Oregon Coordinate Systems and NATF2022

OGIC TAC
April 10, 2024

Brady Callahan, Geospatial Lead
Oregon Parks and Recreation Department

BACKGROUND

DECADE PLUS IN THE MAKING

Horizontal Datum

- North American Terrestrial Reference Frame of 2022 (NATRF2022)

Vertical Datum

- North American-Pacific Geopotential Datum of 2022 (NAPGD2022)

- GEOID 2022

National Geodetic Survey Positioning America for the Future geodesy.noaa.gov

New Datums Are Coming!

New Datums

NOAA is Replacing NAD 83 and NAVD 88.
NOAA's National Geodetic Survey (NGS) will be replacing the datums of the National Spatial Reference System (NSRS), including **the North American Datum of 1983 (NAD 83) and the North American Vertical Datum of 1988 (NAVD 88)**. NGS will provide the tools to easily transform between the new and old datums. Read the NGS Ten-Year Plan and visit the **New Datums Web page** on our site to learn more.

Benefits
The new reference frames (geometric and geopotential) will rely primarily on **Global Navigation Satellite Systems (GNSS)**, such as the Global Positioning System (GPS), as well as on a gravimetric geoid model resulting from NGS' **Gravity for the Redefinition of the American Vertical Datum (GRAV-D)** Project.

The target accuracy of differential orthometric heights (heights relative to sea level) in the geopotential reference frame will be 2 centimeters over any distance, where possible.

What You Can Expect
The magnitude of change with the new datums will vary depending on the datum you are using and your geographic location. The new geometric datum will change latitude, longitude, and ellipsoid height between 1 and 4 meters. In the conterminous United States (CONUS), the new vertical datum will change heights on average 50 centimeters, with approximately a 1-meter tilt towards the Pacific Northwest.

How You Can Prepare
- Learn if **legislation** or other formal documents referencing NAD 83 and NAVD 88 need to be changed in your state.
- **Transform existing data** to the latest NSRS datums and realizations; i.e. NAD 83 (2011), GEOID18, and NAVD 88.
- **Obtain precise ellipsoidal heights** on NAVD 88 bench marks, and visit the GPS on Bench Marks Web page to learn more.
- Require and provide **complete metadata** on all mapping contracts. See our website for more details.

The new datums will extend across CONUS and U.S. territories. The terrestrial reference frames replacing NAD 83 will be consistent with geocentric global reference frames defining latitude and longitude. The geopotential datum replacing NAVD 88 will be based on a gravimetric geoid model, enhanced by data from NGS' Gravity for the Redefinition of the American Vertical Datum (GRAV-D) Project.

National Oceanic and Atmospheric Administration • National Geodetic Survey

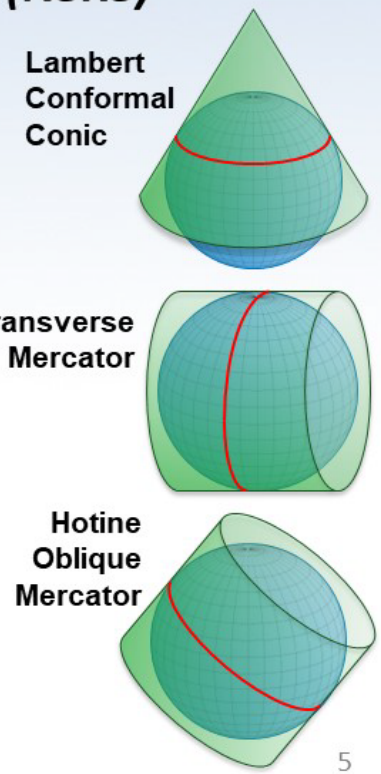
STATE PLANE UPDATE

NEW DATUM = NEW SPCS

NOAA's National Geodetic Survey Positioning America for the Future geodesy.noaa.gov

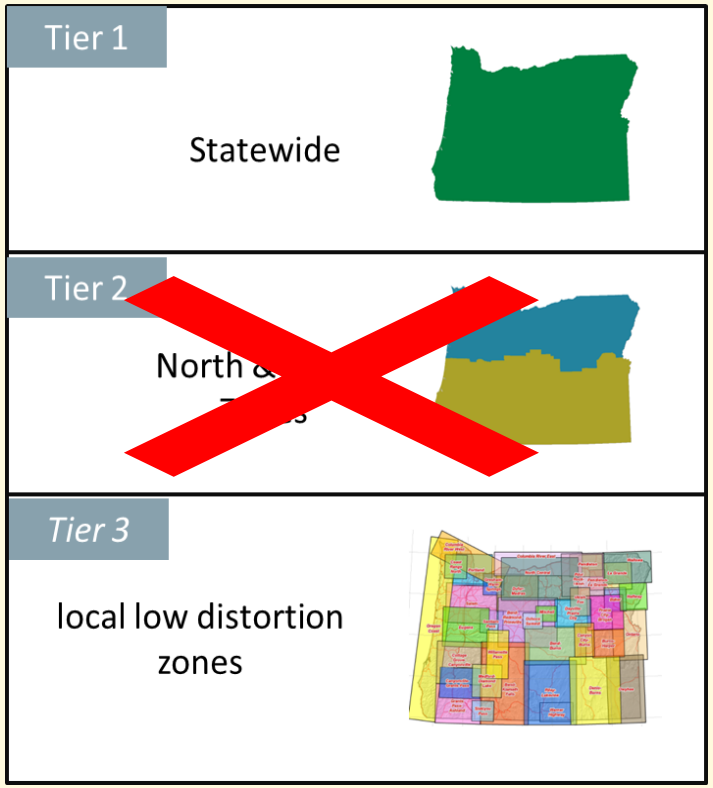
State Plane Coordinate System of 2022 (SPCS2022)

- **Part of modernizing the *National Spatial Reference System (NSRS)***
- **Third generation of State Plane**
  - First in 1930s (SPCS 27), second in 1980s (SPCS 83)
  - Same 3 map projection types
  - Same ellipsoid as SPCS 83 (GRS 80)
- **Same as existing State Plane, *but different…***
  - Based on new terrestrial reference frames instead of NAD 83
  - More zones, most designed by state stakeholders
  - Designed to reduce linear distortion at topographic surface (i.e., reduce difference between "grid" and "ground" distances)



SPCS2022 AND OREGON

DIRECTION TO NGS



Oregon Tiered Proposal

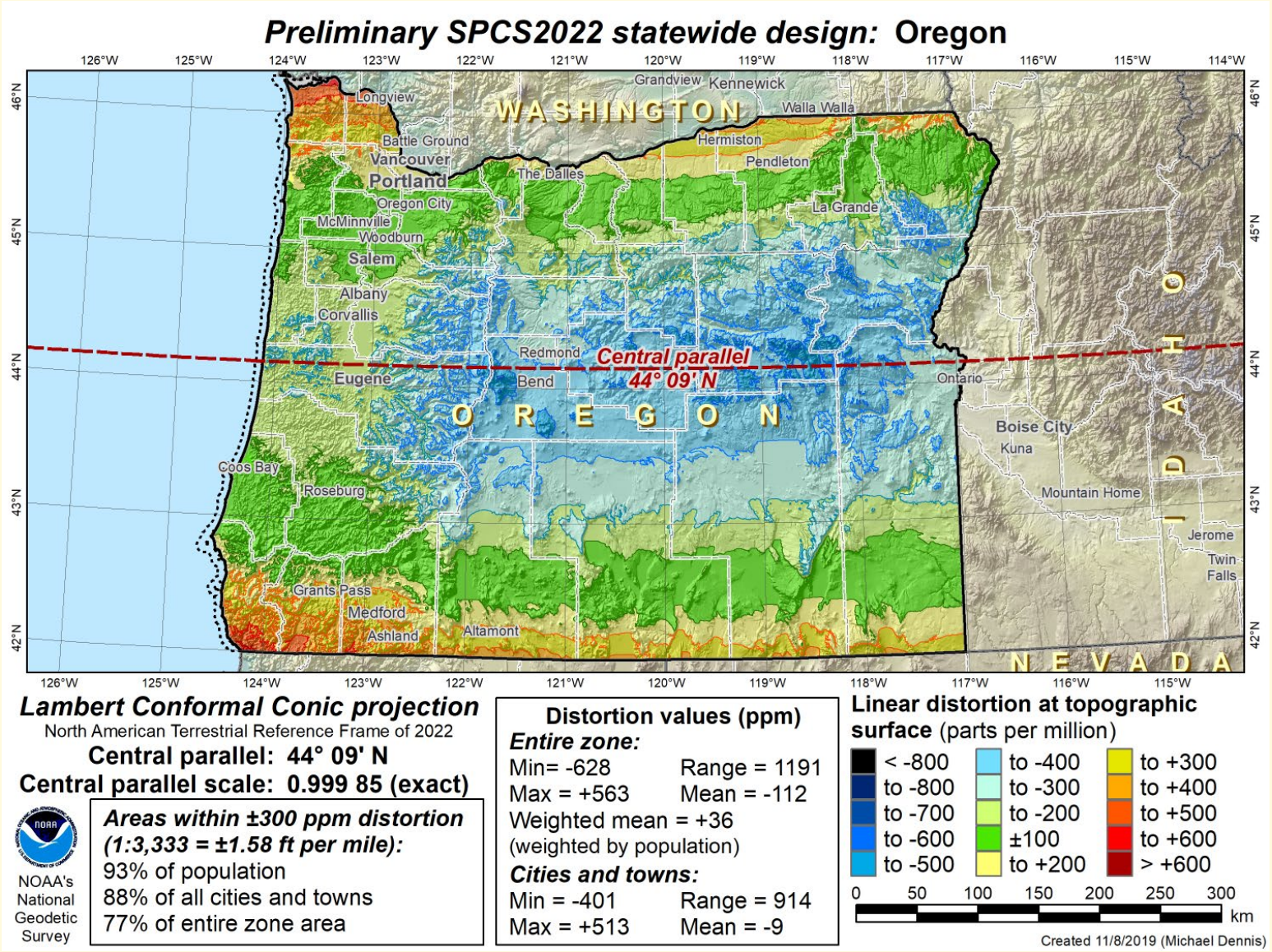
- Initially – "Let's have them all!"
  - ***NGS reminder-** "*Pick any **two*** but one MUST be the statewide zone"

- Modified Oregon proposal (accepted by NGS)
  - Tier 1 – Statewide
  - Tier 2 – Low distortion zones

Support from OACES, OGIC, URISA

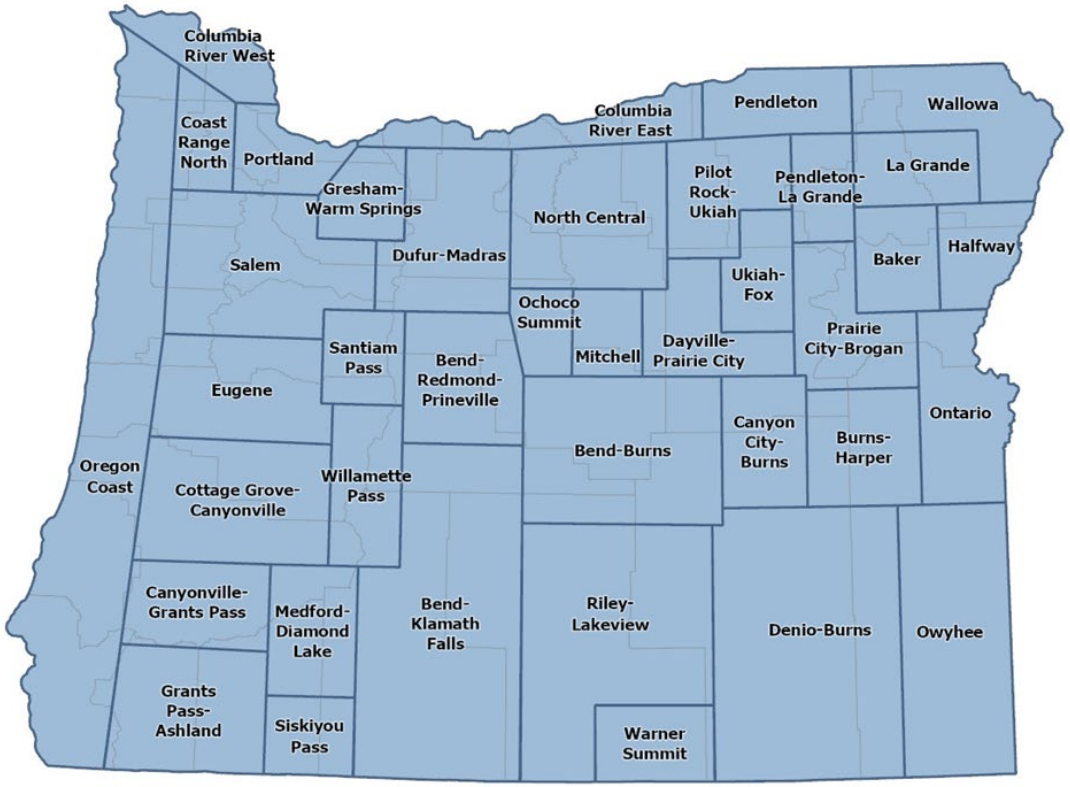
SPCS2022 AND OREGON

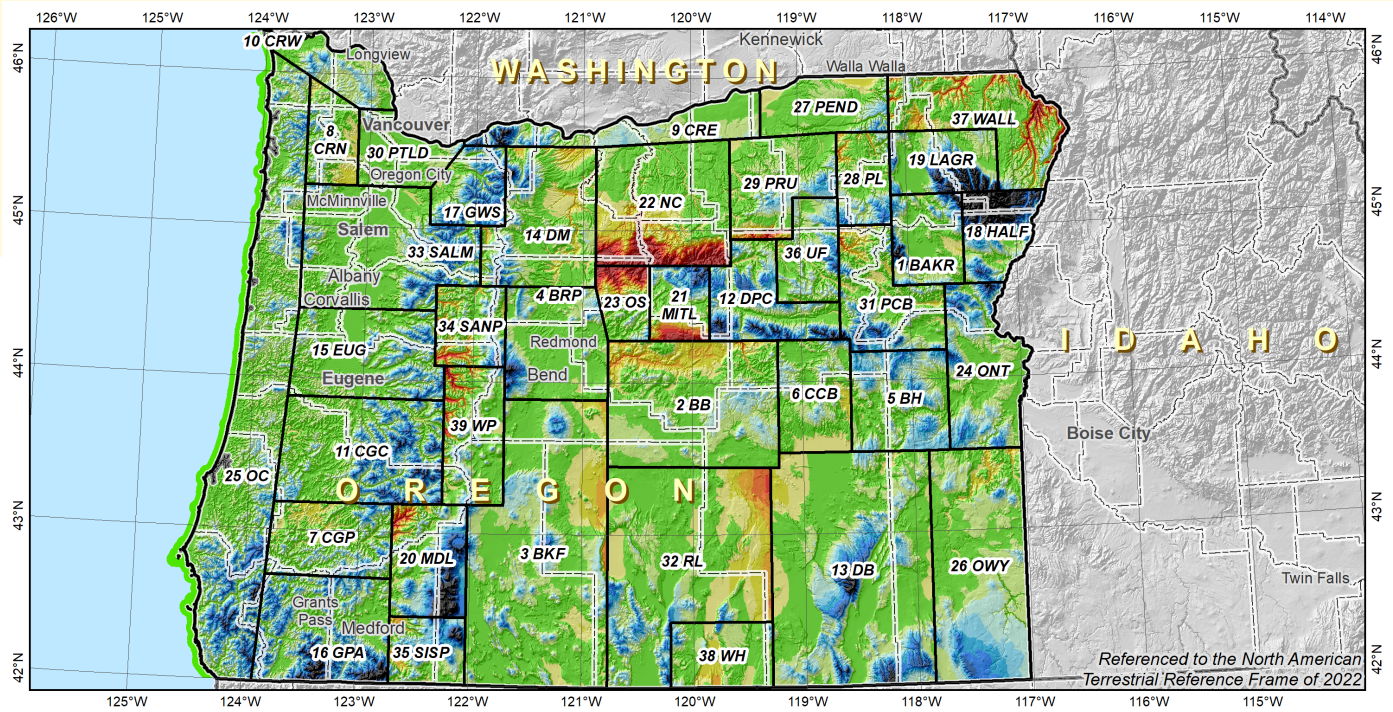
STATEWIDE ZONE



SPCS2022 AND OREGON

LOW DISTORTION ZONES





Preliminary SPCS2022 design

Oregon complete coverage layer (39 zones)

Distortion statistics (ppm)

	Cities	Area
Min	-129	-365
Max	+186	+241
Range	315	606
Mean	+7	-22

Mean weighted by pop: -2

NOAA's National Geodetic Survey

Percent within distortion ranges

Range	Pop	Cities	Area
±20 ppm	90%	81%	43%
±25 ppm	93%	85%	50%
±30 ppm	95%	88%	56%
±40 ppm	97%	92%	66%
±50 ppm	98.7%	96%	74%
±75 ppm	99.6%	98%	86%
±100 ppm	99.9%	98%	92%
±150 ppm	99.98%	99.6%	98%
±200 ppm	99.996%	100%	99.5%

Linear distortion at topographic surface (parts per million)

<-160	to -80	to +60
to -160	to -60	to +80
to -140	to -40	to +100
to -120	±20	to +120
to -100	to +40	>+120

0 50 100 150 200 250 km

Created 10/19/2022 (Michael Dennis)

SPCS2022 AND OREGON

EXISTING COORDINATE SYSTEMS

- Oregon Statewide Lambert
  - Oregon Coordinate Reference System Standard
  - OGIC Endorsed

- Oregon Coordinate System (ORS 93.312)
  a) Oregon State Plane 1927
  b) Oregon State Plane 1983
  c) Oregon Coordinate Reference System

  - Implemented under Oregon Administrative Rule (734-005-0010)
    - Three Systems (SPCS 1927, 1983, **OCRS**)
    - Description for development of **OCRS**

SPCS2022 AND OREGON

EXISTING COORDINATE SYSTEMS

Oregon Coordinate System (ORS 93.312)

Planned to be updated to include the zones from SPCS 2022

- Add 39 low distortion projections (aka “OCRS”)
  - New datum
  - Different coordinate ranges
- Add single statewide zone
  - Different than current statewide OGIC Lambert

- New systems to be approved by ODOT OAR Committee (Summer 2024)
- New systems to be defined and published in OAR 734-005-0015

SPCS2022 AND OREGON

EXISTING COORDINATE SYSTEMS

Oregon Statewide Lambert

- *Planned* replacement with single zone SPCS2022/OCRS
- Tied to OAR (ORS)

NEW COORDINATE SYSTEMS/DATUM

GETTING READY

1. Familiarize yourself with the different datums and realizations in use in Oregon
2. Understand the quality of your data and how the spatial location was generated
3. Document the process of coordinate system/datum conversion including the transformations and assumptions

NEW COORDINATE SYSTEMS/DATUM

NAD83 PITFALL

"Our data is NAD83. So, we'll be fine"

- NAD83 has multiple realizations that are different
- Sometimes data providers have used the generic "NAD83" datum tag or some other realization as opposed to including the correct one.

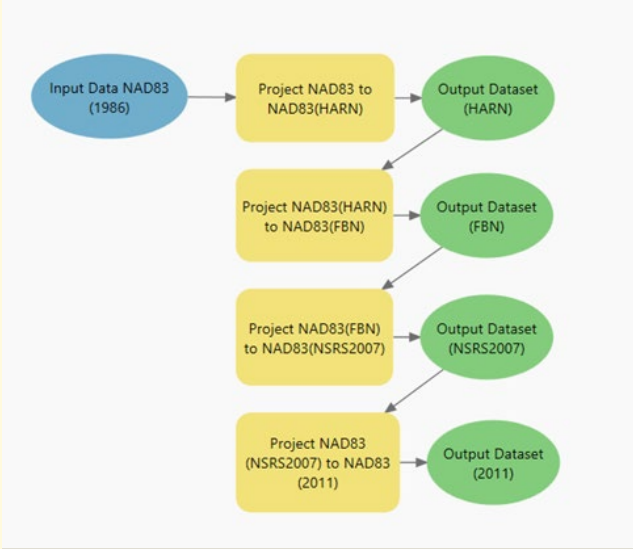
  Seen occasionally in wide area remote sensing data (orthophotograpy, lidar) that is most typically controlled with GNSS and tied to NGS control

NEW COORDINATE SYSTEMS/DATUM

NGS RECOMMENDATION

Migrate data to SRS based on NAD83(2011)

- Step through all intermediate realizations (no “jump over transforms”)



NGS NADCON 5 Technical Report

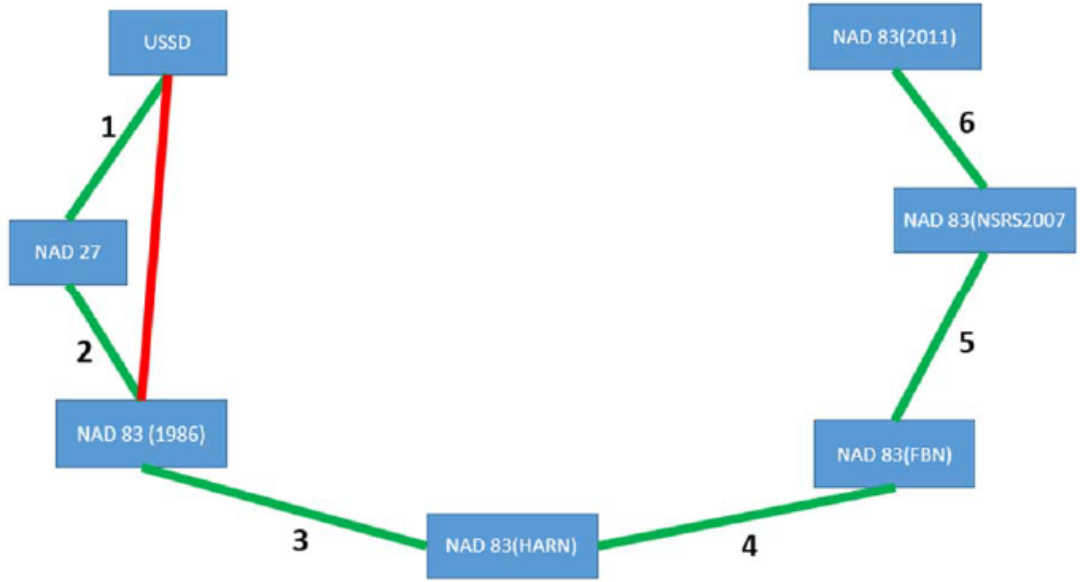


Figure 3-1: Chronological chain of transformations in CONUS (green), with potential realization skipping transformation (red)

Consider a potential transformation from USSD to NAD 83(1986), shown as a red line. Because each transformation is built by pairs of coordinates, there is absolutely no way to ensure (in fact, it’s a ridiculous assumption) that the points with USSD/NAD 27 pairs, and the points with NAD 27/NAD 83(1986) pairs are the same, or that either one would align with the points with USSD/NAD 83(1986) pairs. As such, knowing the very data itself can not be identical, it is a simple matter to predict that a grid created along the red line will not be identical to that created by going through the two green lines (1 and 2). Therefore, with non-uniqueness being an issue, NGS chose not to create

NEW COORDINATE SYSTEMS/DATUM

TRANSFORM REQUIREMENTS

Esri software users need to install the supplemental **ArcGIS Coordinate Systems Data** available from My Esri

ESRI Transformation Names for CONUS

- NAD_1927_To_NAD_1983_7 (WKID::8555)
- NAD_1983_To_NAD_1983_HARN_47 (WKID::8556)
- NAD_1983_HARN_To_FBN_NADCON5_3D_CONUS_1 (WKID::8861)
- NAD_1983_FBN_To_NSRS2007_NADCON5_3D_CONUS_1 (WKID::8862)
- NAD_1983_NSRS2007_To_2011_NADCON5_3D_CONUS_1 (WKID::8559)

NEW COORDINATE SYSTEMS/DATUM

WHAT TO DO ABOUT WEB MERCATOR

- WGS 1984 Web Mercator (auxiliary sphere) – EPSG:3857
    - GCS is WGS 1984 – EPSG:4326
        - Datum is WGS 1984 – EPSG:6326
            - Generic datum tag for ‘current’ WGS 1984 realization
              …includes all realizations