

# Cardno TBE

## SURVEY CONTROL PACKAGE

**VERSION NO:** 1

**DATE:** 5-07-2013

**P.I. NUMBER:**

**PI# 0011682**

**CARDNO PROJECT  
NUMBER:**

**GA06900200**

**DESCRIPTION:**

**SR299 BRIDGE IMPROVEMENT PROJECT AT  
I-24 INTERCHANGE.**

**SURVEY  
DATA:**

**HORIZONTAL DATUM: NAD83(94)  
VERTICAL DATUM: NAVD88  
GEORGIA WEST ZONE**

**LENGTH:**

**APPROXIMATELY 1 MILE**

**COUNTY:**

**DADE**



6649 PEACHTREE IND. BLVD.

Suite J

NORCROSS, GA, 30092

678-421-0080

[www.cardno.com](http://www.cardno.com)

# Cardno TBE

## SURVEY CONTROL PACKAGE

PI #: 0011682

Final Coordinates

Georgia State Plane West Zone (1002)

NAVD 88

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	Northing (m)	Easting (m)	Elevation (m)	Northing (ft)	Easting (ft)	Elevation (ft)
SD1	552074.889	585473.03	238.098	1811265.698	1920839.433	781.16
SD2	552601.412	585806.757	229.333	1812993.133	1921934.335	752.40
SD3	552744.797	585914.599	233.368	1813463.555	1922288.147	765.64

	Convergence	Point Scale Factor	Combined Scale Factor
SD1	-0.7189814	1.00006161	1.00002883
SD2	-0.71701323	1.00006067	1.00002927
SD3	-0.71637065	1.00006036	1.00002832

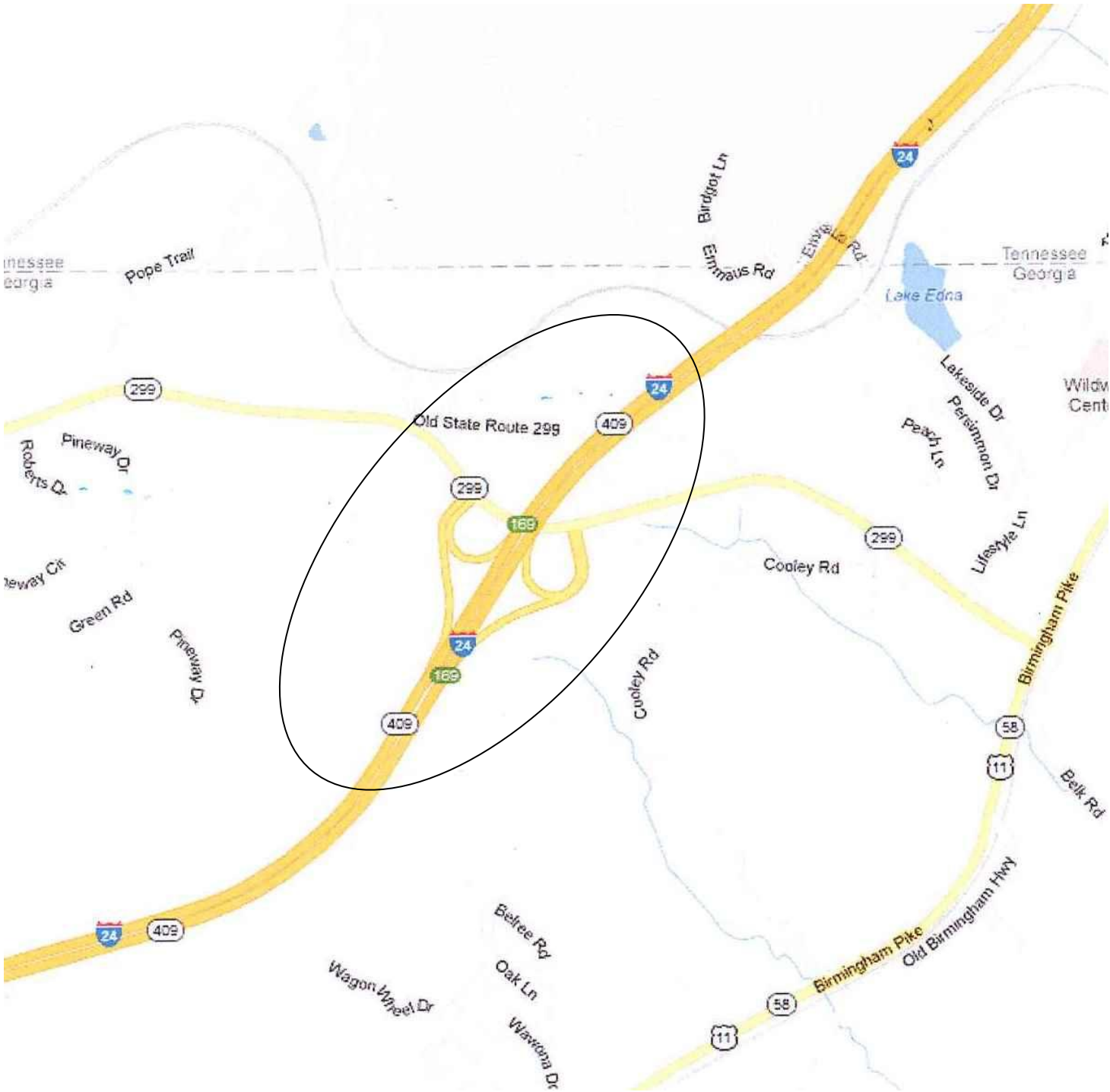
### SURVEY NOTES:

*SURVEY CONTROL POINT LOCATIONS DERIVED FROM OPUS OBSRVATIONS ON MARCH 18, 2013 AND PROCESSED ON APRIL 18, 2013.*

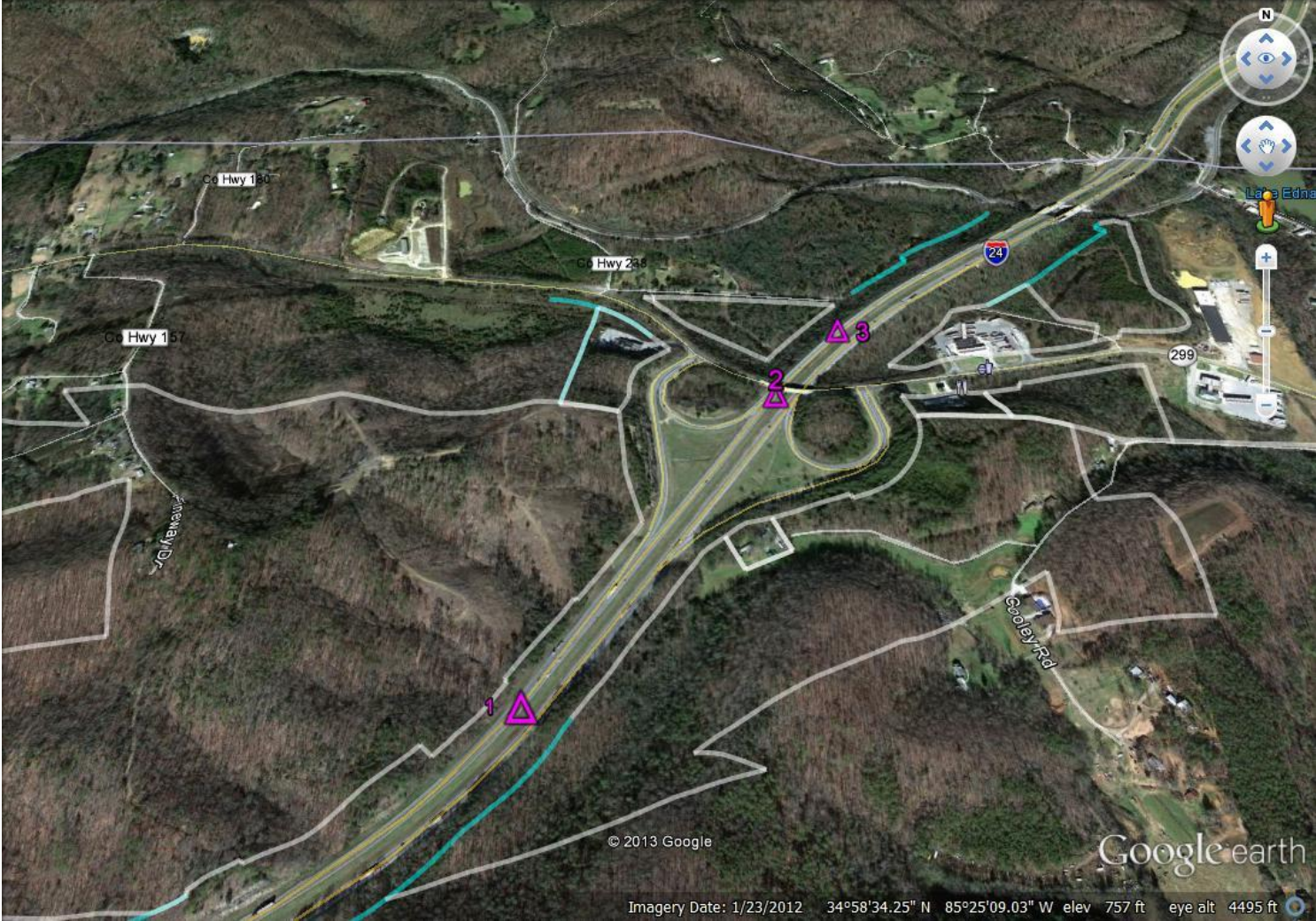
*ELEVATIONS FOR THIS CONTROL DERIVED FROM A 3-WIRE LEVEL LOOP TIED TO NGS MONUMENT C-392.*

*Survey Control Points are 5/8" Rebar, center punched, and set 0.5' below the natural ground surface.*

# PROJECT LOCATION




# SURVEY CONTROL LOCATIONS



Cardno TBE  
 6649 Peachtree Industrial Blvd., Suite J  
 Norcross, Georgia 30092  
 678-421-0080 Voice / 678-421-0082 Fax  
 Vertical Control Monument

**Station Name: NGS C392**

<b>County:</b>	DADE	<b>Elevation:</b>	782.080'
<b>State Plane Zone:</b>	WEST	<b>Described By:</b>	T. HURLEY
<b>Northing:</b>	N/A	<b>Easting:</b>	N/A
<b>Units of Measure:</b>	U.S. FEET	<b>Date:</b>	3/14/2013
<b>Horizontal Datum:</b>	N/A	<b>Vertical Datum:</b>	NAVD 88
NGS Monument C292: Vertical Order – First, Class-II (Geoid 12A)			
<b>To Reach Description:</b>			
0.9 miles East along SR299 from the Church of Christ in Hooker, a Brass Disk found in the Southwest Abutment in the West end of the South Side of a large overpass over Interstate Highway 24.			
<b>Sketch</b>			
			

**Cardno TBE**  
 6649 Peachtree Industrial Blvd., Suite J  
 Norcross, Georgia 30092  
 678-421-0080 Voice / 678-421-0082 Fax  
 Horizontal Control Delta

**Station Name: SD1**

**Combined Scale Factor: 1.00002883**

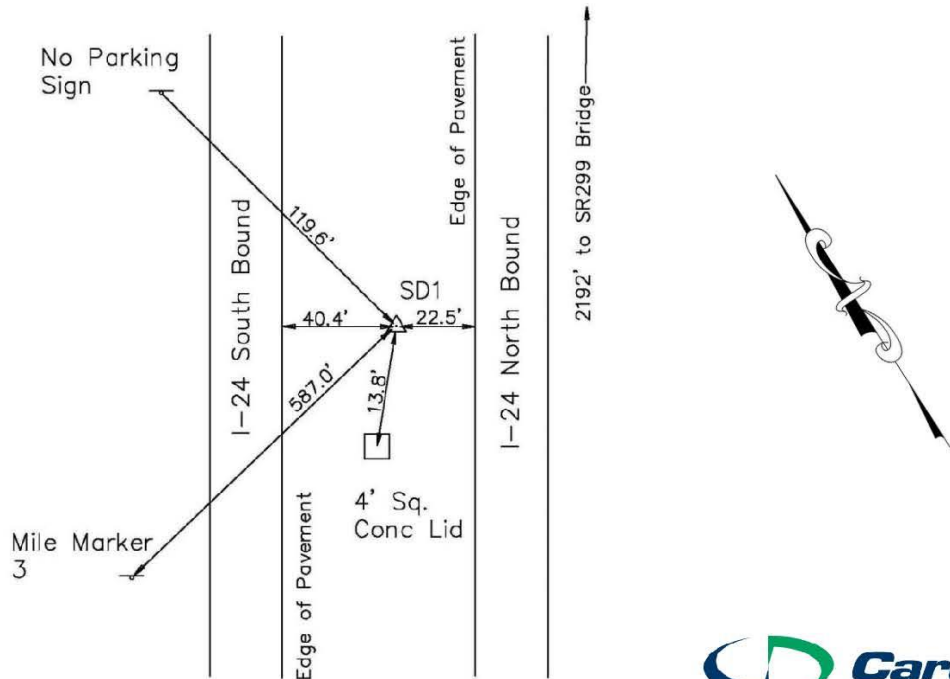
<b>County:</b>	<b>DADE</b>	<b>Elevation:</b>	<b>781.16'</b>
(Elevations derived from a 3-Wire Level Loop to NGS Mon. C392)			
<b>State Plane</b>	<b>WEST</b>	<b>Described By:</b>	<b>T. Hurley</b>
<b>Northing:</b>	<b>1811265.698'</b>	<b>Easting:</b>	<b>1920839.433'</b>
<b>Units of</b>	<b>U.S. FEET</b>	<b>Date:</b>	<b>3/18/2013</b>
<b>Horizontal</b>	<b>NAD 83 (OPUS)</b>	<b>Vertical</b>	<b>NAVD 88</b>
OPUS Observation: 3/18/2013		OPUS Processing: 4/18/2013	

**To Reach Description:**

Showing a #5 Rebar set in the I-24 grassed median 2192.4 feet Southwest from the centerline intersection of I-24 and the SR299 Overpass Bridge.

I-24 Station and Offset: 155+11.1, Rt. 8.7'

**Sketch**



**Visible From Ground To: SD2; N32°22'04"E, 2045.20'**

**Visible From Ground To: SD3; N33°23'27"E, 2632.37'**

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 678-421-0080 Voice / 678-421-0082 Fax  
 Horizontal Control Delta

<b>Station Name: SD2</b>		<b>Combined Scale Factor: 1.00002927</b>	
<b>County:</b>	<b>DADE</b>	<b>Elevation:</b>	<b>752.40'</b>
(Elevations derived from a 3-Wire Level Loop to NGS Mon. C392)			
<b>State Plane Zone:</b>	<b>WEST</b>	<b>Described By:</b>	<b>T. Hurley</b>
<b>Northing:</b>	<b>1812993.133'</b>	<b>Easting:</b>	<b>1921934.335'</b>
<b>Units of Measure:</b>	<b>U.S. FEET</b>	<b>Date:</b>	<b>3/18/2013</b>
<b>Horizontal Datum:</b>	<b>NAD 83 (OPUS)</b>	<b>Vertical Datum:</b>	<b>NAVD 88</b>
OPUS Observation: 3/18/2013		OPUS Processing: 4/18/2013	
To Reach Description:			
Showing a #5 Rebar set in the I-24 grassed median 147.4 feet Southwest from the centerline intersection of I-24 and the SR299 Overpass Bridge.			
I-24 Station and Offset: 175+56.1, Rt. 5.0'			
Sketch			
<b>Visible From Ground To: SD1; S32°22'04"W, 2045.20'</b>		<b>Visible From Ground To: SD3; N36°56'51"E, 588.63'</b>	



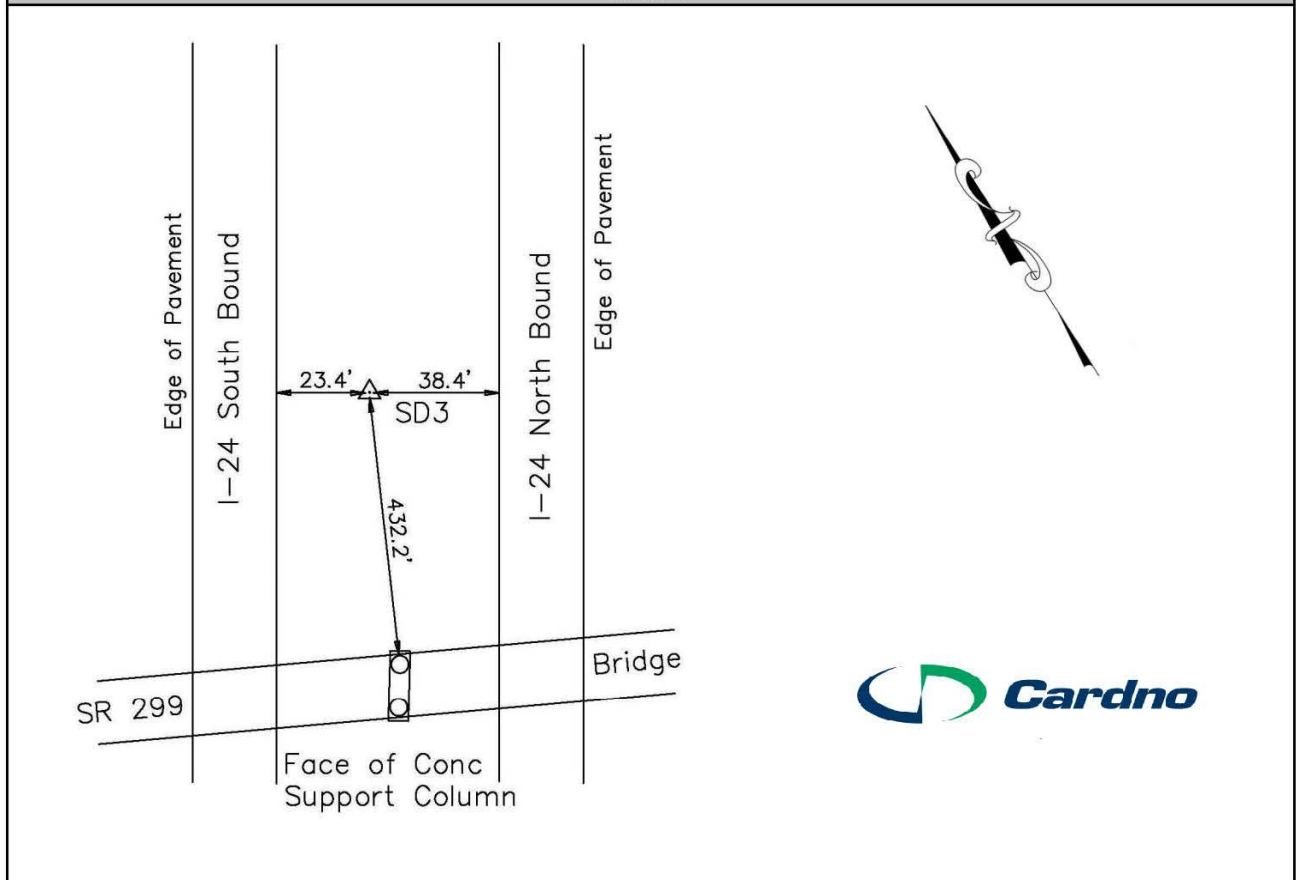
**Cardno TBE**  
 6649 Peachtree Industrial Blvd., Suite J  
 Norcross, Georgia 30092  
 678-421-0080 Voice / 678-421-0082 Fax  
 Horizontal Control Delta

**Station Name: SD3**

**Combined Scale Factor: 1.000060**

<b>County:</b>	<b>DADE</b>	<b>Elevation:</b>	<b>765.64'</b>
(Elevations derived from a 3-Wire Level Loop to NGS Mon. C392)			
<b>State Plane Zone:</b>	<b>WEST</b>	<b>Described By:</b>	<b>T. Hurley</b>
<b>Northing:</b>	<b>1813463.555'</b>	<b>Easting:</b>	<b>1922288.147'</b>
<b>Units of Measure:</b>	<b>U.S. FEET</b>	<b>Date:</b>	<b>3/18/2013</b>
<b>Horizontal Datum:</b>	<b>NAD 83 (OPUS)</b>	<b>Vertical Datum:</b>	<b>NAVD 88</b>
OPUS Observation: 3/18/2013		OPUS Processing: 4/18/2013	
<b>To Reach Description:</b>			
Showing a #5 Rebar set in the I-24 grassed median 441.5 feet Northeast from the centerline intersection of I-24 and the SR299 Overpass Bridge.			
I-24 Station and Offset: 181+45.0, Lt. 6.9'			

**Sketch**



<b>Visible From Ground To: SD1; S33°23'27"W, 2632.37'</b>	<b>Visible From Ground To: SD2; S36°56'51"W, 588.63'</b>
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# SD1 OPUS Solution

**From:** [opus](#)  
**To:** [Tony.DiMarino](#)  
**Subject:** OPUS solution : 1\_\_0800.13o OP1366302365439  
**Date:** Thursday, April 18, 2013 12:27:28 PM

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FILE: 1\_\_0800.13o OP1366302365439

## NGS OPUS SOLUTION REPORT =====

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

USER: Tony.DiMarino@Cardno.com                      DATE: April 18, 2013  
RINEX FILE: 1\_\_080p.13o                                      TIME: 16:27:05 UTC

SOFTWARE: page5 1209.04 master63.pl 082112      START: 2013/03/21 15:45:00  
EPHEMERIS: igs17324.eph [precise]                      STOP: 2013/03/21 20:17:00  
NAV FILE: brdc0800.13n                                      OBS USED: 6278 / 7408 : 85%  
ANT NAME: LEIAX1202GG      NONE                      # FIXED AMB: 49 / 52 : 94%  
ARP HEIGHT: 1.586                                      OVERALL RMS: 0.013(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)                      IGS08 (EPOCH:2013.2185)

X:	417726.821(m)	0.021(m)	417726.043(m)	0.021(m)
Y:	-5215655.794(m)	0.009(m)	-5215654.332(m)	0.009(m)
Z:	3635473.000(m)	0.008(m)	3635472.869(m)	0.008(m)

LAT:	34 58 20.44249	0.001(m)	34 58 20.46727	0.001(m)
E LON:	274 34 44.75663	0.021(m)	274 34 44.73066	0.021(m)
W LON:	85 25 15.24337	0.021(m)	85 25 15.26934	0.021(m)
EL HGT:	208.845(m)	0.013(m)	207.525(m)	0.013(m)
ORTHO HGT:	238.144(m)	0.026(m)	[NAVD88 (Computed using GEOID12A)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 16)	SPC (1002 GA W)
Northing (Y) [meters]	3871115.003	552074.889
Easting (X) [meters]	644150.178	585473.030
Convergence [degrees]	0.90526556	-0.71898140
Point Scale	0.99985610	1.00006161
Combined Factor	0.99982332	1.00002883

US NATIONAL GRID DESIGNATOR: 16SFD4415071115(NAD 83)

BASE STATIONS USED				
PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
	TN25		82557.5	
	TN29		83450.8	
	TN21		22014.9	

NEAREST NGS PUBLISHED CONTROL POINT				
EE1520	C 392	N345839.1	W0852503.1	653.8

BASE STATION INFORMATION

STATION NAME: tn25 a 6 (TDOT District 25; Tullahoma, Tennessee USA)

MONUMENT: NO DOMES NUMBER

XYZ 346089.3334 -5195693.1406 3671326.1282 MON @ 2005.0000 (M)  
 XYZ -0.0126 0.0001 0.0009 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0008 -0.0005 0.0334 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0000 -0.0008 0.0413 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1035 0.0012 0.0077 VEL TIMES 8.2185 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ 0.0013 -0.0267 0.0199 ARP TO L1 PHASE CENTER  
 XYZ 346089.2311 -5195693.1662 3671326.1559 L1 PHS CEN @ 2013.2185  
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ 346089.2311 -5195693.1661 3671326.1559 NEW L1 PHS CEN @ 2013.2185  
 XYZ 346089.2298 -5195693.1394 3671326.1359 NEW ARP @ 2013.2185  
 XYZ 346089.2298 -5195693.1394 3671326.1359 NEW MON @ 2013.2185  
 LLH 35 22 1.47446 273 48 39.19516 301.3574 NEW L1 PHS CEN @ 2013.2185  
 LLH 35 22 1.47443 273 48 39.19517 301.3241 NEW ARP @ 2013.2185  
 LLH 35 22 1.47443 273 48 39.19517 301.3241 NEW MON @ 2013.2185

STATION NAME: tn29 a 3 (TDOT District 29; Delano, Tennessee USA)

MONUMENT: NO DOMES NUMBER

XYZ 493628.4265 -5191458.8611 3660321.4562 MON @ 2005.0000 (M)  
 XYZ -0.0138 -0.0007 0.0009 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0008 -0.0005 0.0334 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0000 -0.0008 0.0413 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1136 -0.0056 0.0071 VEL TIMES 8.2186 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ 0.0021 -0.0267 0.0199 ARP TO L1 PHASE CENTER  
 XYZ 493628.3150 -5191458.8934 3660321.4831 L1 PHS CEN @ 2013.2185  
 XYZ -0.0000 -0.0000 -0.0000 + XYZ ADJUSTMENTS  
 XYZ 493628.3150 -5191458.8935 3660321.4831 NEW L1 PHS CEN @ 2013.2185  
 XYZ 493628.3129 -5191458.8668 3660321.4632 NEW ARP @ 2013.2185  
 XYZ 493628.3129 -5191458.8668 3660321.4632 NEW MON @ 2013.2185  
 LLH 35 14 46.29944 275 25 53.83936 198.2338 NEW L1 PHS CEN @ 2013.2185  
 LLH 35 14 46.29942 275 25 53.83938 198.2005 NEW ARP @ 2013.2185  
 LLH 35 14 46.29942 275 25 53.83938 198.2005 NEW MON @ 2013.2185

STATION NAME: tn21 a 5 (TDOT District 21; Chatanooga, Tennessee USA)

MONUMENT: NO DOMES NUMBER

XYZ 436685.8201 -5208212.5694 3643827.9357 MON @ 2005.0000 (M)  
 XYZ -0.0138 -0.0007 0.0007 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0008 -0.0005 0.0334 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0000 -0.0008 0.0412 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1132 -0.0054 0.0055 VEL TIMES 8.2186 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ 0.0018 -0.0268 0.0198 ARP TO L1 PHASE CENTER  
 XYZ 436685.7087 -5208212.6016 3643827.9610 L1 PHS CEN @ 2013.2186  
 XYZ -0.0000 -0.0000 -0.0000 + XYZ ADJUSTMENTS  
 XYZ 436685.7087 -5208212.6016 3643827.9610 NEW L1 PHS CEN @ 2013.2186  
 XYZ 436685.7069 -5208212.5748 3643827.9412 NEW ARP @ 2013.2186  
 XYZ 436685.7069 -5208212.5748 3643827.9412 NEW MON @ 2013.2186  
 LLH 35 3 51.76270 274 47 34.03944 196.3166 NEW L1 PHS CEN @ 2013.2186  
 LLH 35 3 51.76267 274 47 34.03945 196.2833 NEW ARP @ 2013.2186  
 LLH 35 3 51.76267 274 47 34.03945 196.2833 NEW MON @ 2013.2186

REMOTE STATION INFORMATION

STATION NAME: 1\_\_\_ 1  
 MONUMENT: NO DOMES NUMBER  
 XYZ 417725.8317 -5215653.6606 3635472.4024 MON @ 2013.2182 (M)  
 NEU -0.0016 0.0005 1.5860 MON TO ARP (M)  
 NEU 0.0016 -0.0005 0.0634 ARP TO L1 PHASE CENTER (M)  
 NEU -0.0012 0.0002 0.0621 ARP TO L2 PHASE CENTER (M)  
 XYZ 0.1043 -1.2963 0.9077 MON TO ARP  
 XYZ 0.0036 -0.0509 0.0377 ARP TO L1 PHASE CENTER  
 XYZ 417725.9396 -5215655.0079 3635473.3478 L1 PHS CEN @ 2013.2185

BASELINE NAME: tn25 1\_\_\_  
 XYZ 0.2244 -0.6749 0.4704 + XYZ ADJUSTMENTS  
 XYZ 417726.1640 -5215655.6827 3635473.8182 NEW L1 PHS CEN @ 2013.2185  
 XYZ 417726.1605 -5215655.6318 3635473.7805 NEW ARP @ 2013.2185  
 XYZ 417726.0561 -5215654.3355 3635472.8728 NEW MON @ 2013.2185  
 LLH 34 58 20.46728 274 34 44.73117 209.1803 NEW L1 PHS CEN @ 2013.2185  
 LLH 34 58 20.46723 274 34 44.73119 209.1169 NEW ARP @ 2013.2185  
 LLH 34 58 20.46728 274 34 44.73117 207.5309 NEW MON @ 2013.2185

BASELINE NAME: tn29 1\_\_\_  
 XYZ 0.2036 -0.6735 0.4665 + XYZ ADJUSTMENTS  
 XYZ 417726.1432 -5215655.6814 3635473.8143 NEW L1 PHS CEN @ 2013.2185  
 XYZ 417726.1397 -5215655.6305 3635473.7767 NEW ARP @ 2013.2185  
 XYZ 417726.0353 -5215654.3341 3635472.8689 NEW MON @ 2013.2185  
 LLH 34 58 20.46724 274 34 44.73036 209.1757 NEW L1 PHS CEN @ 2013.2185  
 LLH 34 58 20.46718 274 34 44.73038 209.1123 NEW ARP @ 2013.2185  
 LLH 34 58 20.46724 274 34 44.73036 207.5263 NEW MON @ 2013.2185

BASELINE NAME: tn21 1\_\_\_  
 XYZ 0.2065 -0.6660 0.4623 + XYZ ADJUSTMENTS  
 XYZ 417726.1461 -5215655.6738 3635473.8101 NEW L1 PHS CEN @ 2013.2186  
 XYZ 417726.1426 -5215655.6229 3635473.7724 NEW ARP @ 2013.2186  
 XYZ 417726.0382 -5215654.3266 3635472.8647 NEW MON @ 2013.2186  
 LLH 34 58 20.46726 274 34 44.73049 209.1673 NEW L1 PHS CEN @ 2013.2186  
 LLH 34 58 20.46721 274 34 44.73051 209.1039 NEW ARP @ 2013.2186  
 LLH 34 58 20.46726 274 34 44.73049 207.5179 NEW MON @ 2013.2186

G-FILES

Axx2013 321 13 321  
 B2013 3211545 13 3212016 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090001 -716368263 14 199611960 41 358532632 25 X0803A1\_\_\_X0803ATN25  
 D 1 2 -6700727 1 3 4609319 2 3 -9395021

Axx2013 321 13 321  
 B2013 3211545 13 3212016 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090005 759022776 11 241954674 38 248485943 28 X0803A1\_\_\_X0803ATN29  
 D 1 2 -5054995 1 3 6644404 2 3 -9458152

Axx2013 321 13 321  
 B2013 3211545 13 3212016 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090004 189596687 12 74417518 45 83550765 34 X0803A1\_\_\_X0803ATN21  
 D 1 2 -5580733 1 3 7054670 2 3 -9396254

POST-FIT RMS BY SATELLITE VS. BASELINE

```

OVERALL 01 03 06 09 11 12 14 15
tn25-1___| 0.014 0.018 ... ... 0.019 ... 0.018
          16 18 19 20 21 22 24 25 30
tn25-1___| 0.019 0.011 ... ... 0.013 0.010 0.014 0.017 0.016
          31 32
tn25-1___| 0.016 0.013

```

```

OVERALL 01 06 09 11 12 14 15 16
tn29-1___| 0.013 0.019 ... ... 0.017 ... ... 0.019
          18 19 20 21 22 24 25 30 31
tn29-1___| 0.012 ... 0.014 0.013 0.008 0.011 0.015 0.015 0.012
          32
tn29-1___| 0.013

```

```

OVERALL 01 06 09 11 12 14 15 16
tn21-1___| 0.014 0.027 ... ... 0.017 ... ... 0.017
          18 19 20 21 22 24 25 30 31
tn21-1___| 0.014 ... ... 0.018 0.009 0.016 0.018 0.016 0.013
          32
tn21-1___| 0.013

```

OBS BY SATELLITE VS. BASELINE

```

OVERALL 01 03 06 09 11 12 14 15
tn25-1___| 2347 13 ... ... 142 ... 60
          16 18 19 20 21 22 24 25 30
tn25-1___| 21 356 ... ... 198 488 235 281 58
          31 32
tn25-1___| 340 155

```

```

OVERALL 01 06 09 11 12 14 15 16
tn29-1___| 2158 20 ... ... 133 ... ... 21
          18 19 20 21 22 24 25 30 31
tn29-1___| 309 ... 17 147 438 181 278 132 328
          32
tn29-1___| 154

```

```

OVERALL 01 06 09 11 12 14 15 16
tn21-1___| 1773 1 ... ... 145 ... ... 21
          18 19 20 21 22 24 25 30 31
tn21-1___| 216 ... ... 55 343 92 278 135 332
          32
tn21-1___| 155

```

Covariance Matrix for the xyz OPUS Position (meters<sup>2</sup>).

```

0.0000007244 -0.0000001621 0.0000000796
-0.0000001621 0.0000095244 -0.0000005784
0.0000000796 -0.0000005784 0.0000042444

```

Covariance Matrix for the enu OPUS Position (meters<sup>2</sup>).

```

0.0000007547 0.0000003355 -0.0000004248
0.0000003355 0.0000054074 -0.0000022566
-0.0000004248 -0.0000022566 0.0000083312

```

Horizontal network accuracy = 0.00465 meters.

Vertical network accuracy = 0.00566 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)
TN25	0.00000	0.00000	0.00000
TN29	0.00000	0.00000	0.00000
TN21	0.00000	0.00000	0.00000

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

	Xr(m)	Yr(m)	Zr(m)
TN25	0.00000	0.00000	0.00000
TN29	0.00000	0.00000	0.00000
TN21	0.00000	0.00000	0.00000

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

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
TN25	0.00000	0.00000	0.00000
TN29	0.00000	0.00000	0.00000
TN21	0.00000	0.00000	0.00000

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)
TN25	-417726.82100	5215655.79400	-3635473.00000
TN29	-417726.82100	5215655.79400	-3635473.00000
TN21	-417726.82100	5215655.79400	-3635473.00000

STATE PLANE COORDINATES - U.S. Survey Foot

SPC (1002 GA W)	
Northing (Y) [feet]	1811265.698
Easting (X) [feet]	1920839.433
Convergence [degrees]	-0.71898140
Point Scale	1.00006161
Combined Factor	1.00002883

\*\* 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: 237.758 (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.

# SD2 OPUS Solution

**From:** [opus](#)  
**To:** [Tony DiMarino](#)  
**Subject:** OPUS solution : 2\_\_0800.13o OP1366302680094  
**Date:** Thursday, April 18, 2013 12:32:36 PM

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FILE: 2\_\_0800.13o OP1366302680094

## NGS OPUS SOLUTION REPORT =====

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

USER: Tony.DiMarino@Cardno.com                      DATE: April 18, 2013  
RINEX FILE: 2\_\_080p.13o                                TIME: 16:32:09 UTC

SOFTWARE: page5 1209.04 master3.pl 0821123    START: 2013/03/21 15:36:00  
EPHEMERIS: igs17324.eph [precise]            STOP: 2013/03/21 20:09:00  
NAV FILE: brdc0800.13n                        OBS USED: 7514 / 8220 : 91%  
ANT NAME: LEIAX1202GG    NONE                        # FIXED AMB: 51 / 52 : 98%  
ARP HEIGHT: 1.518                            OVERALL RMS: 0.012(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)                      IGS08 (EPOCH:2013.2185)

X:	418028.000(m)	0.008(m)	418027.222(m)	0.008(m)
Y:	-5215319.280(m)	0.004(m)	-5215317.819(m)	0.004(m)
Z:	3635902.772(m)	0.010(m)	3635902.641(m)	0.010(m)

LAT:	34 58 37.66143	0.006(m)	34 58 37.68619	0.006(m)
E LON:	274 34 57.65136	0.008(m)	274 34 57.62539	0.008(m)
W LON:	85 25 2.34864	0.008(m)	85 25 2.37461	0.008(m)
EL HGT:	200.047(m)	0.008(m)	198.727(m)	0.008(m)
ORTHO HGT:	229.356(m)	0.019(m)	[NAVD88 (Computed using GEOID12A)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 16)	SPC (1002 GA W)
Northing (Y) [meters]	3871650.664	552601.412
Easting (X) [meters]	644468.780	585806.757
Convergence [degrees]	0.90742795	-0.71701323
Point Scale	0.99985723	1.00006067
Combined Factor	0.99982583	1.00002927

US NATIONAL GRID DESIGNATOR: 16SFD4446871650(NAD 83)

BASE STATIONS USED			
PID	DESIGNATION	LATITUDE	LONGITUDE DISTANCE(m)
	TN29		82952.1
	P778		46548.0
	TN22		45999.3

NEAREST NGS PUBLISHED CONTROL POINT			
EE1520	C 392	N345839.1 W0852503.1	48.4

BASE STATION INFORMATION

STATION NAME: tn29 a 3 (TDOT District 29; Delano, Tennessee USA)

MONUMENT: NO DOMES NUMBER

XYZ 493628.4265 -5191458.8611 3660321.4562 MON @ 2005.0000 (M)  
 XYZ -0.0138 -0.0007 0.0009 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0008 -0.0005 0.0334 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0000 -0.0008 0.0413 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1136 -0.0056 0.0071 VEL TIMES 8.2185 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ 0.0021 -0.0267 0.0199 ARP TO L1 PHASE CENTER  
 XYZ 493628.3150 -5191458.8934 3660321.4831 L1 PHS CEN @ 2013.2185  
 XYZ -0.0000 -0.0000 -0.0000 + XYZ ADJUSTMENTS  
 XYZ 493628.3150 -5191458.8935 3660321.4831 NEW L1 PHS CEN @ 2013.2185  
 XYZ 493628.3129 -5191458.8667 3660321.4632 NEW ARP @ 2013.2185  
 XYZ 493628.3129 -5191458.8667 3660321.4632 NEW MON @ 2013.2185  
 LLH 35 14 46.29944 275 25 53.83936 198.2338 NEW L1 PHS CEN @ 2013.2185  
 LLH 35 14 46.29942 275 25 53.83938 198.2005 NEW ARP @ 2013.2185  
 LLH 35 14 46.29942 275 25 53.83938 198.2005 NEW MON @ 2013.2185

STATION NAME: p778 a 3 (MonteagleTN\_2008; Monteagle, TN USA)

MONUMENT: NO DOMES NUMBER

XYZ 380625.9293 -5201629.0811 3659995.4998 MON @ 2005.0000 (M)  
 XYZ -0.0138 -0.0006 0.0005 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 -0.1136 -0.0053 0.0039 VEL TIMES 8.2185 YRS  
 XYZ 0.0005 -0.0068 0.0048 MON TO ARP  
 XYZ 0.0058 -0.0693 0.0506 ARP TO L1 PHASE CENTER  
 XYZ 380625.8220 -5201629.1625 3659995.5591 L1 PHS CEN @ 2013.2185  
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ 380625.8220 -5201629.1625 3659995.5591 NEW L1 PHS CEN @ 2013.2185  
 XYZ 380625.8162 -5201629.0932 3659995.5086 NEW ARP @ 2013.2185  
 XYZ 380625.8157 -5201629.0864 3659995.5038 NEW MON @ 2013.2185  
 LLH 35 14 25.26303 274 11 6.43997 551.0305 NEW L1 PHS CEN @ 2013.2185  
 LLH 35 14 25.26299 274 11 6.43994 550.9445 NEW ARP @ 2013.2185  
 LLH 35 14 25.26299 274 11 6.43994 550.9362 NEW MON @ 2013.2185

STATION NAME: tn22 a 6 (TDOT District 22; Dunlap, Tennessee USA)

MONUMENT: 49450M001

XYZ 419473.1103 -5188697.5147 3673388.6509 MON @ 2005.0000 (M)  
 XYZ -0.0137 0.0017 0.0003 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0008 -0.0005 0.0334 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0000 -0.0008 0.0413 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1129 0.0138 0.0025 VEL TIMES 8.2185 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ 0.0017 -0.0267 0.0200 ARP TO L1 PHASE CENTER  
 XYZ 419472.9990 -5188697.5276 3673388.6734 L1 PHS CEN @ 2013.2185  
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ 419472.9990 -5188697.5276 3673388.6734 NEW L1 PHS CEN @ 2013.2185  
 XYZ 419472.9973 -5188697.5009 3673388.6534 NEW ARP @ 2013.2185  
 XYZ 419472.9973 -5188697.5009 3673388.6534 NEW MON @ 2013.2185  
 LLH 35 23 25.74399 274 37 19.00380 206.2279 NEW L1 PHS CEN @ 2013.2185  
 LLH 35 23 25.74396 274 37 19.00382 206.1945 NEW ARP @ 2013.2185  
 LLH 35 23 25.74396 274 37 19.00382 206.1945 NEW MON @ 2013.2185

REMOTE STATION INFORMATION

STATION NAME: 2\_\_ 1  
 MONUMENT: NO DOMES NUMBER  
 XYZ 418027.0292 -5215317.1021 3635902.0990 MON @ 2013.2182 (M)  
 NEU -0.0016 0.0005 1.5180 MON TO ARP (M)  
 NEU 0.0016 -0.0005 0.0634 ARP TO L1 PHASE CENTER (M)  
 NEU -0.0012 0.0002 0.0621 ARP TO L2 PHASE CENTER (M)  
 XYZ 0.1000 -1.2407 0.8688 MON TO ARP  
 XYZ 0.0036 -0.0509 0.0377 ARP TO L1 PHASE CENTER  
 XYZ 418027.1327 -5215318.3937 3635903.0055 L1 PHS CEN @ 2013.2185

BASELINE NAME: tn29 2\_\_  
 XYZ 0.1877 -0.7188 0.5456 + XYZ ADJUSTMENTS  
 XYZ 418027.3204 -5215319.1125 3635903.5512 NEW L1 PHS CEN @ 2013.2185  
 XYZ 418027.3169 -5215319.0616 3635903.5135 NEW ARP @ 2013.2185  
 XYZ 418027.2169 -5215317.8209 3635902.6446 NEW MON @ 2013.2185  
 LLH 34 58 37.68626 274 34 57.62518 200.3121 NEW L1 PHS CEN @ 2013.2185  
 LLH 34 58 37.68621 274 34 57.62520 200.2487 NEW ARP @ 2013.2185  
 LLH 34 58 37.68626 274 34 57.62518 198.7307 NEW MON @ 2013.2185

BASELINE NAME: p778 2\_\_  
 XYZ 0.1946 -0.7152 0.5433 + XYZ ADJUSTMENTS  
 XYZ 418027.3274 -5215319.1090 3635903.5488 NEW L1 PHS CEN @ 2013.2185  
 XYZ 418027.3238 -5215319.0581 3635903.5111 NEW ARP @ 2013.2185  
 XYZ 418027.2238 -5215317.8173 3635902.6423 NEW MON @ 2013.2185  
 LLH 34 58 37.68625 274 34 57.62546 200.3083 NEW L1 PHS CEN @ 2013.2185  
 LLH 34 58 37.68620 274 34 57.62548 200.2449 NEW ARP @ 2013.2185  
 LLH 34 58 37.68625 274 34 57.62546 198.7269 NEW MON @ 2013.2185

BASELINE NAME: tn22 2\_\_  
 XYZ 0.1956 -0.7154 0.5359 + XYZ ADJUSTMENTS  
 XYZ 418027.3283 -5215319.1091 3635903.5414 NEW L1 PHS CEN @ 2013.2185  
 XYZ 418027.3248 -5215319.0582 3635903.5037 NEW ARP @ 2013.2185  
 XYZ 418027.2248 -5215317.8175 3635902.6349 NEW MON @ 2013.2185  
 LLH 34 58 37.68605 274 34 57.62550 200.3043 NEW L1 PHS CEN @ 2013.2185  
 LLH 34 58 37.68600 274 34 57.62552 200.2409 NEW ARP @ 2013.2185  
 LLH 34 58 37.68605 274 34 57.62550 198.7229 NEW MON @ 2013.2185

G-FILES

Axx2013 321 13 321  
 B2013 3211536 13 32120 9 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090005 756010960 11 238589541 36 244188186 27 X0803A2\_\_X0803ATN29  
 D 1 2 -5011481 1 3 6574571 2 3 -9449412

Axx2013 321 13 321  
 B2013 3211536 13 32120 9 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090002 -374014081 9 136887309 29 240928615 18 X0803A2\_\_X0803AP778  
 D 1 2 -6702413 1 3 4442245 2 3 -9285657

Axx2013 321 13 321  
 B2013 3211536 13 32120 9 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090003 14457725 6 266203166 39 374860185 30 X0803A2\_\_X0803ATN22  
 D 1 2 -5764603 1 3 6006025 2 3 -8830089

POST-FIT RMS BY SATELLITE VS. BASELINE



```

OVERALL 01 06 09 11 12 14 15 16
tn29-2___| 0.012 0.019 ... .. 0.016 ... ..
          18 19 20 21 22 24 25 30 31
tn29-2___| 0.011 ... .. 0.013 0.009 0.012 0.014 0.015 0.012
          32
tn29-2___| 0.013

```

```

OVERALL 01 03 06 09 11 12 14 15
p778-2___| 0.011 0.016 ... .. 0.016 ... 0.012
          16 18 19 20 21 22 24 25 30
p778-2___| ... 0.009 ... .. 0.011 0.009 0.011 0.012 0.012
          31 32
p778-2___| 0.010 0.011

```

```

OVERALL 01 03 06 09 11 12 14 15
tn22-2___| 0.014 0.017 ... .. 0.018 ... 0.017
          16 18 19 20 21 22 24 25 30
tn22-2___| ... 0.011 ... .. 0.013 0.012 0.017 0.015 0.016
          31 32
tn22-2___| 0.016 0.015

```

#### OBS BY SATELLITE VS. BASELINE

```

OVERALL 01 06 09 11 12 14 15 16
tn29-2___| 2278 86 ... .. 167 ... ..
          18 19 20 21 22 24 25 30 31
tn29-2___| 314 ... .. 161 469 188 260 130 330
          32
tn29-2___| 173

```

```

OVERALL 01 03 06 09 11 12 14 15
p778-2___| 2654 84 ... .. 162 ... 86
          16 18 19 20 21 22 24 25 30
p778-2___| ... 379 ... .. 221 539 261 260 130
          31 32
p778-2___| 356 176

```

```

OVERALL 01 03 06 09 11 12 14 15
tn22-2___| 2582 84 ... .. 167 ... 85
          16 18 19 20 21 22 24 25 30
tn22-2___| ... 377 ... .. 219 537 259 267 86
          31 32
tn22-2___| 330 171

```

Covariance Matrix for the xyz OPUS Position (meters<sup>2</sup>).

```

0.0000006356 -0.0000001426 0.0000000735
-0.0000001426 0.00000086289 -0.0000005345
0.0000000735 -0.0000005345 0.0000004000

```

Covariance Matrix for the enu OPUS Position (meters<sup>2</sup>).

```

0.0000006639 0.0000003081 -0.0000003897
0.0000003081 0.00000049933 -0.00000019681
-0.0000003897 -0.00000019681 0.00000076072

```

Horizontal network accuracy = 0.00447 meters.

Vertical network accuracy = 0.00541 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)
TN29	0.00000	0.00000	0.00000
P778	0.00000	0.00000	0.00000
TN22	0.00000	0.00000	0.00000

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

	Xr(m)	Yr(m)	Zr(m)
TN29	0.00000	0.00000	0.00000
P778	0.00000	0.00000	0.00000
TN22	0.00000	0.00000	0.00000

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

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
TN29	0.00000	0.00000	0.00000
P778	0.00000	0.00000	0.00000
TN22	0.00000	0.00000	0.00000

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)
TN29	-418028.00000	5215319.28000	-3635902.77200
P778	-418028.00000	5215319.28000	-3635902.77200
TN22	-418028.00000	5215319.28000	-3635902.77200

STATE PLANE COORDINATES - U.S. Survey Foot

SPC (1002 GA W)	
Northing (Y) [feet]	1812993.133
Easting (X) [feet]	1921934.335
Convergence [degrees]	-0.71701323
Point Scale	1.00006067
Combined Factor	1.00002927

\*\* 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: 228.969 (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.

# SD3 OPUS Solution

**From:** [opus](#)  
**To:** [Tony DiMarino](#)  
**Subject:** OPUS solution : 3\_\_0800.13o OP1366303584936  
**Date:** Thursday, April 18, 2013 12:47:49 PM

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FILE: 3\_\_0800.13o OP1366303584936

## NGS OPUS SOLUTION REPORT =====

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

USER: Tony.DiMarino@Cardno.com                      DATE: April 18, 2013  
RINEX FILE: 3\_\_080p.13o                                TIME: 16:47:18 UTC

SOFTWARE: page5 1209.04 master3.pl 0821123    START: 2013/03/21 15:25:00  
EPHEMERIS: igs17324.eph [precise]            STOP: 2013/03/21 20:04:00  
NAV FILE: brdc0800.13n                        OBS USED: 8016 / 9343 : 86%  
ANT NAME: LEIAX1202GG    NONE            # FIXED AMB: 44 / 50 : 88%  
ARP HEIGHT: 1.584                            OVERALL RMS: 0.013(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)            IGS08 (EPOCH:2013.2185)

X:	418127.335(m)	0.019(m)	418126.557(m)	0.019(m)
Y:	-5215231.429(m)	0.016(m)	-5215229.968(m)	0.016(m)
Z:	3636023.680(m)	0.026(m)	3636023.549(m)	0.026(m)

LAT:	34 58 42.35740	0.011(m)	34 58 42.38216	0.011(m)
E LON:	274 35 1.83174	0.018(m)	274 35 1.80577	0.018(m)
W LON:	85 24 58.16826	0.018(m)	85 24 58.19423	0.018(m)
EL HGT:	204.110(m)	0.029(m)	202.790(m)	0.029(m)
ORTHO HGT:	233.422(m)	0.051(m)	[NAVD88 (Computed using GEOID12A)]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 16)	SPC (1002 GA W)
Northing (Y) [meters]	3871797.020	552744.797
Easting (X) [meters]	644572.493	585914.599
Convergence [degrees]	0.90812351	-0.71637065
Point Scale	0.99985760	1.00006036
Combined Factor	0.99982557	1.00002832

US NATIONAL GRID DESIGNATOR: 16SFD4457271797(NAD 83)

BASE STATIONS USED			
PID	DESIGNATION	LATITUDE	LONGITUDE DISTANCE(m)
P778			46539.7
TN25			82567.2
TN22			45846.9

NEAREST NGS PUBLISHED CONTROL POINT			
EE1520	C 392	N345839.1 W0852503.1	160.5

BASE STATION INFORMATION

STATION NAME: p778 a 3 (MonteagleTN\_2008; Monteagle, TN USA)

MONUMENT: NO DOMES NUMBER

XYZ 380625.9293 -5201629.0811 3659995.4998 MON @ 2005.0000 (M)  
 XYZ -0.0138 -0.0006 0.0005 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 -0.1136 -0.0053 0.0039 VEL TIMES 8.2185 YRS  
 XYZ 0.0005 -0.0068 0.0048 MON TO ARP  
 XYZ 0.0058 -0.0693 0.0506 ARP TO L1 PHASE CENTER  
 XYZ 380625.8220 -5201629.1625 3659995.5591 L1 PHS CEN @ 2013.2185  
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ 380625.8220 -5201629.1625 3659995.5591 NEW L1 PHS CEN @ 2013.2185  
 XYZ 380625.8162 -5201629.0932 3659995.5086 NEW ARP @ 2013.2185  
 XYZ 380625.8157 -5201629.0864 3659995.5038 NEW MON @ 2013.2185  
 LLH 35 14 25.26303 274 11 6.43997 551.0305 NEW L1 PHS CEN @ 2013.2185  
 LLH 35 14 25.26300 274 11 6.43994 550.9445 NEW ARP @ 2013.2185  
 LLH 35 14 25.26300 274 11 6.43994 550.9362 NEW MON @ 2013.2185

STATION NAME: tn25 a 6 (TDOT District 25; Tullahoma, Tennessee USA)

MONUMENT: NO DOMES NUMBER

XYZ 346089.3334 -5195693.1406 3671326.1282 MON @ 2005.0000 (M)  
 XYZ -0.0126 0.0001 0.0009 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0008 -0.0005 0.0334 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0000 -0.0008 0.0413 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1035 0.0012 0.0077 VEL TIMES 8.2185 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ 0.0013 -0.0267 0.0199 ARP TO L1 PHASE CENTER  
 XYZ 346089.2311 -5195693.1662 3671326.1559 L1 PHS CEN @ 2013.2185  
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ 346089.2311 -5195693.1661 3671326.1559 NEW L1 PHS CEN @ 2013.2185  
 XYZ 346089.2298 -5195693.1394 3671326.1359 NEW ARP @ 2013.2185  
 XYZ 346089.2298 -5195693.1394 3671326.1359 NEW MON @ 2013.2185  
 LLH 35 22 1.47446 273 48 39.19516 301.3574 NEW L1 PHS CEN @ 2013.2185  
 LLH 35 22 1.47443 273 48 39.19517 301.3240 NEW ARP @ 2013.2185  
 LLH 35 22 1.47443 273 48 39.19517 301.3240 NEW MON @ 2013.2185

STATION NAME: tn22 a 6 (TDOT District 22; Dunlap, Tennessee USA)

MONUMENT: 49450M001

XYZ 419473.1103 -5188697.5147 3673388.6509 MON @ 2005.0000 (M)  
 XYZ -0.0137 0.0017 0.0003 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0008 -0.0005 0.0334 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0000 -0.0008 0.0412 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1129 0.0138 0.0025 VEL TIMES 8.2185 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ 0.0017 -0.0267 0.0200 ARP TO L1 PHASE CENTER  
 XYZ 419472.9990 -5188697.5276 3673388.6734 L1 PHS CEN @ 2013.2185  
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ 419472.9990 -5188697.5276 3673388.6734 NEW L1 PHS CEN @ 2013.2185  
 XYZ 419472.9973 -5188697.5009 3673388.6534 NEW ARP @ 2013.2185  
 XYZ 419472.9973 -5188697.5009 3673388.6534 NEW MON @ 2013.2185  
 LLH 35 23 25.74399 274 37 19.00380 206.2279 NEW L1 PHS CEN @ 2013.2185  
 LLH 35 23 25.74396 274 37 19.00382 206.1945 NEW ARP @ 2013.2185  
 LLH 35 23 25.74396 274 37 19.00382 206.1945 NEW MON @ 2013.2185

REMOTE STATION INFORMATION

STATION NAME: 3\_\_ 1  
 MONUMENT: NO DOMES NUMBER  
 XYZ 418126.3429 -5215229.0150 3636022.9211 MON @ 2013.2182 (M)  
 NEU -0.0016 0.0005 1.5840 MON TO ARP (M)  
 NEU 0.0016 -0.0005 0.0634 ARP TO L1 PHASE CENTER (M)  
 NEU -0.0012 0.0002 0.0621 ARP TO L2 PHASE CENTER (M)  
 XYZ 0.1043 -1.2946 0.9067 MON TO ARP  
 XYZ 0.0036 -0.0509 0.0377 ARP TO L1 PHASE CENTER  
 XYZ 418126.4508 -5215230.3605 3636023.8655 L1 PHS CEN @ 2013.2185

BASELINE NAME: p778 3\_\_  
 XYZ 0.2153 -0.9570 0.6320 + XYZ ADJUSTMENTS  
 XYZ 418126.6661 -5215231.3175 3636024.4975 NEW L1 PHS CEN @ 2013.2185  
 XYZ 418126.6625 -5215231.2666 3636024.4598 NEW ARP @ 2013.2185  
 XYZ 418126.5582 -5215229.9720 3636023.5531 NEW MON @ 2013.2185  
 LLH 34 58 42.38219 274 35 1.80580 204.4433 NEW L1 PHS CEN @ 2013.2185  
 LLH 34 58 42.38214 274 35 1.80582 204.3799 NEW ARP @ 2013.2185  
 LLH 34 58 42.38219 274 35 1.80580 202.7959 NEW MON @ 2013.2185

BASELINE NAME: tn25 3\_\_  
 XYZ 0.2226 -0.9594 0.6387 + XYZ ADJUSTMENTS  
 XYZ 418126.6734 -5215231.3199 3636024.5042 NEW L1 PHS CEN @ 2013.2185  
 XYZ 418126.6698 -5215231.2690 3636024.4665 NEW ARP @ 2013.2185  
 XYZ 418126.5655 -5215229.9744 3636023.5598 NEW MON @ 2013.2185  
 LLH 34 58 42.38232 274 35 1.80608 204.4496 NEW L1 PHS CEN @ 2013.2185  
 LLH 34 58 42.38226 274 35 1.80610 204.3862 NEW ARP @ 2013.2185  
 LLH 34 58 42.38232 274 35 1.80608 202.8022 NEW MON @ 2013.2185

BASELINE NAME: tn22 3\_\_  
 XYZ 0.2035 -0.9437 0.6130 + XYZ ADJUSTMENTS  
 XYZ 418126.6542 -5215231.3042 3636024.4785 NEW L1 PHS CEN @ 2013.2185  
 XYZ 418126.6507 -5215231.2533 3636024.4408 NEW ARP @ 2013.2185  
 XYZ 418126.5464 -5215229.9587 3636023.5341 NEW MON @ 2013.2185  
 LLH 34 58 42.38195 274 35 1.80538 204.4208 NEW L1 PHS CEN @ 2013.2185  
 LLH 34 58 42.38190 274 35 1.80540 204.3574 NEW ARP @ 2013.2185  
 LLH 34 58 42.38195 274 35 1.80538 202.7734 NEW MON @ 2013.2185

G-FILES

Axx2013 321 13 321  
 B2013 3211525 13 32120 4 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090002 -375007425 9 136008856 32 239719506 20 X0803A3\_\_X0803AP778  
 D 1 2 -6541207 1 3 4534661 2 3 -9401416

Axx2013 321 13 321  
 B2013 3211525 13 32120 4 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090001 -720373357 12 195368350 41 353025761 26 X0803A3\_\_X0803ATN25  
 D 1 2 -6174170 1 3 4542242 2 3 -9484122

Axx2013 321 13 321  
 B2013 3211525 13 32120 4 1 page5 v1209.04IGS 126 1 2 27NGS 2013 418IFDDPX  
 IIGS08\_1735 IGS 20130407  
 C00090003 13464510 6 265324578 36 373651193 26 X0803A3\_\_X0803ATN22  
 D 1 2 -4307145 1 3 4483450 2 3 -8775597

POST-FIT RMS BY SATELLITE VS. BASELINE

	OVERALL	01	03	06	09	11	12	14	15	
p778-3___		0.011	0.016	...	...	...	...	0.021	...	0.014
		16	18	19	20	21	22	24	25	30
p778-3___		...	0.009	...	...	0.012	0.007	0.011	0.011	0.016
		31	32							
p778-3___		0.008	0.013							

	OVERALL	01	03	06	09	11	12	14	15	
tn25-3___		0.015	0.023	...	...	...	...	0.023	...	0.016
		16	18	19	20	21	22	24	25	30
tn25-3___		...	0.010	...	...	0.015	0.009	0.016	0.017	0.018
		31	32							
tn25-3___		0.017	0.017							

	OVERALL	01	03	06	09	11	12	14	15	
tn22-3___		0.013	...	...	...	...	...	0.023	...	0.017
		16	18	19	20	21	22	24	25	30
tn22-3___		...	0.009	...	...	0.012	0.010	0.012	0.017	0.015
		31	32							
tn22-3___		0.013	0.014							

OBS BY SATELLITE VS. BASELINE

	OVERALL	01	03	06	09	11	12	14	15	
p778-3___		2775	35	...	...	...	...	263	...	92
		16	18	19	20	21	22	24	25	30
p778-3___		...	431	...	...	240	540	264	320	111
		31	32							
p778-3___		337	142							

	OVERALL	01	03	06	09	11	12	14	15	
tn25-3___		2584	35	...	...	...	...	246	...	71
		16	18	19	20	21	22	24	25	30
tn25-3___		...	408	...	...	212	541	243	303	35
		31	32							
tn25-3___		349	141							

	OVERALL	01	03	06	09	11	12	14	15	
tn22-3___		2657	...	...	...	...	...	258	...	103
		16	18	19	20	21	22	24	25	30
tn22-3___		...	427	...	...	204	539	259	313	76
		31	32							
tn22-3___		340	138							

Covariance Matrix for the xyz OPUS Position (meters<sup>2</sup>).

0.0000005800	-0.0000001300	0.0000000652
-0.0000001300	0.0000088911	-0.0000005409
0.0000000652	-0.0000005409	0.0000038933

Covariance Matrix for the enu OPUS Position (meters<sup>2</sup>).

0.0000006124	0.0000003224	-0.0000004259
0.0000003224	0.0000050002	-0.0000021371
-0.0000004259	-0.0000021371	0.0000077518

Horizontal network accuracy = 0.00446 meters.

Vertical network accuracy = 0.00546 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)
P778	0.00000	0.00000	0.00000
TN25	0.00000	0.00000	0.00000
TN22	0.00000	0.00000	0.00000

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

	Xr(m)	Yr(m)	Zr(m)
P778	0.00000	0.00000	0.00000
TN25	0.00000	0.00000	0.00000
TN22	0.00000	0.00000	0.00000

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

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
P778	0.00000	0.00000	0.00000
TN25	0.00000	0.00000	0.00000
TN22	0.00000	0.00000	0.00000

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)
P778	-418127.33500	5215231.42900	-3636023.68000
TN25	-418127.33500	5215231.42900	-3636023.68000
TN22	-418127.33500	5215231.42900	-3636023.68000

STATE PLANE COORDINATES - U.S. Survey Foot

SPC (1002 GA W)	
Northing (Y) [feet]	1813463.555
Easting (X) [feet]	1922288.147
Convergence [degrees]	-0.71637065
Point Scale	1.00006036
Combined Factor	1.00002832

\*\* 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: 233.035 (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.

