT>
62                 <DEGREES>44</DEGREES>
63                 <MINUTES>22</MINUTES>
64                 <SECONDS>54.41960</SECONDS>
65             </LAT>
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67                 <DEGREES>-99</DEGREES>
68                 <MINUTES>36</MINUTES>
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70             </EAST_LONG>
71             <EL_HEIGHT UNIT="m">580.422</EL_HEIGHT>
72         </ELLIP_COORD>
73     </COORD_SET>
74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76     <ELEMENT_1_1>2.6202E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>4.5634E-06</ELEMENT_2_1>
78     <ELEMENT_2_2>1.3741E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-7.9501E-06</ELEMENT_3_1>
80     <ELEMENT_3_2>-8.8118E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.1337E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>3.6162E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-4.8764E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.7796E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-9.3194E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>1.4793E-05</ELEMENT_3_2>
89     <ELEMENT_3_3>2.1302E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-21T14:42:52Z" />
92 <POINT_ID COORD_TYPE="Local">NVA46</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

# OPUS-RS solution : SD\_NVA47\_TD.16o OP1479823863255

opus <opus@ngs.noaa.gov>

Tue 11/22/2016 9:15 AM

Inbox

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_NVA47\_TD.16o OP1479823863255

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 22, 2016  
RINEX FILE: sd\_n323o.16o                  TIME: 14:14:57 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3      START: 2016/11/18 14:25:45  
EPHEMERIS: igr19235.eph [rapid]          STOP: 2016/11/18 15:26:00  
NAV FILE: brdc3230.16n                  OBS USED: 4842 / 4860 : 100%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 37.22/ 53.08  
ARP HEIGHT: 2.00                  NORMALIZED RMS:      0.291

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88148)

X:    -731918.752(m) 0.006(m)      -731919.635(m) 0.006(m)  
Y:    -4516150.066(m) 0.019(m)      -4516148.768(m) 0.019(m)  
Z:    4429937.743(m) 0.013(m)      4429937.678(m) 0.013(m)

LAT: 44 16 8.20233    0.006(m)      44 16 8.22660    0.006(m)  
E LON: 260 47 39.43667    0.005(m)      260 47 39.38801    0.005(m)  
W LON: 99 12 20.56333    0.005(m)      99 12 20.61199    0.005(m)  
EL HGT:    570.645(m) 0.023(m)      569.783(m) 0.023(m)  
ORTHO HGT:    595.190(m) 0.024(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4901765.259      48717.824  
Easting (X) [meters]    483581.903      663419.319  
Convergence [degrees]    -0.14359293      0.56214792  
Point Scale            0.99960331      1.00003157  
Combined Factor        0.99951388      0.99994210

US NATIONAL GRID DESIGNATOR: 14TMQ8358101765(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	77684.2

DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	200045.7
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	189094.5
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	88091.7
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	146242.6
DL3887	MNBV BEAVER CREEK CORS ARP	N433629.883	W0962241.338	238583.6
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	196583.0
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	179854.9
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	241345.9

NEAREST NGS PUBLISHED CONTROL POINT

AC8010	REE HEIGHTS	N441607.701	W0991219.589	26.6
--------	-------------	-------------	--------------	------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8003853" REFERENCE_NUMBER="916482853840"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2 <SOLUTION_TIME>2017-01-03T20:23:48Z</SOLUTION_TIME>
3 <OBSERVATION_TIME START="2016-11-18T14:25:45Z" END="2016-11-18T15:26:00Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">SD_NVA47_TD.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
17 <ACCURACY UNIT="m">
18 <LAT>0.006</LAT>
19 <LONG>0.006</LONG>
20 <EL_HEIGHT>0.020</EL_HEIGHT>
21 </ACCURACY>
22 <PERCENT_OBS_USED TOTAL="242" PROCESSING_INTERVAL="15.0" USABLE="242"
USED="236">97</PERCENT_OBS_USED>
23 <USED_SATELLITES TOTAL="17" GPS_SV="G02 G05 G06 G09 G12 G19 G20 G21 G29"
QZSS_SV="" GLN_SV="R02 R03 R04 R10 R16 R17 R18 R19" GAL_SV="" BDS_SV="">G02 G05
G06 G09 G12 G19 G20 G21 G29 R02 R03 R04 R10 R16 R17 R18 R19</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28 <EPOCH>2016.88</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.007">-731919.642</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.015">-4516148.776</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.014">4429937.672</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>16</MINUTES>
39 <SECONDS>8.22625</SECONDS>
40 </LAT>
41 <EAST_LONG>
42 <DEGREES>-99</DEGREES>
43 <MINUTES>12</MINUTES>
44 <SECONDS>20.61223</SECONDS>
45 </EAST_LONG>
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47 </ELLIP_COORD>
48 </COORD_SET>

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49 </POSITION>
50 <POSITION TYPE="CUSTOM">
51   <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52   <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
55     <RECT_COORD>
56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.007">-731918.750</COORDINATE>
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59     </RECT_COORD>
60     <ELLIP_COORD>
61       <LAT>
62         <DEGREES>44</DEGREES>
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71       <EL_HEIGHT UNIT="m">570.647</EL_HEIGHT>
72     </ELLIP_COORD>
73   </COORD_SET>
74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76   <ELEMENT_1_1>4.3316E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>5.2295E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>2.2500E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-4.6300E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-1.7992E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>2.0240E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>3.4238E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>2.4918E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>3.1449E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-1.2507E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>-2.6796E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>4.0502E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-03T20:23:48Z" />
92 <POINT_ID COORD_TYPE="Local">SD_NVA47_TD</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

# OPUS-RS solution : ESP\_NVA\_48.16o OP1479741939623

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 10:33 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_48.16o OP1479741939623

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: esp\_324o.16o                  TIME: 15:33:09 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3      START: 2016/11/19 14:12:30  
EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 15:15:30  
NAV FILE: brdc3240.16n                  OBS USED: 6192 / 6192 : 100%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 49.64/ 79.91  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.259

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88419)

X:    -697417.244(m) 0.008(m)      -697418.129(m) 0.008(m)  
Y:    -4503739.386(m) 0.018(m)      -4503738.089(m) 0.018(m)  
Z:    4447778.636(m) 0.015(m)      4447778.573(m) 0.015(m)

LAT: 44 29 41.35203    0.008(m)    44 29 41.37660    0.008(m)  
E LON: 261 11 50.98538    0.008(m)    261 11 50.93682    0.008(m)  
W LON: 98 48 9.01462    0.008(m)    98 48 9.06318    0.008(m)  
EL HGT:    429.509(m) 0.022(m)      428.647(m) 0.022(m)  
ORTHO HGT:    454.298(m) 0.023(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4926852.765      74210.451  
Easting (X) [meters]    515701.873      695239.947  
Convergence [degrees]    0.13841428      0.84751360  
Point Scale            0.99960303      0.99998595  
Combined Factor        0.99953572      0.99991861

US NATIONAL GRID DESIGNATOR: 14TNQ1570126852(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	193352.2
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	188365.1



11/21/2016

OPUS-RS solution : ESP\_NVA\_48.16o OP1479741939623 - Arry Lazaridis

DM2666 MNMS MARSHALL CORS ARP	N442749.382 W0954744.480	239227.2
DP7425 NDFO NDFORMAN CORS ARP	N460615.246 W0973826.736	200737.8
DP6621 SDWE SDWEBSTER CORS ARP	N452116.159 W0973109.815	139248.8
DL6462 ECSD EROS_USGS_SD2006 CORS ARP	N434401.292 W0963650.385	194536.3
DP4771 NEVN NDOR VALENTINE CORS ARP	N425220.908 W1003237.144	228471.4
DK6507 MNGR GRACEVILLE CORS ARP	N453329.862 W0962938.579	216936.7
DP4732 NEHA HARTINGTON CORS ARP	N423643.728 W0971638.569	242766.7

NEAREST NGS PUBLISHED CONTROL POINT

AB8943	A 463	N442938.	W0984809.	103.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">ESP_NVA_48.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
17    <ACCURACY UNIT="m" >
18      <LAT>0.006</LAT>
19      <LONG>0.006</LONG>
20      <EL_HEIGHT>0.024</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="253" PROCESSING_INTERVAL="15.0" USABLE="253"
USED="246">97</PERCENT_OBS_USED>
23    <USED_SATELLITES TOTAL="17" GPS_SV="G02 G05 G06 G09 G12 G19 G20 G25 G29"
QZSS_SV=" " GLN_SV="R03 R04 R05 R10 R11 R18 R19 R20" GAL_SV=" " BDS_SV=" ">G02 G05
G06 G09 G12 G19 G20 G25 G29 R03 R04 R05 R10 R11 R18 R19 R20</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28    <EPOCH>2016.89</EPOCH>
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30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.008">-697418.135</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.018">-4503738.080</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.017">4447778.557</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
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40        </LAT>
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42          <DEGREES>-98</DEGREES>
43          <MINUTES>48</MINUTES>
44          <SECONDS>9.06351</SECONDS>
45        </EAST_LONG>
46        <EL_HEIGHT UNIT="m">428.630</EL_HEIGHT>
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48    </COORD_SET>
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49 </POSITION>
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53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
55     <RECT_COORD>
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57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.018">-4503739.362</COORDINATE>
58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.017">4447778.637</COORDINATE>
59     </RECT_COORD>
60     <ELLIP_COORD>
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71       <EL_HEIGHT UNIT="m">429.492</EL_HEIGHT>
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73   </COORD_SET>
74 </POSITION>
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76   <ELEMENT_1_1>6.0758E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>9.4622E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>3.1671E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-9.4644E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-2.6900E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>2.9163E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85   <ELEMENT_2_1>-1.2707E-06</ELEMENT_2_1>
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87   <ELEMENT_3_1>-1.8905E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>-7.3424E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>5.9617E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-21T14:42:29Z" />
92 <POINT_ID COORD_TYPE="Local">NVA_48</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

# OPUS-RS solution : ESP\_NVA\_49.16o OP1479734063343

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 8:16 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_49.16o OP1479734063343

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: esp\_322t.16o                  TIME: 13:16:03 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3      START: 2016/11/17 19:14:15  
EPHEMERIS: igr19234.eph [rapid]          STOP: 2016/11/17 20:30:15  
NAV FILE: brdc3220.16n                  OBS USED: 4036 / 4264 : 95%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 39.14/ 66.77  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.336

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87931)

X: -747295.812(m) 0.011(m)      -747296.697(m) 0.011(m)  
Y: -4493249.209(m) 0.008(m)      -4493247.915(m) 0.008(m)  
Z: 4450437.066(m) 0.010(m)      4450437.004(m) 0.010(m)

LAT: 44 31 38.38944    0.002(m)      44 31 38.41370    0.002(m)  
E LON: 260 33 26.17230    0.012(m)      260 33 26.12315    0.012(m)  
W LON: 99 26 33.82770    0.012(m)      99 26 33.87685    0.012(m)  
EL HGT: 546.497(m) 0.012(m)      545.648(m) 0.012(m)  
ORTHO HGT: 570.350(m) 0.014(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4930540.294      77271.078  
Easting (X) [meters]    464820.407      644297.529  
Convergence [degrees]    -0.31046727      0.39440132  
Point Scale            0.99961522      0.99998064  
Combined Factor        0.99952957      0.99989496

US NATIONAL GRID DESIGNATOR: 14TMQ6482030540(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	241984.9
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	243755.3

11/21/2016

OPUS-RS solution : ESP\_NVA\_49.16o OP1479734063343 - Arry Lazaridis

DL9800 MNHD HENDRICKS CORS ARP      N442731.985 W0962607.763 239306.1  
DP4771 NEVN NDOR VALENTINE CORS ARP      N425220.908 W1003237.144 204168.7

NEAREST NGS PUBLISHED CONTROL POINT

PS0333    X 47 RESET                    N443139.    W0992628.      130.1

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4 <CONTRIBUTOR />
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30 <RECT_COORD>
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78   <ELEMENT_2_2>9.3146E-05</ELEMENT_2_2>
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80   <ELEMENT_3_2>-6.4960E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>8.9625E-05</ELEMENT_3_3>
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85   <ELEMENT_2_1>2.6376E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.2546E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-1.6991E-06</ELEMENT_3_1>
88   <ELEMENT_3_2>2.2623E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>1.5771E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-18T14:00:31Z" />
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10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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93
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## OPUS-RS solution : SD\_NVA51\_TD.16o OP1479742839372

opus &lt;opus@ngs.noaa.gov&gt;

Mon 11/21/2016 10:53 AM

Inbox

To: Arry Lazaridis &lt;alazaridis@espassociates.com&gt;;

FILE: SD\_NVA51\_TD.16o OP1479742839372

6011 Warning - OPUS-RS was able to find a set of reference stations  
 6011 with data suitable for use with your dataset. However, your  
 6011 position does not fall within the polygon enclosing these reference  
 6011 stations. This means that the geographic interpolation algorithms  
 6011 performed within OPUS-RS must instead perform extrapolation.  
 6011 Extrapolation, especially if your position is far from the  
 6011 reference stations, is prone to error. Use this solution with  
 6011 caution.

mnhd  
 mnmr  
 nevn  
 mngr  
 neha

Your station is 18.2 KM outside the polygon enclosing the reference stations

## NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
 RINEX FILE: sd\_n324t.16o                  TIME: 15:53:07 UTC

SOFTWARE: rsgps 1.37 RS54.prl 1.99.3      START: 2016/11/19 19:05:45  
 EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 20:05:45  
 NAV FILE: brdc3240.16n                  OBS USED: 3295 / 3545 : 93%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 37.56/ 39.29  
 ARP HEIGHT: 2.00                        NORMALIZED RMS:    0.312

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88474)

X:	-709505.698(m)	0.010(m)	-709506.581(m)	0.010(m)
Y:	-4526644.010(m)	0.016(m)	-4526642.710(m)	0.016(m)
Z:	4422908.087(m)	0.017(m)	4422908.021(m)	0.017(m)

LAT:	44 10 50.57267	0.009(m)	44 10 50.59704	0.009(m)
E LON:	261 5 30.99493	0.010(m)	261 5 30.94660	0.010(m)
W LON:	98 54 29.00507	0.010(m)	98 54 29.05340	0.010(m)

EL HGT: 565.637(m) 0.021(m) 564.768(m) 0.021(m)  
 ORTHO HGT: 590.552(m) 0.023(m) [NAVD88 (Computed using GEOID12B)]

## UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4891948.845	39191.294
Easting (X) [meters]	507349.040	687316.354
Convergence [degrees]	0.06407731	0.77280978
Point Scale	0.99960066	1.00005355
Combined Factor	0.99951201	0.99996486

US NATIONAL GRID DESIGNATOR: 14TNP0734991948(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	199654.9
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	213144.8
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	196497.2
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	244581.8
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	218679.1

## NEAREST NGS PUBLISHED CONTROL POINT

PS0619	EDEN	N441138.026	W0985737.708	4439.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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BDS_SV="">G08 G13 G15 G18 G20 G21 G24 G27 G32 R05 R06 R07 R08 R15 R16 R20 R21  
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81     <ELEMENT_3_3>1.1623E-04</ELEMENT_3_3>
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86     <ELEMENT_2_2>2.8546E-05</ELEMENT_2_2>
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93
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# OPUS-RS solution : ESP\_NVA\_52.16o OP1479741980138

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 10:34 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: ESP\_NVA\_52.16o OP1479741980138

6011 Warning - OPUS-RS was able to find a set of reference stations  
 6011 with data suitable for use with your dataset. However, your  
 6011 position does not fall within the polygon enclosing these reference  
 6011 stations. This means that the geographic interpolation algorithms  
 6011 performed within OPUS-RS must instead perform extrapolation.  
 6011 Extrapolation, especially if your position is far from the  
 6011 reference stations, is prone to error. Use this solution with  
 6011 caution.

mnhd  
 mnmr  
 nevn  
 mngr  
 mnbv  
 neha

Your station is 43.3 KM outside the polygon enclosing the reference stations

## NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
 RINEX FILE: esp\_324v.16o                  TIME: 15:33:09 UTC

SOFTWARE: rsgps 1.37 RS91.prl 1.99.3      START: 2016/11/19 21:56:00  
 EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 23:00:15  
 NAV FILE: brdc3240.16n                  OBS USED: 4950 / 5406 : 92%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 18.54/ 6.88  
 ARP HEIGHT: 2.000                      NORMALIZED RMS:    0.294

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88507)

X:	-721127.068(m)	0.009(m)	-721127.952(m)	0.009(m)
Y:	-4509900.406(m)	0.018(m)	-4509899.109(m)	0.018(m)
Z:	4438020.631(m)	0.017(m)	4438020.567(m)	0.017(m)

LAT:	44 22 14.01104	0.005(m)	44 22 14.03541	0.005(m)
E LON:	260 54 55.38291	0.010(m)	260 54 55.33423	0.010(m)
W LON:	99 5 4.61709	0.010(m)	99 5 4.66577	0.010(m)

EL HGT: 576.216(m) 0.023(m) 575.355(m) 0.023(m)  
 ORTHO HGT: 600.690(m) 0.025(m) [NAVD88 (Computed using GEOID12B)]

## UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4913034.792	60110.566
Easting (X) [meters]	493258.364	672960.096
Convergence [degrees]	-0.05917156	0.64785231
Point Scale	0.99960056	1.00000915
Combined Factor	0.99951025	0.99991881

US NATIONAL GRID DESIGNATOR: 14TMQ9325813034(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	211218.2
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	218823.7
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	203897.8
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	243284.0
DL3887	MNBV BEAVER CREEK CORS ARP	N433629.883	W0962241.338	233039.6
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	243991.4

## NEAREST NGS PUBLISHED CONTROL POINT

PS0682	CHAIN	N442543.225	W0990504.851	6457.8
--------	-------	-------------	--------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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93
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# OPUS-RS solution : SD\_NVA53\_TD.16o OP1479742856293

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 10:56 AM

Inbox

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_NVA53\_TD.16o OP1479742856293

6011 Warning - OPUS-RS was able to find a set of reference stations  
 6011 with data suitable for use with your dataset. However, your  
 6011 position does not fall within the polygon enclosing these reference  
 6011 stations. This means that the geographic interpolation algorithms  
 6011 performed within OPUS-RS must instead perform extrapolation.  
 6011 Extrapolation, especially if your position is far from the  
 6011 reference stations, is prone to error. Use this solution with  
 6011 caution.

- mngr
- mnrn
- nevn
- mndv
- mnhd
- mnms
- mnan
- mnmr
- neha

Your station is 7.6 KM outside the polygon enclosing the reference stations

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
 For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
 RINEX FILE: sd\_n324q.16o                  TIME: 15:55:36 UTC

SOFTWARE: rsgps 1.37 RS51.prl 1.99.3      START: 2016/11/19 16:36:30  
 EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 17:36:15  
 NAV FILE: brdc3240.16n                  OBS USED: 6408 / 7173 : 89%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 38.55/ 55.81  
 ARP HEIGHT: 2.00                          NORMALIZED RMS:    0.272

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88446)

X: -693811.316(m) 0.007(m)      -693812.199(m) 0.007(m)  
 Y: -4528939.271(m) 0.017(m)      -4528937.970(m) 0.017(m)  
 Z: 4422998.516(m) 0.015(m)      4422998.450(m) 0.015(m)

LAT: 44 10 55.72687 0.006(m) 44 10 55.75136 0.006(m)  
 E LON: 261 17 25.01270 0.008(m) 261 17 24.96454 0.008(m)  
 W LON: 98 42 34.98730 0.008(m) 98 42 35.03546 0.008(m)  
 EL HGT: 531.677(m) 0.021(m) 530.805(m) 0.021(m)  
 ORTHO HGT: 556.734(m) 0.023(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4892144.721	39583.716
Easting (X) [meters]	523201.731	703172.541
Convergence [degrees]	0.20231004	0.91318135
Point Scale	0.99960662	1.00005318
Combined Factor	0.99952329	0.99996981

US NATIONAL GRID DESIGNATOR: 14TNP2320192144(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	232461.8
DK6513	MNRM RUSHMORE CORS ARP	N433814.531	W0954612.437	243755.2
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	207733.0
DK6501	MNDV DOVRAY CORS ARP	N440325.719	W0953549.678	249521.6
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	184012.5
DM2666	MNMS MARSHALL CORS ARP	N442749.382	W0954744.480	234537.8
DO2875	MNAN APPLETON CORS ARP	N451143.692	W0960117.714	241000.7
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	198690.6
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	209497.9

NEAREST NGS PUBLISHED CONTROL POINT

PS0616	BATES	N441239.169	W0984437.740	4198.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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# OPUS-RS solution : SD\_NVA54\_TD.16o OP1479823889157

opus <opus@ngs.noaa.gov>

Tue 11/22/2016 9:17 AM

Inbox

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_NVA54\_TD.16o OP1479823889157

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 22, 2016  
RINEX FILE: sd\_n323p.16o                  TIME: 14:16:28 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3      START: 2016/11/18 15:55:30  
EPHEMERIS: igr19235.eph [rapid]          STOP: 2016/11/18 16:55:15  
NAV FILE: brdc3230.16n                  OBS USED: 5958 / 6921 : 86%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 29.32/ 57.61  
ARP HEIGHT: 2.00                  NORMALIZED RMS:    0.277

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88165)

X:    -738572.435(m) 0.008(m)      -738573.319(m) 0.008(m)  
Y:    -4510024.356(m) 0.013(m)      -4510023.059(m) 0.013(m)  
Z:    4434985.850(m) 0.011(m)      4434985.786(m) 0.011(m)

LAT: 44 19 57.82873    0.004(m)    44 19 57.85299    0.004(m)  
E LON: 260 41 58.76965    0.008(m)    260 41 58.72081    0.008(m)  
W LON: 99 18 1.23035    0.008(m)    99 18 1.27919    0.008(m)  
EL HGT:    535.046(m) 0.017(m)      534.188(m) 0.017(m)  
ORTHO HGT:    559.385(m) 0.018(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

                         UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4908873.389      55735.697  
Easting (X) [meters]    476055.340      655802.626  
Convergence [degrees]    -0.20988703      0.49517485  
Point Scale              0.99960705      1.00001714  
Combined Factor          0.99952320      0.99993325

US NATIONAL GRID DESIGNATOR: 14TMQ7605508873(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	84421.5

11/22/2016

OPUS-RS solution : SD\_NVA54\_TD.16o OP1479823889157 - Arry Lazaridis

DL9800 MNHD HENDRICKS CORS ARP	N442731.985 W0962607.763	228670.9
DP4771 NEVN NDOR VALENTINE CORS ARP	N425220.908 W1003237.144	190792.3
DP9063 SDPI SDPIERRE CORS ARP	N442400.063 W1001741.899	79640.3
DP6617 SDAB SDABERDEEN CORS ARP	N452729.471 W0982448.998	143354.0
DL3887 MNBV BEAVER CREEK CORS ARP	N433629.883 W0962241.338	247910.1
DP6615 NDAS NDASHLEY CORS ARP	N460200.316 W0992247.944	189120.4
DP6621 SDWE SDWEBSTER CORS ARP	N452116.159 W0973109.815	180883.8
DP6862 NDEL NDELLENDALE CORS ARP	N460010.356 W0983123.166	195415.3

NEAREST NGS PUBLISHED CONTROL POINT

PS0699	HELM	N441705.658 W0991801.448	5314.3
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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87   <ELEMENT_3_1>1.0989E-05</ELEMENT_3_1>
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93
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# OPUS-RS solution : GCP\_67.16o OP1479747681076

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 12:07 PM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_67.16o OP1479747681076

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

- mnmr
- mnhd
- mnms
- mngr
- mnan
- ecsd
- nevn
- neha

Your station is 37.2 KM outside the polygon enclosing the reference stations

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: gcp\_324p.16o                  TIME: 17:06:44 UTC

SOFTWARE: rsgps 1.37 RS91.prl 1.99.3      START: 2016/11/19 15:41:00  
EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 16:46:15  
NAV FILE: brdc3240.16n                  OBS USED: 6360 / 7168 : 89%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 51.13/ 72.37  
ARP HEIGHT: 0.073152                  NORMALIZED RMS:    0.289

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88436)

X: -689201.877(m) 0.007(m)      -689202.762(m) 0.007(m)  
Y: -4500838.735(m) 0.012(m)      -4500837.438(m) 0.012(m)  
Z: 4451929.576(m) 0.014(m)      4451929.514(m) 0.014(m)

LAT: 44 32 50.74562    0.007(m)    44 32 50.77027    0.007(m)

11/21/2016

OPUS-RS solution : GCP\_67.16o OP1479747681076 - Arry Lazaridis

E LON: 261 17 38.65084 0.008(m) 261 17 38.60231 0.008(m)  
 W LON: 98 42 21.34916 0.008(m) 98 42 21.39769 0.008(m)  
 EL HGT: 404.497(m) 0.016(m) 403.635(m) 0.016(m)  
 ORTHO HGT: 429.293(m) 0.018(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4932719.588	80173.867
Easting (X) [meters]	523358.919	702826.634
Convergence [degrees]	0.20629065	0.91586253
Point Scale	0.99960671	0.99997752
Combined Factor	0.99954332	0.99991410

US NATIONAL GRID DESIGNATOR: 14TNQ2335832719(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	184427.1
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	180826.6
DM2666	MNMS MARSHALL CORS ARP	N442749.382	W0954744.480	231603.5
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	207305.8
DO2875	MNAN APPLETON CORS ARP	N451143.692	W0960117.714	224003.3
DL6462	ECSD EROS_USGS_SD2006 CORS ARP	N434401.292	W0963650.385	190246.0
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	237838.7
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	244011.5

NEAREST NGS PUBLISHED CONTROL POINT

PS0642	NANCE	N443341.499	W0983956.648	3557.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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# OPUS-RS solution : GCP\_69.16o OP1479747703748

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 12:08 PM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_69.16o OP1479747703748

6011 Warning - OPUS-RS was able to find a set of reference stations  
 6011 with data suitable for use with your dataset. However, your  
 6011 position does not fall within the polygon enclosing these reference  
 6011 stations. This means that the geographic interpolation algorithms  
 6011 performed within OPUS-RS must instead perform extrapolation.  
 6011 Extrapolation, especially if your position is far from the  
 6011 reference stations, is prone to error. Use this solution with  
 6011 caution.

- mnmr
- neha
- nevn
- mnmr
- mngr
- ecsd
- mnhd
- mnan
- mnms

Your station is 21.3 KM outside the polygon enclosing the reference stations

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
 For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
 RINEX FILE: gcp\_324r.16o                  TIME: 17:07:49 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3      START: 2016/11/19 17:17:00  
 EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 18:19:00  
 NAV FILE: brdc3240.16n                  OBS USED: 6246 / 6255 : 100%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 34.15/ 40.97  
 ARP HEIGHT: 0.073152                  NORMALIZED RMS:    0.273

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88454)

X: -691104.384(m) 0.008(m)      -691105.268(m) 0.008(m)  
 Y: -4515625.255(m) 0.010(m)      -4515623.956(m) 0.010(m)  
 Z: 4436763.306(m) 0.012(m)      4436763.242(m) 0.012(m)

11/21/2016

OPUS-RS solution : GCP\_69.16o OP1479747703748 - Arry Lazaridis

LAT: 44 21 21.90501 0.008(m) 44 21 21.92958 0.008(m)  
 E LON: 261 17 54.79490 0.008(m) 261 17 54.74658 0.008(m)  
 W LON: 98 42 5.20510 0.008(m) 98 42 5.25342 0.008(m)  
 EL HGT: 422.603(m) 0.013(m) 421.736(m) 0.013(m)  
 ORTHO HGT: 447.552(m) 0.016(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4911466.962	58920.020
Easting (X) [meters]	523792.694	703523.975
Convergence [degrees]	0.20872481	0.91903635
Point Scale	0.99960696	1.00001216
Combined Factor	0.99954073	0.99994590

US NATIONAL GRID DESIGNATOR: 14TNQ2379211466(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	190474.1
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	225411.7
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	222001.1
DK6513	MNRM RUSHMORE CORS ARP	N433814.531	W0954612.437	248299.7
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	219502.6
DL6462	ECSD EROS_USGS_SD2006 CORS ARP	N434401.292	W0963650.385	181029.3
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	180857.9
DO2875	MNAN APPLETON CORS ARP	N451143.692	W0960117.714	231708.8
DM2666	MNMS MARSHALL CORS ARP	N442749.382	W0954744.480	231746.7

NEAREST NGS PUBLISHED CONTROL POINT

PS0621	ROSE	N442058.542	W0984538.995	4789.4
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4   <CONTRIBUTOR />
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7     <ANTENNA>
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9       <ARP_HEIGHT UNIT="m">0.073</ARP_HEIGHT>
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14    </RECEIVER>
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20      <EL_HEIGHT>0.018</EL_HEIGHT>
21    </ACCURACY>
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23    <USED_SATELLITES TOTAL="18" GPS_SV="G05 G10 G13 G15 G16 G18 G20 G21 G27 G29"
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G13 G15 G16 G18 G20 G21 G27 G29 R04 R05 R06 R07 R19 R20 R21
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24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
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27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.013">4436763.200</COORDINATE>
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77     <ELEMENT_2_1>1.2731E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.8169E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.0454E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.4884E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.6410E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
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84     <ELEMENT_1_1>2.4075E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>2.9173E-07</ELEMENT_2_1>
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87     <ELEMENT_3_1>-5.5007E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>1.7129E-05</ELEMENT_3_2>
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90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-21T14:42:39Z" />
92 <POINT_ID COORD_TYPE="Local">GCP_69</POINT_ID></TRIMBLE_RTX_SOLUTION>
93

```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Friday, January 06, 2017 9:30 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP70\_TD.16o OP1483712701845

FILE: SD\_GCP70\_TD.16o OP1483712701845

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 06, 2017  
RINEX FILE: sd\_g322w.16o TIME: 14:29:25 UTC

SOFTWARE: rsgps 1.37 RS54.prl 1.99.3 START: 2016/11/17 22:09:15  
EPHEMERIS: igs19234.eph [precise] STOP: 2016/11/17 23:09:15  
NAV FILE: brdc3220.16n OBS USED: 5382 / 6165 : 87%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 31.21/ 44.94  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.315

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87963)

X:	-755647.952(m)	0.008(m)	-755648.836(m)	0.008(m)
Y:	-4505652.130(m)	0.022(m)	-4505650.834(m)	0.022(m)
Z:	4436646.343(m)	0.020(m)	4436646.279(m)	0.020(m)

LAT:	44 21 10.74781	0.004(m)	44 21 10.77196	0.004(m)
E LON:	260 28 46.06478	0.009(m)	260 28 46.01574	0.009(m)
W LON:	99 31 13.93522	0.009(m)	99 31 13.98426	0.009(m)
EL HGT:	607.557(m)	0.029(m)	606.703(m)	0.029(m)
ORTHO HGT:	631.602(m)	0.030(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4911211.121	57858.542
Easting (X) [meters]	458514.572	638227.397
Convergence [degrees]	-0.36390093	0.33933388
Point Scale	0.99962117	1.00001281
Combined Factor	0.99952595	0.99991755

US NATIONAL GRID DESIGNATOR: 14TMQ5851411211(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	101860.3
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	246020.2
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	184071.8
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	61946.2
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	150760.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	187093.4
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	193414.8
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	199422.8
DP7425	NDFO NDFORMAN CORS ARP	N460615.246	W0973826.736	244267.5

NEAREST NGS PUBLISHED CONTROL POINT

PS0705	PRATT	N441925.545	W0993403.551	4966.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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12 <RECEIVER>
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14 </RECEIVER>
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33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4436646.266</COORDINATE>
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38 <MINUTES>21</MINUTES>
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# OPUS-RS solution : GCP\_72.16o OP1479734218981

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 8:19 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_72.16o OP1479734218981

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: gcp\_320p.16o                    TIME: 13:18:15 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3      START: 2016/11/15 15:03:00  
EPHEMERIS: igr19232.eph [rapid]            STOP: 2016/11/15 16:11:45  
NAV FILE: brdc3200.16n                    OBS USED: 3205 / 3765 : 85%  
ANT NAME: TRMR8\_GNSS3    NONE            QUALITY IND. 20.65/ 71.03  
ARP HEIGHT: 2.000                        NORMALIZED RMS:    0.296

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87336)

X:    -864288.761(m) 0.010(m)      -864289.645(m) 0.010(m)  
Y:    -4489212.027(m) 0.018(m)      -4489210.736(m) 0.018(m)  
Z:    4433456.676(m) 0.011(m)      4433456.612(m) 0.011(m)

LAT: 44 18 47.20391    0.007(m)    44 18 47.22734    0.007(m)  
E LON: 259 6 8.73749    0.007(m)    259 6 8.68731    0.007(m)  
W LON: 100 53 51.26251    0.007(m)    100 53 51.31269    0.007(m)  
EL HGT:    578.712(m) 0.021(m)      577.879(m) 0.021(m)  
ORTHO HGT:    601.594(m) 0.022(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4908401.456      53711.581  
Easting (X) [meters]    348665.437      528388.704  
Convergence [degrees]    -1.32585544      -0.63524663  
Point Scale            0.99988166      1.00002145  
Combined Factor        0.99979094      0.99993071

US NATIONAL GRID DESIGNATOR: 14TLQ4866508401(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	211774.6
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	162605.0

11/21/2016

OPUS-RS solution : GCP\_72.16o OP1479734218981 - Arry Lazaridis

DP1963	SDRC	RAPID CITY	CORS	ARP	N440457.973	W1031332.337	187866.0
DP6615	NDAS	NDASHLEY	CORS	ARP	N460200.316	W0992247.944	225351.4
DP6617	SDAB	SDABERDEEN	CORS	ARP	N452729.471	W0982448.998	233875.7

NEAREST NGS PUBLISHED CONTROL POINT

AB6184	PUBLIC	RM 1	N442119.10	W1005558.49	5470.5
--------	--------	------	------------	-------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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BDS_SV="">G02 G05 G06 G12 G13 G15 G20 G21 G25 G26 G29 R01 R07 R08 R13 R14 R15
R17 R22 R23 R24</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28 <EPOCH>2016.88</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-864289.652</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4489210.778</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.012">4433456.641</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
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42 <DEGREES>-100</DEGREES>
43 <MINUTES>53</MINUTES>
44 <SECONDS>51.31265</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">577.930</EL_HEIGHT>
47 </ELLIP_COORD>

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48     </COORD_SET>
49 </POSITION>
50 <POSITION TYPE="CUSTOM">
51     <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-864288.759</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4489212.054</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.012">4433456.723</COORDINATE>
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68                 <MINUTES>53</MINUTES>
69                 <SECONDS>51.26220</SECONDS>
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71             <EL_HEIGHT UNIT="m">578.763</EL_HEIGHT>
72         </ELLIP_COORD>
73     </COORD_SET>
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76     <ELEMENT_1_1>3.2098E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>3.3916E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.5680E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-2.8306E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.2208E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.3711E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>2.5487E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>2.4537E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>2.3962E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-1.0907E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>-9.2626E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>2.7655E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-15T19:08:59Z" />
92 <POINT_ID COORD_TYPE="Local">JV_02</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## OPUS-RS solution : SD\_GCP74\_TD.16o OP1478874223317

opus &lt;opus@ngs.noaa.gov&gt;

Fri 11/11/2016 9:25 AM

To: Arry Lazaridis &lt;alazaridis@espassociates.com&gt;;

FILE: SD\_GCP74\_TD.16o OP1478874223317

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
 2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
 2005 process the data.  
 2005

## NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 11, 2016  
 RINEX FILE: sd\_g315v.16o                  TIME: 14:25:05 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3      START: 2016/11/10 21:29:30  
 EPHEMERIS: igu19224.eph [ultra-rapid]      STOP: 2016/11/10 22:29:30  
 NAV FILE: brdc3150.16n                  OBS USED: 2890 / 3020 : 96%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 21.31/ 45.27  
 ARP HEIGHT: 2.000                      NORMALIZED RMS:    0.320

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.86043)

X: -883288.775(m) 0.006(m)      -883289.659(m) 0.006(m)  
 Y: -4490661.770(m) 0.011(m)      -4490660.480(m) 0.011(m)  
 Z: 4428318.766(m) 0.007(m)      4428318.701(m) 0.007(m)

LAT: 44 14 53.76743    0.006(m)    44 14 53.79068    0.006(m)  
 E LON: 258 52 20.22938    0.005(m)    258 52 20.17907    0.005(m)  
 W LON: 101 7 39.77062    0.005(m)    101 7 39.82093    0.005(m)  
 EL HGT:    608.815(m) 0.012(m)      607.986(m) 0.012(m)  
 ORTHO HGT:    631.382(m) 0.015(m) [NAVD88 (Computed using GEOID12B)]

## UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)

Northing (Y) [meters]    4901649.535      46736.486  
 Easting (X) [meters]    330124.273      509927.991  
 Convergence [degrees]    -1.48500640      -0.79812630  
 Point Scale            0.99995491      1.00003651  
 Combined Factor        0.99985946      0.99994105

US NATIONAL GRID DESIGNATOR: 14TLQ3012401649(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	68538.6
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	159986.2
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	168815.4
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	230567.5
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	241357.0

## NEAREST NGS PUBLISHED CONTROL POINT

PT0915	U 432	N441440.	W1010742.	427.8
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="7786561" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2   <SOLUTION_TIME>2016-11-11T14:39:09Z</SOLUTION_TIME>
3   <OBSERVATION_TIME START="2016-11-10T21:29:30Z" END="2016-11-10T22:29:30Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">SD_GCP74_TD.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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16  <DATA_QUALITY>
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18      <LAT>0.007</LAT>
19      <LONG>0.004</LONG>
20      <EL_HEIGHT>0.015</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="241" PROCESSING_INTERVAL="15.0" USABLE="241"
USED="234">97</PERCENT_OBS_USED>
23    <USED_SATELLITES TOTAL="19" GPS_SV="G01 G08 G11 G14 G18 G21 G24 G27 G31 G32"
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G08 G11 G14 G18 G21 G24 G27 G31 G32 R05 R06 R07 R08 R15 R16 R21 R22
R23</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28    <EPOCH>2016.86</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-883289.655</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4490660.496</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4428318.694</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
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42          <DEGREES>-101</DEGREES>
43          <MINUTES>7</MINUTES>
44          <SECONDS>39.82059</SECONDS>
45        </EAST_LONG>
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47      </ELLIP_COORD>
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48     </COORD_SET>
49 </POSITION>
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51     <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
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55         <RECT_COORD>
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57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4490661.771</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4428318.777</COORDINATE>
59         </RECT_COORD>
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71             <EL_HEIGHT UNIT="m">608.822</EL_HEIGHT>
72         </ELLIP_COORD>
73     </COORD_SET>
74 </POSITION>
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77     <ELEMENT_2_1>1.7505E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.5479E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.5398E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-7.8472E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.1317E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85     <ELEMENT_2_1>-6.3786E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>1.9129E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-1.9524E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>6.6005E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>2.1531E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-11T14:39:09Z" />
92 <POINT_ID COORD_TYPE="Local">SD_GCP74_TD</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:48 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : GCP\_75\_2\_TD.16o OP1483649249378

FILE: GCP\_75\_2\_TD.16o OP1483649249378

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: gcp\_320o.16o TIME: 20:47:59 UTC

SOFTWARE: rsgps 1.37 RS91.prl 1.99.3 START: 2016/11/15 14:44:45  
EPHEMERIS: igs19232.eph [precise] STOP: 2016/11/15 15:44:45  
NAV FILE: brdc3200.16n OBS USED: 2270 / 2650 : 86%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 21.30/ 45.86  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.291

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87332)

X:	-885483.819(m)	0.005(m)	-885484.702(m)	0.005(m)
Y:	-4499808.594(m)	0.010(m)	-4499807.302(m)	0.010(m)
Z:	4418648.860(m)	0.010(m)	4418648.794(m)	0.010(m)

LAT:	44 7 36.92132	0.004(m)	44 7 36.94453	0.004(m)
E LON:	258 52 2.75754	0.004(m)	258 52 2.70736	0.004(m)
W LON:	101 7 57.24246	0.004(m)	101 7 57.29264	0.004(m)
EL HGT:	608.106(m)	0.014(m)	607.272(m)	0.014(m)
ORTHO HGT:	630.926(m)	0.016(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4888181.221	199564.595
Easting (X) [meters]	329386.953	536037.721
Convergence [degrees]	-1.48515737	-0.55135315
Point Scale	0.99995801	0.99994623
Combined Factor	0.99986267	0.99985089

US NATIONAL GRID DESIGNATOR: 14TLP2938688181(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	73450.2
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	147297.8
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	167666.0
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	232399.9
DI2251	P043 NEWCASTLE_WY2006 CORS ARP	N435252.101	W1041108.484	246393.2

NEAREST NGS PUBLISHED CONTROL POINT

PT0908	Q 432	N440801.	W1010757.	743.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007650" REFERENCE_NUMBER="225381494724"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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3 <OBSERVATION_TIME START="2016-11-15T14:44:45Z" END="2016-11-15T15:44:45Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">GCP-75-2_TD.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
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14 </RECEIVER>
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16 <DATA_QUALITY>
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21 </ACCURACY>
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23 <USED_SATELLITES TOTAL="18" GPS_SV="G02 G05 G06 G09 G12 G13 G20 G21 G29"
QZSS_SV="" GLN_SV="R01 R07 R08 R13 R14 R15 R22 R23 R24" GAL_SV="" BDS_SV="">G02
G05 G06 G09 G12 G13 G20 G21 G29 R01 R07 R08 R13 R14 R15 R22 R23
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24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28 <EPOCH>2016.88</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-885484.694</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4499807.268</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.012">4418648.749</COORDINATE>
34 </RECT_COORD>
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36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>7</MINUTES>
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40 </LAT>
41 <EAST_LONG>
42 <DEGREES>-101</DEGREES>
43 <MINUTES>7</MINUTES>
44 <SECONDS>57.29258</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">607.216</EL_HEIGHT>
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48     </COORD_SET>
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50 <POSITION TYPE="CUSTOM">
51     <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52     <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53     <EPOCH>2010.0</EPOCH>
54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-885483.802</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4499808.544</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.012">4418648.834</COORDINATE>
59         </RECT_COORD>
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66             <EAST_LONG>
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68                 <MINUTES>7</MINUTES>
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74 </POSITION>
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76     <ELEMENT_1_1>4.2116E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>4.1739E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>1.5712E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-3.7674E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.2742E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.5114E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>2.7391E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>2.8509E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>3.0588E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-4.7176E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>-2.0695E-05</ELEMENT_3_2>
89     <ELEMENT_3_3>2.9239E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T21:56:08Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-75</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Tuesday, November 15, 2016 9:35 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP77A\_TD.16o OP1479220282666

FILE: SD\_GCP77A\_TD.16o OP1479220282666

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 15, 2016  
RINEX FILE: sd\_g319u.16o TIME: 14:34:22 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3 START: 2016/11/14 20:45:15  
EPHEMERIS: igu19231.eph [ultra-rapid] STOP: 2016/11/14 21:45:00  
NAV FILE: brdc3190.16n OBS USED: 3305 / 3505 : 94%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 28.37/ 55.07  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.314

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87127)

X: -821273.140(m) 0.004(m) -821274.023(m) 0.004(m)  
Y: -4503159.215(m) 0.014(m) -4503157.921(m) 0.014(m)  
Z: 4427458.713(m) 0.015(m) 4427458.648(m) 0.015(m)

LAT: 44 14 17.28874 0.004(m) 44 14 17.31242 0.004(m)  
E LON: 259 39 50.96672 0.003(m) 259 39 50.91711 0.003(m)  
W LON: 100 20 9.03328 0.003(m) 100 20 9.08289 0.003(m)  
EL HGT: 532.320(m) 0.020(m) 531.477(m) 0.020(m)  
ORTHO HGT: 556.202(m) 0.022(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4899190.213 45038.791  
Easting (X) [meters] 393329.033 573170.349  
Convergence [degrees] -0.93202763 -0.23768862  
Point Scale 0.99973994 1.00003898  
Combined Factor 0.99965650 0.99995552

US NATIONAL GRID DESIGNATOR: 14TLP9332999190(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	152668.1
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	167671.1
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	203649.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	213219.6
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	231801.7

NEAREST NGS PUBLISHED CONTROL POINT

PT0115	O 13	N441417.04	W1001932.33	814.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>  
10 <REFERENCE>Bottom of antenna mount</REFERENCE>  
11 </ANTENNA>  
12 <RECEIVER>  
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21 </ACCURACY>  
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28 <EPOCH>2016.87</EPOCH>  
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31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-821274.025</COORDINATE>  
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4503157.965</COORDINATE>  
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.012">4427458.667</COORDINATE>  
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43 <MINUTES>20</MINUTES>  
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78     <ELEMENT_2_2>1.7792E-04</ELEMENT_2_2>
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80     <ELEMENT_3_2>-1.1485E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.4822E-04</ELEMENT_3_3>
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87     <ELEMENT_3_1>-1.2109E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>8.8572E-06</ELEMENT_3_2>
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91 <RETRIEVAL TIME="2016-11-15T13:52:01Z" />
92 <POINT_ID COORD_TYPE="Local">GCP77A</POINT_ID></TRIMBLE_RTX_SOLUTION>
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## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:27 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : GCP77B\_TD.16o OP1479140632493

FILE: GCP77B\_TD.16o OP1479140632493

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: gcp7318v.16o TIME: 16:26:18 UTC

SOFTWARE: rsgps 1.37 RS52.prl 1.99.3 START: 2016/11/13 21:16:45  
EPHEMERIS: igu19230.eph [ultra-rapid] STOP: 2016/11/13 22:16:30  
NAV FILE: brdc3180.16n OBS USED: 2965 / 3000 : 99%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 6.17/ 36.02  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.316

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86860)

X: -821274.825(m) 0.004(m) -821275.708(m) 0.004(m)  
Y: -4503170.334(m) 0.016(m) -4503169.040(m) 0.016(m)  
Z: 4427446.225(m) 0.011(m) 4427446.160(m) 0.011(m)

LAT: 44 14 16.74485 0.005(m) 44 14 16.76853 0.005(m)  
E LON: 259 39 50.98192 0.005(m) 259 39 50.93231 0.005(m)  
W LON: 100 20 9.01808 0.005(m) 100 20 9.06769 0.005(m)  
EL HGT: 531.662(m) 0.019(m) 530.818(m) 0.019(m)  
ORTHO HGT: 555.544(m) 0.020(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4899173.426 45022.001  
Easting (X) [meters] 393329.097 573170.616  
Convergence [degrees] -0.93202216 -0.23768563  
Point Scale 0.99973994 1.00003902  
Combined Factor 0.99965660 0.99995566

US NATIONAL GRID DESIGNATOR: 14TLP9332999173(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	152651.4
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	167672.5
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	203660.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	213235.3
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	231801.1

NEAREST NGS PUBLISHED CONTROL POINT

PT0115	O 13	N441417.04	W1001932.33	814.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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80     <ELEMENT_3_2>-9.5902E-05</ELEMENT_3_2>
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92 <POINT_ID COORD_TYPE="Local">GCP77B</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:49 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : GCP78\_TD.16o OP1483649300523

FILE: GCP78\_TD.16o OP1483649300523

### NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: gcp7318n.16o TIME: 20:48:55 UTC

SOFTWARE: rsgps 1.37 RS54.prl 1.99.3 START: 2016/11/13 13:53:00  
EPHEMERIS: igs19230.eph [precise] STOP: 2016/11/13 14:53:00  
NAV FILE: brdc3180.16n OBS USED: 2605 / 2630 : 99%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 37.48/ 43.67  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.307

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86776)

X:	-859224.864(m)	0.007(m)	-859225.747(m)	0.007(m)
Y:	-4502503.366(m)	0.010(m)	-4502502.073(m)	0.010(m)
Z:	4420898.062(m)	0.007(m)	4420897.996(m)	0.007(m)

LAT:	44 9 22.24552	0.005(m)	44 9 22.26891	0.005(m)
E LON:	259 11 45.57195	0.006(m)	259 11 45.52201	0.006(m)
W LON:	100 48 14.42805	0.006(m)	100 48 14.47799	0.006(m)
EL HGT:	487.655(m)	0.012(m)	486.816(m)	0.012(m)
ORTHO HGT:	511.137(m)	0.014(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4890801.858	202614.215
Easting (X) [meters]	355744.480	562350.212
Convergence [degrees]	-1.25691777	-0.32469570
Point Scale	0.99985593	0.99995090
Combined Factor	0.99977948	0.99987444

US NATIONAL GRID DESIGNATOR: 14TLP5574490801(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	205911.7
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	144179.6
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	194020.5
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	236828.4
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	238093.9

NEAREST NGS PUBLISHED CONTROL POINT

PT0336	1698	N440933.	W1004744.	753.2
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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America</TECTONIC_PLATE>
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69                 <SECONDS>14.42783</SECONDS>
70             </EAST_LONG>
71             <EL_HEIGHT UNIT="m">487.668</EL_HEIGHT>
72         </ELLIP_COORD>
73     </COORD_SET>
74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76     <ELEMENT_1_1>2.2459E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>6.4181E-06</ELEMENT_2_1>
78     <ELEMENT_2_2>1.7037E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-1.1966E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.7001E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.1106E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>4.0983E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>-1.0203E-05</ELEMENT_2_1>
86     <ELEMENT_2_2>2.5292E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-2.5355E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>1.9736E-05</ELEMENT_3_2>
89     <ELEMENT_3_3>2.3761E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T21:57:23Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-78</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

# OPUS-RS solution : SD\_GCP79\_TD.16o OP1479825074955

opus <opus@ngs.noaa.gov>

Tue 11/22/2016 9:36 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_GCP79\_TD.16o OP1479825074955

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 22, 2016  
RINEX FILE: sd\_g323r.16o                  TIME: 14:35:17 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3      START: 2016/11/18 17:37:45  
EPHEMERIS: igr19235.eph [rapid]          STOP: 2016/11/18 18:38:30  
NAV FILE: brdc3230.16n                  OBS USED: 5400 / 5904 : 91%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 28.33/ 52.05  
ARP HEIGHT: 0.073152                  NORMALIZED RMS:      0.302

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88185)

X: -719190.810(m) 0.007(m)      -719191.693(m) 0.007(m)  
Y: -4518119.320(m) 0.017(m)      -4518118.022(m) 0.017(m)  
Z: 4429952.052(m) 0.017(m)      4429951.987(m) 0.017(m)

LAT: 44 16 10.21197 0.005(m)      44 16 10.23631 0.005(m)  
E LON: 260 57 20.09188 0.005(m)      260 57 20.04337 0.005(m)  
W LON: 99 2 39.90812 0.005(m)      99 2 39.95663 0.005(m)  
EL HGT: 527.506(m) 0.024(m)      526.642(m) 0.024(m)  
ORTHO HGT: 552.173(m) 0.025(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES    STATE PLANE COORDINATES  
UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4901807.649      48919.033  
Easting (X) [meters]    496454.912      676296.365  
Convergence [degrees]    -0.03100593      0.67630122  
Point Scale            0.99960015      1.00003144  
Combined Factor        0.99951748      0.99994873

US NATIONAL GRID DESIGNATOR: 14TMQ9645401807(NAD 83)

BASE STATIONS USED  
PID    DESIGNATION                  LATITUDE    LONGITUDE    DISTANCE(m)  
DP6619 SDHU SDHURON CORS ARP      N442229.102 W0981435.368    64982.7  
DP6862 NDEL NDELLENDALE CORS ARP    N460010.356 W0983123.166    196959.3

DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	196879.1
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	100791.5
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	141198.1
DL3887	MNBV BEAVER CREEK CORS ARP	N433629.883	W0962241.338	226318.2
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	197809.7
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	170563.0
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	233163.9

## NEAREST NGS PUBLISHED CONTROL POINT

PS0683	LIKENESS	N441812.533	W0990340.657	4008.7
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="7833758" REFERENCE_NUMBER="1394636983"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2   <SOLUTION_TIME>2016-11-22T13:53:46Z</SOLUTION_TIME>
3   <OBSERVATION_TIME START="2016-11-18T17:37:45Z" END="2016-11-18T18:38:30Z" />
4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">SD_GCP79_TD.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">0.073</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
17    <ACCURACY UNIT="m" >
18      <LAT>0.008</LAT>
19      <LONG>0.006</LONG>
20      <EL_HEIGHT>0.025</EL_HEIGHT>
21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="243" PROCESSING_INTERVAL="15.0" USABLE="243"
USED="237">97</PERCENT_OBS_USED>
23    <USED_SATELLITES TOTAL="16" GPS_SV="G05 G13 G15 G16 G18 G20 G21 G24 G26 G27 G29"
QZSS_SV=" " GLN_SV="R04 R05 R19 R20 R21" GAL_SV=" " BDS_SV=" ">G05 G13 G15 G16 G18
G20 G21 G24 G26 G27 G29 R04 R05 R19 R20 R21</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28    <EPOCH>2016.88</EPOCH>
29    <COORD_SET>
30      <RECT_COORD>
31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-719191.698</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.019">-4518118.043</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.018">4429951.995</COORDINATE>
34      </RECT_COORD>
35      <ELLIP_COORD>
36        <LAT>
37          <DEGREES>44</DEGREES>
38          <MINUTES>16</MINUTES>
39          <SECONDS>10.23599</SECONDS>
40        </LAT>
41        <EAST_LONG>
42          <DEGREES>-99</DEGREES>
43          <MINUTES>2</MINUTES>
44          <SECONDS>39.95672</SECONDS>
45        </EAST_LONG>
46        <EL_HEIGHT UNIT="m">526.663</EL_HEIGHT>
47      </ELLIP_COORD>
48    </COORD_SET>
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49 </POSITION>
50 <POSITION TYPE="CUSTOM">
51   <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52   <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
53   <EPOCH>2010.0</EPOCH>
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55     <RECT_COORD>
56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-719190.807</COORDINATE>
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67         <DEGREES>-99</DEGREES>
68         <MINUTES>2</MINUTES>
69         <SECONDS>39.90792</SECONDS>
70       </EAST_LONG>
71       <EL_HEIGHT UNIT="m">527.528</EL_HEIGHT>
72     </ELLIP_COORD>
73   </COORD_SET>
74 </POSITION>
75 <COVARIANCE_MATRIX COORD_SET="Rect" UNIT="m*m">
76   <ELEMENT_1_1>3.9734E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>2.6475E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>3.5452E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-4.8968E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-2.7750E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>3.4146E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>6.6385E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>-1.9937E-05</ELEMENT_2_1>
86   <ELEMENT_2_2>3.9292E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>4.3393E-07</ELEMENT_3_1>
88   <ELEMENT_3_2>1.3666E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>6.3004E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-22T13:53:46Z" />
92 <POINT_ID COORD_TYPE="Local">SD_GCP79_TD</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Friday, January 06, 2017 10:13 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP80\_TD.16o OP1483715401598

FILE: SD\_GCP80\_TD.16o OP1483715401598

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 06, 2017  
RINEX FILE: sd\_g324v.16o TIME: 15:12:19 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3 START: 2016/11/19 21:57:15  
EPHEMERIS: igs19236.eph [precise] STOP: 2016/11/19 22:57:00  
NAV FILE: brdc3240.16n OBS USED: 4095 / 5904 : 69%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 35.69/ 32.03  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.265

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.88507)

X:	-720045.254(m)	0.007(m)	-720046.137(m)	0.007(m)
Y:	-4524951.068(m)	0.009(m)	-4524949.769(m)	0.009(m)
Z:	4422838.598(m)	0.005(m)	4422838.532(m)	0.005(m)

LAT:	44 10 49.59143	0.005(m)	44 10 49.61572	0.005(m)
E LON:	260 57 30.45181	0.006(m)	260 57 30.40336	0.006(m)
W LON:	99 2 29.54819	0.006(m)	99 2 29.59664	0.006(m)
EL HGT:	497.097(m)	0.010(m)	496.230(m)	0.010(m)
ORTHO HGT:	521.965(m)	0.013(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4891915.300	39025.836
Easting (X) [meters]	496679.584	676643.289
Convergence [degrees]	-0.02895089	0.67833792
Point Scale	0.99960014	1.00005362
Combined Factor	0.99952223	0.99997568

US NATIONAL GRID DESIGNATOR: 14TMP9667991915(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	67297.8
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	206609.3
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	189381.4
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	102979.8
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	150434.4
DL3887	MNBV BEAVER CREEK CORS ARP	N433629.883	W0962241.338	223234.2
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	207652.3
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	177604.0
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	225350.3

NEAREST NGS PUBLISHED CONTROL POINT

PS0147	E 79	N441041.	W0985912.	4396.0
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007652" REFERENCE_NUMBER="225381494724"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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4 <CONTRIBUTOR />
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9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
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18 <LAT>0.008</LAT>
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20 <EL_HEIGHT>0.014</EL_HEIGHT>
21 </ACCURACY>
22 <PERCENT_OBS_USED TOTAL="240" PROCESSING_INTERVAL="15.0" USABLE="240"
USED="233">97</PERCENT_OBS_USED>
23 <USED_SATELLITES TOTAL="18" GPS_SV="G01 G11 G12 G14 G18 G22 G24 G31 G32"
QZSS_SV="" GLN_SV="R01 R07 R08 R10 R11 R16 R17 R23 R24" GAL_SV="" BDS_SV="">G01
G11 G12 G14 G18 G22 G24 G31 G32 R01 R07 R08 R10 R11 R16 R17 R23
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24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
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28 <EPOCH>2016.89</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-720046.137</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4524949.749</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4422838.513</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>10</MINUTES>
39 <SECONDS>49.61572</SECONDS>
40 </LAT>
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42 <DEGREES>-99</DEGREES>
43 <MINUTES>2</MINUTES>
44 <SECONDS>29.59677</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">496.203</EL_HEIGHT>
47 </ELLIP_COORD>

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48     </COORD_SET>
49 </POSITION>
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51   <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
52   <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
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57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4524951.033</COORDINATE>
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59     </RECT_COORD>
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72     </ELLIP_COORD>
73   </COORD_SET>
74 </POSITION>
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79   <ELEMENT_3_1>-9.7564E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-7.0638E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>9.1128E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>5.7731E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>7.5070E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.9217E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-3.6928E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>-5.6219E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>2.0249E-04</ELEMENT_3_3>
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91 <RETRIEVAL TIME="2017-01-04T21:58:29Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-80</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

# OPUS-RS solution : SD\_GCP81\_TD.16o OP1479747615044

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 12:04 PM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_GCP81\_TD.16o OP1479747615044

6011 Warning - OPUS-RS was able to find a set of reference stations  
 6011 with data suitable for use with your dataset. However, your  
 6011 position does not fall within the polygon enclosing these reference  
 6011 stations. This means that the geographic interpolation algorithms  
 6011 performed within OPUS-RS must instead perform extrapolation.  
 6011 Extrapolation, especially if your position is far from the  
 6011 reference stations, is prone to error. Use this solution with  
 6011 caution.

- mnmr
- mngr
- nevn
- mnms
- mnan
- mnhd
- neha

Your station is 12.6 KM outside the polygon enclosing the reference stations

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
 For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
 RINEX FILE: sd\_g324r.16o                  TIME: 17:03:41 UTC

SOFTWARE: rsgps 1.37 RS51.prl 1.99.3      START: 2016/11/19 17:52:15  
 EPHEMERIS: igr19236.eph [rapid]          STOP: 2016/11/19 18:52:15  
 NAV FILE: brdc3240.16n                  OBS USED: 3906 / 4044 : 97%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 29.05/ 32.21  
 ARP HEIGHT: 0.073152                  NORMALIZED RMS:    0.308

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88461)

X:	-701238.954(m)	0.005(m)	-701239.837(m)	0.005(m)
Y:	-4527934.356(m)	0.022(m)	-4527933.056(m)	0.022(m)
Z:	4422883.855(m)	0.017(m)	4422883.789(m)	0.017(m)

LAT:	44 10 49.95728	0.008(m)	44 10 49.98170	0.008(m)
E LON:	261 11 47.64673	0.006(m)	261 11 47.59849	0.006(m)

11/21/2016

OPUS-RS solution : SD\_GCP81\_TD.16o OP1479747615044 - Arry Lazaridis

W LON: 98 48 12.35327 0.006(m) 98 48 12.40151 0.006(m)  
EL HGT: 550.414(m) 0.027(m) 549.544(m) 0.027(m)  
ORTHO HGT: 575.398(m) 0.028(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4891944.532	39290.551
Easting (X) [meters]	515711.840	695682.347
Convergence [degrees]	0.13699314	0.84685724
Point Scale	0.99960304	1.00005360
Combined Factor	0.99951678	0.99996730

US NATIONAL GRID DESIGNATOR: 14TNP1571191944(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	205539.6
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	238204.0
DM2666	MNMS MARSHALL CORS ARP	N442749.382	W0954744.480	241973.1
DO2875	MNAN APPLETON CORS ARP	N451143.692	W0960117.714	247675.1
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	191417.8
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	213651.2

NEAREST NGS PUBLISHED CONTROL POINT

PS0617	SPIRE A	N441215.698	W0984919.614	3038.9
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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3   <OBSERVATION_TIME START="2016-11-19T17:52:15Z" END="2016-11-19T18:52:15Z" />
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23    <USED_SATELLITES TOTAL="18" GPS_SV="G05 G13 G15 G16 G18 G20 G21 G24 G26 G27 G29"
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24  </DATA_QUALITY>
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57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4527934.347</COORDINATE>
58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4422883.864</COORDINATE>
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76   <ELEMENT_1_1>2.1415E-05</ELEMENT_1_1>
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78   <ELEMENT_2_2>1.1980E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-8.9173E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.6547E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.2283E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>3.4321E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>-2.9560E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.1791E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>4.1890E-06</ELEMENT_3_1>
88   <ELEMENT_3_2>9.4032E-06</ELEMENT_3_2>
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90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-21T14:42:45Z" />
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6 <OBS_FILE TYPE="T02">SD_GCP82_TD.t02</OBS_FILE>  
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9 <ARP_HEIGHT UNIT="m">0.073</ARP_HEIGHT>  
10 <REFERENCE>Bottom of antenna mount</REFERENCE>  
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28 <EPOCH>2016.89</EPOCH>  
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31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.007">-691178.890</COORDINATE>  
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80   <ELEMENT_3_2>-3.7458E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>3.3278E-04</ELEMENT_3_3>
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# OPUS-RS solution : GCP\_96.16o OP1479734246324

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 8:24 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_96.16o OP1479734246324

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: gcp\_321s.16o                  TIME: 13:23:22 UTC

SOFTWARE: rsgps 1.37 RS50.prl 1.99.3      START: 2016/11/16 18:57:45  
EPHEMERIS: igr19233.eph [rapid]          STOP: 2016/11/16 20:01:30  
NAV FILE: brdc3210.16n                  OBS USED: 6704 / 6992 : 96%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 32.80/ 53.13  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.289

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87654)

X:    -783730.700(m) 0.005(m)      -783731.585(m) 0.005(m)  
Y:    -4487027.502(m) 0.015(m)      -4487026.209(m) 0.015(m)  
Z:    4450354.624(m) 0.017(m)      4450354.562(m) 0.017(m)

LAT: 44 31 36.70959    0.004(m)    44 31 36.73364    0.004(m)  
E LON: 260 5 32.38515    0.004(m)    260 5 32.33560    0.004(m)  
W LON: 99 54 27.61485    0.004(m)    99 54 27.66440    0.004(m)  
EL HGT:    481.652(m) 0.022(m)      480.809(m) 0.022(m)  
ORTHO HGT:    505.156(m) 0.024(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4930793.782	77070.948
Easting (X) [meters]	427875.300	607339.386
Convergence [degrees]	-0.63652568	0.06534491
Point Scale	0.99966397	0.99998071
Combined Factor	0.99958848	0.99990520

US NATIONAL GRID DESIGNATOR: 14TMQ2787530793(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	156823.2
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	133567.3



11/21/2016

OPUS-RS solution : GCP\_96.16o OP1479734246324 - Arry Lazaridis

DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	190838.5
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	232517.3
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	172486.0
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	196765.2
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	209739.1
DP7425	NDFO NDFORMAN CORS ARP	N460615.246	W0973826.736	249637.8

NEAREST NGS PUBLISHED CONTROL POINT

PS0522	RR BM	N443133.	W0995444.	379.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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BDS_SV=" " >G08 G10 G13 G15 G18 G20 G21 G24 G27 G29 G32 R02 R03 R04 R05 R12 R13
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# OPUS-RS solution : GCP\_99.16o OP1479742229405

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 10:42 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_99.16o OP1479742229405

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: gcp\_321u.16o                  TIME: 15:41:21 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3      START: 2016/11/16 20:28:00  
EPHEMERIS: igr19233.eph [rapid]          STOP: 2016/11/16 21:32:45  
NAV FILE: brdc3210.16n                  OBS USED: 7380 / 8100 : 91%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 20.87/ 17.67  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.294

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87671)

X:    -760326.572(m) 0.003(m)      -760327.457(m) 0.003(m)  
Y:    -4491077.762(m) 0.016(m)      -4491076.468(m) 0.016(m)  
Z:    4450383.367(m) 0.016(m)      4450383.305(m) 0.016(m)

LAT: 44 31 36.80899    0.004(m)      44 31 36.83318    0.004(m)  
E LON: 260 23 27.95856    0.003(m)      260 23 27.90926    0.003(m)  
W LON: 99 36 32.04144    0.003(m)      99 36 32.09074    0.003(m)  
EL HGT:    519.521(m) 0.023(m)      518.674(m) 0.023(m)  
ORTHO HGT:    543.208(m) 0.024(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4930576.506      77144.927  
Easting (X) [meters]    451616.027      631088.959  
Convergence [degrees]    -0.42699597      0.27679612  
Point Scale            0.99962879      0.99998071  
Combined Factor        0.99954737      0.99989926

US NATIONAL GRID DESIGNATOR: 14TMQ5161630576(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	139989.1
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	110020.0

DP9063 SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	56392.2
DO2366 P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	239196.0
DP6615 NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	168401.9
DP4771 NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	198668.9
DP6862 NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	184853.4
DP6621 SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	188832.1
DP7425 NDFO NDFORMAN CORS ARP	N460615.246	W0973826.736	233542.7

NEAREST NGS PUBLISHED CONTROL POINT

AB8999	D 464	N443137.	W0993613.	420.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
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13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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81   <ELEMENT_3_3>9.5622E-05</ELEMENT_3_3>
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91 <RETRIEVAL TIME="2016-11-17T13:59:56Z" />
92 <POINT_ID COORD_TYPE="Local">GCP_99</POINT_ID></TRIMBLE_RTX_SOLUTION>
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# OPUS-RS solution : GCP\_100.16o OP1479734646559

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 8:26 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_100.16o OP1479734646559

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: gcp\_322o.16o                    TIME: 13:25:49 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3      START: 2016/11/17 14:29:30  
EPHEMERIS: igr19234.eph [rapid]            STOP: 2016/11/17 15:34:00  
NAV FILE: brdc3220.16n                    OBS USED: 3495 / 3495 : 100%  
ANT NAME: TRMR8\_GNSS3    NONE            QUALITY IND. 52.45/ 61.52  
ARP HEIGHT: 2.000                    NORMALIZED RMS:    0.263

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87876)

X:    -736627.523(m) 0.010(m)      -736628.408(m) 0.010(m)  
Y:    -4494884.830(m) 0.023(m)      -4494883.535(m) 0.023(m)  
Z:    4450517.453(m) 0.020(m)      4450517.391(m) 0.020(m)

LAT: 44 31 43.06305    0.007(m)    44 31 43.08740    0.007(m)  
E LON: 260 41 34.88882    0.011(m)    260 41 34.83978    0.011(m)  
W LON: 99 18 25.11118    0.011(m)    99 18 25.16022    0.011(m)  
EL HGT:    514.459(m) 0.029(m)      513.607(m) 0.029(m)  
ORTHO HGT:    538.453(m) 0.030(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4930635.008      77498.662  
Easting (X) [meters]    475608.095      655087.220  
Convergence [degrees]    -0.21527228      0.49048002  
Point Scale            0.99960732      0.99998043  
Combined Factor        0.99952669      0.99989977

US NATIONAL GRID DESIGNATOR: 14TMQ7560830635(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL9802	MNMR MARIETTA CORS ARP	N445610.247	W0962631.420	231402.9
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	249400.5



11/21/2016

OPUS-RS solution : GCP\_100.16o OP1479734646559 - Arry Lazaridis

DL9800 MNHD HENDRICKS CORS ARP        N442731.985 W0962607.763 228518.4  
DP4771 NEVN NDOR VALENTINE CORS ARP    N425220.908 W1003237.144 209282.1  
DO2366 P802 MANDANDBMND2012 CORS ARP   N463327.161 W1003724.231 247825.7

NEAREST NGS PUBLISHED CONTROL POINT

AB8981    14 284.89                    N443143.    W0991840.    328.8

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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81   <ELEMENT_3_3>1.4817E-04</ELEMENT_3_3>
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# OPUS-RS solution : GCP\_101.16o OP1479747659251

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 12:05 PM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_101.16o OP1479747659251

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

- mnmr
- mnbv
- mngr
- neha
- mnan
- mnhd
- nevn

Your station is 43.6 KM outside the polygon enclosing the reference stations

6030 \*\*\*\*\* WARNING \*\*\*\*\*

6030 One or both of the standard deviations associated with  
6030 horizontal coordinates is greater than 5 cm, and/or the  
6030 standard deviation associated with the vertical coordinate  
6030 is greater than 10 cm. This means that the vectors used to  
6030 determine your position did not agree as well as expected.  
6030 Often this is the result of problems with the adopted coordinates  
6030 at one or more of the reference stations selected by OPUS-RS.  
6030 If a problem reference station can be identified, it can  
6030 be excluded with the Exclude feature on the OPUS Options  
6030 page.

6030

NGS OPUS-RS SOLUTION REPORT  
=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: gcp\_324u.16o                    TIME: 17:04:20 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3      START: 2016/11/19 20:33:45  
EPHEMERIS: igr19236.eph [rapid]            STOP: 2016/11/19 21:37:45  
NAV FILE: brdc3240.16n                    OBS USED: 3315 / 3895 : 85%

ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 41.14/ 22.85  
 ARP HEIGHT: 0.073152 NORMALIZED RMS: 0.381

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.88492)

X: -712250.381(m) 0.089(m) -712251.265(m) 0.089(m)  
 Y: -4505555.708(m) 0.174(m) -4505554.411(m) 0.174(m)  
 Z: 4443713.655(m) 0.070(m) 4443713.592(m) 0.070(m)

LAT: 44 26 34.62035 0.178(m) 44 26 34.64482 0.178(m)  
 E LON: 261 1 0.71951 0.061(m) 261 1 0.67087 0.061(m)  
 W LON: 98 58 59.28049 0.061(m) 98 58 59.32913 0.061(m)  
 EL HGT: 498.866(m) 0.088(m) 498.006(m) 0.088(m)  
 ORTHO HGT: 523.415(m) 0.089(m) [NAVD88 (Computed using GEOID12B)]

#### UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4921072.386	68250.630
Easting (X) [meters]	501342.158	680947.242
Convergence [degrees]	0.01180992	0.71967527
Point Scale	0.99960002	0.99999507
Combined Factor	0.99952184	0.99991686

US NATIONAL GRID DESIGNATOR: 14TNQ0134221072(NAD 83)

#### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DL3887	MNBV BEAVER CREEK CORS ARP	N433629.883	W0962241.338	228501.0
DK6507	MNGR GRACEVILLE CORS ARP	N453329.862	W0962938.579	232104.4
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	245731.2
DO2875	MNAN APPLETON CORS ARP	N451143.692	W0960117.714	248702.9
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	215157.8

#### NEAREST NGS PUBLISHED CONTROL POINT

PS0623	AREO	N442619.530	W0985901.253	467.8
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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76     <ELEMENT_1_1>2.8396E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>1.8746E-05</ELEMENT_2_1>
78     <ELEMENT_2_2>2.4674E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-2.6177E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.0377E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.3015E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>8.0973E-05</ELEMENT_1_1>
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86     <ELEMENT_2_2>2.7937E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-5.6440E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>4.5518E-06</ELEMENT_3_2>
89     <ELEMENT_3_3>2.9637E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-21T14:42:33Z" />
92 <POINT_ID COORD_TYPE="Local">GCP_101</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 2:07 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : GCP\_106.16o OP1479150213243

FILE: GCP\_106.16o OP1479150213243

1008 NOTE: Antenna offsets supplied by the user were <=0. Coordinates  
1008 returned will be for the antenna reference point (ARP).  
1008

### NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: gcp\_316w.16o TIME: 19:05:28 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3 START: 2016/11/11 22:51:00  
EPHEMERIS: igr19225.eph [rapid] STOP: 2016/11/11 23:58:15  
NAV FILE: brdc3160.16n OBS USED: 4068 / 4992 : 81%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 36.45/ 34.19  
ARP HEIGHT: 0.000 NORMALIZED RMS: 0.337

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86332)

X:	-822571.725(m)	0.010(m)	-822572.609(m)	0.010(m)
Y:	-4493907.965(m)	0.023(m)	-4493906.672(m)	0.023(m)
Z:	4436381.283(m)	0.015(m)	4436381.219(m)	0.015(m)

LAT:	44 21 4.78609	0.007(m)	44 21 4.80981	0.007(m)
E LON:	259 37 38.34928	0.007(m)	259 37 38.29951	0.007(m)
W LON:	100 22 21.65072	0.007(m)	100 22 21.70049	0.007(m)
EL HGT:	416.635(m)	0.028(m)	415.795(m)	0.028(m)
ORTHO HGT:	440.174(m)	0.029(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4911811.651	57629.718
Easting (X) [meters]	390597.777	570285.359
Convergence [degrees]	-0.95967581	-0.26376040
Point Scale	0.99974719	1.00001316
Combined Factor	0.99968188	0.99994784

US NATIONAL GRID DESIGNATOR: 14TLQ9059711811(NAD 83)



BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	164897.4
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	169776.8
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	197653.2
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	202566.6
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	229935.9
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	234135.5

NEAREST NGS PUBLISHED CONTROL POINT

PT0123	U 13	N442100.	W1002228.	204.0
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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3   <OBSERVATION_TIME START="2016-11-11T22:51:00Z" END="2016-11-11T23:58:15Z" />
4   <CONTRIBUTOR />
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9       <ARP_HEIGHT UNIT="m">0.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
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13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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18      <LAT>0.006</LAT>
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G10 G11 G12 G14 G18 G22 G24 G25 G31 G32 R01 R07 R08 R10 R11 R23
R24</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
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27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28    <EPOCH>2016.87</EPOCH>
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33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4436381.211</COORDINATE>
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41        <EAST_LONG>
42          <DEGREES>-100</DEGREES>
43          <MINUTES>22</MINUTES>
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53   <EPOCH>2010.0</EPOCH>
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77   <ELEMENT_2_1>3.6594E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>1.5268E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-1.6408E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.4838E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>8.9424E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85   <ELEMENT_2_1>8.7635E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.6081E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-3.4240E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>-1.0202E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>2.1283E-04</ELEMENT_3_3>
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91 <RETRIEVAL TIME="2016-11-14T14:03:12Z" />
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93

```

# OPUS-RS solution : GCP\_109.16o OP1479747640898

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 12:05 PM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_109.16o OP1479747640898

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: gcp\_321w.16o                  TIME: 17:04:20 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3      START: 2016/11/16 22:04:30  
EPHEMERIS: igr19233.eph [rapid]          STOP: 2016/11/16 23:11:00  
NAV FILE: brdc3210.16n                  OBS USED: 6384 / 7584 : 84%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 33.86/ 53.67  
ARP HEIGHT: 0.073152                  NORMALIZED RMS:      0.317

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87689)

X:    -770445.128(m) 0.006(m)      -770446.012(m) 0.006(m)  
Y:    -4497410.600(m) 0.014(m)      -4497409.306(m) 0.014(m)  
Z:    4442364.023(m) 0.013(m)      4442363.960(m) 0.013(m)

LAT: 44 25 31.20149    0.004(m)      44 25 31.22557    0.004(m)  
E LON: 260 16 44.75647    0.005(m)      260 16 44.70720    0.005(m)  
W LON: 99 43 15.24353    0.005(m)      99 43 15.29280    0.005(m)  
EL HGT:    567.827(m) 0.019(m)      566.978(m) 0.019(m)  
ORTHO HGT:    591.608(m) 0.021(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4919368.188      65823.021  
Easting (X) [meters]    442616.868      622224.851  
Convergence [degrees]    -0.50462940      0.19752903  
Point Scale            0.99964049      0.99999835  
Combined Factor        0.99955150      0.99990932

US NATIONAL GRID DESIGNATOR: 14TMQ4261619368(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	154343.7
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	117864.6

DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	184869.4
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	247256.8
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	180721.0
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	198975.6
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	202255.3
DP7425	NDFO NDFORMAN CORS ARP	N460615.246	W0973826.736	247910.1

## NEAREST NGS PUBLISHED CONTROL POINT

PS0707	MADRA	N442735.376	W0994441.723	4283.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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12 <RECEIVER>
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14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
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BDS_SV="">G01 G08 G10 G11 G12 G14 G18 G22 G24 G25 G31 G32 R04 R05 R06 R13 R14
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56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-740424.903</COORDINATE>
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76   <ELEMENT_1_1>2.6397E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>1.2250E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>2.2309E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-1.3400E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-1.0287E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>1.1902E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>6.7720E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>-2.9549E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.7655E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-4.9409E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>2.4972E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>2.7314E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-18T14:00:35Z" />
92 <POINT_ID COORD_TYPE="Local">GCP_110</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:56 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP111\_TD.16o OP1483649353978

FILE: SD\_GCP111\_TD.16o OP1483649353978

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: sd\_g324u.16o TIME: 20:55:09 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3 START: 2016/11/19 20:31:00  
EPHEMERIS: igs19236.eph [precise] STOP: 2016/11/19 21:31:00  
NAV FILE: brdc3240.16n OBS USED: 4557 / 4732 : 96%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 31.24/ 61.05  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.297

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.88491)

X:	-713536.938(m)	0.005(m)	-713537.822(m)	0.005(m)
Y:	-4513338.385(m)	0.009(m)	-4513337.087(m)	0.009(m)
Z:	4435734.684(m)	0.012(m)	4435734.620(m)	0.012(m)

LAT:	44 20 31.15864	0.009(m)	44 20 31.18306	0.009(m)
E LON:	261 0 58.21148	0.005(m)	261 0 58.16292	0.005(m)
W LON:	98 59 1.78852	0.005(m)	98 59 1.83708	0.005(m)
EL HGT:	553.583(m)	0.012(m)	552.720(m)	0.012(m)
ORTHO HGT:	578.179(m)	0.015(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4909858.020	57031.920
Easting (X) [meters]	501288.934	681032.603
Convergence [degrees]	0.01130175	0.71918221
Point Scale	0.99960002	1.00001514
Combined Factor	0.99951326	0.99992835

US NATIONAL GRID DESIGNATOR: 14TNQ0128809858(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	59164.0
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	188109.5
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	206195.9
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	104709.5
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	131972.6
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	190548.3
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	161444.9

NEAREST NGS PUBLISHED CONTROL POINT

PS0156	M 79	N441929.19	W0985901.81	1912.7
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007653" REFERENCE_NUMBER="225381494724"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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3 <OBSERVATION_TIME START="2016-11-19T20:31:00Z" END="2016-11-19T21:31:00Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">SD_GCP111_TD.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
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18 <LAT>0.009</LAT>
19 <LONG>0.005</LONG>
20 <EL_HEIGHT>0.016</EL_HEIGHT>
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22 <PERCENT_OBS_USED TOTAL="241" PROCESSING_INTERVAL="15.0" USABLE="241"
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23 <USED_SATELLITES TOTAL="18" GPS_SV="G08 G11 G14 G15 G18 G21 G24 G27 G32"
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24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
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28 <EPOCH>2016.89</EPOCH>
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30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-713537.827</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4513337.114</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.013">4435734.629</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
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41 <EAST_LONG>
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43 <MINUTES>59</MINUTES>
44 <SECONDS>1.83712</SECONDS>
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78     <ELEMENT_2_2>1.8075E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-3.5619E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-9.1593E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.5932E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85     <ELEMENT_2_1>-2.0806E-05</ELEMENT_2_1>
86     <ELEMENT_2_2>2.7756E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>-9.0931E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>-8.5838E-06</ELEMENT_3_2>
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91 <RETRIEVAL TIME="2017-01-04T21:59:52Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-111</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:56 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP112\_TD.16o OP1483649378844

FILE: SD\_GCP112\_TD.16o OP1483649378844

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: sd\_g322u.16o TIME: 20:55:08 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3 START: 2016/11/17 20:49:30  
EPHEMERIS: igs19234.eph [precise] STOP: 2016/11/17 21:49:45  
NAV FILE: brdc3220.16n OBS USED: 4600 / 4904 : 94%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 24.05/ 37.70  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.333

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87948)

X: -743016.765(m) 0.006(m) -743017.649(m) 0.006(m)  
Y: -4507107.634(m) 0.016(m) -4507106.338(m) 0.016(m)  
Z: 4437252.409(m) 0.017(m) 4437252.345(m) 0.017(m)

LAT: 44 21 39.19208 0.007(m) 44 21 39.21631 0.007(m)  
E LON: 260 38 19.43983 0.008(m) 260 38 19.39093 0.008(m)  
W LON: 99 21 40.56017 0.008(m) 99 21 40.60907 0.008(m)  
EL HGT: 576.458(m) 0.022(m) 575.602(m) 0.022(m)  
ORTHO HGT: 600.684(m) 0.023(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES  
UTM (Zone 14) SPC (4001 SD N)  
Northing (Y) [meters] 4912020.458 58824.198  
Easting (X) [meters] 471211.899 650918.856  
Convergence [degrees] -0.25259054 0.45205594  
Point Scale 0.99961019 1.00001115  
Combined Factor 0.99951985 0.99992077

US NATIONAL GRID DESIGNATOR: 14TMQ7121112020(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	89142.2
DP7425	NDFO NDFORMAN CORS ARP	N460615.246	W0973826.736	236195.0
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	74541.3
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	143081.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	185894.6
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	182722.9
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	194014.7
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	233292.8

NEAREST NGS PUBLISHED CONTROL POINT

PS0700	PENO	N442039.368	W0992455.235	4690.3
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007654" REFERENCE_NUMBER="225381494724"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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4 <CONTRIBUTOR />
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9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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14 </RECEIVER>
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16 <DATA_QUALITY>
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23 <USED_SATELLITES TOTAL="20" GPS_SV="G01 G08 G11 G14 G15 G18 G21 G24 G27 G31 G32"
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G08 G11 G14 G15 G18 G21 G24 G27 G31 G32 R04 R05 R06 R14 R15 R16 R20 R21
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33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4437252.351</COORDINATE>
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43 <MINUTES>21</MINUTES>
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53     <EPOCH>2010.0</EPOCH>
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80     <ELEMENT_3_2>-8.6678E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.1174E-04</ELEMENT_3_3>
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92 <POINT_ID COORD_TYPE="Local">GCP-112</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:54 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP113.16o OP1483649394709

FILE: SD\_GCP113.16o OP1483649394709

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: sd\_g321s.16o TIME: 20:53:09 UTC

SOFTWARE: rsgps 1.37 RS52.prl 1.99.3 START: 2016/11/16 18:51:45  
EPHEMERIS: igs19233.eph [precise] STOP: 2016/11/16 19:51:30  
NAV FILE: brdc3210.16n OBS USED: 5409 / 6390 : 85%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 29.43/ 73.63  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.267

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87652)

X:	-748171.068(m)	0.006(m)	-748171.950(m)	0.006(m)
Y:	-4528409.772(m)	0.013(m)	-4528408.473(m)	0.013(m)
Z:	4414569.538(m)	0.013(m)	4414569.471(m)	0.013(m)

LAT:	44 4 38.73485	0.008(m)	44 4 38.75894	0.008(m)
E LON:	260 37 6.60693	0.005(m)	260 37 6.55831	0.005(m)
W LON:	99 22 53.39307	0.005(m)	99 22 53.44169	0.005(m)
EL HGT:	421.822(m)	0.017(m)	420.958(m)	0.017(m)
ORTHO HGT:	446.636(m)	0.019(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4880543.216	194194.275
Easting (X) [meters]	469453.527	676237.408
Convergence [degrees]	-0.26538348	0.65662542
Point Scale	0.99961148	0.99993893
Combined Factor	0.99954537	0.99987280

US NATIONAL GRID DESIGNATOR: 14TMP6945380543(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	96773.0
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	224414.2
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	163602.5
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	81305.5
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	171509.8
DL6462	ECSD EROS_USGS_SD2006 CORS ARP	N434401.292	W0963650.385	225571.3
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	204713.4
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	235801.7
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	217382.3

NEAREST NGS PUBLISHED CONTROL POINT

PS0412	TT 4 D RM 1	N440255.51	W0992314.71	3221.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007656" REFERENCE_NUMBER="225381494724"
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3 <OBSERVATION_TIME START="2016-11-16T18:51:45Z" END="2016-11-16T19:51:30Z" />
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8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
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18 <LAT>0.009</LAT>
19 <LONG>0.006</LONG>
20 <EL_HEIGHT>0.018</EL_HEIGHT>
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22 <PERCENT_OBS_USED TOTAL="240" PROCESSING_INTERVAL="15.0" USABLE="240"
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23 <USED_SATELLITES TOTAL="19" GPS_SV="G13 G15 G18 G20 G21 G24 G27 G29 G32"
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BDS_SV="">G13 G15 G18 G20 G21 G24 G27 G29 G32 R02 R03 R04 R05 R12 R13 R17 R18
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24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28 <EPOCH>2016.88</EPOCH>
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31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-748171.962</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4528408.486</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.016">4414569.461</COORDINATE>
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36 <LAT>
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39 <SECONDS>38.75835</SECONDS>
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43 <MINUTES>22</MINUTES>
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46 <EL_HEIGHT UNIT="m">420.962</EL_HEIGHT>
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54     <COORD_SET>
55         <RECT_COORD>
56             <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-748171.071</COORDINATE>
57             <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4528409.770</COORDINATE>
58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.016">4414569.545</COORDINATE>
59         </RECT_COORD>
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68                 <MINUTES>22</MINUTES>
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70             </EAST_LONG>
71             <EL_HEIGHT UNIT="m">421.826</EL_HEIGHT>
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76     <ELEMENT_1_1>2.7669E-05</ELEMENT_1_1>
77     <ELEMENT_2_1>-5.0718E-06</ELEMENT_2_1>
78     <ELEMENT_2_2>1.4789E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>1.2585E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.1993E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>2.6258E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84     <ELEMENT_1_1>8.8537E-05</ELEMENT_1_1>
85     <ELEMENT_2_1>6.1736E-06</ELEMENT_2_1>
86     <ELEMENT_2_2>3.2495E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>6.3471E-05</ELEMENT_3_1>
88     <ELEMENT_3_2>3.9577E-05</ELEMENT_3_2>
89     <ELEMENT_3_3>3.1711E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T22:01:49Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-113</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
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# OPUS-RS solution : SD\_GCP114.16o OP1479733539471

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 8:09 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_GCP114.16o OP1479733539471

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: sd\_g321v.16o                  TIME: 13:09:12 UTC

SOFTWARE: rsgps 1.37 RS53.prl 1.99.3      START: 2016/11/16 21:40:30  
EPHEMERIS: igr19233.eph [rapid]          STOP: 2016/11/16 22:40:15  
NAV FILE: brdc3210.16n                  OBS USED: 3990 / 4095 : 97%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 24.94/ 32.25  
ARP HEIGHT: 2.00                  NORMALIZED RMS:      0.296

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87684)

X:    -765436.481(m) 0.004(m)      -765437.365(m) 0.004(m)  
Y:    -4509156.747(m) 0.012(m)      -4509155.451(m) 0.012(m)  
Z:    4431401.494(m) 0.014(m)      4431401.429(m) 0.014(m)

LAT: 44 17 14.11330    0.003(m)      44 17 14.13735    0.003(m)  
E LON: 260 21 56.84001    0.004(m)      260 21 56.79093    0.004(m)  
W LON: 99 38 3.15999    0.004(m)      99 38 3.20907    0.004(m)  
EL HGT:    580.763(m) 0.018(m)      579.909(m) 0.018(m)  
ORTHO HGT:    604.768(m) 0.020(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES    STATE PLANE COORDINATES  
UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4903973.835      50507.138  
Easting (X) [meters]    449398.625      629197.313  
Convergence [degrees]    -0.44285111      0.25888277  
Point Scale            0.99963149      1.00002731  
Combined Factor        0.99954047      0.99993625

US NATIONAL GRID DESIGNATOR: 14TMQ4939803973(NAD 83)

BASE STATIONS USED  
PID    DESIGNATION                  LATITUDE    LONGITUDE    DISTANCE(m)  
DP6619 SDHU SDHURON CORS ARP      N442229.102 W0981435.368 111379.9  
DP4771 NEVN NDOR VALENTINE CORS ARP    N425220.908 W1003237.144 173514.1

DP9063 SDPI SDPIERRE CORS ARP	N442400.063 W1001741.899	54164.1
DP6617 SDAB SDABERDEEN CORS ARP	N452729.471 W0982448.998	161978.0
DP6615 NDAS NDASHLEY CORS ARP	N460200.316 W0992247.944	195097.1
DP6621 SDWE SDWEBSTER CORS ARP	N452116.159 W0973109.815	205043.1
DP6862 NDEL NDELLENDALE CORS ARP	N460010.356 W0983123.166	209738.2

## NEAREST NGS PUBLISHED CONTROL POINT

PS0483	S 314	N441832.	W0993837.	2518.4
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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4   <CONTRIBUTOR />
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11    </ANTENNA>
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14    </RECEIVER>
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BDS_SV="">G01 G08 G11 G12 G14 G18 G21 G22 G24 G27 G31 G32 R04 R05 R06 R13 R14
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24  </DATA_QUALITY>
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31        <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-765437.367</COORDINATE>
32        <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4509155.471</COORDINATE>
33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4431401.425</COORDINATE>
34      </RECT_COORD>
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55         <RECT_COORD>
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58             <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4431401.508</COORDINATE>
59         </RECT_COORD>
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72         </ELLIP_COORD>
73     </COORD_SET>
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78     <ELEMENT_2_2>1.6185E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-8.9504E-06</ELEMENT_3_1>
80     <ELEMENT_3_2>-8.8428E-05</ELEMENT_3_2>
81     <ELEMENT_3_3>1.0422E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85     <ELEMENT_2_1>1.0379E-06</ELEMENT_2_1>
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89     <ELEMENT_3_3>2.2369E-04</ELEMENT_3_3>
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91 <RETRIEVAL TIME="2016-11-17T13:21:06Z" />
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93
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# OPUS-RS solution : SD\_GCP115.16o OP1479747201088

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 11:57 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_GCP115.16o OP1479747201088

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: sd\_g321q.16o                  TIME: 16:56:57 UTC

SOFTWARE: rsgps 1.37 RS50.prl 1.99.3      START: 2016/11/16 16:32:00  
EPHEMERIS: igr19233.eph [rapid]          STOP: 2016/11/16 17:32:00  
NAV FILE: brdc3210.16n                  OBS USED: 5856 / 6776 : 86%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 30.68/ 55.47  
ARP HEIGHT: 0.073152                  NORMALIZED RMS:    0.271

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87626)

X: -766010.361(m) 0.006(m)      -766011.243(m) 0.006(m)  
Y: -4525483.750(m) 0.008(m)      -4525482.452(m) 0.008(m)  
Z: 4414652.724(m) 0.009(m)      4414652.657(m) 0.009(m)

LAT: 44 4 39.39422 0.005(m)      44 4 39.41818 0.005(m)  
E LON: 260 23 34.20813 0.005(m)      260 23 34.15932 0.005(m)  
W LON: 99 36 25.79187 0.005(m)      99 36 25.84068 0.005(m)  
EL HGT: 520.387(m) 0.011(m)      519.527(m) 0.011(m)  
ORTHO HGT: 545.040(m) 0.014(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4880672.007      27221.495  
Easting (X) [meters]    451384.601      631469.210  
Convergence [degrees]    -0.42237130      0.27802475  
Point Scale              0.99962907      1.00008218  
Combined Factor          0.99954751      1.00000058

US NATIONAL GRID DESIGNATOR: 14TMP5138480672(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	113881.8
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	153855.2

DP9063 SDPI SDPIERRE CORS ARP	N442400.063 W1001741.899	65597.0
DP6617 SDAB SDABERDEEN CORS ARP	N452729.471 W0982448.998	180183.3
DP4732 NEHA HARTINGTON CORS ARP	N423643.728 W0971638.569	249370.2
DP6621 SDWE SDWEBSTER CORS ARP	N452116.159 W0973109.815	217937.9
DP6615 NDAS NDASHLEY CORS ARP	N460200.316 W0992247.944	218098.6
DP6862 NDEL NDELLENDALE CORS ARP	N460010.356 W0983123.166	230377.6

## NEAREST NGS PUBLISHED CONTROL POINT

PS0711 BRULE	N440518.936 W0993613.756	1249.5
--------------	--------------------------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4   <CONTRIBUTOR />
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9       <ARP_HEIGHT UNIT="m">0.073</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
12    <RECEIVER>
13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
15  </DATA_SOURCES>
16  <DATA_QUALITY>
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21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="241" PROCESSING_INTERVAL="15.0" USABLE="241"
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23    <USED_SATELLITES TOTAL="16" GPS_SV="G02 G05 G13 G15 G16 G18 G20 G21 G26 G29"
QZSS_SV="" GLN_SV="R01 R02 R03 R17 R18 R24" GAL_SV="" BDS_SV="">G02 G05 G13 G15
G16 G18 G20 G21 G26 G29 R01 R02 R03 R17 R18 R24</USED_SATELLITES>
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33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4414652.661</COORDINATE>
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43          <MINUTES>36</MINUTES>
44          <SECONDS>25.84081</SECONDS>
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48    </COORD_SET>
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53   <EPOCH>2010.0</EPOCH>
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78   <ELEMENT_2_2>7.1623E-05</ELEMENT_2_2>
79   <ELEMENT_3_1>-3.2903E-06</ELEMENT_3_1>
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81   <ELEMENT_3_3>7.6305E-05</ELEMENT_3_3>
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84   <ELEMENT_1_1>2.8725E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>1.4941E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.2750E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>3.5113E-06</ELEMENT_3_1>
88   <ELEMENT_3_2>4.7617E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>1.1980E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-17T13:20:00Z" />
92 <POINT_ID COORD_TYPE="Local">GCP115</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
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3 <OBSERVATION_TIME START="2016-11-17T13:24:15Z" END="2016-11-17T14:24:00Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">SD_GCP116_TD.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
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18 <LAT>0.007</LAT>
19 <LONG>0.005</LONG>
20 <EL_HEIGHT>0.014</EL_HEIGHT>
21 </ACCURACY>
22 <PERCENT_OBS_USED TOTAL="240" PROCESSING_INTERVAL="15.0" USABLE="240"
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23 <USED_SATELLITES TOTAL="18" GPS_SV="G02 G05 G06 G09 G12 G17 G19 G29" QZSS_SV="
GLN_SV="R01 R02 R08 R14 R15 R16 R17 R18 R23 R24" GAL_SV=" " BDS_SV=" ">G02 G05 G06
G09 G12 G17 G19 G29 R01 R02 R08 R14 R15 R16 R17 R18 R23 R24</USED_SATELLITES>
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25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
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28 <EPOCH>2016.88</EPOCH>
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31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.004">-786394.592</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4521859.115</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4414773.044</COORDINATE>
34 </RECT_COORD>
35 <ELLIP_COORD>
36 <LAT>
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38 <MINUTES>4</MINUTES>
39 <SECONDS>45.01467</SECONDS>
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46 <EL_HEIGHT UNIT="m">514.187</EL_HEIGHT>
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48 </COORD_SET>

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53   <EPOCH>2010.0</EPOCH>
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71       <EL_HEIGHT UNIT="m">515.044</EL_HEIGHT>
72     </ELLIP_COORD>
73   </COORD_SET>
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76   <ELEMENT_1_1>1.9150E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>7.6619E-07</ELEMENT_2_1>
78   <ELEMENT_2_2>1.6100E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-5.7526E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.1561E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>9.5249E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>4.3882E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>-1.0189E-05</ELEMENT_2_1>
86   <ELEMENT_2_2>2.3056E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-2.8295E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>2.2463E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>2.0847E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-18T14:05:57Z" />
92 <POINT_ID COORD_TYPE="Local">GCP116</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:52 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP117\_TD.16o OP1483649420890

FILE: SD\_GCP117\_TD.16o OP1483649420890

### NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: sd\_g319n.16o TIME: 20:51:11 UTC

SOFTWARE: rsgps 1.37 RS53.prl 1.99.3 START: 2016/11/14 13:54:00  
EPHEMERIS: igs19231.eph [precise] STOP: 2016/11/14 14:54:00  
NAV FILE: brdc3190.16n OBS USED: 3234 / 3252 : 99%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 26.22/ 42.13  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.313

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87049)

X: -790790.429(m) 0.005(m) -790791.312(m) 0.005(m)  
Y: -4515882.970(m) 0.011(m) -4515881.674(m) 0.011(m)  
Z: 4419922.005(m) 0.008(m) 4419921.939(m) 0.008(m)

LAT: 44 8 40.49579 0.006(m) 44 8 40.51962 0.006(m)  
E LON: 260 4 2.87405 0.004(m) 260 4 2.82486 0.004(m)  
W LON: 99 55 57.12595 0.004(m) 99 55 57.17514 0.004(m)  
EL HGT: 413.877(m) 0.012(m) 413.025(m) 0.012(m)  
ORTHO HGT: 438.015(m) 0.015(m) [NAVD88 (Computed using GEOID12B)]

#### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4002 SD S)

Northing (Y) [meters]	4888354.212	201296.351
Easting (X) [meters]	425416.531	632066.583
Convergence [degrees]	-0.64951375	0.27649153
Point Scale	0.99966841	0.99994902
Combined Factor	0.99960354	0.99988413

US NATIONAL GRID DESIGNATOR: 14TMP2541688354(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	137312.3
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	149734.7
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	189078.4
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	214378.4
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	233643.4
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	234444.6

NEAREST NGS PUBLISHED CONTROL POINT

PS0444	A 350	N440953.	W0995425.	3033.0
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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3 <OBSERVATION_TIME START="2016-11-14T13:54:00Z" END="2016-11-14T14:54:00Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">GCP-117_TD.t02</OBS_FILE>
7 <ANTENNA>
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9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
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18 <LAT>0.006</LAT>
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20 <EL_HEIGHT>0.016</EL_HEIGHT>
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23 <USED_SATELLITES TOTAL="19" GPS_SV="G02 G05 G06 G09 G12 G17 G19 G20 G29"
QZSS_SV="" GLN_SV="R05 R06 R07 R08 R11 R12 R13 R21 R22 R23" GAL_SV=""
BDS_SV="">G02 G05 G06 G09 G12 G17 G19 G20 G29 R05 R06 R07 R08 R11 R12 R13 R21
R22 R23</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
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32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4515881.699</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4419921.943</COORDINATE>
34 </RECT_COORD>
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36 <LAT>
37 <DEGREES>44</DEGREES>
38 <MINUTES>8</MINUTES>
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43 <MINUTES>55</MINUTES>
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58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4419922.028</COORDINATE>
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68         <MINUTES>55</MINUTES>
69         <SECONDS>57.12583</SECONDS>
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78   <ELEMENT_2_2>1.7371E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-1.3650E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-1.1009E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>1.1650E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85   <ELEMENT_2_1>-6.6272E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.5068E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-2.4894E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>1.4788E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>2.5631E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T22:03:39Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-117</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Tuesday, November 15, 2016 9:38 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP118\_TD.16o OP1479220342787

FILE: SD\_GCP118\_TD.16o OP1479220342787

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.  
2005

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 15, 2016  
RINEX FILE: sd\_g319p.16o TIME: 14:35:23 UTC

SOFTWARE: rsgps 1.37 RS53.prl 1.99.3 START: 2016/11/14 15:25:30  
EPHEMERIS: igu19231.eph [ultra-rapid] STOP: 2016/11/14 16:25:15  
NAV FILE: brdc3190.16n OBS USED: 2670 / 2750 : 97%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 17.95/ 48.67  
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.313

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87066)

X: -789467.416(m) 0.007(m) -789468.299(m) 0.007(m)  
Y: -4509763.979(m) 0.014(m) -4509762.683(m) 0.014(m)  
Z: 4426363.590(m) 0.009(m) 4426363.525(m) 0.009(m)

LAT: 44 13 31.38855 0.006(m) 44 13 31.41244 0.006(m)  
E LON: 260 4 14.03475 0.005(m) 260 4 13.98550 0.005(m)  
W LON: 99 55 45.96525 0.005(m) 99 55 46.01450 0.005(m)  
EL HGT: 417.756(m) 0.016(m) 416.905(m) 0.016(m)  
ORTHO HGT: 441.733(m) 0.018(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 14) SPC (4001 SD N)

Northing (Y) [meters] 4897326.404 43568.795  
Easting (X) [meters] 425765.964 605638.534  
Convergence [degrees] -0.64829417 0.04994169  
Point Scale 0.99966777 1.00004213  
Combined Factor 0.99960229 0.99997663

US NATIONAL GRID DESIGNATOR: 14TMP2576597326(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	135589.4
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	158306.0
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	182020.1
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	205537.5
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	226419.4

NEAREST NGS PUBLISHED CONTROL POINT

PS0721	STAN	N441305.101	W0995832.594	3786.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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7 <ANTENNA>  
8 <NAME>TRM60158.00 NONE</NAME>  
9 <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>  
10 <REFERENCE>Bottom of antenna mount</REFERENCE>  
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12 <RECEIVER>  
13 <NAME>TRIMBLE R8 GNSS3</NAME>  
14 </RECEIVER>  
15 </DATA_SOURCES>  
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20 <EL_HEIGHT>0.015</EL_HEIGHT>  
21 </ACCURACY>  
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BDS_SV=" ">G02 G05 G06 G12 G13 G15 G20 G21 G26 G29 R01 R06 R07 R08 R13 R14 R21  
R22 R23 R24</USED_SATELLITES>  
24 </DATA_QUALITY>  
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26 <REF_FRAME>ITRF2008</REF_FRAME>  
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53   <EPOCH>2010.0</EPOCH>
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57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4509763.978</COORDINATE>
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79   <ELEMENT_3_1>-2.3137E-05</ELEMENT_3_1>
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81   <ELEMENT_3_3>1.1190E-04</ELEMENT_3_3>
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87   <ELEMENT_3_1>-1.9044E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>-1.1044E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>2.3880E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-15T13:51:54Z" />
92 <POINT_ID COORD_TYPE="Local">GCP118</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Friday, January 06, 2017 9:25 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : GCP\_119.16o OP1483712629410

FILE: GCP\_119.16o OP1483712629410

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 06, 2017  
RINEX FILE: gcp\_318t.16o TIME: 14:24:38 UTC

SOFTWARE: rsgps 1.37 RS51.prl 1.99.3 START: 2016/11/13 19:58:15  
EPHEMERIS: igs19230.eph [precise] STOP: 2016/11/13 20:58:15  
NAV FILE: brdc3180.16n OBS USED: 3440 / 3700 : 93%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 7.90/ 47.78  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.303

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86845)

X:	-823535.665(m)	0.004(m)	-823536.548(m)	0.004(m)
Y:	-4509580.410(m)	0.016(m)	-4509579.115(m)	0.016(m)
Z:	4420622.899(m)	0.017(m)	4420622.833(m)	0.017(m)

LAT:	44 9 6.68685	0.003(m)	44 9 6.71048	0.003(m)
E LON:	259 39 2.65389	0.003(m)	259 39 2.60434	0.003(m)
W LON:	100 20 57.34611	0.003(m)	100 20 57.39566	0.003(m)
EL HGT:	587.300(m)	0.023(m)	586.454(m)	0.023(m)
ORTHO HGT:	611.394(m)	0.024(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4889624.586	202027.456
Easting (X) [meters]	392100.035	598725.684
Convergence [degrees]	-0.93993622	-0.01098898
Point Scale	0.99974319	0.99995019
Combined Factor	0.99965113	0.99985811

US NATIONAL GRID DESIGNATOR: 14TLP9210089624(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	169990.8
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	143021.6
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	211004.1
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	230381.3
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	222595.5

NEAREST NGS PUBLISHED CONTROL POINT

AC7852	83 102.34	N440737.022	W1002026.695	2850.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007644" REFERENCE_NUMBER="225381494724"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2 <SOLUTION_TIME>2017-01-04T21:41:39Z</SOLUTION_TIME>
3 <OBSERVATION_TIME START="2016-11-13T19:58:15Z" END="2016-11-13T20:58:15Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">SD_GCP119_TD.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
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19 <LONG>0.005</LONG>
20 <EL_HEIGHT>0.014</EL_HEIGHT>
21 </ACCURACY>
22 <PERCENT_OBS_USED TOTAL="241" PROCESSING_INTERVAL="15.0" USABLE="241"
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25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-823536.551</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4509579.157</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4420622.852</COORDINATE>
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35 <ELLIP_COORD>
36 <LAT>
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38 <MINUTES>9</MINUTES>
39 <SECONDS>6.70998</SECONDS>
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41 <EAST_LONG>
42 <DEGREES>-100</DEGREES>
43 <MINUTES>20</MINUTES>
44 <SECONDS>57.39547</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">586.497</EL_HEIGHT>
47 </ELLIP_COORD>
48 </COORD_SET>

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53   <EPOCH>2010.0</EPOCH>
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55     <RECT_COORD>
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70       </EAST_LONG>
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72     </ELLIP_COORD>
73   </COORD_SET>
74 </POSITION>
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76   <ELEMENT_1_1>3.0664E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>1.6108E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>1.3962E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-2.0107E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.4003E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.0014E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85   <ELEMENT_2_1>-6.2810E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.8486E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-1.8266E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>-2.6230E-07</ELEMENT_3_2>
89   <ELEMENT_3_3>2.0780E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T21:41:39Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-119</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Monday, November 14, 2016 11:23 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP120\_TD.16o OP1479140320160

FILE: SD\_GCP120\_TD.16o OP1479140320160

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 14, 2016  
RINEX FILE: sd\_g317n.16o TIME: 16:20:05 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3 START: 2016/11/12 13:44:15  
EPHEMERIS: igr19226.eph [rapid] STOP: 2016/11/12 14:44:30  
NAV FILE: brdc3170.16n OBS USED: 2104 / 2144 : 98%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 39.51/ 26.16  
ARP HEIGHT: 0.073 NORMALIZED RMS: 0.302

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86501)

X: -841933.395(m) 0.007(m) -841934.278(m) 0.007(m)  
Y: -4506003.270(m) 0.020(m) -4506001.976(m) 0.020(m)  
Z: 4420783.038(m) 0.018(m) 4420782.972(m) 0.018(m)

LAT: 44 9 14.36976 0.003(m) 44 9 14.39327 0.003(m)  
E LON: 259 24 59.36396 0.007(m) 259 24 59.31420 0.007(m)  
W LON: 100 35 0.63604 0.007(m) 100 35 0.68580 0.007(m)  
EL HGT: 572.920(m) 0.027(m) 572.077(m) 0.027(m)  
ORTHO HGT: 596.702(m) 0.028(m) [NAVD88 (Computed using GEOID12B)]

#### UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4890195.659	35801.145
Easting (X) [meters]	373371.814	553317.673
Convergence [degrees]	-1.10320206	-0.41297232
Point Scale	0.99979721	1.00006067
Combined Factor	0.99970740	0.99997084

US NATIONAL GRID DESIGNATOR: 14TLP7337190195(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	142428.7
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	188478.9
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	211649.5
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	224655.7

NEAREST NGS PUBLISHED CONTROL POINT

PT1055	CHRISTIAN	N441005.426	W1003804.732	4383.5
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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4   <CONTRIBUTOR />
5   <DATA_SOURCES>
6     <OBS_FILE TYPE="T02">SD_GCP120_TD.t02</OBS_FILE>
7     <ANTENNA>
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9       <ARP_HEIGHT UNIT="m">0.073</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
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14    </RECEIVER>
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21    </ACCURACY>
22    <PERCENT_OBS_USED TOTAL="242" PROCESSING_INTERVAL="15.0" USABLE="242"
USED="236">97</PERCENT_OBS_USED>
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QZSS_SV=" " GLN_SV="R03 R04 R05 R10 R11 R19 R20 R21" GAL_SV=" " BDS_SV=" ">G02 G05
G06 G09 G12 G17 G19 G24 G29 R03 R04 R05 R10 R11 R19 R20 R21</USED_SATELLITES>
24  </DATA_QUALITY>
25  <POSITION TYPE="INTERNAL">
26    <REF_FRAME>ITRF2008</REF_FRAME>
27    <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28    <EPOCH>2016.87</EPOCH>
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81   <ELEMENT_3_3>1.2843E-04</ELEMENT_3_3>
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89   <ELEMENT_3_3>2.6589E-04</ELEMENT_3_3>
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91 <RETRIEVAL TIME="2016-11-14T14:29:22Z" />
92 <POINT_ID COORD_TYPE="Local">GCP120</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:52 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP121\_TD.16o OP1483649466853

FILE: SD\_GCP121\_TD.16o OP1483649466853

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: sd\_g317w.16o TIME: 20:51:54 UTC

SOFTWARE: rsgps 1.37 RS50.prl 1.99.3 START: 2016/11/12 22:31:30  
EPHEMERIS: igs19226.eph [precise] STOP: 2016/11/12 23:31:15  
NAV FILE: brdc3170.16n OBS USED: 2904 / 3138 : 93%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 16.41/ 36.06  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.256

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86601)

X:	-836508.428(m)	0.010(m)	-836509.312(m)	0.010(m)
Y:	-4497658.764(m)	0.019(m)	-4497657.471(m)	0.019(m)
Z:	4430053.503(m)	0.014(m)	4430053.438(m)	0.014(m)

LAT:	44 16 17.40181	0.007(m)	44 16 17.42540	0.007(m)
E LON:	259 27 50.69825	0.008(m)	259 27 50.64840	0.008(m)
W LON:	100 32 9.30175	0.008(m)	100 32 9.35160	0.008(m)
EL HGT:	445.178(m)	0.024(m)	444.339(m)	0.024(m)
ORTHO HGT:	468.761(m)	0.025(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4903175.551	215340.837
Easting (X) [meters]	377421.732	583826.272
Convergence [degrees]	-1.07229416	-0.13975285
Point Scale	0.99978479	0.99997185
Combined Factor	0.99971501	0.99990205

US NATIONAL GRID DESIGNATOR: 14TLQ7742103175(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	183251.5
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	155449.8
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	213355.5
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	216114.8
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	215881.9
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	249162.9

NEAREST NGS PUBLISHED CONTROL POINT

PT0349	1530.0	N441611.	W1003228.	459.4
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">SD_GCP121_TD.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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13 <NAME>TRIMBLE R8 GNSS3</NAME>
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18 <LAT>0.006</LAT>
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20 <EL_HEIGHT>0.015</EL_HEIGHT>
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QZSS_SV=" " GLN_SV="R01 R02 R08 R10 R11 R12 R18 R24" GAL_SV=" " BDS_SV=" ">G01 G11
G12 G14 G18 G22 G24 G31 G32 R01 R02 R08 R10 R11 R12 R18 R24</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
America</TECTONIC_PLATE>
28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-836509.318</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4497657.484</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4430053.433</COORDINATE>
34 </RECT_COORD>
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38 <MINUTES>16</MINUTES>
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41 <EAST_LONG>
42 <DEGREES>-100</DEGREES>
43 <MINUTES>32</MINUTES>
44 <SECONDS>9.35174</SECONDS>
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46 <EL_HEIGHT UNIT="m">444.345</EL_HEIGHT>
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    America</TECTONIC_PLATE>
53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
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56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.006">-836508.425</COORDINATE>
57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4497658.761</COORDINATE>
58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4430053.516</COORDINATE>
59     </RECT_COORD>
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76   <ELEMENT_1_1>3.9729E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>2.5840E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>1.4992E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-1.1517E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.6964E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>9.7591E-05</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>3.8247E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>6.2824E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>3.4123E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-2.6731E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>1.1511E-07</ELEMENT_3_2>
89   <ELEMENT_3_3>2.1487E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T21:43:00Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-121</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Friday, January 06, 2017 9:52 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : GCP\_122\_2\_TD.16o OP1483714240599

FILE: GCP\_122\_2\_TD.16o OP1483714240599

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 06, 2017  
RINEX FILE: gcp\_320n.16o TIME: 14:51:55 UTC

SOFTWARE: rsgps 1.37 RS94.prl 1.99.3 START: 2016/11/15 13:20:15  
EPHEMERIS: igs19232.eph [precise] STOP: 2016/11/15 14:20:30  
NAV FILE: brdc3200.16n OBS USED: 3633 / 3864 : 94%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 24.61/ 34.16  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.287

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87316)

X: -881985.343(m) 0.005(m) -881986.227(m) 0.005(m)  
Y: -4484181.171(m) 0.024(m) -4484179.881(m) 0.024(m)  
Z: 4435080.644(m) 0.019(m) 4435080.580(m) 0.019(m)

LAT: 44 20 0.09961 0.006(m) 44 20 0.12292 0.006(m)  
E LON: 258 52 21.50184 0.006(m) 258 52 21.45146 0.006(m)  
W LON: 101 7 38.49816 0.006(m) 101 7 38.54854 0.006(m)  
EL HGT: 598.942(m) 0.030(m) 598.114(m) 0.030(m)  
ORTHO HGT: 621.362(m) 0.031(m) [NAVD88 (Computed using GEOID12B)]

#### UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4911100.469	222497.496
Easting (X) [meters]	330397.665	536673.691
Convergence [degrees]	-1.48702063	-0.54776127
Point Scale	0.99995377	0.99998477
Combined Factor	0.99985987	0.99989087

US NATIONAL GRID DESIGNATOR: 14TLQ3039711100(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	66767.6
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	169026.6
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	170013.8
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	229990.2
DI2251	P043 NEWCASTLE_WY2006 CORS ARP	N435252.101	W1041108.484	249967.8
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	233571.8
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	248125.8

NEAREST NGS PUBLISHED CONTROL POINT

PT0919	W 432	N441938.	W1010713.	885.7
--------	-------	----------	-----------	-------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007659" REFERENCE_NUMBER="225381494724"
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3 <OBSERVATION_TIME START="2016-11-15T13:20:15Z" END="2016-11-15T14:20:30Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">GCP-122-2_TD.t02</OBS_FILE>
7 <ANTENNA>
8 <NAME>TRM60158.00 NONE</NAME>
9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
15 </DATA_SOURCES>
16 <DATA_QUALITY>
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18 <LAT>0.007</LAT>
19 <LONG>0.005</LONG>
20 <EL_HEIGHT>0.015</EL_HEIGHT>
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32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.013">-4484179.909</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4435080.588</COORDINATE>
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78   <ELEMENT_2_2>1.6067E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-6.6825E-06</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.1185E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.0008E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85   <ELEMENT_2_1>-8.1432E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.0881E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-2.6982E-05</ELEMENT_3_1>
88   <ELEMENT_3_2>2.1373E-05</ELEMENT_3_2>
89   <ELEMENT_3_3>2.1055E-04</ELEMENT_3_3>
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91 <RETRIEVAL TIME="2017-01-04T22:04:41Z" />
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3   <OBSERVATION_TIME START="2016-11-10T15:03:45Z" END="2016-11-10T16:10:45Z" />
4   <CONTRIBUTOR />
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6     <OBS_FILE TYPE="T02">GCP_124.t02</OBS_FILE>
7     <ANTENNA>
8       <NAME>TRM60158.00 NONE</NAME>
9       <ARP_HEIGHT UNIT="m">2.000</ARP_HEIGHT>
10      <REFERENCE>Bottom of antenna mount</REFERENCE>
11    </ANTENNA>
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13      <NAME>TRIMBLE R8 GNSS3</NAME>
14    </RECEIVER>
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16  <DATA_QUALITY>
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24  </DATA_QUALITY>
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77   <ELEMENT_2_1>6.2313E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>2.0015E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-5.6016E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-1.6412E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>1.8937E-04</ELEMENT_3_3>
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83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2016-11-11T14:36:33Z" />
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7     <ANTENNA>
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13      <NAME>TRIMBLE R8 GNSS3</NAME>
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BDS_SV=" ">G08 G13 G15 G18 G20 G21 G24 G27 G32 R03 R04 R05 R06 R13 R14 R15 R19
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92 <POINT_ID COORD_TYPE="Local">GCP126</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Friday, January 06, 2017 9:27 AM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : GCP\_131.16o OP1483712649607

FILE: GCP\_131.16o OP1483712649607

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 06, 2017  
RINEX FILE: gcp\_318r.16o TIME: 14:26:14 UTC

SOFTWARE: rsgps 1.37 RS90.prl 1.99.3 START: 2016/11/13 17:00:00  
EPHEMERIS: igs19230.eph [precise] STOP: 2016/11/13 18:00:00  
NAV FILE: brdc3180.16n OBS USED: 5740 / 5810 : 99%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 22.44/ 60.34  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.302

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86811)

X:	-826722.390(m)	0.004(m)	-826723.274(m)	0.004(m)
Y:	-4495808.666(m)	0.010(m)	-4495807.373(m)	0.010(m)
Z:	4433718.745(m)	0.013(m)	4433718.681(m)	0.013(m)

LAT:	44 19 3.80902	0.003(m)	44 19 3.83270	0.003(m)
E LON:	259 34 49.56244	0.003(m)	259 34 49.51265	0.003(m)
W LON:	100 25 10.43756	0.003(m)	100 25 10.48735	0.003(m)
EL HGT:	428.867(m)	0.017(m)	428.027(m)	0.017(m)
ORTHO HGT:	452.491(m)	0.019(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4908142.662	220460.906
Easting (X) [meters]	386796.378	593120.752
Convergence [degrees]	-0.99186580	-0.05948777
Point Scale	0.99975760	0.99998139
Combined Factor	0.99969037	0.99991415

US NATIONAL GRID DESIGNATOR: 14TLQ8679608142(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	173659.2
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	160897.0
DO2366	P802 MANDANDBMND2012 CORS ARP	N463327.161	W1003724.231	249448.2
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	202911.5
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	225823.6
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	207449.8
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	239377.5

NEAREST NGS PUBLISHED CONTROL POINT

PT0259	BM	N441829.	W1002535.	1204.5
--------	----	----------	-----------	--------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007646" REFERENCE_NUMBER="225381494724"
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3 <OBSERVATION_TIME START="2016-11-13T17:00:00Z" END="2016-11-13T18:00:00Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">SD_GCP131_TD.t02</OBS_FILE>
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10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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12 <RECEIVER>
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14 </RECEIVER>
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20 <EL_HEIGHT>0.011</EL_HEIGHT>
21 </ACCURACY>
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23 <USED_SATELLITES TOTAL="17" GPS_SV="G02 G05 G13 G15 G16 G18 G20 G21 G26 G29"
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26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28 <EPOCH>2016.87</EPOCH>
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31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-826723.279</COORDINATE>
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33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.008">4433718.688</COORDINATE>
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36 <LAT>
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39 <SECONDS>3.83240</SECONDS>
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46 <EL_HEIGHT UNIT="m">428.046</EL_HEIGHT>
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80   <ELEMENT_3_2>-4.7253E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>7.2139E-05</ELEMENT_3_3>
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83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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85   <ELEMENT_2_1>2.7002E-06</ELEMENT_2_1>
86   <ELEMENT_2_2>2.2071E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>2.7412E-06</ELEMENT_3_1>
88   <ELEMENT_3_2>2.2540E-07</ELEMENT_3_2>
89   <ELEMENT_3_3>1.1814E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T21:44:13Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-131</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
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# OPUS-RS solution : GCP\_132.16o OP1478876739638

opus <opus@ngs.noaa.gov>

Fri 11/11/2016 10:07 AM

Inbox

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: GCP\_132.16o OP1478876739638

2005 NOTE: The IGS precise and IGS rapid orbits were not available  
2005 at processing time. The IGS ultra-rapid orbit was/will be used to  
2005 process the data.

2005

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

sdhu

nevn

sdab

ndas

ndel

Your station is 4.2 KM outside the polygon enclosing the reference stations

## NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 11, 2016  
RINEX FILE: gcp\_315q.16o                  TIME: 15:06:59 UTC

SOFTWARE: rsgps 1.37 RS51.prl 1.99.3      START: 2016/11/10 16:32:45  
EPHEMERIS: igu19224.eph [ultra-rapid]      STOP: 2016/11/10 17:40:15  
NAV FILE: brdc3150.16n                  OBS USED: 3252 / 3940 : 83%  
ANT NAME: TRMR8\_GNSS3    NONE                  QUALITY IND. 19.33/ 26.32  
ARP HEIGHT: 2.000                  NORMALIZED RMS:    0.376

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.85987)

X:    -799146.317(m) 0.004(m)      -799147.201(m) 0.004(m)  
Y:    -4501011.566(m) 0.009(m)      -4501010.272(m) 0.009(m)  
Z:    4433486.727(m) 0.011(m)      4433486.663(m) 0.011(m)



LAT: 44 18 53.54332 0.004(m) 44 18 53.56717 0.004(m)  
 E LON: 259 55 55.76032 0.005(m) 259 55 55.71084 0.005(m)  
 W LON: 100 4 4.23968 0.005(m) 100 4 4.28916 0.005(m)  
 EL HGT: 421.296(m) 0.014(m) 420.451(m) 0.014(m)  
 ORTHO HGT: 445.111(m) 0.016(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4907400.500	53512.540
Easting (X) [meters]	414840.474	594587.210
Convergence [degrees]	-0.74604186	-0.04801604
Point Scale	0.99968919	1.00002106
Combined Factor	0.99962316	0.99995500

US NATIONAL GRID DESIGNATOR: 14TMQ1484007400(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	145655.9
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	164808.5
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	182268.2
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	198503.3

NEAREST NGS PUBLISHED CONTROL POINT

PT0156	F 14	N441923.	W1000403.	909.6
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
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33        <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.009">4433486.668</COORDINATE>
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80   <ELEMENT_3_2>-5.7427E-05</ELEMENT_3_2>
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92 <POINT_ID COORD_TYPE="Local">GCP_132</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:54 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP133\_TD.16o OP1483649528194

FILE: SD\_GCP133\_TD.16o OP1483649528194

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: sd\_g319s.16o TIME: 20:53:36 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3 START: 2016/11/14 18:10:45  
EPHEMERIS: igs19231.eph [precise] STOP: 2016/11/14 19:10:30  
NAV FILE: brdc3190.16n OBS USED: 4613 / 4613 : 100%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 23.37/ 39.36  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.305

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.87098)

X:	-807788.216(m)	0.004(m)	-807789.099(m)	0.004(m)
Y:	-4509004.033(m)	0.013(m)	-4509002.738(m)	0.013(m)
Z:	4423995.340(m)	0.009(m)	4423995.275(m)	0.009(m)

LAT:	44 11 41.12642	0.003(m)	44 11 41.15018	0.003(m)
E LON:	259 50 35.53620	0.005(m)	259 50 35.48678	0.005(m)
W LON:	100 9 24.46380	0.005(m)	100 9 24.51322	0.005(m)
EL HGT:	520.129(m)	0.015(m)	519.281(m)	0.015(m)
ORTHO HGT:	544.143(m)	0.017(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4894155.051	206808.959
Easting (X) [meters]	407558.681	614112.417
Convergence [degrees]	-0.80645848	0.12178497
Point Scale	0.99970510	0.99995745
Combined Factor	0.99962357	0.99987590

US NATIONAL GRID DESIGNATOR: 14TMP0755894155(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	154056.9
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	150212.3
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	196765.5
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	245881.6
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	213291.0
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	238556.6
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	245326.3

NEAREST NGS PUBLISHED CONTROL POINT

PT1014	PARK	N441139.685	W1000420.185	6757.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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USED="234">97</PERCENT_OBS_USED>
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G18 G20 G21 G24 G26 G27 G29 R01 R02 R08 R17 R23 R24</USED_SATELLITES>
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33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.011">4423995.274</COORDINATE>
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36 <LAT>
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38 <MINUTES>11</MINUTES>
39 <SECONDS>41.14970</SECONDS>
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42 <DEGREES>-100</DEGREES>
43 <MINUTES>9</MINUTES>
44 <SECONDS>24.51332</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">519.295</EL_HEIGHT>
47 </ELLIP_COORD>
48 </COORD_SET>
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51   <REF_FRAME AUTO_DETECTED="True">NAD83-2011</REF_FRAME>
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    America</TECTONIC_PLATE>
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76   <ELEMENT_1_1>2.4448E-05</ELEMENT_1_1>
77   <ELEMENT_2_1>1.4150E-05</ELEMENT_2_1>
78   <ELEMENT_2_2>1.3444E-04</ELEMENT_2_2>
79   <ELEMENT_3_1>-1.3132E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-1.0007E-04</ELEMENT_3_2>
81   <ELEMENT_3_3>1.2974E-04</ELEMENT_3_3>
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83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
84   <ELEMENT_1_1>3.1976E-05</ELEMENT_1_1>
85   <ELEMENT_2_1>-6.7443E-07</ELEMENT_2_1>
86   <ELEMENT_2_2>2.2956E-05</ELEMENT_2_2>
87   <ELEMENT_3_1>-2.6024E-07</ELEMENT_3_1>
88   <ELEMENT_3_2>7.4651E-06</ELEMENT_3_2>
89   <ELEMENT_3_3>2.3370E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T22:06:01Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-133</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Thursday, January 05, 2017 3:54 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP134\_TD.16o OP1483649564615

FILE: SD\_GCP134\_TD.16o OP1483649564615

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: January 05, 2017  
RINEX FILE: sd\_g317t.16o TIME: 20:53:28 UTC

SOFTWARE: rsgps 1.37 RS93.prl 1.99.3 START: 2016/11/12 19:39:00  
EPHEMERIS: igs19226.eph [precise] STOP: 2016/11/12 20:39:30  
NAV FILE: brdc3170.16n OBS USED: 3490 / 3670 : 95%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 26.23/ 47.20  
ARP HEIGHT: 1.417 NORMALIZED RMS: 0.271

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.86568)

X:	-846160.767(m)	0.004(m)	-846161.651(m)	0.004(m)
Y:	-4496918.074(m)	0.012(m)	-4496916.782(m)	0.012(m)
Z:	4429004.693(m)	0.011(m)	4429004.628(m)	0.011(m)

LAT:	44 15 29.39880	0.003(m)	44 15 29.42230	0.003(m)
E LON:	259 20 36.83009	0.002(m)	259 20 36.78016	0.002(m)
W LON:	100 39 23.16991	0.002(m)	100 39 23.21984	0.002(m)
EL HGT:	462.819(m)	0.016(m)	461.982(m)	0.016(m)
ORTHO HGT:	486.237(m)	0.018(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 14)	SPC (4002 SD S)
Northing (Y) [meters]	4901881.565	213889.684
Easting (X) [meters]	367773.410	574198.652
Convergence [degrees]	-1.15618133	-0.22289307
Point Scale	0.99981502	0.99996922
Combined Factor	0.99974247	0.99989666

US NATIONAL GRID DESIGNATOR: 14TLQ6777301881(NAD 83)

BASE STATIONS USED



PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	192961.8
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	154236.4
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	206404.5
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	221363.8
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	221823.5

NEAREST NGS PUBLISHED CONTROL POINT

PT0343	R 76	N441442.	W1003953.	1605.7
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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1 <TRIMBLE_RTX_SOLUTION SID="8007666" REFERENCE_NUMBER="225381494724"
SOFTWARE_VERSION="5.0.0.15127" SOLUTION_TYPE="Static">
2 <SOLUTION_TIME>2017-01-04T22:07:12Z</SOLUTION_TIME>
3 <OBSERVATION_TIME START="2016-11-12T19:39:00Z" END="2016-11-12T20:39:30Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">SD_GCP134_TD.t02</OBS_FILE>
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9 <ARP_HEIGHT UNIT="m">1.417</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
11 </ANTENNA>
12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
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20 <EL_HEIGHT>0.017</EL_HEIGHT>
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23 <USED_SATELLITES TOTAL="18" GPS_SV="G08 G13 G14 G15 G18 G20 G21 G24 G27 G32"
QZSS_SV="" GLN_SV="R01 R06 R07 R08 R16 R22 R23 R24" GAL_SV="" BDS_SV="">G08 G13
G14 G15 G18 G20 G21 G24 G27 G32 R01 R06 R07 R08 R16 R22 R23
R24</USED_SATELLITES>
24 </DATA_QUALITY>
25 <POSITION TYPE="INTERNAL">
26 <REF_FRAME>ITRF2008</REF_FRAME>
27 <TECTONIC_PLATE MODEL="MORVEL56" AUTO_DETECTED="True">North
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28 <EPOCH>2016.87</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
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32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.012">-4496916.817</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.013">4429004.644</COORDINATE>
34 </RECT_COORD>
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42 <DEGREES>-100</DEGREES>
43 <MINUTES>39</MINUTES>
44 <SECONDS>23.21980</SECONDS>
45 </EAST_LONG>
46 <EL_HEIGHT UNIT="m">462.018</EL_HEIGHT>
47 </ELLIP_COORD>

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78     <ELEMENT_2_2>1.5273E-04</ELEMENT_2_2>
79     <ELEMENT_3_1>-2.5478E-05</ELEMENT_3_1>
80     <ELEMENT_3_2>-1.1858E-04</ELEMENT_3_2>
81     <ELEMENT_3_3>1.6622E-04</ELEMENT_3_3>
82 </COVARIANCE_MATRIX>
83 <COVARIANCE_MATRIX COORD_SET="Ellip" UNIT="m*m">
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86     <ELEMENT_2_2>2.5782E-05</ELEMENT_2_2>
87     <ELEMENT_3_1>8.1370E-06</ELEMENT_3_1>
88     <ELEMENT_3_2>-2.6180E-07</ELEMENT_3_2>
89     <ELEMENT_3_3>2.8230E-04</ELEMENT_3_3>
90 </COVARIANCE_MATRIX>
91 <RETRIEVAL TIME="2017-01-04T22:07:12Z" />
92 <POINT_ID COORD_TYPE="Local">GCP-134</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
```

## Jamey Gray

---

**From:** opus <opus@ngs.noaa.gov>  
**Sent:** Friday, November 11, 2016 2:28 PM  
**To:** Jamey Gray  
**Subject:** OPUS-RS solution : SD\_GCP135\_TD.16o OP1478892376278

FILE: SD\_GCP135\_TD.16o OP1478892376278

6011 Warning - OPUS-RS was able to find a set of reference stations  
6011 with data suitable for use with your dataset. However, your  
6011 position does not fall within the polygon enclosing these reference  
6011 stations. This means that the geographic interpolation algorithms  
6011 performed within OPUS-RS must instead perform extrapolation.  
6011 Extrapolation, especially if your position is far from the  
6011 reference stations, is prone to error. Use this solution with  
6011 caution.

sdrc  
sdhu  
ndas

Your station is 0.7 KM outside the polygon enclosing the reference stations

### NGS OPUS-RS SOLUTION REPORT

=====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: [jgray@espassociates.com](mailto:jgray@espassociates.com) DATE: November 11, 2016  
RINEX FILE: sd\_g315q.16o TIME: 19:27:25 UTC

SOFTWARE: rsgps 1.37 RS91.prl 1.99.3 START: 2016/11/10 16:17:45  
EPHEMERIS: igr19224.eph [rapid] STOP: 2016/11/10 17:18:30  
NAV FILE: brdc3150.16n OBS USED: 2214 / 2265 : 98%  
ANT NAME: TRMR8\_GNSS3 NONE QUALITY IND. 16.24/ 41.33  
ARP HEIGHT: 0.0731 NORMALIZED RMS: 0.363

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.85984)

X: -867301.335(m) 0.004(m) -867302.218(m) 0.004(m)  
Y: -4496665.544(m) 0.010(m) -4496664.252(m) 0.010(m)  
Z: 4425423.466(m) 0.013(m) 4425423.401(m) 0.013(m)

LAT: 44 12 42.46663 0.004(m) 44 12 42.49000 0.004(m)  
E LON: 259 4 58.96387 0.002(m) 259 4 58.91380 0.002(m)  
W LON: 100 55 1.03613 0.002(m) 100 55 1.08620 0.002(m)

EL HGT: 621.606(m) 0.016(m) 620.771(m) 0.016(m)  
ORTHO HGT: 644.732(m) 0.018(m) [NAVD88 (Computed using GEOID12B)]

UTM COORDINATES STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4897183.789	42471.301
Easting (X) [meters]	346856.825	526714.930
Convergence [degrees]	-1.33697562	-0.64896370
Point Scale	0.99988844	1.00004554
Combined Factor	0.99979099	0.99994808

US NATIONAL GRID DESIGNATOR: 14TLP4685697183(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP1963	SDRC RAPID CITY CORS ARP	N440457.973	W1031332.337	185279.4
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	214159.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	235809.3

NEAREST NGS PUBLISHED CONTROL POINT

AC8015	HRN WENDTE	N441242.196	W1005117.577	4960.8
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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3 <OBSERVATION_TIME START="2016-11-10T16:17:45Z" END="2016-11-10T17:18:30Z" />
4 <CONTRIBUTOR />
5 <DATA_SOURCES>
6 <OBS_FILE TYPE="T02">SD_GCP135_TD.t02</OBS_FILE>
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9 <ARP_HEIGHT UNIT="m">0.073</ARP_HEIGHT>
10 <REFERENCE>Bottom of antenna mount</REFERENCE>
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12 <RECEIVER>
13 <NAME>TRIMBLE R8 GNSS3</NAME>
14 </RECEIVER>
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16 <DATA_QUALITY>
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QZSS_SV="" GLN_SV="R02 R03 R04 R05 R18 R19 R20" GAL_SV="" BDS_SV="">G02 G05 G12
G13 G15 G18 G20 G21 G26 G29 R02 R03 R04 R05 R18 R19 R20</USED_SATELLITES>
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28 <EPOCH>2016.86</EPOCH>
29 <COORD_SET>
30 <RECT_COORD>
31 <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-867302.219</COORDINATE>
32 <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4496664.246</COORDINATE>
33 <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4425423.388</COORDINATE>
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53   <EPOCH>2010.0</EPOCH>
54   <COORD_SET>
55     <RECT_COORD>
56       <COORDINATE AXIS="X" UNIT="m" UNCERTAINTY="0.005">-867301.327</COORDINATE>
57       <COORDINATE AXIS="Y" UNIT="m" UNCERTAINTY="0.011">-4496665.522</COORDINATE>
58       <COORDINATE AXIS="Z" UNIT="m" UNCERTAINTY="0.010">4425423.472</COORDINATE>
59     </RECT_COORD>
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79   <ELEMENT_3_1>-1.0415E-05</ELEMENT_3_1>
80   <ELEMENT_3_2>-8.7871E-05</ELEMENT_3_2>
81   <ELEMENT_3_3>1.0901E-04</ELEMENT_3_3>
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88   <ELEMENT_3_2>1.3508E-05</ELEMENT_3_2>
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91 <RETRIEVAL TIME="2016-11-11T14:41:09Z" />
92 <POINT_ID COORD_TYPE="Local">GCP135</POINT_ID></TRIMBLE_RTX_SOLUTION>
93
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# OPUS-RS solution : SD\_GCP138.16o OP1479733491063

opus <opus@ngs.noaa.gov>

Mon 11/21/2016 8:13 AM

To: Arry Lazaridis <alazaridis@espassociates.com>;

FILE: SD\_GCP138.16o OP1479733491063

## NGS OPUS-RS SOLUTION REPORT =====

All computed coordinate accuracies are listed as 1-sigma RMS values.  
For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 21, 2016  
RINEX FILE: sd\_g321u.16o                  TIME: 13:12:36 UTC

SOFTWARE: rsgps 1.37 RS50.prl 1.99.3      START: 2016/11/16 20:17:15  
EPHEMERIS: igr19233.eph [rapid]          STOP: 2016/11/16 21:17:45  
NAV FILE: brdc3210.16n                  OBS USED: 6336 / 6624 : 96%  
ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 20.11/ 53.02  
ARP HEIGHT: 2.00                  NORMALIZED RMS:    0.290

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.87668)

X:    -751378.698(m) 0.007(m)      -751379.581(m) 0.007(m)  
Y:    -4518285.488(m) 0.016(m)      -4518284.190(m) 0.016(m)  
Z:    4424433.081(m) 0.014(m)      4424433.016(m) 0.014(m)

LAT: 44 12 1.56225    0.003(m)      44 12 1.58639    0.003(m)  
E LON: 260 33 29.77179    0.008(m)      260 33 29.72298    0.008(m)  
W LON: 99 26 30.22821    0.008(m)      99 26 30.27702    0.008(m)  
EL HGT:    499.308(m) 0.020(m)      498.448(m) 0.020(m)  
ORTHO HGT:    523.656(m) 0.022(m) [NAVD88 (Computed using GEOID12B)]

### UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 14)      SPC (4001 SD N)  
Northing (Y) [meters]    4894229.849      40947.539  
Easting (X) [meters]    464704.117      644627.500  
Convergence [degrees]    -0.30796435      0.39510896  
Point Scale            0.99961532      1.00004844  
Combined Factor        0.99953706      0.99997015

US NATIONAL GRID DESIGNATOR: 14TMP6470494229(NAD 83)

### BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	97613.4
DL9800	MNHD HENDRICKS CORS ARP	N442731.985	W0962607.763	241484.6



DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	172347.7
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	71614.9
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	161702.5
DP4732	NEHA HARTINGTON CORS ARP	N423643.728	W0971638.569	248728.6
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	198991.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	203774.2
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	212963.1

## NEAREST NGS PUBLISHED CONTROL POINT

PS0376	N 48 RESET	N441201.	W0992630.	18.1
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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## OPUS-RS solution : GCP\_139.16o OP1479823770573

opus &lt;opus@ngs.noaa.gov&gt;

Tue 11/22/2016 9:14 AM

To: Arry Lazaridis &lt;alazaridis@espassociates.com&gt;;

FILE: GCP\_139.16o OP1479823770573

1008 NOTE: Antenna offsets supplied by the user were  $\leq 0$ . Coordinates  
 1008 returned will be for the antenna reference point (ARP).

1008

## NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: alazaridis@espassociates.com      DATE: November 22, 2016  
 RINEX FILE: gcp\_325p.16o                  TIME: 14:13:29 UTC

SOFTWARE: rsgps 1.37 RS92.prl 1.99.3      START: 2016/11/20 15:41:15  
 EPHEMERIS: igr19240.eph [rapid]          STOP: 2016/11/20 16:46:00  
 NAV FILE: brdc3250.16n                  OBS USED: 6328 / 7256 : 87%  
 ANT NAME: TRMR8\_GNSS3    NONE          QUALITY IND. 33.65/ 68.12  
 ARP HEIGHT: 0.000                      NORMALIZED RMS:    0.312

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)      IGS08 (EPOCH:2016.88709)

X:	-773284.389(m)	0.006(m)	-773285.272(m)	0.006(m)
Y:	-4516649.069(m)	0.021(m)	-4516647.772(m)	0.021(m)
Z:	4422219.574(m)	0.016(m)	4422219.508(m)	0.016(m)

LAT:	44 10 24.27024	0.008(m)	44 10 24.29420	0.008(m)
E LON:	260 17 5.00771	0.003(m)	260 17 4.95868	0.003(m)
W LON:	99 42 54.99229	0.003(m)	99 42 55.04132	0.003(m)
EL HGT:	413.204(m)	0.025(m)	412.348(m)	0.025(m)
ORTHO HGT:	437.451(m)	0.027(m)	[NAVD88 (Computed using GEOID12B)]	

## UTM COORDINATES    STATE PLANE COORDINATES

	UTM (Zone 14)	SPC (4001 SD N)
Northing (Y) [meters]	4891381.937	37830.582
Easting (X) [meters]	442820.655	622771.256
Convergence [degrees]	-0.49844063	0.20151031
Point Scale	0.99964021	1.00005548
Combined Factor	0.99957545	0.99999069

US NATIONAL GRID DESIGNATOR: 14TMP4282091381(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DP6619	SDHU SDHURON CORS ARP	N442229.102	W0981435.368	119642.5
DE6268	SFSD SIOUX FALLS COOP CORS ARP	N433419.390	W0964342.615	249177.9
DP4771	NEVN NDOR VALENTINE CORS ARP	N425220.908	W1003237.144	159307.8
DP9063	SDPI SDPIERRE CORS ARP	N442400.063	W1001741.899	52682.2
DP6617	SDAB SDABERDEEN CORS ARP	N452729.471	W0982448.998	176026.9
DP6615	NDAS NDASHLEY CORS ARP	N460200.316	W0992247.944	208394.7
DP6621	SDWE SDWEBSTER CORS ARP	N452116.159	W0973109.815	217821.2
DP6862	NDEL NDELLENDALE CORS ARP	N460010.356	W0983123.166	223928.8

## NEAREST NGS PUBLISHED CONTROL POINT

PS0454	L 350	N440856.	W0994223.	2815.7
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This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

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