The National Geodetic Survey Ten Year Strategic Plan, 2013-2023:

Positioning America for the Future

I have always found that plans are useless, but planning is indispensable.

Dwight Eisenhower

Executive Summary

Mission:

To define, maintain and provide access to the National Spatial Reference System (NSRS) to meet our nation's economic, social, and environmental needs.

Vision:

Everyone accurately knows where they are and where other things are anytime, anyplace!

Goal 1: Support the Users of the National Spatial Reference System

This is an **operational** goal. Its focus is on maintaining the good work NGS currently does through all of our *operational* products and activities. Where a product is incomplete, under development, or otherwise not operational, it is *not* part of this goal.

Objective 1: "Bluebooking and Datasheets" Maintain the capability to ingest internal and external survey data, analyze it, store it and return useful information to the public
NGS intends to maintain the current ability to ingest surveys through "bluebooking" as it exists in 2012, while improvements are being developed. This includes maintaining other technical abilities and standards on which bluebooking is built.

Objective 2: "Shoreline" Maintain annual production of the national shoreline
The National Shoreline is that shoreline shown on NOAAs nautical charts and provides critical baseline data for updating nautical charts; defining our nation's territorial limits, and managing our coastal resources. NGS must continue its current work to define it.

Objective 3: "Airport Surveys" Maintain airport surveying operational capacity
The remote sensing and field operations expertise required to fulfill congressional mandates is well illustrated through the Aeronautical Survey Program (ASP). These surveys provide critical information about airport features; internal ability to perform these surveys will be maintained.

Objective 4: "Field Operations" Maintain geodetic surveying operational capacity
Although the way NGS does business has changed in recent decades, such that fewer field crews are needed, it is still critical that the capacity and expertise required to do these types of surveys exists in house. NGS employees are the resource and authority for many surveying activities and must know and fully understand the associated field work procedures.

Objective 5: "Online Tools" Maintain online tools allowing users to access the NSRS
The most up to date information on geodetic coordinates is derived using active control stations, or Continuously Operating Reference Stations (CORS). Many NGS software tools, like the Online Positioning User Service (OPUS), make use of data from CORS. As improvements are made to CORS and OPUS, basic functions will be maintained.

Goal 2: Modernize and Improve the National Spatial Reference System

This goal is about **projects** – agents of change for the better. Its focus is on improving things NGS is doing (under three categories: **Starting** new work, **improving** existing work and **retiring** outdated work).

Objective 1: "Replace NAD 83" By 2022, reduce all definitional and access-related errors in the geometric reference frame to one cm when using 15 minutes of GNSS data
The North American Datum of 1983 (NAD 83), in both its definition and in the services through which NGS provides access, needs improving. These improvements can be combined into this one overarching objective, which will be to improve tools over the next ten years, while preparing for the ultimate replacement of NAD 83 by a truly geocentric reference frame.

Objective 2: "Replace NAVD 88" By 2022, reduce all definitional and access-related errors in orthometric heights in the geopotential reference frame to two cm when using 15 minutes of GNSS data
The North American Vertical Datum of 1988 (NAVD 88) in both its definition and in the services through which NGS provides access, needs improving. NGS will continue to collect airborne gravity data through the Gravity for the Redefinition of the American Vertical Datum (GRAV-D) project, support Height Modernization, and work across agencies to connect important data.

Objective 3: "Re-invent Bluebooking" By 2018, increase the efficiency and accuracy of soliciting, accepting, processing, storing, reporting the results of and re-processing all survey data while maintaining the standards of quality expected by external users.
The era of expanding the passive control network is coming to an end. There are reasons for surveying passive control marks **but** the tools NGS will build for the future will allow users to easily see and understand all of the information, both historical and recent, which exist on a point. Tools such as OPUS-Database (OPUS-DB) and OPUS-Projects, will be completed to one day carry the weight and authority of bluebooking.

Objective 4: "Fix the Toolkit" Continually increase use of commercially available software and usefulness of all NGS products and services, and interoperability of NGS software with commercial software from 2013 to 2016
It is NGS' intention to properly evaluate the tools it provides to the public, and begin a program of creating consistency and modernizing, effectively cleaning up the toolkit to make it a more user friendly and scientifically accurate product for the nation. Future products and service of should be broadened to include accuracy, velocity, and useful metadata about geodetic control.

Objective 5: "Better Surveying" Continually improve the efficiency and accuracy of geospatial data collection methodologies

NGS will engage in a renewed effort of field surveying research, updating geodetic surveying manuals to the latest technologies, and verifying these manuals with scientific fact. That is, NGS will re-invest in creating surveying standards, not merely guidelines.

Goal 3: Expand the National Spatial Reference System stakeholder base through partnerships, education and outreach

This goal is about the **public** – current users of the NSRS and those groups who would benefit greatly from beginning to engage with NGS. Its focus is on reaching new stakeholders, providing training and education to existing stakeholders, and improving NGS' ability to meet our mission through engagement of outside experts.

Objective 1: "Validate RTNs" Provide a process for RTN operators to validate that their RTNs are aligned to the NSRS to NGS acceptable standards by 2015.

Considering RTN use is expected to grow, NGS will engage the RTN user community by seeking to jointly develop a methodology by which users of RTNs may have a complete understanding of how their derived coordinates are consistent with the NSRS.

Objective 2: "Engage New Stakeholders" Annually increase the number of stakeholder communities directly educated or engaged by NGS

As the global community becomes more "geospatially enabled" the potential for misuse and misunderstanding of that data grows. NGS intends to reach a broader audience, with user-friendly educational material, to increase public understanding of geodesy. The NGS Corbin Training Center (CTC) has provided training to non-traditional customers in the past, but the focus has been on high accuracy geospatial professionals not the general public.

Objective 3: "University Engagement" Annually increase the number of collaborations between NGS and Universities for solving research problems for the next three years.

NGS recognizes that graduate students can become a significant resource augmenting the research completed by professionals. As such, NGS will increase University collaborations, whether it be through grants, the encouraging of NGS employees to achieve advanced degrees, or the teaching of seminars by NGS employees at Universities.

Objective 4: "Dynamic Web Presence" Increase online stakeholder engagement and improve NGS response mechanisms.

NGS intends to consolidate its web presence, focusing it on both outward looking materials (such as education and outreach), as well as building a tiered response system for inquiries, much like the system of old, where questions are tracked and monitored for consistency of message.

Objective 5: "Educational Portfolio" Achieve creation of an online educational portfolio and reduce latency of all components to under than five years by 2017

NGS will continue to organize its overall "educational toolkit," making sure that information is easy to find, up to date, easy to use and regularly monitored. The initial steps must be geared toward improving the actual field manuals NGS uses and provides to the public. Eventually the portfolio will expand to include all levels, from universities down to elementary school.

Objective 6: "IOCM" Increase the use and users of data obtained through and provided to the Integrated Ocean and Coastal Mapping Program (i.e. "Map once use many times")

NOAA implemented the Integrated Ocean and Coastal Mapping (IOCM) program in 2007 recognizing the multiple-uses of ocean and coastal geospatial data that includes uses for shoreline data. NGS intends to continue to broaden the useable products that come out of the Coastal Mapping Program (CMP) as well as leverage IOCM partner data for use in CMP products.

Goal 4: Develop and enable a workforce with a supportive environment

This goal is about **employees**, current and future, who enable NGS to fulfill its mission. Its focus is on ensuring NGS has the most qualified workforce, employs experts in many fields, and that existing employees are trained and compelled to be better so that NGS can meet its mission in the long term.

Objective 1: "Educated Workforce" Annually increase the scientific and technical knowledge and capabilities of NGS's workforce

The fields of geodesy and remote sensing are small and continue to shrink, reducing the number of persons hired with actual "geodetic or remote sensing science" degrees but it is imperative that employees have significant knowledge of finer geospatial details of what the agency does. In order to accomplish this, NGS will use a combination of employee-led educational classes, long term training, and guest lecturers to broaden geodetic knowledge throughout the agency.

Objective 2: "Recruiting" Align the NGS workforce with the NGS mission over the next three years

Difficulty to systematically hire to fill important gaps has led to a situation where over half of the NGS workforce is eligible for retirement. Without a singular effort to recruit and retain new talent, NGS will encounter problems with successfully fulfilling its mission. NGS will therefore use every tool in the allowable government personnel toolbox to recruit, hire and retain a broad spectrum of new employees in the next three years.

Objective 3: "Institutional Knowledge" Achieve succession planning by 2014 and maintain it perpetually

NGS will institute a policy of requesting "on the job documentation" including dissemination of that information through mentoring from those employees who are preparing to retire. This way, new employees may be able to do the jobs of retiring ones with continuity. Furthermore, an investigation into what institutional knowledge has already left, and which can and should be resurrected, should be pursued.

Enterprise Goal: Improve Organizational and Administrative Functionality

All of the above mentioned goals require that NGS operate efficiently, effectively, in a safe workplace with functioning equipment. This goal acknowledges that some significant improvements, and therefore taxpayer savings, can be gleaned from improving day to day operations and behind the scenes work.

Objective 1: "Project Management" Achieve complete adoption of project management in NGS operations by 2016
Project management is a tool that NGS must adopt in order to properly plan, budget, execute and evaluate the various projects that have, historically, been performed in an ad hoc fashion.

Objective 2: "I.T. Support" Continually maintain I.T. infrastructure
NGS has had varied success rates with IT infrastructure. NGS will evaluate its actual state of I.T. needs, and prepare a budget on a "must pay" basis, prior to other projects.

Objective 3: "Socio-Economic Awareness" Update or improve knowledge base for program evaluation through analysis of socio-economic benefits of NGS products and services on a 10 year cycle
Offices are required to perform program evaluation on a recurring basis but this objective also carries the very real positive benefits of self-reflection, leading to improved services and more efficient use of tax dollars.

Objective 4: "Records Management" Improve the management of NGS records
In 2011, NGS began a process of coming into compliance with federal and NOAA-specific records retention guidelines. Many activities will continue to ensure NGS will be fully organized, efficient, and in compliance with all federal guidance.

Objective 5: "Regional Advisor Program" Achieve a fully staffed regional advisor program by 2016.
Recognizing the benefits of NGS' current state advisor program but also its patchwork nature and the reality of shrinking state budgets, NGS determined in 2010 to transition to a "regional advisor program." It will consists of a smaller cadre of advisors, all well trained and dynamic educators, able to cover multi-state regions, all at the cost to NGS alone.

Mission:

To define, maintain and provide access to the National Spatial Reference System to meet our nation's economic, social, and environmental needs.

To understand the mission of the National Geodetic Survey (NGS), it is critical to understand what the National Spatial Reference System (NSRS) is. NGS defines the NSRS as the official reference system of the Federal government which allows a user to determine geodetic coordinates (including, but not limited to, latitude, longitude, height, scale and orientation relative to the International Terrestrial Reference Frame, or ITRF) which keeps all federal civilian maps in the nation consistent with one another. The NSRS also encompasses the official national shoreline of the United States. This mission is derived from congressional acts, executive orders, National Research Council (NRC) studies, and over 200 years of history.

The NSRS is the foundation of all surveying, mapping, charting, and positioning activities in the United States and its territories. All activities, from hydrographic mapping which allows commerce to flow through U.S. ports, to subsidence monitoring which informs communities about the changing local vulnerabilities to flooding, to environmental monitoring used in restoration, must be built upon an extremely accurate NSRS to be accurate themselves.

NGS defines the NSRS and its elements through many activities.. NGS currently defines two datums, NAD 83 and NAVD 88, which define latitude, longitude and height for everything in the nation. NGS defines the national shoreline which NOAA and other agencies then use in their products. NGS also defines a civilian-use geoid, a mathematical approximation of the earth's shape, which is necessary to connect Global Navigation Satellite Systems (GNSS)-derived ellipsoidal heights to physically-defined ("orthometric," colloquially known as "sea level") heights on the ground. To maintain the NSRS, NGS regularly updates the shoreline and updates the datums and the geoid as technology improves so accuracy can be improved. NGS must track all of the temporal changes to the defining points of the NSRS in such a way as to maintain the accuracy of the NSRS definition continually. Without continuous maintenance the NSRS would soon become obsolete.

NGS provides access to the NSRS in two different ways. The primary access is through precise GNSS orbits and "active control," which are the Continuously Operating Reference Stations (CORS). Users can access the NSRS through CORS by connecting their own GNSS surveys to CORS using tools such as Online Positioning User Service (OPUS). More historic, but increasingly secondary, access is through the over 1,000,000 passive geodetic control bench marks with published (but generally unmonitored) coordinates. No matter the method of access, NGS has written, and continues to write, guidelines and specifications. These, along with the online toolkit, provide the tools and knowledge stakeholders need to access and properly utilize the NSRS.

Through its mission, NGS directly supports many activities including geodesy, surveying, remote sensing, mapping, and charting, and indirectly supports many more scientific undertakings. In fulfilling the above mission NGS will provide the latest geospatial foundation to compliment today's technology which enables world-class positioning services to the U.S. community.

Vision:

> *Everyone accurately knows where they are and where other things are anytime, anyplace!*

In this time of smart phones, GNSS enabled cars, and other GNSS enabled electronics it may seem that this vision of the future is already a reality. But the accuracy of these devices is the key distinction between what exists today, and the world NGS envisions for tomorrow. The function of the NSRS is to provide a consistent coordinate system, the foundation of all current and emerging geospatial technologies in the United States and its territories. Providing positions and elevations of the highest accuracies meets the full-spectrum of positioning needs for any user within the country, from the scientist to the average citizen.

When mapping flood plains, monitoring sea level change, or landing a plane in low visibility, even centimeter differences can be crucial. Through diligent work on the above mission NGS strives to support a world in which everyone knows their own position, and others positions, as well as their relationship to each other, not just generally but accurately.

Check in on the last ten year plan….

The last NGS 10 year plan, which took effect in 2008, vigorously advanced the select projects which NGS knew it could and would undertake in the upcoming years. Specifically, it encompassed five technical improvements which NGS intended to undertake to achieve the vision of the agency. Now in 2013, NGS realizes that creating an un-prioritized list of dozens of projects with over 100 milestones was not the most strategic way to lead an agency into the future. As expected on the release of the last ten year plan, NGS has revisited the plan after the five years, and decided to strategically position the entire agency for success by writing a more intrinsic *strategic* plan rather than a 10 year project to-do list. This new strategic plan will replace the 10 year plan of 2008-2018.

For a more detailed look at what NGS accomplished in the last ten year plan, see Appendix A.

Justification of Objectives:

There are many orders, laws and mandates from which NGS draws its mission and work. All of the goals and objectives in this plan relate directly to these public requirements or more generally further the science, service, and stewardship which NGS and the National Oceanic and Atmospheric Administration (NOAA) as a whole, strive to improve. Direct mission-related objectives are drawn from language in Office of Management and Budget (OMB) circular A-10, Executive Order 12906, or the original legislation which created NGS' predecessor agencies, the U.S. Coast and Geodetic Survey Act. There are additional OMB, Department of Commerce (DOC), and Congressional mandates with which NGS complies, including the Air Commerce Act of 1926. While other objectives have a less direct tie to these requirements, they are still critical to the work of NGS for many reasons. As a scientific agency there are many scientific requirements and processes which must be met before the true mission related science work can be undertaken. Though this work is not explicitly required, NGS could not meet its mission without completing some of this basic work first. NGS must also maintain personnel and infrastructure internally so that it continually has the tools needed to meet its mission and further its scientific goals. In all aspects of its work NGS strives to use tax dollars more efficiently and improve its service to the nation. This is inherent to all objectives in this plan but some objectives, especially in the enterprise goal, focus specifically on improving functionality and organization so that taxpayers get more out of every dollar spent.

Implementation:

This plan lays out the direction NGS will take in the future, but that is just the first step. Each objective in this plan will have a designated "objective lead" within NGS. That person will be in charge of writing an objective implementation plan (including identifying resources and gaps toward the completion of the objective), executing that plan and measuring progress towards its completion. Many of these objectives will require cross-divisional work and objective leads will have to coordinate with many subject matter experts. Additionally, existing NGS programs which cross cut many objectives are writing strategic plans to fit the NGS wide 10 year plan. Those plans will both clarify how all the pieces fit and provide a clear way forward.

Goal 1: Support the users of the National Spatial Reference System

This is an **operational** goal. Its focus is on maintaining the good work NGS currently does through all of our *operational* products and activities. Where a product is incomplete, under development, or otherwise not operational, it is *not* part of this goal. This goal is listed first in order to acknowledge that the majority of NGS resources are currently dedicated to maintaining existing operations, not improving them.

Objective 1-1: Maintain the capability to ingest internal and external survey data, analyze it, store it and return useful information to the public

Nickname: Bluebooking and Datasheets

Description: For many years, NGS has used a very complex, rigorous process of assuring that quality survey data are being used to compute various geodetic quantities on passive control bench marks. Most of this information is reported on one of the primary products of NGS – the "datasheet." The specification which describes the format of the submitted survey data was originally published by the Federal Geodetic Control Subcommittee (FGCS), of the Federal Geographic Data Committee (FGDC) under the title "Input Formats and Specifications of the National Geodetic Survey Data Base." Because that document was published with a blue cover, the process of submitting survey data came to be called "bluebooking." However, so much more is part of this objective than just the actual blue book. To properly ingest data accurate orbits must exist; GNSS antennas and level rods must be calibrated; least squares adjustment software must exist; a network of CORS stations must be monitored; and an up-to-date datasheet creation program must be maintained, just to name a few.

This objective intends to maintain the current ability of NGS to ingest GNSS and leveling surveys through "bluebooking." (While this process is a bit dated, and in need of an update, those updates are covered in Objective 2-3. Once those improvements have been made, this objective will continue. To wit, bluebooking will be maintained after "re-invention," in its new form). This objective addresses the fact that bluebooking as it exists in 2012 should not be interrupted while improvements are being developed.

Examples of strategies supporting this objective:

- Accept all complete GNSS projects from outside users in bluebook format, evaluate them, adjust them to the latest realization of NAD 83, and load appropriate ones into the NGS Integrated Database (IDB) within (an annual median timespan of) six weeks of receipt
- Accept all complete geodetic leveling projects from outside users in bluebook format, evaluate them, adjust them to the latest realization of NAVD 88 (or comparable official vertical datums, e.g. PRVD02) and load appropriate ones into the NGS IDB within (an annual median timespan of) six weeks of receipt
- Serve as an International GNSS Service (IGS) Analysis Center and perform GNSS orbit determination on a continuing basis
- Contribute to the global tracking network used by the IGS Analysis Centers
- Continually maintain the operational delivery of datasheets and other currently available geospatial products of NGS
- Select, by 3rd quarter FY13, employees responsible for maintaining and updating Horizontal Time Dependent Positioning (HTDP) and other crustal motion models (such as Vertical Time Dependent Positioning, (VTDP) and provide resources so that within one year the employee would be able to update the software

Examples of evidence of progress:

- Annual median delay in loading GNSS projects never longer than six weeks
- Enhanced and new tools to facilitate existing bluebooking process are deployed, such as improved database checking and loading programs, new analysis tools (e.g., Geographic Information Systems (GIS) tools for GNSS and leveling), enhancement of Leveling Online Computations User Service (LOCUS) to allow fully constrained multiple-line adjustments, refine ADJUST to simplify its use (in the short term; see Objective 2-3 for the longer term)
- Daily orbit computations
- There is a dedicated employee maintaining HTDP

Objective 1-2: Maintain annual production of the national shoreline

Nickname: Shoreline

Description: The National Shoreline is that shoreline shown on NOAAs nautical charts and provides critical baseline data for updating nautical charts; defining our nation's territorial limits, including the Exclusive Economic Zone; and managing our coastal resources. The National

Shoreline contributes to our nation's economy by supporting activities including maritime trade and transportation, coastal and marine planning, coastal engineering and construction, scientific research, and the insurance industry, to provide a means for enhancing our global competitiveness and more efficiently managing our resources.

Examples of strategies supporting this objective:

- Conduct shoreline mapping to meet annual NOAA charting requirements
- Update shoreline in ports to meet annual NOAA charting requirements
- Conduct Coast and Shoreline Change Analysis Program (CSCAP)
-
- Conduct Emergency Response missions to meet NOAA requirements and continue to develop the capability to meet national interests

Create NOAA Coastal Mapping Survey Priorities plan and update plan annually

- Maintain operation of VDatum (a datum conversion tool)

Examples of evidence of progress:

- Annual delivery of shoreline delivered to meet NOAA Nautical Charting requirements
- Number of ports with updated shoreline delivered to meet NOAA Nautical Charting requirements
- Annual evaluation of priority ports for coast and shoreline change to be used for updating NOAA Nautical Charts
- Timely, near real-time geo-referenced imagery is provided in the wake of natural or manmade disasters to meet NOAA requirements or when tasked by the appropriate federal partners
- Coastal Mapping Survey Priority plan published

Objective 1-3: Maintain airport surveying operational capacity

Nickname: Airport Surveys

Description: The remote sensing and field operations expertise required to fulfill congressional mandates is well illustrated through the Aeronautical Survey Program (ASP), which provides position, height, and orientation information needed for safe navigation and also provides quality assurance of this data if collected by private surveyors. These surveys provide critical information about airport features, obstructions, and aids to navigation. The Federal Aviation Administration (FAA) uses ASP information to establish instrument approach and departure procedures, determine takeoff weights, update aeronautical publications, and for

airport planning and construction studies. ASP also supports the FAA to develop standards and guidance documents for conducting aeronautical surveys.

Examples of strategies supporting this objective:

- Annually conduct aeronautical surveys and provide quality assurance of commercially conducted surveys
- Provide routine training and outreach to ASP partners and commercial surveyors
- Annually conduct remote sensing studies to verify and provide improved accuracies for obstacles in the FAA Obstacle Repository System

Examples of evidence of progress:

- Meet yearly FAA deliverables for Aeronautical Survey Program
- Identification of out-year funding and requirements

Objective 1-4: Maintain geodetic surveying operational capacity

Nickname: Field Operations

Description: Historically, NGS has maintained many field crews to perform critical field work in areas such as leveling, GNSS surveys, gravity surveys, shoreline collection, and more. Although the way NGS does business has changed in recent decades, such that fewer field crews are needed, it is still critical that the capacity and expertise required to do these types of surveys exists in house. NGS employees are the resource and authority for many surveying activities and must know and fully understand the associated field work procedures in order to properly quality check data, assess the work of partners, write field standards and guidelines, integrate new technologies into current survey practices and procedures, and undertake the foundational surveys for which NGS is the authority. NGS employees also provide technical support and training to private surveyors who perform these various types of surveys.

Examples of strategies supporting this objective:

- Perform routine geodetic surveys and training in coastal and wetland environments to provide scientific research and monitoring programs sufficient access to the NSRS

- Perform at least two Geoid Slope Validation Surveys (GSVS) prior to 2022
- Annual training for all field personnel and office personnel involved in NGS surveys
- Maintain the Table Mountain Gravity Observatory (TMGO) facility and instrumentation, and training employees in the instruments' use for continuity in their operations.

Examples of evidence of progress:

- New survey and evaluation methods/workflows\
- Completion of two NGS-led terrestrial geodetic surveys per quarter (leveling, GPS, gravity, etc.)
- Maintain current yearly totals of surveys reviewed and added to the NGS database.

Objective 1-5: Maintain online tools to access the NSRS

Nickname: Online Tools

Description: The most up to date information on geodetic coordinates is derived using active control stations, or CORS. Many NGS software tools make use of GNSS data from CORS and can provide users with timely access to the NSRS. Although CORS have many uses, including control for "Bluebooking" (Objective 1-1), their maintenance and monitoring, as well as the use of the OPUS software suite, are included in this objective. In addition to the well-known GNSS tools in OPUS, NGS also has developed the Leveling Online Computation User Service (LOCUS) as part of the greater set of automated online positioning tools for the users of the NSRS. The improvements for CORS and OPUS are subsequently described in Objectives 2-1, 2-2, and 2-3.

Examples of strategies supporting this objective:

- Compute IGS and North American Datum of 1983 (NAD 83) coordinates for each CORS on a daily basis
- Calibrate single and multi-frequency geodetic quality GNSS antennas and publish calibration data in accordance with IGS Standards within one month of receipt
- Accept dual frequency GNSS submissions from outside users submitted to OPUS, process and return results within 15 minutes of receipt for 95% of all submissions

Examples of evidence of progress:

- Positive status reports and web transaction logs of CORS and OPUS

- Coordinate time series plots for all CORS are available on-line to the public
- No decline in monthly counts of OPUS solutions
- New antennas calibrated at the NGS Facility at Corbin, Virginia within one month of production

Goal 2: Modernize and Improve the National Spatial Reference System

This goal is about **projects** – agents of change for the better. Its focus is on improving things NGS is doing (under three categories: **Starting** new work, **improving** existing work and **retiring** outdated work). Each of the objectives under this goal is effectively a project (or program, consisting of multiple projects). That is, they are temporary ventures with a specific product or output which, if adopted, will change operations.

Objective 2-1: By 2022, reduce all definitional and access-related errors in the geometric reference frame to one cm when using 15 minutes of GNSS data

Nickname: Replace NAD 83

Description: The North American Datum of 1983 (NAD 83), in both its definition and in the services through which NGS provides access, needs improving. From the standpoint of its definition, NAD 83 is non-geocentric by over two meters and has non-zero, residual plate velocities. Both of these exist, despite NGS' best attempt in the 1980s to originally define NAD 83 as "geocentric" and "plate fixed." Since the mid-1990s, NAD 83 has been defined through its relationship to the International Terrestrial Reference Frame (ITRF) of the International Earth Rotation and Reference System Service (IERS). The ITRF itself is realized through the analysis of data from four primary space geodesy observation networks (Very Long Baseline Interferometry (VLBI), Satellite Lase Ranging (SLR), GNSS and Doppler Orbitography and Radio Positioning Integrated by Satellite (DORIS)). Because of this reliance upon the ITRF, NGS has the duty to contribute to the upkeep of ITRF. However, the running of VLBI and SLR sites by the U.S. Government is currently a National Aeronautics and Space Administration (NASA) function. NGS has contributed to the ITRF through re-starting the IERS Site Survey program (ISS) and by acting as both an analysis center and analysis center coordinator of the International GNSS Service (IGS), which represents the GNSS arm of the ITRF. However, NGS can, and will, do much more than this in the future. Because of poor geographic coverage of the IGS tracking network in the USA, NGS has proposed the installation of new GNSS sites which are suitable to be used as IGS fiducial sites. These new installations will be called

"Foundation CORS," and NGS is scheduled to begin installation of the first ones in 2013, with about 20 total before the set is complete.

As a separate issue, over and above datum definition, users often have to take hours of GNSS data, and post process that data in order to achieve one cm of positional accuracy within the datum itself.

Improvements in all of these areas can be combined into this one overarching objective, which will be to improve tools over the next ten years, while preparing for the ultimate replacement of NAD 83 by a truly geocentric reference frame.

Examples of strategies supporting this objective:

- Start establishing and continue to establish one Foundation CORS each year until 2023
- Conduct one International Earth Rotation and Reference System Service (IERS) local terrestrial site survey each year until 2023
- Continue to improve access to the NSRS, i.e. Precise Point Positioning (PPP), RTNs, by 2017
- Define the term "plate fixed" in a way that is implementable and truly provides for the least change to the most coordinates over time on the various plates by 2015
- Perform research on alternative ways to use GNSS to access the NSRS, besides maintenance of a GNSS differentially-processed network with thousands of stations by 2023

Examples of evidence of progress:

- Increasing number of Foundation CORS
- NAD 83 stakeholder transition plan exists
- Increasing number of IERS site surveys
- Research papers published comparing PPP to Differential GNSS.

<u>Objective 2-2:</u> By 2022, reduce all definitional and access-related errors in orthometric heights in the geopotential reference frame to two cm when using 15 minutes of GNSS data

Nickname: Replace NAVD 88

Description: The North American Vertical Datum of 1988 (NAVD 88) is in need of improvement, in both its definition and in the services NGS provides to access it. From the standpoint of definition, NAVD 88 has a bias of half a meter and a one meter tilt, relative to the best known geoid model. As for access, users often have to take hours of GNSS data or else rely on passive control whose heights may be decades old. Vertical motion is not tracked in any systematic way, although its existence has been known for decades.

The NGS National Height Modernization Program (Height Mod) will play a significant role in this objective. Improvements in all of these areas can be combined into this one overarching objective, which will be to improve tools over the next ten years while preparing for the ultimate replacement of NAVD 88 by a true 4-dimensional geopotential field, capable of describing heights, deflections and other aspects of the gravity field at any location on or near the Earth's surface. Of specific interest to NGS stakeholders, the vertical datum will be accessed through GNSS and an accurate geoid model rather than through publication of heights on passive geodetic bench marks. Furthermore, NGS must develop a comprehensive strategy for incorporating past and future leveling data into a GNSS/geoid based vertical datum, and provide this guidance to NGS stakeholders. This must include a connection between the new geoid based vertical datum and the update to the International Great Lakes Datum (IGLD) in 2015.

The early years of Height Mod focused on improving access to NAVD 88 (and other official datums) by using GNSS to establish orthometric heights. The Height Mod program's effectiveness at densifying the passive control network has greatly improved the hybrid geoid model, and it continues to work with partners in this effort. As Height Mod has expanded and grown, the program additionally supports the GRAV-D project and continued improvements to geoid modeling; improvements which will be instrumental to the replacement of NAVD 88.

Related to all of the above work, NGS must ensure an actual connection to the NSRS and charting data. The National Tidal Reference Service (NTRS) used for oceanographic charts, created by the Office of the Coast Survey (OCS), is maintained through the National Water Level Observation Network (NWLON) of the Center for Operational Oceanographic Products and Services (CO-OPS). NGS will work with these agencies to use GNSS technology to track vertical motion of tide gauges and great lake water level gauges to maintain the accurate connection between NSRS and Charts.

Examples of strategies supporting this objective:

- Compute and publish a gravimetric geoid model for all US territories, annually, using all available gravity sources, until 2021

- By June 2013, develop, and get approval of, a plan for improving and executing the long term terrestrial gravity program of NGS, and by January 2018, have all elements of the plan successfully executed
- Rigorous vertical deflections database exists by 2023
- Achieve a ground-based network for monitoring temporal changes to geoid in five years
- Investigate how and whether existing leveling can be used to improve the definition of the new geopotential framework, and how it would be incorporated into the geopotential reference surface once it is established.
- Use Interferometric Synthetic Aperture Radar (InSAR) and other remote sensing technologies to monitor vertical motion in the U.S.

Examples of evidence of progress:

- NAVD 88 stakeholder transition plan exists
- A vertical crustal monitoring expert is hired or identified
- GRAV-D percentage flown meets Government Performance and Results Act (GPRA) standard
- Gravity and deflection database manager hired or identified
- Increase the number of successful research grants (academic or private industry) supported by and supporting Height Mod

Objective 2-3: ***By 2018, increase the efficiency and accuracy of soliciting, accepting, processing, storing, reporting the results of and re-processing all survey data while maintaining the standards of quality expected by external users.***

Nickname: Re-invent Bluebooking

Description: Prior to the 1980s and the rise of GPS, NGS generally received and stored data from only its own field parties, for the exclusive purpose of providing static, definitive coordinates on passive control to define, maintain and provide access to the NSRS. With the completion of the original NAD 83 and NAVD 88 projects, and the rise of easy-to-use GPS equipment allowing for geodetic quality surveys by a broader number of people, NGS began accepting external survey data, but still for the same purpose – expanding or updating the static, definitive coordinates on the passive control network of the NSRS. As of 2012, over 90% of all survey data processed by NGS came from external parties, via the FGDC's specifications.

As first mentioned in the 2008-2018 NGS Ten Year Plan, the era of expanding the passive control network for the purposes of providing a static coordinate on a point, is coming to an end. Still, there are other (real, critical, and perhaps legal) reasons for surveying passive control bench marks; these include monitoring vertical motion of critical infrastructure, such as levees; providing a local network in order to re-create active stations like tide gages and CORS in the event of their failure; and providing an updated coordinate on a starting point from which a non-GNSS survey (such as leveling or transits) may begin.

In 2012, NGS debated, and as a matter of policy decided to continue to receive survey data from outside parties. But this decision came with the understanding that the purpose of such surveys is not to expand the passive control of the NSRS using the same "most recent coordinate wins" business model. Rather, the tools NGS will build for the future will include those which allow users to easily see and understand all of the information, both historical and recent, which exist on a point, including the estimation of a point's motion into the past, or its secular motion into the future. Being "bluebooking," is the way to put survey data into the NGS IDB, under the current business model, then "bluebooking" must be "re-invented."

Tools such as OPUS-Database (OPUS-DB) and OPUS-Projects, which are currently in various stages of development, will be completed to one day carry the weight and authority of bluebooking, while supporting the new business model of using survey data for the NSRS of the future.

Examples of strategies supporting this objective:

- By January 2014, produce a software design document for the current GNSS project processing and a design for an improved, more efficient process
- By January 2016, NGS will have rebuilt the entire GNSS holdings of the IDB through re-processing of hundreds of thousands of original receiver files
- Assess long term viability of NGS Electronic Distance Measurement Instruments (EDMI) Calibration Base Lines (CBL) program by Sept 2013; operate the CBL Service on an as-scheduled basis until assessment is made
- By January 2014, develop and implement a new, efficient method of soliciting, accepting, processing, storing, reporting the results of and re-processing **GNSS** projects from external users, all while maintaining the standards of quality expected by external users
- If it is determined that leveling will continue to be used and ingested by NGS, then by January 2018, develop and implement a new, efficient method of soliciting, accepting, processing, storing, reporting the results of and re-processing **leveling** projects from external users all while maintaining the standards of quality expected by external users

- By January 2016, develop and implement a new, efficient method of soliciting, accepting, processing, storing, reporting the results of and re-processing **terrestrial gravity** projects from external users all while maintaining the standards of quality expected by external users

Examples of evidence of progress:

- A project plan for re-inventing bluebooking exists
- The entire GNSS archive at NGS is categorized, stored, and readily accessible in a geodatabase
- A modern format (e.g., XML) of the NGS datasheet replaces the current datasheet
- OPUS-Projects (i.e., PAGES/GPSCOM) proven as good as or better than PAGES/ADJUST
- Written documentation as to the processing steps for accepting leveling, GNSS and gravity field projects

Objective 2-4: *Continually increase use of commercially available software, and usefulness of all NGS products and services, and interoperability of NGS software with commercial software from 2013 to 2016.*

Nickname: Fix the Toolkit

Description: NGS has over 800 computer programs (many of which are obsolete), in its total geodetic "toolkit," of which a small portion are publicly available. Most of these programs were written decades ago, and in response to a particular need, without much consideration of overlap with other programs. This has led to two basic difficulties. The first is that NGS employees as a whole do much of their work in command-line mode, rather than through commercially available geospatial software, such as those that are used in a GIS. This failure to adopt such software also means that many tools written by NGS are not geared explicitly for the large growing field of geospatial professionals who are GIS-literate.

The second problem is that related programs have no consistency. As an example, VDatum, NADCON, VERTCON and INTG (all official products of NGS) interpolate data off of a grid using different interpolation methods. This inconsistency creates systematic errors when comparing data from various products.

It is NGS' intention to properly evaluate the tools it provides to the public, and begin a program creating of consistency and modernizing, effectively cleaning up the toolkit to make it a more user friendly and scientifically accurate product for the nation. Future products and service of NGS should be broadened beyond dissemination of coordinates to include accuracy, velocity, and useful metadata about geodetic control.

Examples of strategies supporting this objective:

- By January 2015, evaluate the entire suite of programs offered online by NGS and develop a prioritized plan for continuing, fixing or retiring every program in the entire suite
- Provide complete coverage of VDatum for the entire United States by January 2018
- By June 2014, offer at least one product or service of NGS with a web service capability able to integrate with GIS and surveying tools
- Consolidate multiple versions of interpolation modules into a standard toolkit by 2014
- Ensure transformations between datums are freely available, transparent, and consistent with the most recent global standards by 2018
- Achieve the public availability of a single datum/plate motion software, incorporating all aspects of VDatum, NADCON, VERTCON and HTDP, by 2016
- Develop an online feedback tool for every tool in the toolkit

Examples of evidence of progress:

- A well-defined list of applications that are tied directly to quality control activities.
- VDATUM, GEOCON, NADCON, VERTCON, HTDP all rolled into a single comprehensive transformation tool
- Increased number of GIS licensed software and GIS trained employees

Objective 2-5: Continually improve the efficiency and accuracy of geospatial data collection methodologies

Nickname: Better Surveying

Description: Originally, the only surveyors who provided data to NGS for creating the NSRS were NGS' own surveyors. NGS employed the nation's geodetic surveying experts. Over time, and especially as local users densified the passive control network using leveling or GNSS, the

field of geodetic surveying grew. NGS' role as the nation's sole source of expertise dwindled, as our stakeholders relied more and more on CORS and networks provided by the GNSS receiver manufacturers.

This situation is viewed as untenable, as "access to the NSRS" (part of the NGS mission) includes providing instructions to users on the best field procedures. As such, NGS will engage in a renewed effort of field surveying research, updating geodetic surveying manuals to the latest technologies, and verifying these manuals with scientific fact. That is, NGS will re-invest in creating surveying standards, not merely guidelines. It is understood that active research of new technologies or existing technologies for new purposes will also be important to improving surveying in NGS.

Examples of strategies supporting this objective:

- By January 2014, replace NGS 58 and NGS 59 with new guidance on best practices for using GNSS to obtain (1) ellipsoid heights (2) orthometric heights and (3) dynamic heights, addressing also how the replacements for NAD 83 and NAVD 88 will impact such work
- Write new standard field procedures for NGS-conducted GNSS, leveling, gravity and transit surveys (including Airports) by June 2014
- Through implementation of the NGS IERS Site Survey (ISS) program, contribute to future realizations of the IGS frame and ITRF by conducting an annual local site survey for the IERS and actively participate in the IERS site survey and co-location working group
- Research new surveying technologies and techniques which may have the potential to improve the production cycle without increasing costs

Examples of evidence of progress:

- NGS 58 and 59 replaced with new manuals based on scientific studies
- A prioritized field surveying research plan exists
- A new leveling manual is written
- A new gravity surveying manual is written

Goal 3: Expand the National Spatial Reference System stakeholder base through partnerships, education, and outreach

This goal is about the **public** – current users of the NSRS and those groups who would benefit greatly from beginning to engage with NGS. Its focus is on reaching new stakeholders, providing training and education to existing stakeholders, and improving NGS' ability to meet our mission through engagement of outside experts. Objectives under this goal either demonstrate how NGS plans to engage with the public or responds to an existing stakeholder need which NGS aims to meet. In many cases the objectives and activities pursued under this goal will be done continually, rather than on a set timeline, to ensure NGS is constantly engaging more users and improving interactions with existing stakeholders.

Objective 3-1: Provide a process for RTN operators to validate that their RTNs are aligned to the NSRS to NGS's acceptable standards by 2015.

Nickname: Validate RTNs

Description: Real Time Reference Networks (RTNs) are providing a fast and efficient method for users, in particular, the survey community, to utilize GNSS to obtain centimeter positioning nearly instantaneously, thus eliminating the need for additional equipment and post-processing of their data. NGS recognizes that a large and growing number of people in the positioning community rely on RTNs. Most of the RTNs have the capability to express coordinates in the NSRS, yet NGS does not have any formal guidance or mechanism to validate whether such coordinates are consistent with the NSRS or to what accuracy. NGS' responsibility includes providing "access to the NSRS," and therefore views the situation as one requiring clarification and validity to the end user.

Considering RTN use is expected to grow, it would be prudent to engage the RTN user community by seeking to jointly develop a methodology by which users of RTNs may have a complete understanding of how their derived coordinates are consistent with the NSRS.

Examples of strategies supporting this objective:

- By January 2015, define and make operational a process for RTN operators to validate that their RTNs are aligned to the NSRS to NGS's acceptable standards
- By January 2014, hold an RTN symposium
- A new NSRS compliant RTN validation manual is written
- A new NSRS compliant RTN user manual is written
- NGS enters into a public-private partnership with an RTN operator for the purpose of directly validating the procedures outlines above
- A list on the NGS website of "valid" RTNs

Examples of evidence of progress:

- RTN operators routinely meet with NGS to discuss validation
- Feedback from Symposium will be used to update NGS RTN Guidelines
- Manuals are completed

Objective 3-2: Annually increase the number of stakeholder communities directly educated or engaged by NGS

Nickname: Engage new stakeholders

Description: As the global community becomes more "geospatially enabled" (consider how many electronic gadgets are carried with some form of GNSS enabled technology inside), the potential for misunderstanding and misuse of that data grows. For example, street maps in smartphones contain no metadata on the geometric reference frame underlying that data. This is not yet a problem, with GNSS being inaccurate to a few meters at ground level. But as GPS gives way to multi-constellation GNSS and further technological improvements arrive, the two meter horizontal offset between NAD 83 and the World Geodetic System 1984 (WGS 84, an international geodetic reference frame) will become apparent, and affect "lane information" navigation. That is, GNSS will tell a car where it is in WGS 84, while the roads may be in NAD 83, and failure to account for the different frames will make a serious difference to lane identification.

Another example of the need to educate stakeholders is that of environmental scientists having a newfound capability to very precisely geo-reference data sets without fully understanding the advantages to connecting those measurements to the NSRS.

NGS has a long history of engagement with other related agency such as the U.S. Army Corps of Engineers (USACE), National Geospatial Intelligence Agency (NGA), U.S. Geologic Survey (USGS), Federal Emergency Management Agency (FEMA), and state geodetic agencies. Considering the vast number of changes proposed in this plan NGS will increase partnerships and engagements with these and other agencies to ensure their successful adoption of an improved NSRS.

In order to address issues like the above, NGS intends to reach a broader audience, with user-friendly educational material. If NGS can reach a broader community of users with the same tax dollars used to support its mission, then the efficiency of those dollars spent grows. While the NGS Corbin Training Center (CTC) has provided training to non-traditional customers such as environmental scientists in the past, the focus has been on high accuracy geospatial professionals. The CTC should reach out to a broader spectrum of the geospatially enabled public (such as offering a fundamental course on geodesy to GIS professionals).

Examples of strategies supporting this objective:

- Host National Partner and Stakeholder meetings or 'town halls' to brief stakeholders on changes to NGS products and services, and get user input
- Participate in regional conferences held by our partners
- Solicit feedback to NGS operational activities
- Engage the local user community where NGS field activities are being conducted. This can be done through NGS regional advisors, Spatial Reference Centers, universities, or other partners
- NGS will develop a plan to engage with academia, private sector, and other government agencies (federal, municipal, state, and tribal)
- Convert the Geodetic Glossary into the first draft of an NGS wiki by June 2013
- Complete a formal needs assessment of user community, especially non-surveyors, regarding NGS products and services by Sept 2016
- By 2015 implement a partnership program to establish strategically located, OPUS-DB derived passive "commemorative" monuments in high visibility locations, such as visitors centers for national parks with the function of "calibrating" GNSS hand held devices and educating the public about NGS
- Build capacity within the user community and keep them informed about NGS activities, products and services through training classes and workshop efforts

Examples of evidence of progress:

- Increasing numbers of attendees at Corbin Training Center classes and NGS webinars

- Completed needs assessment of user community
- Satisfaction of web site visitors is high as measured through a customer satisfaction review service (e.g. foresee)
- An on-line suggestion box is active and it is demonstrated that suggestions are being considered and some acted upon

Objective 3-3: ***Annually increase the number of collaborations between NGS and Universities for solving research problems for the next three years.***

Nickname: University engagement

Description: Graduate students, mentored by professors, can become a significant resource augmenting the research completed by paid professionals. NGS recognizes this fact, and the additional fact that every interaction or collaboration with a University has the potential to lead to new hires for the agency.

Regardless of the type of collaboration, whether it be more grants, the encouraging of NGS employees to achieve advanced degrees, or the teaching of seminars by NGS employees at Universities, these collaborations generally should increase over the next few years and then be maintained indefinitely.

Examples of strategies supporting this objective:

- By January 2014, develop a one-hour seminar, at the college level, on NGS, and deliver the seminar to at least four American universities per year, every year
- By 2015, provide direct and indirect support to academic institutions with geodetic, surveying, and remote sensing programs to develop and maintain NGS core capability
- By 2015, build and leverage interagency and academic partnerships (JALBTCX, UNH/JHC, etc.)
- Increase collaborative research with Universities by 2014
- Prepare technical specifications and geographically-prioritized plan for potential partners, most of which would be universities, to participate in the GRAV-D program by collection ground based gravity data and provide a webinar to potential partners to introduce the criteria by Sept 2014

Examples of evidence of progress:

- Graduate students are working on NGS research problems
- NGS employees sent on long term training
- NGS materials are routinely used in an increasing number of academic courses and professional organizations' continuing education.

Objective 3-4: *Increase online stakeholder engagement and improve NGS response mechanisms.*

Nickname: Dynamic web presence

Description: In the era prior to e-mail, questions for NGS came in the form of written letters, which were then filtered through the information center for eventual reply by appropriate individuals. Today, 200 employees of NGS each with their own e-mail address provide 200 entry points through which people may send inquiries. This has come to mean less consistent answers, and a serious drain on NGS employees who feel obligated to respond to constituents directly.

NGS intends to consolidate its web presence, focusing it on both outward looking materials (such as education and outreach), as well as building a tiered response system for inquiries, much like the system of old, where questions are tracked and monitored for consistency of message. Examples of this are a recently initiated "speaker request queue," instituted in 2012 as the one and only method by which external users can request an NGS employee to travel to a function for an user-requested speaking/educational engagement.

Examples of strategies supporting this objective:

- Develop and implement a tiered "request" queue for all queries from the public, by June 2014
- Support current and potential users of the NSRS by developing a "speaker request" policy to ensure NGS is effective and efficient with its resources by matching appropriate speakers to requests by July 2013
- Expand Info Center Services by 2016
- Improve consistency in receiving, tracking, and addressing comments from users of NGS products and services by Sept 2016

Examples of evidence of progress:

- NGS Facebook page running and updated
- FGCS website continually updated and maintained
- NGS Twitter account running and tweets sent out on a regular basis to update stakeholders on major events and new items

Objective 3-5: *Achieve creation of an online educational portfolio and reduce latency of all components to at or below five years by 2017*

Nickname: Educational portfolio

Description: Through creation of the Corbin Training Center, NGS dedicated itself to providing training and education outreach to users of the NSRS. NGS then took a further step of organizing all of the outreach presentation materials in a single, easy to use website. With these first steps in mind, NGS will continue to organize its overall "educational toolkit," making sure that information is easy to find, up to date, easy to use and regularly monitored.

The initial steps must be geared toward improving the actual field manuals NGS uses and provides to the public, as these are truly "learn only by doing" manuals which teach people how to access the NSRS accurately. Furthermore, NGS should engage universities to make sure that the textbooks which are being written have the latest NGS material in them. Eventually, material even down to the elementary school level will be available on the NGS web page for teachers and professors to use in the classroom.

In addition to this, NGS should engage professional surveying organizations to help design and vet the content of NGS field manuals to ensure their value to geospatial professionals.

Examples of strategies supporting this objective:

- Inventory the entire (truly) operational product and service suite of NGS, and develop some form of training, manual or tutorial (online or not) for each by January 2014
- Develop three new outreach/education learning modules by 2016
- Develop curriculum and training materials for core geodetic topics by July 2016
- Support current and potential users of the NSRS through web based and classroom training opportunities. At least one training option each year will highlight the new

datums and at least two will be on OPUS Projects, once it is an official NGS tool, by 2018

- Review and revise specifications and guidelines for acquiring heights using leveling and GNSS by Sept 2015 (first draft) and the final draft by Sept 2016
- Educate state lawmakers and professional societies regarding the planned replacement of NAD 83 and the need to address NAD 83-specific laws

Examples of evidence of progress:

- Seminars or webinars on new datums created and regularly delivered
- A "new datum informational packet" prepared for state lawmakers to assist in changing NAD 83-specific laws
- Web based training modules on core geodetic topics completed and available by July 2016
- Manuals or tutorials for each NGS operational product or service exist

Objective 3-6: *Increase the use and users of data obtained through and provided to the Integrated Ocean and Coastal Mapping Program (i.e. "Map once use many times")*

Nickname: IOCM

Description: Recognizing the availability and the multiple-uses of ocean and coastal geospatial data that includes uses for shoreline data, as well as other applications, NOAA implemented the Integrated Ocean and Coastal Mapping (IOCM) program in 2007. The mission of IOCM is to plan, acquire, integrate, and disseminate ocean and coastal geospatial data and derivative products in a manner that permits easy access to and use by the greatest range of users- or "Map once, use many times". NGS has embraced this program, as the Coastal Mapping Program (CMP) data has many uses and stakeholders beyond nautical chart applications to include other government agencies, as well as state, local, and public entities along the coast. NGS intends to continue to broaden the useable products that come out of the CMP as well as leverage IOCM partner data for use in CMP products, without expending significant additional resources, and thereby gain more efficient use of tax dollars.

Examples of strategies supporting this objective:

- By June 2015, identify (in conjunction with CO-OPS and Coast Survey) applicable IOCM requirements for topographic-bathymetric LIDAR, and incorporate those requirements into LIDAR-based coastal mapping program data collections
- Research and develop a methodology to extract bathymetry from commercial satellite imagery to meet NOAA Nautical Charting requirements including reconnaissance of uncharted regions and remote areas
- Continue to be a leader in IOCM and leverage this leadership to align data providers and stakeholders
- Develop the Continually Updated Shoreline Product (CUSP) as a new, separate product from the National Shoreline currently mapped by NGS

Examples of evidence of progress:

- Delivering topographic/bathymetric (a.k.a. topo-bathy) elevation data that can be reliably used for shoreline extractions and shallow water depths to NOAA standards
- Delivery of reconnaissance bathymetry for Alaska and the Pacific Trust Territories
- Operational availability of CUSP by Q2 of FY13
- IOCM partner data incorporated into CUSP and shoreline products and vice versa

Goal 4: Develop and enable a workforce with a supportive environment

This goal is about **employees**, current and future, who enable NGS to fulfill its mission. Its focus is on ensuring NGS has the most qualified workforce, employs experts in many fields, and that existing employees are trained and compelled to be better so that NGS can meet its mission in the long term. Each of the objectives under this goal aims to develop employees and the workforce as a whole to best meet the needs of NOAA and the Nation. This goal also attempts to instill best practices in the workforce so that projects, like those undertaken to fulfill the preceding goals, can always be performed consistently.

Objective 4-1: Annually increase the scientific and technical knowledge and capabilities of NGS' workforce

Nickname: Educated Workforce

Description: The fields of geodesy and remote sensing are small, compared to many other disciplines, and the number of institutions generating degrees in these fields are shrinking, reducing the number of persons hired with actual "geodetic or remote sensing science" degrees over the last ten years. Working at NGS requires attention to geodesy, and it is therefore imperative that employees have significant knowledge of finer geospatial details of what the agency does, so that they may more effectively perform their own job within the agency.

In order to accomplish this, NGS will use a combination of employee-led educational classes, long term training, and guest lecturers to broaden geodetic knowledge throughout the agency.

Examples of strategies supporting this objective:

- Develop four in-house classroom training courses (for employees/contractors of NGS) on basic geodesy, remote sensing, surveying, least squares adjustments and NGS operations by June 2013, and offer these courses on a bi-annual basis through the Corbin training center. For example, compare CATREF, NETSTAT, GPSCOM, and ADJUST
- Increase the number of NGS employees actively involved in professional organizations
- By June 2014, provide at least one day of training yearly in GIS to every employee of NGS

- Provide and encourage rotational assignments within and outside the organization to share and gain knowledge of core function areas
- Increase the use of GIS, provide a way for NGS to perform core data processing, analysis, and display in a GIS environment increasing productivity and geographical analysis by Sept 2015
- 80% of NGS geodesists, technicians, and program analysts will use NGS products and tools in computer languages and platforms developed in the last decade by 2018
- Develop a training plan for educating the NGS workforce about java, C++, oracle, Microsoft Office, GIS and other modern tools
- Develop an NGS orientation class for new employees

Examples of evidence of progress:

- NGS-wide employee education plan exists
- Increasing numbers of rotational assignments
- Increased number of GIS licenses on NGS computers
- Number of free licenses given to NGS by industry is increased

Objective 4-2: Align the NGS workforce with the NGS mission over the next three years

Nickname: Recruiting

Description: In the last 20 years, despite consistent efforts to bring in new employees, NGS has not been able to systematically hire to fill important gaps. Most new hires are done one at a time, often on an ad hoc basis. This has led to a situation where over half of the NGS workforce is eligible for retirement. Without a singular effort to recruit and retain new talent, NGS will encounter problems with successfully fulfilling its mission.

NGS will therefore use every tool in the allowable government personnel toolbox to recruit, hire and retain a broad spectrum of new employees in the next three years.

Examples of strategies supporting this objective:

- Employ (short or long term; contracts, internships or otherwise) at least ten new field employees before the end of 2015

- Employ (short or long term; contracts, internships or otherwise) at least ten new office employees before the end of 2015
- Create a standing vacancy for anyone to apply to, any time
- Advertise frequently and broadly to any university which has a bachelor's program in a field related to NGS work (e.g. Surveying, Civil Engineering, Aerospace Engineering, Mathematics, Physics, Electrical Engineering, etc.)
- Create educational orientation materials about what NGS as an organization does as well as individual division orientations about how each division helps NGS accomplish its goals
- Develop a training plan for education the work force in the use of GIS

Examples of evidence of progress:

- An increased count of short and long term employees, even after accounting for retirees, over the next three years.
- A standing opening for employment exists
- Quarterly flyers are posted at Universities about NGS

Objective 4-3: Achieve succession planning by 2014 and maintain it perpetually

Nickname: Institutional knowledge

Description: Much of NGS' workforce has highly specialized knowledge gained by decades of expertise and experience. Although external education and employee training can improve general knowledge about NGS specific methodologies, for the larger field of geodesy, and other specific interest areas, there is a huge resource of knowledge which is solely held by specific NGS experts. Knowledge of past surveying techniques and specific anecdotes from past adjustments are both examples of the many types of experiences retiring or retired employees alone hold. There is a critical need to immediately inventory, and maintain, institutional knowledge before it is lost forever.

NGS should immediately institute a policy of requesting "on the job documentation" including dissemination of that information through mentoring from those employees who are preparing to retire. This way, new employees may be able to do the jobs of retiring ones with continuity. Furthermore, an investigation into what institutional knowledge has already left, and which can and should be resurrected, should be pursued. Retirees who have such knowledge should be sought out and that knowledge regained and distributed to existing employees.

Examples of strategies supporting this objective:

- Define core capabilities by June 2013
- Maintain within NGS critical field experience and technical knowledge by offering at least one internal training/field experience per year - open to all employees
- Prepare a geographically-specific 'succession' plan for each region in the advisor program by 2016
- Develop a set of people who are experts on various projects, programs, key points of contact. Begin seeking additional people as needed to begin shadowing those individuals and assist with writing documents on what they do.

Examples of evidence of progress:

- Number of mentored employees goes up
- A document of core capabilities exists, broken down into office and project manuals
- An archive of core work for every employee who retires or otherwise leaves NGS in 2013 or later

Goal 5: Improve Organizational and Administrative Functionality (Enterprise Goal)

All of the above mentioned goals require that NGS operate efficiently, effectively, in a safe workplace with functioning equipment. This goal acknowledges that some significant improvements, and therefore taxpayer savings, can be gleaned from improving day to day operations and behind the scenes work. An effectively managed office is instrumental for NGS meeting its mission. The objectives under this goal help management and personnel in support roles to maintain office operations, respond to needs within NOAA, and comply with guidelines and partnerships across the government.

Objective 5-1: Achieve complete adoption of project management in NGS operations by 2016

Nickname: Project management

Description: NGS has historically been full of scientifically-minded employees. This has led to a wealth of useful service to the nation, but a somewhat unfocused and individualized approach to managing tasks, despite an ever-shrinking resource pool. Project management is a tool that NGS must adopt in order to properly plan, budget, execute and evaluate the various projects that have, historically, been performed in an ad hoc fashion.

NGS must get to a point where its business logic consists of "no resources are put toward unauthorized projects." This will include an accounting system which will prevent the under-assigning of tasks to some employees and over-assigning of tasks to others. Only when this is the case, can NGS efficiently spend resources on priority items.

Examples of strategies supporting this objective:

- Design and approve, by June 2013, a method by which project management will be part of the NGS decision making process
- By 2017, NGS will not approve any major resource allocation without a project plan being approved.

Examples of evidence of progress:

- All supervisors and managers have received project management training
- An easy project management process is developed for new and long term projects
- Software and templates exist for creating, approving and tracking projects

Objective 5-2: Continually maintain I.T. infrastructure

Nickname: I.T. Support

Description: NGS has had varied success rates with IT infrastructure. On the one hand, PCs are replaced on a regular cycle, but very little attention is paid to a long-term view of I.T. needs. Budgeting for such needs has always been ad hoc, and this must change immediately.

NGS will evaluate its actual state of I.T. needs, and prepare a budget on a "must pay" basis, prior to other projects.

Examples of strategies supporting this objective:

- Maintain all computer systems of NGS in an operational capacity, resolving 90% of all issues within 24 hours and 100% within 2 weeks.
- By September 2014, evaluate the existing and predicted future data processing load on computers within NGS and modify the number of servers necessary to achieve this load
- Transition from Sybase to Oracle by September 2014
- Create a budget that addresses and meets the I.T. operational requirements of NGS
- Use our Continuity of Operations Plan (COOP) site in Boulder and existing cloud computing technology to make our I.T. architecture more robust and fault tolerant by 2014

Examples of evidence of progress:

- Sybase completely retired
- Annual budget for I.T. part of NGS planning cycle
- Users no longer ask for computer equipment specifically nor are given a budget for computer equipment, but just request resource needs in a general sense
- Project plans allow for clearly identified computing and data storage needs along with long-term operational documentation

Objective 5-3: *Update or improve knowledge base for program evaluation through analysis of socio-economic benefits of NGS products and services on a 10 year cycle*

Nickname: Socio-Economic Awareness

Description: As part of OMB & DOC mandates (as illustrated in the FY 2012 Budget: Analytical Perspectives), offices are required to perform program evaluation on a recurring basis. Part of this program evaluation is to analyze the socio-economic benefits of services offered to the nation. However, even without a mandate, this objective carries the very real positive benefits of self-reflection, leading to improved services and more efficient use of tax dollars.

NGS has performed socio-economic scoping studies on Height Modernization (1998), CORS, GRAV-D, the NSRS (in 2009), and the Coastal Mapping Program (2012). NGS has also participated in several other studies and evaluations, including the 2010 National Research Council study "Precise Geodetic Infrastructure: National Requirements for a Shared Resource." However a comprehensive view of many other NGS products and services including, for example, the Aeronautical Survey Program, has never been done. NGS should periodically review and evaluate the socio-economic benefits and cost-benefit of NGS' signature products and services, including proposals for new initiatives such as foundation CORS. NGS will share its findings with the National Coordination Office, which are also performing GNSS socio-economic studies.

Examples of strategies supporting this objective:

- Develop a priority list of NGS products and services that could benefit from socio-economic analysis
- Gather and publicize socio-economic information relating to NGS products and services to the NGS Website
- Incorporate socio-economic information and data into NGS communications, press releases, budget formulation and outreach activities
- Work with the NOAA Chief Economist and staff on Social Science Needs Assessments and any other activities that advance and promote conducting benefit analyses of NGS products and services

Examples of evidence of progress:

- One new socio-economic benefits study (for example, on the NGS/FAA Aeronautical Survey Program) has been conducted and published
- NGS has participated in at least one interagency study through the National Academies of Science or similar entity, which investigates the socio-economic benefits of NGS products and services.

Objective 5-4: Improve the management of NGS records

Nickname: Records Management

Description:

In 2011, NGS began a process of coming into compliance with federal and NOAA-specific records retention guidelines. File rooms and cabinets were purged of trash, extra copies of publications, and all records kept beyond approved retention periods. Many things remain to be done:

- Keep NGS's records retention schedules up-to-date as NGS activities and record keeping needs evolve.
- Manage records in accordance with the retention guidance found at http://www.archives.gov/records-mgmt/grs/ and at http://www.corporateservices.noaa.gov/audit/records_management/.
- Consolidate records kept in file rooms and reallocate empty space to others in NOAA so NGS can realize savings on rent.
- Create a digital online library of all official papers ever written by NGS employees, including an offsite backup. This will replace the fragile and deteriorating paper copies which are (in many cases) the only copies of papers still available.
- Create a single system for taking in digital files of surveys and archiving them. This will replace the aging "Sybase" based Integrated Database, whose haphazard nature was the result of years of force-fitting new data into old definitions.

Examples of strategies supporting this objective:

- Conduct one records clean out day per year
- Conduct one paper shredding event per year
- Make all (appropriate) digital copies available on-line

- Establish document sharing relationships with related and similar organizations

Examples of evidence of progress:

- NGS has a digital library of every official paper ever written by employees
- An archivist is hired
- All GNSS data stored in Oracle

Objective 5-5: *Achieve a fully staffed regional advisor program by 2016.*

Nickname: Regional Advisor Program

Description: The NGS "state advisor" program has been a long standing cost-sharing partnership between NGS and various states. On many levels it is a success, especially in those states with very active geodetic communities and advisors with the right personality to engage dynamically with the citizens of the state. However, it has been a patchwork success, and one that doesn't serve the nation equitably. Recognizing this, plus the reality of shrinking state budgets, NGS determined in 2010 to transition to a "regional advisor program" consisting of a smaller cadre of advisors, all well trained and dynamic educators, able to cover multi-state regions, all at the cost to NGS alone.

Examples of strategies supporting this objective:

- Regional Advisors provided train-the-trainer opportunities in NGS-related core topics, such as New Datums, 10-Year Plan Objectives, and using OPUS
- Achieve continuity of leadership, skills, and knowledge by developing people with potential and desire for succession by 2015
- Transition from state to regional advisor program by Oct 2016

Examples of evidence of progress:

- Regions are identified by the states contained within them
- The Geodetic Advisor website is updated
- A regional advisor on-going education plan is in place by 2016

Appendix A: Comparison with the previous NGS Ten Year Plan (2008-2018)

This new plan represents a different approach to planning at its core, but many of the projects and principles found in the last 10 year plan carry through to this one. NGS continues to advance many of the same projects and continues to fulfill its mission and mandates, but with some important improvements. Below is an explanation of some changes between the two plans.

Mission

NGS maintains the same core mission across the plans; however the secondary mission from the 10 year plan is no longer articulated. Global leadership is seen as something that comes with good work, not a goal to be explicitly achieved in and of itself.

Vision

The vision in the previous 10 year plan was not descriptive of how the world would look if NGS fulfilled its mission, but rather was a statement of what NGS was doing. The new vision truly encompasses what it is that NGS is aiming for.

Goals and objectives and strategies

This terminology was used inconsistently throughout the previous 10 year plan. The five "technical improvements" in the plan were a hybrid of what are now called "Goals" or "Objectives." But, regardless of their categorization or terminology, below is a limited snapshot of how NGS did at the halfway mark:

Complete Success:

1) Began an absolute antenna calibration program
2) New CORS positions and velocities (NAD 83(2011) from the MYCORS effort)
3) Revitalization of the Table Mountain Geophysical Observatory
4) Purchase of new absolute gravimeter (A-10)
5) Digital Cameras for Shoreline Mapping
6) Critical analysis of the advisor program
7) Re-establish the membership of FGCS and keep it active
8) Continue to provide airport surveys to the FAA as requested, through a mix of core capabilities and outside contracting (overseen by NGS).

Moderate Success:

1) Proof that one cm geoid accuracy is achievable (GSVS11: in one area, and only with new airborne gravity)
2) Completion of VDatum in all areas of the USA
3) Update NGS web page
4) Efficiency of Shoreline mapping improved to 15 year cycle

Measurable, but Minor Success:

1) CORS on tide gages
2) Train all field personnel in use of relative gravimeters
3) Plan for new vertical datum
4) Joint USA/Canada North American Geoid
5) Phase out all DOS based programs
6) Make all field manuals and technical documents available digitally
7) Set aside a budget annually for visiting scientists
8) Vertical crustal velocity model

Still Awaiting Initialization:

1) Foundation CORS
2) OPUS use of any of these data: Galileo, GLONASS, single-frequency, triple-frequency, code-only, kinematic, L5 or L1C
3) GLONASS orbits
4) Hiring a gravity database manager
5) New gravity interpolation tool
6) Formally adopt a geospatial graphic and analysis tool for use by all of NGS
7) Identify critical institutional knowledge and plan to retain it
8) Develop requirements for researchers to publish regularly
9) Develop a college level course on geodesy
10) Develop K-12 educational material

Some of the items which are included under "measurable, but minor, success" and "still awaiting initialization" are included in the new strategic plan. However, after five years, NGS has determined that some of these items are no longer realistic or necessary to call out in and of themselves; for example NGS leadership does not believe that there should be a *requirement* for researchers to publish regularly (yet it is a likely outcome of determining better survey methods!). Likewise, just because complete success was reached in only five years does not mean that all work on that topic has been left out of the new plan. For example, NGS has re-established membership of the FGCS but work to maintain that group must continue and even expand. The old plan and the new plan have both called out projects on very different levels, but while this plan is a better more complete document to move NGS forward, it recognizes the importance of the majority of the original projects.

Appendix B: Acronym List

CONUS	Conterminous United States
CO-OPS	Center for Operational Oceanographic Products and Services
CORS	Continuously Operating Reference Station
DOC	Department of Commerce
FGCS	Federal Geodetic Control Subcommittee
FGDC	Federal Geographic Data Committee
GNSS	Global Navigation Satellite Systems
GPRA	Government Performance and Results Act
GPS	Global Positioning System
GRAV-D	Gravity for the Redefinition of the American Vertical Datum
IDB	Integrated Database (as in “NGS IDB”)
IERS	International Earth Rotation and Reference System Service
IGS	International GNSS Service
IOCM	Integrated Ocean and Coastal Mapping
ITRF	International Terrestrial Reference Frame
LIDAR	Light Detection and Ranging
MYCORS	Multi-Year CORS repressing project
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NSRS	National Spatial Reference System
NWLON	National Water Level Observation Network

OMB	Office of Management and Budget
OPUS	Online Positioning User Service (See Glossary for more details)
RTK	Real-Time Kinematic
SRC	Spatial Reference Center