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The California Surveyor

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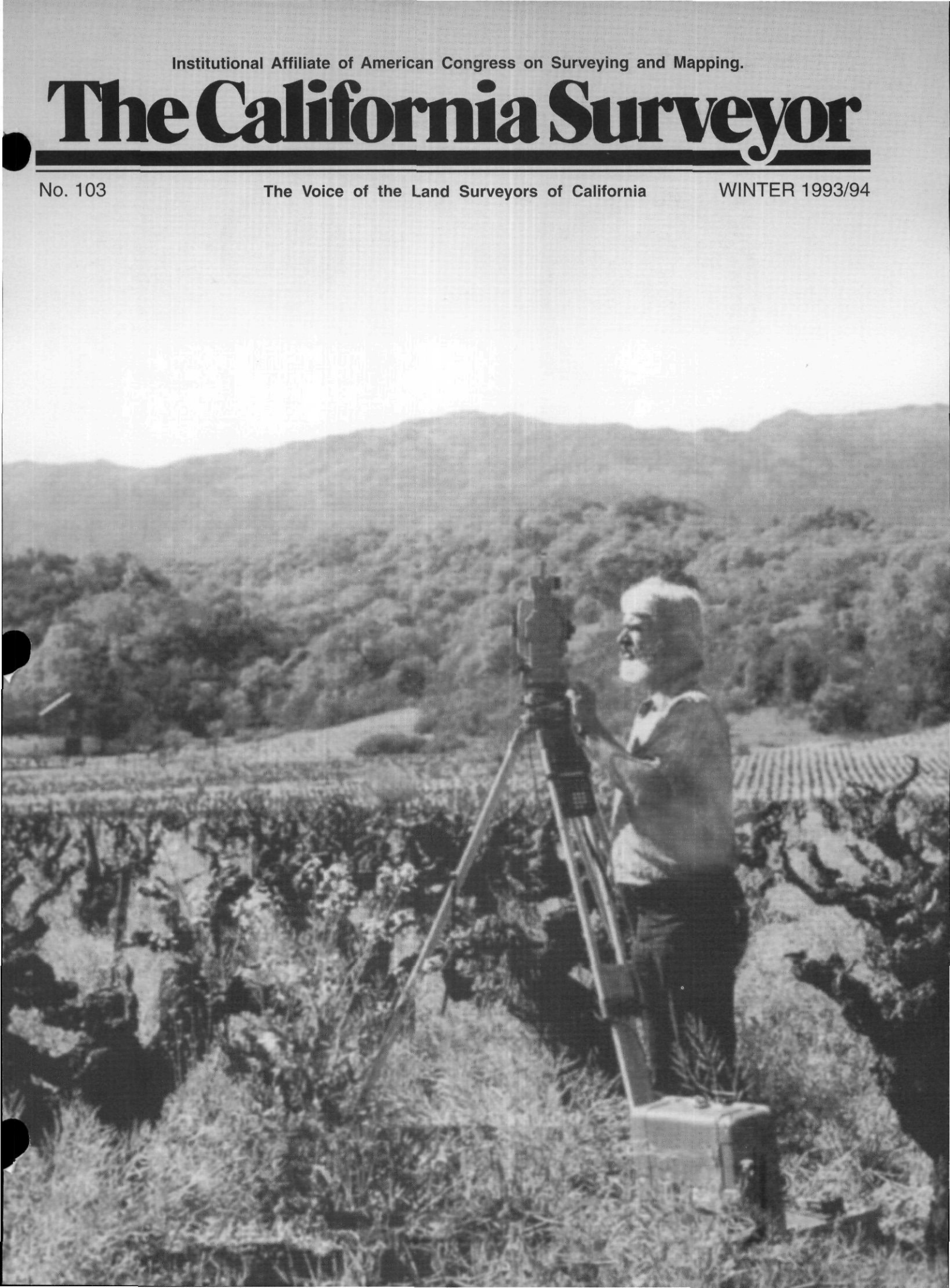

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The California Surveyor

is the quarterly publication of the California Land Surveyors Association, Inc. and is published as a service to the land surveying profession of California. It is mailed to all Licensed Land Surveyors in the State of California as well as to all members of California Land Surveyors Association, Inc. *The California Surveyor* is an open forum for all surveyors, with an editorial policy predicated on the preamble to the Articles of Incorporation of the California Land Surveyors Association, Inc. and its stated aims and objectives, which read:

"Recognizing that the true merit of a profession is determined by the value of its services to society, the 'California Land Surveyors Association' does hereby dedicate itself to the promotion and protection of the profession of land surveying as a social and economic influence vital to the welfare of society, community and state."

"The purpose of this organization is to promote the common good and welfare of its members in their activities in the profession of land surveying, to promote and maintain the highest possible standards of professional ethics and practices, to promote professional uniformity, to promote public faith and dependence in the Land Surveyors and their work."

PERSONNEL

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EDITORIAL MATERIAL

All articles, reports, letters, and contributions are accepted and will be considered for publication regardless of the author's affiliation with the California Land Surveyors Association, Inc. Contributions submitted on floppy diskette medium is encouraged. For compatibility, disks should be 5.25 or 3.5 inch, MSDOS (IBM compatible) format. We can accept ASCII text files or word processor files from the following programs: WordPerfect, Microsoft Word.

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Summer	April 10, 1994	Winter	October 10, 1994

Articles, reports, letters, etc., received after the above mentioned date will be considered for the next edition.

Cover Photo :

Neal Campbell hard at work in his field of dreams. Photo courtesy of Professionl Surveyor.

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From the 1994 President

HAPPY 1994!

By Kurtis K. Hoehn, P.L.S.

As the new year begins, I find myself behind the eight ball on some of the things I had planned to have underway by now. With your help, I may be able to accomplish them yet.

This will be a busy year for us in CLSA. My New Year's resolution is to get the organization back to basics. CLSA has in the past, been guilty of taking on more projects than it was capable of accomplishing. The organization may have prioritized some of these projects incorrectly — and as a result, suffered from the slings and arrows of some of our more vocal members. I want you all to know I have observed the most conscientious group of people you could ever want to meet in CLSA. We are not all infallible. Sometimes we make mistakes.

For the New Year, I want to strive to make the surveying profession a better one in spite of these minor setbacks.

In the last few years that I have been an officer in CLSA, I've traveled throughout the State, attending chapter, regional and state meetings. I've been privileged to hear some great things about our organization and some not so good things as well. We have our critics as well as our supporters. I feel qualified to put this research to good use for the organization. I want to provide the leadership to make CLSA the best professional organization it can be.

The original goal of this organization, was and still is to make the surveying profession better for *all* surveyors in California. In my travels, I found we could benefit most by improving communication. The state organization needs to communicate with the chapters better, and the chapters should improve communications with the state. Sometimes we forget that we are a group of representatives determining what is relevant for all our members. The general membership needs to communicate their views and opinions to their elected representatives. Without the general membership letting their representatives know how the state and local chapters are doing, communication breaks down.

In my travels, I found we could benefit most by improving communication

CLSA gets together with engineers and government officials to work *with* them and let them know when our goals are incongruent. We should be proud of the successful track record we've earned for improving conditions for the general public as well as the surveying profession. We've accomplished this using the system; either through legislation or by educating the populous.

In the last few years as an officer in CLSA, I have seen letters written to the president voicing concerns over a variety of positions CLSA has taken. These communiqués were a revelation to me. They underscore why we spend the energy to organize and use our collective voice to improve laws and regulations pertaining to surveying. The concerns were plausible, of course. What bothered me though, is so many of the authors didn't belong to either the local or state CLSA. The only reason they wrote was they were *finally* personally affected by the stand or position taken by our organization.

Get involved!

If you believe strongly enough about something, don't just fire off a letter and complain. Get involved! Let your opinions be known by joining your local chapter, and the state organization.

I began by making my New Year's resolutions. I'd like to take them a step further by requesting that the board of directors take on the responsibilities of their positions and represent their constituency with the respect deserved a professional organization. Committees should also perform their duties with due diligence and hold up their end of the bargain; like turning in required reports and letting people know what's going on in their areas.

I have planned an orientation meeting of all new board members (and old board members, if interested) to communicate what will be expected of them and what is available at the central office for their use and reference. The chapter and state members are paying to have us represent them. Let's give them what they expect.

We all need to insure that we are communicating with each other and focus on improving this skill. Without this two-way dialogue, we could miss important ideas and concerns of our individual members. ⊕

Letters To The Editor

■ CURTIS M BROWN SCHOLARSHIP AWARDED

The California Land Surveyors Association, San Diego Chapter, is pleased to announce they have awarded their Curtis M. Brown Scholarship of $1,000 to Jon Drake, a senior at California State Polytechnic University, Pomona.

The Curtis M. Brown Memorial Scholarship Fund was established in 1989 in honor of the Chapter's longtime member, Curtis M. Brown, a well-known surveyor and author. The scholarship is intended to aid and award a student enrolled in a four year institution, or in a community college with the intent to attend a four-year institution, majoring in surveying or surveying engineering. The Scholarship Committee not only reviews the academic and financial status of applicants but also considers their activities and involvement in the surveying profession.

Jon Drake is a full-time surveying engineering student with a GPA of 3.91. His interest and involvement in surveying began with his work as an engineering aide for the County of Orange Survey Division. He continues to work in the summers as a land surveyor trainee with the Bureau of Land Management. He is a student member of the American Congress on Surveying and Mapping and the secretary of Cal Poly's student chapter of the California Land Surveyors Association.

Jon is a member of the National Honor Society of Phi Kappa Phi and of the Tau Beta Pi National Engineering Honor Society. His goal is to complete his bachelor's degree program and return to the work force to gain the additional experience required to seek registration as a Professional Land Surveyor.

BETH SWERSIE
San Diego Chapter, CLSA
Education Committee Chairperson

■ LETTER TO AMERICAN CONGRESS ON SURVEYING AND MAPPING

[Editor's Note : This letter was sent to ACSM and distributed by NSPS to all the affiliate newsletters]

I have just completed my first ALTA survey. I am writing because I feel that the standards and methods specified are faulty and inapplicable. The general requirements seem reasonable, but the specifications for accuracy would, in most cases, simply not apply.

The as-built survey of a parcel of land is generally not accomplished by doing a control traverse, especially not one with long legs as specified. The minimum length of measured distances which you specify is longer than the entire width of the property which I have just surveyed. The mapping of a small parcel of land is best done by selecting a few strategic control points and using a total station to locate all features, no matter how close or far. This includes property corners as well as improvements. Redundancy of measurements is accomplished by overlapping some of the shots from the various control points, by taking direct and reverse measurements of angles and distances to property corners and control points, and by comparing record and computed data.

It is patently absurd to require that lines shorter than a certain length be measured by chain

Obtaining multiple sets of angles is a useless and futile waste of time for a small tract of land where the distances are so short. An angular error of 20" is of no consequence at all for most observations. Even for distances hundreds or thousands of feet from the site, a direct and reverse reading is all that is needed. The reason is simple: The further away a monument is from the property in question, the greater is the effect of the angular error out at that monument, but our property is not out at that monument—our property corners are close by. An error of 1/10 foot in the calculated position of a monument 1000 feet away would result in an error of only 1/100 foot for our 100 foot wide parcel if that error were due to angular error.

Since our parcels are usually small, the lengths of the lines will necessarily be short. The property corners will generally be marked with rebars or other monuments. Due to the actions of man and nature, the exact positions of property corners will never be known. The position may be known to an accuracy of less than 0.01 foot in some downtown areas of cities, but for most property corners, 0.05 foot is about as close as we can expect a position to be marked and maintained. Getting a 5" angle to the approximate center of a slightly bent 5/8" rebar forty feet away must be quite a challenge for those surveyors who are taking your specifications seriously. Perhaps the next update should require that all rebars be straightened with a properly calibrated sledge hammer. For the survey which I have just completed, all of the property corners were dependent on 1-1/2 inch aluminum centerline caps flush with the asphalt street. Originally there may have been punch marks in the caps, but now they are worn down, so that we had to estimate the center of the caps for our control. Obviously there is a fixed error involved which is not addressed by your standards. To talk of one part in fifteen thousand for such a survey is meaningless.

It is patently absurd to require that lines shorter than a certain length be measured by chain. This is one issue which needs to be aired and hammered at until it disappears forever, because the assumptions and reasoning are just plain wrong. Even in a very precise control traverse the errors in absolute positions of the monuments are often quite large in comparison

CLSA / NALS '94 Joint Conference - March 10 - 12, 1994 in Sparks, Nevada

with the 5mm error of an EDM measurement. The concept of linear precision, where a ratio of error to length is specified for closure, is meaningful only for traverses or surveys where scalar error has enough magnitude to make itself known above the various random errors which make up the inherent error of each measurement. We seldom think in terms of linear precision for small surveys — the concept does not apply. What is important is to have a good idea of what fixed error is acceptable. If you are staking a lot in a subdivision and the length of the lot line is 5 feet, it would be ridiculous to think that some arbitrary standard for linear precision would apply. For one part in fifteen thousand you would need a microscope to set the rebar. To refrain from using a total station on a nearby point because of the 5mm error inherent in EDM measurements, while using it for longer distances doesn't make much sense or dollars. You are going to have a comparable error in all your shots whether they are long or short.

In the case of an as-built survey, where the main purpose is to locate the improvements and show distances to the property lines, one should match the accuracy of these distances to the nature of the thing being located. Most buildings are somewhat rough in their outer lines. Sometimes it is hard to say just what is the wall line of a building. In my past surveys, I have expressed the building dimensions and the lot line ties to the nearest tenth of a foot and there has never been a problem. The clients have never seemed concerned with this level of accuracy and I believe that this is pretty much the accepted standard for all but the most stringent surveys in highly developed downtown areas. If our goal is to determine the location of improvements with an accuracy of one tenth of a foot with respect of the property lines, why are we pretending that we are doing a 1:15,000 control survey. To require better accuracy might be appropriate for Madison Avenue, but for a lot with a dilapidated apartment building in Spenard, Alaska you can not justify splitting hairs.

The trouble with your standards is that they are out of touch with reality. They do not address the real areas of concern— areas of real potential problems and liability with which we are all familiar. The surveyor is held to an arbitrary and artificial set of rules which can not possibly be observed, and which totally ignore many areas which should be addressed. The easiest course of action would be to just stamp and sign the drawings, collect the fee, and not rock the boat. It is hard to know what to do. I feel that ACSM is working against our interests by entering into such an agreement. There is no protection from liability for the surveyor, only for the title companies. Given the unrealistic requirements of the agreement, any surveyor would be left wide open to attack by lawyers. It is hard for me to justify further support of ACSM, but also seems counterproductive to resign.

What should be done?

WILLIAM D. FLEMING
Fleming Surveying Services
Anchorage, Alaska

■ NCEES RECORDS VERIFICATION PROGRAM

The NCEES Records Verification Program provides and serves as a verifying agency for the Professional Engineer or Professional Land Surveyor who is seeking multiple state registration and who meets the requirement of holding a current registration with at least one registration board. Through this program, the Council verifies and houses the Record Holder's file which contains their college transcripts, registration information, professional engineer references and employment verifications. When registration in additional states is needed, a copy of the NCEES Record can be transmitted to other registration authorities with a written release.

The intent of the program is to reduce the amount of paperwork required by the registrant at such time as they choose to become registered in another state.

Licensure is not guaranteed based on the Council Record, as this is a distinctive function of the registration board. NCEES merely functions as a centralized recordkeeping service for the convenience of the professional who seeks multiple state registration. The Council Record is designed to be a recognized and reliable source of information for review.

Further information concerning the program can be obtained by contacting the NCEES Records Department.

NCEES
PO Box 1686
Clemson SC 29633-1686
Telephone: (803) 654-6824, Ext. 223

■ BLM PLAT APPROVALS

The following plats are now on file in the Survey Records Office, Bureau of Land Management, California State Office, 2800 Cottage Way, Room E-2841, Sacramento, California 95825.

TP/RG/MER	Approval Date	Type of Survey/Plat
T. 2 S., R. 26 E., MDM	04/05/93	Dependent Resurvey and Metes-and-Bounds Survey
T. 43 N., R. 1 E., MDM	04/07/93	Dependent Resurvey, Subdivision and Metes-and-Bounds Survey
T. 11 N., R. 9 E., MDM	05/13/93	Supplemental Plat of Section 12
T. 18 N., R. 10 E., MDM	06/08/93	Corrective Dependent Resurvey
T. 3 S., R. 14 E., SBM	07/23/93	Dependent Resurvey, Retracement and Metes-and-Bounds Survey
T. 8 S., R. 21 E., MDM	08/13/93	Supplemental Plat, E 1/2 Sec 32 and the W 1/2 Sec 33
T. 13 S., R. 19 E., SBM	08/18/93	Dependent Resurvey and Survey
T. 10 N., R. 9 W., MDM	09/01/93	Corrective Dependent Resurvey
T. 17 S., R. 13 E., SBM	09/01/93	Dependent Resurvey and Subdivision
T. 21 N., R. 5 E., MDM	09/13/93	Dependent Resurvey and Subdivision
T. 7 N., R. 3 W., SBM	09/14/93	Supplemental Plat of Sec 20
T. 7 N., R. 3 W., SBM	09/14/93	Supplemental Plat of Secs. 3 & 4
T. 6 N., R. 3 W., SBM	09/14/93	Supplemental Plat, W 1/2 Sec 6 and the NW 1/4 Sec 7
T. 1 S., R. 19 W., SBM	09/27/93	Dependent Resurvey and Survey
T. 45 N., R. 8 W., MDM	09/27/93	Supplemental Plat, E 1/2 Sec 24
T. 16 N., R. 9 W., MDM	09/30/93	Dependent Resurvey

CLIFFORD A. ROBINSON Chief, Branch of Cadastral Survey ⊕

News Highlights

■ IRWA FORMS SURVEYING COMMITTEE

International Right of Way Association, the association serving professionals employed in all aspects of right-of-way activities, has formed an ad hoc committee representing that segment of the right-of-way industry principally involved in surveying. The new committee, known as the International Surveying Committee (ISC), was established by IRWA's International Executive Committee (IEC) at the association's 1993 International Education Seminar in Calgary, Alberta, (Canada) to determine the interest and support for a permanent surveying industry committee in IRWA.

The ISC will be chaired by IRWA International Secretary Woodrow W. Pemberton, Jr., SR/WA. The new committee will report directly to the IEC, and will begin to develop plans for the formation of a surveying industry committee within each of the association's 75 chapters. The ISC will also identify surveying topics, speakers and exhibitors for the association's 40th International Education Seminar on June 26-30, 1994 in Pittsburgh, Pennsylvania.

In addition to opportunities for participation at the chapter level, IRWA members who are Professional Land Surveyors will be encouraged to share their experience of the value of IRWA membership with potential clients and custodians of land information, and to submit technical feature articles for publication in IRWA's professional journal, *Right of Way*.

For more information about the benefits of membership, contact IRWA Headquarters, 13650 S. Gramercy Place, Gardena, CA 90249; phone (310) 538-0233, or Fax (310) 538-1471. To speak with a land surveyor member of the ISC, call Don Bender, SR/WA, in Los Angeles (213) 481-6748; Al Hebrank in Washington State, (206) 447-1729; or Ron Williams, SR/WA, in West Virginia (304) 343-4202. In Canada, call Land Surveyor Committee members Walter Carbis in Ontario (416) 798-8606 or Bernie McKenna in Alberta (403) 245-4711.

■ GEORGE HARLAN DYE (1916 - 1993)

G. Harlan Dye, a land surveyor and owner of the former firm of Dye Surveying, Inc. in Lemon Grove, passed on to a better life on October 1, 1993.

Mr. Dye was born in Enid, Oklahoma where he graduated from high school in 1932. Two years later, he headed west to San Diego where his first job was as a firefighter. He later took a job building aircraft at Consolidated Aircraft until 1948. While working at Consolidated, he first became interested in land surveying via correspondence courses.

After leaving Consolidated, his first surveying job was with what was called La Mesa - Spring Valley Water Department (now Helix Water District) where he soon advanced to the position of party chief. Leaving Helix, he joined the well known private land surveying firm of Daniels, Brown and Hall. After becoming licensed as a land surveyor with that firm, in 1954, he established his own firm called Dye Surveying in Lemon Grove where he surveyed property for land development in Lemon Grove and Allied Gardens.

For six years beginning in the late 1950's, he taught surveying and mathematics at San Diego City College to many young people who today are actively practicing their profession in the area.

His six children noted his enthusiasm for teaching and as a result, five of them eventually earned their teaching credentials.

Mr. Dye was a charter member of CLSA, a Life Member of ACSM and a Life Member of CCCE&LS where he served as President of the San Diego Chapter in 1981.

Aside from his interest in land surveying, he was until his death, also an active member of the Lemon Grove Rotary Club where he served as President in 1964 and again in 1982. He was also an avid tennis player and a prominent member of St. Martin's Catholic Church in La Mesa.

Mr. Dye will always be remembered by his family, friends and fellow surveyors as a man who had a great deal of love and enthusiasm for his profession and was always willing to share his knowledge with the younger generation.

■ RIVERSIDE CITY SURVEYOR

George Pierce Hutchinson, Riverside city surveyor for 24 years and a Public Works Department employee since 1962, died of a heart attack on October 23, 1993. A Riverside native, he was 58 and a Riverside resident all his life.

City Public Works Director Barry Beck, who knew Mr. Hutchinson 29 years and was his boss the past six years said he was "probably one of the nicest, most thoughtful, most intelligent and most ethical employees the city has ever seen."

Mr. Hutchinson started with Public Works as chief of party on the survey crew. As city surveyor, he was in charge of all city land records and all surveying operations.

Mr. Hutchinson was a longtime member of the California Land Surveyors Association and served as Riverside-San Bernardino Chapter President in 1990. He was a candidate for the board of trustees of the Alvord Unified School District in 1979 and was a member of the Twinhill Elementary School PTA five years. He was a YMCA Indian Guides member for five years and received a service award for his work with the group in 1974 and 1975. He was also a member of Take Off Pounds Sensibly for 20 years.

Mr. Hutchinson is survived by his wife, Alice; two sons, Bryan of Bella Vista and John of Rialto; two daughters, Wendy Ortiz of Moreno Valley and Robin Sharkey of Riverside; a brother, William of Riverside and six grandchildren.

■ SENATE BILL 1209 SIGNED BY GOVERNOR

Coast Surveying, Inc. in Irvine was the site of a special bill signing ceremony where Governor Pete Wilson signed into law a bill which allows Caltrans greater flexibility in hiring private sector surveying and engineering firms for highway related work.

Senator Marian Bergeson (R-Newport Beach), the author of Senate Bill 1209, attended the festive ceremony with Assembly Member Richard Katz (D-Los Angeles), one of the bill's principal co-authors.

Continued on Page 15

DATUMS & REFERENCE SYSTEMS: HISTORY, RELATIONSHIP & ANOMALIES

ABSTRACT

With the advent of a fully operational Global Positioning System (GPS) constellation in 1994, we can expect a surge in the momentum for GPS use. The application of GPS by various kinds of users to measure spatial relationships will proliferate as a result of decreased equipment costs, user friendly software and the development of high production methods. GPS is the future of surveying and unless you are retiring, it will soon become as much a part of your instrumentation tool chest as the steel tape once was.

First order measurements of lines over 5 km (3 miles) in length will be made in less than 5 minutes, any time of the day or night anywhere in the world where the sky is visible, regardless of the weather. As a result, GPS is becoming feasible for smaller projects when compared with conventional survey methods.

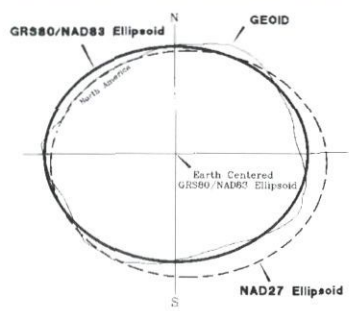
This technology confronts us with a two-fold problem. How should we collect and process quality measurements, and knowing how, when and where these measurements should be anchored? In other words, what coordinate system should we use or which one to choose.

We hear acronyms referring to horizontal datums[1] such as NAD27, NAD83, and WGS84, vertical datums referred to as NGVD29 and NAVD88 and associated terms such as the GRS80 reference ellipsoid and the geoid. Further confusing the issues are the adjustments on NAD83 in 1986 and 1991, and the new adjustment of the NGRS? What are the various reference systems referred to as the NGRS, HPGN, HARN and VLBI?

Horizontal control (primarily triangulation stations) in the National Geodetic Reference System (NGRS) have three sets of similar coordinates that may vary as much as 300 feet. If you choose the wrong one, you will generate data that does not serve the best use, or you could possibly find yourself in violation of state statutes or local ordinances. You may find your measurements do not fit existing control by several feet. A private surveyor may propose on a contract only to find later that the nearest points planned for project control do not meet the project requirements. If you represent a government agency writing an RFP, you may not realize the intended long term benefits of your project.

HORIZONTAL DATUMS

The North American Datum of 1927 (NAD27), although not the first, is the oldest continental system in the United States. NAD27 was established in the 1930's. The origin was based on the best known latitude and longitude at the time, at station Meades Ranch" in Kansas near the center of the US. The system is based on Clark's Spheroid of 1866 and was orientated to best fit the North American continent (see Figure 1) about station Meades Ranch" with the azimuth to station Waldo" held fixed. Initially, a block adjustment of conventional baseline and triangulation survey measurements established coordinates on 25,000 stations across the United States with an average precision of 1:100,000. This framework of triangulation stations serve as monuments that reference the datum for local use and is known as the National Geodetic Reference System (NGRS). Additional surveys over the years have been constrained to the original primary network through supplemental adjustments in a patchwork manner leading to significant deficiencies.



THE GEOID, NAD27
AND GRS80/NAD83 ELLIPSOID

Figure # 1

In the past 30 years, driven by the demand of the space age, geodesists and geophysists have learned a great deal about the shape and mass of the earth. During this era came the establishment of a world-wide net of Very Long Baseline Interferometry (VLBI) stations used to relate the observatories around the world. The relationship of the stations in this network were determined using quasars (celestial objects emitting radio waves) as control points at infinite distance from the earth and atomic clocks as the measuring tape. Connecting distances in this on-going system are measured to a high degree of precision. With this ability to span continents and the high precision requirements to compute space craft launches and orbits came the need for a datum to fit the entire world. This resulted, after several earlier versions, in the present global Geodetic Reference System of 1980 (GRS80). GRS80 is an earth-centered-earth-fixed ellipsoid of revolution that best fits the global geoid (approximate mean sea level surface discussed later see Figure 1). The surface of the ellipsoid is within 100 meters above or below the geoid world wide and about 30 meters above the geoid in California.

Since the early 1960's, instruments using light and radio waves became available to surveyors allowing very precise measurements of distance. With the use of these instruments, it soon became apparent that not only were there inconsistencies in the NAD27 positions but the accuracy of the system was no match for the methods and technology available to many surveyors.

In the late 1970's the National Geodetic Survey (NGS) formerly the United States Coast & Geodetic Survey (USC&GS) in conjunction with Canada and Mexico initiated a project to establish a new horizontal datum for North America consistent with the world. This new datum adopted the defining parameters of the GRS80 ellipsoid and is titled the North American Datum of 1983 (NAD83) (see Figure 1).

Continued on the next page

Datums & Reference Systems...

Continued from Page 9

Inter continental high precision traverses were measured with electronic distance instruments and connections made to satellite and VLBI stations. These new measurements were combined with one-hundred and fifty years of measurements in block adjustments to strengthen the NGRS and remove inconsistencies associated with NAD27. This adjustment established positions on 250,000 stations including the original 25,000.

NAD83 was introduced to the survey community in 1986 (referred to as the 1986 adjustment of the 1983 Datum). This resulted in two published positions for those station in the NGRS previously published with NAD27 values. The shift from NAD27 to NAD83 averages about 10 meters in latitude and 100 meters in longitude in California. Current USGS quadrangle maps indicate this shift in the lower left corner of the map. The majority of the shift is due to the difference in the datum definitions (origin and parameters) and to a lesser extent, the distortions in the network.

NAD27 and NAD83 are unrelated because the datums have different origins & defining parameters and because the adjustments are comprised of different kinds of measurements. For this reason there is no direct (constant) relationship between the two systems even though they are referenced to the same monuments in the NGRS[2].

The World Geodetic System of 1984 (WGS84) is the most recent datum established by the Department of Defense for the purpose of providing a more accurate geodetic and gravitational model for DoD navigation and weapon systems. WGS84 is the basis for the Global Positioning System and all positions and vectors are referenced to this datum.

The system is a three dimensional orthogonal (all axis are perpendicular) coordinate system in meters with the origin of 0,0,0 located at the center of mass of the earth. The X-Y plane coincides with the earth's equator with the positive X axis through Greenwich, England. The positive Y axis is at 90 degrees east longitude and the positive Z axis points to the Earth's mean North Pole (BIH Conventional Terrestrial Pole at epoch 1984.0). The defining ellipsoid parameter for the semi-major axis is the same as GRS80/NAD83; however, the semi-minor axis (the distance from the equatorial plane to the north or south pole of the ellipse) is slightly different in the sixth decimal place due to a difference of one term in the definition of the gravity model.

The transformation from WGS84 to GRS80/NAD83 is approximately a translation of about one meter and a rotation about all three axis of about 1/100 of a second. GPS measurements are referenced to WGS84; however, there is no practical difference in a measurement taken in NAD83 or WGS84 between the same points. This difference may be ignored when a GPS vector is constrained to a monument in the NGRS or HPGN.

GEOID & ELLIPSOID

The geoid is a theoretical irregular surface that represents mean sea level across the face of the earth as if it were extended into the land masses. In a more precise definition it is an equipotential surface at sea level, meaning the force of gravity is equal everywhere (water does not flow). Surveyors are particularly interested in measuring elevations (orthometric heights) relative to this surface, which is done in every day practice with differential or trigonometric levels.

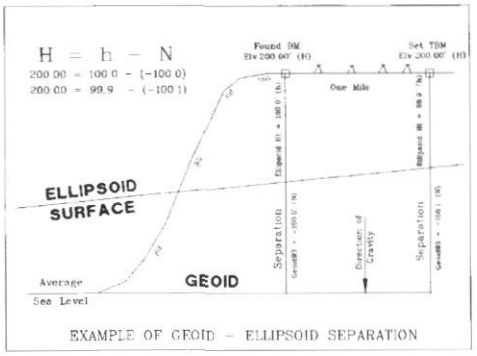
WGS84 and GRS80/NAD83 also serve as vertical datums. The surface of the ellipsoid of revolution has a height of zero. The distance between the ellipsoidal surface and the geoid is the geoid separation (see Figure 2). In California, the geoid is below the ellipsoid about thirty meters (geoid separation is negative). Therefore, along the ocean shoreline the ellipsoidal surface is about 100 feet overhead. This separation varies because of the irregular distribution of mass and rotational forces causing variations in gravity potentials (forces).

GPS measurements are related to the ellipsoid which provides us with accurate relative ellipsoidal height differences between points on the earth's surface; however, GPS measurements do not give us any information about the orthometric height that would be measured with a level (Orthometric Height = Ellipsoid Height - Geoid Separation) (see Figure 2). The relationship to the geoidal surface can be modeled by including benchmarks with known elevations in the GPS survey and/or by a NGS program called Geoid93 that will calculate the geoidal separations in the NAD83 datum based on an algorithm that accesses a data base of gravity readings[3].

VERTICAL DATUMS

The vertical datum predominately in use is the National Geodetic Vertical Datum of 1929. This datum is not mean sea level or the geoid but could be thought of as an early attempt to model the geoid. The origin of NGVD29 is zero based on an adjustment that distorted the actual measurements by constraining to local mean sea level at 26 tide stations along the east and west coasts of the US, Canada and the Gulf of Mexico. Numerous supplementary adjustments have occurred over the years conforming as much as possible to the original network. Benchmark monuments across the US serve as a reference system for local use and are considered part of the National Geodetic Reference System (NGRS). These elevations are considered normal orthometric heights.

The new North American Vertical Datum of 1988 (NAVD88) has its origin at a selected benchmark at Fathers Point on the Saint Lawrence Seaway. This choice was made to approximate



EXAMPLE OF GEOID – ELLIPSOID SEPARATION

Figure # 2

the geoid, minimize the variation from NGVD29 and thereby minimize the impact on USGS mapping products and conform to established international treaties regarding shipping in the Great Lakes. The adjustment was based on a new inter-continental network of first order leveling measurements across the US and Canada referred to as the A" net (vertical network). A free adjustment taking

into account the affects of gravity resulted in Helmert Orthometric Heights" and what is considered a better model of heights above the selected geoid. The results of this adjustment were published in 1991 and referenced by the vertical benchmarks of the NGRS.

There are 52,000 benchmarks in California but only about 13,000 have NAVD88 elevations available based on new measurements. The remaining benchmarks are planned to be included in an adjustment of the old measurements constrained to the A" net. The completion date for this phase is unknown and some benchmarks may not be included. The validity of such an adjustment given the history of tectonic movement and subsidence in California is questionable. Such an adjustment may result in an accurate position of where the monuments used to be, not where they exist today.

The NGVD29 & NAVD88 datums are unrelated because they have different origins, definitions of height and measurements. For this reason there is no direct (constant) relationship between the two systems even though they may be referenced in some cases to the same monuments in the NGRS[4].

In California, elevations based on NAVD88 will be greater than NGVD29 by two to three feet from southern California to northern California[5].

HPGN REFERENCE FRAME

With the advent of GPS technology, very high precision surveying over long distances became accessible to the surveying community. The 1986 adjustment on the NAD83 datum provided consistent positions for the NGRS; however, many of the distortions in the NAD27 measurements were passed into the 1986 adjustment. By the end of the 80's it became apparent that constraining GPS measurements to the NAD83-1986 adjusted positions of the NGRS might degrade the everyday precision of GPS. Additionally, many stations in the NGRS are not accessible or usable for GPS occupations.

The solution: a new reference system utilizing high accuracy - high precision GPS measurements referred to as the A" net (horizontal network) was established on the North American continent by the National Geodetic Survey. The A" net adjustment was constrained to the VLBI stations such that the integrity of the GRS80/NAD83 datum as originally fixed by the VLBI stations was retained and remained fixed. The VLBI stations are generally of Order AA" (1:100,000,000 at the 95% level of confidence). The A" network is generally of Order A" (1:10,000,000 at the 95% level).

A further densification of the A" net is or will be completed on a state by state basis. This densification is referred as the High Precision Geodetic Network" (HPGN) and in some states as the High Accuracy Reference Network" (HARN). In California, Caltrans working in a cooperative effort with the NGS, performed the survey of the HPGN. The HPGN was connected and adjusted to fit AA", A" and B" stations in and near the state and is referred to as the B" Order net (1:1,000,000 at the 95% level of confidence).

The California HPGN consists of about 240 stations at an average spacing of 80 km (50 miles) with very precise relationships to adjacent stations in the order of 1-3 centimeters (0.03-0.10 feet).

The adjustment of the HPGN was published in 1992; however, it is referred to as the 1991 adjustment" (correctly as 1991.35) since the mean time of the field observations occurred in April 1991. Expect that in the future, due to the high precision of GPS, that regional adjustments will be time tagged because the movement of the Pacific Plate relative to the North American Plate (2-3 centimeters per year northwesterly) can now be measured and monitored.

Local Caltrans Districts and public agencies are in the process of densifying the primary HPGN network with 800+ First Order (1:100,000) stations known as HPGN-D stations. The actual precision of the densification network will probably exceed 1:500,000. The HPGN and HPGN-D stations will provide an accessible reference system generally about every 10-15 miles along highway corridors throughout the state.

Existing first order or second order horizontal control stations in the NGRS were included in the HPGN survey at about a 1 x 1 degree (latitude & longitude) spacing. As a result, about 100 of these stations now have two NAD83 positions derived from the 1986 adjustment and the 1991.35

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Advanced Technologies

[Editor's Note : The following introduction and report have been edited in the pursuit of brevity and I apologize for having to abridge this and future reports. The purpose here is to allow the surveying community the opportunity to review and comment on the direction of the California Geodetic Control Committee. Those individuals interested in addressing the following reports should contact Greg Helmer, Committee Chair (address follows) for complete copies of the reports.]

INTRODUCTION TO THE CALIFORNIA GEODETIC CONTROL COMMITTEE

A well understood axiom states that progress necessitates change, and the corollary to this is that change promotes confusion. GPS and the on-going spatial information revolution are the catalyst to just such a chain of events that is occurring within the surveying profession. Faced with technological advancements which on one hand provide tremendous opportunity and improvement for geodetic surveying, yet on the other hand press the limits of understanding of physical geodesy, the California Geodetic Control Committee (CGCC) has invested its collective resources to help clarify and document a path toward meeting these challenges.

In late 1992, members of the Advanced Technologies Committee of the California Land Surveyors Association began to discuss the need to develop standards and specifications for high-production-type GPS surveys. To initiate action, the committee held an informal meeting in January 1993 at the annual California State University, Fresno Surveying Engineering Conference. Various GPS surveying issues were discussed, including geodetic reference networks. As a result of this meeting, a second meeting was held in March 1993 at the annual CLSA conference in San Diego to continue discussions. At the March meeting, the group established a formal California Geodetic Control Committee (CGCC) consisting of 15 members from various public and private or-

Advanced Technologies

CALIFORNIA REFERENCE SYSTEM (HORIZONTAL COMPONENT) A PROPOSAL

OCTOBER 1993

THE CALIFORNIA GEODETIC CONTROL COMMITTEE

ABSTRACT

Global Positioning System (GPS) technology and the expanding use of spatial information for geographic information systems (GISs) and other new uses of survey data are causing momentous changes in surveying. These changes have created a critical need for a new, statewide high-accuracy horizontal geodetic network for referencing spatial data. The existing network, the National Geodetic Reference System (NGRS), has served the nation and California well, but it is not adequate for the horizontal referencing needs of the 21st century.

To meet California's long-term spatial referencing needs, it is proposed that a new, high-accuracy horizontal geodetic network be established and maintained as the California Spatial Reference System" (CSRS). The CSRS will be California's official horizontal reference system for all surveying activities, including the only legal reference system for California Coordinate System coordinate values after December 31, 1999. The proposed 1,100-station network is to be established and maintained through cooperative efforts involving federal/state/local agencies and private firms/individuals.

INTRODUCTION

Today, the surveying profession is undergoing tremendous changes; not only in technology (technically), but also in data usage. The primary causes of these changes are . . .

- Advances in positioning technology resulting from the Global Positioning System (GPS).
- Expanding use of spatial information by new, emerging technologies, many of which are not traditional surveying activities; e. g. , fleet management, vehicle routing, and search and rescue.
- Budgetary constraints; private and public, at all levels.
- Increased spatial information needs for resource management, environmental assessments, infrastructure improvements, crustal motion studies, assessment of earthquake and flood hazards, Geographic Information Systems (GISs), etc. These changes are demanding, and will require the use of one, consistent/accurate statewide, horizontal spatial reference system for all surveying activities. The use of unrelated local datums of varying accuracy standards and pre-GPS-established reference networks is rapidly becoming inadequate (and unnecessary). Evidence of these demands and changes are already apparent: (a) various local agencies have, or are considering, regulations which require recorded surveying documents to be referenced to a specific network; (b) interest and use of the California High Precision Geodetic Network (HPGN) is expanding; (c) the Governor's GIS Task Force has recommended that the California HPGN be used as the foundation" for all future geographic information production (GIS data); and (d) at the national level, efforts are underway to establish a new, high-accuracy National Spatial Reference System.

To be effective, a statewide spatial reference system must meet the following essential criteria.

- Be part of an overall national spatial referencing system.
- Sufficiently precise to meet nearly all spatial positioning needs.
- Maintained systematically.
- Have readily accessible in-the-ground" monuments and easy availability of current, valid station information.
- The needs for a clearly-defined and well-maintained horizontal spatial reference system are especially critical in California where crustal motions are prominent (a factor that is insignificant in most states). It is not practical to maintain the existing geodetic horizontal control networks to GPS accuracy standards. Instead, a small (in number of stations), well-maintained, high-accu-

racy network that is suited for GPS surveys is required.

- This document describes a new horizontal California Spatial Reference System" and proposes that it be systematically established and maintained to meet California's horizontal-position referencing needs of today and throughout the 21st century. (Note: Another California Geodetic Control Committee document will address the vertical-position referencing needs. Possibly, the same in-the-ground" monuments will serve both horizontal and vertical positioning needs.)

BACKGROUND
EXISTING GEODETIC CONTROL:

Currently, the recognized horizontal geodetic control network (system) within California is the National Geodetic Reference System (NGRS) which includes 18,000 stations (9,000 of which are first or second order). This horizontal control system is the result of many years of effort, dating back to 1807, by the National Geodetic Survey (NGS) and its predecessor agencies to establish, maintain, and improve the national geodetic network. The NGRS, which was established basically through the use of traditional survey methods (mostly triangulation for horizontal positioning), has served the nation and California well for many years.

In the 1980's, NGS redefined the horizontal datum for the NGRS, replacing the North American Datum of 1927 (NAD27) with the North American Datum of 1983 (NAD83). When the new datum was established, the entire network also was readjusted to improve the horizontal accuracy of the stations. The readjustment was completed in 1986. Thus, changes in station coordinates from NAD27 to NAD83 were caused by both a datum change and a new adjustment. Although the NAD83 readjustment removed many of the distortions and errors in the historical NGRS network, this network remains inadequate as a horizontal control system for many GPS surveys and today's expanding spatial information needs. The reasons are discussed under Issues", below.

CALIFORNIA HIGH-ACCURACY NETWORK:

In 1991/92, a high-accuracy (order B), horizontal geodetic control network, consisting of 238 stations, was established throughout California by GPS survey methods. This network is referred to as the California High-Precision Geodetic Network" (HPGN). (Similar networks in other states are often called High-Accuracy Reference Networks" or HARNs.)

The California Department of Transportation (Caltrans) sponsored (funded) the establishment of the HPGN. The actual survey efforts were accomplished as a cooperative NGS and Caltrans project with assistance from various local agencies, universities, and private firms. HPGN stations generally are located along transportation corridors and are spaced about 40 miles apart on a grid-like network.

The HPGN is **not** a new datum; the datum remains NAD83. The HPGN is a new adjustment of the HPGN stations (on NAD83) at the epoch date of the HPGN surveys. The epoch date represents the mean date of the GPS data collection effort and is 1991. 35 for the HPGN. The actual adjustment was performed by NGS in 1992 and the results were published with a time tag of NAD83(1992). About 100 stations in the HPGN had existing NAD83(1986) coordinates. Coordinate shifts for these stations from NAD83(1986) to NAD83(1992), which resulted from the high-accuracy GPS survey, range from zero to 1.3 meters with an average shift of 0.3 meter.

NGS is in the process of adjusting the 18,000 historical NGRS stations to the HPGN.

CRUSTAL MOTIONS IN CALIFORNIA:

For much of California, the earth's surface (crust) is moving relative to the other continental states. The crustal motions are caused primarily by the northwest movement of the Pacific tectonic plate relative to the North American plate. Two types of motions occur: (a) secular, which is a relatively constant movement; and (b) episodic, which is the sudden movement caused by an earthquake.

Fortunately for California surveyors, the geophysical scientists have been studying California's crustal motions for a number of years and have developed considerable knowledge regarding these motions. Schematic maps have been developed which show the estimated secular crustal motions throughout California. In some areas, the secular motion exceeds five centimeters per year (a meter in 20 years). The scientists also have learned

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ganizations. The Committee includes a broad representation of California surveyors (GPS experience, organizational size, geographic location, etc.).

Although the Committee officially is comprised of 15 members, all interested California surveyors are encouraged to participate in the activities of the Committee. In fact, a number of other surveyors actively assist the Committee in developing consensus positions, preparing policy/procedural documents, and other Committee efforts.

Included herewith is a draft document prepared by this committee to further these goals. The "California Spatial Reference System (Horizontal Component)", version 3.0 is a proposal to establish an official geodetic reference system for the state of California. The horizontal component of this system, as proposed by this document, would be founded upon the NAD83 datum and the California High-Precision Geodetic Network (HPGN). This is consistent with the National Spatial Reference System proposals and the California GIS Task Force's 1993 report to the governor. This proposal also addresses the incorporation of active GPS control stations into the system, and defines procedures for readjusting the network, and time dating coordinates, to accommodate secular and episodic motions of the earth's crust.

The committee haas also prepared a draft document titled "Specifications for High-Production GPS Surveying Techniques", version 1.02. This is a supplement to the current Federal Geodetic Control Subcommittee's "Geometric Geodetic Accuracy Standards and Specifications For GPS Relative Positioning", version 5.0. The CGCC document provides a set of specifications to utilize techniques such as intermittent kinematic, pseudo-static, fast ambiguity (static) resolution, and ultra-high-precision differential, to establish geodetic quality control networks.

Within the activities of the CGCC are the completion of other documents including the Vertical Component of the California Spatial Reference System and guidelines for GPS height determination. It is a goal of

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this Committee that these efforts will assist the surveying profession's progress into the information-based society. Along the way this is certain to stimulate the enthusiasm and imagination of many, and the defiance of others. This should be recognized as a natural process in the dynamics of change.

The survey community is invited to critique and make suggestions on the draft documents and activities of the CGCC in writing or by attending the next committee meeting to be held at the Fresno Survey Conference January 29, 1994. To request copies of the latest versions of all three documents (please send $5.00 to cover postage and copying) or submit comments and information to the committee write to Greg Helmer CGCC Chair at *14725 Alton Parkway, Irvine CA 92713-9739*

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that, in general, an earthquake must exceed a magnitude of six or seven to cause significant episodic crustal motion. The Landers 7. 5 earthquake in June 1992 displaced one California HPGN monument nearly two meters. Fortunately, studies have shown that displacements caused by earthquakes dissipate relatively quickly as the distance from the epicenter increases.

For most local surveys, the effects of crustal motions usually can be ignored (and in practice, are ignored). But, crustal motions can become an important consideration when the local survey data is used for other purposes; e. g. , the data is (a) incorporated into geographic information data base, (b) used as control for another survey, (b) merged with data from another survey, and/or (d) used for current/historical data comparisons. The importance of considering crustal motions will increase as survey records and data bases mature and new data is mixed with historical data.

In addition, the effects of crustal motions must be considered for high-accuracy GPS surveys and long, east-to-west GPS surveys.

NGS's ROLE - PAST, FUTURE:

Until recently, NGS actively provided all required geodetic control needs for the surveying profession. Over 285,000 horizontal control stations have been established nationwide and are included in the NGRS. Data for these stations is readily available from NGS's National Geodetic Information Center; but, as mentioned previously, the historical NGRS is inadequate for the needs of today and in the future.

Unfortunately, resources at the Federal level are not available to establish and maintain a new horizontal reference system of sufficient accuracy, density, and timely availability to fulfill today's GPS surveying and spatial referencing needs. Thus, NGS is formulating various policies to guide the development of a modern National Spatial Reference System. Key preliminary policies, as expressed in the March 24, 1993 draft of a Program Development Plan for a National Spatial Reference System", are summarized below.

NGS resources are dedicated to the establishment and maintenance of a national network consisting of 1,300 very-high-accuracy stations at a 100-kilometer spacing.

The states are to carry the load" to establish and maintain a modern National Spatial Reference System having an estimated 25,000 high-accuracy stations (25-kilometer spacing in rural areas and 10-kilometer to 15-kilometer spacing in urban areas).

NGS will work with state and local governments and with other Federal agencies to densify" the national network to about 25,000 permanently-monumented stations, as noted above, by incorporating their surveys into the national network.

ISSUES

The critical horizontal spatial referencing issues challenging California's professional surveyors are as follows:

1. **Inadequate Network Accuracy:** Although the historical NGRS was established through exemplary survey efforts, most horizontal stations within the NGRS are of insufficient accuracy for today's GPS survey methods (except the HPGN stations). Routinely, GPS surveys exceed the accuracy of the controlling NGRS stations which means high-accuracy GPS surveys are adjusted to less-accurate control.
2. **Poor Station Location:** The survey methods used to establish the NGRS required lines of sight" between stations; thus, many stations are located on mountain peaks, tops of tall buildings, or where towers are required for use. As a result, numerous NGRS stations are inaccessible and unusable, or at best, inconvenient to use.
3. **Limited Network Maintenance:** For many years, NGS had an active program to maintain the NGRS stations. However, in recent years, budget constraints have eliminated these maintenance efforts. This reduced maintenance effort, together with normal construction activities and other events, has resulted in many stations being lost or destroyed.
4. No Established Crustal Motion Procedures: In addition to a maintenance issue, California's crustal motions require the development and use of specific procedures for data publication, coordinate notation, and survey adjustments. Today, these procedures are not established.
5. **Reduced NGS Assistance:** NGS does not have the resources to estab-

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News Highlights... *Continued from Page 8*

Without the passage of SB 1209 as much as $1.5 billion worth of planned highway projects could have been delayed greatly affecting minority- and women-owned engineering, surveying and construction inspection firms.

"Caltrans is required to earmark at least 20% of all contract work for minority, women and disabled veteran business owners," said Ruel del Castillo, President of Coast Surveying, Inc. "With the court ruling banning contracting out, our firm was looking at 15 cancelled contracts and had already notified employees that we would be cutting staff. This law means these people will be back at work and contributing to the local economy."

A recent Superior Court ruling had essentially barred Caltrans from contracting out with private surveying and engineering firms, forcing the department to suspend or cancel existing contracts. SB 1209 clarifies the legislature's intentions and insures Caltrans' ability to hire private-sector firms.

■ 33rd ANNUAL SURVEYING ENGINEERING CONFERENCE

The 33rd Annual Surveying Engineering Conference at California State University, Fresno has been scheduled for 28 and 29 of January, 1994.

The conference will be held at the Holiday Inn Convention Center in downtown Fresno, California. The cost for the conference will be $80.00 for pre-registration. Prices for the luncheon and dinner banquet will be determined at a later date. For additional information, please contact Professor James K. Crossfield by phone at (209) 278-2889, by fax at (209) 278-6759, or by writing to Professor Crossfield or Timothy R. Case at: California State University, Fresno, Department of Civil and Surveying Engineering, 2320 East San Ramon Avenue, Fresno, CA 93740-0094.

■ FUTURE EVENTS

15-19 August 1994. U.S. Army Corps of Engineers Symposium on Surveying, Mapping, Remote Sensing and GIS. Marriott Hotel, New Orleans, LA. Contact: Leonard P. Halphen, U.S.

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Datums & Reference Systems...

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adjustment. Differences between the 1986 and the 1991 adjustments varies from 0.02-1.31 meters (0.06-4.30 feet) and averages 0.3 meters (1 foot). The NGS is processing a new adjustment of the NGRS by constraining the measurements used in the 1986 adjustment to the HPGN survey. This new adjustment of the NGRS will be known as the 1991.35 adjustment" since that is the date of the HPGN survey. This adjustment will improve the relative accuracy of the positions of stations in the NGRS with the origin of GRS80/NAD83 datum and be consistent with the positions published for the HPGN. The precision between adjacent stations in the NGRS will remain relatively the same as the 1986 adjustment and a traverse from an HPGN station to a third order station will still be limited in its classification to the lower order station and its associated NGRS network distortions[6].

Since HPGN is constrained directly or indirectly to the VLBI stations which serve to define the origin and orientation of the GRS80/NAD83 datum, then the HPGN also serves as a reference system for NAD83 ellipsoidal heights.

CAVEAT SURVEYUS

Control stations take on different values for different datums, and different values are published on the same datum for successive adjustments. If you do not clearly understand when, where and why you should choose a particular datum and adjustment, then you are apt to choose wrong and nullify the accuracy and precision of GPS measurements.

[Author's note: This paper is based on a presentation before the Central Coast Chapter of the California Land Surveyors Association in the Fall of 1992. The editorial comments of Don D'Onofrio, Greg Helmer and Elan McGee are greatly appreciated.]

Michael R. McGee, PLS has over twenty years experience, has served as State President of the California Land Surveyors Association and holds a Bachelor of Science Degree in Surveying from the California State University at Fresno. He offers consulting services to surveyors and engineers on boundary, geodetic and general surveying problems, trains companies in the application of GPS technology and works with attorneys as an expert witness.

Footnotes

[1]Datum: The mathematical model and parameters that define and fix a coordinate system that is realized by measurements between and positions assigned to a reference frame of physical monuments.

[2]A Corps of Engineers program known as Corpscon which incorporates the NGS program Nadcon will approximate a translation from one datum to the other and is available from the NGS or California Land Surveyors Association.

[3]See GPS and Geoid90 the New Leveling Rod" by Dennis Milbert published in February 1992 issue of GPS World.

[4]A program known as Vertcon, available from the NGS or CLSA will approximate a translation from one datum to the other.

[5]See NAVD88" by Greg Helmer,PLS published in the Fall 1992 edition No.98 of the California Surveyor and "Special Report, Results of the General Adjustment of the North American Vertical Datum of 1988" by David Zilkoski, John Richards and Gary Young published in ACSM's Surveying & Land Information Systems, Vol.52,No.3,1992.

[6]See California's New High Precision Geodetic Network" by Michael Stephens published in the Fall 1992 edition No.98 of the California Surveyor. ⊕

California Spatial Reference System...

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lish and maintain a new (modern) horizontal, spatial reference system that meets the needs for local and regional surveys. Resources at the national level will be focused on a framework network (station spacing 100 kilometers). The individual states, in cooperation with NGS, are to develop, establish, and maintain a densified network that meets the needs of the local surveyor. Refer also to Background", above.

RECOMMENDATION (PROPOSAL)

To meet California's horizontal spatial referencing needs of today and throughout the 21st century, it is recommended that a California Spatial Reference System (CSRS), consisting of about 1,100 first-order or better monumented stations, be developed, established, and maintained, through cooperative efforts involving NGS, state and local agencies, and the private sector; and that this System be designated as California's official, and only, horizontal spatial reference system for all land surveying activities.

CSRS RECOMMENDATION DETAILS

DEFINITION, STANDARDS, SPECIFICATIONS

Note: Although the described California Spatial Reference System may serve both horizontal and vertical positioning needs, the following is limited to horizontal control.

1. Name: California Spatial Reference System (CSRS).
2. **Definition:** The CSRS is a high-accuracy, monumented geodetic spatial-reference network consisting of . . .
   a. The California HPGN, about 240 stations, and
   b. HPGN Densification Surveys, about 850 stations.
3. **Status:**
   a. Official horizontal spatial reference system for California.
   b. After December 31, 1999, only legal reference system for California Coordinate System.
   c. Part of the National Spatial Reference System (NSRS).
4. **Datum:** NAD83.
5. **Standards & Specifications:**
   a. HPGN - Order B or better (1:1,000,000).
   b. HPGN Densification Surveys - First-order or better (1:100,. 000*). Actual accuracy ratios are expected to exceed 1:500,000.

   The California Geodetic Control Committee will encourage the FGCS to establish another accuracy order between first and B.

   *Reference: Federal Geodetic Control Subcommittee Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques".
6. **Reference Control Network:**
   a. HPGN - As specified by NGS.
   b. HPGN Densification Surveys - The California HPGN.
7. **Survey Method:** GPS only.
8. **Stations:** See Appendix A for a tabulation of the proposed CSRS stations (HPGN and HPGN densification).
   a. Monuments: Existing NGRS stations shall be used when the requirements for stability, durability, and location are met. New monuments shall conform to the following:
      HPGN - NGS Class A Rod.
      HPGN Densification Surveys - NGS Class B Rod.
   b. Final Spacing - About 25 kilometers (15 miles), rural areas; 10 to 15 kilometers (6 to 9 miles), urban areas.
   c. Location - Station locations shall be secure, accessible, stable, and GPS suitable.

ESTABLISHMENT:

Since the HPGN has been established, the following is limited to the establishment of the HPGN densification stations. These stations will be established on a survey-by-survey basis as interest develops within an area and resources become available.

1. **Coordination/Review:** The California NGS State Geodetic Advisor shall coordinate the HPGN densification surveys and perform the required on site" NGS reviews. The Advisor also will provide assistance (advice) for densification surveys.
2. **Standards, Specifications, Procedures:** See Description", above and the other applicable subsections in this section, CSRS Recommendation Details".
3. **Who Initiates:** Any state or local agency, or private firm may initiate a HPGN densification survey.
4. **Who Accomplishes:** The HPGN densification surveys shall be accomplished through cooperative efforts involving NGS, state and local agencies, and/or private firms. The field efforts for the densification surveys shall be performed at the local level (state and local agencies, private firms, individual surveyors). Also, see subsection Adjustment", below.
5. **Planning:** Prior to planning the station locations, the lead agency/firm should contact others who are interested in geodetic control and determine their interest and support for the proposed densification survey. Contacts should include various state and local agencies, local professional surveying organizations, interested college/university scientists, and local geodetic surveyors.
6. **NGS Submittal:** All HPGN densification surveys (CSRS surveys) shall be submitted to NGS, in the required format, for inclusion in the National Spatial Reference System.
7. **NGS On-Site Reviews:** At a minimum, the following on-site reviews shall be made by the California NGS State Geodetic Advisor for each HPGN densification survey.
   Prior to constructing the monuments, a review of the network schematic and observation schedules.
   Prior to submittal of the survey to NGS for final processing, a review of the on-site data quality checks, on-site adjustments, observation data (log sheets, mark rubbings, raw data files), station descriptions/recovery, initial required blue-book files, and the project report.
8. **References:**
   Federal Geodetic Control Subcommittee Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques".
   California Department of Transportation (Caltrans) CA-HPGN Densification Surveys".

DATA PUBLICATION/DISTRIBUTION:

1. **Epoch Dates:**
   a. When published, shown on a survey document, or included in an electronic file, coordinate values for the National Spatial Reference System (within California), CSRS, and California Coordinate System shall be time-dated with an epoch date.
   b. The epoch date shall be the time (date) the coordinates are valid. See additional details under the subsections Adjustment" and Statutes", below.
2. **Data Publication and Distribution:**
   a. NGS Publication and Distribution: The CSRS will be part of the National Spatial Reference System; thus, NGS shall be responsible for the integrity, publication, and distribution of CSRS data in the same manner as other NGS data. Data will be available from NGS's National Geodetic Information Center, Silver Spring, Maryland.
   b. Local Publication and Distribution: In addition to the NGS data distribution efforts, the California Geodetic Control Committee will pursue publication of the CSRS data in hardcopy and electronic-media forms at the local level for distribution (sale) to California surveyors. To minimize the sale price, the data will be published by California Coordinate Zones; i. e. , six publications. In addition to the NGS Data Sheets, these publications also will include a to reach" sketch for each station and a notice identifying the station's adopt-the-monument" sponsor (see below, Maintenance"). It is anticipated that the local publication and distribution of the CSRS data will be accomplished through a California professional surveying organization or a surveying book distributor.
   c. Coordinate Values by Epoch: For each CSRS station, the NGS station Data Sheets (or another document) shall

Continued on the next page

Continued from Page 17

show a listing of the geographic coordinate values, by epoch, that have been published for the station. (Alternative: A tabulation which shows the shift that occurred at each published epoch shall be published.) The listings (or tabulations) shall include, as a minimum, all published data since the origin of the California HPGN or the applicable HPGN densification survey.

3. **Estimated Horizontal Crustal Motions:**

a. Document: NGS will continue to publish a map that shows, in a schematic form, the estimated horizontal crustal motions for California. NGS also will periodically publish a document that tabulates the specific estimated horizontal crustal motion velocity and direction (numerical values) for each CSRS station. These documents will include explanatory notes and shall be revised as data from new surveys become available.

b. Computer Program: NGS will continue to develop, maintain/update, and distribute (sell) to California surveyors a stand-alone computer program for estimating the effects of crustal motions. This program, which is named Horizontal Time Dependent Positioning" (HTDP), estimates updated coordinate and/or observation values, horizontal crustal motion velocities, and station displacements. The HTDP program shall be updated (refined) as data from new surveys become available.

MAINTENANCE:

1. **Coordination:** The California NGS State Geodetic Advisor shall coordinate the CSRS maintenance efforts.
2. **Standards, Specifications, Procedures:** All survey efforts related to maintenance of the CSRS stations shall be performed in accordance with the standards, specifications, and procedures that were used to originally establish the given station(s) and the procedures specified in this section, CSRS Recommendation Details".

Note: Crustal motion resurveys will establish new coordinates, having a new epoch, for all stations included in the resurveys. See policy under Adjustments", below

3. **Who Accomplishes:** The CSRS maintenance efforts shall be accomplished through cooperative efforts involving NGS, state and local agencies, private firms, and individual California surveyors. See also Adopt A Monument" program, below.
4. **Annual Inspections:** Each CSRS station shall be inspected annually and a report made to the California NGS State Geodetic Advisor. This effort shall be accomplished at the local level (public agencies, private firms, and individual surveyors).
5. **Lost or Damaged Stations:** Efforts to replace lost or damaged CSRS stations should be initiated and completed as soon as feasible after the need is discovered. The field effort required to replace lost and damaged stations shall be accomplished at the local level (state and local agencies, private firms, individual surveyors).
6. ***Crustal Motion Resurveys:***

a. Earthquake (Episodic) Resurveys: After each major California earthquake, NGS shall determine, in cooperation with the California Geodetic Control Committee and California's geophysical scientists, the need for a resurvey and, if required, the extent of the area to be resurveyed.

b. Accumulated Secular Motion Resurveys: Eventually, accumulated secular crustal motions will distort the CSRS to the extent that it does not meet the required network standards, especially for long east-west surveys and for survey data that is to be correlated with other data referenced to geodetic control on the North American tectonic plate.

c. Secular Motion Verification Surveys: The current HTDP program has been developed primarily from non-GPS survey data. To maintain and improve the accuracy of the program's crustal motion estimates, high-accuracy surveys of the network will be required periodically. The secular motion resurveys, as discussed above, will provide this information. But, at times, it may be advantageous to improve the HTDP program without adjusting the network. The secular motion verification surveys will provide the required information to update the HTDP program, and possibly, allow the network to remain unchanged (coordinates and epoch) for a longer period.

d. Who Accomplishes: Crustal-motion-related surveys shall be cooperative projects involving NGS, state and local agencies, and/or private firms. NGS's field effort (resource expenditures) shall include, at a minimum, that effort required for the very-high-accuracy, 1,300-station national network. Generally, NGS shall perform all final data processing and adjustments for crustal-motion-related surveys. See Adjustments", below.

7. **CSRS Adopt A Monument" Program:** To aid in the maintenance efforts for the CSRS, the California Geodetic Control Committee will explore the feasibility of an Adopt A Monument" program in which agencies, firms, and individuals can voluntarily assist in maintaining one or more CSRS stations. The responsibilities of the sponsor for a CSRS station will be as follows:

ADJUSTMENTS:

1. **The California HPGN:** Resurveys of HPGN stations will be necessary to reestablished HPGN stations that are lost, damaged, or displaced by earthquakes, and for periodic readjustments to eliminate accumulated secular crustal motions. All HPGN resurveys shall be adjusted as directed by NGS.

Major HPGN resurveys, such as those required for crustal motions, will be referenced to stable (no crustal motion), high-accuracy, horizontal control on the North American tectonic plate; i. e. , National Spatial Reference System control. New coordinates, based on the resurvey results, will be published for all stations in the resurvey, including those not affected by crustal motion (except the controlling stations on the North American tectonic plate). The epoch of the new coordinates will correspond to the mean date of the data collection.

Minor HPGN resurveys, such as those required to replace lost or damaged stations, shall be adjusted to adjacent order B HPGN stations as specified for HPGN densification surveys in the next subsection (except as otherwise noted below). This adjustment procedure will be limited to surveys involving 10 or fewer stations.

(Note: For small earthquake resurveys, an exception to the specified procedures for densification surveys shall be made. The epoch date of the published coordinates shall correspond to the mean date of the resurvey data collection; not the epoch date of the controlling HPGN stations. The control data will be updated to the data collection epoch by the HTDP program or other means approved by NGS.)

NGS will perform all final data processing and adjustments for HPGN resurveys.

2. **HPGN Densification Surveys:** In general, HPGN densification surveys will be referenced to adjacent order B HPGN stations. During the final adjustment, corrections will be applied to the observations for the estimated secular crustal motions as directed by NGS. The epoch of the densification surveys will be the epoch of the controlling HPGN stations.

CONTINUOUS OPERATING GPS STATIONS:

Continuous operating GPS stations are facilities that collect GPS data on a continuous (24-hour) basis. Often, the data collected is made available to others through electronic data transfer means. A fee is charged for data from some facilities.

The primary benefits of continuous operating GPS stations are:

- Some continuous operating GPS stations can serve as GPS receivers at known points for geodetic surveys. Potentially, this could significantly reduce GPS equipment needs (costs) for GPS surveys.
- Continuous operating GPS stations provide data which can be used to improve the accuracy of GIS-type GPS surveys, freeing up" geodetic-quality field receivers for other surveys. Similarly, the accuracy and functionality of hand-held GPS receivers can be improved.

The California Geodetic Control Committee (CGCC) recognizes the benefits and expanding use of continuous operating GPS stations. The CGCC has initiated efforts to establish standards, procedures, and guidelines for this evolving GPS survey methodology. Preliminary concepts and planned efforts are listed below.

The CGCC will encourage owners of continuous operating GPS stations to make their stations, CSRS stations; i. e. , NAD83, first-order or better, NGS-published stations. The required surveys and submittals to NGS might be a cooperative effort, involving the station owner and others. Preferably, the epoch of the NAD83 coordinates shall be the epoch of the area's CSRS stations.

Continuous operating GPS stations which are included in the CSRS shall have a permanent monument (mark) or other means to verify that the position of the GPS receiver antenna has not changed. Reasonable accommodations should be made to provide station access to surveyors using the station, when necessary to resolve specific survey issues.

In support of the expected expanding use of continuous operating GPS stations, the CGCC will compile information and encourage research into the following:

a. Guidelines for the establishing continuous operating GPS stations (e. g. , receiver standards, data collection specifications, station accessibility and monumentation requirements [if any], electronic transmission standards and formats, etc.).

b. Standards and procedures for performing surveys that use data from continuous operating GPS stations to establish positions.

STATUTES:

Another California Geodetic Control Committee document is being prepared, by another subcommittee, to detail the recommended legislation actions necessary to establish, maintain, and promote a California Spatial Reference System. To be an effective system, the following key actions will be required.

Add statutes which define the National and California Spatial Reference Systems.

Add a statute which names the CSRS as the official California horizontal spatial reference system.

Clarify and revise existing California Coordinate System (CCS) statutes so that CCS coordinates must be based on (direct ties to) at least two in the ground" monuments listed below, after December 31, 1999.

a) National Spatial Reference System monuments.
b) California Spatial Reference System monuments.
c) Second order or better horizontal geodetic control monuments shown on a subdivision map, official map, record of survey, or any map filed with the County Surveyor by a public officer, providing the monument coordinates (i) are established by GPS methods in accordance with the applicable Federal Geodetic Control Subcommittee standards and specifications and (ii) are based on direct ties to two or more National or California Spatial Reference monuments.

Note: Retain last sentence of Section 8813.

Prior to January 1, 2000, the California Geodetic Control Committee and, hopefully, other professional surveying organizations will promote the use of the horizontal geodetic control specified above.

Add a CCS provision which requires that documents using CCS coordinates must state the epoch (date) that the coordinate data is valid; i. e. , the basis of the coordinate data shown.

Add a CCS provision which requires that the epoch for a given survey's CCS coordinates must be the epoch of the published or recorded coordinates for one of the controlling stations for that survey.

CURRENT STATUS (10/93):

1. **The California HPGN:** The California High-Precision Geodetic Network survey established 238, order B horizontal control stations that are distributed throughout California (see Appendix A). Field efforts for the HPGN were completed in 1991, and the station Data Sheets (final coordinates) were published in August 1992 by NGS.
2. **HPGN Densification Surveys:** In addition to the HPGN stations, the proposed CSRS will include about 850, first-order horizontal geodetic control stations (see Appendix A). A number of surveys have already been initiated to establish these stations. To date, surveys are underway for approximately 300 HPGN densification stations. For additional information, refer to Appendix A.

Continued on the next page

SUMMARY & STATUS
CALIFORNIA SPATIAL REFERENCE SYSTEM - HORIZONTAL
(HPGN and HPGN Densification)

COUNTY	STATIONS HPGN	HPGN-D	Total	AREA (sq.mi.)	STATION SPACING	HPGN DENSIFICATION STATUS Underway	Obs.Comp.	Processing	Complete
Alameda	2	10	12	825	8.3	10			
Alpine	0	5	5	727	12.1				
Amador	2	5	7	601	9.3			2	
Butte	2	11	13	1,665	11.3		5		
Calaveras	0	9	9	1,036	10.7			5	
Colusa	1	7	8	1,156	12.0				
Contra Costa	3	8	11	780	8.4	8			
Del Norte	4	6	10	1,003	10.0				
El Dorado	2	9	11	1,805	12.8				
Fresno	7	32	39	5,998	12.4			12	
Glen	2	6	8	1,319	12.8				
Humbolt	4	23	27	3,600	11.5				
Imperial	8	18	26	4,597	13.3				
Inyo	11	18	29	10,098	18.7				
Kern	10	45	55	8,170	12.2		2		
Kings	2	10	12	1,436	10.9	3		1	
Lake	2	8	10	1,327	11.5		4		
Lassen	7	18	25	4,690	13.6				
Los Angeles	7	47	54	4,079	8.7			47	
Madera	2	9	11	2,147	14.0			5	
Marin	3	7	10	588	7.7		7		
Mariposa	1	7	8	1,461	13.5		5		
Mendocino	5	28	33	3,510	10.3		2		
Merced	2	13	15	2,008	11.6		1		
Modoc	6	10	16	4,340	16.5				
Mono	7	12	19	3,103	12.8		2		
Monterey	11	19	30	3,324	10.5		19		
Napa	1	5	6	797	11.5		5		
Nevada	2	7	9	992	10.5		5		
Orange	3	15	18	785	6.6			15	
Placer	4	6	10	1,507	12.3		1		
Plumas	4	8	12	2,618	14.8				
Riverside	13	38	51	7,243	11.9		9		2
Sacramento	1	8	9	1,015	10.6			1	
San Benito	0	7	7	1,397	14.1		7		
San Bernardino	23	61	84	20,164	15.5			2	
San Diego	9	42	51	4,281	9.2		3	1	22
San Francisco	1	0	1	91	9.5				
San Joaquin	3	13	16	1,436	9.5		7		
San Luis Obispo	5	27	32	3,326	10.2		27		
San Mateo	*1*	*6*	*7*	*531*	*8.7*			*1*	
Santa Barbara	7	19	26	2,745	10.3		18	1	
Santa Clara	4	22	26	1,316	7.1			22	
Santa Cruz	1	5	6	440	8.6				
Shasta	8	16	24	3,850	12.7				
Sierra	0	7	7	959	11.7				
Siskiyou	10	18	28	6,318	15.0				
Solano	2	8	10	872	9.3			2	
Sonoma	3	17	20	1,598	8.9		17		
Stanislaus	3	9	12	1,521	11.3		2		
Sutter	1	4	5	607	11.0		3		
Tehama	2	10	12	2,976	15.7				
Trinity	3	14	17	3,223	13.8				
Tulare	5	17	22	4,845	14.8	4	5	1	
Tuolumne	2	13	15	2,293	12.4			2	
Ventura	3	18	21	1,864	9.4			18	
Yolo	1	7	8	1,034	11.4				
Yuba	0	3	3	639	14.6		4		
TOTAL	238	850	1,088	158,693	12.1	25	160	138	24

Note: For HPGN densification surveys that are not completed, the HPGN-D station count is an estimate.

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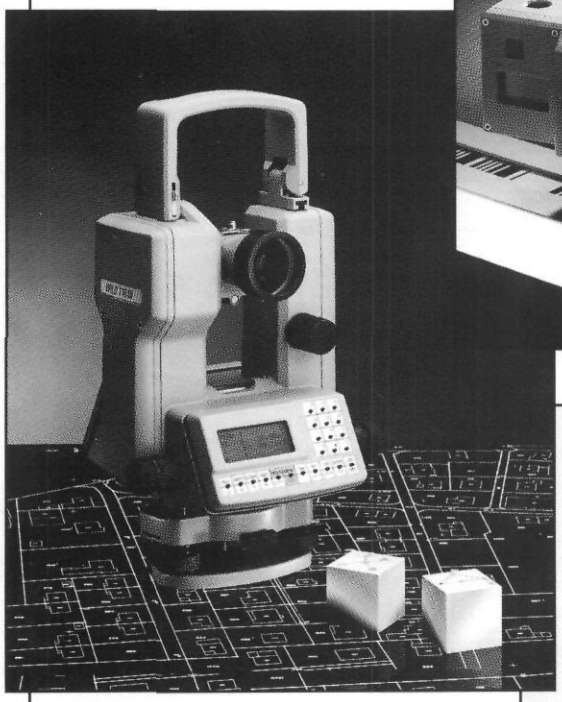

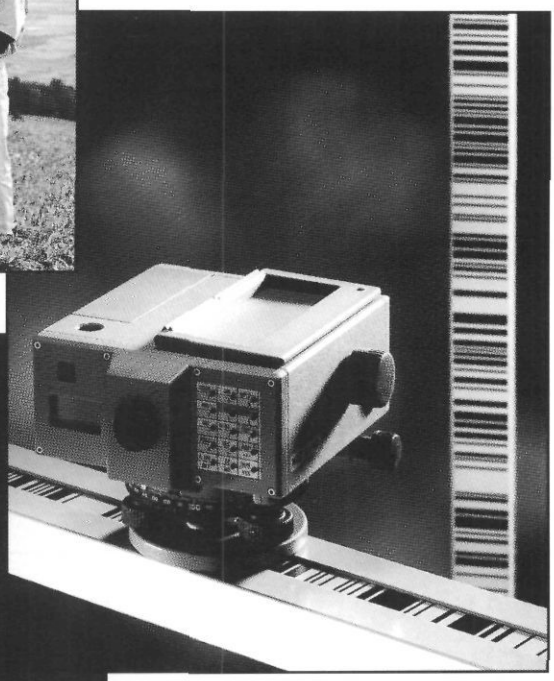

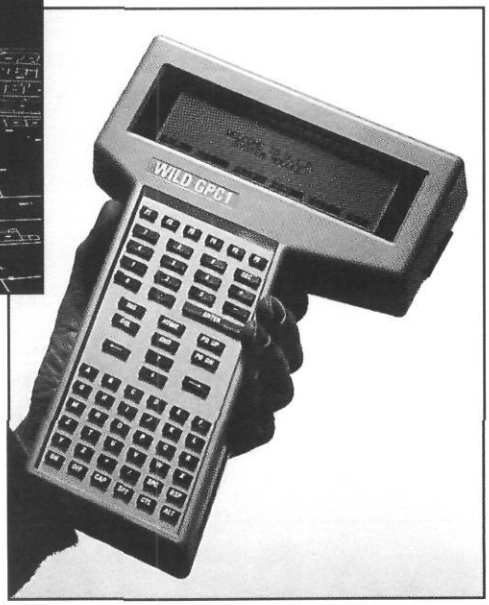

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GPS Technology in Emergency Response and Damage Assessment
Legal Aspects of Electronic Data Collection
Preparation and Presentation of Proposal "Making the Short List"
Archeological Surveys
Subdivision Map Act Update
Nevada Water Rights

FRIDAY, MARCH 11, 1994

3-D Control for the Golden Gate Bridge
Prescriptive Easements - Unwritten Rights
What You Should Know About Survey Certificates
Contracting and Subcontracting
Workman's Compensation

SATURDAY, MARCH 12, 1994

Mock Trail — Closing

SOCIAL ACTIVITIES

Exhibitor Sponsored Cocktail Party
Scholarship Auction
Joint Luncheons
Dinner/Show

LOCAL ATTRACTIONS

Skiing at nearby resorts
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INFORMATION

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Registration Material will be mailed in January

My License is Better Than Your License

By John R. Rinaldi Jr., P.L.S. City Surveyor, Henderson, Nevada

Yep, you read it right. My license has to be better than yours, because after all, on matters of interpretation regarding information that I want (or don't want) shown on Parcel Maps and Subdivision Plats, what I say goes! I am the one whose signature or approval you need in order to record your Parcel Map or Subdivision Plat - you know, the one that your impatient client has been hounding you about.

You could always raise an exception and challenge me regarding the requirements that I might impose, or challenge my interpretation of a particular statute or ordinance. But why would you? After all, if you did, think of how angry your now very impatient client will be given the additional delay. Now assume for just a moment that you raised an exception, and by some remote chance you even won, what do you think would happen on the next map you submitted. Talk about winning the battle and losing the war.

Does some of this ring a bell with you or conger up some memories of situations you've remarkably lived through? If it does, I feel for you. Honestly stated, if this rings a bell with you we both have a problem.

To be in a position such as mine is a tremendous responsibility. It's kind of like being judge and jury all wrapped into one. I recognize that the decisions that I make can have a serious effect on you. It is therefore paramount that someone in a position such as this be not only technically competent, but impartial, fair, reasonable and conscious of the effects that a decision can have on you and your project. To be technically competent to hold a position such as this requires, I believe, a broad background in land surveying; one that provides exposure to the varies aspects of the goals and needs of developers and their consultants hired to process their project through the approval process.

As I said, that person must be technically competent. He/she must be well versed in the state laws and local ordinances. But most importantly, that person must be willing to listen and evaluate the special situations that arise. That's why it is important that you take the time to make your concerns known.

Go in and talk about a judgment or interpretation that's been made. In many cases, we come to better understand your particular situation. Sometimes your concern can be incorporated with similar ones from other consultants and possibly utilized to propose a processing change or even a statutory or ordinance amendment. So you see, it's a process....for both of us.

Does some of this ring a bell with you or conger up some memories of situations you've remarkably lived through?

In situations such as this, after you've voiced your concern or explained your special situation, we are often faced with making that 'judgment call' that you may dislike or even find extremely objectionable. Bear in mind that, if we must make this sort of judgment call, we are employed by the public, and I believe, obligated to render the opinion or judgment that offers the most protection to the general public. However, that opinion must be balanced with the realities of the specific situation at hand. Therefore, that opinion must, at a minimum, not jeopardize the public welfare.

And lastly, what about those 'picky' comments that we make on your maps? Who are we to tell you that your lettering size is too small or that a particular dimensioning is unclear? Keep in mind that we see hundreds of maps each year. We aim for a certain amount of consistency. This is done in an effort not to rob you of your ability to explore and apply the art of mapping. Instead it is done in an effort to help ensure that your maps are clear, legible for reproduction after microfilming, and free (hopefully) of ambiguity in interpretation. For example, spelling out whether an easement being offered on a map is intended to be public or private or for the exclusive use of the City or County is extremely important. I have seen numerous maps that simply indicated 20' wide easement." Situations such as this have resulted in disputes as to who can use it and for what purpose. If the easement being offered is intended to be private, it is even more critical that you specify the party that is to benefit from that easement. A little explanation here can reduce or eliminate the chances for alternate interpretations in the future.

In closing, let me remind you of what I said before. The preparation, review and approval of maps and plats used for instruments of conveyance is a process. Be part of that process and never hesitate to make your concerns known. And finally, for the argument of winning the battle and losing the war," I say.....NOT A CHANCE.

(John Rinaldi is the survey, property and right-of-way manager for the city of Henderson, Nevada)

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News Highlights... *Continued from Page 15*

Army Engineer District, New Orleans, Attn: CELMN-ED-SS, PO Box 60267, New Orleans, LA 70160-0267 [504-862-1841, FAX: 504-862-1850]

■ NATIONWIDE HARN PROGRAM EXPANSION IS WELL UNDERWAY

The nationwide expansion of the HARN (High Accuracy Reference Network) program by the NGSD is well underway. Progress is being made on a state-by-state basis to allow the surveying and mapping communities to take full advantage of the technology revolution created by the Global Positioning System (GPS) in combination with modern computing capabilities. The control points of this network are usually located from 25 to 100 kilometers (15 to 60 miles) apart. These control points have North American Datum of 1983 (NAD 83) horizontal positions, with differential positions that are accurate locally at the 1 - 3 cm level and absolute positions relative to the NAD 83 coordinate system accurate to the 5 - 10 cm level.

Since GPS has 3-dimensional capability, HARN stations also have a vertical coordinate (ellipsoid height) associated with them. Ellipsoid heights can be converted to orthometric heights, the quantity obtained from leveling surveys, using geoid height information. NGSD currently publishes such geoid information from the high-resolution geoid height model known as GEOID93. This geoid can provide 10 cm accuracy (one sigma) between points spaced 100 km apart.

The high-accuracy reference network is independent of the existing horizontal reference network, but upgrades it. The existing reference network in a state is linked to stations of the high-accuracy network at intervals of 100 km or less. Using these connections, a complete readjustment of the existing statewide reference network is performed, holding fixed the high-accuracy network positions. The result is an upgraded, compatible higher accuracy statewide reference network that includes all of the existing network stations. Currently, HARN observations have been completed in at least 100 km spacing in 27 states. In 17 of these states, densification to the 25 - 50 km level has been completed. Inquiries: William Strange, (301) 713-3222. ⊕

Press Releases

STAR*NET LEAST SQUARES V5

Starplus Software, Inc. began shipping its new STAR*NET Version 5 least squares survey adjustment package. The enhanced version features many asked-for additions including several new data types, latitude and longitude entry and output, support of "HP" notation for angular data, rescaling of adjusted coordinates to ground, proportional weighting for elevation differences, and user-defined earth radius of curvature and refraction values to name a few. A new "output" viewer provides lightning-fast navigation through adjustment results. An optional output file lists differences between "provisional" and "adjusted" coordinates critical for deformation surveys.

In addition, the company released its new STAR*NET-PLUS adjustment package. This special DOS-Extended edition of its least squares program takes advantage of the 32-bit architecture of the 386/486 to gain extraordinary capacity and speed. With an ability to adjust networks having several thousand coordinates in minutes, it is well suited for large township or county remonumentation projects.

For more information, contact:
Ron Sawyer
STARPLUS SOFTWARE, INC.
460 Boulevard Way
Oakland, CA 94610
(800) 446-7848
(510) 653-4836
(510) 653-2727 Fax

New TopoSURF Program For Digital Elevation Models

Thornwood, N.Y. — Carl Zeiss now offers the TopoSURF program package for generating digital elevation models (DEM) from digitized photo pairs. It uses image correlation methods for identifying matching photo points. A dense and precise grid-type elevation model is derived from point groups consisting of several hundred thousand points.

TopoSURF affords an elevation precision of about 0.01% of the flying height and a production rate of 0.5 to 2 models per hour. It can also handle cut-out areas, e.g. densely built-up or wooded areas, and slope breaks. The TopoSURF program recognizes and eliminates outliers on the ground surface and provides automatic quality control using statistical analysis.

TopoSURF program package can be interfaced with all Zeiss digital and analytical photogrammetric systems.

New PHODIS Photogrammetric Digital Image Processing System

Carl Zeiss has introduced PHODIS, a new photogrammetric image processing system for the production of digital orthophotos. The system consists of hardware & software modules which guide the user from image digitization with the PS1 PhotoScan precision scanner to digital image output with precision laser recorders. PHODIS is designed to operate with a variety of software programs, including the TOPOSURF program package for automatic generation of digital elevation models, and mono-plotting with either the CADMAP or PHOCUS programs.

For more information contact the Photogrammetry Division, Carl Zeiss, Inc., Thornwood, NY 10594. Call (914) 681-7303, or fax (914) 681-7472.

Program Provides Raster Detail At Very Low Cost

SAN DIEGO, Calif., August 6, 1993 — Horizons Technology, Inc. (HTI) introduced today a new, easy-to-use Windows and DOS version of its CD ROM-based Sure!MAPS desktop mapping software. Available since September, Sure!MAPS retails for $199 with optional map sets $99 each.

For more information contact Horizons Technology at (619) 277-7100.

Laser Technology and ConTerra Systems Combine to Link Trimble's PathFinder

Laser Technology, Inc. and ConTerra Systems, announce the introduction of a user friendly interface linking Trimble Pathfinder GPS products, ConTerra's GPS-Touchdown data logging software, and Laser Technology's Criterion Series of hand held survey lasers.

When used together, the system enables you to record accurate coordinates of a point feature without actually placing the GPS antenna over or near the feature. This can save time, money and frustration when the features you wish to map are inaccessible or offset from your travel route. The Criterion will also compute other measurements such as tree height and diameter, all of which are automatically transferred to GPS-Touchdown as attribute values.

More information about the Criterion and GPS-Touchdown may be obtained from:

Laser Technology, Inc.
7399 S. Tucson Way
Englewood, CO 80112
Ph: 303-649-1000
Fax: 303-649-9710

ConTerra Systems
888 43rd Avenue
San Francisco, CA 94121
Ph: 415-387-1184
Fax: 415-751-8104

Land Navigation At Your Finger-Tips

Sunnyvale, CA — August 2, 1993 — Land navigators, you can now go anywhere you want without getting lost. Trimble's satellite-based Global Positioning System (GPS) handheld Scout is now available for search and rescue efforts, backpackers, hunters, off-road drivers and amateur radio operators. Scout GPS_ is a pocket sized, low-cost GPS receiver which directly targets the land navigation user. It fits in the palm of your hand and receives positioning data from 24 orbiting satellites to pinpoint your location 24 hours a day, anywhere on Earth, in any weather.

Topographical Map Reading Made Easy

Trimble developed a unique topographical (TOPO) map reading system termed Over and Up_, enabling you to pinpoint your exact location on *any* TOPO map without having to interpolate Latitude/Longitude or UTM coordinates. Scout GPS does it for you, displaying either *real-time* position information or actually *calculating* map locations "Over and Up" from a selected reference point (*any* South-East point on a TOPO map), in user-definable measurements (centimeter or inches, scale miles or kilometers). No other GPS receiver in the world can do this! When required, Scout GPS also displays position Latitude/Longitude or Universal Transverse Mercator (UTM) coordinate systems. Scout GPS is the perfect traveling companion when you're out there!

The whole package retails for $795 and is available through Trimble Navigation. An external antenna kit accessory is available for $150. Patent Pending on all Scout GPS features. ⊕

Here's Some Important Information About CLSA

The goal of the California Land Surveyors Association is to promote and enhance the profession of surveying, to promote the common good and welfare of its members, to promote and maintain the highest possible standards of professional ethics and practice, and to elevate the public's understanding of our profession. CLSA represents all land surveyors, whether they are employees or proprietors, whether in the public or the private sector.

Representation

LOCAL: Your local chapter represents you in local issues. Through your chapter representative to the State Board of Directors, the individual member can direct the course CLSA will take. STATE: The surveyor is represented at the state level through an active legislative program, legislative advocate, and liaison with the State Board of Registration. REGIONAL: CLSA is an active member of the Western Federation of Professional Land Surveyors. This federation is composed of associations throughout the western United States and addresses regional issues. NATIONAL: Through institutional affiliation with the National Society of Professional Surveyors and the American Congress on Surveying and Mapping, CLSA is represented at the national level.

Education Opportunities

CLSA presents annual conferences which provide technical and business programs, as well as exhibits of the latest in surveying and computing technology. Seminars and workshops are presented to assist in continuing education. CLSA publishes the *California Surveyor* magazine and the *CLSA News* to keep the membership abreast of changing legislation, legal opinions, and other items which affect our profession.

Business and Professional Services

CLSA provides a fully staffed central office which is available to answer questions or to provide up-to-date referrals concerning legislation, educational opportunities, job opportunities, or other issues concerning our membership. Health and professional liability insurance programs are available to members.

Join CLSA Today!

Application for Membership in the California Land Surveyors Association

Mail Your Completed Application To:

CLSA Central Office
P.O. Box 9098
Santa Rosa, CA 95405-9990

Questions?

Phone (707) 578-6016
Fax (707) 578-4406

** First year's annual dues are to be prorated from date of application*

Name _____ Work Phone (____) _____

Firm or Agency _____ Home Phone (____) _____

Mailing Address _____ Suite or Apartment No. _____

City _____ County _____ State _____ Zip _____

Signature _____ PLS , PS, CE, or LSIT No. _____

Recommended by (Affiliate and Student Memberships only) _____

Mailing Address (above) is: ☐ Home ☐ Business

Employment: ☐ Private (principal) ☐ Private (employee) ☐ Public ☐ Retired

☐ $145.00 CORPORATE MEMBER: Shall have a valid Calif. Professional Land Surveyor or Photogrammetric license.
☐ $ 72.50 AFFILIATE MEMBER: Any person, who in their profession, relies upon the fundamentals of land surveying.
☐ $ 72.50 ASSOCIATE MEMBER: Any person who holds a valid certificate as a Land Surveyor in Training.
☐ $ 14.50 STUDENT MEMBER: A student in a college or university actively pursuing the study of land surveying.
☐ $290.00 SUSTAINING MEMBER: Any individual, company, or corporation desirous of supporting the association.

Dues (prorated* from above) $ _____ + Entrance Fee $15.00 = Total Amount $ _____

☐ Check enclosed I authorize charge to my ☐ Master Card ☐ Visa Expiration Date _____

Card Number _____ Signature _____

NGS Horizontal & Vertical Data Base for California Order Form

In July 1992 the NGS came on line with a new integrated data base. This base is intended to collectively hold all data for all "horizontal & vertical" control. The information is available in a readable ASCII format, that has been compressed onto a 3.5" IBM compatible disk. Each control station is considered a record which will fill one to several pages when printed. Each record contains the station name, geodetic latitude and longitude, state plane coordinates in meters and feet, azimuth marks, recovery information, and the new HPGN stations. Updates will be available when the readjustment of the NGS is complete. A minimal charge will be set at that time.

The above described database is not the same as the horizontal control previously made available to CLSA.

MEMBER
$50.00 *(for first disk)* per county
$40.00 (thereafter)

COUNTIES

(prices include tax only)

NON-MEMBER
$85.00 *(for first disk)* per county
$75.00 *(thereafter)*

* The whole state can be purchased for $500.00 (member) - $640.00 (non-member)

Alameda	Humboldt	Modoc	San Francisco	Sonoma
Alpine	Imperial	Mono	San Joaquin	Stanislaus
Amador	Inyo	Monterey	San Luis Obispo	Sutter
Butte	Kings	Napa	San Mateo	Tehama
Calaveras	Lake	Nevada	Santa Barbara	Trinity
Colusa	Lassen	Orange	Sant Clara	Tulare
Contra Costa	Madera	Placer	Santa Cruz	Tuolumne
Del Norte	Marin	Plumas	Shasta	Ventura
El Dorado	Mariposa	Riverside	Sierra	Yolo
Fresno	Mendocino	Sacramento	Siskiyou	Yuba
Glenn	Merced	San Benito	Solano	

Kern */2 disks*	Los Angeles */3 disks*	San Bernadino */3 disks*	San Diego */2 disks*
$60.00 (member)	$70.00 (member)	$70.00 (member)	$60.00 (member)
$95.00 (non-member)	$105.00 (non-member)	$105.00 (non-member)	$95.00 (non-member)

Also Available:

SEEKER - *Seeker allows you to extract full report or summary information from NGS data files based on geographic coordinates. Supports ASCII or DXF file formats.* - $30.00 (member) $60.00 (non-member)
GEOID93 *(calcs. estimated geoid heights)* • $50.00 (member) $85.00 (non-member)
VERTCON *(calcs. est. difference between NGVD29 & NAVD88)* • $50.00 (member) $85.00 (non-member)
CORCON *(calcs. geodetic & SPC transformations in NAD27 & NAD83)* (includes NADCON)• $50.00 (member) $85.00 (non-member)

County	Quantity	Total
	Subtotal	$
	Shipping	$ 4.00
	TOTAL	**$**

- Make your check or money order payable to California Land Surveyors Association (CLSA)
- Mail your order form and payment to:
  CLSA Central Office
  P.O. Box 9098,
  Santa Rosa, CA 95405-9990
  Phone: (707) 578-6016 Fax: (707) 578-4406
- Minimum order for Master Card or Visa is $20.00
- If you are paying by Master Card or Visa, you may fax your order to (707) 578-4406.
- Member prices are only available to members of the State California Land Surveyors Association.

NAME	PAYMENT ENCLOSED ❑ CHECK ❑ MASTERCARD ❑ VISA
COMPANY NAME (if company is mailing address below)	CHARGE CARD ACCOUNT NUMBER (minimum charge card order is $20.00)
STREET ADDRESS (we cannot ship to P.O Box)	EXPIRATION DATE
CITY/STATE/ZIP CODE	NAME ON CARD
DAYTIME TELEPHONE	AUTHORIZED SIGNATURE

CLSA PUBLICATION ORDER FORM	CLSA Member Price	Non-member Price	Quantity	Total Amount
1994 Complete Package including PLS Roster, Pre-'82 CE Numerical Listing, PLS Act & Board Rules, Subdivision Map Act, and Binder	$ 22.00	$ 38.00		
1994 Refill Package including PLS Roster, PLS Act & Board Rules, Subdivision Map Act.	$ 16.00	$ 32.00		
PLS Act and Board Rules (1994 publication) (5½ x 8½)	$ 5.00	$ 10.00		
Subdivision Map Act – 5½ x 8½ (1994 publication)	$ 6.00	$ 12.00		
Pre-'82 CE Numerical Listing	$ *9.00*	$ *18.00*		
Binder with index tabs for LS Roster, Pre-'82 CEs, LS Act & Board Rules, Subdivision Map Act, and Misc. Statutes *(text of Misc. Statutes will be available at later date)*	$ 6.00	$ 6.00		
California Coordinate Projection Tables – NAD '83	$ 6.00	$ 12.00		
Right of Entry Cards *(minimum order is two)*	2 / $ *3.00*	2 / $ *6.00*		
Corner Record Forms *(minimum order is 25)* (Form PWA-102) (8/88)	25 / $ 10.00	25 / $ 15.00		
Land Surveying Brochure *(minimum order is 100)*	100 / $ 15.00	100 / $ 30.00		
Standard Contract – Agreement for Prof. Services	$6.00 / pad of 25	$12.00 / pad of 25		
Land Surveying for the Land Owner & Real EstateProfessional	$ 5.50	$ 11.00		
Easement And Related Land Use Law in California, Second Edition *by Donald E. Bender, J.D., L.S.*	$ 20.00	$ 30.00		
Cadastral Survey Measurement Management System Three-ring binder documentation & three disks	$ 50.00 / set	$100.00 / set		
NGS 1983 California Horizontal Control Coordinates Data Disks	$ 35.00	$ 70.00		
NGS Search Program (for use with NGS disk)	$ 20.00	$ 40.00		
MEMBERSHIP ITEMS (not available to non-members)				
Lapel Pin with CLSA logo	$ 6.00	not available		
Decal of CLSA logo *(minimum order is two)*	2 / $1.50	not available		
Shareware Disk #2 – BLM – SPC & UTM Conversion	$ 3.50	not available		
		Subtotal		
		7½% CA Sales Tax		
		Shipping Charge		
		TOTAL		$

SHIPPING CHARGES

Up to $10.00	$ 2.50	$30.01 to $40.00	$ 4.50
$10.01 to $20.00	$ 2.75	$40.01 to $50.00	$ 5.00
$20.01 to $30.00	$ 3.75	Over $50.00	Add 10%*

* Add 10% to a maximum of $10.00 shipping.

- Make your check or money order payable to California Land Surveyors Association (CLSA).
- Mail your order form and payment to:
  CLSA Central Office
  P.O. Box 9098, Santa Rosa, CA 95405-9990
  Phone: (707) 578-6016 Fax: (707) 578-4406
- Minimum order for Master Card or Visa is $20.00.
- If you are paying by Master Card or Visa, you may fax your order to (707) 578-4406 between the hours of 9:00 AM and 5:00 PM, Monday through Friday.
- Member prices are only available to members of the State California Land Surveyors Association.

NAME	PAYMENT ENCLOSED: ☐ CHECK ☐ MASTERCARD ☐ VISA DISK SIZE: ☐ IBM 5¼" ☐ IBM 3½"
COMPANY NAME (if company is mailing address below)	ACCOUNT NUMBER (minimum charge card order is $20.00)
STREET ADDRESS (we cannot ship to P.O. box)	EXPIRATION DATE
CITY/STATE/ZIP CODE	NAME ON CARD
DAYTIME TELEPHONE	AUTHORIZED SIGNATURE

Sustaining Members

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