

National Geodetic Survey

# NGS Activities Update

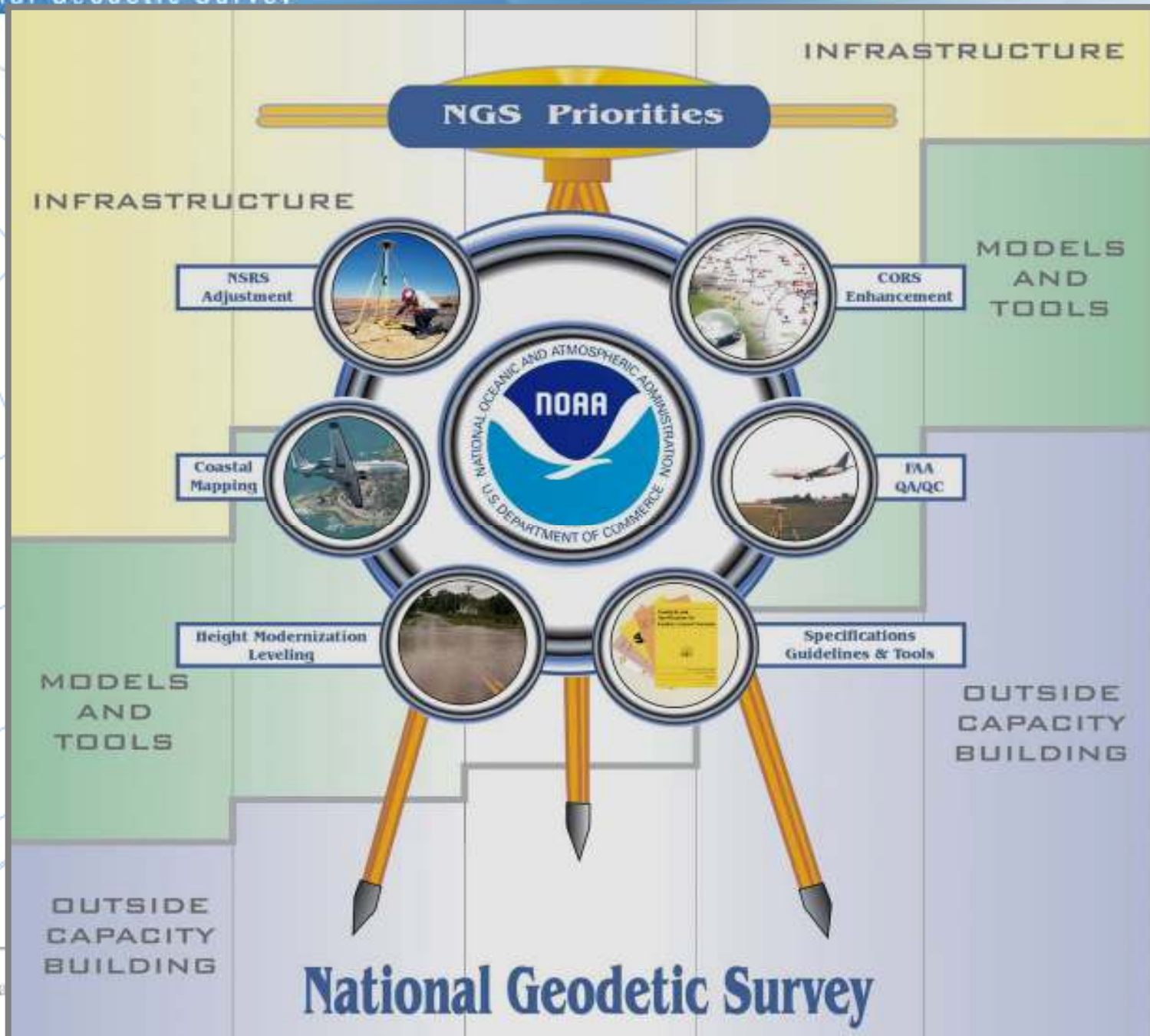
## NGS Products and Services, Ongoing and Future Initiatives

**Daniel J. Martin**  
**National Geodetic Survey**  
**VT Geodetic Advisor**

**Maine Society of Land Surveyors**  
**January 25, 2008**



National Oceanic and Atmospheric Administration



# NATIONAL READJUSTMENT NAD 83 (NSRS2007)

- **WHAT?**

- **WHY**
- **HOW**
- **WHEN**
- **POST**



# NATIONAL SPATIAL REFERENCE SYSTEM

- **A component of the National Spatial Data Infrastructure (NSDI) -**  
<http://www.fgdc.gov/nsdi/nsdi.html>
- **Contains all geodetic control contained in the National Geodetic Survey (NGS) Integrated Data Base:**
  - **Horizontal and vertical control points**
  - **Geoid models such as GEOID 03**
  - **Gravity**
  - **Precise GPS orbits**
  - **Continuously Operating Reference Stations (CORS)**
  - **National Shoreline data as observed by NGS**
  - **Standards and Specifications for data submittal**



# NATIONAL READJUSTMENT

WHAT

**WHY?**

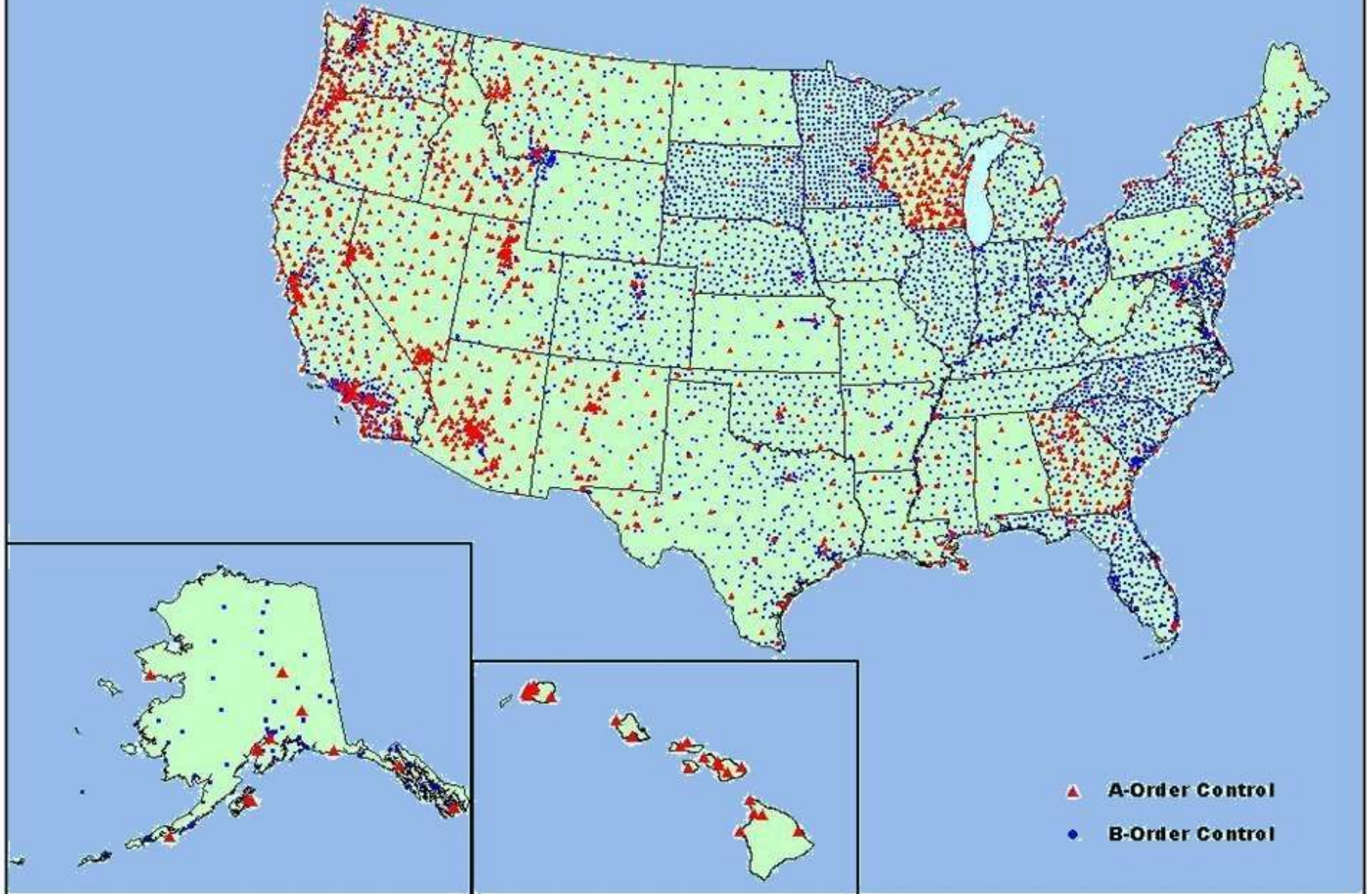
HOW

WHEN

POST

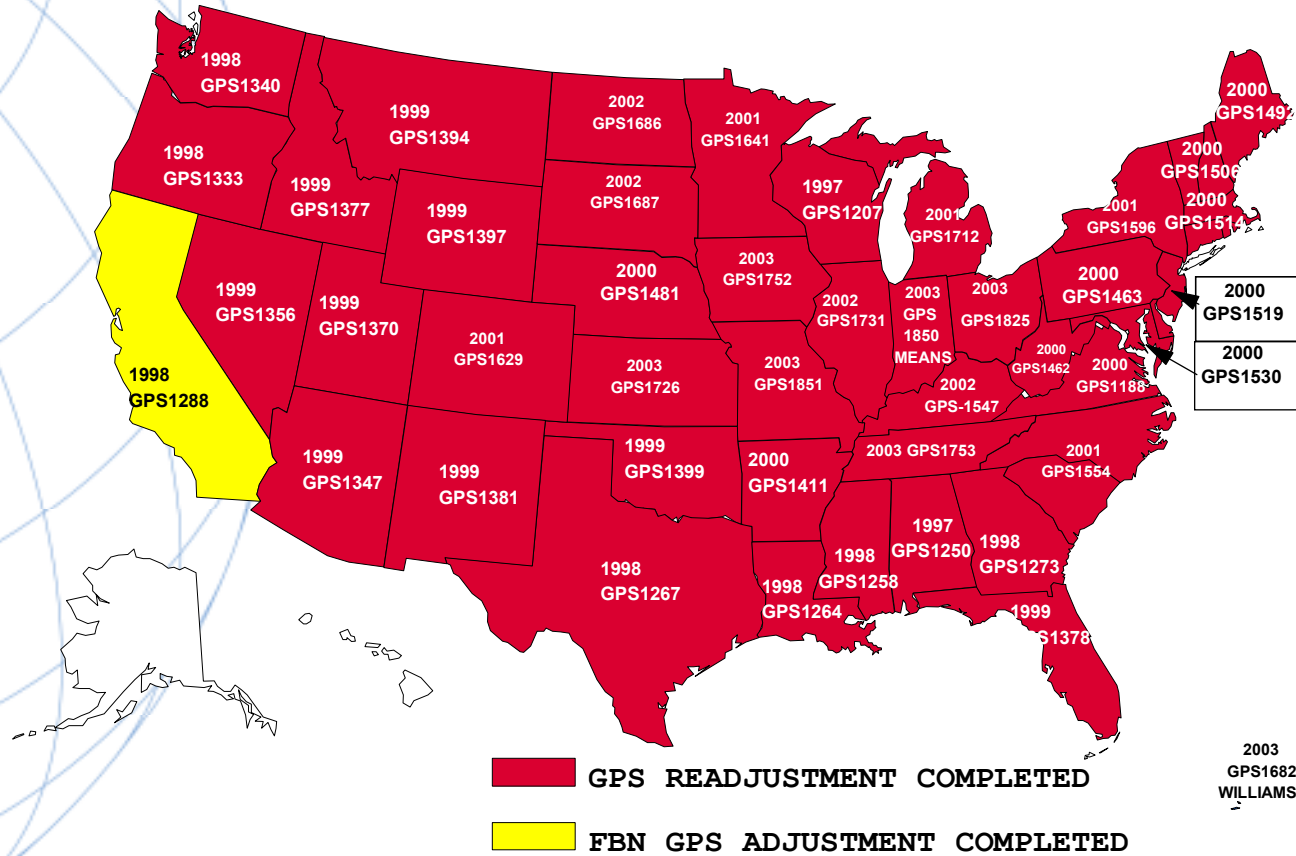


# U.S. HARN





# FBN/CBN SURVEYS



# Reasons for Readjustment

- **Multiple epoch dates**
- **Inconsistencies between states**
- **Need to be Consistent with CORS**
- **Compute Network and Local accuracies**

**September 24, 2003 NGS Executive Steering Committee approved a plan for the readjustment of the horizontal positions and ellipsoid heights for GPS stations in the contiguous United States.**

**Orthometric Height adjustment will not be attempted**



# NATIONAL READJUSTMENT

WHAT

WHY

**HOW?**

WHEN

POST



# NGS Adjustment Team (2005)



# **NAD 83 READJUSTMENT**

**ONLY GPS DATA WAS USED**

**CONTINUOUSLY OPERATING  
REFERENCE STATIONS**

**FEDERAL BASE NETWORK**

**COOPERATIVE BASE NETWORK**

**USER DENSIFICATION NETWORK**

**AIRPORT SURVEYS**



# Network Accuracy

- **Network accuracy of a control point**
  - **A value that represents the uncertainty of its coordinates with respect to the geodetic datum at the 95-percent confidence level**
  - **Datum is considered to be best expressed by the Continuous Operating Reference Stations (CORS)**
- **Local and Network accuracy values at CORS sites are considered to be infinitesimal (approach zero)**
- **These accuracies will be implemented with the National Readjustment**



# Local Accuracy

- **Local Accuracy of a control point:**
  - **A value that represents the uncertainty of its coordinates relative to other directly connected, adjacent control points at the 95-percent confidence level**
  - **An approximate average of the individual local accuracy values between this control point and other observed control points used to establish its coordinates**



## **AVERAGE SHIFTS USA Wide**

- **Based on the final adjusted results from the original published positions and ellipsoid heights**

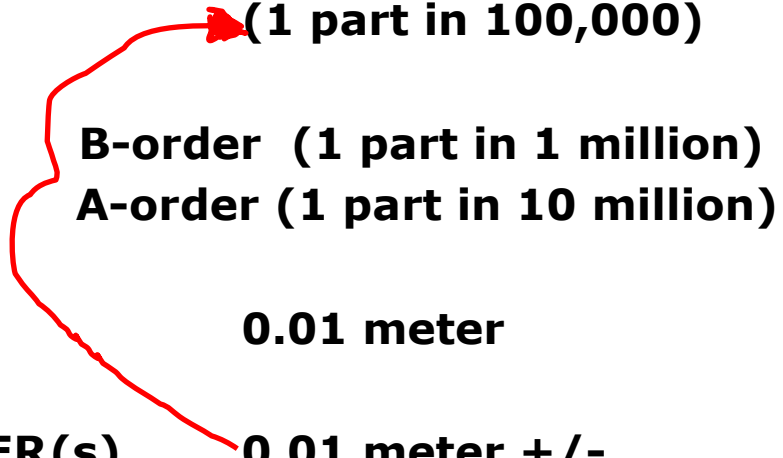
**< Average horizontal shift: 2.5 cm.**

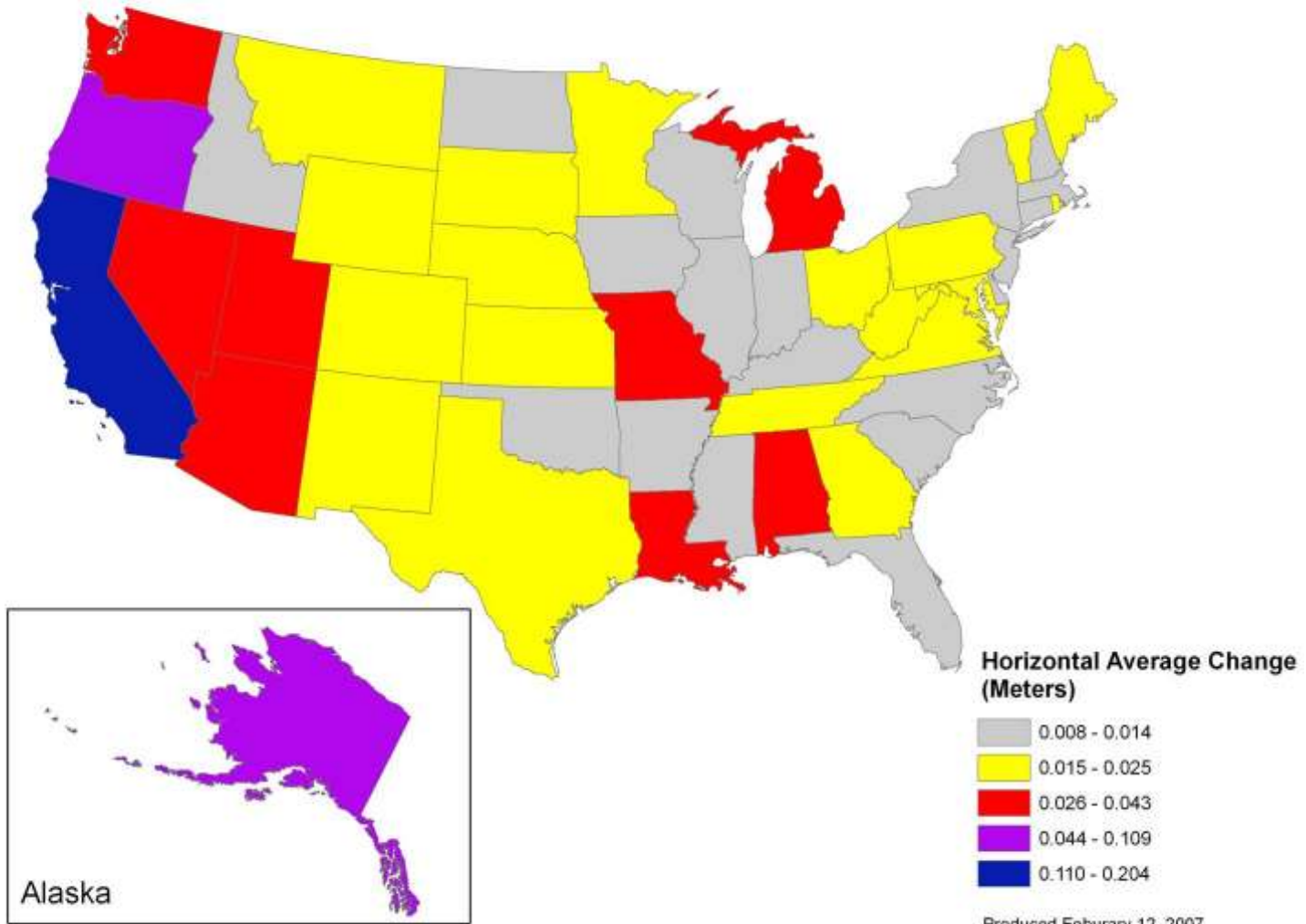
**< Average ellipsoid height shift: 2.7 cm.**



# Improving Positional Accuracy

<b>NETWORK</b>	<b>TIME SPAN</b>	<b>NETWORK ACCURACY</b>	<b>LOCAL ACCURACY</b>
<b>NAD 27</b>	<b>1927-1986</b>	<b>10 METERS</b>	<b>(1 part in 100,000)</b>
<b>NAD83(86)</b>	<b>1986-1990</b>	<b>1 METER</b>	<b>(1 part in 100,000)</b>
<b>HARN</b>	<b>1990-2007</b>	<b>0.1 METER</b>	<b>B-order (1 part in 1 million) A-order (1 part in 10 million)</b>
<b>CORS</b>	<b>1996 -</b>	<b>0.01 METER</b>	<b>0.01 meter</b>
<b>NAD83(2007)</b>	<b>2007-</b>	<b>0.01-??? METER(s)</b>	<b>0.01 meter +/-</b>





# FINAL STATISTICS (ME)

## Free adjustment

**No. of Stations = 446**  
**No. of rejected vectors = 132**  
**Standard error of unit weight = 1.03**

## Constrained adjustment

**No. of Stations = 446**  
**No. of rejected vectors = 132**  
**Min Horz Shift = 0.000 (m)**  
**Max Horz Shift = 0.056 (m)**  
**Ave Horz Shift = 0.017 (m)**  
**Min Vert Shift = 0.000 (m)**  
**Max Vert Shift = 0.131 (m)**  
**Ave Vert Shift = 0.010 (m)**  
**Standard error of unit weight = 1.03**



# NATIONAL READJUSTMENT

WHAT

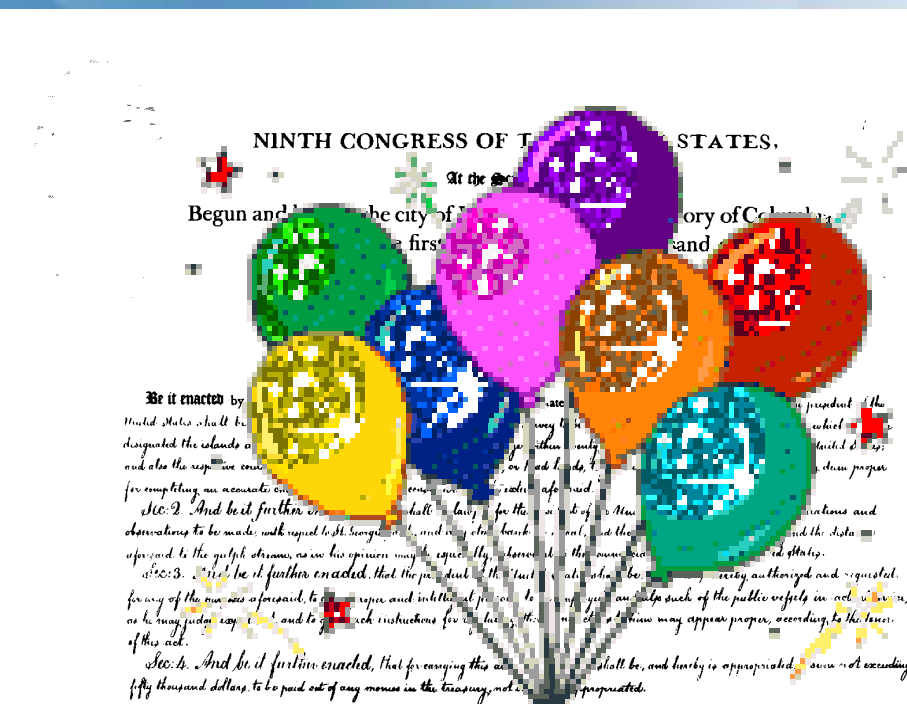
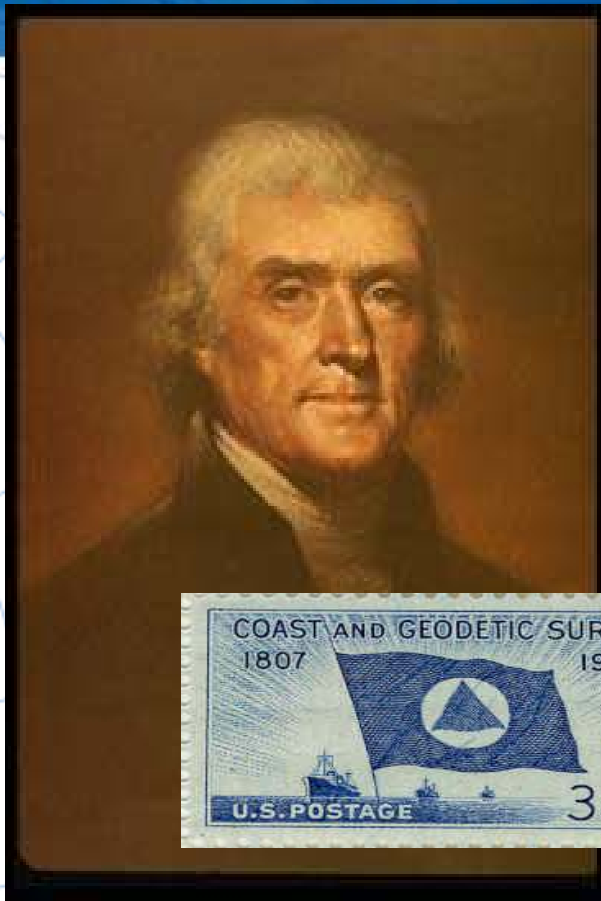
WHY

HOW

**WHEN?**

POST





*Mathew* Speaker of the House of Representatives  
*John* Vice President of the United States, and President of the Senate

February 10, 1807  
 1807

*Happy Birthday*

*John Quincy Adams*



# NATIONAL READJUSTMENT

WHAT

WHY

HOW

WHEN

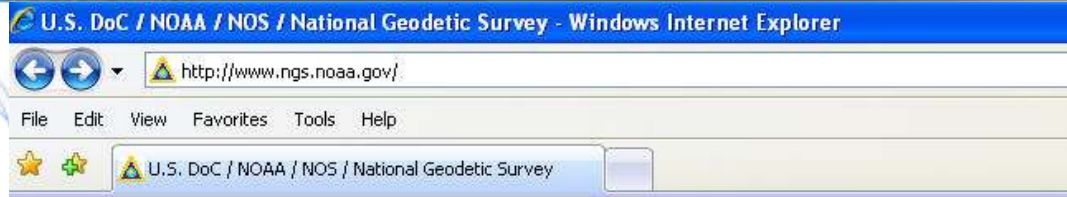
**POST?**



## Readjustment Implementation Team

- Recently formed to work out the details
  - Datasheets
  - Implementing accuracies (new projects)
  - Education
  - Future adjustments








U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
National Ocean Service

NGS, Positioning America for the Future

Search for

Go

- [aeronautical data](#)
- [CORS / OPUS GPS data](#)
- [datasheets](#)
- [geodetic tool kit](#)
- [download software](#)

Tuesday, January 15, 2008

• **Upcoming Events**

*Check these out...*

**UPDATE! 12/20/2007 - NGS announces the release of the GRAV-D project plan** The GRAV-D project is an ambitious proposal to collect the necessary gravity data over the United States which supports the re-definition of the vertical datum by 2017, as described in the NGS 10 year plan. Click [here](#) for details.

**UPDATE! 11/15/2007 - Data sheet modifications for the NAD 83 (NSRS2007) coordinates** The following modifications to the data sheets have been implemented ... [more](#)

**UPDATE! Webpage for Corbin Training Center Launched** NGS has established a training center in Corbin, VA. The mission of the Corbin Training Center is to provide high quality training to improve the geodetic positioning capacity of partners internal as well as external to NOAA, and to increase the knowledge and skills of NGS employees.



The NGS Geodetic Tool Kit - Windows Internet Explorer

http://www.ngs.noaa.gov/TOOLS/

The NGS Geodetic Tool Kit

### NGS Geodetic Tool Kit

on-line interactive computation of geodetic values

See the text version of an [article](#) about the NGS Geodetic Toolkit that appeared in the *Professional Surveyor* magazine, May 2003 Volume 23, Number 4

( [See all the Professional Surveyor Articles about the NGS Geodetic Toolkit](#) )

To learn more about a particular online program, click on its link for a description:

<a href="#">DEFLEC99</a>	<a href="#">LVL_DH</a>	<a href="#">Surface Gravity Prediction</a>
<a href="#">DYNAMIC_HT</a>	<a href="#">Magnetic Declination</a>	<a href="#">Tidal and Orthometric Elevations</a>
<a href="#">G99SSS</a>	<a href="#">NADCON</a>	<a href="#">U.S. National Grid</a>
<a href="#">GEOD99</a>	<a href="#">NAVD 88 Modelled Geoids</a>	<a href="#">Universal Transverse Mercator Coordinates</a>
<a href="#">GEOD01</a>	<a href="#">Online Adjustment User Services</a>	<a href="#">VERTCON</a>
<a href="#">GEOD96</a>	<a href="#">Online Adjustment Utilities User Services</a>	<a href="#">XYZ Coordinate Conversion</a>
<a href="#">USG02003</a>	<a href="#">OPCS</a>	
<a href="#">HTDP</a>	<a href="#">State Plane Coordinates</a>	
<a href="#">KLD91</a>		
<a href="#">Inverse Forward Inverse 3D Forward ID</a>		

**Geoid 06 March**

OR... Know what you want to do?  
Select a function from this list:

SELECT A TOOLKIT SHORTCUT

For more information contact NGS Information Services:  
by [e-mail](#),  
or call (301) 713-3242, Monday - Friday, 7:00 AM - 4:30 PM eastern time.



Download PC Software from NGS - Windows Internet Explorer

http://www.ngs.noaa.gov/PC\_PROD/pc\_prod.shtml

File Edit View Favorites Tools Help

Download PC Software from NGS



## Download NGS PC Software



download free geodetic software developed by NGS

[ADJUST AND UTILITIES](#)

- [CALIBRAT](#)
- [CARIB97](#)
- [COMPGB](#)
- [COMPVECS](#)
- [CORPSCON](#)
- [CR8BB](#)
- [CR8SER](#)
- [DCAR97](#)
- [DEFLEC99](#)
- [DMEX97](#)

- [DSWIN](#)
- [DSFILES](#)
- [DSUPDATE](#)
- [ENHANCEMENTS](#)
- [G99SSS](#)
- [GEOID99](#)
- [GEOID03](#)
- [Gethv1st](#)
- [USGG2003](#)
- [GPPCGP](#)
- [HTDP](#)

- [INTERORB](#)
- [INV/FWD3D](#)
- [LOOP](#)
- [LVL\\_DH](#)
- [MEXICO97](#)
- [MTEN4](#)
- [NA2VBBK](#)
- [NADCON](#)
- [PCVOBS](#)
- [PROMPTER](#)

- [SPCS83](#)
- [TOLADD](#)
- [Translev](#)
- [USNG](#)
- [UTMS](#)
- [VDatum](#)
- [VERTCON](#)
- [VFPROC](#)
- [WDDPROC](#)
- [WinDesc](#)
- [XYZWIN](#)

[Software Download FAQ](#) | [Manuals](#)

Extra!! [User-Contributed Software is also available to perform related functions](#)




# National Geodetic Survey

NGS DATASHEET PAGE - Windows Internet Explorer

HTTP://www.ngs.noaa.gov/cgi-bin/datasheet.pl

File Edit View Favorites Tools Help

NGS DATASHEET DATASHEET PAGE

NGS DATASHEET PAGE  updated: 01/30/08 14:19:45

This page is maintained by [NGS Software Requests](#)

Part of the [mission](#) of the [National Geodetic Survey](#), is to provide the public with survey control information, such as *Latitude, Longitude, Height and Gravity Data*. This is done for [publishable](#) stations in the form of DATASHEETS.

Click [here](#) to see what a DATASHEET looks like. (or check out the *Tell me more...* link below)

Last change to datasheet format was made on [10/01/07](#).

Click [here](#) for information about the similarities and differences between NAD83(NSRS2007) and NAD 83(CORS96)

Retrieval Links	Info Links
<a href="#">DATASHEETS</a>	<a href="#">Tell me more about DATASHEETS</a>
<a href="#">ShapeFiles</a>	<a href="#">Tell me more about ShapeFiles</a>
<a href="#">SOTS</a>	<a href="#">Tell me more about SOTS</a>
<a href="#">TIDAL BENCHMARK</a>	<a href="#">Tell me more about TIDAL BENCH MARKS</a>
<a href="#">ARCHIVED DATASHEETS</a>	<a href="#">Tell me more about ARCHIVED DATASHEETS</a>
<small>PointData: generated: 10/10/08</small>	
<small>PointData: generated: 10/10/08</small>	
<small>2000 PointData: generated: 10/10/08</small>	
<small>2000 PointData: generated: 10/10/08</small>	
<small>2000 Data (except for NS) generated: 10/10/08</small>	



NGS DATASHEET RETRIEVAL PAGE - Windows Internet Explorer

http://www.ngs.noaa.gov/cgi-bin/datasheet.cgi

File Edit View Favorites Tools Help

NGS DATASHEET RETRIEVAL PAGE

NGS DATASHEET RETRIEVAL PAGE

This page is maintained by [NGS Software Requests](#) updated 01/30/08 14:39:45

[Tell me more about DATASHEET](#)

---

**Retrieval Methods**

- [PIDs](#) - Permanent Identifiers
- [CORS SiteID](#) - CORS Site IDs
- [Radial Search](#) - provide center coordinates and radius in Miles
- [Rectangular Search](#) - provide min/max coordinates
- [Station Name](#)
- [Project Identifier](#)
- [USGS Quad](#)
- [COUNTY](#)
- [Load Date](#)
- [Map Search](#) - Interactive MAP retrieval

---

**Determine if a control point [is publishable](#)**

---

[Return to DATASHEET PAGE](#)   [Return to NGS HOME PAGE](#)



The NGS Data Sheet See file dsdata.txt for more information about the datasheet. DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.58

1 National Geodetic Survey, Retrieval Date = JANUARY 14, 2008

PE1052

\*\*\*\*\*

PE1052 DESIGNATION - Y 151  
 PE1052 PID - PE1052  
 PE1052 STATE/COUNTY- ME/KNOX  
 PE1052 USGS QUAD - ROCKLAND (1979)  
 PE1052  
 PE1052 \*CURRENT SURVEY CONTROL  
 PE1052

$H = h - N$   
 $18.581 = -6.509 - (-25.11)$   
 $18.581 \neq 18.601$

PE1052\* NAD 83(2007)- 44 03 38.27673(N) 069 05 36.90789(W) ADJUSTED  
 PE1052\* NAVD 88 - 18.581 (meters) 60.96 (feet) ADJUSTED  
 PE1052

PE1052 EPOCH DATE - 2002.00  
 PE1052 X - 1,638,189.075 (meters) COMP  
 PE1052 Y - -4,288,552.412 (meters) COMP  
 PE1052 Z - 4,412,930.830 (meters) COMP  
 PE1052 LAPLACE CORR- 2.88 (seconds) DEFLEC99  
 PE1052 ELLIP HEIGHT- -6.509 (meters) (02/10/07) ADJUSTED  
 PE1052 GEOID HEIGHT- -25.11 (meters) GEOID03  
 PE1052 DYNAMIC HT - 18.580 (meters) 60.96 (feet) COMP



PE1052

PE1052 ----- Accuracy Estimates (at 95% Confidence Level in cm) -----

PE1052 Type PID Designation North East Ellip

PE1052	NETWORK PE1052 Y 151	1.06	0.55	1.57
--------	----------------------	------	------	------

PE1052 MODELED GRAV- 980,530.9 (mgal) NAVD 88

PE1052 VERT ORDER - SECOND CLASS 0

PE1052

PE1052.This mark is at Knox Co Regional Airport (RKD)

PE1052

PE1052.The horizontal coordinates were established by GPS observations and adjusted by the National Geodetic Survey in February 2007.

PE1052

PE1052.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007). See National Readjustment for more information. The horizontal coordinates are valid at the epoch date displayed above. The epoch date for horizontal control is a decimal equivalence of Year/Month/Day.

PE1052

PE1052.The orthometric height was determined by differential leveling and adjusted in June 1991.

PE1052

PE1052.The X, Y, and Z were computed from the position and the ellipsoidal ht.

PE1052

PE1052.The Laplace correction was computed from DEFLEC99 derived deflections.



**PE1052**

**PE1052.The ellipsoidal height was determined by GPS observations  
PE1052.and is referenced to NAD 83.**

**PE1052**

**PE1052.The geoid height was determined by GEOID03.**

**PE1052**

**PE1052.The dynamic height is computed by dividing the NAVD 88  
PE1052.geopotential number by the normal gravity value computed on the  
PE1052.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45  
PE1052.degrees latitude (g = 980.6199 gals.).**

**PE1052**

**PE1052.The modeled gravity was interpolated from observed gravity values.**

**PE1052**

<b>PE1052;</b>	<b>North</b>	<b>East</b>	<b>Units</b>	<b>Scale Factor</b>	<b>Converg.</b>
<b>PE1052;SPC ME E</b>	<b>- 43,940.306</b>	<b>252,444.002</b>	<b>MT</b>	<b>0.99992781</b>	<b>-0 24 46.1</b>
<b>PE1052;SPC ME E</b>	<b>- 144,160.82</b>	<b>828,226.70</b>	<b>sFT</b>	<b>0.99992781</b>	<b>-0 24 46.1</b>
<b>PE1052;UTM 19</b>	<b>- 4,878,611.443</b>	<b>492,504.509</b>	<b>MT</b>	<b>0.99960069</b>	<b>-0 03 54.3</b>

**PE1052**

<b>PE1052!</b>	<b>- Elev Factor x Scale Factor = Combined Factor</b>
<b>PE1052!SPC ME E</b>	<b>- 1.00000102 x 0.99992781 = 0.99992883</b>
<b>PE1052!UTM 19</b>	<b>- 1.00000102 x 0.99960069 = 0.99960171</b>

**PE1052**

**PE1052**

**SUPERSEDED SURVEY CONTROL**

**PE1052**

<b>PE1052</b>	<b>ELLIP H (02/06/02)</b>	<b>-6.521 (m)</b>	<b>GP( ) 4 2</b>
<b>PE1052</b>	<b>NAD 83(1996)-</b>	<b>44 03 38.27729(N)</b>	<b>069 05 36.90764(W) AD( ) 1</b>
<b>PE1052</b>	<b>ELLIP H (06/17/97)</b>	<b>-6.550 (m)</b>	<b>GP( ) 4 2</b>
<b>PE1052</b>	<b>NAVD 88 (06/17/97)</b>	<b>18.58 (m)</b>	<b>61.0 (f) LEVELING 3</b>
<b>PE1052</b>	<b>NGVD 29 (??/??/92)</b>	<b>18.793 (m)</b>	<b>61.66 (f) ADJ UNCH 2 0</b>

GPRA County Scorecard - Windows Internet Explorer

http://www.ngs.noaa.gov/scorecard/

File Edit View Favorites Tools Help

GPRA County Scorecard

Home RSS Feeds (3) Print Page Tools



## How Well is NOAA Meeting Local Positioning Needs?

National Geodetic Survey (NGS), has developed a new performance metric to evaluate how well it is enabling counties with accurate positioning capacity to the centimeter level relative to the National Spatial Reference System (NSRS). This metric makes use of NOAA's Online Positioning User Service (OPUS), as well as a County Scorecard, to assess county positioning capability and the success of NOAA's products and services.

[FY 2008 GPRA Action Plan](#)

### We Need Representatives!

Are you interested in becoming a County Geospatial Representative?

We are looking for County Surveyors, GIS Professionals and others who can speak for the needs of individual Counties to fill out a brief web-based County Scorecard.

If so, please fill out the form below and send it to us.

Fields marked with (\*) are required

\*Email

\*Name

\*Position

\*US County

### GPRA Results

NGS began tracking its progress toward "fully or substantially" enabling counties with accurate positioning. The maps below are the quarterly updates of the percentage of U.S. counties rated as enabled or substantially enabled with accurate position capacity. It is a graphical representation of NGS' Government Performance and Results Act (GPRA) performance measure. The Government Performance and Results Act of 1993 seeks to improve Federal program effectiveness and public accountability by promoting a new focus on results, service quality and customer satisfaction. For more information on GPRA click here. NGS' GPRA measure tracks progress in facilitating the capacity of state and local governments and the private sector to utilize accurate positioning information. NOAA will track county level use of its Online Position User Service (OPUS), submitted accepted bluebook data, county scorecard submissions, and identification of county representatives and State Advisors/Coordinators to determine how well it is enabling state and local governments and the private sector with accurate positioning capacity. Click the maps below for the full image and slide show feature. Just click the 'close' link when you are done viewing to return to this page. Also below is a file containing month by month progress and GPRA targets.



# What Does NGS Do?? What is Our Mission??

## The NGS Year Plan

### Excerpts from the Executive Summary

- To define, maintain and provide access to the **National Spatial Reference System** to meet our nation's economic, social, and environmental needs, and
- To be a world leader in geospatial activities, including the development and promotion of **standards, specifications, and guidelines.**



**In order to achieve the vision of the future, five technical improvements have been identified. They are:**

- Modernize CORS
- Improve Gravity Field Modeling
- Migrate the Coastal Mapping Program toward Integrated Ocean and Coastal Mapping (IOCM)
- Add and Improve Core Capabilities
- Implement a Global Leadership Strategy



## Cont....

Bold initiatives will be required in all of these areas. One common theme for all of them is ***change for the better***. NGS will transform CORS into a fully GNSS-capable system which best serves the mission of defining the NSRS. The geoid modeling efforts will include new theory and data collection at levels not seen at NGS since the NAD 83 and NAVD 88 efforts. Time dependencies will be both acknowledged and tracked in all components of the NSRS, from the shoreline to the gravity field, from heights to latitude and longitude. Coordinates which are epoch tagged and tracked for motion will be the foundation of the NSRS.

**So what does this mean?**



## Changes for the Better Modernize CORS

- NGS provides 1-cm access to the geodetic latitude, longitude and height components of the NSRS for all GPS-exclusive users (with geodetic quality receivers) with *less than 15 minutes* of data anywhere in the United States or her territories
- NGS provides 1-cm access to geodetic latitude, longitude and height to all GNSS (generic) users, without regard to constellation, with *less than 4 hours of data* anywhere in the United States or her territories
- All existing NWLON sites are collocated with a CORS antenna
- NGS provides 1-cm orbits for GPS, GLONASS and Galileo
- NGS products and services directly support real-time access to all components of the NSRS without competing with private industry



## Changes for the Better Improve Gravity Field Modeling

- NGS will compute a pole-to-equator, Alaska-to-Newfoundland geoid model, preferably in conjunction with Mexico and Canada as well as other interested governments, with an accuracy of 1 cm in as many locations as possible
- NGS redefines the vertical datum based on GNSS and a gravimetric geoid
- NGS redefines the national horizontal datum to remove gross disagreements with the ITRF



## The official page of the GRAV-D project



# GRAV-D

**G**ravity for the **R**e-definition of the **A**merican **V**ertical **D**atum

*A NOAA contribution to the  
Global Geodetic Observing System (GGOS) component of the  
Global Earth Observation System of Systems (GEOSS)*

[What is GRAV-D?](#)

Download [the GRAV-D plan](#) here.

### Links

[GGOS \(Global Geodetic Observing System\)](#)

[GEOSS \(Global Earth Observation System of Systems\)](#)

### Latest News

[2007 Nov 15-17: NGS Trains Airborne Gravimeter Operators](#)

[2007 Nov 14: NGS Releases Final Version of the GRAV-D plan](#)

[2007 Oct 25: NGS Acquires Airborne Gravimeter](#)

[2007 Apr 10-11: NGS Holds Gravity Seminar at Corbin](#)

[2007 Feb 12: NGS Releases Draft of 10 year plan \(first public reference to definition of vertical datum redefinition\)](#)

## **Changes for the Better**

### **Migrate the Coastal Mapping Program toward Integrated Ocean and Coastal Mapping (IOCM)**

- A highly automated system for extracting a delineated shoreline is in place
- NGS coastal missions are strongly integrated with Integrated Ocean and Coastal Mapping (IOCM), and Global Geodetic Observing System (GGOS) and Global Earth Observation System of Systems (GEOSS)



## **Changes for the Better**

### **Add and Improve Core Capabilities**

- All NGS standards, specifications and guidelines are updated to the latest technologies, and available digitally with an annual status check and potential update cycle.



## **Changes for the Better Implement a Global Leadership Strategy**

- NGS develops strong ties to multiple Universities, funding research, and applying said research for application to the mission.
- NGS strongly holds a position as world leader in geospatial activities
- NGS provides technical support to at least two other countries in developing critical geodetic infrastructure



# What Will This Look Like for station Y 151??

```

HTDP Output

*****
HTDP (version 2.9) OUTPUT

TRANSFORMING POSITIONS FROM NAD_83(CORS96)   (EPOCH = 01-15-2008)
                                TO ITRF2000     (EPOCH = 01-01-2017)

      INPUT COORDINATES   OUTPUT COORDINATES   INPUT VELOCITY

Y 151
LATITUDE   44 03 38.27673 N   44 03 38.31288 N   -2.70 mm/yr north
LONGITUDE  69 05 36.90789 W   69 05 36.92362 W   -0.40 mm/yr east
ELLIP. HT.                -6.509                -7.690 m   -1.10 mm/yr up
X              1638189.075            1638188.168 m   0.01 mm/yr
Y              -4288552.412           -4288551.019 m  -1.16 mm/yr
Z              4412930.830            4412930.810 m  -2.71 mm/yr
    
```

```

Output from USGG2003

      latitude           longitude           N
Station Name  ddd mm ss.sssss ddd mm ss.sssss meters
USER LOCATION 44  3 38.31288  69  5 36.92362  -26.203
    
```



# My Crystal Ball Looking to 2017

## Output from INVERS3D

First Station : Old Y 151  
-----

X = 1638189.0746 m LAT = 44 3 38.27673 North  
Y = -4288552.4119 m LON = 69 5 36.90789 West  
Z = 4412930.8301 m EHT = -6.5090 Meters

Second Station : New Y 151  
-----

X = 1638188.1678 m LAT = 44 3 38.31288 North  
Y = -4288551.0192 m LON = 69 5 36.92362 West  
Z = 4412930.8106 m EHT = -7.6900 Meters

Forward azimuth FAZ = 342 34 45.9236 From North  
Back azimuth BAZ = 162 34 45.9127 From North  
Ellipsoidal distance S = 1.1694 m  
Delta height dh = -1.1810 m  
Mark-to-mark distance D = 1.6620 m

DX = -0.9068 m DN = 1.1158 m  
DY = 1.3927 m DE = -0.3501 m  
DZ = -0.0195 m DU = -1.1810 m

Zenith (mk-to-mk) ZD = 135 16 58.02  
Apparent zenith distance = 135 16 58.01

$$H_{17} = h_{ITRF} - N_{USGG}$$

$$H_{17} = -7.690\text{m} - (-26.203\text{m}) =$$

$$H_{17} \text{ 18.513m}$$

$$\text{NAVD17} - \text{NAVD88} = -0.068\text{m}$$



## Contact Information

**Daniel J. Martin**

**NOAA/National Geodetic Survey**

**1 National Life Drive**

**Montpelier, VT 05633-5001**

**(802) 828-2952**

**[Dan.martin@noaa.gov](mailto:Dan.martin@noaa.gov)**

