NOAA Technical Memorandum NOS NGS-5

NATIONAL GEODETIC SURVEY DATA: AVAILABILITY, EXPLANATION, AND APPLICATION

National Geodetic Survey
Rockville, Md.
June 1976

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NOS NGS-2 Final report on responses to geodetic data questionnaire. John F. Spencer, Jr., March 1976, 39 pp.

NOS NGS-3 Adjustment of Geodetic Field Data Using a Sequential Method. Marvin C. Whiting and Allen J. Pope, March 1976, 11 pp.

NOS NGS-4 Reducing the Profile of Sparse Symmetric Matrices. Richard A. Snay, June 1976.

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UNITED STATES DEPARTMENT OF COMMERCE
Elliot L. Richardson, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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NATIONAL GEODETIC SURVEY DATA: AVAILABILITY, EXPLANATION, AND APPLICATION

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ABSTRACT. Geodetic data have been issued by the National Ocean Survey and its predecessors for more than 100 years. During this period, the data were furnished in a variety of formats, finally evolving into the present-day tabulations. Although much of the data is available in a modern standardized form, some material is still published on old-style listings. Explanations are given to assure that the user fully understands the published information. Some of the data was computed on several reference surfaces, which must be considered when the information is used to relate maps and charts of the past with the present. Explanations are provided in regard to survey accuracies and problems inherent to certain geometric configurations.

Since hundreds of publications and thousands of papers dealing with geodetic surveys have been published or presented, the compilation of a complete bibliography would be a formidable task. This report gives a concise listing of publications and papers of general interest and their sources of availability. Also included are detailed references to the application of geodetic control and practices, as only a brief discussion of this subject is presented in the text.

INTRODUCTION

For more than 150 years, the Coast and Geodetic Survey (C&GS) collected and published data related to the oceans and the land. With the formation of the National Oceanic and Atmospheric Administration (NOAA) in October 1970, the Coast and Geodetic Survey became a major line component of this agency and was renamed the National Ocean Survey (NOS). This reorganization later included the transfer of the seismological and geomagnetic activities from NOS to the Environmental Research Laboratories (ERL), another mainline component of NOAA which is located in Boulder, Colorado, and the establishment within NOS of the Office of the National Geodetic Survey (NGS), the latter to include all geodetic functions of the former C&GS.

In 1973, the seismological and geomagnetic functions were transferred to the U. S. Geological Survey (USGS). However, the national data bank for geomagnetic data remained with NOAA and geomagnetic information is available from the National Geophysical and Solar-Terrestrial Data Center, EDS/NOAA, Boulder, Colorado 80302. The crustal movement studies which are performed by NGS will continue to be published and distributed by that office. Results of these studies and requests for geodetic data may be obtained from the Director, National Geodetic Survey Information Center, C18, Rockville, Maryland 20852.

These organizational changes should have little effect on most users of geodetic control, since these data will continue to be published and issued by the NGS. However, those surveyors and engineers who require information relating to seismic and magnetic data should refer their requests to the organizational components noted in the previous paragraph.

NGS will provide, upon request, price lists for the geodetic data. Also available is an information bulletin listing specific publications of this office, in addition to those mentioned in this Technical Memorandum. The primary content of the information bulletin is directed to servicing procedures.

AVAILABILITY AND EXPLANATION

Publications

Some bound publications of NGS and NOS are printed and sold by the Superintendent of Documents, U. S. Government Printing Office. Requests should be directed to that agency and not to the NGS. If, however, a publication cannot be furnished by the GPO, it occasionally may be obtained from NGS stock. The Department of Commerce also maintains field offices in most major cities. These offices are usually able to fill requests promptly.

During its long history, the Coast and Geodetic Survey prepared more than 300 Special Publications dealing with all of the scientific disciplines in which the organization was involved. Many of the older publications are out of print. Most will not be reprinted because they are of little present-day interest, and their contents have been superseded by later publications. NGS has retained file copies of those documents concerned with geodetic surveying and generally can furnish commercial-type copies of excerpts or occasionally even an entire publication.

The NGS, as in the past, will furnish data and their personnel are always available for advice concerning technical matters, such as specifications, use of theodolites and electronic distancing equipment, computations, and review of unsatisfactory closures between points established by this agency.

Also available from NGS are numerous papers, technical bulletins, data reports, and similar pamphlet-type publications which have been prepared and issued over the years. Generally such material is limited in depth and scope but often appears in lists of references. For this reason, NGS has maintained a supply of the more popular ones and will reproduce a few copies of others upon request.

The reference library of any surveyor or engineer who performs control surveys or employs the State Coordinate Systems should contain the following NGS and ACSM publications and papers. All are included in the more comprehensive bibliography cited at the end of this paper; hence, only a brief identification is given below.

(1) Coast and Geodetic Survey, ____: *Plane Coordinate Projection Tables, Special Publication series.* For states where projects will be undertaken.

(2) Coast and Geodetic Survey, 1949, reprinted 1971: *Sines, Cosines, and Tangents, ten decimal places with ten-second interval, 0°-6°, Special Publication No. 246.* For plane coordinate computations on Lambert projection.

(3) Mitchell, H. C., and Simmons, L. G., 1945, revised 1974, reprinted 1975: *The State Coordinate Systems (A Manual for Surveyors), Special Publication No. 235.*

(4) Dracup, J. F., and Kelley, C. F., 1973, reprinted 1975: *Horizontal Control as Applied to Local Surveying Needs.*

(5) Simmons, L. G., 1968, reprinted 1975: *Geodetic and Grid Angles - State Coordinate Systems, ESSA Technical Report C&GS 36.*

(6) Federal Geodetic Control Committee, 1974, reprinted 1975/1976: *Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys.*

(7) Federal Geodetic Control Committee, 1975/1976: *Specifications to Support Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys.*

(8) Dracup, J. F., 1969, revised 1973: *Suggested Specifications for Local Horizontal Control Surveys, Technical Monograph No. CS-1.*

(9) Dracup, J. F., 1970: Standards and specifications for supplemental horizontal control surveys.

(10) Mitchell, H. C., 1948, reprinted 1974/1976: *Definitions of Terms Used in Geodetic and Other Surveys, Special Publication No. 242.*

(11) Tomlinson, R. W., and Burger, T. C., 1971, revised 1975: *Electronic Distance Measuring Instruments, Technical Monograph No. CS-2.*

The impression from a cursory review of the reference material is that the use of the State Plane Coordinate System involves very complex procedures. Such is not really the case. In the final analysis, State plane coordinates are really nothing more than an adaptation of the latitude and departure practices which have been in use for centuries.

Numerous reasons have been given during the last 40 years for not employing the State plane coordinate systems. Some are quite valid, e.g., a lack of national network control; but others, especially those related to scale factors, are irrelevant. The application of a scale factor is arithmetical, not an involved mathematical procedure. In those higher elevation sections of the country, the reasons given for not using the system include the reduction to sea level in addition to scale factors. The sea level reduction is also arithmetical. In fact, the two factors can often be combined, thus resulting in a single computation to reduce each measured distance.

Some surveyors and engineers contend the State systems are not adaptable to their projects because ground distances are required in laying out structures, etc. This problem, of course, can be generally overcome by projecting the State plane coordinates to the average elevation and correcting for the average scale factor of the site. In a few projects examined by the author, this has been a needless exercise since the distance measurements made at the site for construction purposes either involved such short lengths or such inaccurate taping procedures that the requirement for project coordinates was seldom justified.

Horizontal Control Data

Early in the 1930's, it was decided to lithoprint horizontal and vertical control data in a loose-leaf form rather than in bound volumes by States as previously. For this format (which became known as the "lithos"), separate listings for the geographic positions, plane coordinates by zones, and descriptions were required to complete the data for horizontal control points. Leveling data were issued by lines, and material involving several lines was often required to furnish the complete data for an area.

As time passed and a tremendous amount of data was accumulated, it became obvious that this format was cumbersome and that a new approach to publishing the material was mandatory. It was then decided to issue the data in 30' by 30' quads, the advantages being that all data for a horizontal control point could be printed on a single sheet of paper and all the leveling control for an area of about 800 square miles could be assembled in a single volume.

At present, previously published adjusted geodetic data for most States have been converted to the quad format. With rare exceptions, all new adjusted data are being prepared in this form. The New Adjustment of the North American Datum now underway is scheduled for completion in 1983. Published data for this adjustment will be computer generated, probably in a format similar to the quad format.

The diagrams for the quad format are on a 1:250,000 scale, and show horizontal and vertical control established by NGS, USGS, and any other Federal, State, or local Government agencies whose data have been accepted for publication by NGS. The acceptance or adjustment of data published by NGS is made with the understanding that prescribed specifications for the stated standard of accuracy have been rigorously followed by the establishing agencies; the NGS accepts no responsibility for the accuracy of such surveys.

Diagrams

NGS will continue to publish the State diagrams showing control established or adjusted by NGS, one for the horizontal control and another for the vertical control (fig. 1 and 2). In areas where the control is congested, larger-scale diagrams, such as nautical base charts, supplement the State diagrams.

The normal dimensions of the quad-format diagrams are 1° in latitude by 2° in longitude with the data assembled in 30'

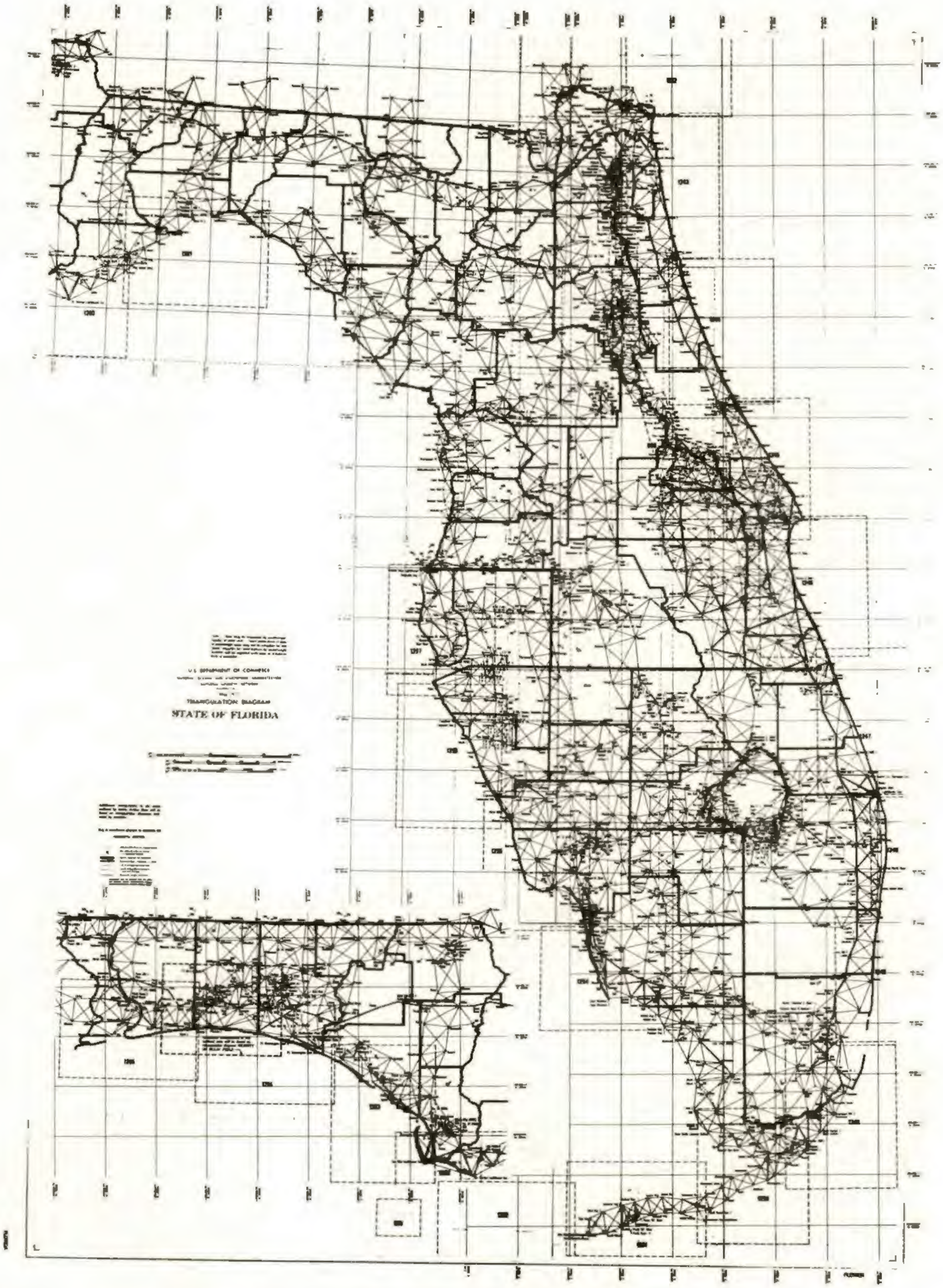


Figure 1.--State diagram showing horizontal control established by or accepted for adjustment by NGS.

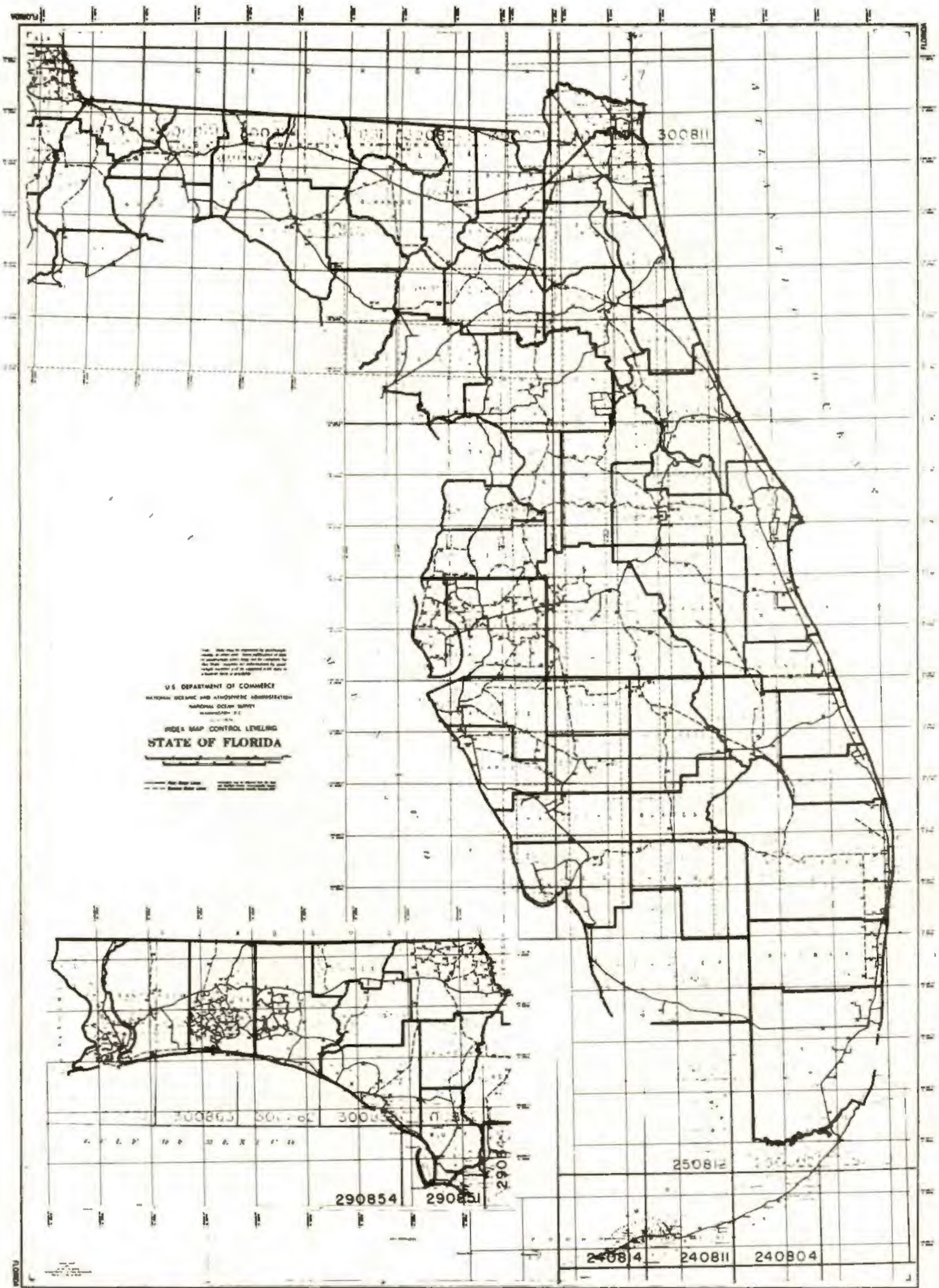


Figure 2.--State diagram showing vertical control established by or accepted for adjustment by NGS.

by 30' volumes. The horizontal and vertical control data are issued separately and designated as shown below:

26°

25 081 4	25 081 1	25 080 4	25 080 1
25 081 3	25 081 2	25 080 3	25 080 2

DIAGRAM NG-17-8 MIAMI

25°

82° 81° 80°

Each station is assigned a number identified as "QSN" (Quad Station Number). These numbers are assigned to stations in a new project and tabulated in alphabetical sequence, generally in two groupings, the marked stations in one group, and intersection points in the other. When the horizontal control data for an entire state are converted to the quad format, the stations are normally tabulated in alphabetical sequence and in two groupings, but not by project. There are variations to these practices due to certain situations, such as clustering all intersection points in a general location, to save paper, or to satisfy some particular condition.

All QSN's begin with 1001, thus each station has a unique 10 digit identifier. In some of the earlier listings, nearby marks connected by traverse or replacement stations were assigned the same number as the station. Later, in many cases, a letter was added. For example: 250802 station 1029A could be the point connected by traverse and 1029B the replacement station for 250802 station 1029. For inclusion in the planned data bank, stations containing a letter will need to be renumbered to avoid the alpha-numeric identification. The data bank, when finally compiled, will contain all the observations, the adjusted results, and descriptions and recovery notes for all horizontal control stations.

In a few instances along coastlines, quad dimensions are 2° in latitude by 1° in longitude, and on other occasions, to offset the need of an additional sheet, they are slightly larger than normal size. Larger-scale base maps are also used to supplement the regular quad diagrams in areas where a large concentration of control exists.

Control established or adjusted by the NGS is shown in black; that established, computed, and issued by the USGS in red; and data accepted by the NGS for publication in brown. The accuracy of the control is also indicated. A sample regular-size quad sheet (without color coding) is shown in figure 3.

Data Sheet Format

An example of the new format for horizontal control data sheets is shown in figure 4. This single-sheet type of listing replaces the multi-page tabulations previously employed. In the old "litho" format, separate sheets were necessary for the listings of the various data; for the example shown in figure 4, the user would have received as many as eight sheets of paper. Since much of the horizontal control data for a few States is still issued in the "litho" type format, examples and explanations of the data are given later.

The form shown in figure 4 is largely self-explanatory. The following comments should assure a more complete understanding of the tabulated data.

(1) Source - Archive number assigned to computations in which position was determined. Other source numbers are occasionally shown on data sheets prepared several years ago. These refer to projects in which the station was used as control, but this practice has been discontinued.

(2) Field sketch - A sketch is drawn for each project and filed by State and number. Sketches for projects that extend into more than one State are assigned to one of these States. Usually only the sketch for the project in which the station was originally positioned is shown. The field sketch number and locality are omitted on more recent tabulations.

(3) Geodetic positions - Positions given to five decimal places of seconds are for computational purposes only and are not an indication of accuracy.

(4) Elevations - Values shown to one decimal in meters and to even feet were probably determined from vertical angles (trigonometric leveling). Elevations given to two decimals in meters and one decimal in feet were generally determined in the

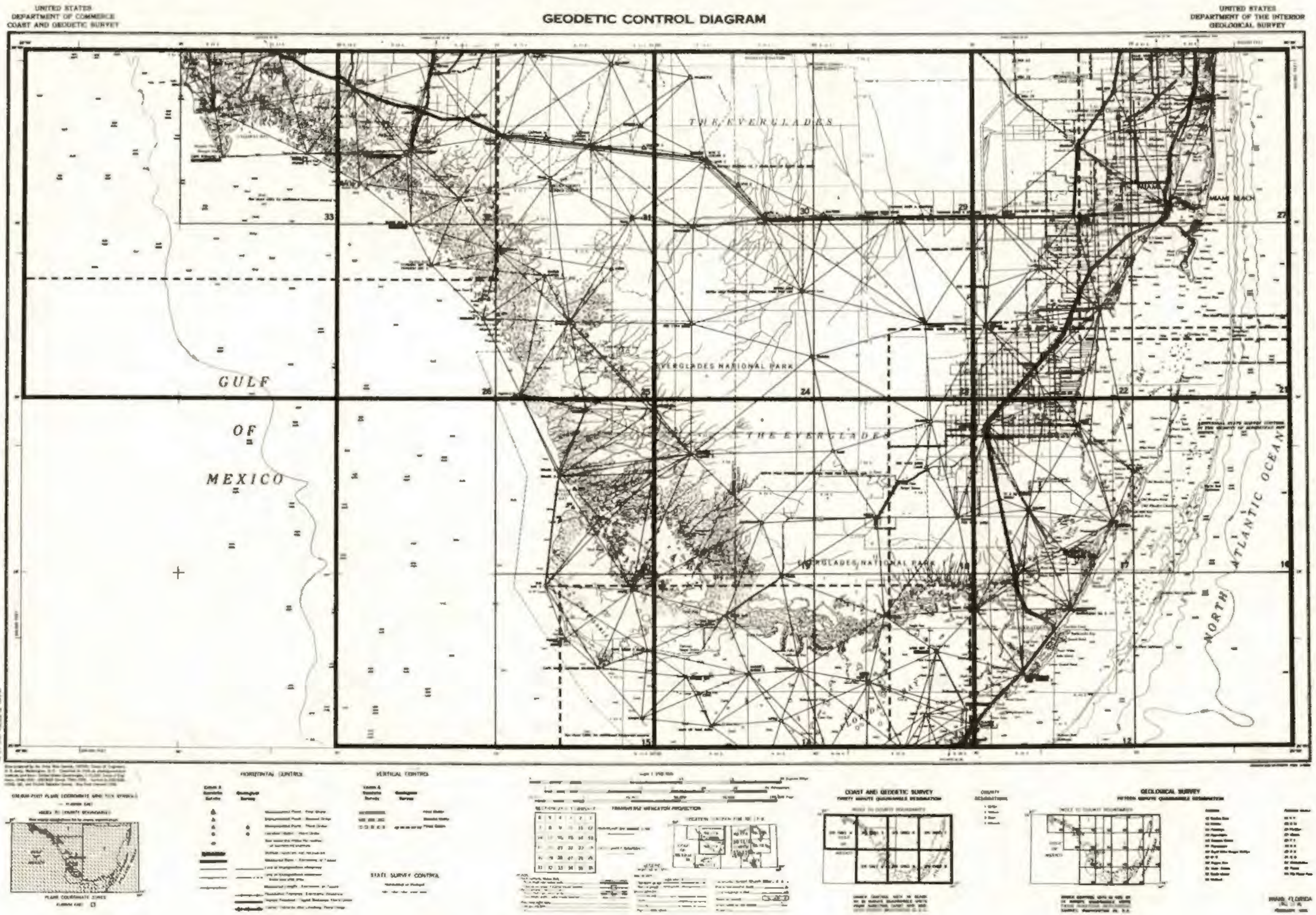


Figure 3.--Sample quad sheet.

MARCH 1976

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

HORIZONTAL CONTROL DATA

by the

National Geodetic Survey

NORTH AMERICAN 1927 DATUM

FLORIDA VOL II PAGE 646

QUAD 290813 STATION 1001
FLA
LATITUDE 29°00' TO 29°30'
LONGITUDE 81°30' TO 82°00'
DIAGRAM NH 17-8 DAYTONA BEACH

****

VOLUSIANA (Volusia County,Fla.,K.G.C.,1935)--This station is on Highway 19 about 1.4 miles E of the St. Johns River and about 5 miles W of Barberville. It is 30 meters N of the center of the highway, and 10 meters S of a woods road on property of Volusia Masonic Lodge No.77.

Surface, underground, reference and azimuth marks are standard bronze disks set in concrete as described in notes 1a, 7a and 11a.

Reference mark No.1 is NE of the station, reference mark No.3 is NW, both on N side of woods road. Reference mark No.2, the azimuth mark, is 0.25 mile W of the station, about 15 meters N of the center of the highway and in range with a concrete culvert.

To reach station from DeLand, Florida, go N on Highway 17 about 10 miles to Barberville and turn W on Highway 19. Go 4.8 miles and reach station on right side of road. Concrete culvert mentioned above is 0.25 mile further down the road.

OBJECT	DISTANCE	DIRECTION
GROVE		0°00'00"0
R.M.No.1	134.41 feet	61 51 08
R.M.No.2 Az.Mk.	0.25 mile	300 39 25
R.M.No.3	168.16 feet	337 48 18
R.M.No.1 to R.M.No.3	204.09 feet	

Height of light above station mark - 38 meters.
Height of telescope above station mark - 36 meters.

VOLUSIANA (Volusia County,Fla.,K.G.C.,1935;H.A.P.,1935)--Recovered by the field inspection party. Station found in good condition. Description adequate.

VOLUSIANA (Volusia County,Fla.,K.G.C.,1935;L.D.G.,1938)--Station recovered as described, in good condition.

RECOVERY NOTE, TRIANGULATION STATION

R

NAME OF STATION: VOLUSIANA
ESTABLISHED BY: K.G.C. YEAR: 1935 STATE: Florida BENCH MARK(S) ALSO ☐
RECOVERED BY: V.R.S. YEAR: 1963 COUNTY: Volusia
AIRLINE DISTANCE AND DIRECTION FROM NEAREST TOWN:

Detailed statement as to the fitness of the original description, including marks found, stampings, changes made, and other pertinent facts:

Station was searched for but not recovered. The area of the azimuth mark is clear off and is part of a new subdivision.

U.S. DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY

RECOVERY NOTE, TRIANGULATION STATION

R 8

NAME OF STATION: VOLUSIANA
ESTABLISHED BY: K.G.C. YEAR: 1935 STATE: Florida
RECOVERED BY:* L.M. Chase YEAR: 1968 COUNTY: Volusia

HEIGHT OF TELESCOPE ABOVE STATION MARK 35 METERS. HEIGHT OF LIGHT ABOVE STATION MARK 38 METERS.

DISTANCES AND DIRECTIONS TO AZIMUTH MARK, REFERENCE MARKS AND PROMINENT OBJECTS WHICH CAN BE SEEN FROM THE GROUND AT THE STATION

OBJECT	BEARING	DISTANCE FEET	DISTANCE METERS	DIRECTION ° ' "
HINSON 1935				00 00 00.0
RM 4	SW	313.43	95.535	61 22 41.3
RM 3	NW	168.18	51.265	123 36 21
RM 1	NE	134.39	40.962	207 39 24
RM 1 to RM 3		204.10	62.213	

Station and all marks were recovered and found in good condition. Reference mark 4 was established at this time. Azimuth mark is no longer visible from the ground. The distance and direction to the reference marks checked with the original description. Due to various changes, a complete new description follows.

The station is located about 15 miles northwest of DeLand, 5 miles west of Barberville, 1 1/2 miles east of the St. Johns River and on property of Mr. Orval H. Lyoan of Ashland, Kentucky.

ADJUSTED HORIZONTAL CONTROL DATA

NAME OF STATION VOLUSIANA
STATE FLORIDA YEAR 1935 FIRST - ORDER
LOCALITY ST JOHNS RIVER
SOURCE G-3606 FIELD SKETCH FLA 211

GEODETIC LATITUDE	29 10 13.93255	ELEVATION	8.3	METERS
GEODETIC LONGITUDE	81 30 01.82028		27	FEET

STATE COORDINATES (Feet)				
STATE & ZONE	CODE	X	Y	θ (OR Δ α) ANGLE
FLA. W.	0902	659,410.80	1,758,565.62	+ 0 14 37
FLA. E.	0901	340,266.46	1,758,566.99	- 0 14 38

TO STATION OR OBJECT	GEODETIC AZIMUTH (From north)	PLANE AZIMUTH (From north)	CODE
HINSON	0 33 32.7	0 18 56	0902
HINSON	0 33 32.7	0 48 11	0901
AZIMUTH MARK RM 2	87 01 05.5	86 46 28	0902
AZIMUTH MARK RM 2	87 01 05.5	87 15 44	0901

To reach the station from the junction of U.S. Highway 17 and State Highway 40 in Barberville, go southwest and westerly on State Highway 40 for 4.9 miles to a triangle blazed power line pole on left, a triangle blazed pine tree and station on right as described.

Station mark, stamped VOLUSIANA 1935, projects about 6 inches. It is about 230 feet northeast of a triangle blazed power line pole, 104.5 feet north of center of highway, 99.5 feet northeast of a triangle blazed pine tree and 22 feet north of a triangle blazed pine tree. (Note 1a 7a)

RM 1, stamped VOLUSIANA NO 1 1935, projects about 5 inches. It is 10 feet northwest of a 6-inch pine tree, 8 feet west of a 4-inch pine tree and 1.4 feet southwest of a metal witness post. (Note 11a)

RM 3, stamped VOLUSIANA NO 3 1935, projects about 6 inches. It is 8 feet northeast of a 7-inch pine tree and 1.5 feet southeast of a metal witness post. (Note 11a)

RM 4, stamped VOLUSIANA NO 4 1935 1968, projects about 3 inches. It is 38.5 feet south of center of highway, 34 feet southwest of power line pole number R2AA624, 4.5 feet southwest of a small pine tree and 1.5 feet south of a metal witness post. (Note 11b)

RM 2 AZ MK, stamped VOLUSIANA NO 2 1935, projects about 5 inches. It is 54 feet north of center of highway, 38 feet north of north end of concrete culvert, 19.3 feet northwest of a "Fishing Camp" sign and 6.5 feet southwest of a triangle blazed pine tree.(Note 11a)

To reach the AZ MK from station, go west on State Highway 40 for 0.25 mile to mark on right as described.

All marks are standard disks set in concrete posts.

Robert P. Kennedy

*Name of chief of party should be inserted here. The officer who actually visited the station should sign his name at the end of the recovery note.

NOTE - One of these forms must be used for every station recovered.

Figure 4.--Sample sheet of horizontal control data, provided upon request by NGS.

course of a leveling project or from a spur line run by the horizontal control party from nearby bench marks. Elevations determined in such spur leveling usually carry the notation "WYE LEVELING." Those with no check are so indicated, and the source of the data, if other than the NGS, is also noted. Because of policy changes, remarks concerning the elevations are not always shown on the latest listings.

A few words of caution with respect to these values. Vertical angle elevations can be ± 3 feet or more in error relative to leveling control in the general area, and many elevations shown to two decimals in meters are unadjusted values. These data are tabulated for use in reducing electronic distance measurements and to furnish elevation control for projects where accuracy is not critical.

Whenever a project requires accurate elevations, the State or quad diagrams should be examined to ascertain the availability of leveling control in the immediate area; then a request should be made to the appropriate agency for the data.

(5) State coordinates - The "X" coordinate is the value in feet referenced east or west of a meridian selected, and designated as the central meridian for a particular zone. To keep the coordinates positive, a large constant value is assigned to the central meridian in the State system, the computed coordinate (X') is added to this constant value when the point is east of the central meridian and subtracted when west of this meridian. For the example shown, the central meridians for both zones have assigned values of 500,000.00 feet. The station is therefore 159,410.80 feet east of the central meridian for the west zone and 159,733.54 feet west of the central meridian for the east zone.

The "Y" coordinate is the distance in feet north of some parallel of latitude which is below the southernmost extremity of the zone; it is usually assigned a numerical value in feet of 0.00.

(6) θ (or $\Delta\alpha$ angle) - The angle between the geodetic and grid meridian; often referred to as the mapping angle.

These angles are applied with the opposite sign to geodetic or astronomic azimuths to obtain plane (grid) azimuths. In this example, the coordinates are computed on the transverse Mercator projection and the mapping angles are identified as $\Delta\alpha$ (delta alpha) angles. Similar values on the Lambert projection are referred to as θ (theta) angles. Another term, the (t-T) or second term correction may be computed and applied as an additional refinement, but generally it is quite small and usually can be ignored. However, the computations are rather simple (see reference no. 5, page 3). Where significant, these corrections should be applied to the azimuths and angles in projects where a high accuracy is required.

Astronomic azimuths should also be corrected for the deflection of the vertical at the point of observation when such azimuths are to control higher grade projects. This correction is known as the Laplace correction and can amount to as much as 20" in the conterminous United States, but generally is considerably smaller. Values of 5 to 7" are not uncommon, however. The NGS will furnish estimated corrections upon request. Since these estimations involve, in many cases, a review of the local topography, reasonably accurate positions of the points from which the observations were made are required. Scaled values from USGS topographic sheets are usually satisfactory for this purpose.

(7) Geodetic and plane azimuths - For the more recent listings, the number of azimuths is limited to those required to compute the azimuths of the marks and objects given in that portion of the description or recovery notes known as the "box" or "box score." In earlier versions, all geodetic azimuths and distances from the station were shown, but revisions necessary to keep the listings up-to-date became too costly and the practice was discontinued. It was felt that with the availability of electronic computers, these data could be easily computed and their elimination from the format would cause little inconvenience.

(8) Descriptions and recovery notes - Anyone using a station to control a survey should verify the descriptive and observational data contained therein to insure that a recovery has been made. Any discrepancies should be reported to the NGS or to the establishing agency.

The "DIRECTION" shown in the box does not refer to a compass bearing but to the angular direction from the initial point taken in a clockwise manner. The direction to the initial point is usually assigned a value of 0° 00' 00".0.

The angles between any of the other points are obtained by differencing the directions involved. All points shown in the box, with the possible exception of the initial point, were visible at tripod height at the time the descriptive information was prepared. When the initial station carries the notation VG (visible from ground), it, too, can be observed from tripod height.

(9) Additional explanatory notes - When a point has been determined by procedures which do not provide a check, the notation "NO OBSERVATIONAL CHECK ON THIS POSITION" appears under source. The agency making the observations, if other than the NGS, is identified by the statement "Observations by ________________" which immediately follows the station name. Other comments are added below the azimuths when needed to explain particular circumstances. In general, only the date of establishment is shown but on occasion, especially in crustal movement areas where new positions have been determined, the original date and the date of the new observations used in the new position determination are noted.

"Litho" Type Format

The old style horizontal control listings, commonly called "lithos," involve separate sheets for the geographic positions, plane coordinates, descriptions, and recovery notes (see fig. 5, 6, and 7). There were some advantages to this format such as all geodetic azimuths and lengths were available and the data were assembled in a more orderly fashion with regard to the actual route of the survey and the area covered; but these advantages were more than offset by the numerous sheets of paper required to complete the compilation of the data for a point.

In the early forms used for this type of listing, there were other disadvantages; the order of accuracy, for example, was not indicated but could be ascertained by a review of the data as follows:

(a) First-order - Azimuths to hundredths of seconds, logarithms of the distances in meters to seven places, and the distance in meters to two decimal places.

(b) Second-order - Azimuths, logarithms, and distances to one less decimal or significant figure than for first-order points. Since surveys made to third-order accuracy were also listed in the same manner, it is occasionally difficult to determine the accuracy of a particular point. Any problems in this regard would generally be in the coastal regions because units other than geodetic parties may have performed the surveys.

Geodetic parties seldom, if ever, perform surveys to less than second-order specifications, except to locate certain structures. But photogrammetric or hydrographic support units often establish control only to the accuracy required for the particular project involved and these accuracies may be third-order or even less on occasion. Data for surveys made to less than third-order requirements are not published, however.

Department of Commerce
U. S. Coast and Geodetic Survey
Form [illegible]

GEOGRAPHIC POSITIONS

475
Accession No. of Computation: [illegible]

Locality Colquitt, Ga. to Mobile, Ala. Datum North American 1927 State Florida

STATION	LATITUDE AND LONGITUDE	SECONDS IN METERS	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE		
						LOGARITHM (METERS)	METERS	FEET
Chumuckla, 1938 (d.m.)	30 45 03.891		133 32 05.07	313 27 37.06	McDavid	4.2827163	19174.16	62907.2
	87 11 44.128		190 16 11.18	10 16 55.60	New York	4.1113747	12923.34	42399.3
			357 17 37.9		Azimuth mark			
Barth, 1938 (d.m.)	30 45 20.805		181 50 41.99	1 50 49.86	McDavid	4.1032480	12683.76	41613.3
	87 20 42.753		233 41 25.33	53 46 45.64	New York	4.3142171	20616.60	67639.6
			272 02 38.07	92 07 13.49	Chumuckla	4.1564147	14335.56	47032.6
			16 32 25.3		Azimuth mark			
Quintette, 1938 (d.m.)	30 39 28.331	(Bench Mark¹)	171 37 37.92	351 37 07.25	Barth	4.0402598	10971.34	35995.1
	87 19 42.687		230 54 33.54	50 58 37.90	Chumuckla	4.2148423	16399.94	53805.5
			320 59 22.25	141 03 02.01	Escambia	4.2621495	18287.30	59997.6
			24 47 59.66	204 46 08.84	Hurst	4.1409257	13833.30	45384.8
			270 45 28.4		Azimuth mark			
Pace, 1938 (d.m.)	30 39 18.959		10 40 14.13	190 39 24.03	Escambia	4.1514329	14172.06	46496.2
	87 10 52.458		91 12 31.62	271 08 01.26	Quintette	4.1498294	14119.83	46324.8
			125 23 33.34	305 18 31.92	Barth	4.2846346	19259.04	63185.7
			172 37 40.09	352 37 13.71	Chumuckla	4.0298171	10710.68	35140.0
			356 55 22.4		Azimuth mark			
Cantonment, 1938 (d.m.)	30 36 46.139	(Bench Mark¹)	40 32 20.21	220 30 16.77	Hurst	3.9978773	9951.24	32648.4
	87 19 17.717		172 25 05.82	352 24 53.10	Quintette	3.7023158	5038.67	16531.0
			250 41 12.65	70 45 30.11	Pace	4.1539493	14254.41	46766.3
			310 21 21.67	130 24 48.59	Escambia	4.1532738	14232.26	46693.7
			158 11 29.5		Azimuth mark			
Oak Grove, 1938 (d.m.)	30 53 53.936		226 46 42.13	46 50 31.70	Flomaton	4.2109137	16252.26	53321.0
	87 25 01.627		293 11 53.97	113 14 14.74	McDavid	3.8990709	7926.31	26004.9
			121 24 59.8		Azimuth mark			

¹Bench Mark=Elevation determined by spirit leveling.

Figure 5.--Sample of geographic positions on old format.

DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
Form No. 700
Rev. Sept. 1938

PLANE COORDINATES Rev.8/55; 10/57

9

State Florida Locality Colquitt,Ga. to Mobile,Ala. North American 1927 datum. Projection Lambert Zone North

Station	x Coordinate / y Coordinate	Plane azimuth	Mark	Station	x Coordinate / y Coordinate	Plane azimuth	Mark
	Feet	° ′ ″			Feet	° ′ ″	
Pocosin,1938, r.'45	1,316,233.44	139 47 43 *	Azimuth Mark	Jay,(Fla.),1938, r.'44	1,160,939.91	326 19 42 *	Azimuth Mark
(d.m.)	592,606.84			(d.m.)	731,361.14		
Rock Creek,(Fla.-Ala),	1,285,747.01	200 59 31 *	Azimuth Mark	Santa,(Fla.),1938,	1,180,895.79	278 14 43 *	Azimuth Mark
1938, r.'50 (d.m.)	733,320.35	270 43 54 *	Az. Mark, 1950	(d.m.)	719,296.41		
Otahitee,(Fla.),1938,	1,284,787.33	346 22 01 *	Azimuth Mark	New York,(Fla.),1938,	1,161,799.56	99 35 06 *	Azimuth Mark
r.'50 (d.m.)	693,153.30			(d.m.)	688,353.03		
Munson,(Fla.),1938,	1,256,820.62	271 53 01 *	Azimuth Mark	Flomaton,(Ala.),1938,	1,124,833.18	274 33 50 *	Azimuth Mark
r.'50 (d.m.)	694,588.33			r.'44 (d.m.)	737,581.67		
Alaflora,(Fla.-Ala.)	1,263,721.48	207 24 58 *	Azimuth Mark	McDavid,(Fla.), 1938,	1,108,687.17	280 15 45 *	Azimuth Mark
1938, (d.m.)	733,902.07			(d.m.)	691,219.02		
Juniper,(Fla.)1938,	1,235,857.74	308 04 00 *	Azimuth Mark	Chumuckla, 1938,	1,153,256.13	358 38 54 *	Azimuth Mark
(d.m.)	700,369.90			(d.m.)	646,822.65		
Camp,(Fla.-Ala.),1938,	1,228,045.53	176 53 25 *	Azimuth Mark	Berth, 1938,	1,106,309.98	17 58 12 *	Azimuth Mark
(d.m.)	735,801.03			(d.m.)	649,673.16		
Berry,(Fla.), 1938,	1,200,145.54	30 03 09 *	Azimuth Mark	Quintette,1938,	1,110,686.38	272 10 46 *	Azimuth Mark
(d.m.)	695,094.75			(d.m.)	613,942.83		
Dixon,(Fla.-Ala.),1938,	1,205,577.19	21 49 00 *	Azimuth Mark	Pace, 1938,	1,156,944.38	350 16 13 *	Azimuth Mark
(d.m.)	735,827.75			(d.m.)	611,877.30		

[1] No check on this position. * This azimuth has been computed by the θ formula neglecting the second term. ** This azimuth has been computed by the θ formula using both terms.

Figure 6.--Sample of plane coordinates on old format.

No. 625

UNITED STATES COAST AND GEODETIC SURVEY
Descriptions of Triangulation Stations

Shady to Lily, Florida.

WOODS (Marion County, Fla., H.C.W., 1933)--This station is about 4.5 miles S of the courthouse in Ocala, and about 250 yards W of the Orange Avenue macadam road, on land owned by W.E. Woods, who lives about 0.2 mile S of the W side of the road. The station is on enclosed timber land, about 200 yards W of a partly built rock foundation, on which Mr. Woods intends to build a house. It is on the highest part of the hill, about 75 yards N of the edge of the cleared, cultivated land. The station is 41 feet W of a blazed oak tree, and the mark projects 8 inches.

Surface, underground, reference and azimuth marks are standard bronze disks set in concrete as described in notes 1a, 7a, and 11a.

Reference mark No.1 is ESE of the station, 10 feet from the road leading to the station and 13 feet WNW of a pine tree which is slightly to the right of an extension of the line between the station and the reference mark. The mark projects 8 inches.

Reference mark No.2 is SW of the station, and about 30 feet from the edge of the clearing. The mark projects 8 inches.

The azimuth mark is N of the station, 33 feet E of the center line of the Orange Avenue road, and projects 8 inches. The mark is 0.4 mile N of the entrance to the station, and 2.2 miles S of the point where the turn into Orange Avenue is made.

To reach from the courthouse in Ocala, go S 1.8 miles to the Orange Avenue cross road, turn right (S) and go 2.6 miles to the rock foundation mentioned above. Turn in here and follow the dim road around the foundation to the top of the hill, and the station.

A 116-foot tower was erected first, but the line to MARTEL was obstructed by a ridge about 1/2 mile W. A 136-foot tower was necessary to clear the line.

OBJECT	DISTANCE	DIRECTION
HOTEL	feet	0°00'00.0
R.M.No.1	134.72	81 50 35.4
R.M.No.2	129.68	168 43 11.2
Az.Mk. (Approx.)	0.4 mile	340 54 28.8

LUCIUS (Marion County, Fla., H.C.W., 1933)--This station is about 11 miles S of Ocala, 3.7 miles by road SW of the Belleview railroad station, 0.2 mile N of the macadam road leading from Belleview SW to the Orange Avenue macadam road, on the highest point of a hill, in open timber land and on property which has been taken over by the State for taxes. The mark is about 250 paces E of the farmhouse owned by Mr. C.E. Lucius, 276 feet E of the private road leading from the highway to the farmhouse, 22 feet SE of an oak tree marked with a triangular blaze and 19 feet NE of a large charred stump. The mark projects 6 inches above the ground.

Surface, underground, reference and azimuth marks are standard bronze disks set in concrete as described in notes 1a, 7a and 11a.

Reference mark No.1 is N of the station, 96 feet E of the private road and projects 12 inches above the ground.

Reference mark No.2 is S of the station and projects 12 inches above the ground.

The azimuth mark is 0.15 mile S of the station, 36 feet E of the center line of the macadam road, 27 feet W of a concrete culvert and projects 12 inches above the ground.

To reach from Ocala follow U.S. Highway 441 S about 3 miles to the junction with a macadam road called Orange Avenue. This is about 0.3 mile S of a Seaboard Airline Railroad underpass. At the junction there is a filling station on either side of U.S. Highway 441. Turn right and follow Orange Avenue 9.4 miles to crossroads. A macadam road leads E and a graded sand road W. Turn E and follow the macadam road 2.5 miles to the private road leading N to the Lucius's home. Follow this road N 0.2 mile to a blazed oak tree at the point where the road swings sharp left. Turn right and go 276 feet to the station.

OBJECT	DISTANCE	DIRECTION
WHITE	feet	0°00'00.0
R.M.No.2	180.00	22 31 49.2
Large White Bldg.(S)	2.5 miles	228 28
R.M.No.1	144.00	273 53 21.9
Az.Mk. (Approx.)	0.15 mile	273 46 57.6
Unpainted bungalow (S)	0.2 mile	317 13

Height of telescope above station mark - 116 feet.

LUCIUS (Marion County, Fla., H.C.W., 1933; J.S.B., 1936)--Station mark, reference and azimuth marks recovered in good condition.

Reference mark No.1 is S of the station instead of N as originally described.

Reference mark No.2 is W of the station instead of S as originally described.

The azimuth mark is S of the station as described.

There is an error in mileage in describing how to reach the station from Ocala. It should be made to read as follows:

To reach from Ocala, follow U.S. Highway 441 S about 2.0 miles or 0.2 mile S of the Seaboard Airline Railroad underpass to road forks at a filling station on either side of U.S. 441. Here U.S. 441 bears left and a macadam road called Orange Avenue turns right (S). Turn right and follow Orange Avenue 9.4 miles to crossroads. A macadam road leads E and a graded sand road W. Turn E and follow the macadam road 2.5 miles to the private road leading N to the Lucius' home. Follow this road N 0.2 mile to a blazed oak tree at the point where the road swings sharp left. Turn right and go 276 feet to the station.

LUCIUS (Marion County, Fla., H.C.W., 1933; E.B.L., 1937)--Station was recovered approximately as described. Marks in good condition and undisturbed. Corrected description as follows:

About 11 miles S of Ocala, 3.5 miles SW of Belleview, 0.2 mile N of the macadam road leading W from Belleview (at junctions of U.S. Highways 441 and Florida 23) to Orange Ave. At the highest point of a small hill, in open timber land which has been taken for taxes. The mark is 200 yards E by N of C.E. Lucius' home. 270 feet ENE of sand road leading to the Lucius home. 19 feet E of a fire blackened stump, 3 feet high, 22 feet SE of an oak tree marked with a triangular blaze. Mark, note 1b, projects 8 inches.

Reference mark No.1 is S of station, note 11b, and projects 10 inches.

Reference mark No.2 is a standard disk set in concrete as described in note 11b, is W of the station, 30 yards E of the center line of the sand road. It projects 12 inches.

OBJECT	DISTANCE	DIRECTION
WOODS	feet	0°00'00.0
R.M.No.1 (S)	114.06	197 57 46.
R.M.No.2 (W)	180.05	306 35 56.

WHITE (Marion County, Fla., H.C.W., 1933)--This station is about 13 miles SSW of Ocala, in open timber land and on the highest point of a ridge.

Surface, underground, reference and azimuth marks are standard bronze disks set in concrete as described in notes 1a, 7a and 11a.

Reference mark No.2 is N of the station and projects 7 inches.

Reference mark No.1 is SW of the station and projects 6 inches.

The azimuth mark is about 0.2 mile N of the station, 174 paces SE of the two blazed trees marking the trail, 37 paces S of the sand road and projects 10 inches above the ground.

To reach from Ocala follow U.S. Highway 441 to the intersection with Orange Avenue, which is about 0.2 mile S of the Seaboard Airline railroad underpass. Follow Orange Avenue S 10.4 miles to Danks Corner. There is an old church on the W side of the highway and a small store on the E side. Turn W on a sand road and go 1.1 miles to a road leading SW through the woods; there is a cross road at 1.0 mile. Follow the road SW 0.7 mile to a E-W road at the SE corner of a cleared field and wire fence. Turn W and go 3.7 miles to two blazed trees on the S side of the road. One tree is a pine and the other is an oak. Turn S and follow the blazed trail 0.25 mile to the station on the ridge. The mark is 24 feet SW of a blazed pine tree, 18 feet S of a 10-foot stump, 30 feet N of a leaning oak tree and projects 5 inches above the ground.

OBJECT	DISTANCE	DIRECTION
STOKES	feet	0°00'00.0
R.M.No.2	178.62	43 33 24.0
R.M.No.1	199.72	292 46 46.8
Az.Mk. (Approx.)	0.2 mile	88 48 28.9

Height of telescope above station mark - 116 feet.

WHITE (Marion County, Fla., H.C.W., 1933; J.S.B., 1936)--All marks recovered as described in good condition.

WHITE (Marion County, Fla., H.C.W., 1933; E.B.L., 1937)--Station, reference and azimuth marks recovered as described and in good condition.

TURNER (Citrus County, Fla., G.L.A., 1934)--Station is in clearing on W side of Withlacoochee River, and about 0.5 mile N of Turners Camp. It is 121 feet W of road, 163 feet W of prominent palmetto on high-water line on W bank of river, 170 feet S of edge of live oaks. Mark projects 3 inches.

Surface, underground, reference and azimuth marks are standard bronze disks set in top of concrete as described in notes 1b, 7a and 11b.

Reference mark No.1 is 7.5 feet E of road, 93 feet W of high-water line, 52 feet S of palmetto. Mark projects 3 inches.

Reference mark No.2 is 9.5 feet S of twin-oak in N edge of clearing, 102 feet W of road at entrance to woods, 146 feet W of high-water line, and projects 6 inches.

Azimuth mark is 3 feet NW of wire fence, 8 feet SW of 12-inch ash, 55 feet NE of 12-inch sweet gum tree in fence corner, 150 feet E of road, and projects 4 inches.

To reach from courthouse in Inverness, go NW on U.S. Highway 41 (Main Street) 0.65 mile; turn right on paved street and follow macadam road to its end and continue on sand road, following main-travelled way for a total distance of 7.7 miles to Turner's Camp on Withlacooche River. Just before entering camp turn left at large pine tree and follow dim trail through fenced lane for 0.6 mile to clearing on left and station.

OBJECT	DISTANCE	DIRECTION
CHASSA	feet	0°00'00.0
R.M.No.2 (N)	168.74	79 29 12.7
R.M.No.1 (ESE)	162.56	220 01 48.4
Az.Mk. (SSE)	0.15 mile	264 08 34.8

A 126-foot tower saw stations CASSA and LIVEOAK, but failed to see LECANTO.

TURNER (Citrus County, Fla., G.L.A., 1934; E.B.L., 1937)--Station and all marks recovered as described and in good condition. Additional description follows:

Station is on the W shore of the Withlacoochee River, near the S tip of a small triangular clearing, on a slight rise at the N end of a double row of palmettoes, 40 feet W of the taller of two palm trees, 62 feet W of a 4-foot burned out snag, about 55 yards E of edge of river swamp, about 90 yards W of the high-water line of W bank of river. Mark projects 4 inches.

WILDWOOD (Sumter County, Fla., E.B.L., 1937)--Station is about 2.7 miles by road WNW of Wildwood, near the house of and on timber land owned by Mr. Caruthers. Mark lies 22 feet E of center line of woods road and 22 feet SW of triangular blaze on 22-inch pine. It projects 2 inches.

Surface, underground, reference and azimuth marks are standard bronze disks set in concrete as described in notes 1a, 7a and 11a.

Reference mark No.1 is located NW of the station, 6 feet SSE of a 20-inch pine, and 17 paces W of the center line of the woods road. It projects 4 inches.

Reference mark No.2 lies S of the station, 10 yards E of the center line of the woods road and 8 feet ESE of a 16-inch pine tree. It projects 4 inches.

Azimuth mark lies on the first road 0.45 mile W of the lane leading to the Caruthers dwelling. The mark is 8 yards N of the center line of the road and 65 yards E of a sand cross road. It is 45 yards WNW of a small pond and projects 6 inches.

To reach station from junction of Routes 23 and 34 in Wildwood go W on Route 36, 2.2 miles to a sand T-road going N. Turn N and go 0.45 mile to point where road turns W, continue N past Caruthers dwelling and through gate into woods. Station lies 95 yards N of gate on E side of woods road.

OBJECT	DISTANCE	DIRECTION
SUMPTER	feet	0°00'00.0
R.M.No.2	90.22	[illegible]
Az.Mk. (Approx.)	0.5 mile	[illegible] 54.8
R.M.No.1	91.69	188 00 48

Height of light above station mark - 34.7 meters.

Height of telescope above station mark - 31 meters.

Figure 7.--Sample description of triangulation stations on old format.

In those cases in which the accuracy of the control is important and there are doubts about the accuracy, the NGS should be consulted prior to beginning field operations. The accuracy of the control is discussed further in a later section.

Intersection points such as water tanks, church spires, etc., with very rare exceptions, are always located to third-order accuracy. No check points in this listing format are given to hundredths of seconds in position and to even feet for the State plane coordinates.

Field Positions

At the conclusion of a field project, lists of geographic positions computed from the unadjusted observations and lists of descriptions and recovery notes are prepared and published. The listing format is very similar to the "litho" type and all the data are printed on yellow paper (fig. 8 and 9).

These positions must be used with care since the values, regardless of the number of decimal places shown, have not been processed to remove or distribute the closures other than those involved in the triangles. The general practice is to initiate the computations from one published line and proceed in a continuous operation without consideration of ties to intermediate established control or to any lengths or azimuths observed in the project. Plane coordinates are not computed for field positions.

In some instances it is neither possible nor feasible to adjust a field project immediately upon completion; on occasion this could present a problem to a user who may urgently require a high degree of relative accuracy between a few points. The NGS, in such cases, will provide, upon request, internally consistent positions and plane coordinates for specific points; and, although the final adjusted data may differ somewhat from these values, the differences will be more or less constant in a general area.

Survey Data on Other Datums and Spheroids

The principal purpose for establishing geodetic surveys during the early years of the Coast and Geodetic Survey (originally known as the Survey of the Coast and then the Coast Survey) was to determine the relationship of our coastal cities in order to place the hydrographic surveys of the coast, rivers, and harbors and the resulting charts and maps on a single base or datum. Ideally the coastal surveys should have been planned and executed in a continuously connected manner, but such a plan was

NOAA Form 76-45
(2-71)
(Formerly C&GS Form 28d)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION

FIELD GEOGRAPHIC POSITIONS

G-14963 5.

LOCALITY Pinellas County NORTH AMERICAN 1927 DATUM Class 1 First - ORDER TRIANGULATION. STATE Florida

STATION		LATITUDE AND LONGITUDE ° ′ ″	AZIMUTH ° ′ ″	BACK AZIMUTH ° ′ ″	TO STATION	DISTANCE METERS
BAUDER 1973		27 54 52.3012	172 12 06.22	352 11 53.50	HARRIS	5470.627
	d.m.	82 47 34.4189	208 53 11.57	28 53 41.60	BREEZE	3628.172
			92 45 44.9		RM 3	
HALL 1973		27 55 00.7258	218 00 17.43	38 01 26.57	HARRIS	6550.298
	d.m.	82 50 29.1373	273 05 43.98	93 07 05.78	BAUDER	4784.620
			275 04 25.7		RM 3	
BOOTH 1926		28 00 02.8458	292 59 35.92	113 03 13.03	CYPRESS 2 RM 4	13,743.180
r.'73	d.m.	82 39 46.9342	18 18 54.18	198 18 03.37	JORDAN	9,428.929
GANDY 1973		27 52 38.1252	142 47 19.65	322 45 13.29	COURTNEY	12,196.135
	d.m.	82 35 17.3449	212 25 21.93	32 26 52.39	CYPRESS 2 RM 4	9,851.058
			76 07 47.2		RM 3	
FRANKLAND 1973		27 53 35.7468	125 20 29.50	305 19 17.93	JORDAN	5,125.525
	d.m.	82 39 02.3913	171 13 43.19	351 13 22.20	COURTNEY	8,031.248
			91 48 14.0		RM 2	
HONEY 1967		27 53 35.1763	149 49 24.09	329 48 59.07	NEWPORT	2,908.685
r.'73	d.m.	82 43 33.2775	227 14 57.71	47 15 52.93	JORDAN	4,393.167
			1 52 19.4		Azimuth mark 2	
			268 05 08.3		Azimuth mark 1	
DUMP 1973		27 51 52.4485	161 55 29.12	341 54 54.81	JORDAN	6,462.908
	d.m.	82 40 21.9632	214 23 16.07	34 23 53.28	FRANKLAND	3,853.287
			340 57 27.5		RM 3	
ST PETERSBURG NORTH-		27 53 05.8908	214 33 48.75	34 34 29.02	NEWPORT	4,148.272
WEST BASE 1933 r.'73		82 45 52.8121	256 42 04.02	76 43 09.29	HONEY	3,921.455
	d.m.		316 14 23.5		RM 5	
WALSING 1973		27 52 47.2283	141 53 26.65	321 52 31.49	HALL	5,223.058
	d.m.	82 48 31.2520	201 58 54.45	21 59 21.04	BAUDER	4,151.861
			92 40 25.2		RM 3	

[1]No check on this position. **Abbreviations used:** d.=described; m.=marked; n. =not; r.=recovered; l.=lost; p.=probably.
(Examples: n.d.=not described; p. l.=probably lost.)

comp:HLM
check: HDAK

Figure 8.--Sample format of field geographic positions.

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

UNADJUSTED HORIZONTAL CONTROL DATA

by the
National Geodetic Survey
NORTH AMERICAN 1927 DATUM

G-

Page No

NOAA FORM 76-39
(12-70)
FORMERLY C&GS FORM 525

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL GEODETIC SURVEY

DESCRIPTION OF TRIANGULATION STATION

NAME OF STATION BAUDER
STATE Florida
COUNTY Pinellas
NEAREST TOWN Largo
QUADRANGLE NO. 270824
CHIEF OF PARTY J.D. Stachelhaus
YEAR 1973
DESCRIBED BY D.J. Novak

NOTE.* HEIGHT OF TELESCOPE ABOVE STATION MARK 23.7 METERS.† HEIGHT OF LIGHT ABOVE STATION MARK 26.4 METERS

1b
7a

SURFACE-STATION MARK, UNDERGROUND-STATION MARK — DISTANCES AND DIRECTIONS TO AZIMUTH MARK, REFERENCE MARKS AND PROMINENT OBJECTS WHICH CAN BE SEEN FROM THE GROUND AT THE STATION

NOTE	OBJECT	BEARING	DISTANCE FEET	DISTANCE METERS	DIRECTION‡
	HARRIS 1934				00 00 00.0
desc	RM 1	SE	70.35	21.441	131 10 22
desc	RM 2	WSW	79.90	24.352	277 44 55
11b	RM 3	W	0.15 mile		280 33 38.7
	RM 1 to RM 2		143.96	(43.879)	

The station is located in the center of Largo, at the northeast corner of the grounds of the Bauder Elementary School, in a half moon shaped grassy area and on property of Pinellas County.

To reach the station from the Largo Town Hall in Largo, go west on 1st Ave SW for 0.05 mile to a crossroad. Turn left and go south on 4th Street SW for 0.05 mile to a side road right and the school in the southwest angle of the intersection. Turn right and go west on 2nd Ave SW for 0.05 mile to the station on the left.

Station marks are standard disks stamped BAUDER 1973. The surface disk is set in the top of a 12-inch cylindrical concrete monument 2 inches below the surface of the ground. It is 70.5 feet southwest of power line pole number 8A84 which has a transformer, 62 feet southeast of power line pole number 8A85, 53 feet north-northeast of the northwest corner of the most northeasterly building of the Bauder Elementary School, 24 feet south of the center of 2nd Ave SW and 16.5 feet north of the north edge of a paved driveway. The underground mark is set in the top of an irregular mass of concrete 48 inches below the surface of the ground.

Reference mark 1, a standard disk stamped BAUDER NO 1 1973, is cemented in a drill hole in a covered concrete sidewalk. It is 42.5 feet southwest of the east 1 of 3 palm trees and 11.7 feet north of the north face of the school building.

Reference mark 2, a standard disk stamped BAUDER NO 2 1973, is cemented in a drill hole in the concrete sidewalk. It is 53 feet south-southwest of power line pole number 8A85, 52 feet northwest of a 36-inch live oak tree and 24 feet south of the center of 2nd Ave SW.

Reference mark 3, a standard disk stamped BAUDER NO 3 1973, is set in the top of a 12-inch cylindrical concrete monument 1-inch below the ground surface. It is 31 feet east of the center of Ridge Road, 14 feet north of the center of 2nd Ave SW, 12.4 feet southeast of power line pole number 8A16 and 2 feet southwest of a metal witness post.

To reach reference mark 3 from the station, go west on 2nd Ave SW for 0.15 mile to the junction of Ridge Road and the mark in the northeast angle of the intersection.

*Refers to notes in manuals of triangulation and state publications of triangulation.
†To nearest meter only, when no trigonometric leveling is being done.
‡Direction-angle measured clockwise, referred to initial station.

U.S. GOVERNMENT PRINTING OFFICE 1971

Quad. 260801 PEC

RECOVERY NOTE, TRIANGULATION STATION

R

NAME OF STATION BRAY
ESTABLISHED BY J.B. YEAR 1934 STATE Florida BENCH MARK ALSO ☐
RECOVERED BY * C.L. Hardt YEAR 1970 COUNTY Palm Beach
AIRLINE DISTANCE AND DIRECTION FROM NEAREST TOWN 2 miles southeast of Lake Worth
HEIGHT OF TELESCOPE ABOVE STATION MARK 5.61 FEET HEIGHT OF LIGHT ABOVE STATION MARK 4.6 FEET

DISTANCES AND DIRECTIONS TO AZIMUTH MARK, REFERENCE MARKS AND PROMINENT OBJECTS WHICH CAN BE SEEN FROM THE GROUND AT THE STATION

OBJECT	BEARING	DISTANCE FEET	DISTANCE METERS	DIRECTION
PIER "A" Point				0 00 00.00
PIER	N	(1 mile)		0 14 25.91
RM 1	S	112.21	(34.202)	162 38 09
RM 2	N	124.37	(37.908)	345 53 20
Lake Worth WQXT Rad Tower (red lt)	N	(1 mile)		346 10 02.2

The station mark, reference marks 1 and 2 were recovered in good condition. Reference mark 3 (AZ MK) was not recovered at this time. Observed directions between reference marks checked very close but a difference in distance was noted; reference mark 1, 0.11 feet (0.034 meters) reference mark 2, 0.04 feet (0.015 meters). A tie to this station was made by a geodimeter traverse.

A new description follows:

The station is located 2 miles southeast of Lake Worth, 2 miles northeast of Lantana, 1 mile south of the Lake Worth Public Beach and 0.1 mile east of Highway A1A. It is in the approximate center of a sand ridge that is covered with seagrape bushes and is the highest and last solid ground before reaching the ocean.

To reach the station from the junction of State Highways 808 and A1A, which is 1 mile east of the business district of Lake Worth, go south on Highway A1A for 1.0 mile to a sand road on the left. Turn left and follow sand road east for 0.1 mile to a cut opening onto the beach and the station on the left, 140 feet to the north.

The station mark is a standard disk, stamped BRAY 1934, set in the top of a round concrete monument 5 inches under the sand. It is 12 feet west of the edge of the sand ridge and 1.4 feet east of a metal witness post. Note: 1b 7a

Reference mark 1 is a standard disk , stamped BRAY NO 1 1934, set in the top of a round concrete monument projecting 5 inches on the north side and exposed 18 inches on the south side. It is 29 feet north of the center of the sand road, 20 feet west of the edge of the ridga and 1.2 feet southeast of a metal witness post. Note: 11b

Reference mark 2 is a standard disk, stamped BRAY NO 2 1934, set in the top of a round concrete monument flush with the ground. It is 10 feet west of the edge of the ridge and 1.1 feet east of a metal witness post. Note: 11b

* Name of chief of party should be inserted here. The person who actually visited the station should sign his name at the end of the recovery note.

FORM C&GS-526e (12-69)
USCOMM-DC

U.S. DEPARTMENT OF COMMERCE
ESSA
COAST AND GEODETIC SURVEY

Figure 9.--Sample format of descriptive information issued with unadjusted horizontal control data.

neither possible nor, in truth, necessary. Consequently, many harbors and rivers were surveyed on independent systems long before the establishment of the national network in their areas; and, while the vast majority of this work was eventually computed on the North American Datum (or its equivalents, the New England Datum or the U. S. Standard Datum), many of the stations involved were not recomputed on the North American 1927 Datum. Prior to the adoption of the New England Datum in 1880, the computations were carried out on the Bessel spheroid and undoubtedly not all stations computed on this spheroid were converted to the Clarke Spheroid of 1866 when it was adopted in 1880.

Many of these early stations, not included in today's published files, appeared on maps and charts and were used in surveys of the time; and indeed some may still physically exist. Nevertheless, their value in resurveys, erosion studies, and other research endeavors is considerable. Annually, numerous requests for conversion of these points to the North American 1927 Datum are received. Occasionally, the requests are of such a nature that a review of the original field records is necessary. Fortunately, these early records are readily accessible, but often the research required to resolve a particular problem entails a very large effort. In such cases, it may be necessary to require reimbursement for gathering, reviewing, and evaluating the data.

Physical Geodesy Data

These data refer to the physical properties of the Earth's gravity field as applied in geodesy. The fundamental parameters are gravity intensity, astronomic position, and their temporal variations. Deflections of the vertical and geoidal separations are major elements related to the precise size and shape of the Earth. Knowledge of the intensity and direction of the gravity field at points on and above the Earth's surface is essential in studying the Earth's internal constitution, in metrology, and in space technology applications. Polar variation, or the wobble of the Earth's axis within the body of the Earth, is also included. Data are available in tabular form or, in certain cases, on charts showing contours of gravity intensity anomalies or geoidal separations.

Listed gravity data are compiled for distribution by NGS. An index map is available showing the current density of stations by 1° x 1° square subdivisions. The data are in automated format and can be furnished for any selected area in the form of punch cards, printouts, or magnetic tape. A sample listing is shown in figure 10.

GRAVITY LIBRARY - AUGUST 19 1970
LATITUDE 24 00.00 THRU 32 00.00
LONGITUDE 78 00.00 THRU 85 00.00

LATITUDE	LONGITUDE	TYPE UNIT	ELEVATION METERS	OBSERVED GRAVITY GALS	FREE AIR ANOMALY	BOUGUER ANOMALY	ISC CR TC	SOURCE	BASE STA REFERENCE	SEQUENCE	STD DEV FREE AIR	STD DEV BOUGUER
+28 27.70	- 80 32.40	1	+ 2.0	979.24580	+ 26.7	+ 26.5		361	21750	656	1	1
+28 27.80	- 80 34.20	1	+ 3.0	979.24310	+ 24.2	+ 23.9		361	21750	656	1	1
+28 28.00	- 80 35.40	1	+ 4.1	979.24070	+ 21.9	+ 21.4		361	21750	656	1	1
+28 28.10	- 80 32.00	1	+ 2.4	979.24700	+ 27.5	+ 27.3		361	21750	656	1	1
+28 28.10	- 80 32.60	1	+ 2.7	979.24620	+ 26.8	+ 26.5		361	21750	656	1	1
+28 28.40	- 80 42.50	1	+ 1.8	979.22320	+ 3.2	+ 3.0		361	21750	656	1	1
+28 28.50	- 80 34.70	1	+ 1.8	979.24350	+ 23.4	+ 23.2		361	21750	656	1	1
+28 28.60	- 80 32.20	1	+ 2.4	979.24760	+ 27.5	+ 27.2		361	21750	656	1	1
+28 28.70	- 80 33.40	1	+ 2.0	979.24600	+ 25.7	+ 25.4		361	21750	656	1	1
+28 29.00	- 80 33.90	1	+ 2.3	979.24580	+ 25.2	+ 24.9		361	21750	656	1	1
+28 29.10	- 80 32.50	1	+ 2.1	979.24790	+ 27.1	+ 26.9		361	21750	656	1	1
+28 29.20	- 80 35.00	1	+ 2.4	979.24420	+ 23.4	+ 23.1		361	21750	656	1	1
+28 29.20	- 80 35.00	1	+ 3.4	979.24380	+ 23.3	+ 22.9		361	21750	656	1	1
+28 29.50	- 80 33.60	1	+ 2.3	979.24680	+ 25.6	+ 25.3		361	21750	656	1	1
+28 29.50	- 80 34.60	1	+ 2.6	979.24470	+ 23.5	+ 23.3		361	21750	656	1	1
+28 29.80	- 80 32.80	1	+ 2.4	979.24880	+ 27.2	+ 26.9		361	21750	656	1	1
+28 30.00	- 80 34.50	1	+ 2.8	979.24570	+ 24.0	+ 23.7		361	21750	656	1	1
+28 30.60	- 80 33.40	1	+ 2.1	979.24850	+ 25.8	+ 25.6		361	21750	656	1	1
+28 30.70	- 80 34.10	1	+ 2.5	979.24750	+ 24.8	+ 24.5		361	21750	656	1	1
+28 31.30	- 80 47.00	1	+ 4.9	979.23850	+ 15.8	+ 15.2		361	21750	656	1	1
+28 31.40	- 80 33.50	1	+ 4.7	979.24850	+ 25.6	+ 25.1		361	21750	656	1	1
+28 31.50	- 80 33.80	1	+ 2.7	979.24870	+ 25.1	+ 24.8		361	21750	656	1	1
+28 31.50	- 80 34.70	1	+ 2.4	979.24680	+ 23.1	+ 22.8		361	21750	656	1	1
+28 31.60	- 80 39.90	1	+ 2.4	979.24020	+ 16.3	+ 16.1		361	21750	656	1	1
+28 32.46	- 81 20.16	1	+ 34.0	979.21789	+ 2.7	- 1.0	1	2733		151		
+28 32.77	- 81 20.27	1	+ 34.0	979.21786	+ 2.3	- 1.4		2752	1650	5084	2	1

Figure 10.--Sample listing of gravity data.

Astronomic data are available for more than 3,000 stations in the U. S. and territories. The data are maintained in a card file, one card for each station. Copies of the cards are furnished on request, and contain final results in latitude, longitude, and azimuth; precision figures; and deflections of the vertical where available. A sample data card is shown in figure 11. Many of these data are now available on computer listings.

Anyone considering the observation of astronomical azimuths should consult the following two articles, referenced in the bibliography of this paper, prior to initiating operations:

(1) Poling, Jr., A. A., 1973: Astronomical azimuths for local control.

(2) Rice, D. A., 1959: Ephemeris time and universal time.

Vertical Control Data

Quad Type Format

Figures 12 through 15 illustrate the format used in tabulating vertical control data on the quad system. The line numbers do not correspond to those shown on the State leveling diagrams nor are they necessarily the same as those assigned when the line continues into adjacent quads. In crustal movement or subsidence areas, several elevations identified by the year of observation are often listed for each bench mark.

Listings by Lines

In some States and localities within States which have not been completely converted to the quad-type publication, leveling control is published by lines where the numbers correspond to those shown on the State leveling diagrams. This format is quite similar to the quad type; no examples are shown here. In the oldest listings there may be no route sketch included, and the elevations are often tabulated with the bench mark descriptions rather than in separate lists. Also, for all types of listings which follow this general format, when a line extends into another State, the line number may not be identical.

Field Elevations

Unadjusted field elevations are generally available shortly after the completion of a survey project. These data, as for any material that has not been verified or adjusted in the office, must be used with caution.

NOAA FORM 76-49 (4-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Quad. 290812
State Florida

Station: FAVORETTA 1934

ASTRONOMY, ABSTRACT OF RESULTS

LATITUDE

Station FAVORETTA 1934 Chief of Party L. S. Baker

Observer R. B. Gassett Date 26 Sept. 1962

	PRELIMINARY	FINAL		INSTRUMENT NO.	CHRONOMETER NO.
Mean Observed Latitude	29° 22′ 06.″51		± 0.″08	T-4 33114	7897
Reduction to Sea Level (m.)	0.00				
Variation of Pole C.I.O.1968 BIH	-.10				
Eccentric Reduction—in Latitude	+0.31				
Astronomic Latitude (ϕ_A)	29° 22′	06.″72	± 0.″08		
Geodetic Latitude (ϕ_G)	29° 22′	04.404			
Deflection in the Meridian ($\phi_A - \phi_G$)		+2.42			

No. of Observations: Accepted 16, Rejected 0

in Longitude +1.″24

VALUE OF 1/2 TURN OF MICROMETER 76.6512 ± .0238

±

(λ_G) 81° 11′ 06.″809

Remarks: None x = +.007
y = +.102

LONGITUDE

Station FAVORETTA 1934 Chief of Party L. S. Baker

Observer R. B. Gassett Date 1 Oct. 1962

		PRELIMINARY	FINAL		INSTRUMENT NO.	CHRONOMETER NO.
Mean Observed Longitude	Time	05h 24m s	44.s298 ± 0.s008		T-4 33114	7897
	Arc	81° 11′ ″	04.″47 ± 0.″12		NO. OF SETS 4	
Eccentric Reduction—in Longitude			+1.24	in Latitude +0.31		
Variation of Pole C.I.O.1968 BIH			+.01			
Astronomic Longitude (λ_A)		81° 11′	05.″72 ± 0.″12	Cos ϕ .8715		
Geodetic Longitude (λ_G)		81° 11′	06.809	(ϕ_G) 29° 22′ 04.″404		
Deflection in Longitude ($\lambda_A - \lambda_G$)			-1.09			
Deflection in Prime Vertical ($\lambda_A - \lambda_G$) Cos ϕ			-0.95			

Remarks: None x = -.003
y = +.102

AZIMUTH

Station FAVORETTA 1934 Mark WELCOME 3

Observer H. C. Howes, N. E. Matlock Date 18, 19 Oct. 1962

Chief of Party S. C. Miller Instrument No. T-3 53077

Mean Observed Azimuth	148° 05′	05.66 ± 0.″24	No. of Observations: Accepted 31, Rejected 1
Diurnal Aberration		+0.32	
Elevation of mark (m.)		0.00	Sin ϕ .4904 Cos ϕ
Eccentricity		0.00	(ϕ_G) 29° 22′ 04.″404
Variation of Pole C.I.O.1968 BIH		-.07	(λ_G) 81° 11′ 06.″809
Astronomic Azimuth (α_A)	148° 05′	05.″91 ± 0.″24	(α_G)
($\lambda_A - \lambda_G$) -1.″09	($\lambda_A - \lambda_G$) Sin ϕ	-0.53	($\alpha_A - \alpha_G$) Cot ϕ
Laplace Azimuth	148° 05′	05.″38	$-(\alpha_A - \alpha_G)$ Cot ϕ

Remarks: None x = -.042
y = +.110

ACCESSION NUMBERS 872 A 1962
Vol. 18,19 G-12984 A-3047

USCOMM-DC 34242-P71

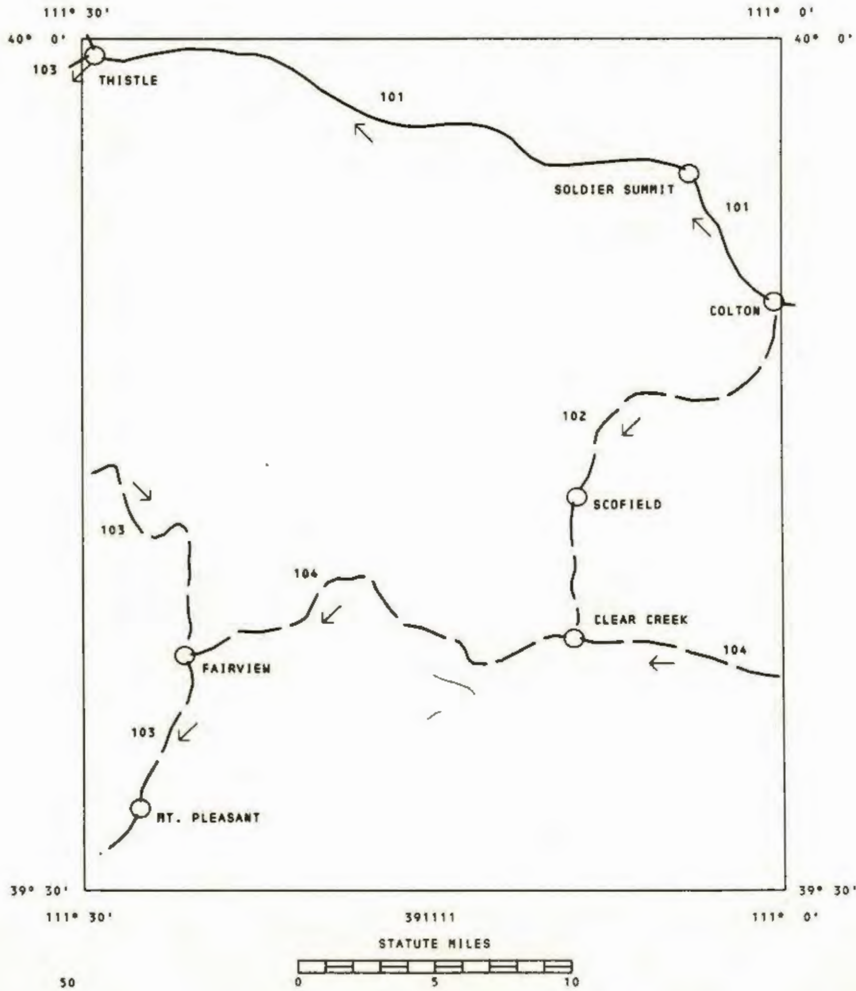
Figure 11.--Sample data card showing astronomic data.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

JULY 1974

VERTICAL CONTROL DATA
BY THE
NATIONAL GEODETIC SURVEY
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUAD 391111
UT
LATITUDE 39° 30' TO 40° 0'
LONGITUDE 111° 0' TO 111° 30'
DIAGRAM NJ 12-2



USCOMM-NOAA-ASHEVILLE 50

Figure 12.--30-min. quad diagram showing routes of vertical control.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

JULY 1974

VERTICAL CONTROL DATA

BY THE
NATIONAL GEODETIC SURVEY
NATIONAL GEODETIC VERTICAL DATUM OF 1929 *

QUAD 391111 PAGE NO. 1
UT
LATITUDE 39° 30' TO 40° 0'
LONGITUDE 111° 0' TO 111°30'
DIAGRAM NJ 12-2

LINE 101

ADJUSTMENT OF 1929
CHIEF OF PARTY
J. H. BRITTAIN
OBSERVATIONS OF 1927

CIRCLE-00353
4.0MM FIRST-ORDER

BENCH MARK	ADJUSTED ELEVATION (METERS)	(FEET)
7192 (USGS)	2190.871	7187.883
C 15	2188.858	7181.278
D 15	2205.523	7235.953
E 15	2231.107	7319.890
54 RS (USGS)	.	7443.177
G 15 RESET	.	7054.454
H 15	1990.961	6532.011
35 ARS (USGS)	.	6335.952
K 15	1868.498	6130.230
E 17	1539.805	5051.844

LINE 102

CHIEF OF PARTY
F.B. QUINN
OBSERVATIONS OF 1938

L-07990
8.4MM SECOND-ORDER

BENCH MARK	ADJUSTED ELEVATION (METERS)	(FEET)
BM (USGS)	2187.088	7175.471
A 239	2193.320	7195.917
B 239	2223.746	7295.740
C 239	2259.172	7411.967
7498 (USGS)	2285.325	7497.770
D 239	2300.055	7546.097
7573 (USGS)	2308.208	7572.846
E 239	2327.653	7636.641
F 239	2331.984	7650.851
G 239	2331.642	7649.729
H 239	2331.284	7648.554
7702 (USGS)	2347.672	7702.320
K 239	2360.596	7744.722
L 239	2390.068	7841.415
7922 (USGS)	2414.708	7922.254
M 239	2432.148	7979.472
N 239	2465.694	8089.531
P 239	3000.516	9844.193

LINE 103

CHIEF OF PARTY
H.J. OLIVER
OBSERVATIONS OF 1934

L-01740
8.4MM SECOND-ORDER

BENCH MARK	ADJUSTED ELEVATION (METERS)	(FEET)
A 42	1542.241	5059.836
A 42 RESET 1964	.	5059.731
K 42	1865.294	6119.719
L 42	1903.678	6245.650
M 42	1956.206	6417.986
N 42	DESTROYED	
P 42	1918.820	6295.329
Q 42	1893.364	6211.812
R 42	1862.590	6110.847
S 42	1835.818	6023.013
SS 42	1815.993	5957.970
T 42	1825.801	5990.149
U 42	DESTROYED	
V 42	1782.242	5847.239
WW 42	1781.080	5843.427
VV 42	1805.571	5923.777
W 42	1774.236	5820.973
X 42	1754.153	5755.084

LINE 104

CHIEF OF PARTY
C. LEFEVER
OBSERVATIONS OF 1935

L-07127
8.4MM SECOND-ORDER

BENCH MARK	ADJUSTED ELEVATION (METERS)	(FEET)
F 131	1986.935	6518.803
G 131	2087.269	6847.982
H 131	2198.562	7213.115
J 131	2269.224	7444.946
K 131	2364.193	7756.523
L 131	2891.440	9486.333
8303 (USGS)	2531.254	8304.622
9821 (USGS)	2993.776	9822.080
N 131	2731.780	8962.515
8472 (USGS)	2582.715	8473.457
8442.83 (USGS)	2574.078	8445.121
P 131	2622.784	8604.917
Q 131	2619.587	8594.428

*NOTE: THE WORDS "SEA-LEVEL DATUM OF 1929" WERE OFFICIALLY CHANGED IN 1973 TO "NATIONAL GEODETIC VERTICAL DATUM OF 1929." THE DATA REMAIN THE SAME, ONLY THE NAME WAS CHANGED.

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Figure 13.--30-min. quad format listing of elevations.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

JULY 1974

VERTICAL CONTROL DATA

BY THE
NATIONAL GEODETIC SURVEY
NATIONAL GEODETIC VERTICAL DATUM OF 1929

DESCRIPTION INDEX

QUAD 391111 PAGE NO. 1
UT
LATITUDE 39° 30' TO 40° 0'
LONGITUDE 111° 0' TO 111°30'
DIAGRAM NJ 12-2

BENCH MARK	STATE	LINE	PAGE(S)
A 42	UT	103	5
A 42 RESET 1964	UT	103	5
A 132	UT	104	12
A 239	UT	102	2
B 132	UT	104	12
B 239	UT	102	3
BM (USGS)	UT	102	2
C 15	UT	101	1
C 132	UT	104	12
C 239	UT	102	3
D 15	UT	101	1
D 239	UT	102	3
E 15	UT	101	1
E 17	UT	101	2
E 239	UT	102	3
F 131	UT	104	8
F 239	UT	102	4
G 15 RESET	UT	101	1
G 131	UT	104	8
G 239	UT	102	4
H 15	UT	101	2
H 131	UT	104	9
H 239	UT	102	4
J 131	UT	104	9
K 15	UT	101	2
K 42	UT	103	6
K 131	UT	104	9
K 239	UT	102	4
L 42	UT	103	6
L 131	UT	104	9
L 239	UT	102	4
M 42	UT	103	6
M 239	UT	102	5
N 42	UT	103	6
N 131	UT	104	10
N 239	UT	102	5
P 42	UT	103	6
P 131	UT	104	10
P 239	UT	102	5
Q 42	UT	103	6
Q 131	UT	104	10
R 42	UT	103	7
R 131	UT	104	10
S 42	UT	103	7
S 131	UT	104	11
SS 42	UT	103	7
T 42	UT	103	7
T 131	UT	104	11
U 42	UT	103	7
U 131	UT	104	11
V 42	UT	103	7
V 131	UT	104	11
VV 42	UT	103	8
W 42	UT	103	8
W 131	UT	104	11
WW 42	UT	103	8
X 42	UT	103	8
X 131	UT	104	11
Y 131	UT	104	12
Z 131	UT	104	12
35 ARS (USGS)	UT	101	2
54 RS (USGS)	UT	101	1
7192 (USGS)	UT	101	1
7498 (USGS)	UT	102	3
7573 (USGS)	UT	102	3
7702 (USGS)	UT	102	4
7922 (USGS)	UT	102	5
8303 (USGS)	UT	104	9
8442.83 (USGS)	UT	104	10
8472 (USGS)	UT	104	10
9821 (USGS)	UT	104	9

Figure 14.--30-min. quad format of vertical control data descriptive index.

VERTICAL CONTROL DATA

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

BY THE
NATIONAL GEODETIC SURVEY
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUAD 391111 PAGE NO. 1
UT
LATITUDE 39° 30' TO 40° 0'
LONGITUDE 111° 0' TO 111°30'
DIAGRAM NJ 12-2

JULY 1974

RECOVERY NOTE, BENCH MARK
DESIGNATION-7192 (USGS) STATE-UT COUNTY-UTAH
QUAD- 391111-101 ESTABLISHED BY-USGS CP-BRITTAIN
DISTANCE AND DIRECTION FROM NEAREST TOWN-AT COLTON
DISK STAMPED-7192 1910 29 RECOVERY DATE-1927
DETAILED DESCRIPTION-THIS PUBLIC SCHOOL BUILDING IS BEING DISMANTLED. AT COLTON, UTAH COUNTY, IN THE SOUTH WALL OF THE PUBLIC SCHOOL BUILDING, 3 FEET WEST OF THE MAIN ENTRANCE, AND ABOUT 4 FEET ABOVE THE GROUND. SET VERTICALLY.

RECOVERY NOTE, BENCH MARK
DESIGNATION-E 15 STATE-UT COUNTY-UTAH
QUAD- 391111-101 ESTABLISHED BY-C+GS CP-BRITTAIN
DISTANCE AND DIRECTION FROM NEAREST TOWN-3 MILES SOUTHEAST
DISK STAMPED-7319.890 E 15 1927 RECOVERY DATE-1927
DETAILED DESCRIPTION-3.0 MILES SOUTHEAST ALONG THE DENVER + RIO GRANDE WESTERN RAILROAD FROM SOLDIER SUMMIT, UTAH COUNTY, 0.4 MILE EAST OF MILEPOST 649, AT A CONCRETE CULVERT UNDER THE TRACK, IN THE TOP OF THE WEST END OF THE SOUTH HEADWALL, AND 17 FEET SOUTH OF THE CENTERLINE OF THE SOUTH TRACK.

RECOVERY NOTE, BENCH MARK
DESIGNATION-C 15 STATE-UT COUNTY-UTAH
QUAD- 391111-101 ESTABLISHED BY-C+GS CP-BRITTAIN
DISTANCE AND DIRECTION FROM NEAREST TOWN-0.4 MILE NORTHWEST
DISK STAMPED-7181.278 C 15 1927 RECOVERY DATE-1927
DETAILED DESCRIPTION-0.4 MILE NORTHWEST ALONG THE DENVER + RIO GRANDE WESTERN RAILROAD FROM COLTON, UTAH COUNTY, 80 FEET NORTHWEST OF A ROAD CROSSING, AT A CONCRETE CULVERT UNDER THE TRACK, IN THE TOP OF THE EAST END OF THE NORTH HEADWALL, AND 40 FEET NORTHEAST OF THE CENTERLINE OF THE NORTH TRACK.

DESCRIPTION OF BENCH MARK
DESIGNATION-54 RS (USGS) STATE-UT COUNTY-UTAH
QUAD- 391111-101 ESTABLISHED BY-USGS CP-BRITTAIN
DISTANCE AND DIRECTION FROM NEAREST TOWN-AT SOLDIER SUMMIT
DISK STAMPED-54 RS 1938 7443 LEVELING DATE-
DETAILED DESCRIPTION-AT SOLDIER SUMMIT, UTAH COUNTY, 21.3 FEET EAST OF THE NORTHEAST CORNER OF THE DENVER + RIO GRANDE WESTERN RAILROAD STATION, AND 18 FEET SOUTH OF THE CENTERLINE OF THE SOUTH TRACK. SET IN THE TOP OF A CONCRETE POST.
NOTE-THIS BENCH MARK WAS ESTABLISHED BY THE UNITED STATES GEOLOGICAL SURVEY IN MAY 1938 TO REPLACE F 15.

RECOVERY NOTE, BENCH MARK
DESIGNATION-D 15 STATE-UT COUNTY-UTAH
QUAD- 391111-101 ESTABLISHED BY-C+GS CP-BRITTAIN
DISTANCE AND DIRECTION FROM NEAREST TOWN-2.2 MILES NORTHWEST
DISK STAMPED-D 15 1927 RECOVERY DATE-1927
DETAILED DESCRIPTION-2.2 MILES NORTHWEST ALONG THE DENVER + RIO GRANDE WESTERN RAILROAD FROM COLTON, UTAH COUNTY, AT BRIDGE 646 A, AND IN THE TOP OF THE EAST END OF THE NORTH ABUTMENT.

DESCRIPTION OF BENCH MARK
DESIGNATION-G 15 RESET STATE-UT COUNTY-UTAH
QUAD- 391111-101 ESTABLISHED BY-C+GS CP-BRITTAIN
DISTANCE AND DIRECTION FROM NEAREST TOWN-2.5 MILES WEST
DISK STAMPED-G 15 1927 LEVELING DATE-1927
DETAILED DESCRIPTION-2.5 MILES WEST ALONG U.S. HIGHWAY 50 FROM SOLDIER SUMMIT, UTAH COUNTY, 2.7 MILES EAST OF GILLULY, ON THE WEST SIDE OF THE POINT OF A RIDGE, 45 FEET NORTH OF THE CENTER LINE OF THE HIGHWAY, AND IN THE TOP OF A BOULDER.
NOTE-IN SEPTEMBER 1934 IT WAS REPORTED THAT THE BOULDER CONTAINING THE ORIGINAL BENCH MARK G 15 HAD BEEN MOVED. IN MAY 1938, THE UNITED STATES GEOLOGICAL SURVEY SET THE BOULDER IN THE ABOVE-DESCRIBED LOCATION AND RESET THE MARK.

Figure 15.--30-min. quad format showing vertical control descriptions.

Accuracy of Horizontal Control Stations

The accuracy of control points published as part of the national network is noted on the listings of geographic positions or on the data sheet for each point, or can be ascertained. With few exceptions, stations forming the basic network have been established by one Federal agency (the former Coast and Geodetic Survey, now the National Ocean Survey, Office of the National Geodetic Survey). Since about 1940, the standards and specifications employed have been continually upgraded for first- and second-order surveys. At the present time, all primary arcs and area networks are accomplished to first-order (1:100,000) standards. On occasion, supplemental surveys may be performed to second-order class I (1:50,000) standards, and in rare instances to second-order class II (1:20,000) criteria.

Prior to this time, most basic area networks were established to standards approaching first-order; however, because of the lack of sufficient scale and a very slight reduction in the specifications, this work has been classified as second-order. There is little doubt that with the introduction of a few measured distances most of these area nets can be upgraded to minimum first-order standards. As currently adjusted, however, the relative accuracy of many stations may barely meet the listed standard and in some isolated instances may fall below standard. Where such conditions exist, the cause in almost every case can be traced to the piecemeal manner in which the network was adjusted. Plans are underway for a new adjustment, the results of which will better reflect the excellent quality of the observations.

For many years, in an effort to provide the local surveyor or engineer with convenient control, a large number of stations supplemental to the basic net was established along highways or other easy-to-reach locations. The observations involved with these points are generally of the same precision and quality as the basic stations and acceptable geometry was usually obtained; however, no effort was made to establish continuous chains. As a result, stations located quite close to one another, but not connected, may have relative accuracies somewhat less than the stated standard. At the time much of this work was accomplished, few local practitioners had the equipment or trained personnel to meet even these lower standards, and there did not seem to be any reason for concern about the possible less-than-desirable relationship of these points. About a decade ago, however, with the increased use of electronic distancers and quality theodolites at all levels of the surveying profession, it was realized this practice could no longer be tolerated; so a decision was made to connect all points which were within a specified distance. This specification, known as the 20 percent rule, is rather rigorously followed. Essentially, the rule states that a connection will be made between two points whenever this distance is 20 percent or less than the total distance along the shortest directly connected route between two points. For example, in figure 16, VERONA should have been connected to KOLLATH because this distance is less than 20 percent of the shortest directly connected route, KOLLATH-HILT + HILT-VERONA. Similarly, a connection SAUK-MARXVILLE should have been made since this distance is less than 20 percent of the sum of the distances SAUK-REUTER + REUTER-ROBSON + ROBSON-MARXVILLE. When a survey is made between two unconnected stations, an evaluation such as this should be made. Should the distance be greater than 20 percent of the route as described above, satisfactory results will usually be obtained, but should it be less, there is a good chance that excessive closures may result.

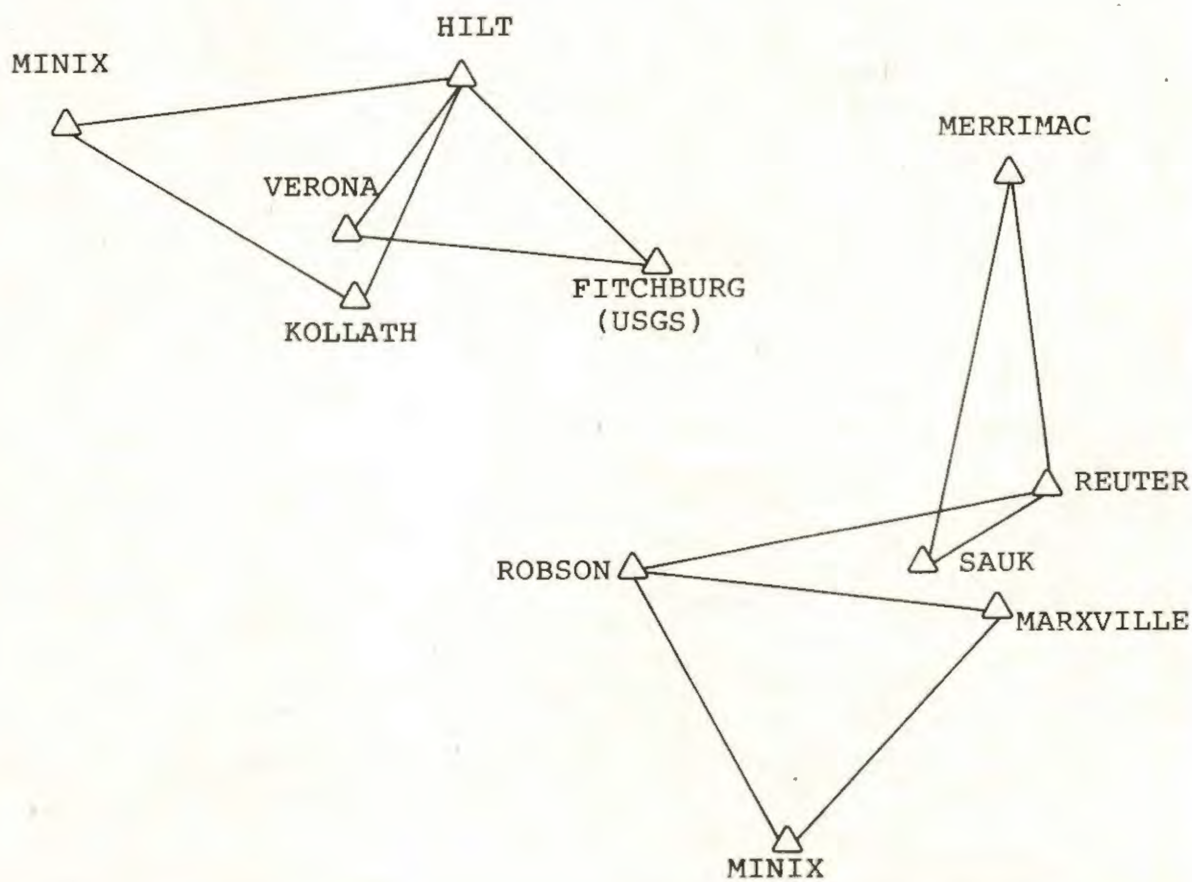


Figure 16.--Samples where problems may exist because of the relative locations of stations.

Another method for evaluating the control in a locality is to measure lines of the network at every opportunity. By comparing these measurements with computed or published distances, the scale differentials can be determined, and, often, a better understanding of the survey closures can be obtained.

Whenever difficulties are encountered, the agency that published the data should be consulted. Often a review of the computations or a check of the field records can resolve or at least clarify a problem. On occasion, revisions will be made to the published data when serious distortions in the network are uncovered by additional observations. When these recomputations are made, observations secured by other organizations, private and public, will be included, providing the data furnished were obtained by acceptable survey practices.

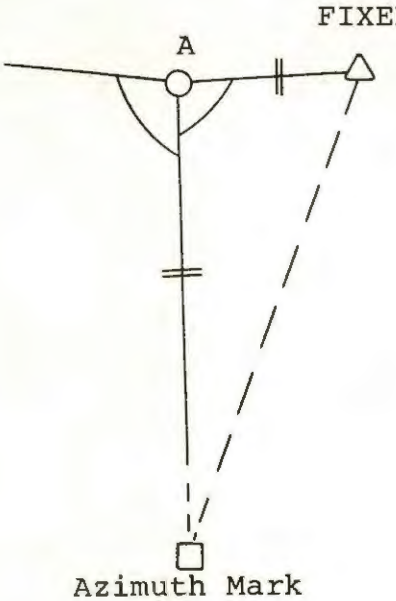
APPLICATION

Geodetic data have numerous applications, some having little to do with surveying per se, but no effort is made here to expound on this subject except to note that the results of geodetic operations affect everyone's daily life in one way or another. The publications listed in the bibliography contain numerous examples of the application of geodetic data. In a publication of this size, it is the author's opinion that the possible solution to a particular problem is more worthwhile than an enumeration of the attributes of geodetic control data.

Accordingly, one of the main complaints expressed by users is the lack of orientation at a station site or the blockage of the lines of sight to the azimuth mark or some other point which could be used to provide orientation.

On these occasions, the only solution would seem to be astronomical observations. In many instances, however, a variety of "tricks of the trade" can often be used; so the astronomic work may not be necessary. Figures 17, 18, and 19, and the accompanying text, describe some of the methods that have proven successful. In addition to these procedures, there are numerous other geometrical and trigonometrical innovations that can be employed by imaginative surveyors. These practices would not be suggested for surveys where results better than 1:15,000 are expected, but could be used in higher grade surveys as a check, providing good quality orientation has been introduced elsewhere in the traverse.

In the examples shown in figures 17 and 18, A is a point on a traverse terminating at control point FIXED. The line between FIXED and its azimuth mark is obstructed. An intersection point may be substituted for the azimuth mark in the example



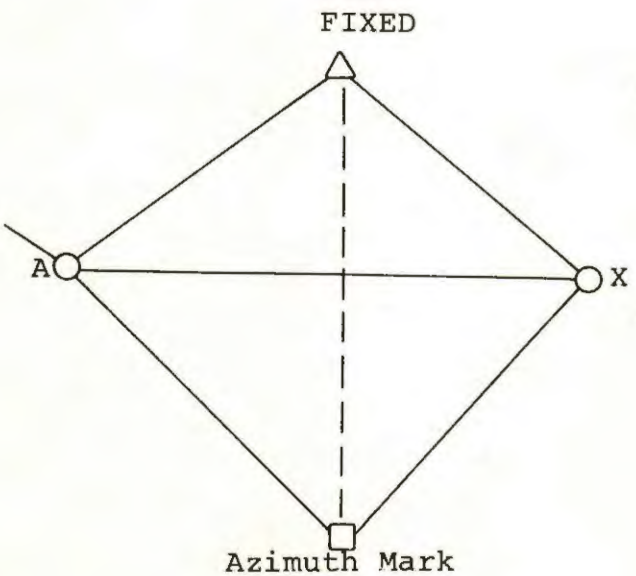
(1) Measure distances shown by two parallel cross hashes.

(2) Measure angle at A.

(3) Compute angle at Azimuth Mark by side-angle-side computation.

(4) To obtain the azimuth A to Azimuth Mark, apply computed angle at Azimuth Mark to grid (plane) azimuth FIXED to Azimuth Mark. In this example, the computed angle would be subtracted.

Figure 17.--Example of establishing azimuth control by computation using observed angles and distances.



(1) Observe angles as indicated by full lines - no distances are necessary (assume a distance for one line and compute other lines).

(2) Compute angle at FIXED between Azimuth Mark and A by side-angle-side computation and use to determine the azimuth FIXED to A.

Figure 18.--Example of establishing azimuth control by computation using triangulation procedures.

shown in figure 18. Since this point would not normally be occupied, extra care must be exercised in making the observations. In this case, a check of sorts would be obtained by using the traverse distance A to FIXED in the computation and comparing the computed distance between FIXED and the intersection point with that obtained from the published data. The triangle closures should seldom exceed 5".

In the example shown by figure 19, A is a point on a traverse terminating at control point FIXED (1). No azimuth control is available at FIXED (1), but orientation can be obtained at FIXED (2). FIXED (1) and FIXED (2) are not intervisible, of course; however, the azimuth could be carried between the points through one or more intermediate points.

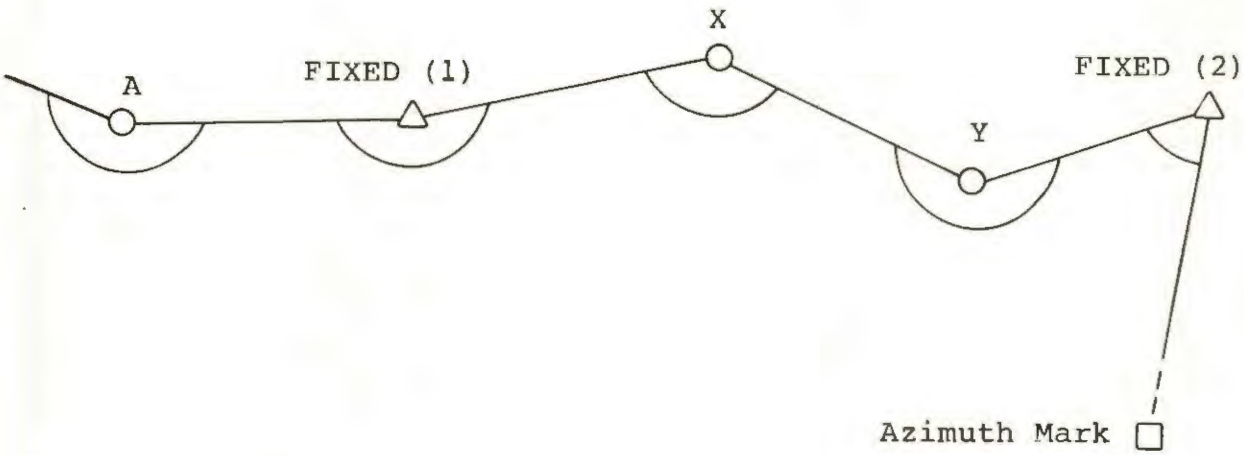


Figure 19.--Example of establishing azimuth control by angulation from adjacent control stations.

(1) Observed angles as indicated; no distances between FIXED (1) and FIXED (2) are required.

(2) Starting with the grid azimuth FIXED (2)-Azimuth Mark, compute the grid azimuth FIXED (1)-A using the observed angles. The distribution of the azimuth closure should be made from FIXED (2) through FIXED (1) to azimuth control.

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