

## OPUS solution : 033845\_14\_260\_A0.14O OP1411080480949

opus &lt;opus@ngs.noaa.gov&gt;

Thu 9/18/2014 4:51 PM

To:John Freetly &lt;John.Freetly@neciusa.com&gt;;

FILE: 033845\_14\_260\_A0.14O OP1411080480949

## NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.

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

USER: john.freetly@neciusa.com                      DATE: September 18, 2014  
 RINEX FILE: 0338260o.14o                              TIME: 22:51:00 UTC

SOFTWARE: page5 1209.04 master53.pl 022814      START: 2014/09/17 14:31:00  
 EPHEMERIS: igr18103.eph [rapid]                      STOP: 2014/09/17 18:26:00  
 NAV FILE: brdc2600.14n                              OBS USED: 9844 / 10544 : 93%  
 ANT NAME: CHCX90D-OPUS      NONE                      # FIXED AMB: 51 / 59 : 86%  
 ARP HEIGHT: 1.8000                                      OVERALL RMS: 0.014(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)                      IGS08 (EPOCH:2014.7115)

X: -1308942.458(m) 0.004(m)                      -1308943.320(m) 0.004(m)  
 Y: -4259791.610(m) 0.017(m)                      -4259790.359(m) 0.017(m)  
 Z: 4549219.495(m) 0.008(m)                      4549219.458(m) 0.008(m)

LAT: 45 46 59.17612 0.009(m)                      45 46 59.19716 0.009(m)  
 E LON: 252 55 8.15316 0.007(m)                      252 55 8.09801 0.007(m)  
 W LON: 107 4 51.84684 0.007(m)                      107 4 51.90199 0.007(m)  
 EL HGT: 1048.406(m) 0.014(m)                      1047.722(m) 0.014(m)  
 ORTHO HGT: 1063.207(m) 0.025(m) [NAVD88 (Computed using GEOID12A)]

## UTM COORDINATES      STATE PLANE COORDINATES

UTM (Zone 13)                      SPC (2500 MT )

Northing (Y) [meters] 5072055.406                      173283.673  
 Easting (X) [meters] 338230.497                      788007.896  
 Convergence [degrees] -1.49183440                      1.76945851  
 Point Scale 0.99992173                      0.99962032  
 Combined Factor 0.99975741                      0.99945605

US NATIONAL GRID DESIGNATOR: 13TCL3823072055(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DM7161	WYSH SHERIDAN CORS ARP	N444801.769	W1070035.715	109365.9
DI3425	P052 LRRNCHJRDNMT2006 CORS ARP	N472229.026	W1070107.185	177014.8
DL7728	P051 BILLINGSAPMT2005 CORS ARP	N454823.741	W1083246.070	113953.0

NEAREST NGS PUBLISHED CONTROL POINT

QV0446	STORM	N453946.592	W1070212.840	13809.8
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BASE STATION INFORMATION

STATION NAME: wysh a 1 (Sheridan; Sheridan, Wyoming USA)  
 MONUMENT: NO DOMES NUMBER  
 XYZ -1326396.2772 -4335757.8813 4472504.2552 MON @ 2005.0000 (M)  
 XYZ -0.0156 -0.0003 -0.0049 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0013 -0.0002 0.0667 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0004 0.0006 0.0577 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1511 -0.0032 -0.0477 VEL TIMES 9.7105 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ -0.0138 -0.0444 0.0479 ARP TO L1 PHASE CENTER  
 XYZ -1326396.4420 -4335757.9289 4472504.2554 L1 PHS CEN @ 2014.7115  
 XYZ 0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ -1326396.4420 -4335757.9288 4472504.2555 NEW L1 PHS CEN @ 2014.7115  
 XYZ -1326396.4283 -4335757.8845 4472504.2075 NEW ARP @ 2014.7115  
 XYZ -1326396.4283 -4335757.8845 4472504.2075 NEW MON @ 2014.7115  
 LLH 44 48 1.79014 252 59 24.23028 1220.7139 NEW L1 PHS CEN @ 2014.7115  
 LLH 44 48 1.79010 252 59 24.23029 1220.6472 NEW ARP @ 2014.7115  
 LLH 44 48 1.79010 252 59 24.23029 1220.6472 NEW MON @ 2014.7115

STATION NAME: p052 a 2 (LRRnchJrdnMT2006; Jordan, MT United States)  
 MONUMENT: NO DOMES NUMBER  
 XYZ -1266648.1846 -4138194.5676 4670709.5484 MON @ 2005.0000 (M)  
 XYZ -0.0158 0.0003 -0.0057 VEL (M/YR)  
 NEU -0.0000 0.0000 0.0083 MON TO ARP (M)  
 NEU 0.0012 0.0008 0.0860 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0006 -0.0006 0.1183 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1535 0.0032 -0.0556 VEL TIMES 9.7105 YRS  
 XYZ -0.0016 -0.0054 0.0061 MON TO ARP  
 XYZ -0.0161 -0.0551 0.0641 ARP TO L1 PHASE CENTER  
 XYZ -1266648.3559 -4138194.6249 4670709.5630 L1 PHS CEN @ 2014.7115  
 XYZ -0.0000 0.0000 -0.0000 + XYZ ADJUSTMENTS  
 XYZ -1266648.3559 -4138194.6249 4670709.5630 NEW L1 PHS CEN @ 2014.7115  
 XYZ -1266648.3398 -4138194.5698 4670709.4989 NEW ARP @ 2014.7115  
 XYZ -1266648.3381 -4138194.5644 4670709.4928 NEW MON @ 2014.7115  
 LLH 47 22 29.04861 252 58 52.75780 858.7207 NEW L1 PHS CEN @ 2014.7115

LLH 47 22 29.04858 252 58 52.75777 858.6347 NEW ARP @ 2014.7115  
 LLH 47 22 29.04858 252 58 52.75777 858.6264 NEW MON @ 2014.7115

STATION NAME: p051 a 1 (BillingsAPMT2005; Billings, MT United States)  
 MONUMENT: NO DOMES NUMBER

XYZ -1416838.9478 -4223178.9397 4551064.1207 MON @ 2005.0000 (M)  
 XYZ -0.0158 -0.0003 -0.0052 VEL (M/YR)  
 NEU -0.0000 0.0000 0.0083 MON TO ARP (M)  
 NEU 0.0012 0.0008 0.0860 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0006 -0.0006 0.1184 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1534 -0.0029 -0.0505 VEL TIMES 9.7105 YRS  
 XYZ -0.0018 -0.0055 0.0060 MON TO ARP  
 XYZ -0.0181 -0.0563 0.0625 ARP TO L1 PHASE CENTER  
 XYZ -1416839.1212 -4223179.0044 4551064.1386 L1 PHS CEN @ 2014.7115  
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ -1416839.1212 -4223179.0043 4551064.1387 NEW L1 PHS CEN @ 2014.7115  
 XYZ -1416839.1031 -4223178.9481 4551064.0762 NEW ARP @ 2014.7115  
 XYZ -1416839.1013 -4223178.9426 4551064.0702 NEW MON @ 2014.7115  
 LLH 45 48 23.76228 251 27 13.87303 1081.1886 NEW L1 PHS CEN @ 2014.7115  
 LLH 45 48 23.76225 251 27 13.87299 1081.1026 NEW ARP @ 2014.7115  
 LLH 45 48 23.76225 251 27 13.87299 1081.0943 NEW MON @ 2014.7115

#### REMOTE STATION INFORMATION

STATION NAME: 0338 1  
 MONUMENT: NO DOMES NUMBER  
 XYZ -1308943.0525 -4259790.3832 4549218.9656 MON @ 2014.7112 (M)  
 NEU -0.0011 0.0007 1.8000 MON TO ARP (M)  
 NEU 0.0011 -0.0007 0.0892 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0007 -0.0031 0.1017 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.3683 -1.2009 1.2894 MON TO ARP  
 XYZ -0.0187 -0.0586 0.0647 ARP TO L1 PHASE CENTER  
 XYZ -1308943.4395 -4259791.6426 4549220.3197 L1 PHS CEN @ 2014.7115

BASELINE NAME: wysh 0338  
 XYZ -0.2697 0.0240 0.4967 + XYZ ADJUSTMENTS  
 XYZ -1308943.7092 -4259791.6187 4549220.8163 NEW L1 PHS CEN @ 2014.7115  
 XYZ -1308943.6905 -4259791.5601 4549220.7516 NEW ARP @ 2014.7115  
 XYZ -1308943.3222 -4259790.3592 4549219.4623 NEW MON @ 2014.7115  
 LLH 45 46 59.19723 252 55 8.09792 1049.6150 NEW L1 PHS CEN @ 2014.7115  
 LLH 45 46 59.19720 252 55 8.09795 1049.5258 NEW ARP @ 2014.7115  
 LLH 45 46 59.19723 252 55 8.09792 1047.7257 NEW MON @ 2014.7115

BASELINE NAME: p052 0338  
 XYZ -0.2658 0.0160 0.4926 + XYZ ADJUSTMENTS  
 XYZ -1308943.7052 -4259791.6266 4549220.8123 NEW L1 PHS CEN @ 2014.7115  
 XYZ -1308943.6866 -4259791.5681 4549220.7475 NEW ARP @ 2014.7115  
 XYZ -1308943.3183 -4259790.3672 4549219.4582 NEW MON @ 2014.7115  
 LLH 45 46 59.19699 252 55 8.09820 1049.6166 NEW L1 PHS CEN @ 2014.7115  
 LLH 45 46 59.19696 252 55 8.09823 1049.5273 NEW ARP @ 2014.7115  
 LLH 45 46 59.19699 252 55 8.09820 1047.7273 NEW MON @ 2014.7115

BASELINE NAME: p051 0338  
 XYZ -0.2679 0.0333 0.4884 + XYZ ADJUSTMENTS  
 XYZ -1308943.7074 -4259791.6094 4549220.8081 NEW L1 PHS CEN @ 2014.7115  
 XYZ -1308943.6888 -4259791.5508 4549220.7434 NEW ARP @ 2014.7115  
 XYZ -1308943.3204 -4259790.3499 4549219.4540 NEW MON @ 2014.7115  
 LLH 45 46 59.19727 252 55 8.09787 1049.6026 NEW L1 PHS CEN @ 2014.7115  
 LLH 45 46 59.19723 252 55 8.09790 1049.5133 NEW ARP @ 2014.7115  
 LLH 45 46 59.19727 252 55 8.09787 1047.7133 NEW MON @ 2014.7115

G-FILES

Axx2014 917 14 917  
 B2014 9171430 14 9171826 1 page5 v1209.04IGS 126 1 2 27NGS 2014 918IFDDPX  
 IIGS08\_1808 IGS 20140831  
 C00090005 -174531060 6 -759675253 17 -767152548 18 X2604A0338X2604AWYSH  
 D 1 2 7143891 1 3 -6478120 2 3 -8149215

Axx2014 917 14 917  
 B2014 9171430 14 9171826 1 page5 v1209.04IGS 126 1 2 27NGS 2014 918IFDDPX  
 IIGS08\_1808 IGS 20140831  
 C00090004 422949801 6 1215958028 16 1214900346 18 X2604A0338X2604AP052  
 D 1 2 7081604 1 3 -5816837 2 3 -8118733

Axx2014 917 14 917  
 B2014 9171430 14 9171826 1 page5 v1209.04IGS 126 1 2 27NGS 2014 918IFDDPX  
 IIGS08\_1808 IGS 20140831  
 C00090002-1078957808 7 366114074 19 18446162 18 X2604A0338X2604AP051  
 D 1 2 2244069 1 3 -3285412 2 3 -9402785

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 01 02 04 06 07 08 10 11  
 wysh-0338| 0.014 0.015 0.014 0.013 0.009 0.018 ... 0.023 0.016  
 12 15 17 20 24 25 26 28 30  
 wysh-0338| 0.016 0.019 ... 0.025 0.010 ... 0.010 0.011 0.013

OVERALL 01 02 04 06 07 08 10 11  
 p052-0338| 0.013 0.014 0.014 0.012 0.009 0.012 0.022 0.031 0.015  
 12 15 17 19 20 24 25 26 28  
 p052-0338| 0.020 0.015 ... .. 0.021 0.012 0.026 0.011 0.009  
 30  
 p052-0338| 0.013

OVERALL 01 02 04 06 07 08 10 11  
 p051-0338| 0.013 0.015 0.014 0.012 0.009 0.016 0.022 0.032 0.016  
 12 15 17 20 24 25 26 28 30  
 p051-0338| 0.011 0.020 ... 0.020 0.010 0.040 0.011 0.010 0.014

OBS BY SATELLITE VS. BASELINE

```

OVERALL 01 02 04 06 07 08 10 11
wysh-0338| 3252 308 190 398 300 71 ... 31 194
12 15 17 20 24 25 26 28 30
wysh-0338| 198 201 ... 230 332 ... 141 429 229
OVERALL 01 02 04 06 07 08 10 11
p052-0338| 3307 313 186 402 282 52 32 31 198
12 15 17 19 20 24 25 26 28
p052-0338| 188 222 ... .. 220 350 24 163 422
30
p052-0338| 222
OVERALL 01 02 04 06 07 08 10 11
p051-0338| 3285 299 193 398 299 57 34 31 194
12 15 17 20 24 25 26 28 30
p051-0338| 190 202 ... 211 350 20 155 425 227
    
```

Covariance Matrix for the xyz OPUS Position (meters^2).

```

0.0000003267 0.0000000185 -0.0000000295
0.0000000185 0.0000026711 -0.0000002360
-0.0000000295 -0.0000002360 0.0000024111
    
```

Covariance Matrix for the enu OPUS Position (meters^2).

```

0.0000005186 -0.0000004305 0.0000004793
-0.0000004305 0.0000022116 -0.0000000389
0.0000004793 -0.0000000389 0.0000026787
    
```

Horizontal network accuracy = 0.00306 meters.

Vertical network accuracy = 0.00321 meters.

#### Derivation of NAD 83 vector components

Position of reference station ARP in NAD\_83(2011)(EPOCH:2010.0000).

```

Xa(m) Ya(m) Za(m)
WYSH -1326395.57266 -4335759.14462 4472504.25410 2010.00
P052 -1266647.47169 -4138195.81057 4670709.52375 2010.00
P051 -1416838.24007 -4223180.19340 4551064.10960 2010.00
    
```

Position of reference station monument in NAD\_83(2011)(EPOCH:2010.0000).

```

Xr(m) Yr(m) Zr(m)
WYSH -1326395.57266 -4335759.14462 4472504.25410 2010.00
P052 -1266647.47009 -4138195.80517 4670709.51765 2010.00
P051 -1416838.23827 -4223180.18790 4551064.10360 2010.00
    
```

Velocity of reference station monument in NAD\_83(2011)(EPOCH:2010.0000).

```

Vx (m/yr) Vy (m/yr) Vz (m/yr)
WYSH -0.01560 -0.00030 -0.00490
P052 -0.01580 0.00030 -0.00570
P051 -0.01580 -0.00030 -0.00520
    
```

Vectors from unknown station monument to reference station monument  
in NAD\_83(2011)(EPOCH:2010.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
WYSH	-17453.11466	-75967.53462	-76715.24090	2010.00
P052	42294.98791	121595.80483	121490.02265	2010.00
P051	-107895.78027	36611.42210	1844.60860	2010.00

STATE PLANE COORDINATES - International Foot

SPC (2500 MT )

Northing (Y) [feet]	568515.988
Easting (X) [feet]	2585327.743
Convergence [degrees]	1.76945851
Point Scale	0.99962032
Combined Factor	0.99945605

\*\* Orthometric Heights Above Future Geopotential Datum.

Prototype orthometric heights are now being made available as a precursor to the completion of GRAV-D and the replacement of NAVD 88 with a new geopotential reference system. The following height reflects the current best estimate of the true orthometric height, based on the existing gravimetric geoid model. This height is subject to change as data and modeling for the gravimetric geoid change throughout the lifetime of the GRAV-D project, or as new realizations of the ITRF are adopted. However, at the completion of GRAV-D, these heights will supersede the NAVD 88 heights

APPROX ORTHO HGT: 1062.340 (m) [PROTOTYPE (Computed using USGG2012,GRS80,IGS08)]

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.