The South Carolina Spatial Reference System

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Introduction and History

Geodetic control is defined as a set of coordinates designating the location of a point with respect to the reference planes of the geodetic Equator and a selected geodetic meridian. The duties of the South Carolina Geodetic Survey (SCGS) as defined in South Carolina Coode of Laws, Chapter 2 "Coordinate System for Defining Location of Points Within State", Section 27-2-85 are "to establish horizontal and vertical geodetic control within the state at a density that effectively will provide land and land related items and records to be referenced to the national horizontal and vertical coordinate system". A secondary mission of the SCGS is to coordinate the development of an accurate, uniform statewide mapping system on a county-by-county base. The county mapping program is a two-step process; a geodetic control survey and an aerial photogrammetric mission. Several months before the imagery of the county is taken, the SCGS completes a survey establishing geodetic control. With the control project complete, a photogrammetric firm will contract a plane outfitted with a digital camera and capture images of the entire county. Using the control, the aerial images are rectified, removing any vertical displacement from the tilt of the airplane and terrain. The result is a two dimensional planimetrically correct image. During the rectification process a coordinate system is assigned to the imagery. The mosaic of images is then imported into the county's Geographic/Land Information System (GLIS) as a base map. The same geodetic control is also used to create a digital terrain model which will facilitate the creation of contour lines.

Geodetic coordinates established by the SCGS during the county surveys use standards outlined by the Federal Geodetic Control Committee, specifically the NOAA Technical Memorandum NOS NGS-58, and *Guidelines for Establishing GPS-Derived Ellipsoidal Heights*

(Standards 2 CM and 5 CM), Version 4.3. The control is adjusted to an epoch of the North American Datum of 1983. To ensure the accuracy and integrity of the geodetic data established, the SCGS submits every geodetic control project to the National Geodetic Survey (NGS) for placement into the National Spatial Reference System (NSRS). The integrity of the data contained within the NSRS, (i.e. the attribute information of the geodetic control monument and its coordinate) are maintained by requiring every project submitted to the NGS for placement into the NSRS be submitted using a standard defined by the National Geodetic Survey called "Blue Booking". With the blue booking process protocol complete several different pieces of data are loaded into the NSRS. These include: the station name, the coordinate (latitude and longitude), the elevation, how the monument was set into the ground, and a brief set of directions describing how to find the monument. Since the data for every project is in the same format, the data can be loaded into the NSRS using the same import routine whether the project was done in South Carolina or California.

The SCGS maintains and upgrades the state geodetic network that includes approximately 20,000 monuments. When a county's geodetic network is upgraded, the SCGS consults with county and city officials and private surveyors to determine where additional geodetic control is needed to supplement the existing control that will be upgraded. The additional control is usually for new- and future-growth areas. Two of the many significant uses: Accurate vertical control is especially important for regulating development in flood-prone areas and when counties and municipalities, using GPS to accurately and quickly map and provide databases for infrastructure that are incorporated into computerized GIS systems need accuracy verification. Good practice methodologies dictate users should occupy a geodetic control monument for accuracy verification for data collected in the field. The offset from truth for data

collected at field locations should be similar to the offset observed at the geodetic control monument.

Problem Statement

Due to a shift in the paradigm of the NGS administration, discussion of discontinuing the NSRS has occurred. The focus of NGS seems to be moving away from supporting the "grass roots" and move towards a more global scientific arena. Continuously Operating Reference Stations (CORS) stations, an active network used to track crustal motion have become the focus of NGS. CORS stations have been established at various locations around the Earth. All of the data from the CORS sites are sent to the NSRS for archiving. The passive network, control networks similar to the county projects submitted by the SCGS are viewed by some of the NGS administration as data which should reside with the submitting agency instead of in the NSRS, a responsibility of the state or submitting agency and less of one for the federal government. The NSRS continues to grow as blue booked projects for passive networks are received from other federal agencies, states, municipalities, and the private surveying community. As the IT infrastructure ages, software used to maintain the NSRS becomes outdated and the focus of the NGS 10 year plan indicate the discontinuation of the NSRS, it is becoming apparent that the states interested in maintaining a network of geodetic control need to become proactive and investigate the creation of a network database similar, in concept, to the NSRS. If access to the NSRS was denied to the user by the NGS, and a state did not have a similar database operating, how would a county be able to cost effectively re-fly their aerial imagery and update their base map? How would highway engineers be able to create roads? How would the registered land surveyor layout a new subdivision? How would anyone using a receiver that tracks the Global

Positioning System (GPS) be able to know the receiver is operating properly? The answer is it would be difficult and very expensive.

The purpose of this project is two tiered. The first tier is to determine if the need for a spatial reference system, which would include a database for geodetic control, exists and the location of where the spatial reference system should reside if the NGS were to discontinue support for the NSRS. The second tier would be conceptualizing the design of a user interface for the search engine associated with the reference system's database and design the format of the output created by the search engine. Other states, North Carolina and Texas, have been proactive and have developed prototype models of reference system databases. The rationale behind the creation was not due in part to the termination of the NSRS but as a need to store geodetic information that was not submitted to the NSRS. Contact can be made with representatives of both states to discover the types of problems encountered and to learn from past mistakes. A benefit of not having an operational database may be the SCGS or an alternate section of state government, could take the prototype from the other states and redesign it to meet the needs of the users in SC. The second tier would be creating the model design for the front end of the search engine and the output generated after a query. To use the old cliché, "if it ain't broke don't fix it", creating a design model for the front end emphasis needs to be placed on keeping the interface be easy to understand and require little effort to use. Consideration of using a hybrid of the NGS search engine's front end will be considered since user familiarity exits and educational outreach would be minimal. The output created by the data query should be simple yet contain everything a user would need. Creation of a screen display and subsequent hardcopy are requirements. Output could be used for planning, an office application where a

paper copy would not be needed, or occupation of a monument in the field where the printout would be another tool required for finding the site.

Data Collection

A survey was created and used as the data collection tool for this project. Distribution of the survey and the subsequent collection of the replies in a timely manner was a concern. Consultation with the South Carolina Budget and Control Board's Office of Human Resources provided an answer for the problem using the internet service SurveyMonkey.com™ (SurveyMonkey). A survey questionnaire was created using tools contained in the software.

One group of individuals very familiar with geodetic control is the Society of South Carolina Professional Surveyors (SCSPLS). Members of the SCSPLS have used the NSRS and the various search engines to retrieve geodetic control required for projects. The SCSPLS is also very familiar with the output generated from the search engines; the NGS data sheet (Appendix 1). With this rationale a ten question survey was created focusing on the work completed by the NGS creating the NSRS. The questions of the survey were created to: 1. indicate if the need for the NSRS existed; 2. where a replacement to the NGS NSRS should be housed; 3. determine the most commonly used type of search engine and determine the best suitable interface if an interface of vector data or raster imagery facilitated searching for geodetic control; and 4. What critical pieces of information should be included in the output created by the search engine. After the survey was written, a link to the survey and SurveyMonkey was created. An email was sent to the board of the SCSPLS. Contained in the email was a request for the board to email the SCSCPL membership and request their participation in the survey. Approximately 30% of the SCSPLS membership participated in the survey.

Replies to the survey questionnaire are stored indefinitely at the site hosting the service. Several tools for analysis of the replies are provided by SurveyMonkey. Results can be filtered or cross tabbed. Filtered responses, depending on how the questions were created, allow the investigator ways to determine if regional influences affect the answers for specific questions. Cross tabbing replies provide the ability to make comparisons of questions and investigate the answers and determine if the answers are interrelated. All answers can be displayed using various styles of graph or chart types: column, pie, line, bar and area. The final results of the survey can be downloaded to offsite locations in various format types.

Data Analysis

One of the many useful tools provided by SurveyMonkey is the ability to download the replies to surveys hosted by the software company. The questions and replies to the survey used in this project are included in Appendix 2 of this project.

If the NSRS was discontinued, does the need for a spatial reference system exist in South Carolina? Tier one of the survey was designed to determine if the need for a statewide spatial reference system, similar to the NSRS hosted by the NGS, exists. Ninety-nine percent of those surveyed, the SCSPLS and GLIS technicians, confirmed the use of the NSRS. Approximately 91% of those answering the survey confirmed the extreme importance for a similar tool providing the same or similar information at the state level if the NGS were to discontinue support of the NSRS. Access to geodetic control is one way for the surveying and GLIS community to "ground truth" the accuracy of the instruments used to collect data for counties using GLIS. Data for a GLIS is collected as one of three different types of features: a point, a line, or a polygon. A considerable amount of spatial data archived in GLIS databases are

collected by receivers that record the signals transmitted by satellites in the United States Global Positioning System (GPS). While collecting data for point features, surveyors or field technicians should collect data at a geodetic control monument. Without occupying geodetic control, neither the surveyor nor GLIS technician will be able to provide an accurate quality assessment for the data. Using the same receiver, on the same day, for data collection at a point feature and the geodetic control monument, the assumption can be made that the offset distance from "truth" should be very similar for the data collected, hence the quality assessment. Chapter 2 of the South Carolina Code of Law, section 27-2-85 "Coordinate System for Defining Location of Points within State" mandates that the SCGS should establish horizontal and vertical geodetic control within the state. Since the SCGS creates the data for the spatial reference system, this mandate could indirectly be used to make the argument the SCGS should house the replacement to the NSRS. This assumption was confirmed by 96% of those responding to the survey.

The second tier of the survey focused on the creation of a user interface used with the search engine to select geodetic control in the spatial reference system's database and to design the format and screen display for output generated by the search engine. Replies from the survey indicate some interest, 17%, in having the search engine designed to operate without connection to the internet while 43% replied positively realizing the benefit of using the internet. Initial design for the search engine will require connection to the internet; updates for future use would provide the user with a stand-alone application. Up until two years ago, the search engines used by NGS for retrieving geodetic control operated with a menu based front end. Conversations with software engineers at NGS indicate the most common search algorithms for obtaining data on geodetic control include using the station name, pulling data for an entire county, and a radial search. Replies from the survey confirmed the supposition. The radial search routine requires

the user to provide a coordinate, latitude and longitude, and a radial search distance in miles. All data identified in the search criteria are provided to the user as a list. The user selects the control stations of interest. A data sheet of all selected stations is then provided for download or display. With the growth of spatial data and the use of GLIS systems an alternative to the menu driven search engine was introduced. Using background raster data provided by Google™ Earth, layers of digital data like streets, political boundaries, and hydrography and software that creates .kml files (keyhole markup language) the NGS created a search engine entitled DSWorld. DS World plots geodetic control by state, county and type (horizontal or vertical) in Google Earth. This allows the user to see the locations of the control overlaid onto a raster background. Should technology like this be used for a South Carolina search engine? Replies to the survey indicated 64% of the users saw benefits using this tool and 55% requested. Regardless of the display, required data for any screen display is road centerlines and geodetic control.

The model for the output was the datasheet produced by NGS (Appendix 1). Duplication of the output was not considered although various parts of the datasheet were. The survey questionnaire had 18 different categories to select for placement onto the output. The three replies that had 100% need were: the station name, the horizontal datum and the vertical datum. This is data the SCGS is required to maintain in the South Carolina Code of Laws. To complete the remaining most desired fields in the output were: the latitude and longitude of the monument, the state plane coordinate for the site, the elevation and estimated accuracy, can the site be occupied with a GPS receiver, and the "to reach" statement. All of these, except for the "to reach" statement, are fields requiring a character string of 80 spaces or less. The "to reach" is a field of varied length. The intent for that section is to provide to anyone interested in going to

that site the necessary instructions required to drive to the area then using accurate measurements from various identifiable landmarks, which are described in the text, find the control monument.

Implementation

Findings of the survey indicate a need exists for the SCSRS and the SCGS should maintain the database. Although it is beyond the scope of this project to design and build a spatial database, establishing the framework for development is possible. Two prototype spatial reference databases exist. The first is housed in North Carolina and was created by the North Carolina Geodetic Survey (NCGS). The second is in Texas, and was created at the Texas A&M University, Corpus Christi (Texas A&M). Contact has been made with representatives at each facility. Offers to share the databases have been extended to the SCGS. In addition to the databases, the SCGS will request any documentation, primarily a user's manual and the relevant literature about software used to create the database.

Testing of the databases will require two phases. The first phase will focus on importing the geodetic control database for SC. The NGS will export the data from the NSRS and make it available to the SCGS on their ftp site. Milestones for this test are: a successful import of the data from the NSRS, and retrieving the information from the software. The second phase tests a problem, not addressed by this survey, but a requirement nonetheless. It is imperative that the database can be updated with new geodetic control and new data can be appended to existing geodetic control. Data, submitted by the SCGS, follow the protocol specified in the Federal Geographic Data Committee (FGDC), Federal Geodetic Control subcommittee (FGCS), publication *Input Formats and Specifications of the National Geodetic Survey Data Base* (September 1994 [updated]). The publication describes the bluebooking format and procedures

of submitting data for adjustment and assimilation into the NGS data base. The bluebook format is used exclusively by the SCGS when submitting geodetic control projects for placement into the NSRS. There are sixteen counties in South Carolina requiring geodetic control projects. When a project is submitted to the NGS for placement into the NSRS all of the collected data, results from the processing, final coordinates, and the section written describing the "to reach" for the station are placed into the bluebook format. If data compatibility does not exist, modifications to the database will be required. Milestones for this test will be adding new data created from a control project, successfully updating information to existing control, retrieving data for new and modified geodetic control stations.

Interest in the use of raster imagery and vector data while conducting a search for geodetic control, another topic in the survey, was evenly split. Thoughts about using raster imagery originated from the use of a program written by the NGS entitled DS World. This application interfaces geodetic control selected after a search was conducted with the raster imagery displayed with Google™ Earth. A user interface on the Google™ Earth desktop provides to the user the ability to change the displayed from raster imagery with a layer of geodetic control data overlaid to a vector background with the same layer of geodetic control visible. When the format of display is changed in DS World, transitioning from Google™ Earth to Google™ Map, the geodetic control is no longer visible. The .kml file created for Google™ Earth does not transfer to Google™ Map.

An alternative solution could be the use of a GLIS data viewer tool. Environmental Systems Research Institute, Inc. (ESRI) has such a tool entitled ArcGIS Explorer (ArcExplorer). ArcExplorer can be downloaded from the ESRI website and used as a tool for viewing GLIS data. Incorporating ArcExplorer would require the SCGS to create layers of spatial data which

Google either has access to or owns. This data includes, but is not limited to: seamless mosaic of aerial imagery for the state, digital road centerline files, hydrography, and political boundaries. The aerial imagery would need to be subdivided into 46 county-wide layers. The user interface in ArcExplorer's will prompt the user to select a county and the type of geodetic control (horizontal, vertical, or both) or the name of a specific station. Once the county is selected, the software will search and display the various layers of data and the geodetic control. Since the imagery is compiled as a layer and if a user is interested in looking at vector data only, the raster background will vanish if the raster layer is deselected. The remaining layers of data will still be displayed.

Design of the output for the data sheet will require input from SCGS staff and the expertise of an individual hired to create the database program. Primary fields for consideration will include the "ten most wanted" from the replies to the survey. If, during the implementation phase, user response indicates additional data be included, modifications will be made. The printed data sheet will be designed to fit on a 8.5x11 inch sheet of paper using the portrait format. All of the fields have a fixed length except for the "To Reach". The "To Reach" is a text field that will vary in length based upon how much of a description is required to adequately explain in detail how to get to the geodetic monument.

Intern labor	$10.00/hr
Work day	7.5 hr/day
Work week	37.5 hrs/wk
Pay per week	$375.00
Length of Employment	10 weeks
Intern Salary for Project	$3750.00
Cost of software	$1000.00
Phase 1 expenditures	$4750.00

Table 1 Cost Estimate

Creation of the South Carolina Spatial Reference System is envisioned as a two phase operation. Having worked with the two prototype databases from NC and Texas, Phase I would be the acquisition of the database software and hiring a database engineer. Conversations

with NC and Texas indicate Oracle is the software used for their databases. If a copy of Oracle is not available from the Office of Research and Statistics and the package is not listed under state contract, retail purchase price for the package is approximately $1,000.00. A suitable candidate for summer internship would be a student from the University of South Carolina's College of Engineering and Computing with a background in database software. The analysis above provides some idea about the time and cost to fill the position (Table 1).

Phase II of the project addresses the infrastructure required to house and serve the South Carolina Spatial Reference System to the public. Consultation with the IT department of the Office of Research and Statistics (ORS), and possibly the Division of State Information Technology (DSIT), about the acquisition of a server, hosting the server, internet bandwidth required for optimal customer user, and support will be addressed at that time. DSIT has infrastructure in place to provide 24/7 service for users. DSIT's access to the internet is linked directly to the metronet. This would eliminate the probability of a bottleneck of a large number of users attempting to download geodetic information at the same time.

Project Evaluation

The results of this project can be evaluated and measured by reaching the project goals. Contact has been made with North Carolina and Texas and the downloading the databases will be done. This is a preliminary success. Having a data sheet from the National Geodetic Survey and referencing the survey results for the desired fields of output has been completed. This can be viewed as a preliminary success. Testing of the databases will follow. Evaluation will not be possible until that milestone is attained. Phase II of the project will likely follow once funding is approved and made available. The final evaluation will be feedback from the users once the

South Carolina Spatial Reference System is operational. Benchmarking the service will take a month or possibly longer. With any software, use and familiarity require time.

Summary and Recommendations

Summary - If the National Spatial Reference System is discontinued by the National Geodetic Survey, results of the project's survey indicate the South Carolina Geodetic Survey should take the initiative and build a state-wide spatial reference system. The SCGS should host and maintain the system, append the reference system's database with new geodetic data, update existing geodetic control with new information, and make everything contained in the spatial reference system available to users.

Recommendation – Download and analyze the databases from North Carolina and Texas. Test each and determine the likes and dislikes. Attempt to update each with geodetic information from South Carolina and retrieve the data.

Recommendation – Download a copy of ArcExplorer. Test the functionality of the data viewer with imagery from South Carolina. Determine the steps required to interface the data viewer with the database of geodetic control.

Recommendation – Due to the lack of expertise in database administration, it would be prudent to investigate hiring a short-term database engineer. This could be as simple as hiring a summer intern. Work on the design and modifications, if any are needed with either the North Carolina and Texas databases. This could become a full time job of administration and a funding source would need to be discovered.

Recommendation – Follow up with the IT staff of ORS, and DSIT, to investigate the cost for hosting and maintaining a server for the South Carolina Spatial Reference system.

References Cited

NOAA Technical memorandum, NOS NGS-58, 1997, **Guidelines for Establishing GPS-Derived Ellipsoidal Heights (Standards 2CM and 5 CM)**, Version 4.3, National Geodetic Survey Information Center, Silver Spring MD 20910.

Federal Geographic Data committee, 1994 updated, **Input Formats and Specifications of the National Geodetic Survey Data Base**, National Geodetic Survey Information Center, Silver Spring MD 20910.

Appendix 1

The National Geodetic Survey's Data Sheet

The Data Sheet is the template used in the survey. A data sheet for station SURVEY was downloaded from the NSRS. The data sheet has been modified to show the "ten most wanted" parts from the replies to the survey.

```
  DESIGNATION -  SURVEYS
  PID         -  EC2938
  STATE/COUNTY-  SC/RICHLAND
  USGS QUAD   -  COLUMBIA NORTH (1997)

                      *CURRENT SURVEY CONTROL

 ______________________________________________________________________
* NAD 83(2007)-  34 04 49.30949(N)     081 07 15.40361(W)      ADJUSTED
* NAVD 88      -        98.988  (meters)      324.76   (feet)  ADJUSTED
 ______________________________________________________________________
  EPOCH DATE  -        2002.00
  X           -    816,248.773 (meters)                       COMP
  Y           -  -3,224,931.301 (meters)                       COMP
  Z           -   3,553,871.496 (meters)                       COMP
  LAPLACE CORR-          -1.86  (seconds)                      DEFLEC09
  ELLIP HEIGHT-         68.218 (meters)          (02/10/07)  ADJUSTED
  GEOID HEIGHT-        -30.77  (meters)                       GEOID09
  DYNAMIC HT  -         98.889 (meters)      324.44  (feet)  COMP

  -------- Accuracy Estimates (at 95% Confidence Level in cm) --------
  Type    PID     Designation                      North   East   Ellip
  ---------------------------------------------------------------------
  NETWORK EC2938 SURVEYS                            0.14   0.12   0.31
  ---------------------------------------------------------------------
  MODELED GRAV-     979,634.4   (mgal)                        NAVD 88

  VERT ORDER  -  FIRST     CLASS II

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

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

.The orthometric height was determined by differential leveling and
.adjusted in March 1994.

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

.The Laplace correction was computed from DEFLEC09 derived deflections.

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

.The geoid height was determined by GEOID09.

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

.The modeled gravity was interpolated from observed gravity values.

;                      North          East      Units Scale Factor Converg.
;SPC SC       -   249,194.094    598,439.034   MT  0.99981930   -0 04 01.4
;SPC SC       -   817,565.93   1,963,382.66    iFT  0.99981930   -0 04 01.4
;UTM  17      - 3,771,073.208    488,841.476   MT  0.99960153   -0 04 04.0
```

Station name

Latitude, Longitude, Orthometric Height

NAD83 (2007) - Horizontal Datum
NAVD 88 - Verical Datum

Horizontal and Vertical Accuracy

State Plane Coordiante International Feet

```
;                    North          East      Units Scale Factor Converg.
;SPC SC       -   249,194.094    598,439.034   MT  0.99981930   -0 04 01.4
;SPC SC       -   817,565.93   1,963,382.66   iFT  0.99981930   -0 04 01.4
;UTM  17      - 3,771,073.208    488,841.476   MT  0.99960153   -0 04 04.0

!             -  Elev Factor  x  Scale Factor =  Combined Factor
!SPC SC       -   0.99998929  x   0.99981930  =   0.99980859
!UTM  17      -   0.99998929  x   0.99960153  =   0.99959083
```

Scale Factor

```
: ------------------------------------------------------------------------|
| PID    Reference Object                        Distance      Geod. Az   |
|                                                              dddmmss.s  |
| EC2939 SURVEYS AZ MK                         APPROX. 0.7 KM 2180431.2  |
|-------------------------------------------------------------------------|
```

SUPERSEDED SURVEY CONTROL

```
  NAD 83(2001)-  34 04 49.30949(N)    081 07 15.40362(W) AD(       ) A
  ELLIP H (09/24/02)   68.224  (m)                       GP(       ) 4 1
  NAD 83(1995)-  34 04 49.30962(N)    081 07 15.40365(W) AD(       ) B
  ELLIP H (09/11/96)   68.214  (m)                       GP(       ) 4 1
  NAD 83(1986)-  34 04 49.32481(N)    081 07 15.40459(W) AD(       ) 1
  NAVD 88 (07/03/96)   98.99   (m)          324.8     (f) LEVELING    3
  NGVD 29 (08/04/92)   99.2    (m)          325.      (f) GPS OBS

_U.S. NATIONAL GRID SPATIAL ADDRESS: 17SMT8884171073(NAD 83)
_MARKER: DD = SURVEY DISK
_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
_SP_SET: CONCRETE POST
_STAMPING: SURVEYS 1989
_MARK LOGO: SCGS
_PROJECTION: FLUSH
_MAGNETIC: M = MARKER EQUIPPED WITH BAR MAGNET
_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
+STABILITY: SURFACE MOTION
_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
+SATELLITE: SATELLITE OBSERVATIONS - March 01, 2006
```

GPSable

```
  HISTORY      - Date     Condition        Report By
  HISTORY      - 1989     MONUMENTED       SCGS
  HISTORY      - 19910122 GOOD
  HISTORY      - 19930119 GOOD             SCGS
  HISTORY      - 19950131 GOOD             SCGS
  HISTORY      - 19960115 GOOD             SCGS
  HISTORY      - 19960208 GOOD             GEOMET
  HISTORY      - 19960226 GOOD             SCGS
  HISTORY      - 19961008 GOOD             SCGS
  HISTORY      - 19970207 GOOD             SCGS
  HISTORY      - 20010620 GOOD             SCGS
  HISTORY      - 20011220 GOOD             SCGS
  HISTORY      - 20060301 GOOD             SCGS
```

STATION DESCRIPTION

```
'DESCRIBED BY SOUTH CAROLINA GEODETIC SURVEY 1989
'STATION IS LOCATED 3.5 MILES EAST OF IRMO, 7.25 MILES NORTHWEST OF
'COLUMBIA.  OWNERSHIP--SOUTH CAROLINA GEODETIC SURVEY, NO 5 GEOLOGY
'ROAD, COLUMBIA, SC 29210, PHONE 803-737-9440.
'TO REACH THE STATION FROM THE JUNCTION OF U.S. HIGHWAY 176 (BROAD
'RIVER ROAD) AND STATE HIGHWAY 60 (NEWBERRY AVENUE), 2.2 MILES EAST OF
'IRMO, GO SOUTHEAST ON HIGHWAY 176 FOR 1.35 MILES TO THE JUNCTION OF
'GEOLOGY ROAD ON THE LEFT (ENTRANCE TO HIGHWAY PATROL ACADEMY), TURN
'LEFT ON GEOLOGY ROAD FOR 0.4 MILE TO THE STATION ON THE LEFT IN A
'GRASSY MEDIAN IN FRONT OF THE SOUTH CAROLINA GEODETIC SURVEY OFFICE
'BUILDING.
'STATION IS A CONCRETE POST FLUSH WITH THE GROUND AND 1.5 FEET ABOVE
'THE ROAD, 39.0 FEET NORTHWEST OF THE CENTER OF GEOLOGY ROAD, 102.8
'FEET EAST SOUTHEAST OF THE SOUTH CORNER OF THE BUILDING, 106.6 FEET
'SOUTH SOUTHEAST OF THE NORTHEAST CORNER OF THE BUILDING, 22.3 FEET
'NORTH NORTHEAST OF A FIRE HYDRANT, 19.0 FEET SOUTHWEST OF A METAL
'LAMP POST.
```

To Reach

Appendix 2

The South Carolina Spatial Reference Center's Survey

Speculation has started to grow about the National Geodetic Survey's possible abandonment of the National Spatial Reference System. The survey was a tool of investigation to determine if the need for a spatial reference system existed for South Carolina. The abstracted results indicate the need does exist, information on the user interface and how the output should be constructed.

Search Engine for Geodetic Control in South Carolina

SurveyMonkey

1. What chapter of the SCPLS are you affiliated with?

	Response Percent	Response Count
Aiken	6.7%	6
Central	2.2%	2
Coastal	**23.6%**	**21**
Foothills	10.1%	9
Grand Strand	14.6%	13
Low Country	7.9%	7
Mid-State	4.5%	4
Midlands	18.0%	16
Northwest	4.5%	4
Pee Dee	2.2%	2
Thomas C. Anderson	1.1%	1
Upper Piedmont	9.0%	8
	answered question	**89**
	skipped question	**8**

2. Have you used the NGS search engine to retrieve geodetic control?

	Response Percent	Response Count
yes	98.9%	94
no	1.1%	1
answered question		95
skipped question		2

3. The National Geodetic Survey has stated it is investigating the possibility of discontinuing the National Spatial Reference System (NSRS) in the future. One of the tools provided to the user community in the NSRS is a search engine designed to retrieve information about geodetic control. Is a geodetic database and search engine used to retrieve data from the geodetic database a valuable tool for the surveying community?

	No Importance	Slightly Important	Moderately Important	Extremely Important	Rating Average	Response Count
Need for Search engine for geodetic control?	0.0% (0)	1.0% (1)	8.2% (8)	**90.7% (88)**	3.90	97
answered question						97
skipped question						0

4. If the NGS were to stop hosting the NSRS who should host the geodetic database and a search engine?

	Response Percent	Response Count
South Carolina Geodetic Survey	95.9%	93
Other (please specify)	4.1%	4
answered question		97
skipped question		0

5. Would you like to have a search engine that can operate as an application on your personal computer that does not require access to the internet? Keep in mind this would require updating the geodetic control database as changes are made.

	Not interested	Maybe	Very interested	Rating Average	Response Count
Interest in stand alone application that does not require access to the internet.	39.6% (38)	**42.7% (41)**	17.7% (17)	1.78	96
				answered question	**96**
				skipped question	**1**

6. The NGS search engine has several ways to search for and retrieve geodetic control if you select DataSheets. Options include: a Radial Search (provide center coordinate and radius in miles), a Rectangular Search (provide max/min coordinates), selecting a state and county and retrieve all of the geodetic control within the county, and a search engine that requires the user to know the station name and request only information about that station. Which do you prefer?

	Dislike	Have used on occasion	Like very much	Rating Average	Response Count
Radial Search	9.9% (9)	37.4% (34)	**52.7% (48)**	2.43	91
Rectangular Search	29.3% (24)	**52.4% (43)**	18.3% (15)	1.89	82
County-wide Search	8.5% (8)	34.0% (32)	**57.4% (54)**	2.49	94
Station Name	7.6% (7)	30.4% (28)	**62.0% (57)**	2.54	92
				Comments	16
				answered question	**97**
				skipped question	**0**

7. The NGS has written an application that is downloaded from their web page called DS World. This application requires Google Earth to be installed onto your computer. Have you downloaded DS World from the NGS web site, installed it on your computer, and used it?

	Response Percent	Response Count
yes	**52.1%**	**50**
no	47.9%	46
answered question		**96**
skipped question		**1**

8. Is a vector map with options to display political boundaries, hydrography, road centerlines, and geodetic control helpful when using a graphic search engine?

	Not at All	Might be helpful	Helpful	Required	Rating Average	Response Count
Political Boundaries	21.7% (20)	20.7% (19)	**43.5% (40)**	14.1% (13)	2.50	92
Hydrography	4.4% (4)	20.0% (18)	**56.7% (51)**	18.9% (17)	2.90	90
Road Centerlines	1.0% (1)	3.1% (3)	43.8% (42)	**52.1% (50)**	3.47	96
Geodetic Control	0.0% (0)	1.1% (1)	28.4% (27)	**70.5% (67)**	3.69	95
answered question						**96**
skipped question						**1**

9. As with DS World, do you find the use of raster imagery helpful while retrieving geodetic control? Would you prefer to have the option of turning the imagery off or on while searching for geodetic control?

	Not at all	Somewhat	Very helpful	Rating Average	Response Count
Importance of Raster Imagery	2.2% (2)	34.1% (31)	**63.7% (58)**	2.62	91
Option of turning imagery on and off	4.3% (4)	40.2% (37)	**55.4% (51)**	2.51	92
				answered question	**92**
				skipped question	**5**

10. In your opinion, which of the following selections are critical pieces of information that should be included on a data sheet? Select as many as you wish.

	Response Percent	Response Count
Station Name	**100.0%**	**97**
Horizontal Datum	**100.0%**	**97**
Vertical Datum	**100.0%**	**97**
Latitude/Longitude	92.8%	90
State Plane Coordinate (International Feet)	90.7%	88
State Plane Coordinate (Survey Feet)	47.4%	46
State Plane Coordinate (Meters)	46.4%	45
UTM Coordinates	35.1%	34
Orthometric Height (Survey Feet)	78.4%	76
Orthometric Height (meter)	50.5%	49
Ellipsoid Height (meters)	53.6%	52
scale factor	90.7%	88
GPSable	79.4%	77
Height Modernization	52.6%	51
Vertical Accuracy	86.6%	84
Superseded control	63.9%	62
"To Reach"	72.2%	70
Other (please specify)	19.6%	19
	answered question	**97**
	skipped question	**0**