

# OPUS-RS solution : 940123226U.14O OP1408550497234

opus <opus@ngs.noaa.gov>

Wed 8/20/2014 10:04 AM

To:Chad Mozol <Chad.Mozol@neciusa.com>;

FILE: 940123226U.14O OP1408550497234

## 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: cmozol@neciusa.com                      DATE: August 20, 2014  
RINEX FILE: 9401226u.14o                      TIME: 16:04:23 UTC

SOFTWARE: rsgps 1.37 RS53.prl 1.99.2              START: 2014/08/14 20:59:50  
EPHEMERIS: igr18054.eph [rapid]                  STOP: 2014/08/14 22:00:00  
NAV FILE: brdc2260.14n                      OBS USED: 2440 / 2660 : 92%  
ANT NAME: CHCX91R                      NONE              QUALITY IND. 3.63/ 32.01  
ARP HEIGHT: 1.8                      NORMALIZED RMS:              0.401

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)              IGS08 (EPOCH:2014.61889)

X: -1387195.391(m) 0.012(m)              -1387196.267(m) 0.012(m)  
Y: -4029650.508(m) 0.040(m)              -4029649.285(m) 0.040(m)  
Z: 4730792.856(m) 0.048(m)              4730792.848(m) 0.048(m)

LAT: 48 10 37.79337 0.005(m)              48 10 37.81421 0.005(m)  
E LON: 251 0 14.85222 0.004(m)              251 0 14.79286 0.004(m)  
W LON: 108 59 45.14778 0.004(m)              108 59 45.20714 0.004(m)  
EL HGT: 1016.845(m) 0.063(m)              1016.258(m) 0.063(m)  
ORTHO HGT: 1032.088(m) 0.064(m) [NAVD88 (Computed using GEOID12A)]

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 12)	SPC (2500 MT )
Northing (Y) [meters]	5337933.763	436507.360
Easting (X) [meters]	648982.857	637476.310
Convergence [degrees]	1.49376835	0.36877001
Point Scale	0.99987273	0.99959999
Combined Factor	0.99971341	0.99944071

US NATIONAL GRID DESIGNATOR: 12UXU4898237933(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DG9749	MTMS MONTANA STATE UNI	CORS ARP	N483227.426 W1094111.858	65252.1
DL7731	P053 WHITEWATERMT2007	CORS ARP	N484333.865 W1074331.456	112073.5
DI2257	P049 ARMINGTON_MT2006	CORS ARP	N472059.850 W1105422.382	170217.2
DI3425	P052 LRRNCHJRDNMT2006	CORS ARP	N472229.026 W1070107.185	172985.2

## NEAREST NGS PUBLISHED CONTROL POINT

Information on nearest mark is not available due to database connectivity issues or has restrictions on when or how it can be published.

## OPUS-RS Extended Output, Level 2

## FINAL COORDINATES (ITRF at epoch of observations)

mtms	-1425435.572	-3984013.191	4757493.859
p053	-1283559.265	-4015770.334	4771131.608
p049	-1545099.839	-4044895.875	4669084.581
p052	-1266648.339	-4138194.575	4670709.503
9401	-1387196.267	-4029649.285	4730792.848

## Covariance matrix of the stations:

1	2.5050E-07	4.0480E-07	-5.1060E-07	-3.7680E-10	-1.2720E-07	1.5320E-07	1.2420E-10	-1.6040E-07	2.0430E-07	-8.7760E-11	-1.1780E-07	1.5340E-07	5.6710E-08	-1.6160E-08	2.4430E-08
2	4.0480E-07	1.3520E-06	-1.5750E-06	-1.2370E-07	-3.8230E-07	5.7970E-07	-1.5570E-07	-2.7190E-07	4.0860E-07	-1.2450E-07	-4.4810E-07	5.8560E-07	1.3280E-08	1.4350E-07	-7.9570E-08
3	-5.1060E-07	-1.5750E-06	2.2540E-06	1.7150E-07	5.5150E-07	-7.1790E-07	1.7280E-07	4.6230E-07	-5.9230E-07	1.6570E-07	5.6280E-07	-6.9330E-07	3.3260E-09	-2.8600E-08	7.9010E-08
4	-3.7680E-10	-1.2370E-07	1.7150E-07	2.3650E-07	3.8930E-07	-4.6240E-07	-1.2550E-08	-1.1300E-07	1.3270E-07	2.6450E-08	-1.5180E-07	1.5740E-07	7.4260E-08	3.2340E-08	-3.5530E-08
5	-1.2720E-07	-3.8230E-07	5.5150E-07	3.8930E-07	1.4320E-06	-1.6910E-06	-1.2680E-07	-3.8470E-07	5.5680E-07	-1.3510E-07	-4.1430E-07	5.8250E-07	-4.1530E-09	1.0390E-08	7.2790E-08
6	1.5320E-07	5.7970E-07	-7.1790E-07	-4.6240E-07	-1.6910E-06	2.4080E-06	1.3860E-07	5.8800E-07	-7.5640E-07	1.7070E-07	5.2330E-07	-6.8410E-07	1.7820E-08	1.1760E-07	-9.2660E-08
7	1.2420E-10	-1.5570E-07	1.7280E-07	-1.2550E-08	-1.2680E-07	1.3860E-07	2.7600E-07	3.8370E-07	-4.5470E-07	-1.3520E-08	-1.0250E-07	1.4460E-07	4.1220E-08	-5.2740E-08	6.1690E-08
8	-1.6040E-07	-2.7190E-07	4.6230E-07	-1.1300E-07	-3.8470E-07	5.8800E-07	3.8370E-07	1.3920E-06	-1.6240E-06	-1.0950E-07	-4.8680E-07	5.7350E-07	1.5050E-08	1.9500E-07	-1.5890E-07
9	2.0430E-07	4.0860E-07	-5.9230E-07	1.3270E-07	5.5680E-07	-7.5640E-07	-4.5470E-07	-1.6240E-06	2.2840E-06	1.1670E-07	6.5980E-07	-6.8430E-07	-2.3840E-08	-1.8800E-07	2.8780E-07
10	-8.7760E-11	-1.2450E-07	1.6570E-07	2.6450E-08	-1.3510E-07	1.7070E-07	-1.3520E-08	-1.0950E-07	1.1670E-07	2.3670E-07	3.7030E-07	-4.5380E-07	7.7850E-08	3.6840E-08	-5.0800E-08
11	-1.1780E-07	-4.4810E-07	5.6280E-07	-1.5180E-07	-4.1430E-07	5.2330E-07	-1.0250E-07	-4.8680E-07	6.5980E-07	3.7030E-07	1.6010E-06	-1.7440E-06	-2.4230E-08	-9.8980E-08	1.6600E-07
12	1.5340E-07	5.8560E-07	-6.9330E-07	1.5740E-07	5.8250E-07	-6.8410E-07	1.4460E-07	5.7350E-07	-6.8430E-07	-4.5380E-07	-1.7440E-06	2.3110E-06	2.4700E-09	9.7780E-08	-2.2950E-08
13	5.6710E-08	1.3280E-08	3.3260E-09	7.4260E-08	-4.1530E-09	1.7820E-08	4.1220E-08	1.5050E-08	-2.3840E-08	7.7850E-08	-2.4230E-08	2.4700E-09	2.7120E-06	6.2540E-06	-7.6850E-06
14	-1.6160E-08	1.4350E-07	-2.8600E-08	3.2340E-08	1.0390E-08	1.1760E-07	-5.2740E-08	1.9500E-07	-1.8800E-07						

3.6840E-08 -9.8980E-08 9.7780E-08 6.2540E-06 2.0020E-05 -2.4560E-05  
 15 2.4430E-08 -7.9570E-08 7.9010E-08 -3.5530E-08 7.2790E-08 -9.2660E-08 6.1690E-08 -1.5890E-07 2.8780E-07  
 -5.0800E-08 1.6600E-07 -2.2950E-08 -7.6850E-06 -2.4560E-05 3.3560E-05

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

0.0000027120 0.0000062540 -0.0000076850  
 0.0000062540 0.0000200200 -0.0000245600  
 -0.0000076850 -0.0000245600 0.0000335600

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

0.0000006962 0.0000001913 0.0000008073  
 0.0000001913 0.0000016141 0.0000030545  
 0.0000008073 0.0000030545 0.0000539818

Horizontal network accuracy = 0.00270 meters.

Vertical network accuracy = 0.01441 meters.

		Vectors		
To	From	X	Y	Z
mtms	9401	-38239.305	45636.094	26701.011
p053	9401	103637.002	13878.951	40338.760
p049	9401	-157903.571	-15246.590	-61708.267
p052	9401	120547.928	-108545.289	-60083.346

Covariance matrix of the 4 vectors

1 2.8491E-06 6.6617E-06 -8.2234E-06 2.5807E-06 6.1471E-06 -7.5740E-06 2.6142E-06 6.0947E-06 -7.4813E-06  
 2.5774E-06 6.1766E-06 -7.5585E-06  
 2 6.6617E-06 2.1085E-05 -2.6027E-05 6.0847E-06 1.9484E-05 -2.4018E-05 6.1378E-06 1.9410E-05 -2.3884E-05  
 6.0794E-06 1.9527E-05 -2.3993E-05  
 3 -8.2234E-06 -2.6027E-05 3.5656E-05 -7.4813E-06 -2.4053E-05 3.2856E-05 -7.5772E-06 -2.3910E-05 3.2601E-05  
 -7.4718E-06 -2.4135E-05 3.2811E-05  
 4 2.5807E-06 6.0847E-06 -7.4813E-06 2.8000E-06 6.6151E-06 -8.1297E-06 2.5840E-06 6.0936E-06 -7.4929E-06  
 2.5863E-06 6.0941E-06 -7.4945E-06  
 5 6.1471E-06 1.9484E-05 -2.4053E-05 6.6151E-06 2.1431E-05 -2.6441E-05 6.1841E-06 1.9430E-05 -2.3888E-05  
 6.0862E-06 1.9694E-05 -2.4148E-05  
 6 -7.5740E-06 -2.4018E-05 3.2856E-05 -8.1297E-06 -2.6441E-05 3.6153E-05 -7.6259E-06 -2.3931E-05 3.2608E-05  
 -7.4813E-06 -2.4320E-05 3.2992E-05  
 7 2.6142E-06 6.1378E-06 -7.5772E-06 2.5840E-06 6.1841E-06 -7.6259E-06 2.9056E-06 6.6754E-06 -8.1776E-06  
 2.5794E-06 6.2285E-06 -7.6046E-06  
 8 6.0947E-06 1.9410E-05 -2.3910E-05 6.0936E-06 1.9430E-05 -2.3931E-05 6.6754E-06 2.1022E-05 -2.5837E-05  
 6.0926E-06 1.9437E-05 -2.3925E-05  
 9 -7.4813E-06 -2.3884E-05 3.2601E-05 -7.4929E-06 -2.3888E-05 3.2608E-05 -8.1775E-06 -2.5837E-05 3.5268E-05  
 -7.4937E-06 -2.3878E-05 3.2611E-05  
 10 2.5774E-06 6.0794E-06 -7.4718E-06 2.5863E-06 6.0862E-06 -7.4813E-06 2.5794E-06 6.0926E-06 -7.4937E-06  
 2.7930E-06 6.6117E-06 -8.0905E-06  
 11 6.1766E-06 1.9527E-05 -2.4135E-05 6.0941E-06 1.9694E-05 -2.4320E-05 6.2285E-06 1.9437E-05 -2.3878E-05  
 6.6117E-06 2.1819E-05 -2.6568E-05  
 12 -7.5585E-06 -2.3993E-05 3.2811E-05 -7.4945E-06 -2.4148E-05 3.2992E-05 -7.6046E-06 -2.3925E-05 3.2611E-05  
 -8.0905E-06 -2.6568E-05 3.5917E-05

Correlation matrix of the 4 vectors

1 1.0000E+00 8.5950E-01 -8.1589E-01 9.1369E-01 7.8668E-01 -7.4628E-01 9.0860E-01 7.8752E-01 -7.4633E-01

9.1366E-01 7.8339E-01 -7.4719E-01  
 2 8.5950E-01 1.0000E+00 -9.4922E-01 7.9191E-01 9.1657E-01 -8.6993E-01 7.8417E-01 9.2192E-01 -8.7584E-01  
 7.9220E-01 9.1042E-01 -8.7185E-01  
 3 -8.1589E-01 -9.4922E-01 1.0000E+00 -7.4874E-01 -8.7011E-01 9.1511E-01 -7.4444E-01 -8.7333E-01 9.1933E-01  
 -7.4873E-01 -8.6528E-01 9.1685E-01  
 4 9.1369E-01 7.9191E-01 -7.4874E-01 1.0000E+00 8.5396E-01 -8.0802E-01 9.0593E-01 7.9426E-01 -7.5402E-01  
 9.2485E-01 7.7968E-01 -7.4734E-01  
 5 7.8668E-01 9.1657E-01 -8.7011E-01 8.5396E-01 1.0000E+00 -9.4992E-01 7.8368E-01 9.1540E-01 -8.6889E-01  
 7.8666E-01 9.1075E-01 -8.7038E-01  
 6 -7.4628E-01 -8.6993E-01 9.1511E-01 -8.0802E-01 -9.4992E-01 1.0000E+00 -7.4405E-01 -8.6805E-01 9.1319E-01  
 -7.4451E-01 -8.6592E-01 9.1554E-01  
 7 9.0860E-01 7.8417E-01 -7.4444E-01 9.0593E-01 7.8368E-01 -7.4405E-01 1.0000E+00 8.5413E-01 -8.0782E-01  
 9.0546E-01 7.8226E-01 -7.4441E-01  
 8 7.8752E-01 9.2192E-01 -8.7333E-01 7.9426E-01 9.1540E-01 -8.6805E-01 8.5413E-01 1.0000E+00 -9.4889E-01  
 7.9512E-01 9.0757E-01 -8.7071E-01  
 9 -7.4633E-01 -8.7584E-01 9.1933E-01 -7.5402E-01 -8.6889E-01 9.1319E-01 -8.0782E-01 -9.4889E-01 1.0000E+00  
 -7.5503E-01 -8.6078E-01 9.1626E-01  
 10 9.1366E-01 7.9220E-01 -7.4873E-01 9.2485E-01 7.8666E-01 -7.4451E-01 9.0546E-01 7.9512E-01 -7.5503E-01  
 1.0000E+00 8.4695E-01 -8.0777E-01  
 11 7.8339E-01 9.1042E-01 -8.6528E-01 7.7968E-01 9.1075E-01 -8.6592E-01 7.8226E-01 9.0757E-01 -8.6078E-01  
 8.4695E-01 1.0000E+00 -9.4905E-01  
 12 -7.4719E-01 -8.7185E-01 9.1685E-01 -7.4734E-01 -8.7038E-01 9.1554E-01 -7.4441E-01 -8.7071E-01 9.1626E-01  
 -8.0777E-01 -9.4905E-01 1.0000E+00

G-FILE for the vectors

Axx2014 8142014 814  
 B201408142000201408142200 4 rsgps 1.37IGS  
 lant\_info.003 NGS  
 C00050001 -382393045 16 456360942 45 267010109 59  
 C00050002 1036370018 16 138789511 46 403387599 60  
 C00050003 -1579035714 17 -152465898 45 -617082669 59  
 C00050004 1205479281 16 -1085452893 46 -600833458 59  
 D 1 2 8594975 1 3 -8158880 1 4 9136920 1 5 7866751 1 6 -7462799  
 D 1 7 9085955 1 8 7875238 1 9 -7463306 1 10 9136628 1 11 7833925  
 D 1 12 -7471948 2 3 -9492230 2 4 7919057 2 5 9165657 2 6 -8699252  
 D 2 7 7841663 2 8 9219190 2 9 -8758390 2 10 7922039 2 11 9104165  
 D 2 12 -8718489 3 4 -7487437 3 5 -8701097 3 6 9151053 3 7 -7444380  
 D 3 8 -8733332 3 9 9193277 3 10 -7487297 3 11 -8652804 3 12 9168516  
 D 4 5 8539576 4 6 -8080205 4 7 9059309 4 8 7942553 4 9 -7540173  
 D 4 10 9248529 4 11 7796763 4 12 -7473397 5 6 -9499193 5 7 7836779  
 D 5 8 9153987 5 9 -8688869 5 10 7866621 5 11 9107514 5 12 -8703813  
 D 6 7 -7440509 6 8 -8680491 6 9 9131945 6 10 -7445068 6 11 -8659200  
 D 6 12 9155428 7 8 8541314 7 9 -8078214 7 10 9054614 7 11 7822569  
 D 7 12 -7444057 8 9 -9488856 8 10 7951167 8 11 9075680 8 12 -8707077  
 D 9 10 -7550324 9 11 -8607790 9 12 9162622 10 11 8469543 10 12 -8077721  
 D 11 12 -9490494

ITRF position of 9401 as determined by individual baselines

	X	Y	Z
mtms	-1387196.277	-4029649.305	4730792.869
p053	-1387196.250	-4029649.220	4730792.770

p049 -1387196.266 -4029649.290 4730792.841  
 p052 -1387196.274 -4029649.300 4730792.865

Residuals of position determined by individual baselines from the final position

	X	Y	Z	East	North	Up
mtms	-0.010	-0.020	0.020	-0.003	-0.003	0.030
p053	0.017	0.065	-0.078	-0.005	-0.002	-0.103
p049	0.001	-0.005	-0.007	0.003	-0.008	-0.002
p052	-0.007	-0.014	0.017	-0.002	-0.001	0.023

STATE PLANE COORDINATES - International Foot

SPC (2500 MT )

Northing (Y) [feet] 1432110.761  
 Easting (X) [feet] 2091457.710  
 Convergence [degrees] 0.36877001  
 Point Scale 0.99959999  
 Combined Factor 0.99944071

\*\* 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: 1031.088 (m) [PROTOTYPE (Computed using USGG2012,GRS80,IGS08)]

dop from interpolation is 0.509  
 scatter (mean square distance from rover) is 18485.766  
 average edop for rover is 0.760  
 average ndop for rover is 1.080  
 average hdop for rover is 1.321  
 average vdop for rover is 1.890  
 average gdop for rover is 2.700

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.