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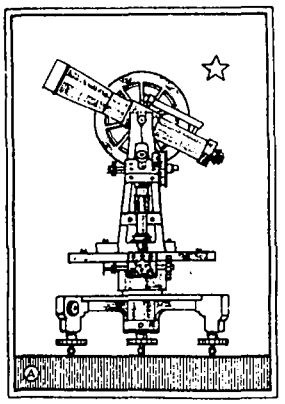

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U. S. Coast and Geodetic Survey
DIVISION OF GEODESY

G E O D E T I C   L E T T E R

Volume 2 JANUARY, 1935 Number 1

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SOMETHING TO THINK ABOUT

The paragraph below is taken from The Kalends of November, 1934, a leaflet issued by the Williams and Wilkins Company, publishers, Baltimore, Maryland.

"The one who is too little for his job is not likely to get anywhere but out; if he is equal to it but does just enough to get by, he is likely to stick where he is for a long time; but if by his devotion and constant self-improvement he makes himself bigger than his job, he is in line for promotion."

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DELAWARE-NEW JERSEY BOUNDARY

The boundary line between Delaware and New Jersey is defined as following the low-water line of the east shore of the Delaware River between its two intersections with the arc of a circle of twelve statute miles radius with its center at the courthouse in New Castle, Del., and as then following the centerline of the main channel of the river and bay southward to the sea. The location of the intersection points of the 12-mile circle with the low-water line had never been made or marked on the ground until this year, when Special Councils of the States of Delaware and New Jersey requested the Coast and Geodetic Survey to undertake it. Lieut. (j.g.) J. H. Brittain was assigned by the Director to the task and an abstract of his report follows:

"At the request of the States of Delaware and New Jersey, the following work was undertaken by the Coast and Geodetic Survey in connection with the location of the Delaware-New Jersey Boundary within the circle whose radius is twelve statute miles and whose center is the New Castle, Del., Courthouse:

"1. The location of two intersections of the 12-mile circle with the New Jersey shore. In this connection it has been understood between the representatives of the States that the northerly intersection of the circle would be located by extending the present circle between Delaware and Pennsylvania, which is not a true 12-mile circle having its center at New Castle, but is a compound curve surveyed under the direction of W. C. Hodgkins, of the Coast and Geodetic Survey, as set forth in Appendix No. 8 to the Survey Report for 1893. Under this plan the northerly intersection on the eastern bank of the Delaware falls somewhat to the north of the intersection of the true circle. It was desired that the southerly intersection of the circle (boundary marker) be

fixed at a point which would equitably compensate for this fact.

"2. The fixation of points at the mouths of Oldman's Creek and the Salem River, It was stipulated between the States that the boundary line at the mouth of each creek should be a line drawn across the mouth of the creek.

"3. The erection of permanent monuments with appropriate inscriptions marking the two intersections of the circle and the boundary lines across the mouths of the creeks above referred to.

"4. The completion of a proper description of the boundary line as thus fixed connecting the same with the work already done by the Coast and Geodetic Survey for the States of Delaware and New Jersey.

"The locations of the monuments were determined by triangulation. The positions of the New Castle courthouse and the center of the eastern arc of the compound curve of the Delaware-Pennsylvania Boundary as determined by the field computations of W. C. Hodgkins in 1893, and the positions of various triangulation stations along the Delaware River as determined by G. L. Anderson in 1933 were used to determine the locations of the monuments. Several additional triangulation stations were established to carry the control to the points where the monuments were placed.

"To establish the monument referencing the extension of the compound curve between Delaware and Pennsylvania to the low-water line on the eastern bank of the Delaware River, a triangulation station was first established near the point where the monument was to be located. The distance and azimuth between this station and the center of the eastern arc was computed. The boundary monument was then located by traverse from the triangulation station, so that its distance from the center of the eastern arc was equal to the radius of the arc as determined by W. C. Hodgkins. The distance to the approximate low-water line along the shore was then measured from the monument to a point on the arc of the curve. The boundary point can therefore be described by distance (approximately) and direction from the monument.

"Near the mouth of Oldman's Creek only one monument was established to serve as a reference point for both ends of the boundary line across the mouth of the creek. My intention at first was to set two monuments, one on the point above high water on the north side of the mouth of the creek and the second on the first prominent point south of the mouth of the creek. These monuments would have served as

reference marks to points on the low-water line of the river directly opposite the monuments. Then the boundary line would be extended in a straight line between the points on the low-water line of the river. This procedure was objected to by the representatives of New Jersey because this would have thrown into Delaware a portion of the long spit, bare at low water, extending south from the point on the north side of the mouth of the creek. The representatives thought that the boundary should be held to the low-water line along the outside of the spit, cutting across the mouth of the creek from the end of the spit. It was then decided that one monument would serve as a reference mark to both points.

"At Salem Cove permanent reference monuments were established on each side of the mouth of the Salem River so that the boundary is a straight line, on the line between the monuments, from the low-water line on the north side of the Cove to the low-water line on the south side of the Cove. The north monument was set near the Salem Cove Rear Range Light. The south monument was established near the point between the Delaware River and Salem Cove, so that the boundary line would leave in New Jersey the site of a proposed wharf on the south side of the Cove just east of the point, for which a permit had been granted by the State of New Jersey.

"In determining the distance that the southern intersection of the 12-mile circle with the east bank of the Delaware River should be moved to the north to compensate for the fact that the compound curve at the north of the 12-mile circle gave to Delaware too great an area, it was agreed by the Special Council of the two States that the length of shore line involved on the eastern bank of the Delaware River should govern. This made it necessary to determine the length of shore line lying between the extension of the compound curve between Delaware and Pennsylvania to the eastern shore of the Delaware River and where the true 12-mile circle would intersect the shore line on the eastern bank of the Delaware River, and then lay off the same distance along the eastern shore of the river north from the intersection of this shore and the 12-mile circle to the south of New Castle. The compensation was arrived at as follows:

"The shore line at each of the places where the compensation is involved is fairly straight but does not make the same angle with the radii of the circle. Upon plotting the approximate locations of the places involved on topographic sheets compiled by the Army Engineers it was found that a line between the boundary monument on the extension of the compound curve and the triangulation station MALLOW (U.S.E.) is very nearly parallel to and lays along the eastern shore of the river, while to the south of New Castle

the circle crosses Artificial Island, the western shore of which is practically a straight line. The distance from the boundary monument on the extension of the compound curve to the point where the true 12-mile circle intersected the line between the boundary monument and MALLOW (U.S.E.) was computed. Then this distance was laid off along the western shore of Artificial Island northward from the intersection of the true 12-mile circle with the western shore of Artificial Island and a monument set. The position of this monument was determined and its distance from the New Castle courthouse computed. This distance from the New Castle courthouse was used as the radius of the southern arc with the center at the New Castle courthouse. A monument was also set on the New Jersey shore about 200 yards south of the mouth of Alloway Creek as a reference mark to the intersection of this arc with the low water line of the New Jersey shore.

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NEED FOR MAPS RECOGNIZED

Information has just been received that a geological survey has been organized in the State of Louisiana. In an announcement concerning this is the following sentence which it is certain will appeal to the readers of the Geodetic Letter.

"Without topographic maps of the entire State, it is difficult and sometimes impossible for any intelligent planning and development of the State's valuable mineral resources (to be made)."

Geologists, engineers and others are realizing as never before the need for topographic maps in order that all classes of planning may be made and carried out. Necessarily, the topographic maps must have as their bases the horizontal and vertical control surveys carried on by the engineers of the U. S. Coast and Geodetic Survey.

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CONTROL SURVEYS FURNISH FRAMEWORK FOR AIRWAY MAPS

By Capt. William Bowie

United States Coast and Geodetic Survey

(Reprinted from Air Commerce Bulletin)

From the dawn of history, maps of at least a primitive nature have been used to assist those who had to travel from one place to another, or to transport goods. Maps were made by Alexander the Great in connection with his military campaign. The Romans had maps of their great domain, showing routes of travel, mountains, rivers, and military transportations. They are just as essential to travel and transportation as tools are to the worker in woods and metals.

Aviation has developed tremendously in recent years and its future is bright. In order to make it possible for the aviator to fly his plane by day or night across countries, transporting passengers, mail, and goods in all kinds of weather, he must have information to guide him on his way.

The maps prepared for the aviator are designed especially for this purpose. They are drawn to the scale of 1:500,000 (8 miles to the inch), and show streams, roads, railroads, towns, and elevations. They are lithographed in colors and readily understood symbols are used to emphasize features such as radio ranges, airports, auxiliary landing fields, airway beacons, lighthouses, and high-tension lines.

While such a map must not be cluttered up with too many details unimportant to the aviator, it is essential that the features shown be in their true positions. They must be accurate as to longitude and latitude, in order that the distances and directions between features can be determined with certainty.

Triangulation Valuable

Fortunately, in this country the longitude and latitude of many points are known. They have been established by the engineers of the United States Coast and Geodetic Survey by the method known as "triangulation". This is a system of surveying by means of which the distances and directions between "stations" can be determined and the longitude and latitude computed. It is based upon the fundamental principle that if the length of one side of a triangle is known and the angles of a chain of triangles are determined, the length of the other sides can be computed.

Since we know the shape and size of the earth with great accuracy, we are able with the angle measurements and the computations to determine the longitude and latitude of each of the triangulation stations.

Triangulation is just as necessary for good maps as the steel framework is for a modern office building. Without the steel frame all designed and fitted together with accuracy and strength, the building would lack form and resistance to forces that would destroy it. Without triangulation the maps of the country would also lack form, strength, and continuity.

The Coast and Geodetic Survey is at work on a plan which calls for the spacing of the arcs of triangulation of chains of triangles at 25-mile intervals over the entire country. Almost one-half of the work has already been done, and many miles of the chains of triangles are added to the net monthly. Great stimulus for this work is resulting from allotment of Public Works Administration funds.

Fitting Maps Together Difficult

Maps for aviation have to be compiled today from all available sources. The fitting together of these pieces of map information is as difficult as fitting together the pieces of a jigsaw puzzle. The problem is even more difficult because the pieces have been made independently of each other, and therefore, do not always fit with exactness. When the country is mapped topographically and all maps are based on triangulation, then maps for the aviator can be prepared more quickly.

The altitude of the terrain is also of immense importance. The pilot in his plane must know how high he must fly to avoid the mountain slopes and summits. The Coast and Geodetic Survey is also assisting in this matter and has already run some 140,000 miles of leveling over the country. The fundamental leveling net of the country when completed, will be like a great fish net 3,000,000 square miles in area, the meshes of which are approximately 25 miles across. Along each line of levels bench marks are set at intervals of a mile or two, whose elevations form the base of the contour or topographic map. Areas to represent different elevations are lithographed in tints on the airway map.

In the course of its triangulation, Coast and Geodetic Survey parties build portable steel towers to elevate the instrument and observer above trees and other objects that would obstruct the line of sight. They are double structures, the inner tower being used for supporting the instruments, and the outer containing a platform on which the observer

stands at his work. The two structures do not touch at any single point, in order to insure the isolation of the delicate instruments used in observing the angle of the triangle. In general they do not exceed 103 feet, although the maximum height of a tower used is 159 feet. Where a tower is used as a station close to an aviation field or route, a lantern is placed on the top to warn the flyer. A tower stays over a station only a short time, two weeks being the maximum period. When observations have been made, it is taken down and carried on trucks to new stations. Each triangulation station is marked by an inscribed metal tablet set in outcropping rock or in a block of concrete. A triangulation party will extend this work along an area for a distance of from two to four hundred miles per month, depending upon the closeness of stations, the roads, and the character of the country. Of course, the weather has much to do with progress, for when the atmosphere is hazy or foggy, when it is raining, or when the wind is blowing hard, observations are not made.

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CHAMBER OF COMMERCE CONTACTS

In a letter dated November 7, 1934, from the Secretary of the Lamar Chamber of Commerce, Lamar, Colo., addressed to the U. S. Geological Survey, and referred to this Office, is the following statement:

"We noted that you made a survey last year establishing bench marks from Pueblo, Colo., eastward into Kansas and from Kit Carson, Colo., southward into Tex.

"This office has frequent requests for data relative to altitude and Government bench marks."

It is suggested that the chiefs of the geodetic parties contact the secretaries or presidents of Chambers of Commerce in each of the large towns and cities that may lie near their routes of work. The officials of the Chambers of Commerce should be told what work is going on and also advised as to the amount of additional work that has already been done in his State. They should also be told that detailed information regarding the control surveys can be obtained by communicating with the Director, U. S. Coast and Geodetic Survey, Washington, D. C.

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ACCOUNTS

In view of the large increase in the quantity of accounts handled by each Chief of Party in recent months, it is felt that a few words of caution would be timely.

First, it will save one handling of the accounts if they are addressed directly to the Disbursing Officer, rather than the Director. This is in accordance with paragraph 15 of the "Regulations and Instructions of the Coast and Geodetic Survey"

Requisitions for funds should not be enclosed with accounts but should be forwarded separately addressed to the Disbursing Agent. Accounts are not always handled immediately after they are received and a requisition for funds enclosed with accounts might not receive the immediate attention it merits.

Cash subreceipts should be very carefully wrapped, or enclosed in a sealed envelope, properly labeled, and attached to the voucher concerned, rather than merely bundled together with an elastic band to hold them. Subreceipts are numerous and in the frequent handling of the accounts in the Office are easily lost unless carefully kept together. Lost subreceipts are difficult of replacement.

A few Chiefs of Party do not attach the bills, etc., pertaining to each voucher to the voucher but merely lay them loose with the voucher. This is dangerous because such matter may easily get out of place in the handling of the accounts, or become lost. Paper clips or pins (but not staples) should be used to clip all papers to its proper voucher.

In a similar manner as above all vouchers listed on an "Abstract of Expenditures" should be clipped or bundled with elastic bands to the "Abstract of Expenditures" to which it pertains, in consecutive numerical order.

Each voucher should show under "Appropriations" the Federal Project number to which it is charged and this Federal Project number should also appear on the "Abstract of Expenditures" and "Statement of Account". Where vouchers charged to different Federal Projects by number are abstracted under one "Abstract of Expenditures", the amounts credited respectively to the various Federal Projects by number should be shown on the "Abstract of Expenditures" and the "Statement of Account"

Occasionally, vouchers and subreceipts fail to have the required certificates regarding the origin of materials and

regarding the dealers compliance with Executive Order No. 6646. This is undoubtedly an oversight but it is felt that more care should be used in checking the vouchers and subreceipts to see that these certificates are on each voucher and subreceipt.

On the duplicate vouchers or invoices each article should be marked as expended or inventoried as the case may be. Articles transferred to truck inventories should be placed on the purchase list with that notation.

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AMERICAN SOCIETY OF CIVIL ENGINEERS MEETING

The annual meeting of the American Society of Civil Engineers is to be held at the Engineers Society Building, 33 West 39th Street, New York City, January 16 - 18, 1935. The Division of Surveying and Mapping will hold its meeting on the afternoon of January 16. The program for the meeting of the Division of Surveying and Mapping includes two papers and discussions which are of particular interest to all members of the Division and particularly to those who will be able to attend the meeting. These papers are:

1. National Planning Compels National Mapping
   Frederick H. McDonald, Director, Am. Soc. C. E., Consulting Engineer, Atlanta, Ga.

   Discussor: Charles J. Tilden, Mem. Am.Soc.C.E., Strathcona Professor of Engineering Mechanics, Yale University, New Haven, Conn.

2. Proposed System of State Surveying and Mapping Information Bureaus - J. S. Dodds, Mem. Am.Soc.C.E., Associate Professor, Department of Civil Engineering, Iowa State College, Ames, Iowa.

   Discussor: Henry J. Sherman, Director, Am.Soc.C.E., Consulting Engineer, New Jersey Board of Commerce and Navigation, Camden, N. J.

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FORWARDING ADDRESSES FOR MAIL

It has been called to the attention of this Office recently that field parties, when they move from one town to another, occasionally leave a blanket mail-forwarding order. That is, they request the Postmaster to forward <u>all</u> mail for the Coast and Geodetic Survey to them at the next town. This should never be done. An accurate list of all persons for

whom it is desired that mail be forwarded should be given the Postmaster. This will obviate the danger of having mail for other Coast Survey parties forwarded to the wrong address.

With numerous Coast and Geodetic Survey parties now working throughout the country, the chance for mail going astray is an ever-present one.

A good practice is to have a form letter prepared similar to the following:

The Postmaster,
_____,
_____.

Dear Sir:

It is requested that all mail for the following members of the U. S. Coast and Geodetic Survey party under my charge be (held until called for) _____, ___.
forwarded to

(here list members of party alphabetically)

_____
Chief of Party.
U. S. Coast and Geodetic Survey.

Such a letter should be sent to the Postmaster of the town to which the party is moving and left with the Postmaster of the town from which the party is moving, crossing out the inappropriate part of the request.

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APPRECIATION OF COAST AND GEODETIC SURVEY SPIRIT

The following is quoted from a letter dated November 23, 1934, addressed to the Chief of the Division of Geodesy, from Prof. Philip Kissam of the Department of Engineering of Princeton University, who has been our State Representative on Civil Works and Relief Control Surveys in New Jersey.

"Yesterday afternoon I had the pleasure of calling on Lieut. Ralph Pfau at his office at the Federal Building in New York City, and the delightful and helpful treatment which I received at his hands reminded me of the long-neglected word of thanks and gratitude which I owe to Lieut. Pfau for his tremendous interest in our work in New Jersey, and for the great assistance which he has been to us by his advice and by actual hard work which he has done to forward the Local Control Surveys in New Jersey.

"I feel that you should know about this, as it seems to me that a remarkable spirit prevails throughout the U. S. Coast and Geodetic Survey. Every one of the officers I have met has shown an interest which is hard to describe."

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CONNECTIONS TO SURVEYS

In recent months much C.W.A. traverse and leveling work has been received in this Office and has been correlated with our own work. The C.W.A. control work will be of greatest use only when completely coordinated with the national control net and every effort should be made to that end.

With this in mind, the chiefs of reconnaissance, triangulation, and leveling parties are being instructed to communicate with the state representatives of the states in which they are working in order that they can obtain the latest data for the C.W.A. work in order to make as many connections to it as possible.

The country is gradually being covered with many separate schemes of triangulation and leveling by other agencies which are very desirable to have tied into the Coast and Geodetic Survey networks. Although every effort is being made in this Office to supply field parties with the necessary data to make such connections, it is frequently impossible to gather all together. Therefore, the field parties are admonished to be on the alert to grasp every opportunity to make such connections. It is especially desirous to make connections to the work of the following organizations: U. S. Geological Survey, Army Engineers, U. S. Land Office, U. S. Forest Service, Mississippi River Commission, Missouri River Commission, Trinity River Survey of the Corps of Engineers, U. S. Army, and C.W.A. Surveys.

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SOME NOTES BY PROF. WILLIAM H. BURGER, NORTHWESTERN UNIVERSITY

(a) First of all I want to heartily concur in what has been said (Geodetic Letter No. 2) regarding an observer's knowledge of his instrument. After having taught the subject for more than 20 years, I have observed that those men who have the best understanding of the construction of their instruments, sources of errors, etc., are the ones who make the best records in observing, for they know better how to guard against errors, or overcome them by proper methods in procedure.

I clearly remember the time I was recording for A. E. Tilton, using one of the old Mendenhall precise levels. Before joining his party I had never seen a precise level and you may be sure that I had "stage fright" when he first gave me a chance to use it. Even though he allowed me to use it several times I never overcame the fear. Therefore when in the following winter Mr. Hayford told me I was to be one of the two men to use the new type (Hayford-Fischer) level in the spring, I obtained permission to take my lunch in the basement of the Survey where the new instruments were being constructed. The men of the Division, from Mr. Fischer down, were most cordial and afforded me every opportunity (to study the new instruments).

This knowledge gave me every confidence and this was no small factor in what ever success attended the work. I should like every observer to be granted such an opportunity.

(b). In the Letters I do not believe enough stress has been given to the Party's obligation to the public. I firmly believe that the Chief of Party, and all members of the party, should make a special effort to acquaint local residents regarding the work done. By this means they will gain the good will of the local people and this will return to them in full measure, for they will find the people more willing to grant them favors and aid them in carrying on the work. They should also remember that other parties of the survey may, later, be in this same locality and these parties will also be benefited by the good-will established. Chiefs of Parties should thoroughly discourage the practice indulged in by some "smart" member of the party in making fun of the questions propounded by visitors - even though they be "country jakes", and of telling them that a railroad, etc., is being run.

(c). I am astounded at the rate of progress which the triangulation and leveling parties have obtained in the past few years. I know what this means and so I take off my hat to the force. It shows skill and endurance on the part of every member of the parties - not to mention the work of the Chief of the Division who has to plan the work and coordinate the movements of the parties. Congratulations!!

(d). I am glad to note that the new precise level has the pivot of the telescope placed in the vertical axis of the instrument. This has always been a source of worry to me, and I brought it to the attention of Prof. Hayford many years ago. He partially convinced me that the errors resulting from this were exceedingly small and need hardly be considered, especially since the errors were of a compensating nature. This point was later brought up in the Survey by Mr. Pagenhart with about the same results. Am glad that it is now settled in favor of the central pivot.

(e). In regard to the two "half interval" spacing of the wires of the precise level. In my summer course in Surveying I have often had the men lay off three distances from the level - namely 50m, 80m, 110m, within which range practically 90% of the leveling is done. With the rod held at one of these points a page or so of notes is taken, no change being made other than to shift the micrometer screw, thus causing a change in readings but not of intervals. This gives a good result for the relative values of the two intervals at that distance. This is repeated for the other points. In regular work a divergence in intervals of two (2 units mm) should be allowed, but not three (3 units mm) excepting occasionally when proved by a second reading. Due to a personal error in estimating the 1/10 centimeters a three divergence may occasionally occur. Of course this divergence is in addition to that actually existing in the non-equality of the upper and lower intervals. In making this test good conditions of sighting etc. should be selected, for the observer is trying to measure a condition which actually exists in the instrument. Such a record might justly be made a part of the official record.

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ANCHORING TOWERS WITH CRIBBING

By J. M. Dykes

Former Building Foreman

Before going into a discussion of cribbing, let us review briefly the usual procedure of anchoring temporary towers.

Each of the towers, one inside the other, has three legs and three anchors. The inner and outer anchors must be entirely separated. An anchor consists of the extension of the angle-iron leg ending in a "T" section to which is bolted a 4 ft. x 2 in. x 8 in. base board. Each pair of anchors is set in a separate hole thus making three excavations necessary. These holes vary in spacing and depth with the height of the steel, the average depth for proper stability being about five feet. After the anchors are properly aligned and leveled in the holes, earth is tamped around and between the base boards and cross boards are snugly fitted across them after which the hole is completely filled with earth, thoroughly tamped. This is the normal procedure. It is perhaps a fair approximation to say that such a method may be used fourteen times out of fifteen.

However in the fifteenth instance, cribbing will be found to be necessary. This is an emergency method used where it is impossible, because of some obstacle such as lime stone strata or swampy soil (near water level), to dig the anchor holes within reasonable time to a sufficient depth to anchor the tower securely. It consists of building up around the anchors rectangular boxing which is filled with earth or stone. The effect is that of extending the holes above the surface. Often two of the holes can be dug to the proper depth, the other being dug only partly deep enough. In this instance cribbing is the practical method of making the shallow anchor of the required strength. Of course different conditions impose different degrees of care and detail.

The cribbing must in all cases be as strong as the doundation it replaces. External anchor strength depends upon resistance to lateral movement and resistance to moment action about the anchors. It is safe to assume that if two of the anchors are fairly well down, there will be no appreciable lateral movement. Only in rare instances is it impossible to get some depth of hole for the anchors. On the point of strength and pulling resistance it should be remembered that even towers built under good anchorage conditions have in rare instances blown over in wind storms. So, if there is any doubt as to the security of the cribbed anchor a factor of safety in the form of guy wires is advisable.

An interesting case of cribbing comes to mind. In building the tower at station MAHON, Delaware, the soil was found to be low and mucky, water seepage being so great that it was impossible to dig. Consequently, the anchors had to be set on the surface. In order to minimize settling and to furnish more weight surface, additional base boards of 9 ft. lengths were bolted to the regular 4 ft. planks. After the anchors were properly placed, rectangular boxing 10 ft. x 5 ft. x 5 ft. was built up around each set of anchors and filled, the usual care of detail being taken. In this particular case the presence of water made atmospheric pressure a strengthening factor. As an extra precaution the tower was guyed.

While this tower was still standing there was quite a wind storm, after which the 103' structure was found to have only a slight eccentricity. The observors were occasioned no difficulties, taking the angles in the usual time.

This extreme case and many others where cribbing was used to a lesser degree, have convinced the writer of the safety and practicability of this method for temporary tower anchoring.

The personal element of supervision and care of detail is important. Thus it is best that the signalman supervise the work in any situation where total or near total cribbing must be used. Cribbing is advisable only when the circumstanc demand it, and should never be used to save labor on merely obstinate holes.

Some years ago upon encountering hard limestone strata it was customary to either blast out the holes or to drill into the rock and bolt the anchors fast. But with the present day five-man, high-speed, one-tower-a-day crews such an alternative would prove to be too slow and too dangerous as well.

So with the added choice of cribbing there can be little doubt as to the final selection of method in these unusual cases where tower anchoring becomes a problem in place of being just a part of the day's work. And it proves itself all the more the answer when its construction speed and ample strength keep the wheels moving smoothly.

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COAST AND GEODETIC SURVEY SPIRIT

An expression of the spirit of cooperation and loyalty of the Coast and Geodetic Survey was once again shown recently. This time the honors go to the office force of the section of triangulation of the Division of Geodesy.

Special triangulation was executed in the Tennessee Valley which it was desirous to have adjusted to the standard datum as quickly as possible. In the normal course of events this would have taken five weeks but it was requested that it be finished in two weeks.

A continuous 24-hour program of work in three 8-hour shifts was instituted to accomplish this, possibly for the first time in the history of the Survey, and all the men cheerfully volunteered to carry it through regardless of the inconvenience of working night shifts. Every opportunity was taken to distribute the work so that a large number of men could work at the same time and the full adjustment was completed before the two weeks were up.

Although the men who did this work are comparatively new to the Service they showed a fine spirit of cooperation and the type of esprit de corps which has always characterized the men of the Coast and Geodetic Survey.

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TIDINGS FROM THE PARTY OF LIEUT. GIBSON

"While in Ohio we really did get in some good progress. One day on the Erie R. R. between Marion and Lima we did 13.1 miles of second-order levels in six hours, flat. In two days work we did 25.0 miles of levels. We did one of the miles in 19-1/2 minutes. On passing one of the 'stone hiding' section gangs I overheard one of them exclaim: '-- yes they are in training! Why no working man, sure as --, would run that -- fast' . ."

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CLIPPINGS

William Bowie, Chief of the Division of Geodesy, presented an illustrated paper entitled, "Fundamental Geodetic Surveys in the United States Nearing Completion" at the meeting of the National Academy of Sciences in Cleveland, Ohio, on November 19, 1934. Science Service sent out the following abstract of this paper:

YOU'LL SOON KNOW JUST WHERE YOU ARE:

U. S. GEODETIC SURVEY NEARLY COMPLETED

By Science Service

"Cleveland, Nov. 19 (S.S.)- You will soon be able to know exactly where you are, at any place in the United States. The U. S. Coast and Geodetic Survey has nearly completed its great double survey of this country. This comprises both triangulation, which gives highly accurate information on north-south, east-west location, and leveling, which tells with like accuracy where you are in an up-and-down sense.

"Progress in these surveys was reported by Dr. William Bowie, Chief of the Division of Geodesy, U. S. Coast and Geodetic Survey, in a paper presented before the autumn meeting of the National Academy of Sciences here today.

"The lines laid down by the survey cover the country as with a huge net. The field workers, with their precision instruments, have already woven 172,000 miles of the levels net, leaving only 28,000 miles yet to be finished. Of the triangulation net 55,000 miles have been completed, with 61,000 miles yet to be done."

* * *

The following article appeared in the Boston Transcript of November 26, 1934:

SOON WE'LL KNOW THE ANSWER

"Where is the Washington Monument? The answer is that nobody knows. That is to say, nobody knows with scientific accuracy its exact position upon the face of the earth. But the Coast and Geodetic Survey will soon supply the answer to the question. It will no longer be the truth to say that the nation which erected this towering shaft to the memory of the Father of His Country does not know where it was put, and that all the honeymoon couples who set forth to visit it might be described as on their way to an unknown destination.

"The Geodetic Survey people took advantage of the scaffolding erected around the monument for the purpose of making repairs to its face. Men of the survey placed their instruments over the apex of the pyramidal top of the shaft. Triangulation with the towers of the Arlington Wireless Station and other nearby landmarks as starting points will tell, when the results have been tabulated and checked, the exact latitude and longitude of the monument. So in addition to having its face washed and lifted, it is to learn at last just where it is at.

"This incident in the work of the Coast and Geodetic Survey is an illustration of the versatility of that branch of the Federal Government. It discovers a valley of mystery under the sea on Georges Bank off Boston Harbor. It explores the tropic seas of the Philippines and sounds the deeps of two oceans. It turns far inland and uses mountain tops in carrying on its work of scientifically mapping the country. It pauses in large operations and ascends a monument to fix its location. It is all in the day's work for a body whose members are sailors and scientists too.

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PRESIDENT ROOSEVELT EXPRESSES INTEREST IN MAPS

The Washington Post of November 22, 1934, carried a report on an interview that President Roosevelt gave to representatives of the press at Warm Springs, Ga. This report contained the following very interesting paragraph:

"The President described himself as tremendously interested in the subject. He added that the government has been making maps according to all kinds of scales and that one of the purposes in view is to complete the standard key map of the United States."

This information should be of interest to many engineers of the country, because in surveying and mapping a larger percentage of the personnel engaged are engineers than in any other class of engineering work. It will be interesting to learn what appropriations may be made by Congress during its coming session for the mapping program of the country. It is possible, also, that funds may be allotted to this work by the Administrator of the Civil Works Administration.

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GEORGIAN BAY TRIANGULATION COMPLETED

(Abstract from The Canadian Surveyor for October, 1934.)

The triangulation net covering Georgian Bay, connecting previously finished nets near Collingwood at the southern end and Sudbury near the northern end, has been completed by the Geodetic Survey, Department of the Interior. Such a large number of triangulation stations, lighthouses, church spires, fire-lookout towers, and other points have had their positions established that, on the average, a position is available for every five miles of the shore of the bay.

With the completion of this connecting net some 1,200 miles of primary and dependent secondary triangulation in northeastern Ontario and western Quebec are being finally adjusted, and the data will shortly be published.

These nets will form a strong basis for future triangulation and traverse northward to James Bay and westward in northern Ontario. Parts of these nets have been commenced.

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EAST AFRICAN TRIANGULATION

A very interesting article entitled, "The East African Arc of Meridian", by Major M. Hotine, R. E., Ordnance Survey of Great Britain, appeared in the September 1934 number of the Geographical Journal.

Major Hotine quoted the following two paragraphs from the writings of Sir David Gill, the originator of the project for a backbone of ruling triangulation in the neighborhood of the 30th Meridian throughout Africa:

"Such a continuous chain of triangulation, if carried through the heart of Africa, would afford to every traveller, explorer, and surveyor points of departure which would give to his labours a precision and value that could be reached in no other way."

"To every Protectorate (and the proposed line traverses the boundaries of most of the Protectorates) the triangles of this great Arc of Meridian would afford a basis for the surveys which will ultimately be found necessary for administrative purposes . . ."

Toward the last of his article Major Hotine spoke of the difficulties of the establishment of boundary lines and those boundaries on farms where triangulation is not available. He said, "The lack of such a fundamental triangulation gave the 'land shark' his opportunity in America; it has led to countless boundary disputes all over the world; it has introduced so much confusion in certain European surveys as to necessitate complete re-survey, which is now proceeding; it has made it impossible to provide topographic mapping quickly and cheaply and of lasting value, and the lack of this essential information has in turn led to wasteful development of communications and natural resources in all of the 'new' countries."

He closed his article with another quotation from the writings of Sir David Gill which reads: "There is one, and only one, remedy for all this, and that is to connect all detached surveys with a general system of triangulation -- and it will save the Government and the inhabitants generally a vast amount of money to establish this triangulation as quickly as possible . . . With the universal experience of the civilized world at my back I do not hesitate to say that it is waste and extravagance to postpone the commencement of a principal triangulation of your country."

Major Hotine's article describes in some detail the character of the country over which his surveying party extended triangulation for a distance of about 360 miles.

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THE WILDE THEODOLITE

A few years ago the Coast and Geodetic Survey purchased a first-order Wilde theodolite which, according to reports that had been made on this instrument, was supposed to be superior to the old type of micrometer microscope theodolite. This instrument was used during one short season of first-order triangulation and did not prove very satisfactory. Many stations had to be reoccupied in order to bring the closing errors within the required limits. It was used also on some second-order triangulation along the Potomac River and seemed to give satisfactory results. The chief of party, now in charge of a first-order triangulation party reported very favorably on it. In consequence, this instrument was sent to him recently as it was thought that

since he had such success with it on the river work he could be equally successful with it on the first-order triangulation. However, after he had it for a few weeks he returned it to the office with the report that it was not satisfactory. It seemed to be very stiff and the accuracy of the observations with it were not up to the standards required.

Since the Geodetic Survey of Canada has used the Wilde and similar instruments on its work and has found a method of improving their construction, our instrument has been sent to that organization with the request that it be inspected and recommendations made as to desirable changes. When returned to this office it is expected that the instrument will be sent to some qualified manufacturer of surveying instruments to be modified along the lines recommended by the Canadian Geodetic Survey.

This Wilde and similar instruments, have many novel features and every effort will be made to put the one we have in serviceable condition. This type of instrument is considered by many, to be a very much more rapid one than the older micrometer microscope types. However, no report from any geodetic organization of the world has ever indicated that, with the Wilde or other instruments of its kind, observations can be made as rapidly as with the Parkhurst or other micrometer microscope theodolites. For a first-order station with five lines and steady lights the observations for the main scheme arcs of triangulation can be completed with the micrometer type instrument within one and one-quarter hours. There have been cases where the observations were made in less than one hour. The record, so far as known, was made by an observer on the party of John Bowie, Jr., observing in Virginia where the five ray station was completed in 38 minutes with an assistant observer reading one of the micrometers. No one of the measurements of a direction at that station had to be rejected because of large residuals. At another time Lieut. P. A. Smith while working in Georgia completed all observations at a five light station in 40 minutes. The triangle closures on the arc of which Bowie's station is a part, averaged less than one second. With such rapidity of observations and such accuracy as is being obtained, the officials of the Division of Geodesy of the Coast and Geodetic Survey feel that it would be unwise to replace the old with the new type of theodolite. The latter has many optical parts which can not be adjusted in the field. In fact, until the instrument is simplified it is very difficult to have it adjusted and repaired except at the factory where it was made. The old fashioned instrument can be readily adjusted in the field and most of the instrument makers know how to repair it.

It is hoped that the Wilde theodolite belonging to this Bureau when modified after the method employed by the Geodetic Survey of Canada, will give results of the required degree of accuracy in first-order triangulation. It is important that it may be moved in azimuth without drag. If this difficulty is overcome the instrument should be at least suitable for use at supplementary stations and it may prove to be adequate for main scheme stations of first-order accuracy.

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NOTES FROM THE U. S. BUREAU OF STANDARDS

Graduation of Precision Circles

(Reprinted from the Journal of The Franklin Institute, November 1934)

The Bureau's circular dividing engine and the type of graduating work done on it have been briefly described in Technical News Bulletin nos. 128 and 149 (December, 1927 and Spetember, 1929). This instrument has been used during the past nine months in producing graduated circles of a high order of accuracy, for the U. S. Coast and Geodetic Survey.

The triangulation program of the Coast and Geodetic Survey has necessitated the acquiring of a considerable number of graduated circles for new theodolites. Two types of Parkhurst theodolites, for which circles have been supplied, are employed in this program, the first order theodolite using a 9-inch circle, and the second order theodolite using a 6-1/2 inch circle. Bith sizes of circles have been made and graduated at the National Bureau of Standards. In addition to the new circles, a number of old ones have been regraduated.

Nearly all of the new circles are of cast sterling silver. A few circles are of duralumin and a few, for regraduation, are of bronze with an inserted sterling silver ring. These special circles require no particular discussion at this time.

The circles go through the following processes: (1) Casting of the sterling-silver disk; (2) heat-treatment to relieve the casting strains; (3) machining to approximate size; (4) heat-treatment to relieve machining strains and to further stabilize the material; (5) machining to a size suitable for plating; (6) electroplating with silver, using cyanide bath; (7) machining to finished size; (8) inscribing the coarse series of numbers and graduations; (9)

polishing to a plane on pitch-lap with chromium oxide; (10) inscribing the fine numbers; (11) polishing the burrs from the fine numbers; (12) graduating the circle; (13) polishing the burrs from the graduation-lines; and (14) filling the lines with special black ink.

With the exception of a few of the first circles, the entire task from the casting of the silver to the completion of the graduated circle was carried out at this Bureau.

In the heat treatment to relieve casting strains, the disks are placed in an electric muffle furnace, and the temperature slowly raised to between 550 and 600° C. with the disks in a reducing atmosphere of illuminating gas. This temperature is held for 2 hours and the disks are then allowed to cool in the furnace. The second heat treatment, fiven after the disks are machined nearly to size, is similar to the first one, except that the temperature is only 400° C. and the time 1-1/2 hours. In this second treatment each disk is mounted on a special mandrel so as to be supported as uniformly as possible. The distortion of circles by internal strains is believed to be one cause in the past for what have been regarded as incorrectly-graduated circles. These two heat treatments are for the purpose of obtaining as great dimensional stability as possible.

The silver-plating was found necessary because it was not possible to graduate the sterling-silver disks and obtain the kind of graduation-line required, for example, on rolled silver. The crystals of the sterling silver are large, and differ in physical characteristics even in a single circle so that the graduating tool will not cut uniform lines all around the circle. Many of the lines made on the sterling-silver crystals seem to be torn rather than cut.

The polishing of the circle is an essential part of the present procedure. This is not done to produce a reflecting surface but for the purpose of getting a true plane for two reasons, first because the accuracy required demands it and secondly because lines with smooth, sharp edges can be made only on such a surface.

In the actual graduation of the circles several changes and improvements have been made, perhaps the most important of which is that of using a specially constructed diamond-point, adjusted so that a very fine shaving is cut out of the material, leaving sharp edges to the line and a very small amount of burr which is quickly removed with a pitchlap and chromium oxide. No charcoal is used in the process at any time.

Although several changes in the ruling mechanism of the dividing-engine were found necessary, the principal elements of the machine, the main central bearing, the worm, the gear-teeth around the periphery of the central table, and the contour of the correcting-device, were found to be satisfactory.

After the circles have been completed they are checked on the Bureau's circle-testing machine. Because of the limited time a complete test of the circle cannot be made, but with the microscopes set 90° apart it is possible to determine with fair accuracy whether or not the graduations are uniformly spaced.

The Coast and Geodetic Survey then makes a more extended test of the circles when actually mounted in a theodolite. A series of collimators set up around a room with the theodolite in the center enables measurements to be made just as they would be in the field, sighting many miles away. The results obtained in these tests agree with those made by this Bureau within the range of experimental error.

There is considerable difficulty in stating precisely how accurate these circles are. When it is considered that there are 4320 lines on each of these circles and that on these 9-inch circles an angle of one second is about 0.00002 inch, one must have considerable numerical data to support any statement made. These circles certainly are accurate within the tolerance of two seconds of arc given in the specifications. It is believed that they may be within approximately ± 1 second.

The successful carrying out of this program of preparation, graduation, and calibration of precision-circles at the National Bureau of Standards has involved the fullest cooperation of several technical divisions of the Bureau, particularly the divisions of metallurgy, chemistry, optics, and weights and measures. L. V. Judson, chief of the length section, has had the immediate supervision of this program and B. L. Page has carried out the actual graduation of these circles.

A paper giving more detailed technical description of this work is in preparation.

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SUGGESTIONS FOR BETTER SIGNAL LAMPS

By R. V. Noyes

The following are a few suggestions regarding the construction of the signal lamps used in triangulation that might well be discussed through the Geodetic Letter.

First, the frame. The wooden frame of the lamp now in use soon becomes loose at the corners, possibly causing the light to be eccentric. The brass plates in the frame into which the connection bolts are screwed, soon come out because they are fastened by only two, one-fourth inch screws. After these are gone the holes in the wood soon become enlarged and again the light may become eccentric.

If it were possible to cast a frame from an aluminum alloy or some light and strong metal, the lights would be stronger and more durable.

The fittings, such as switches, etc., could be bolted to the metal frame with small stove bolts. The bolt heads could be countersunk in the outside of the frame.

The lights could be bolted together by one-fourth inch stove bolts with wing nuts. Many lightkeepers use these now because they are easier to use and can be cheaply purchased in any hardware store. The holes for these connection bolts should not be tapped for one-fourth inch bolts because they would be hard to remove; merely make a hole large enough for the bolt to slide through easily.

Second, the rims. Those now on the lamps are too hard to remove and replace when the lamps are on the tower. The rims rust on the lamps in wet weather and must be pried off. Often they are sprung so that they never again fit correctly

A rim could be made of heavy aluminum with a hinge on one side, and on the opposite side a bolt with a wing-nut, hinged to the outside edge of the lamp and protruding about one inch in front of the rim. A U-shaped notch in the rim should be provided for the bolt to slip into, so that the wing-nut will tighten against the outside of the rim.

The rim could come against a ring of sponge rubber, cemented between the reflector and the outside of the lamp. This would help in the protection of the reflector.

Third, the reflector. Many of the lights on short lines appear in the telescope as double-centered. This may be due to many things, among them poor reflectors. A dent will cause much trouble.

The reflector that I suggest may be too expensive and fragile, but possibly someone can suggest a better one. A reflector made of heavy glass, silvered on the back and then given a heavy coat of paint over the silver, would make a good one. This one would be easy to clean and if mounted in rubber and handled with a little care, the breakage would not be great.

With these suggestions and those from other men in the field, perhaps a light may be constructed that can be easily and safely used on the towers in cold, windy and rainy weather, because it is then that a lightkeeper has his troubles.

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UNIFORM METHOD OF MARKING RECONNAISSANCE STATION LOCATIONS

The following is an extract from a letter by Lieut. Charles Pierce making recommendations for a uniform method of marking proposed triangulation stations so that the triangulation parties will not be in doubt as to whether they have recovered the point described in the reconnaissance description. The recommendation appears to be a step in the right direction.

"I am suggesting a standard practice for reconnaissance parties in the matter of leaving some tangible evidence at the points selected for triangulation stations. This applies to mountain triangulation as encountered in the western part of the United States. Some of the reconnaissance parties leave cairns, some bottles, and some old cans, pieces of wood, etc. In this part of the United States cairns are set up on mountains by various survey parties of the Geological Survey or other organizations, by miners noting claim sites, by sheep herders for bearing markers and infrequently by campers and hikers as a souvenir of their climbs.

"My suggestion is that small stakes, about the size of highway grade stakes, be carried along by the reconnaissance parties (even on tough packs they would not weigh a pound apiece) and that these stakes, marked with pen or pencil, with the name of the station, be driven into soft ground, or on rocky hills, set inside of cairns. Then when the building party came along they would be doubly sure of the proper location. Especially would they be valuable in country where the summits of the hills are covered with fog, or clouds, for then the building party must go entirely by guess as they cannot see the adjacent peaks to make sure the lines are cleared. In some of this western country it is extremely difficult to describe the proper peak or saddle used by the reconnaissance party for the area may be one series of ridges and peaks and the wrong point is many times selected, especially in poor weather."

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NEWS NOTES

Professor Charles B. Breed of the Massachusetts Institute of Technology, who has written many books on surveying, including geodetic surveying, was a recent visitor at the Washington Office.

* * *

An article entitled "Locating Property Boundaries" by Professor S. S. Steinberg, State Representative for Maryland of the Coast and Geodetic Survey, appeared in the January issue of the Scientific Monthly.

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GASOLINE AND OIL CONTRACTS DURING THE THIRD QUARTER FOR THE FISCAL YEAR 1935

All field parties are advised that there has recently been received at this Office contracts for the purchase of gasoline and oil which were made between the Quartermaster, San Francisco, California, and various oil companies in which this Bureau is listed as a participant. These contracts cover the States of Arizona, California, Nevada, Utah and Washington, and are effective January 1st, 1935, to March 31st, 1935, inclusive. There are ten contracts numbered W928qm - 20675, M1814 to W928qm - 20684, M1823 inclusive.

In order to avoid possible disallowances all Chiefs of Parties are advised to purchase under these contracts whenever possible, copies of which can be secured from the Inspector, Field Station, 510 Customhouse, San Francisco, California.

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REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during October, 1934:

First-order	1,669
Second-order	413

Total miles of triangulation completed to October 31, 1934:

First-order	50,543
Second-order	3,321

Levels:

Lineal miles of levels completed in October 1934:

First-order - - - - - - - - - - - - - - - -	751
Second-order - - - - - - - - - - - - - - - -	11,872

Total miles of levels completed to October 31, 1934;

First-order - - - - - - - - - - - - - - - - - -	98,707
Second-order - - - - - - - - - - - - - - - - - -	70,610

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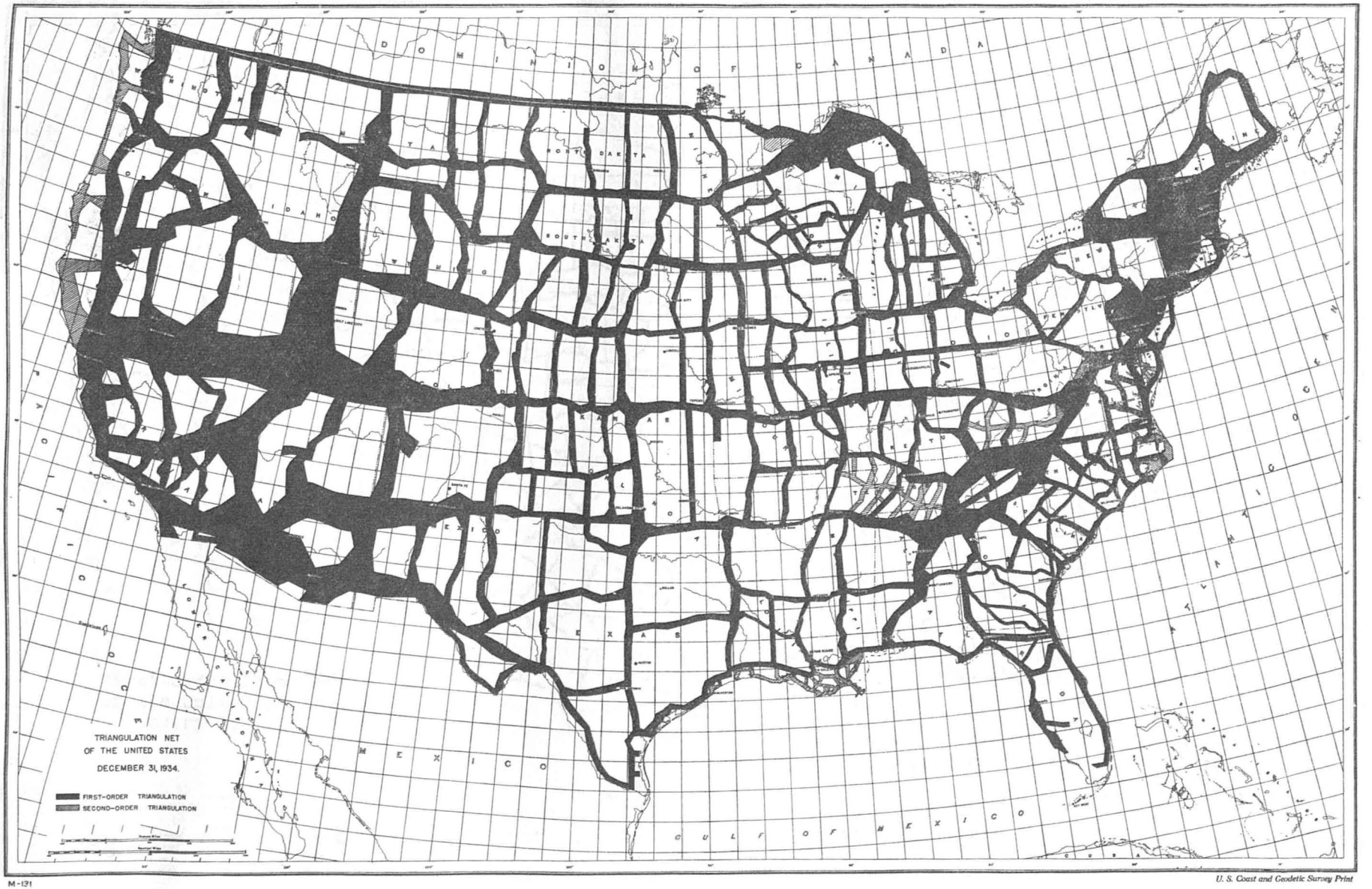
The following two charts show graphically the present condition of the triangulation and leveling throughout the United States:



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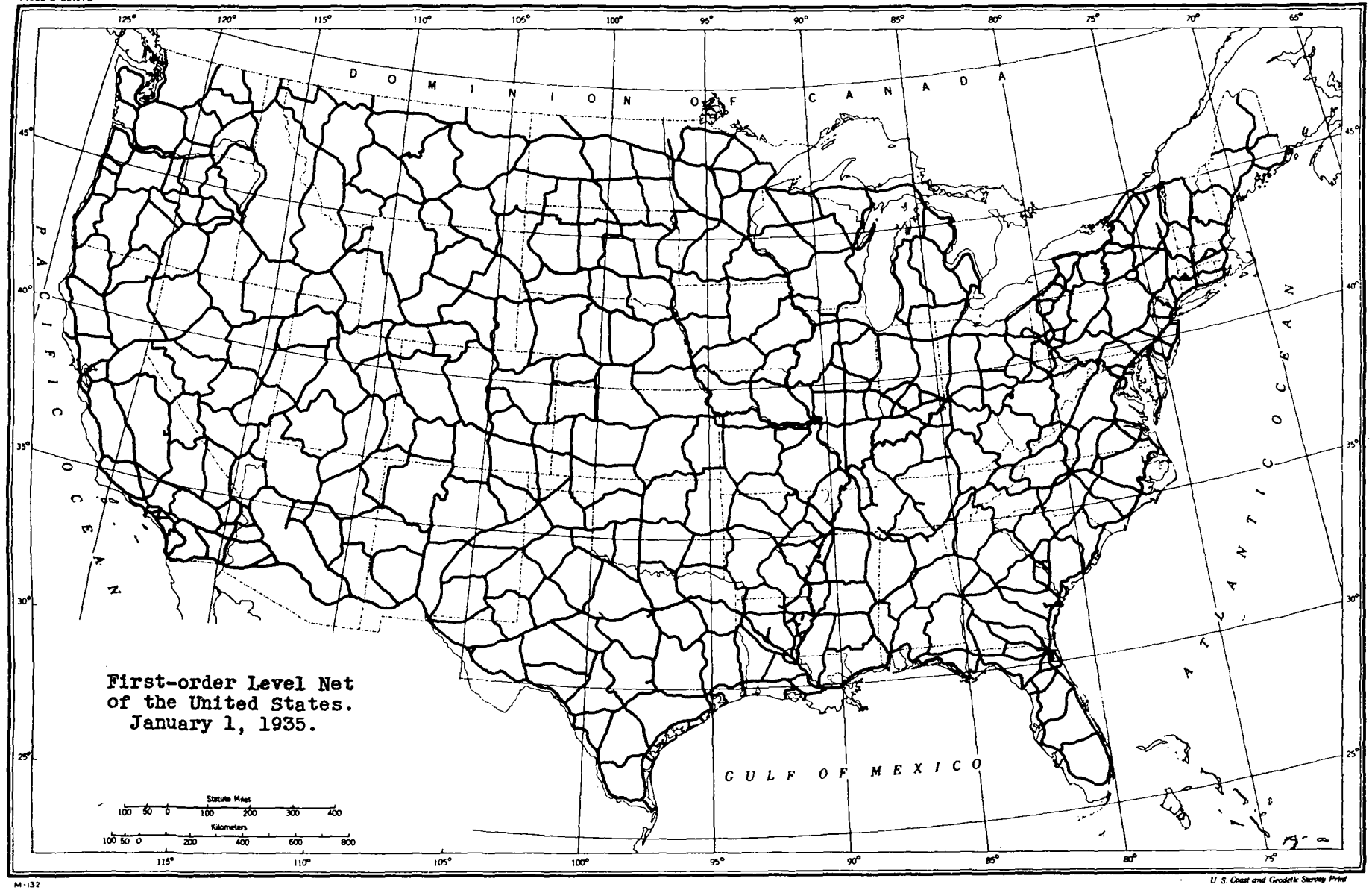

First-order Level Net of the United States. January 1, 1935.

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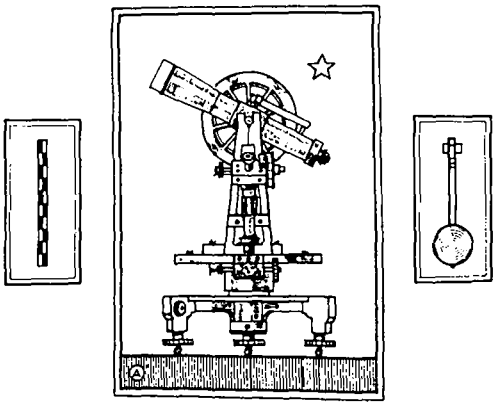
GEODETIC LETTER



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G E O D E T I C   L E T T E R

Volume 2 FEBRUARY, 1935 Number 2

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The importance of geodetic astronomy.
Astronomical longitudes.
Hitching posts for the fixed stars.
Station marks not described by standard notes.
Additional information to be entered on Form 45.
Interest in the State system of plane coordinates.
The Fourth Quadrennial Congress on Photogrammetry.
Locating property boundaries.
Report on inspection of Local Control Survey work - State of South Carolina.
Some remarks about rejections for horizontal angle observations.
Circle graduations.
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Adjustment of Mississippi River triangulation.
Guatemala - Honduras boundary survey.
Gravity survey.
Umbrellas.
Death of Professor George Leonard Hosmer.
Notice.
Report of Progress.

THE IMPORTANCE OF GEODETIC ASTRONOMY

By C. H. Swick
United States Coast and Geodetic Survey,
Washington, D. C., U. S. A.

(The following article is taken from the Proceedings of the Fifth Pacific Science Congress, 1934.)

In all geodetic surveys, the curvature of the earth must be taken into account. Areas no larger than a small county, or a medium sized city, may be accurately surveyed by the use of plane co-ordinates on the assumption that an equipotential surface, at about the elevation of the area in question, is a plane surface. Surveys over larger areas, such as states or counties, cannot be made without gross error unless the curvature of the earth is considered. The determination of the exact curvature of the earth is, therefore, an essential part of geodetic surveys.

Now the shape of the earth can be ascertained in two different ways, one depending on gravity determinations and the other on astronomical data, but the size of the earth can only be obtained with precision from astronomical data. If the latitudes and longitudes of two points on the earth are determined astronomically, and the distance is then measured between them, the curvature of the earth along the line connecting the two points can be computed.

This simple statement of the problem and its solution must be qualified, however, or it becomes very misleading. If the earth were a homogeneous sphere, or consisted of concentric spherical shells of homogeneous material, and its surface were entirely free of bumps and hollows, then its shape and size could be very easily determined in the simple manner just explained. The real earth, with its mountains, valleys, and ocean deeps, and its heterogeneous crust, presents a very much more difficult problem.

The astronomical observations at any station are necessarily related to the plumb line, or to the level surface at right angles to the plumb line, and here lies the trouble. The positive or negative attractions of topographic features, and of the isostatic compensation of these features, deflect the plumb line away from what may be called its normal position by amounts varying from a fraction of a second to more than half a minute. Therefore, before astronomical data can be used to compute the shape and size of the spheroid which most nearly fits the earth as a whole, either the amount and direction by which

the plumb line is deflected away from its normal position must be computed for each station, or such a large number of stations must be used that the errors from this source tend to cancel each other, or "balance out" as it is sometimes expressed.

In 1909, John F. Hayford, who was then chief of the Division of Geodesy of the Coast and Geodetic Survey, determined a spheroid from data in the United States. Hayford used a large number of stations and computed the effect at each station of the surrounding topography within several hundred miles of the station. What is even more important, he computed the effect of the isostatic compensation of the topography, using a new method devised by himself. This was the first attempt that had ever been made to apply the isostatic effect to computed deflections of the vertical, and it was so successful that the resulting spheroid was adopted about 25 years later as the international standard spheroid.

Hayford used about 750 astronomical determinations in his computations. At the present time there are more than 1,300 additional determinations in the United States that could be used in deriving new and somewhat better dimensions for the spheroid. The computations involved in deriving the best figure of the earth by the isostatic method are laborious and time-consuming, but it is hoped that they may be carried out in the not too distant future, with all the available data in North America taken into account.

After the most accurate possible dimensions for the figure of the earth have been derived, the next important reason for making astronomical observations in connection with geodetic surveys is in order that data may be obtained for controlling the azimuths of the lines of triangulation. Although the specifications for first-order triangulation require that the average closure of the triangles of an arc shall not exceed one second by more than a very small amount, it is found that an arc of triangulation has a tendency to swerve in azimuth and that, after 10 or 12 quadrilaterals have been observed, the azimuths derived from the angle observations may be in error by several seconds.

This swerving in azimuth must be corrected by the introduction of what are known as Laplace azimuths. A Laplace azimuth is an astronomical azimuth which has been corrected for the deflection of the vertical and may, therefore, be considered a true azimuth. It is obtained by making astronomical observations for both longitude and azimuth at a triangulation station and using the longitude difference as a basis for the azimuth correction.

The longitudes carried by triangulation are very close to the true values if the starting azimuths are properly controlled, and, therefore, the deflection of the plumb line in the plane of the parallel through a station may be obtained by comparing the astronomical and geodetic longitudes. This deflection along the parallel may be reduced to the corresponding deflection along the prime vertical, and the latter can then be used in deriving the error in the astronomical azimuth caused by the deflection of the plumb line. A true azimuth (Laplace azimuth) is thus obtained.

The Coast and Geodetic Survey, after more than 25 years' experience with Laplace azimuths, has found that they should be spaced along an arc about eight or ten quadrilaterals apart. When the arcs are adjusted to hold these azimuths fixed, the lines of the triangulation midway between the Laplace stations will not be appreciably in error in direction.

The value of Laplace azimuths for the control of triangulation has been clearly demonstrated in the adjustment of the triangulation net of the western half of the country, completed two or three years ago, and in the adjustment of the eastern half of the country recently completed. In the western adjustment 74 Laplace azimuths were used, and in the eastern half there were 102. The remarkably small closures of the many loops of triangulation involved in the two adjustments show that the lengths and azimuths of the whole net must have been very accurately controlled.

It is seen from the preceding discussion that geodetic astronomy includes three different kinds of astronomical determinations, namely, azimuth, latitude, and longitude. A brief explanation of how the observations are made and the degree of accuracy obtained in the three classes of work may be of interest.

The azimuth observations are usually made by the triangulation party. The same instrument is required for the azimuth determinations as for the angle observations of the triangulation, and the work must ordinarily be done while the observing towers or stands are still in place. Especially, when the steel towers are used, is it very necessary to make the azimuth observations while the triangulation work is in progress, that is, before the towers are moved ahead, because the occupied station and the station used as a mark are generally not intervisible from the ground.

To be acceptable for a Laplace station, the observations for azimuth should have a probable error not greater than 0.3 second. From 24 to 26 determinations of the azimuth are made at each station and the mean is taken. Accurate time is needed for azimuth determinations. Either the chronometer error is obtained from radio time signals or else vertical circle observations for time are made on stars near the prime vertical before and after the azimuth observations.

The latitude and longitude observations are made by a special astronomical party which follows the triangulation party, and may perhaps be several months, or even a year or two, later in occupying the stations. During the latter half of the 19th century many latitude and longitude determinations in the United States were made at points other than triangulation stations. With a more extensive triangulation net available in recent years it has become the practice to have all geodetic astronomical work in this country done at triangulation stations. The results thus become more valuable for figure-of-the-earth computations and are also available for the control of the triangulation net of the country.

The instrument used for longitude determinations is a portable astronomical transit of the broken telescope type. It has an objective with a clear aperture of seven centimetres and a focal length of 67 centimetres. It is provided with a micrometer eye-piece with which the transit of a star can be recorded on a chronograph with almost no effect of personal equation.

All modern longitudes in the United States are determined by the radio method. Since the Naval Observatory time signals are used in deriving the time differences, the longitude differences are all referred to the centre of the clock room at the Observatory. The excellent time service maintained by the Observatory makes it possible to determine very accurate longitudes by this method. The probable error of a radio astronomical longitude seldom exceeds 0.02 second of time (o.3 second of arc), and usually averages less than 0.01 second of time.

During recent years the broken telescope transit has been used for latitude as well as for longitude determinations. It may be readily and quickly changed from a longitude to a latitude instrument by the substitution of another micrometer eye-piece and by the addition of sensitive levels to control the position of the telescope in altitude in the meridian. The Talcott method is used and the observations are made in practically the same

manner as with the zenith telescope formerly employed. A probable error in the result not to exceed 0.1 second is specified for latitude work and is ordinarily obtained.

In the early part of this paper, there are discussed two important reasons why astronomical observations are needed in geodetic surveys. Another important reason must not be overlooked, viz., the adoption of a geodetic datum for a country, although it may now be of only academic interest in a country such as the United States in which the horizontal control surveys are well advanced.

Before the geodetic latitudes and longitudes of the stations of a triangulation survey can be computed, the curvature of the mathematical spheroid which most nearly fits the earth must be determined, as already stated, but in addition the latitude and longitude of some starting station must be known or assumed. When geodetic surveys were first started in the United States, they were made first at the most important harbours along the coast and were in detached pieces, each piece being based on an astronomical determination of latitude and longitude at one of the stations. These separate schemes of triangulation were gradually expanded until finally they touched some of the adjacent schemes and then immediately difficulties arose. The deflections of the vertical at the various astronomical stations caused station errors of different amounts, and each piece of triangulation was, therefore, on a separate unrelated datum.

To remedy this condition, it was finally decided to adopt a single datum for the whole United States. At that time the triangulation of the east and west coasts of the country had been joined by the great 39th-parallel arc and there were several other long arcs included in the control net of the country. Astronomical observations had been made at a large number of the stations along these arcs, and it was desired to adopt such a position for some initial station of the scheme as to make the sum of the residuals (differences between the astronomical and geodetic positions) at these astronomical stations a minimum and yet to avoid, if possible, a recomputation of all the triangulation then in existence in this country. After a very careful study of the available data, a position was adopted in March, 1901, for a selected station in Kansas called Meades Ranch, and the resulting datum, identical with that previously in use in New England, was called the United States Standard datum. The reduction of 765 astronomical stations in 1909 showed that this datum approached very closely the ideal one for which the algebraic sum of the station errors of each class would be zero. The datum

has since been adopted by Canada and Mexico and is now called the North American datum.

When a datum is adopted for a country, the spheroid to be used as a basis for the computations must also be specified. In 1901, when the datum was adopted for the United States, Clarke's spheroid of 1866, as expressed in metres, was considered the best one then available, and it was therefore adopted. Although the new international standard spheroid, previously discussed, is somewhat more accurate than Clarke's, the difference between the two is too small to justify making a change.

North America now has the largest control survey in the world, all co-ordinated on a single datum. The same co-ordination is possible in the other continents of the world, although undoubtedly more difficult to bring about. If the control surveys of the several continents were each on a unified basis, it might be desirable for scientific purposes to put the triangulation of practically the whole world on a single datum by making a connection between the eastern and western hemispheres at Bering Strait. Such a connection is well within the realm of possibility.

Mention should be made of one more use for the results of geodetic astronomy. As explained in the early part of this paper, the deflection of the vertical at any point on the earth can be ascertained with reasonable accuracy by comparing astronomical and geodetic data. If the astronomical data are corrected for the attraction of topographic masses and for the effect of the isostatic compensation of these masses, a close agreement may be expected between the corrected astronomical vertical and the geodetic vertical. The agreement actually is fairly close but not perfect, and it has been found in many places in the United States that the lack of agreement is undoubtedly due to concealed geological structure which could not be taken into account in the isostatic reduction of the astronomical data. The residuals that are found after the isostatic corrections have been applied are, therefore, an indication of buried structure and as such have value in geological studies and possibly in the search for valuable mineral deposits.

In the preceding discussion the four most important uses of geodetic astronomy have been emphasized. These four uses are as follows: to serve as a basis for the determination of the shape and size of the earth, to control the azimuths of long arcs of triangulation, to make it possible to select the best starting point or datum for the control surveys of a country or a continent, and to

serve as an aid in geological studies. Triangulation is often spoken of as bearing a relationship to other surveys similar to the relationship of the steel frame work of a modern office building to its superstructure. May not geodetic astronomy be likened to the foundation of such a building? Without it the control surveys of a country could not have that wonderful precision and rigidity which make them of such great value as a basis for all other surveys and as an aid in some branches of science.

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ASTRONOMICAL LONGITUDES

The possibility of high accuracy in field astronomical determinations with the Bamberg broken-telescope transit is illustrated by the longitude results at a recent station in Iowa. Three determinations were made on two successive nights. The seconds of the final results for the three determinations are as follows: 21.137, 21.135, 21.131. The first and last determinations were made by one observer and the second one by another. Thirty-one stars were observed in all. The largest residual on a single star is 0.048 second. On one set of five stars the largest residual was 0.007 second.

Several factors have contributed to the excellency of these results which are fairly typical of many recent stations. First of all, much credit should be given to the Naval Observatory for their unexcelled time service which includes besides the transmission of the time signals, very careful time determinations to give scientific precision to these signals, and extraordinary care in time comparisons. The star places now published by that Observatory are undoubtedly greatly superior to what they were a few years ago.

Another factor is the instrumental equipment now available for field use, especially the Bamberg transit and the uniquely designed radio amplifier and recorder. The final factor is good observing in the field combined with careful handling of the instrumental equipment and close attention to innumerable details in setting up and adjusting the instruments. It is only when all of the factors mentioned above are uniformly good that results like those above can be obtained.

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HITCHING POSTS FOR THE FIXED STARS

The Survey now receives a new bi-monthly astronomical magazine called "The Telescope", published by the Bond Astronomical Club of Harvard. The December, 1934, number of this magazine contains a note under the above heading in which occurs the following paragraphs:

"Although from the beginning of civilization the stars to the unaided eye have appeared to occupy exactly the same positions, when careful measurements are made of their positions in the sky, slow and steady changes are noted. No star, no object, not even our own sun, is stationary; every celestial body is in -- what would be called terrestrially -- rapid motion, from a few miles per second for the slowest to tens of thousands of miles per second for the most rapid of which we have knowledge. Only the enormous distances of these bodies cause their motions to have but little effect upon their positions as seen by the earth-bound observer. Yet very careful measurements of their celestial coordinates at intervals of five to a hundred years do reveal slight changes and give the information on stellar motions that is so essential to the proper interpretation of the structure of the galaxy.

"To define these changes requires the use of stationary or nearly stationary points of reference. External galaxies, huge stellar aggregations hundreds of thousands of light years distant, provide such a set of points, for despite any exceedingly rapid motion through the cosmos they may possess, their distances are so great that they remain apparently fixed in position. Despite the fact that the nebulae present on the photographic plate images of considerable size, which creates difficulty in measuring the location of stars relative to their hazy centres, they furnish, nevertheless, one basis for the estimation of stellar motions."

It is quite remarkable that the great astronomical observatories of the world have been able to analyze the motions of the stars so precisely that an observer with a modern star catalog such as the American Ephemeris and Nautical Almanac published by the U. S. Naval Observatory, and with a portable field instrument can determine his so-called astronomical position on the surface of the earth with an error usually less than 25 feet. This is shown by the average probable errors obtained by the astronomical party of the U. S. Coast and Geodetic Survey during the latter half of the calendar year 1934. The average probable error of the longitude determinations at 25 stations is $\pm .01$ second of time, corresponding to about

12 feet on the earth. The latitudes have not all been computed as yet but the probable error will be about the same or slightly less than that for the longitudes. The azimuths at the same stations have a mean probable error of ± 0.28 seconds.

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STATION MARKS NOT DESCRIBED BY STANDARD NOTES

By Gale Murphy

In preparing descriptions of stations for publication, it has been necessary to pass over and slight a number of essential points of information. One of the reasons for this is the incomplete description of station marks which are not described by standard notes.

The exact geographic position of a point on the earth's surface is of value to an engineer only if he can positively identify it when he wishes to use it for his local surveys. The field parties of the Survey establish a great many stations, the descriptions of which are usually adequate enough to provide for their recovery; but a large number of stations and monuments of various other surveying organizations are recovered and tied in, the descriptions of which, in a great many instances, are decidedly inadequate.

The descriptions of stations marked by standard disks of the Survey is greatly simplified by the use of standard notes as given on page 108 of Special Publication No. 120, "Manual of First-Order Triangulation"; but these notes should not be used to attempt to describe special types of marks of other organizations. If a bronze or aluminum tablet of the U. S. Geological Survey is recovered, it should be described as such, together with the character of its setting; and a complete record of all letters and figures stamped on the tablet should be put on the description card. These stampings should be copied exactly as they appear on the tablet and should be put in quotation marks. In some states, the U. S. Geological Survey's work is done in cooperation with the state, and a special tablet which states this fact is used. Whenever this is the case, it should be so recorded on the description card.

A common cause of confusion in identifying positions of recovered stations is the fact that a reference mark was recovered instead of the true station. Unfortunately the

station and reference marks of some of the early stations were almost identical, but usually there was some slight difference in marking so that by careful inspection each mark might be properly identified. It should be remembered, however, that the local engineer does not have ready access to the detailed information by which he can recognize these differences, and it is, therefore, of the utmost importance when one of these stations is recovered that the recovery note states exactly what was recovered and its present condition. If we are to believe the records some station marks established prior to the use of bronze tablets have shown remarkable changes. Not only have they changed in shape and dimension, but also in composition. Granite monuments have frequently become marble, and limestone changes to cement with astonishing regularity. Stones which according to original notes were marked with cross lines when recovered have been marked with triangles, circles, or quite frequently not marked at all.

These discrepancies naturally raise the question as to which data should be published, the original description or the recovery note. Usually the practice in the Office has been to accept the recovery note as being correct. Cases have arisen, however, which showed, when later data were available, that this policy was sometimes the result of misplaced confidence.

The distances of stations from center lines of roads, fence corners, trees, buildings, and other nearby references will aid in their recovery, but it should be remembered that next year some or all of these points may be obliterated. In such a case, the recovery of a station would become largely a matter of luck and intelligent guesswork, but would be materially aided by the knowledge of exactly what kind of mark was being searched for. The exact dimensions, shape, material, and markings of old marks of the Survey and of county, state, and other public or private monuments should be given in sufficient detail to enable engineers to identify these points 25 years or more hence. In the case of irregular-shaped monuments, the exact spot used as the station should be stated.

A determined effort is being made by the Survey to encourage the local public and private engineer to use the triangulation stations of the Survey for his horizontal control. The movement is making progress, as evidenced by letters which are being received every day requesting information, but lack of confidence caused by discrepancies between data published as compiled from incomplete descriptions and actual conditions in the field may seriously

retard its further growth. Therefore, we in the Office who assemble these descriptions feel that we should have all the facts.

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ADDITIONAL INFORMATION TO BE ENTERED ON FORM 45

In order to expedite the computation of the orthometric correction, to facilitate the handling of information requests, and to make it unnecessary to have both descriptions and field computation in use by one person at the same time, in handling the above features of the work, it has become necessary to add certain information on Form 45, which has, in the past, not been required on that form.

A circular letter was sent to the Chiefs of all leveling parties, under date of December 18, 1934, which read in part, as follows:

In preparing field computations (Form 45) enter in "Remarks Column" the distance and direction from the nearest town opposite each permanent bench mark thus:

"Niobrara, 2.8 miles east of"
or "Niobrara, at"

The cooperation of all field officers in seeing that this additional information is entered on the forms will very greatly aid the members of the office force who are charged with handling computations, etc., after they are received from the field.

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INTEREST IN THE STATE SYSTEM OF PLANE COORDINATES

The following abstract of a letter to the Chief, Division of Geodesy, U. S. Coast and Geodetic Survey, is typical of the interest shown in the State System of Plane Coordinates by engineers throughout the country.

My dear Mr. Bowie:

I wish to thank your Division for the cooperation and information furnished me recently, and also to express my appreciation of your very courteous and interesting letter of Nov. 30th.

I have always been an enthusiastic advocate of relating all surveys to national datums, both horizontal and vertical, and it has been the policy of this bureau to do so whenever the control was available. Thanks to the recent activity of the U. S. Coast and Geodetic Survey, Richmond and vicinity now have an abundance of excellent control and it is already proving of inestimable value.

I was particularly interested and pleased to note in one of your recent publications (Plane Coordinate Systems, Serial No. 562) that you are advocating the establishment of plane coordinate systems on a comprehensive scale. It seems to me that this should be the ideal we should strive toward in providing an adequate, yet simplified, control to be of the greatest practical value to all engineers, whether engaged in private or public enterprises.

You may be interested in the fact that this Bureau has recently, in co-operation with the National Park Service and Civilian Conservation Corps, established first-order traverse control for a battlefield park area around Fort Harrison, about eight miles southeast of Richmond, and at present is establishing similar control for a national park in Chesterfield County, about fourteen miles southwest of Richmond. In each case the traverse was connected to triangulation stations whose geographic positions were transformed to plane coordinates referred to the City of Richmond's origin and meridian. Thus, we are already establishing the nucleus of a system for this vicinity.

* * *

Yours very truly,
(Signed) Geo. J. Parrish
Division Engineer of Surveys.

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THE FOURTH QUADRENNIAL CONGRESS ON PHOTOGRAMMETRY

PARIS Nov. 24., Dec. 2, 1934

By O. S. Reading

The formal opening of this congress at the Sorbonne was a bit of a surprise to one accustomed to the little attention mapping and photogrammetry receives in the United States. The ceremonies were conducted by the Air Minister and attended by the President of France. A military band played the Marseillaise as the officials came in and there was the usual blinking of photo flash lamps and arranging of broadcast microphones which accompany events which the press thinks of some importance.

There were 372 delegates from 32 countries registered at the Congress. The scientific papers were presented during sessions of six committees: Terrestrial photogrammetry; Aerial photography; Mapping from aerial photographs; Architectural, medical, crime detection and other applications; Instruction in photogrammetry; and Bibliography and vocabulary.

There was an excellent exhibit of cameras, photo-mapping machines and maps held in connection with the Congress. One could go from booth to booth and compare the leading machines. In general each country seems to be developing cameras and machines of its own, perhaps on account of possible military exigencies. But the international congresses seem to be forcing all of them to adopt and adapt the leading advantages of the others. Nearly all countries are now making multi-lens cameras and adapting the photo-mapping machines to their use. The photo-mapping machines are rather expensive, costing in this country, with our 45% duty, from forty to sixty thousand dollars. The output of each machine seems to be limited to eight to twelve sheets per year and the machines will probably become obsolete in five to ten years.

The nations of Europe seem to be much more map minded than the United States. All of the leading nations are making large scale maps of their countries and are convinced that they are improving their efficiency and saving money thereby, as well as preparing for national defense. Three times as many government maps are sold to the public per capita in England as in the United States.

One of the most interesting lessons from the European work was that suitable stereoscopes with wandering marks or grids would add considerably to the accuracy with which common points in pastures, forest, marshes, and similarly featureless areas could be identified on the photographs for the use of the radial line method as practiced in the United States.

It was the general opinion at the 1934 Congress that great progress had been made in instruments, methods and maps since the 1930 Congress. There was universal testimony that, not withstanding all its handicaps, photogrammetry has proven more economical and much more satisfactory than the older methods for all large mapping projects.

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LOCATING PROPERTY BOUNDARIES

By Professor S. S. Steinberg
University of Maryland

It is generally admitted that the widespread ownership of land is one of the important factors making for the stability and well-being of the nation. It is likewise generally known that boundary disputes between nations have frequently led to wars, and such disputes between private owners of property have led to ill-feeling, confusion, litigation and loss of money. Therefore, anything which contributes to the security of land tenure, reduces its costs and makes for cordial relations between neighbors, whether they be nations, states or individuals, merits careful and sympathetic consideration. Land being one of the most important things that the human race owns, it is essential that the custodian of a piece of property, whether public or private, should know where the boundary lines are.

Land surveying, the art of measuring land and of delineating its boundaries on a map, is generally supposed to have had its rise among the ancient Egyptians, due to the river Nile's destroying and confounding all their landmarks by its annual inundations. This put the Egyptians to the necessity of inventing methods and measures to enable them to distinguish and adjust the limits of their respective grounds when the waters were withdrawn. The Egyptians, in addition to being the first to measure the earth, likewise were the first to determine the relations between the heavenly bodies. Their knowledge of these matters was engraven on columns and by that means delivered to posterity. It is interesting to note that the modern engineer or surveyor makes astronomic observations for use in all important mapping as did his predecessor in early Egypt.

The present system of locating property boundaries is based on the belief that a point on the earth's surface can be perpetuated by placing on it some physical object for a marker. Many centuries ago the Egyptians learned the fallacy of that theory, but we still adhere to it. In a recent city improvement, a boundary monument of massive concrete was lifted out of the ground by a steam shovel even before the engineer could reach a tape to it to locate its former position. If a monument like this is impermanent, what hope is there of an enduring future for the stake, the pile of rocks or the blaze on a tree, which commonly mark farm boundaries?

It might be of interest to cite from an old deed the description of the starting point of a tract of land which read, "Beginning at a point on Powder Mill Run where Bill Jones killed the Indian." Needless to say, that corner could not be found. Also, there are many cases where excellent surveys have been of only temporary value because the surveyors making them left no permanent monuments.

There is nothing that causes more trouble to an owner of a piece of property than to have doubt raised as to the exact location of his land. He may wish to sell the land and give clear title to it, or he may wish to raise money on it. In either case he must be certain that the exact locations of his boundaries are known. His boundaries will be known if he has placed substantial monuments at their turns, setting the monuments in such a way that they are not likely to be disturbed by man or nature. A small amount of concrete, properly placed, will make an excellent mark, and to establish such a landmark will cost an insignificant amount compared with the cost of doing the survey work over again.

Landmarks have been the subject of legal action for thousands of years. Back in the time of Moses, in 1500 B.C., the laws protected survey monuments. One of these laws read: "Cursed be he that removeth his neighbors' landmarks, and all the people shall say Amen." Job, in speaking of the wrong-doing of his people, listed the removal of landmarks as one of the reprehensible acts they committed. Solomon, in his Proverbs, said, "Remove not the ancient landmarks which thy fathers have set."

In the United States, during Colonial times, with land plentiful and population very scarce, only the crudest kinds of surveys were made on the outlines of a grant from the King or the Colonial governor. After the Revolution, with the western area of the country opening up for settlement, a method of laying out the public lands in squares approximately one mile on a side was adopted. The land there was plentiful and it was not feasible to use exact surveying methods in establishing these township range and section lines. To have done this work in an exact way would have made the cost excessive as compared with the value of the land.

The early surveys were notoriously inaccurate. Practically all the surveying was done with the compass and the chain. Measurements of angles and of distance were made by methods that were crude and unreliable, and frequently no account was taken of the magnetic attraction

of the earth on the compass needle. Finally, it was the common practise not to close the circuit of the property boundaries. There are many deeds on record in which a description encircles the greater part of a tract and, having run to a spot somewhere in the vicinity of the starting point, closes with the charitable phrase, "and thence to the place of beginning."

Because of these inaccuracies, it has come to be the well-established court practise that the actual positions of the boundary marks on the ground, if they can be established with reasonable certainty, will control rather than the metes and bounds as given by the surveyor.

Conditions, however, have changed with the years, and land that was originally worth a few cents or a few dollars an acre may now be worth a hundred or even a thousand dollars an acre. In some of the large cities, lots are worth thousands of dollars a square foot. This increase in the value of land necessarily calls for an increase in the accuracy with which the boundaries of the land are surveyed. The engineer's transit and the steel tape have replaced the compass and the chain.

In addition to the thousands upon thousands of conflicting private property boundaries, there are scores of state boundaries in the United States which have been subject to controversies in the past or may at some future time require redetermination. It is a general legal principle that when a boundary is once accepted by the custodians of abutting properties, it is the boundary for all time to come. But the question arises: "How can a boundary be so located that it might be easily recovered in the future?"

An answer to this question is furnished by the Geodetic Control Surveys that were conducted in Maryland during the past winter under the auspices of the United States Coast and Geodetic Survey and in cooperation with the College of Engineering of the University of Maryland. Similar projects were undertaken in the other states. They were financed by the Civil Works Administration as a means of employment for engineers and for the performance of a work of great economic value to the people of the states. Some 420 Maryland engineers, surveyors and assistants, operating in all sections of the state, were engaged in establishing control lines and elevations which provide a basis for accurately tying in land surveys in the future. In addition these points serve as fundamental control for all engineering projects that might be undertaken in any community.

In conducting the control surveys the general practise is to follow the improved highways, since the aim is to establish points in places readily accessible. The monuments used are three-foot concrete posts which are set flush with the ground at the edge of the road right-of-way. The monuments set west of Frederick were four feet in length, due to lower frost line. The top of the monument has a bronze cap on which will eventually be stamped the number of the marker and its elevation above mean sea level. Monuments are set in pairs one quarter of a mile from each other, with each pair about two miles apart. They are established in every town on the circuit and at important crossroads, so that engineers will have these reliable points for referencing any survey or engineering project in that vicinity.

In establishing these monuments extreme accuracy of measurement is required. Distances are determined with a steel tape which has previously been compared with a master tape standardized by the National Bureau of Standards. The tape is stretched carefully between special chaining tripods, and in stretching it a spring balance is used at one end to make certain that the required tension is given. At the time of each tape measurement a thermometer reading is taken so that correction may later be made for increase or decrease in length of the tape due to temperature. All distances and elevations are determined to the nearest thousandth of a foot.

These control surveys have a real value to every owner of land, whether of a farm or a city lot, because a land survey which has been tied into such geodetic control is indestructible. Should every point of such a survey be lost or destroyed, the property boundaries can be retraced and the old points relocated. This is possible because the geodetic control is part of the triangulation network which has been established throughout the country by the United States Coast and Geodetic Survey in the past hundred years of its operation. Any survey so referenced becomes tied into the geography of the United States, and as there is only one point on the earth's surface that has a given latitude and longitude, that point can be recovered at any time in the future.

To facilitate surveying of counties and other local areas, computations have begun, as part of the Civil Works Administration project, on a system of referencing points in Maryland which will eventually permit coordination of land or engineering surveys in the state. At present at least three separate and unrelated groups of surveys are in use in Maryland; namely, those in Baltimore, in Annapolis and in suburban Washington. When the single coordinated

system for Maryland is fully computed it will be a comparatively simple matter to have these three different units referred to the state-wide system and thereby facilitate surveying operations between those three cities and, also, its extension to the remainder of the state.

It would be advantageous for each state to have a land court, in which all disputes over property boundaries could have a hearing. Since laws relating to the ownership of property are very complicated, it is reasonable to expect that such a court, concentrating on boundary matters, could render decisions more expeditiously than one not so expert. Massachusetts has had a land court for some years. There the law requires that private property boundaries be connected with the control system of the state. The township lines were definitely located and tied into the Coast and Geodetic Survey network and monuments were set upon these lines, thereby making them available in that state to any engineer or surveyor who undertakes a boundary survey.

One of the newest developments in land surveying is the use of the airplane for taking aerial photographs. With geodetic control monuments on the ground serving as a "yard-stick," maps can be constructed with little difficulty from the assembled photographs. This method, which speeds the work and reduces the cost, has been found very useful in locating boundaries of large tracts of land, in city planning and in mapping inaccessible areas. The land areas in Baltimore and in the vicinity of Annapolis have been surveyed from the air, and the resulting maps have been found extremely valuable in defining property boundaries and for many engineering purposes. By means of aerial photography in certain states, parcels of land have been discovered that were not previously listed on the books of the tax assessors.

All Europe, Mexico and many countries of South America have accepted geodetic control, and in those countries it serves as a foundation for all surveying, whether public or private.

As a result of the impetus given to this work last winter under the Civil Works Administration, it is hoped that sufficient funds will be forthcoming for the extension of this project in all the states to a point where geodetic control would become generally available for use by engineers and surveyors in their work, and particularly in so locating boundaries as to avoid over-lapping of adjacent properties. Boundaries that are connected with geodetic control are really tied to the stars; and, as the motions

of the heavenly bodies are immutable, so, by the use of this system, will property boundaries become definitely established for all time.

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REPORT ON INSPECTION OF LOCAL CONTROL SURVEY WORK

STATE OF SOUTH CAROLINA

By Albert J. Hoskinson, Lieut.,
Coast and Geodetic Survey

In accordance with instructions dated November 14, 1934, several days were spent in South Carolina during the month of December inspecting field work in the state and methods of computing the traverses of the Local Control Survey work. This work was started as a C.W.A. project and later taken over as a state relief project. Mr. T. C. Hamby, Consulting Engineer, has been in charge of the work from the start of the project. At present there are about 180 men employed on the work. About 4500 miles of second order traverse have been completed in the state to date and the position and elevation of about 6000 permanent monuments determined. The work has been well distributed over the entire state so that there is a rather complete network of traverse lines spaced from 10 to 30 miles apart. The unit cost of the present work is running about $40.00 per mile. The earlier work was somewhat more expensive so that the average cost per mile of the entire project will be nearer $50.00.

Reconnaissance and Monuments.

A rather careful reconnaissance of each line is made by a supervisory engineer before the monuments are set so that good locations are selected for the stations. All monuments are cast in place, the side walls of the earth hole being used as the form for the concrete mass except for about 12 inches at the top where a metal form is used to give a smooth, well shaped monument. A rich concrete mix with plenty of good crushed stone or gravel is used so that adequate strength is obtained in the structure. Bronze tablets of Coast and Geodetic Survey design are used as the center mark in all monuments. Trucks with large bodies are used by the monument party and most of the mixing of the concrete is done while the truck is in motion between the station locations, thus saving considerable time at each station. Adjacent monuments are intervisible, so that local engineers desiring to use them have a position and an azimuth for starting any local survey.

Chaining.

The chaining parties are well organized and are making very good progress, chaining from 3 to 5 miles per day in both directions. Most of the chaining is done on tripods, it having been found by experience that better checks were possible in this way than when the taping was done directly on a road surface or on the rails of a railroad. A very rigid light tripod has been constructed of wood and is giving excellent results. The legs are fastened rigidly to the head of the tripod and also to each other thus making a very rigid structure but one that is not adjustable. However, most of the taping is done on rather uniform grades so that no serious difficulty is encountered from the fact that the head of the tripod is not exactly level. The difference of elevation of the tripod heads for inclination corrections is determined by the use of a hand level, the levelman standing near the center of the tape in most cases so that short sights are possible and the forward and backward sights are balanced. The elevations of the monuments are determined by Wye Levels run in both directions and tied into first or second order lines wherever possible.

Horizontal Angles.

The angular measurements, to determine the directions of the traverse lines, are slightly behind the rest of the field work due to a shortage of instruments at the start of the work. However, very good progress is now being made by these parties and this phase of the work should soon be up to the rest of the survey work. Most of the work is being done with one-minute instruments, three sets of 6 D. and R. being taken at each station. Two 10-second instruments, which were borrowed from the University, have been available some of the time when not being used for instruction purposes at the University. The longer and controlling traverses where better accuracy was desired have been run with these instruments as far as possible. Good angular closures are being obtained on all of the traverses that have been computed to date. All angle parties are using a diamond shaped target of metal for the object to sight upon at the stations. These are very carefully centered over the mark by a light tripod or by a well braced center pole. A light portable tripod has been designed by the field parties to support the target and provides a rigid support as well as a very quick means of centering the target directly over the mark. The tripod and target can be set up in about half of the time required to center and brace a center pole with target attached.

Computations, Descriptions, and Closures.

Most of the work to date has been computed by the geodetic method but all future work will be computed using the Lambert system of plane coordinates as laid out for the State. All permanent monuments have been referenced to nearby objects as well as possible so that the location will be established and recovery easily made for future work. Adequate descriptions have been written for each mark on forms provided for that purpose. A satisfactory closure, within the limits for second-order accuracy, has been obtained for all of the traverses computed to date. Some of the earlier field work had to be rechained to locate blunders that occurred before the parties were well organized.

The work in South Carolina has been very well laid out and executed, and at the present time lines of traverse have been run over nearly all of the hard surface highways of the State. These lines are spaced from 10 to 30 miles apart. To complete the second-order work with a spacing of 5 to 7 miles about 5000 to 7000 additional miles of traverse will be required. The spacing of 5 to 7 miles furnishes all of the second-order control required in any area for topographic or general mapping purposes for either plane table or air-photo methods, and also furnishes the permanent control for subdivision work such as: County and municipal boundaries, parks and recreation centers, flood control and sanitary districts, townships, school districts and other subdivisions for political or taxation purposes. When the second-order control areas are further divided by third-order work spaced about 2 miles apart, there will then be adequate control for all local surveys and for farm and local real estate boundaries.

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SOME REMARKS ABOUT REJECTIONS FOR HORIZONTAL ANGLE OBSERVATIONS

By J. A. Duerksen

A few years ago the Division of Geodesy adopted an arbitrary rejection limit of 4 seconds from the mean, for first-order horizontal angle measurements with a first-order theodolite. This limit of rejection seems to be a very reasonable limit, especially in the light of the recent circle tests made by Lieut. H. C. Warwick and other experienced observers. The method for analyzing these tests, recently developed by C. A. Whitten of this Office, showed that after eliminating the graduation errors of the circle,

the probable error of a single observation by a good experienced observer was of the order of 0".4, making two pointings direct and two reverse for each of the sixteen positions. This would indicate that the probable error of a single observation, making only one direct and one reverse pointing for each setting, would be of the order of ± 0".5 or ± 0".6. It was found, further, that the probable error of a single observation for standard practice and using a circle having graduation errors less than one second was about ± 0".8 or ± 0".9. This shows conclusively, according to the theory of least squares, that a value more than 4 seconds from the mean is a blunder and could not be classed as an accidental error, and, therefore, should be rejected.

But to use a four-second rejection limit for a circle having a maximum graduation error of two seconds is somewhat questionable. This point was brought up at the meeting of the American Geophysical Union last spring.

In computing the graduation errors of a circle, a mean position of the circle is taken in such a way that the sum of the graduation errors in the positive direction is equal to the sum of the graduation errors in the negative direction from the true value. So if the circle has a maximum graduation error of two seconds, (and this is the limit specified for a first-order circle), there is a certain part of the circle where the graduations are 2 seconds in error in either the positive or negative direction, and another part where the graduations tend to approach 2 seconds in error in the opposite direction. If the initial and the mark happen to fall on these two graduations, the measured horizontal angle will approach 3 seconds in error. Similarly, by using another part of the circle where the effect is in the opposite direction, the measured angle will tend to approach 3 seconds in error in the opposite direction. If there were no observational errors with such a circle, the circle errors would vary roughly between -3 and +3 seconds from the mean. Now it is impossible for any observer to make perfect observations. There are pointing errors on the initial and on the mark, atmospheric disturbances, errors in reading of the micrometer, etc. As stated before, the probable error of a single observation by a good experienced observer, using a circle having no graduation error larger than one second, is about ± 0".8 or ± 0".9. If the observer makes one second error on each of the two observations, which are about 3 seconds out already because of circle error, then there are three possibilities:

First, the v's (errors of observations from the mean) of each may be increased by one second, they will both be rejected, and the mean of the remaining 14 observations will still be about correct.

Second, both v's may be reduced by one second, no rejection will be made and the mean will still remain correct.

Third, one v may be increased and the other decreased by one second, then one will be rejected and the other will be retained, and the true measured angle is changed by 0".25. The above example is a very conservative one, because a probable error of 0".8 implies several errors of about 2 seconds and an average error of about 1 second.

Consequently, it seems to be erroneous and contrary to the theory of averages to use a 4-second rejection limit for any circle which has a maximum graduation error of 2 seconds, because it will mean that good acceptable observations will be rejected and some poor observations may be retained.

Theoretically, a good experienced observer should have on the average not more than about 1 rejection, and probably less, for every set of sixteen positions observed. If there are frequently 3, 4 or more rejections for a set of 16 positions, it would seem that there is a very strong indication that either the observer is not using sufficient care or that the circle is poorly graduated.

If the 4-second rejection limit is to be retained, it would seem to be no more than fair to the observer that the specifications for graduation of circles should be made more rigid, and the maximum allowable graduation error should be reduced to about 1-1/4" instead of 2". Otherwise, the observer will frequently introduce an error into his angle observations by rejecting a good position, which should have been retained to compensate for graduation error in another part of the circle.

Discussion by Captain William Bowie, Chief, Division of Geodesy.

I have read with a great deal of interest the article entitled, "Some Remarks about Rejections for Horizontal Angle Observations."

It is quite evident that there should be a rejection limit for each theodolite or each group of theodolites. Where the circle graduations are of the highest degree of perfection and the graduation error is less than one second, a rejection limit of 4 seconds is reasonable. On the other hand if the errors of the circle are as great as 2 seconds or more then a higher rejection limit should be prescribed.

There are two kinds of errors in the graduation of a circle, - one the accidental error of the spacing of the contiguous marks and the other, the systematic error. A large section of the circle will have errors of one sign while perhaps the opposite side of the circle will have errors of the opposite sign. In addition, the graduations may be made on an elipse instead of a circle. In each of the latter two cases the reading of the microscope spaced 180 degrees apart will tend to eliminate the effects of the errors in graduation. It is possible that the field records for the different theodolites could be analyzed and the degree of excellence of the circle determined. Should this be done the rejection limit that would be reasonable could be determined for each instrument.

We may, however, arrive at a reasonable solution by merely having the observers keep track of the number of rejections for each direction for a large number of stations. If only occasionally a position has to be rejected on the 4-second limit then we may assume that the limit is a reasonable one. If, on the other hand, there are several rejections for each one of the directions then the error limit for rejections should be raised or the circle should be re-graduated.

The Bureau of Standards is now re-graduating circles for us and is doing its work well. I should like every circle that is not high grade to be re-graduated.

Where a circle is poor it is rather dangerous to leave a station with only 10 or 12 positions observed. There is always certain to be a characteristic error for each 4 positions of the 16. Unless we observe all of the 16 positions around a circle there would be an error introduced into the observations that were actually made. The instructions now permit the observer to leave the station and consider it completed if he has as many as 10 positions. This procedure would be one of doubtful expediency if the instrument used had a poor circle.

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CIRCLE GRADUATIONS

In Geodetic Letter No. 1, Vol. 2, there appeared an article entitled "Notes from the U. S. Bureau of Standards".

The Bureau of Standards has finished and delivered to us 40 circles. These circles with only one exception, which was later corrected, have been well within the acceptable limits of accuracy. Tests and comprehensive analysis show that the graduations of these circles are far superior to those of other circles, graduated by foreign commercial instrument makers, which the Coast Survey has been using in recent years. Furthermore the graduating of the circles seems to be improving all the time. Those more recently received are superior to the first. In fact the 6-1/2 inch second-order circles recently received are graduated to an accuracy well within the limits of the first-order circles. This naturally leads us to believe that eventually our instruments will be smaller, lighter, and more compact.

The credit for these increasingly more accurate graduated circles is largely due to the unceasing, tireless efforts, research and study of Dr. L. V. Judson and Mr. B. L. Page of the Bureau of Standards. The whole hearted co-operation shown by these gentlemen is greatly appreciated.

Three circles from some of our older second-order instruments with inferior graduations have been sent to the bureau for regraduation. It is hoped that when these circles are returned and installed in their instruments that it will be possible to produce first-order results with them. This will enable the Office to replace some of the large twelve-inch instruments now in use in the field with these smaller instruments. Whereas both Dr. Judson and Mr. Page were reluctant to say whether or not the regraduation of these old circles would be successful, due to a combination of circumstances, they were willing to attempt the work, and it is quite certain that their best efforts will be put forward to produce circles up to their present standard of accuracy.

It is the purpose of this Bureau to continually strive to improve our instrumental equipment and it is with this in mind that many replacements of circles have been made in our theodolites. Comment from the field is invited in regard to the accuracy of these new circles under field conditions.

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BANKER FACILITATED GEODETIC SURVEYS

During recent years one of the triangulation parties operating in the southern states and in the middle west encountered considerable difficulty in cashing U. S. Treasurer's checks without the payment of exchange as was required by the local Banking Association. In an effort to clarify this trouble the chief of party called on one of the bankers in the area in which his party was operating and after some discussion of the question at hand, found that this banker was very much interested in the surveying work that was being carried on. He was invited to accompany one of the observing parties to a station, and at the appointed time he appeared with a large basket full of fine melons. After the observations were completed the entire observing party enjoyed these melons, and also had a very interesting discussion with the banker on control surveys in his locality.

It was quite a surprise to the chief of party to find out that this banker was so interested in the technical details and the results of the work. He proved to be a great friend, and when the party left the town this banker furnished the chief of party with letters of introduction to a number of prominent bankers along the proposed route which practically eliminated the check-cashing troubles experienced in the past.

In using these letters of introduction the chief of party was further surprised to find that almost all of the bankers he met were similarly interested in the surveying operations.

This incident is mentioned as a possible source of help to other chiefs of parties in similar difficulties.

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LOCATING THE WASHINGTON MONUMENT

On November 19, 1934, work was begun to permanently and accurately locate the Washington Monument, latitudinally and longitudinally speaking. A triangulation party in charge of Lieut. John Bowie, Jr., taking advantage of the scaffolding erected around the Monument for the purpose of repairing and cleaning it, ascended to the 500-foot level in the scaffolding-elevator and then climbed by ladder the additional 55 feet to the wind swept top of the monument. Here they set up their theodolite and proceeded

to observe and record the various angles to other triangulation stations by means of which the position of the monument might be computed. Directions were also taken to various prominent structures such as the Capitol, church spires, etc., in order that they, too, might be located.

These records were then submitted to the triangulation section of the Division of Geodesy where the final computations were made. As a result the position of the Monument is now determined to be exactly 38° 53' 21".681 in latitude and 77° 02' 07".955 in longitude and no longer need be referred to merely as being near 15th Street and Constitution Avenue, N.W.

The historic structure now takes its place in the national network of triangulation stations which covers the United States.

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ADJUSTMENT OF MISSISSIPPI RIVER TRIANGULATION

The Army Engineers have detailed several computers to the Coast and Geodetic Survey for the purpose of making a readjustment of the triangulation along the Mississippi River. This work is being done under the supervision of experienced mathematicians of the Coast and Geodetic Survey. A few years ago a first-order scheme of triangulation was run by Lieut. H. W. Hemple from New Orleans, La., to St. Paul, Minn. This arc and the more recent arc from New Orleans to the Delta by Lieut. C. I. Aslakson, have been used as control for the readjustment of the older second and third-order triangulation and traverse by the Coast and Geodetic Survey, the Mississippi River Commission and the United States Lake Survey.

The work from the headwaters of the Mississippi River to Cairo, Ill., was readjusted first. Three thousand nine hundred second-order triangulation stations and third-order traverse stations were computed in this area. One traverse line of about 150 miles in length was adjusted with a maximum correction of 0.3 second to an angle. The control was exceptionally good. Most of the connections to the first-order work were by triangulation ties.

From Cairo, Ill., to Memphis, Tenn., there were two second-order and one third-order triangulation arcs. This set contained 1,750 positions. The control stations were

connected by traverse to the first-order triangulation. The traverse connections did not have the close agreement that was found on the upper part of the river. A number of these traverse ties had to be rejected.

The third part of the adjustment was from Memphis, Tenn., to Vicksburg, Miss. The same conditions existed here that were found in the second part. Three thousand five hundred positions were required to cover this area.

The fourth section yet to be adjusted runs from Vicksburg to New Orleans. The third-order scheme stops at Donaldsonville. About 3,500 stations cover this area.

The fifth section from New Orleans to the Delta has the 1934 arc for control. The old triangulation is all Coast and Geodetic Survey work from 1858 to 1922. This part is complex, having different arcs over the same area in places. About 1,000 stations will have to be adjusted.

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GUATEMALA - HONDURAS BOUNDARY SURVEY

Lieut. J. P. Lushene has been detailed to duty in cooperation with the Guatemala-Honduras Boundary Commission for the purpose of extending first-order triangulation and making astronomical observations along the boundary between these two countries, which is being settled through a commission appointed for that particular purpose. The Chief Engineer of the Commission is Mr. Sidney H. Birdseye, who has made the reconnaissance for all of the triangulation, extended some second-order work and measured two bases along the boundary. He will also have the triangulation stations prepared for occupation by the party of Lieut. Lushene.

Lieut. Lushene will be assisted by Mr. Philip L. Welker, at present a computer in the Division of Geodesy. Instruments for the work are being loaned by the Coast and Geodetic Survey and it is expected that Lieut. Lushene and Mr. Welker, by operating two observing parties, will be able to complete the total arc along the Guatemala-Honduras Boundary, consisting of some 40 stations, in about two months' time. The triangulation is controlled by two bases located reasonably near the ends of the triangulation. There will be at least one astronomical station at which latitude, longitude and azimuth observations will be made.

The party plans to complete field work during the winter months of January, February and March, which is the dry season and the only time of the year suitable for observations in the mountains of that region.

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GRAVITY SURVEY

During the past several years the U. S. Coast and Geodetic Survey has cooperated with Government officials, scientific organizations and private agencies in extending gravity observations in the southeastern section of the United States and on outlying islands nearby as a means of obtaining a more complete gravity survey of that region. Gravity observations are becoming increasingly more valuable and are used not only for isostatic investigations but also for the location of inequalities in the crust of the earth, and in the study of surface structure and geology, particularly with respect to the search for oil. This winter the party of Mr. H. E. McConnell has been assigned to about three months work on the island of Cuba in cooperation with the Atlantic Refining Company of Cuba and with the Committee on Ocean Basins and Their Margins of the National Research Council, of which Dr. Richard M. Field is Chairman. During the three months in Cuba it is expected that Mr. McConnell will determine gravity at some 80 stations. This is the second Cuban gravity expedition and when completed will provide approximately 150 gravity stations well distributed over the island.

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UMBRELLAS

Mr. S. Y. Symns, Surveyor, offers the following comments in discussing the article on instrument covers and umbrellas in Geodetic Letter No. 10.

"Much has been said about the umbrellas in use at this time. From my experience it seems to me that Lieut. G. R. Fish has very accurately covered the subject in Geodetic Letter No. 10.

"The cost of an umbrella or two is quite often a small item compared to the cost of time that is lost by the observing party during the day when they have to stop and repair the umbrella. I have an umbrella frame which was sent out from the Office in January 1933 and was used

in the field for more than a year without causing any loss of time. The frame is in excellent condition now but the covers on the present umbrellas are too small to fit it. I think umbrellas of this type are a better investment than the $2.11 variety.

"The life of the present umbrellas can be increased from two to three times by lowering the catch on the pole from 1-1/2 to 2-1/2 inches. This will decrease the strain on the clevis on the outer end of the spreaders, which seems to be the weakest point in the structure."

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DEATH OF PROFESSOR GEORGE LEONARD HOSMER

Readers of the Geodetic Letter will regret to learn that Professor George L. Hosmer a member of the civil engineering department of the Massachusetts Institute of Technology for 37 years until his retirement last October, died at his home in Woburn, Massachusetts, January 10, 1935.

Professor Hosmer had a wide variety of scientific interests but he was best known to members of the Survey through his work in surveying and geodesy.

As a member of the American Society of Civil Engineers he took an active part in the formation of the Division of Surveying and Mapping being, at the time of his death, a member of the Executive Committee of the Division.

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NOTICE

The attention of all personnel is called to Paragraph 16a of "Regulations and Instructions of the Coast and Geodetic Survey":

"All official mail from any officer or employee in the field or any field station addressed to the Director shall be forwarded through the chief of party, or officer in charge of field station, as the case may be, or from any officer or employee in the office through the chief of division, and all communications thus forwarded shall be so noted upon their face with indorsement of approval or disapproval or other recommendation, with signature and date."

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REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during November, 1934:

First-order - - - - - - - - - - - - - - - -	1,281
Second-order - - - - - - - - - - - - - - - -	-----

Total miles of triangulation completed to November 30, 1934:

First-order - - - - - - - - - - - - - - - -	51,824
Second-order - - - - - - - - - - - - - - - -	3,321

Levels:

Lineal miles of levels completed in November 1934:

First-order - - - - - - - - - - - - - - - -	593
Second-order - - - - - - - - - - - - - - - -	11,860

Total miles of levels completed to November 30, 1934:

First-order - - - - - - - - - - - - - - - -	99,300
Second-order - - - - - - - - - - - - - - - -	82,470

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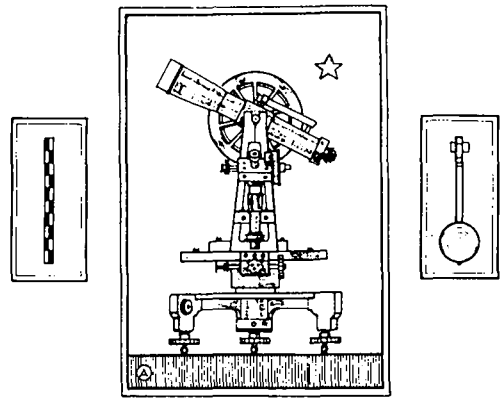
GEODETIC LETTER



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DIVISION OF GEODESY

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IOWA GUARD-POSTS FOR THE LOCAL CONTROL-SURVEY MONUMENTS

By J. S. Dodds
State Representative

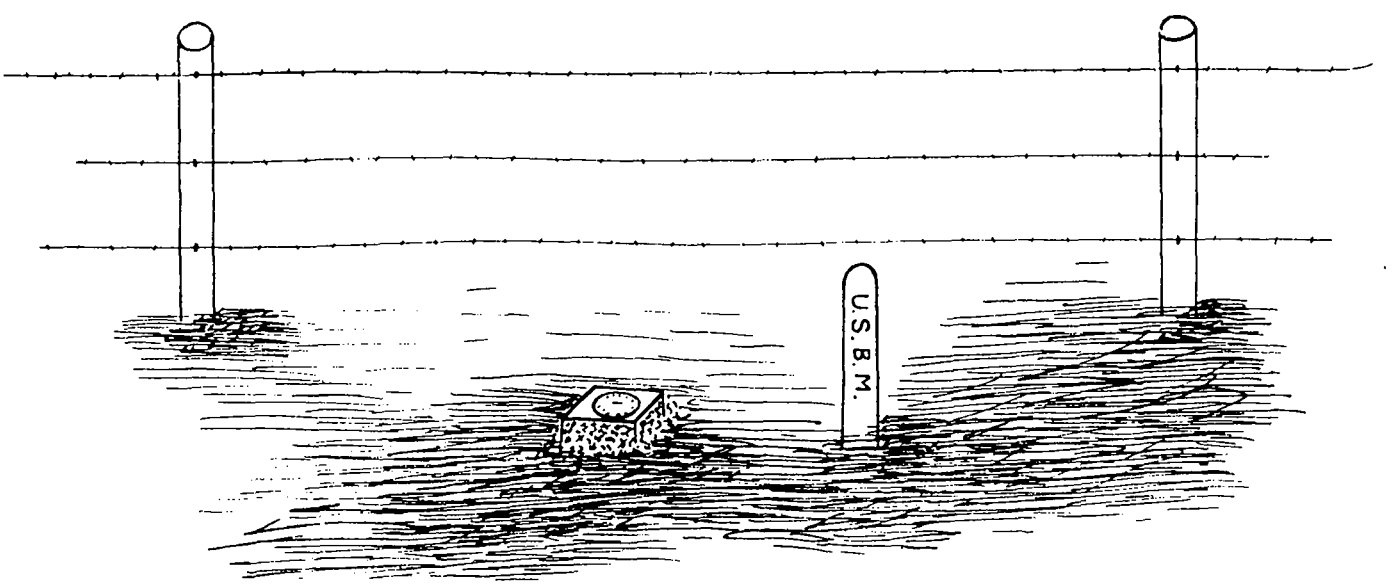
One of the features of the Iowa system of local control surveys is the method of guarding monuments.

White guard-posts about 6 inches in diameter and projecting about 2 feet above ground are set nearby, so the monument can be found readily regardless of vegetation or snow.

The post is branded "U. S. B. M." with a gasoline-torch branding-iron on the face toward the highway and on the face toward the monument. The post keeps the road maintainance machinery from damaging the monument by acting as a guard.

The posts, furnished gratis upon orders of Mr. W. H. Root, Chief of Maintainance, Iowa State Highway Commission, have been painted white and set as relief projects in the various counties by county road forces and district highway maintainance forces.

The local engineers are waiting eagerly for final positions and elevations. The presence of the posts excites many questions from persons who may be prospects for surveys which can be tied in to these monuments.



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PROTECTION OF BENCH MARKS AND TRIANGULATION POINTS IN NEW JERSEY

By Philip Kissam
State Representative

There are located in New Jersey several thousand U. S. Coast and Geodetic Survey points for horizontal and vertical control. The value of this large number of accurately located marks is enhanced in certain areas by the short distances between these points. Unfortunately, experience has indicated that every year a certain number of them are destroyed, either by natural causes or vandalism, but nore frequently by construction work.

Incidents of this nature have been reported to the Office by members of the New Jersey Local Control Survey. Along the old transcontinental level line, which follows the New Jersey Central Railroad right-of-way from Bound Brook to Phillipsburg, some 6 bench marks were destroyed when bridge abutments were altered. Concrete was poured over the marks, rendering them inaccessible. Triangulation station "Weasel", presumably safe on a hill top, was blasted out in quarrying operations. It seems unnecessary that this sort of thing should occur, particularly when engineers who know the value of these markers are in charge of the work.

Any person who becomes aware that a point is in danger of being destroyed has only to notify the Coast and Geodetic Survey direct, or through the Local Control Survey, in order to do a considerable public service.

During the past year information from various sources came to the New Jersey Local Control Survey that 40 points were in danger of destruction. Upon investigation it was found advisable to relocate 24 of them. The New Jersey State Highway Department has been particularly helpful in lending their cooperation. Triangulation station "Club", a second-order station set for the control of the survey of Shark River, in Monmouth County, is in a position where regrading is necessary for the construction of the approach to the new Shark River Bridge on Route 35. On the plans prepared for this work by the Highway Department this point, together with 5 other Coast Survey monuments, are indicated with the following notations:

"Ties to U. S. Coast and Geodetic Survey triangulation station 'Club'. Not to be disturbed until ordered by the engineer. Special care to be taken to protect them."

"U. S. Coast and Geodetic Survey monuments to be protected."

The plan was forwarded to the Local Control Survey Office, with the request that suggestions be offered as to the procedure to be followed for maintaining these points.

Bench mark "Q-15, 1933", in Warren County, was located on a highway bridge which was about to be torn down. When the condition was reported by the field chief in the area, the Highway Department cooperated in the transfer of the bench mark.

County authorities have also aided in salvaging points by lending county trucks and supplying material for new marks. Reference mark No. 1 at triangulation station "Acton 2", in Salem County, is located directly in the center of a proposed county highway, at an elevation of 9/10 of a foot above the proposed finished grade. Upon learning of this monument, the County Engineer, Mr. W. W. Summerill, furnished plans showing the new highway, and aided in the selection of a location clear of the work.

The Erie Railroad only a short time ago reported that "RV-83" and RV-84", at Ramsey, Bergen County, were located on signal boxes that were to be removed. Both bench marks will be transferred.

"G-3", a bench mark set at the old City Hall in Camden, was in danger of being lost when the building was torn down. The contractor reported it, carefully protected the bench mark, and the Survey transferred it to another location. Very probably the old bench mark will be again serviceable, due to the careful protection it received.

A section of the Reading Railroad between Hammonton and Pleasantville, and a section of the Pennsylvania Railroad between Pleasantville and Cape May, were to be abandoned and torn up. Along these railroads runs a precise line of U. S. Coast and Geodetic levels, with 29 bench marks in danger of destruction. The superintendents of the railroads involved cooperated in every way to avoid the loss of these bench marks. Investigation disclosed that 13 were safe as located, and 14 were reset. Three of the original bench marks were already destroyed. Only 2 were lost, but both by accident previous to the abandonment of the line.

Such cooperation is extremely gratifying. It is believed that if the great public value of the points

becomes widespread knowledge, and that if it is realized throughout the State that a telephone call is all that is necessary to prevent their loss, little or no damage will be done these points by construction operations.

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A PROVING OR TESTING GROUND FOR GEODETIC INSTRUMENTS AND THEORIES

By C. A. Whitten

If a person is a careful reader of advertisements, he will find that many articles manufactured at the present time are thoroughly proved and tested before being offered for sale to the public. Manufacturers of automobiles have thousands of acres of land and a skilled personnel devoted to such a program.

Would such a plan be practical for the Survey? The Washington Office has taken the first step by setting aside one room of the Instrument Division for the testing of theodolites. Any test made in that room is made under ideal conditions. Many flaws in workmanship can be and are detected in this way. The next logical step in this testing program would be to subject the instrument to a test under conditions similar to those found in the field. An actual field test by a field party is not practical because the expense of the entire party is chargeable to the test. The Survey has some property at Gaithersburg, Md., (the writer does not know how much.) At this place, or a similar place located conveniently to Washington, a proving or testing ground could be established for the testing of geodetic instruments and the development of new theories. There are many problems which are not completely solved, as, for examples, tower design and construction, personal equation of the observer, refraction, or night error. There are sufficient problems to keep a skilled personnel constantly at work.

This is merely a suggestion of a plan which the writer considers highly feasible. Perhaps men of more experience with the Survey have better plans. The Geodetic Letter seems to me to be a fine place to voice them.

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EMPLOYMENT ON THE LOCAL CONTROL SURVEY PROJECT

The Local Control Survey Project had its inception during the late Fall of 1933 under the direction of the Coast and Geodetic Survey as a part of the Civil Works Administration program. One of the primary objects of these surveys was the employment of idle engineers and other professional men.

At the time the jurisdiction of this project was removed from the Coast and Geodetic Survey, 10,800 employees were on the payroll. No definite statistics were available regarding the status of the employees up to that time, but fragmentary information received from a number of states shows between 70% and 80% of the personnel were graduate and professional engineers or men of college training.

When the project was taken over by the State Civil Works Administration the forces were considerably reduced in most states. After March 31, 1934, the project was continued in about 22 states as a part of the State Emergency Relief Administration program. Conditions of employment vary in these states. In some the employees are subject to budgetary requirements and are permitted to work only a sufficient number of hours to provide for the bare living expenses of themselves and families. In other states, more satisfactory conditions prevail and the technical personnel are permitted to work from 30 to 35 hours per week with a salary commensurate with the duties performed. There is given below an analysis of the qualifications of the personnel employed on this project as of January 1, 1935. There were 2907 men employed in 23 states as of that date. Twenty eight percent were graduates of engineering colleges or professional engineers of several years standing and 27% had some engineering college education. Included in this classification are those engineering students at present being financed by the State Emergency Relief Administration and required to perform work under the engineering authorities of the colleges they are attending. Thirteen percent have attended other than engineering colleges. Included in this classification are graduates having arts degrees and men who have been compelled to drop their college training (other than in engineering) due to lack of funds. Thirty two percent have had no special training along professional lines. Included in this classification are those employed as laborers.

This analysis shows that 68% of those at present employed are men who had some college training. These statistics show that the project even under the restrictions imposed by the present set-up of the Emergency Relief Administration is benefiting men of professional standing.

The statistical table follows:

	Graduate and Professional Engineers	Some Engineering Education	Attended Other Than Engineering College	Not Engineers, Surveyors, or College Men	Totals
Alabama	48	99	60	22	229
Arkansas	0	5	7	19	31
Colorado	16	28	24	12	80
Connecticut	19	19	4	20	62
Florida	39	35	19	63	156
Georgia	102	60	20	36	227
Idaho	42	16	6	13	77
Iowa	11	9	0	4	24
Louisiana	28	22	12	98	160
Maine	20	5	3	10	38
Maryland	5	0	0	2	7
Massachusetts	77	101	17	50	245
Michigan	29	15	4	31	79
New Hampshire	23	4	4	4	35
New Jersey	205	163	32	59	459
North Carolina	33	18	11	91	153
Oklahoma	43	54	56	103	256
Oregon	6	14	2	29	51
South Carolina	47	24	52	129	252
Tennessee	25	50	25	75	175
Texas	5	7	5	55	72
Virginia	6	6	7	14	33
Wisconsin	0	6	0	0	6
TOTALS	829	769	370	939	2907
Percent	28%	27%	13%	32%	

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IT PAYS TO BE COURTEOUS AND HELPFUL

The following letter, dated January 18, 1935, was sent to the Director by Mr. J. T. Meek, Director of the Mercantile Division of the Illinois Chamber of Commerce:

"This letter is a direct effort to commend two members of the Geodetic Survey for their courtesy of the night of January 11.

"On that evening Mr. Joseph Spiess, a prominent Elgin merchant and myself, were returning from Springfield, Illinois, and experienced some tire trouble which we were unable to correct ourselves. We hailed a passing truck which stopped immediately. The two gentlemen who were riding in the truck got out and solved our problem. Instead of going on and leaving us to finish the job of changing tires, these two men insisted upon making the complete change for us and in ship-shape manner. They would accept no recompense of any kind and made their refusal in such a courteous way that we felt bound to report their very commendable actions to you.

"The two men were Gerald B. Siler and Gene Livingston of the Geodetic Survey, bound for Columbia, Missouri, but of the Memphis, Missouri, branch.

"If it is within your province to do so, I hope you will see fit to personally commend these gentlemen for their actions. Your records may also provide us with the names of the immediate commanding officers of these men and with the names of their parents. We should like to transmit our thanks to these parties as well."

While the action of Messrs. Siler and Livingston has been called to the attention of the Washington Office of the Coast Survey yet we believe that our entire personnel engaged on geodetic surveying is imbued with this same spirit of courtesy and helpfulness as were these two members of the Division of Geodesy. It is certain that courtesy shown on the road by the members of our geodetic parties will be appreciated by all travelers and will tend to increase the respect for our personnel and our work on the part of the citizens of our states.

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LOCATIONS FOR BENCH MARKS

The chief of a leveling party is always confronted with the problem where to set bench marks that they may have long life. Along railroads and improved highways the problem is not particularly difficult. It is reasonably certain that the improved highways and railroads will not be widened, although occasionally they are straightened. If the bench marks are set on the outside of a curve on either a highway or railroad, later improvement should not destroy it.

When it comes to the unimproved roads the matter is quite different. There we shall see in the next decade or two a lot of changes. The roads will be widened, surfaced and straightened. This leads to the thought that the setting of bench marks along such roads should be carefully studied. A few suggestions are given here with a view to having this subject considered by the readers of the Geodetic Letter. It is hoped that anyone who may have definite ideas will send them to the Editor.

In general, bench marks should be established near some topographic feature that will have some permanency. A cross road is such a feature and even the junction of a public road and a farm road is quite permanent. The crossing of a road and a stream is also something that will remain indefinitely. If a bench mark is to be set near the intersection of two roads, it should not be close to the intersection. In the improving of highways, curves of large radius are used in turning from one road to another. If a bench mark is set in the corner of the field at an intersection it is liable to be destroyed when the improvment occurs. It is probable that farm roads will never be greatly widened or straightened and therefore it would seem to be reasonable that a mark set on the side of a farm road from 20 to 40 yards away from the public road would not be destroyed by road improvement. Bench marks should not be set along the lateral roads on the inside of a curve for straightening the road would be almost certain to interfere with the mark.

Property lines are excellent locations for bench marks. If there is a well defined division line between two farms, a bench mark set in that line would probably have permanency.

A bench mark can be established on the lawn of a farmhouse close to the road. In general, the owner of the

property is glad to have such a monument established on his land, provided of course, that it is put in a place where it will not be a danger to anyone walking around. School yards are especially good places for locating bench marks. They will be seen by the scholars and teachers and their locations will be well known to the community.

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ACCURATE CENTERING OF INSTRUMENTS AT TRIANGULATION STATIONS

Where triangle sights are 10 or more miles in length, an error in centering the lamps and theodolites of as much as one centimeter would have no appreciable effect on the closing error of the triangles. We must remember however that at each triangulation station we are determining the azimuth between the station and the monument that is set at a distance of 400 or 500 meters. The azimuth of the lines between these 2 monuments will be used in making local surveys and for running traverses to supplement the fundamental triangulation net. For a distance of 400 meters an error in centering the theodolite of 5 millimeters might cause an error in the line to the azimuth mark of 2.6 seconds. This is about the limit in error that can be tolerated. In view of the above, it can be readily seen that the theodolite should be centered at each station with extreme accuracy. It is believed that with care the error in centering should not be more than 1 or 2 millimeters even for a tower 103 feet in height. If on a triangulation party where towers are used there are not enough vertical collimators, the observing party should use the collimators and the building parties should use the transits for centering.

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TRIANGULATION HELPS TO RECOVER PROPERTY BOUNDARIES

Many requests are coming to the Washington Office for triangulation data to be used in property surveys. This is most encouraging for the officials of the Coast and Geodetic Survey have realized for many years that eventually property owners would want their boundary surveys tied into triangulation stations. When this has been done, a geographic description of the boundary is made. By having the longitudes and latitudes of the boundary corners or, what is just as effective, the plane coordinates, based on geographic positions, of those corners, the boundary can be recovered at any time in the future.

A long step forward was made when plane-coordinate systems for the 48 states were devised by Dr. O. S. Adams, mathematician of this Bureau. By using plane coordinates the engineer engaged on local work is not bothered by the rather intricate computations involved in computing the latitudes and longitudes for his traverses. The ordinary method of latitude and departure can now be used.

As rapidly as practicable the plane coordinates are being computed for the adjusted triangulation stations. This work is well advanced and at present there are thirty or forty computers engaged on plane-coordinate work. In publishing the results of triangulation for a state, the report will contain the plane coordinates as well as latitudes and longitudes for the stations.

A manuscript has been prepared and sent to the Public Printer which describes in detail the computation of plane coordinates on the Lambert Systems, which are used in many of the states. That publication can be purchased at a small cost, when it is available, from the Superintendent of Documents, Washington, D. C.

Any community in which a triangulation station is established is very fortunate. There will be many wide areas even when the triangulation net is completed with the 25-mile spacing, which will be quite far from a triangulation station. These areas will eventually, no doubt, be covered by lines of traverse which will be rigidly adjusted to the triangulation stations. Eventually the traverses should be made along the principal highways and many of the subsidiary roads of the highway system. The monuments should be set on the traverses at intervals of about a mile in order that each property owner along the route will have available, by a short traverse, a fundamental station as the starting point for his boundary surveys. Many survey stations are destroyed by forces of nature and the actions of man. Some of the destruction is inevitable but by placing the stations in secure positions and by educating our citizens as to the value of survey monuments, the chances are that the mortality of stations will be far less in the years to come than they have been in the past.

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MORE CARE REQUIRED IN SETTING STATION MARKS

A communication to this Office dated December 24, 1934, from Mr. Harold Wm. Merritt, civil engineer of Twin Falls, Idaho, contains the following statement:

"On December 10th, 1934, members of the Twin Falls party of the State Geodetic Survey, while occupying Kimama Station, discovered the bronze marker lying on top of the rock near the point. Six inches of snow covered the butte at the time but the men had no difficulty in locating the exact point from which the tablet had been removed, as particles of cement still remained in the crack in the lava rock. Neat cement had been used and adhesion to both the rock and marker was poor. Removal of the marker was evidently easy and not the work of souvenir hunters. The point was referenced out by the party and the tablet will be replaced when weather permits."

It is quite evident that the tablet was cemented into the rock with poor material or that the temperature at the time of the setting was below freezing. Personnel on triangulation and leveling engaged in marking stations should be very careful in their work. If the tablet is set into dry rock this would cause a drying out of the cement that is in contact with the rock and the cement in consequence would not set. There is an old saying that a good brick layer will wet his bricks before laying them. It is equally important that the rock or stone into which a tablet is set, should be wet before the cement is poured.

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DETERMINATION OF VARIATION BETWEEN THERMOMETER AND ACTUAL TAPE TEMPERATURE

The following report of tests to determine the variation between thermometer and actual tape temperatures was submitted by Mr. Philip Kissam, State Representative of New Jersey:

Purpose.

The purpose of the investigation was to determine:

1. Variation, if any, between actual tape temperatures and air temperatures.

2. The proper position for the tape thermometer, in order to most nearly record the actual tape temperature.

Equipment.

Three standard tape thermometers were selected which gave approximately the same readings over the required temperature range. A correction of one degree was found necessary for two of the thermometers over part of this range. As the absolute temperatures were not important, no further standardization was thought necessary.

A 100-ft. base line was established, consisting of two measuring posts of 4" by 4" fir, 5 feet long, set 3 feet in the ground in concrete and extending 2 feet above the ground. To the top of each post was nailed a strip of copper, one strip marked with a single scratch and the other with a scale graduated at intervals of .002 of a foot. Set behind each measuring post was a holding post to which the tape and spring balance could be attached by means of turn buckles.

The location of the base line was so chosen that it was entirely in the sun in the morning and entirely in the shade in the afternoon.

Method.

Each tape was placed on the base line when in the shade. The air temperature was determined and the scale reading at the end of the tape was read. The scale reading for 68° F. was then computed by correcting for temperature according to the above-mentioned thermometer reading. Each tape was placed on the base line in the sun and from its length as indicated by the scale reading, the actual temperature of the tape was computed. Thermometers were variously placed to discover which thermometer would most nearly record this actual tape temperature.

Results.

It was discovered that no location of the thermometer could be found which caused it to read a higher temperature than the actual tape temperature. The nearest approach to the tape temperature was recorded by a thermometer attached to the tape so that the metal case of the thermometer was in contact with the tape, and the case of the thermometer painted a dull black.

Next in order was the unpainted thermometer attached to the tape. The thermometer in the sun did not record as high a temperature as that on the tape and the thermometer in the shade recorded a much lower temperature.

The shade thermometer recorded at times from 12° to 18° F. below the actual tape temperature.

Conclusions.

The above results appear to indicate that over a range from 50° F. to 80° F. the best location for a thermometer used to determine tape temperatures is attached to the tape with the metal of the thermometer in contact with the metal of the tape, and with the case of the thermometer painted a dull black.

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Editor's Note:

The Coast and Geodetic Survey found many years ago that it could not get good results with steel tapes on base measurements by daylight taping due to the low coefficient of expansion of invar. This difficulty does not occur with invar tapes and it is recommended that engineers wishing to make accurate traverses use such tapes. Second-order accuracy however can be obtained by careful taping with standardized steel tapes corrected for temperature change.

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PLAN FOR STATE BUREAU OF SURVEYS FOR NEW JERSEY

The following abstract of a letter from Professor Philip Kissam, State Representative of New Jersey to Professor J. S. Dodds, State Representative of Iowa outlines a proposed plan for a State Bureau of Surveys.

"I had thought of asking the New Jersey State Legislature to establish a State Commission of Surveys, to consist, ex-officio and without pay, of the heads of the various State Agencies which make Surveys, viz: The Director of the Bureau of Commerce and Navigation, the State Highway Engineer, and the State Geologist. Major Bowie suggested that to this should be added the County Engineers as associate members, who should meet with the other members at an annual dinner.

"Under this commission should be appointed a Director, possessing the necessary technical knowledge and possibly connected with the U. S. Coast and Geodetic Survey, and paid a retaining fee. The Director should be supplied with an office for records, and with a principal assistant on a full time basis. Under the principal assistant should be a stenographer and a complete field surveying party equipped with truck and instruments. The annual cost of such a set up would be, I believe, in the neighborhood of $14,000.

"The duties of the Commission should of course be to collect and disseminate surveying data. To this end the Commission should acquire copies of all data available from the U. S. Coast and Geodetic Survey, particularly the geographic positions and descriptions of horizontal control points and elevations and descriptions of bench marks.

"The grid coordinates or elevations of these points, together with those of the Local Control Survey, should be compiled on tracings ready for immediate distribution as blue prints. This data should be given out as official information from the U. S. Coast and Geodetic Survey.

"New Jersey has a very large number of points and bench marks set by the old New Jersey Geological Survey. It would be the duty of the Commission to make these points available by computing the plane coordinates of the points and establishing contours of correction for the bench marks. This data could be called official State information. (All, of course, would be on the same datum.)

"A third source of information comes from State and County highway surveys and the many other surveys made within the State. It would be the duty of the Commission to insist when possible, and request where necessary that, in return for information supplied, monuments be set and proper descriptions made of points on these surveys normally marked with stake and tack. Files should be kept of these points together with their adjusted coordinates and elevations.

"The Field party should be chiefly a maintenance party, as the maintenance of marks is vital. Recovery of the points should be systematized. The field party could be ready to add to the system or assist in ties for other surveys. They could also handle the necessary computation and drafting.

"Coordinated points, like telephones, are useless unless the other fellow uses them. It should be the duty of the Commission to take every means available to inform the profession of the existance of these points and the localities where they are to be found. Maps should be prepared to this end. The County engineers should be automatically supplied with the data in their County for use by local engineers. City engineers should be supplied with data upon request and without cost.

"I believe that elevations and coordinates alone are a strong enough argument for the establishment of such a

commission. Once established I think that a Library of Maps and Charts should be compiled. These should be referenced by locality and handled like a library. All maps made in the State, for example highway plans would be included.

"In conclusion I might liken a bureau of this kind to the automobile. The only way we could get along without it is never to have had it."

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RECOMMENDATIONS REGARDING BILBY STEEL TOWERS

By Walter J. Bilby, Signalman

I heartily agree with Lieut. John Bowie, Jr. and Signalman M. Z. Braden, (Geodetic Letter, No. 11, Vol. 1) that something must be done about our present towers. I have tested steel towers from the beginning of their use in geodetic work and have given eight years constant thought on the subject. My findings are that the 1927 model is the best tower we have ever had. Those are the towers with U-206 and U-207 corner posts in the seventy-seven-foot section; U-204 and U-205 corner posts in all the sections above the seventy-seven-foot section. Of course I would continue to use the open-angle corner post on top and not return to the old solid corner post there. I would then use the U-285 and U-286 corner posts in the outer tower in the ninety-foot section. For the inner tower I would use U-207 and U-206 corner posts. This bears out Mr. Braden's idea of the lighter steel toward the top and the heavier steel toward the bases of the taller towers, with reduction in the thickness of the steel, but making the angle of the steel wider. This gives more strength and lighter weight at the same time.

I would like to make a few suggestions for points to watch for in building steel towers. I find that a new builder is inclined to tighten a bolt too tight. The threads will not strip nor will the bolt break, the bolt will stretch, thereby weakening the bolt. This is of course, a weak point in the tower. An old builder is inclined to put three quarter-inch bolts through the heavy corner posts. This bolt will hold but a full nut grip cannot be obtained without stretching the bolt. Then when heavy strains come on the tower this bolt will either break or will strip the threads. Too often old bolts are used in building because the builders did not take enough new ones

along that day. This does not mean that bolts should be used only once, but that, as the builders sort their bolts each day, every bolt should be inspected and thrown away if found to be faulty. It would be much better for the builders to return to camp for more bolts and build the tower right than to go ahead and build it so it would not be perfectly safe. Another point to watch is the riveting in the foot of the anchors. Quite often these rivets work loose and are not noticed. These are very common faults with building and I believe every old steel man will agree with me on this subject.

The weaker points in our towers are not the horizontal ties or diagonal braces but the corner posts alone. Every tower that has failed, where the anchors have held fast, has always buckled a corner post in exactly the same place - between the horizontal ties and between the first and second sections from the ground. In the majority of cases in the second section only.

While considering the subject of strengthening our towers we must consider the problem of weight due to transportation facilities. We must not increase the weight of the entire tower but should take the weight off the top of the tower, put it on the bottom of the tower and leave the general design of the tower as it now is.

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RECONNAISSANCE DATA FROM THE VIEWPOINT OF BUILDING PARTY

By Walter J. Bilby, Signalman

I wish to take this opportunity to give the viewpoint of the building party in regard to reconnaissance data as suggested by Mr. Mussetter's article in Geodetic Letter No. 11.

Since triangulation parties have expanded to such a great extent, it is necessary for the person in charge of building to be able to draw a mental picture of each individual station from the descriptions furnished by the reconnaissance men. This can usually be done but in a few cases the descriptions are lacking in detail for a complete picture. For instance, I would like a description to read, "turn right (north) on gravel road, (or graded road, dirt road, etc.)" This at once tells a person what to expect of the road under any weather condition. It identifies the road to a fuller extent so that the newer inexperienced man will have less trouble in finding the station. Also a note at the beginning of the description noting any correction to speedometer readings will be of great help.

It would greatly assist the steel haulers and building foremen if the stations were marked with a definite point for the station. These points may be marked in a number of ways, any of which would put little extra work on the reconnaissance man; such as a stake, a triangular trench in the ground, a triangular blaze cut upon a nearby tree or fence post. Also the distances to nearby permanent objects should be accurately paced, instead of estimated, as no two persons will estimate two distances the same.

It would be an added advantage if the reconnaissance men would note points for the reference marks and the azimuth mark. Usually the reconnaissance men have had experience building signals and setting marks. Therefore, they are able to select better locations in regard to the permanence and general utility of the marks, than most of the present building foreman. It is only natural for building foremen to select points that are accessible with trucks rather than with thought to the general usefulness of the mark.

It is also suggested that the reconnaissance man makes mention in his description of any agreement or concession made with the property owner. This includes data regarding the station mark, whether it is to be surface, flush, or subsurface. He might also mention whether there would be any possible property damage at that particular station.

I have always practiced putting the station in exactly the spot called for and building the height of steel called for. Recently I have not built less than 64-foot towers as we find they are much more solid, and are easier to build than even the 37-foot tower. A 37 or 50-foot tower is never built unless the station is in a very inaccessible place and the steel has to be packed in to the station site. It might be of help to the reconnaissance man if he would specify a 64-foot tower instead of checking his lines so closely, especially in the open prairie lands. In view of this I believe that a blue print should only call for 4-foot stands and from there jump to the 64-foot towers when steel towers are used by the triangulation party assigned to the project.

Another item in regard to the taller towers -- a 77-foot tower may be hauled on a single truck, while all over 77 feet should be hauled upon two trucks. For the shorter towers a 77-foot tower is always hauled regardless of whether the tower to be built is a 37, 50, 64 or 77-foot one. The 90-foot section should be eliminated if possible as it requires two trucks to haul it. For the occasional few 90-foot towers that have to be used the double haul will not disrupt the organization of the party. However, when all the towers

have to be of that height the party is organized for the double hauls.

For the actual building of the tower there is very little more work on the taller towers as it has been estimated that about four-fifths of the work is on the ground regardless of whether the tower is a 37-foot or 103-foot tower. Of course for the 116-foot towers it requires an additional man on the building parties as well as the tearing-down parties.

It has been the general practice on this party to ship or set aside the extra steel for the taller towers so the steel-haulers do not have to load and unload the extra amount of steel at every station and as the load on the steel truck is smaller it decreases the cost of hauling.

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SPECIAL REPORT ON TRIANGULATION IN MONTANA AND THE DAKOTAS

By Wilbur R. Porter
Jr. H. & G. Engineer

The purpose of this report is to indicate the difficulties encountered in obtaining side and angle closures in the drought area of Montana and the Dakotas; to show the methods used; and, if possible, to determine the cause.

A complete tabulation of weather conditions was maintained, and a constant study was made by John E. Backman, Surveyor in charge of the field work of this party. The data for this report was taken from Mr. Backman's field notes.

Every effort was made to eliminate personal errors. All observing parties and lightkeepers were frequently visited by the Chief of Party so that it was found that the observations were carefully made and the lights accurately pointed at all times.

It is believed that the reasons for all the trouble encountered may be attributed to two factors -- topography and weather conditions. No particular instrument or party was repeatedly involved in the quadrilaterals which caused trouble. It is true that two of the theodolites, Nos. 355 and 361, are more sensitive to temperature changes than Nos. 314 and 362, but it is not believed that this fact was responsible for any of the high closures. This party encountered similar results when using other instruments in parts of Texas and New Mexico.

The arc from Buffalo, Wyo., to Richland, Mont., was through hilly, rough, arid country. The stations, as a rule, were located on high points of divides between dry creeks and coulees. Quite often there were as many as three or four high ridges between two stations. The general weather conditions throughout this arc were clear, hot windy days with somewhat calmer and cooler nights. The air was constantly filled with very fine dust caused by frequent sand storms. Often the lights, as seen through the instrument telescope, appeared as large red balls whose diameters were nearly twice the distance between the vertical cross-hairs and when the wind was blowing, they appeared as red flags fluttering in the breeze. This condition was still existant even after the lightkeepers had dimmed their lights to a minimum.

As indicated in my monthly journals for July and August, it was necessary to reobserve for high closures nearly every night. One closure of 15 seconds was obtained from results of the first run. Five to seven-second closures were not unusual and as high as a ten-second change was obtained upon reobserving the same evening. However, in many instances, it was necessary to make two to four runs on one or two lines before a value could be obtained which would give proper closures. For this reason it was necessary to reoccupy 22 stations between the Yellowstone River and the Canadian Border to obtain closures of 3-1/2" on R_1 triangles and 4" on R_2 triangles.

Side checks also added to the difficulties. Frequently closures of over 5" would give very good side checks while closures under 3" in the same figure would produce poor checks. This made it a necessity to keep triangle computations up to date in order to avoid as much reoccupation as possible. It was necessary to compute triangles before leaving the stations on many nights, but this was done only when experience had taught that trouble might be expected.

On the arc extending south from the vicinity of Val Marie, Sask., Canada, to Lodgegrass, Mont., much adverse weather was encountered. The temperature exceeded 100° F. nearly every day. Wind storms were almost a daily occurrence, so the air was constantly filled with dust. Smoke from the large forest fires in Western Montana and Idaho caused a constant haze. The topographic features were similar to those described for the previous arc.

Out of a total of 58 stations occupied it was found necessary to reoccupy nine stations for closures and one station for side checks. Incidentally, it was necessary to reobserve each night on some lines in order to obtain

closures within the allowable limits. If the triangles had closed with the results obtained from one run at each station the total number of directions necessary to complete this arc would have been 219. The actual number of directions observed was 381, or 74% more than the apparent number. Of this, 21.4% were second runs on front lights, and 52.6% were directions reobserved in an effort to obtain allowable closures. * * *

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LINES FOR LAPLACE AZIMUTH

In selecting lines for use by the astronomical party for Laplace azimuth observations, the triangulation party should not only make sure that only a small amount of building will be required to make the stations intervisible after the steel towers have been removed but it should also use care in avoiding lines which may have excessive refraction from the lower stands.

One of the recent azimuth determinations by the astronomical party seems to be somewhat affected by refraction trouble. The chief of party gave the following explanation of the variable results:

"The line of sight to the Laplace Azimuth Mark is only a little over a mile in length. It passes over a corner of a roof of a house. The clearance is about four to six feet (estimated). The house is located about midway between the two marks. The line of sight to Polaris is over the roof of a church near the station (see description). The line passes to the right of the steeple and over the ridge of the roof, perpendicular to the ridge. The clearance to the right of the steeple is about 12 feet and clearance of the ridge of the roof about 10 feet.

"The azimuth observations made on two nights show a decided change due to refraction we believe. The change occurs between the hours of 8 and 9 p.m., E.S.T. Means of the results for each night grouped by hours indicate this result."

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CHAINING TRIPODS

By N. E. Wolfard
State Representative, Okla.

On the initiation of Local Control Surveys as a "Relief Measure" one of our difficulties was the improvising of a

satisfactory tripod for horizontal measurements. We tried various designs of wooden tripods with varying degrees of success. All designs lacked stability and were also affected by weather conditions.

Toward the latter part of the period some bright minds evolved a design similar to the one shown in the sketch. This type proved so satisfactory that materials were purchased to make up thirty-two tripods of this design.

We are using four tripods with each measurement unit, this allows two tripods to remain in position, so that should the rear tripod be accidentally disturbed during the station measurement, the back station could be rechecked and hence save the measurements thus far made on the given section.

Following is a description and bill of materials for one tripod:

The table top consists of a piece of 2" by 6" hard pine 8" long. This is cut to a 5" width so that a standard 6" nipple may be used. On this top a piece of wall board 3" by 8" is nailed, its purpose being to provide a soft surface in which to stick the marking pins.

The frame work consists of 1/2" iron pipe and fittings. One one side two street ells are screwed into a tee which holds the leg. Six-inch nipples are screwed into the other end of the ells and inserted through holes in the side of the table top. Ells screwed onto the ends of the nipples on the other side of the table provide fittings for the other two legs.

The legs are 1/2" black iron pipe 36" long from end of ell to point. (Overall length including threads 36-1/2" to 36-3/4"). The end is pointed by a blacksmith, it being unnecessary to insert a solid iron point welded in.

The necessary materials for one tripod are:

1 - 2" x 6" x 8" Hard Pine.
1 - 3" x 8" Wall board or masonite.
9'3" of 1/2" Black Pipe.
2 - 1/2" x 6" Black pipe nipples.
2 - 1/2" Black street ells.
2 - 1/2" Black ells.
1 - 1/2" Black tee.

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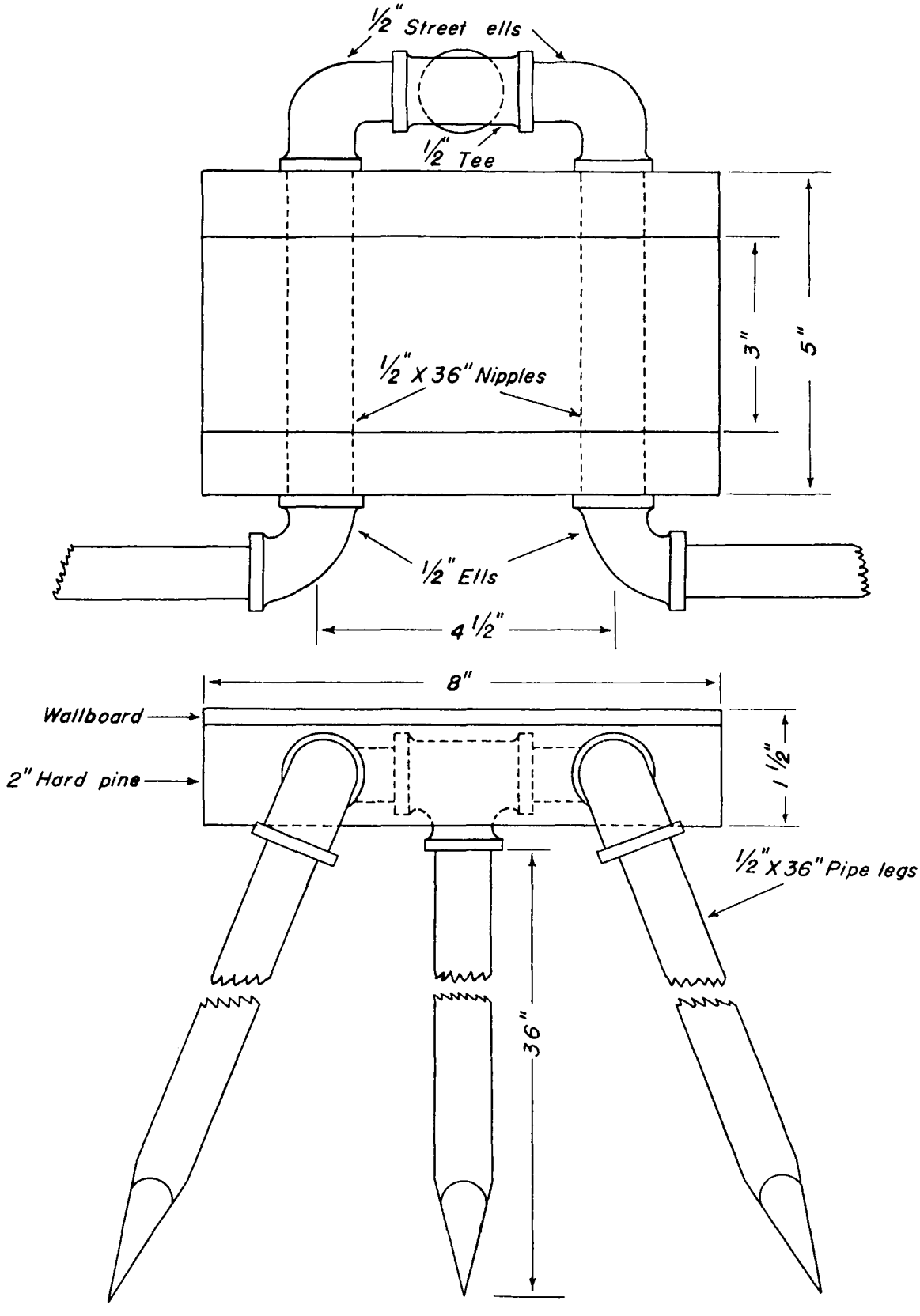

CHAINING TRIPOD
STATE CONTROL SURVEY

OCT. 1934 L.A.M.

FEDERAL SURVEYING IN OREGON

Abstract from Report of Topographic Map Committee of the Portland Oregon Chamber of Commerce, L. A. McArthur, Chairman:

" * * * Accurate topographic maps must be based on networks of geodetic control, including triangulation and levels. The development of these geodetic networks is now a function of the U. S. Coast and Geodetic Survey, which during the past few years has greatly increased its program. A large amount of new work has been carried on in Oregon by this bureau, with the result that the level and triangulation networks of the state are nearing completion.

"The geodetic program of the U. S. Coast and Geodetic at the present time calls for the installation of either a first or second order level bench mark not more than 12 or 15 miles from any place in the United States. A similar program exists for the first or second-order triangulation network. Engineers and executives in touch with development work in the state of Oregon prevailed upon the U. S. Coast and Geodetic Survey to concentrate on a leveling program for this state, with the result that in 1930 and 1931 many hundreds of miles of high grade leveling were completed and properly marked with permanent bench marks. The state engineer, the state highway engineer, various county and federal authorities and many private corporations cooperated with the U. S. Coast and Geodetic Survey in setting permanent bench marks. At the end of 1931 Oregon had one of the most highly developed precise level nets in the United States. The final standard elevations for the bench marks were computed early in 1932 by the U. S. Coast and Geodetic Survey, and Special Publication 177 giving descriptions and elevations of all these bench marks was issued. Oregon is the third state in the Union for which this information is available in printed form. Its usefulness to engineers generally can hardly be overestimated. This publication contains elevations for more than 2,850 permanent marks in Oregon. It is possible for engineers to abandon arbitrary and uncertain local datum planes and adopt instead the U. S. Coast and Geodetic Survey standard. All this work has been without cost to the State except in so far as non-financial cooperation has been accepted by the Survey.

"During the summer of 1933 additional leveling was carried on in Oregon by the U. S. Coast and Geodetic Survey. In the spring of 1934 an intensified program of second-order leveling was inaugurated in the state by the same bureau. Many new lines were completed during the fiscal year ending June 30, 1934, and much additional work was on the program for the second half of 1934.

"At the end of 1933 the U. S. Coast and Geodetic Survey, in cooperation with the CWA authorities, launched a geodetic control project in nearly every state in the Union. Such a project was carried on in Oregon under the immediate jurisdiction of R. H. Baldock, State Highway Engineer. The work was supplemental to the regular activities of the U. S. Coast and Geodetic Survey. Approximately 1,750 miles of third-order levels were completed in various parts of Oregon. A large number of new bench marks were installed, and the elevations of many old marks were re-determined and the marks themselves were made permanent. Over 300 miles of transit traverse lines were also run in various parts of the state by CWA crews. Many triangulation stations were searched for, rebuilt and re-described.

"In the spring of 1932 the U. S. Coast and Geodetic Survey issued Special Publication 175 - First and Second Order Triangulation in Oregon. This volume is of great benefit to surveyors and engineers as it contains exact latitudes and longitudes of several hundred marked stations on the 1927 datum. The U. S. Coast and Geodetic Survey has completed the computations for all the third-order triangulation stations in Oregon, thus putting the geographic positions of these stations on the 1927 datum, which is the standard throughout the entire United States. The geodetic positions of third-order triangulation stations may be secured in provisional form from the U. S. Coast and Geodetic Survey. These points are along the Oregon coast and the Columbia River.

"In 1932 and 1933 the U. S. Coast and Geodetic Survey extended first-order triangulation throughout a large part of central Oregon where there were no accurate values available for latitudes and longitudes. The positions determined from this work are in process of computation in Washington. The arcs extend from the vicinity of Prineville north to Arlington, southeast to Burns and southwest to Klamath Falls. In 1934 an arc was extended north and south adjacent to the Oregon-Idaho boundary line, and at the date of this report a reconnaissance party is preparing for an arc of first-order triangulation from Portland down the Columbia River to the sea, and an arc of second-order triangulation from Portland west to Tillamook. Oregon is now one of the most accurately triangulated states in the Union.

During the fiscal year ended June 30, 1934, a comprehensive tide survey of the Oregon coast was made by the U. S. Coast and Geodetic Survey. Automatic gages were maintained for more than a year at each of twelve important harbors, and supplemental gages were installed at other points. The tide gages were connected to permanent bench marks at each point and levels of first-order accuracy extended the entire length of the Oregon Coast highway connecting the various points.

"The past biennium has witnessed remarkable strides in geodetic progress in the state, all of which will greatly simplify mapping problems in Oregon. The Portland Chamber of Commerce has been actively interested in the work.

"The U. S. Geological Survey has carried on extensive third-order triangulation, traverse and level work in Oregon, and it is planned to adjust these geographic control networks so they will be coordinated with the work of the U. S. Coast and Geodetic Survey, which is of a more accurate character and which forms the first-order backbone or network. The U. S. Geological Survey is, as fast as funds will permit, adjusting its positions for Oregon to fit the U. S. Coast and Geodetic Survey standards. It will probably take several years to accomplish this result.

"It is believed that all level work in Oregon should be coordinated where possible and the descriptions and elevations of bench marks should be available in printed form. The results of third-order triangulation should also be published in printed form, as there is a constant demand from engineers for these data.

"In 1929 your committee reported the then serious deficiency in geodetic control in Oregon, but during the intervening five years great strides have been made so that the principal problem today is that of mapping."

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RECOVERY OF AND STAMPING OF ELEVATIONS ON BENCH MARKS

No doubt in years past an engineer visiting a bench mark of the Coast and Geodetic Survey has been disappointed in not finding the elevation of the mark stamped on the metal disk. To obtain this information, it was necessary for him to write to the Washington Office. This meant a delay of several days with possibly some inconvenience to his surveying program. The reason for the elevations not being stamped is obvious. Lines of levels were first run over the country at very infrequent intervals, until eventually the lines formed closed loops; when the net had been filled in to such an extent that the loops were comparatively small, a general adjustment was made. The datum plane for the elevations of the National net of this country is mean sea level, and the information given is on what is called the 1929 General Adjustment. Had the elevations been stamped on the bench mark disks prior to that date, the information would not agree with the adjusted or standard elevation. Even today as new lines of levels are run, the final elevations cannot be determined until the office computations have been made.

During the past half year, a number of engineers have been employed throughout the country engaged in recovering bench marks and stamping with steel dies the final adjusted elevations on the brass disks. Now it is possible for a local engineer to connect his work to such a bench mark and have an elevation to the thousandth of a foot immediately available.

To insure that the correct elevation is stamped on the metal disk, the engineer doing the work was required to forward a facsimile of the mark after the stamping to the Washington Office. This facsimile was made by inclosing a sheet of carbon paper between the folds of a sheet of thin blank paper which was placed over the mark. Then by rubbing on the paper an exact reproduction of the data stamped on the disk was obtained. Such information upon receipt at the Washington Office is compared with the records, and should any discrepancies be noted, the errors will be immediately corrected. Local surveyors and engineers should therefore have no hesitancy in using such information.

To the casual passer-by who notes such a mark, the stamping of the elevation thereon will also be of interest. In many cases bench marks are established in prominent places visited by many people, and no doubt in the past many of these have had their curiosity aroused as to the elevations of bench marks for which no information was given.

As a further result of this work, the records of the Washington Office have been brought up to date. Information concerning the condition of marks established a number of years ago has been obtained. The mortality on some lines has been relatively high due to highway improvements and changes along the right-of-way of railroads. The engineer recovering the mark also took cognizance of changes in local surroundings and gave additional data and measurements if necessary to clarify the description. Such changes will be incorporated in the description of the bench mark, and will make for an easier recovery in the future.

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TECHNICAL PROCEDURE FOR CITY SURVEYS

The American Society of Civil Engineers has recently published a manual of engineering practice, No. 10 in a series of such manuals, under the above title.

This is a very comprehensive manual covering the necessary types of surveys required for a complete city survey, the order in which they should be taken up, the technical procedure for each with the required accuracy to be obtained and the types of maps to show the final results.

Following is the "Historical Summary" of the compilation of the manual:

The value of comprehensive engineering surveys and maps as a basis for city planning and operation is increasingly recognized by American city governments. Such surveys are designed to supply fundamental information, and since survey needs in all cities of the United States are basically the same, in actual practice a standard form of procedure has been evolved, known as the City Survey. Early in the program of the Surveying and Mapping Division, therefore, it was decided to produce a Manual for the purpose of describing the various divisions of the complete City Survey, to furnish specifications for it, and to make detailed recommendations as to accepted technical methods. Accordingly, on January 19, 1928, a Committee on City Surveys was formed by the Division. This Committee consisted of U. N. Arthur, R. H. Simpson, and Robert H. Randall, Chairman. Mr. Simpson died on May 8, 1933. In recognition of his material service in the preparation of the Manual, G. D. Whitmore, Assoc. M. Am. Soc. C. E., was added to the Committee in January, 1931.

The Committee first prepared a preliminary draft of the proposed Manual, which was distributed widely by the Society in mimeographed form. This draft, in addition to being reviewed by many members of the Society, was sent for comment to the United States Coast and Geodetic Survey, to the United States Geological Survey, and to universities and other agencies or persons whose views were desired. Upon receipt and analysis of these comments, the Committee prepared a final draft which was submitted to the Division, approved in January, 1932, and transmitted by the Division to the Board of Direction of the Society which authorized its publication on January 15, 1934.

Since the text of this Manual was completed and forwarded by the Division to the Board of Direction, new and unforeseen opportunities for the utilization of such a Manual have arisen. City planning and regional planning have received a tremendous impetus from the activities of the Public Works Administration, the Civil Works Administration, and the Federal Emergency Relief Administration. Surveys such as are detailed in the Manual have been begun in many places and may be expected to continue, spurred by the need of providing plans for the construction involved in Federal

employment programs, and, in many instances, financed out of such Federal employment funds. It is to be hoped that this Manual will find increasing use in the organization and training of engineers in the performance of City Surveys.

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THE NEED FOR MAPS

(Reprinted from The Military Engineer, January - February, 1935).

The Editor:

During the past eighteen months of enormous expenditures of government funds in an effort to relieve unemployment and at the same time accomplish something really worthwhile, I have often wondered at the lack of a real effort to complete the topographical map of the United States. The preparation of this map is a public function in no way competing with private enterprises.

I realize that considerable sums have been allotted during this period for map work. In my own state the Coast and Geodetic Survey has done quite a little work on their triangulation system. To my mind, however, it has seemed to be a piecemeal effort and totally inadequate to our needs.

During my thirty-six years of engineering and army experience the need for accurate topographic sheets has constantly arisen. Very few people, I feel, have any conception of the value of accurate maps in the location of large scale industrial enterprises. Their need in military operations is, of course, well known and unquestioned.

The first task of a locating engineer, when assigned a job, be it railroad, highway, transmission, or pipe line, is a study of the topography of the country involved. If good maps are not available, he is out of luck, and must make many costly and time consuming reconnaissance trips.

During the World War it was my privilege to serve on the Board designated to select a site for the Infantry School near Columbus, Georgia. Fortunately the topographic sheet of the Columbus quadrangle was in existence. By the use of this sheet I selected the site of the present Fort Benning the night of my arrival in Columbus. The next day we made an inspection on the ground. A number of boards had visited Columbus prior to this time, but none had

visited this particular site, because they only went where they were taken by the representatives of the Chamber of Commerce. But for this topographic sheet, I feel that the present admirable site of Fort Benning would have been lost to the Army.

A few years ago I took an active part in the promotion of the proposed Great Smoky Mountains National Park. Topographic sheets of this region were in existence but were very old and inaccurate. When the park became a reality and development work started, a special appropriation was secured from Congress for the purpose of making a new topographic map of this area. Practically nothing could be accomplished in the way of development until this map was completed.

Only recently I participated in the efforts of Tennessee to secure a portion of the proposed Scenic Parkway connecting the Shenandoah and Great Smoky Mountains National Parks. The extensive use of the topographic sheets of this region were, of course, necessary in this work. I found, however, that in Virginia many of these quadrangles were unsurveyed.

I believe that less than half the country is now mapped. In many instances where sheets are now published they are very old and obsolete. A few days past I secured the Briceville, Tennessee, sheet, which is the one covering the location of the Norris Dam. I found that the main line of the Louisville and Nashville Railroad from Cincinnati via Knoxville to Atlanta, which almost bisects this sheet, was not shown. Also the little city of LaFollette, about twenty-five hundred population, was not shown, as both were built after surveys were made nearly fifty years ago. We have made more complete maps of the Philippine Islands than of our own country.

I feel that nothing could be done as a relief measure which would prove of greater future benefit to the nation than the completion of this topographic map. All of the mapping agencies of the government could and should be concentrated on this one effort. It is a project that would employ many men, both white collar and laboring classes. The work could be carried on throughout the year by working in the southern states in winter and the northern states in summer. If this map was once completed the present forces of the Geological Survey could, no doubt, keep it up to date.

Much time and money is constantly being spent on surveys and preparation of special maps covering a limited terrain, which would be unnecessary if an accurate topographic map of the entire country were available.

Unless the Army has far better maps than I know of, they would be greatly handicapped in any military operations on our own soil.

Completion of this map is something for which the nation has been striving for one hundred and fifty years. It would be of inestimable value to industry in time of peace and to the Army in time of war.

Frank Maloney,
Lieutenant Colonel,
Infantry Reserve.

Knoxville, Tennessee.

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USE OF GEODETIC CONTROL IN LOCATING PROPERTY BOUNDARIES

A recent paper by Mr. A. H. Holt, published in the "Transactions" of the American Society of Civil Engineers entitled "The Surveyor and His Legal Equipment" very ably sets forth the duties of a surveyor to his client in resurveying or reestablishing property boundaries and points out many of the difficulties he may encounter. It concludes with the following paragraphs:

"As in many things, so in the matter of uncertain boundaries, 'an ounce of prevention is worth a pound of cure.' How much better it would be if surveyors and landowners could appreciate the importance of so marking boundaries when they are first established that there will be little likelihood of their being obliterated, and of so referencing them that they can be re-established economically and precisely if that should ever be required. By the progress of the precise surveys of the United States Coast and Geodetic Survey the most reliable and satisfactory control is being made more and more widely available. While the general use of this control for the description of the boundaries of lands is probably still in the distant future, engineers should be in the lead in recognizing its utility and its value, and in urging and facilitating the adoption of this means of increasing the certainty and permanence of private boundaries.

"In the meantime, and even with the use of the control mentioned, the best and most economical assurance that a boundary can be recovered in the future in its original location is the use of definite, distinctive, and enduring

monuments; and the best law that can be promulgated to contribute to this end, is that which was laid down many centuries ago: 'Thou shalt not remove thy neighbor's landmark, which they of old time have set.'"

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NOTICE

The A B C Triangulation Adjustment, by H. P. Kaufman, Assistant Mathematician, U. S. Coast and Geodetic Survey, has recently been published and is available upon application to interested persons.

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REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during December, 1934:

First-order - - - - - - - - - - - - - - -	1285
Second-order- - - - - - - - - - - - - - -	0

Total miles of triangulation completed to December 31, 1934:

First-order - - - - - - - - - - - - - - - -	53,109
Second-order - - - - - - - - - - - - - - -	3,321

Levels:

Lineal miles of levels completed in December 1934:

First-order - - - - - - - - - - - - - - - -	848
Second-order - - - - - - - - - - - - - - -	8,847

Total miles of levels completed to December 31, 1934:

First-order - - - - - - - - - - - - - - - -	100,148
Second-order - - - - - - - - - - - - - - - -	91,317

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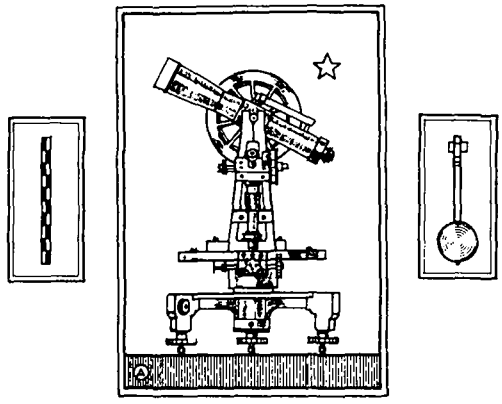
FILE COPY

GEODETIC LETTER



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DIVISION OF GEODESY

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G E O D E T I C   L E T T E R

Volume 2 APRIL, 1935 Number 4

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C O N T E N T S

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THE WORK OF THE COAST AND GEODETIC SURVEY OF INTEREST TO GEOLOGISTS

By

William Bowie
Chief, Division of Geodesy

The Coast and Geodetic Survey is one of the service bureaus of the Federal government designed to find facts that are needed in the planning and execution of the activities of our nation.

When it was organized more than 100 years ago the primary object of the Coast Survey was to chart the shoreline of the country and the waters adjacent thereto to make navigation safe. In order that this charting might be done in a proper way, geodetic surveys were made to give position and correct form to the topographic and hydrographic surveys and the charts. The Bureau also began in the early years of its existence the making of magnetic, tidal and current surveys. The information derived from these classes of work was needed to perfect the charts and to furnish information of value to the navigator.

Later, as the Coast Survey extended its work inland, its name was changed to Coast and Geodetic Survey, the title it now has. This interior work consists of the extension of arcs of triangulation, lines of levels, measurement of bases, astronomical determination of latitude, longitude and azimuth, magnetic surveys, and seismological investigations.

There has been marked improvement in hydrographic surveying instruments and methods during the past few decades. We now have the sonic sounding apparatus for the determination of depths and the radio-acoustic ranging method by which the position of a ship can be determined far out to sea. We also use the taut wire method for determining distances during the hydrographic surveys. With modern methods and better equipment of all kinds, including ships, we are able to make soundings with accuracy and to determine just where those soundings were made. We no longer have to depend upon dead reckoning, which is an inexact method of navigation. During cloudy weather when no astronomical observations can be made to check the courses determined by dead reckoning, the position of the ship as derived from dead reckoning may be in error as much as 5 miles.

The intensive hydrographic surveys made along our coasts furnish information that should be of great value to geologists and physiographers. We are able to outline in great detail the configuration of the so-called drowned valleys.

The geologists have been intensively interested in the topographic mapping of the country. The Association of American State Geologists has done much to secure a greater appreciation of the value of topographic maps. It helped materially in the passage of the so-called Temple Act in 1925, which if put into effect would have greatly advanced the topographic mapping of our country. Dr. George C. Branner, the President of that Association, was instrumental in having $200,000 added to the appropriation for geodetic surveys in the winter of 1929-30. Prior to that time the appropriation for the geodetic surveys was only $88,600 per annum. Already the Secretary of Commerce had agreed to an increase of about $40,000, but Dr. Branner's efforts led to the Secretary of Commerce requesting a supplementary estimate of $200,000.

The field appropriation for the fiscal year 1931 was $326,624. This made it possible to attack the geodetic surveys vigorously. In consequence of this, the officials of the Coast and Geodetic Survey were able to expand even more in the fall of 1932 when an additional increase in funds was made available through the Wagner bill. Then again, in the summer of 1933, Public Works funds were made available for the geodetic work, with a further increase in the forces engaged on the geodetic surveys. If it had not been for the increase by $200,000 in the geodetic funds in 1930, it would have been very difficult for the bureau to have expanded effectively and with efficiency when the Wagner bill funds and Public Works funds were made available.

The Coast and Geodetic Survey is now following a plan for its control surveys which calls for the spacing of the fundamental arcs of triangulation and lines of levels at intervals of about 25 miles over our entire area. The leveling net is well advanced. Already there are some 200,000 miles of levels in the net. The fundamental triangulation is about half done. There will eventually be about 116,400 miles of arcs in the net.

These great networks of arcs of triangulation and lines of leveling form the basis for the topographic mapping of the country. This control-survey work is done with great accuracy and it is expected that none of it will ever have to be done over again because of errors in the accuracy of the observations.

There will at times be destruction of some of the marks by forces of nature and the operations of man. Then again, some of the marks may be disturbed in position or elevation by earthquakes, but the number destroyed and the number disturbed will be exceedingly small.

With the triangulation and leveling nets so far advanced, it will be possible when the topographic work is done in an area to have the maps placed in their proper positions and the elevations of the contours referred to mean sea level. Of course more control surveying must be done. It is understood that for topographic mapping, triangulation stations or lines of traverse should be spaced at intervals of about 7 miles. For placing the contours on the maps the lines of levels should also be spaced at intervals of approximately 7 miles. With the fundamental arcs of triangulation and lines of levels now already well spread over the country, it will be possible to furnish in a short time the detailed control surveys over any quadrangle or series of quadrangles ahead of the topographic surveying. If the officials of the Coast and Geodetic Survey are notified, say six months in advance of the needs of topographic engineers, the additional control surveying could be done before the topographic engineers took the field in any given area.

We should consider the topographic maps as not only of value in geological investigations but as something that is essential to the proper planning of the activities of our people. This country has been running without plans and in consequence much waste has occurred. The country needs to become plan-minded, and those who are engaged in making plans whether Federal, state, county, or city engineers or private individuals, are realizing the fact that it is very difficult or impossible to make plans that are good without having geographic facts. These facts can all be furnished by the topographic map. The topographic map, however, cannot be very useful unless it is accurate in position, distance, direction, area and elevation. The maps that are now being made by the engineers of the U. S. Geological Survey meet all these requirements. All that are needed now to complete the mapping are funds. So far as authorization is concerned, we assume that the Temple Act gives that.

Funds have been made available by the Public Works Administration for the control surveys and to a certain extent for topographic mapping. Much has been accomplished so far as the geodetic work is concerned. The accuracy of results secured with the Public Works funds equals that obtained in our control surveys prior to the use of the emergency funds. However, I must say that we should have a more or less continuing program. While today we have no

difficulty in securing the services of able engineers on our geodetic parties, yet if industrial conditions became normal, the ablest of these engineers would go back to private practice. We could not retain them unless we could give them some assurance of more or less permanent employment.

We have every reason to believe that additional funds will be made available for surveying and mapping after those set aside from public works appropriations have become exhausted. Only recently the Coast and Geodetic Survey had an allotment of nearly a million and a half dollars from the Public Works Administration to continue its present activities until June 30 next. The regular appropriation to the bureau is small but it is possible that additional emergency funds will be forthcoming.

I have stressed the control surveys because of their importance in the topographic mapping of the country but each class of work done by the Coast and Geodetic Survey has its scientific aspect. The geodetic surveys furnish data by means of which we can determine the shape and size of the earth. These data also enable us to discover varied geological structures or at least assist in their discovery. The geodetic surveys if repeated after an earthquake will give us some idea as to the amount of movement, horizontal or vertical, that has taken place at our station marks. They will also give some indication of the extent of the area that is affected by an earthquake. Whether this area is small or large is at present largely a matter of opinion. Geodetic data should make it possible to throw some light on this interesting and important geological problem.

I have mentioned earlier the work that is done in the charting of our coasts and the waters adjacent thereto that is of interest to geologists. It seems to me that we must go out to sea in order to be able to properly interpret what has occurred on the continent. The continents and the continental shelves are certainly one and the same geological structure. The hydrographic charts show the configuration of the ocean bottom over the continental shelves. They are practically a topographic map.

The charting of the coasts and the recharting from time to time furnish information that is of interest and value to geologists and physiographers, for by means of these surveys information is obtained as to the changes in the positions of the shorelines.

The magnetic surveys are becoming of interest to geologists for they make it possible to outline areas underlaid by rocks that are highly magnetic. It is possible that a

combination of magnetic and geodetic surveys would be quite effective in outlining at least the major buried geological structures.

The tidal and current surveys have many scientific aspects. Really the tidal data secured at stations along our coasts furnish the only means by which we can get a true picture as to the stability of the land masses relative to the oceans. We now have the tidal stations tied into the leveling net of the country and therefore if there should be a decided variation in mean sea level at any station with respect to the nearby bench marks, lines of levels could be run inland to throw light on the cause or causes of the change in the position of mean sea level with respect to the local bench marks. With tidal observations carried on over many decades, we no doubt shall secure some very valuable information regarding the uplift or subsidence of sections of the coast.

The Coast and Geodetic Survey is operating two astronomical stations for the determination of variation in latitude. There are stations in other countries that are used in conjunction with the ones at Gaithersburg, Md., and Ukiah, Calif., for the determination of this variation. From the data secured, it may be possible to get some information on the elastic properties of the earth.

In the seismological work of the bureau we are trying to determine with extreme accuracy the epicenters of earthquakes in this country and the surrounding areas. It is hoped that eventually there will be a sufficient number of seismological stations in this country to be able to detect all earthquakes that may occur except those that are exceedingly weak. With a knowledge of the epicenters of the earthquakes we shall be able to outline areas in which earthquakes occur most frequently, and therefore those areas that from a geological standpoint are most active. These earthquake investigations will have a very important economic aspect. With the areas outlined in which earthquake activity is greatest, engineers and architects can plan their buildings with a view to resisting the earthquake shocks.

While most of the work of the Coast and Geodetic Survey is done by engineers and can be considered as engineering in character, yet practically all the data secured have scientific value.

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SIXTH ANNUAL SURVEYORS CONFERENCE

The sixth Annual Surveyors Conference was held on March 6 and 7, 1935, at Iowa State College, Ames, Iowa, under the auspices of the Iowa Engineering Society. This conference was unique in that the entire program, a copy of which follows, deals only with surveying and mapping subjects, whereas such programs usually included talks on highways, water power, sewage, construction, etc. Such a meeting seems indicative of the growing interest in the importance of adequate and accurate maps.

P R O G R A M
SIXTH ANNUAL SURVEYORS CONFERENCE

Auspices
Iowa Engineering Society
Engineering Extension Service, Iowa State College
at
Engineering Hall, Ames, Iowa
March 6 and 7, 1935

WEDNESDAY, March 6, 1935

REGISTRATION, Room 105, Engineering Hall

PROGRESS REPORT ON LOCAL CONTROL SURVEYS . . J. S. Dodds

HOW SHALL WE USE OUR GROWING CO-ORDINATE SYSTEM -
A general discussion led by . . . . . L. W. Mahone

RESTORATION OF MISSING CORNERS AS STATE
OR COUNTY PROJECTS . . . . . K. J. Smith

SECTION LINE PECULIARITIES IN IOWA) . . . . John Burriss,
UNIQUE DESCRIPTIONS) Des Moines (and others)

SURVEYS IN THE "EIGHTIES" . . . . . G. B. Wicks, Des Moines

DINNER - Jointly with Faculty Members - MEMORIAL UNION
Following the dinner, Dr. Wm. Bowie, Chief, Division of Geodesy, U. S. Coast and Geodetic Survey, will speak on ISOSTASY

THURSDAY, March 7, 1935

A PROPOSED SYSTEM OF STATE SURVEYING
AND MAPPING INFORMATION BUREAUS . . . . J. S. Dodds

RECORDING PLATS AND SURVEYS . . . . . E. S. Boudinot

THE VALUE OF ACCURATE MAPS TO
ENGINEERS AND THE PUBLIC . . . . . Dr. Wm. Bowie

THE HISTORY OF PUBLIC LAND SURVEYS IN
IOWA WITH PARTICULAR REFERENCE TO
RESURVEYS . . . . . L. O. Stewart

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MAKING AND SETTING BENCH MARKS

by C. M. Cade*

The markings left in the field are an important part of any surveying operation. This statement is especially true of leveling as when the bench marks of a level line are lost or so disturbed as to make them untrustworthy, the value of the leveling has practically ceased to exist.

Before planning any operation, no matter how small it may seem, a statement of the objective or objectives of that operation should be made as a guide to right thinking. Accordingly it may be said, that bench mark leveling has, as its primary object, the establishing in the field of marks, well defined, easily recoverable, and above all, durable. These marks must maintain their elevation relative to the surrounding territory for a long time; probably one hundred or more years is not too long to set as the proper minimum life of a bench mark and a fairly large percentage along any line should survive and maintain their relative setting indefinitely.

Bench marks may be definite marks on buildings, bridge abutments etc., but a large percentage will, of necessity, be in the form of a brass tablet set in a concrete post. Iron pipe bench marks and cut stone posts have been discarded as either unsuitable or too expensive. Since posts of concrete will form a large item in the bench mark leveling of the future, a full and careful consideration of the factors concerning this material, should be undertaken. A post carrying a bench mark plate in order to conform to our main objective should : (a) be long enough to reach well below the frost line peculiar to the region where the post is set; (b) be massive enough to resist successfully shocks such as occasioned by a truck or car or wagon should one of these vehicles run against it; (c) project sufficiently above the ground level so that it may be easily recovered; (d) taper so that frost action will not heave the post; (e) have on the bottom, an anchor to assist in maintaining stability and (f) the material of which it is made, should be exceedingly durable.

The first five of these requirements, are pretty well satisfied in our northern latitudes by a precast post 7" x 7" chamfered on top and 10" x 10" on the bottom, about five feet long and set with six inches projecting above the surface of the ground. Two cubic feet of concrete mixed

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*Professor C. M. Cade of Michigan State College, was for a number of years a member of the field force of the Coast and Geodetic survey and during the past year he was our representative in the C.W.A. and relief surveying and mapping.

on the job and placed before setting, in the bottom of the hole, will form the required anchor. Earth should be well tamped around this precast post. Before starting to place a post, the bench mark setter should ask himself this question, "Is this mark so placed that it will, in all probability, remain undisturbed for a long period of time?" Before answering this question, he should consider the following items: probable future roadway widening or re-location, park improvements, track re-location, possible grade changes involving cuts or fills; character of sub surface soil and any other items bearing on the subject. Unless the above question can be answered in the affirmative, another location should be sought.

The last requirement of the six stated, requires an application of the principles involved in the making of strong and durable concrete. These principles are few in number but very definite and rigorous. They depend upon the following interpretation of the action of cement in the concrete mass -- i.e. cement and water, when mixed together, form a paste which fills the spaces between the particles of aggregate and binds them together. The aggregate is only an inert filler. The paste hardens through a chemical action called hydration which takes considerable time and during which some of the mixing water combines with the cement. While hydration is ordinarily considered complete at twenty-eight days, it doubtless continues for a much longer period. For good results, a bench mark should be kept moist for not less than twenty-one of the twenty-eight days.

1. Given a clean hard tough aggregate, good cement and clean mixing water (free from organic matter) the strength of concrete depends on the ratios between amounts of mixing water and cement. For example: 6 gallons of mixing water per sack of cement will produce concrete having an average strength of 3000 pounds per square inch so long as the mixture of water, cement and aggregate remains plastic, no matter what the quantity of aggregate.

2. Durability is a function of strength but requires in addition, maximum density in order that imperviousness to water may be secured and economy obtained.

3. Aggregate must be sound, graded as to size and free from organic matter. Sandstones (floaters), micaceous rocks or other unsound particles are unsuitable. It is thought that a 3000 pound concrete will be suitable for bench marks and that a durable and economical mix can be obtained experimentally as follows:

(a) A separated aggregate should be secured, i.e. all aggregate passing through a 1/4" sieve, should be separate from aggregate retained thereon -- All aggregate should pass a 1" sieve. Not less than 10 percent of the fine aggregate should pass through a sieve containing 50 meshes per square inch.

(b) Two parts by volume of sand (aggregate passing a 1/4" sieve) should be added to a cement water paste of one volume of cement with water added in the ratio 6 gallons of water per sack of cement.

(c) Coarse aggregate should be measured into the above mixture until the limit of workability is reached. At this time the mass will be "quaky" but will not run readily. A trowel or shovel drawn over the top will smooth the mass neatly. The mixture will not be harsh. This proportion of coarse aggregate should be recorded and used throughout the manufacture.

The above determination of proper proportions of aggregate can be made using a kitchen scale, a few tin cans, a large pan and a trowel. The elaborate equipment of the concrete laboratory is not needed, although it is desirable, to make standard 6" x 12" cylinders at intervals during the manufacture and have these broken at 7 and 28 day periods. The fracture of the material should be carefully examined for porosity left by excess water and for unsuitable aggregate. The above cylinders should be cured under conditions identical with those under which the bench marks are kept. These conditions must be such as to prevent the evaporation of the mixing water before it has had ample time to unite chemically with the cement and thus build up the internal structure of the mass. A ten day period is the minimum, allowable under ordinary methods. When it is seen clearly that porosity is caused by evaporation of excess mixing water, the importance of a minimum of water and of thorough curing is at once apparent.

While the foregoing discussion may at first impress the chief of party as being too involved for practical application, it's essentials can be very briefly stated. Mixing water kept to a minimum, insures good concrete, provided strong, clean aggregate and clean water are used.

For bench marks, six gallons per sack is probably the maximum. When once the bench mark maker realizes that concrete is not a haphazard mixture of gravel, cement, with some water poured over in indiscriminate amount, when he considers carefully the demands made upon a bench mark material, the problem is more than half solved.

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OBSERVING COMFORT

It has been this writer's experience that a great many observers on triangulation do not pay sufficient attention to the conditions of comfort under which their observations are made. In many instances an observer, in order to save a few minutes of time in preparing the station for occupation, will neglect attending to some minor detail which will cause considerable discomfort during the progress of the observations. This sometimes results in obtaining observations that are not of the best quality.

It would seem economical to spend a few extra minutes in preparing the station properly. For instance, when observations are made from a ground station and the conventional silk observing tent is used, it would be well to see that the sod-cloth of the tent is sufficiently weighted all around. This will, of course, help keep out drafts on cold nights, dust or sand in localities where these elements prevail, and sometimes snakes, lizards or other reptiles. A good and convenient way to weight down the sod-cloth at a station which can be reached by truck is by using small bags 4 inches in diameter and 18 inches long, or some other convenient size, partially filled with sand. These can be made up beforehand and can be conveniently carried in a box made for the purpose on the running-board of the "O" party truck or some other suitable place. This obviates the necessity of digging earth where digging is not good or using rocks which roll off the sod-cloth and are a continual source of annoyance.

Another and perhaps the greatest source of trouble and discomfort to observers is wind coming through the observing flaps of the tent. The way our present observing tents are constructed it is almost impossible to entirely cut out the wind by using the flaps alone, particularly when one or more stations are almost exactly in the direction of the wind. One very simple method of eliminating a good part of this annoyance is to take a strip of signal cloth, (ordinary 36-inch muslin) prefer-

ably black, and secure it around the upper part of the tent over the observing flaps, first having ascertained the direction and elevation of each of the lights or signals to be observed upon. Then point the telescope to this known direction and elevation and cut out a hole in the signal cloth approximately twice the size of the objective lens of the telescope. This will keep out a surprising amount of wind and only requires a very few minutes to arrange.

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CAUTION TO LEVEL PARTIES

The following paragraphs are quoted from a letter received in December 1932, from Mr. G. P. Asbury, Engineer Maintenance of Way, Southern Railway System, Danville. Virginia:

"I noticed one of your parties at work on our double track lines south of Greenville, S.C., a few days ago, and while the train was passing on the northbound track the members of the party remained on the southbound track with the instruments set up. This should not be done for a train in the opposite direction may be due, and the noise of the train while passing may cause the entire party to fail to observe the approach of a train in the opposite direction.

"I would suggest, therefore, that in the interest of safety to the men that they make it a practice to clear both tracks while a train is passing."

The point raised by Mr. Asbury is a vital one in connection with the work done by control leveling parties of this Bureau and this matter of safety, not only for members of the party but for train crews as well, should constantly be on the minds of every member of our field parties.

This Office does not feel inclined to promulgate a specific order that both tracks of a double-track road be cleared at every passing of a train. However, there are some instances where this should always be done and the following points should be kept in mind at all times:

1. Where the party is working along a long tangent and a train is about to pass on the track not occupied by the field party it would not seem necessary to pull up the instrument during the passing of a train. However, since

no observing can be done while a train is passing on an adjoining track, the rodmen should each face away from the instrument to watch for approaching trains on the track occupied by the leveling party. The observer should watch one rodman and the umbrella man should watch the other for visual signals to vacate the track if necessary.

2. Only when the track is plainly visible for a considerable distance both ways from the field party should this method be resorted to. In cuts, on curves, and at summits, or under any other circumstances where the track is not plainly visible for a considerable distance in both directions from the field party, both tracks should be cleared for all passing trains.

3. Another point which should be constantly borne in mind is the fact that trains are often run "on the wrong track", that is, a northbound train on a southbound track. For this reason a sharp lookout should be maintained when a train is passing to guard against surprise from a train on the other track approaching from either direction.

4. When working in the vicinity of cross-overs, a sharp watch should be kept to guard against trains, apparently on the other track, taking the cross-over and suddenly bearing down on the party.

5. Fast freights, specials, and other unusual train movements are always a source of danger to a field party and all hands should at all times be constantly on guard against surprise by approaching trains. Even on a single-track road trains which are coasting down hill may often get extremely close to a field party before they are heard.

6. Aside from the question of safety for the field party, it should also be borne in mind that an instrument left on the track, if struck by the locomotive, becomes a potential source of danger to that train or to persons on the right of way in the vicinity. If an instrument should get under the wheels, it might cause a derailment. An instrument struck by a locomotive might be thrown against a train on the other track and thus become a source of danger to passengers or crew of that train, or it might possibly be whirled back doing damage to the engine which struck it. An instrument, if struck by a locomotive and thrown clear of the tracks, might still be a source of danger to members of the party standing even at a considerable distance from the instrument station.

7. An engineman is under great strain when handling a fast train and the behavior of all members of the field party while on the right of way of the railroad should be such as to cause no extra strain or worry to him. The railroads are courteous in allowing our parties to operate along their right of ways and all hands should cooperate to the fullest extent in making the work safe, not only for the members of the field parties, but also in conducting themselves so as to reduce to an absolute minimum the risk of injury to passengers and crews of trains or damage to railroad property.

8. Thought should also be given to the matter of providing an extra margin of safety in keeping clear of all moving rolling stock. Coal sometimes falls off of the pile in the tender or off coal cars. Loads of timber on freight cars sometimes work loose so that the pieces project beyond the normal clearance lines for the train. The fastenings at the bottom of the sliding doors on the sides of box cars occasionally work loose and allow the doors to swing outward at the bottom when rounding curves. Objects are often thrown from car windows and become a menace to the safety of persons working along the tracks. One case recently brought to my attention illustrates a wide range of accidents which may happen when working along railroads. A man entirely in the clear of the rolling stock, but standing on the lower chord of a bridge high above a river, would have been knocked off of the bridge and probably killed as a result of being struck by a pan of dishwater thrown from a dining car if it were not for the fact that he had a very secure hold on one of the upright members of the bridge. This illustration merely serves to call attention to one of any number of unusual things which may happen and is given simply to stimulate thought and care while on or about railroad property.

This is a most important matter and should receive the careful thought and consideration of <u>all members</u> of <u>every party</u>.

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LEVELING PROGRESS
(Party of A. C. Thorson)

"I read with interest the article, 'Tidings from the party of Lieut. Gibson', in the last Geodetic Letter. It is interesting to see the remarkable speed that our leveling units are making with temporary men behind the guns.

"From my progress report for January, I note that five of my observers bettered 25 miles for two consecutive field days. In fact, one observer, Mr. Gibson, bettered that five times during the month, turning in for the five pairs of days, 25.2, 27.1, 28.2, 26.4 and 27.4 miles.

"Another observer, Mr. Whitehead, turned in 15.8 miles in six and one-half hours.

"One of my units with Mr. Lyman observing turned in what I believe to be an all time record for leveling. This unit ran 22 miles of second-order levels in 8 hours and 24 minutes, including 148 set-ups and tied in 16 bench marks. The recorder was 20 year old Calvin Taylor of Salt Lake City. This day's work was executed on the railroad without use of truck or speeder. This party ran 32.4 miles in two consecutive days."

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THE SECTION OF LEVELING GETS A "BREAK"

In the summer of 1933 a field party of this Bureau ran a line of second-order levels from Cold Spring, New York, to Paterson, New Jersey. The closure of the line, when it came to be fitted to the 1929 General Adjustment elevations of the starting and ending bench marks, was 201.8 mm., which was too large for a line of that length.

Many engineers were interested in the results of the leveling along the line and for this reason the closure, though larger than we believed proper, was distributed through the line and elevations were furnished to various engineers, with the caution that the figures were subject to change as a result of additional field work, recomputation, and readjustment.

An engineer in Monroe, New York, who was working near the Cold Spring end of the line wrote to this Office for the elevations of two marks near his project and the elevations were sent him with the usual caution. In February he reported the results of his leveling between the two bench marks, which disagreed with ours. A study of the original record for this one section then revealed the fact that a "minus backsight" had been added instead of subtracted. Making the proper correction not only brought our leveling into close agreement with that of the engineer who reran the line between the two bench marks, but reduced the closure between Cold Spring and Paterson from 201.8 mm. to 11.8 mm.

Instructions to rerun this line which had just been issued were then cancelled.

The Section of Leveling gets a "break" once in a while.

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LEVELING IN SNOW

By S. Y. Symns, Surveyor, U. S. Coast and Geodetic Survey

During the winter we have done some leveling in snow and ice. All of this leveling has been second order and so far as I can tell the lines have checked out reasonably well. The procedure we followed was the same as that used along any dirt road. The steel footpins are used for turning points. The snow must be scraped away and the pins driven into solid ground. During the short time they are left in place we have never been able to see any sign of them loosening. I consider them satisfactory.

When the instrument is set up in snow the legs are pushed through to solid ground. If there is a hard crust on top, care must be taken to see that none of the legs bind on the crust as this may even lift one of the other legs out of the ground.

Snow cuts down on the party progress a great deal because of the extra time required to set the pins and because of the hard walking. Frozen fingers soom to govern the length of time we have been able to work at low temperatures.

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FAILURE OF BILBY STEEL TOWER

The following is an abstract of a report on the failure of a steel tower:

"A 90-foot tower at Station "SALEM" collapsed during a violent thunder storm on the night of April 5, 1935.

"A thorough inspection was made at this tower the next morning and it appears that the tower may not have been anchored deep enough. Of course, the presence of the observing tent undoubtedly had much to do with the tower blowing over, but it appears that the O-party did not have time to remove the tent. It also appears that

had they remained to remove the tent and to more thoroughly secure the instrument that they would have gone over with the tower and would have probably been killed.

"The tower was not damaged a great deal and with the addition of a few members, most of which we have left from another tower failure, it can be repaired and used. It will be necessary, however, to expend two signal lamps and several other small items of equipment.

"The building foreman in charge of erecting this tower, has been replaced as I consider him to blame for the insufficient depth of the anchors."

It is felt that the failure of this tower should serve as a warning to all tower building parties that towers must be substantially anchored. Too many lives are at stake and too much valuable property is endangered by the failure of a tower to permit such a failure to be occasioned by a preventable cause. A little more care in the anchoring of this tower would have saved considerable expense to the government and much wear and tear on the nerves of the observing party which was occupying this tower when the storm came up.

It is the building foreman's duty to make sure that a tower is securely anchored and the Chief of Party's action in replacing the building foreman responsible for this tower is heartily concurred in this Office.

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THE LEANING TOWER

By Kenneth G. Crosby

Poor foundations occur throughout this area, (Washington, North Carolina) and the party nearly lost a tower at POST 1933 - a first-order station - due to the soft mud suddenly giving away after the tower had remained in collimation for two days. The top of the 116-foot tower was 40 feet from the vertical position before it was finally checked. The tower was jacked and blocked up into a vertical position, then torn down and again erected over the old station mark. This time we were able to keep the tower in collimation until we could finish observing from it.

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REPORT ON COMPASS FOR TRUCKS

By Thomas J. Mitchell

1. The "Pioneer" Airplane Compass, No. C.- 6460, was installed in Ford Truck, No. U. S. 489, on December 31, 1934, and has been in continuous service since. As a result of the experiences of that period the following comments and recommendations are respectfully submitted.

2. Installation: The compass mounting should be attached to the truck where it will be convenient for the driver to obtain readings and where the compass will interfere the least with accessories and clear vision both of the road and gages on the instrument panel. It should preferably be as far away from the engine as possible and approximately on the center line of the car. In the case of the Ford truck, the compass bracket was attached to the front frame of the truck just above the windshield, and the compass extended down below the top of the windshield. This compass has to be read through the side and not at the top.

3. Correcting Variation: The compass when first mounted had a maximum variation of plus and minus forty degrees and an irregular compass card. The latter was obtained by "swinging ship". The adjustable magnets at the base of the compass bowl were moved until the variation was reduced to a maximum of plus ten degrees and a convenient compass card produced. This card is used to correct observed bearings to true. Calibrations were determined with the engine running. There is an appreciable difference in the corrections when the engine is stopped.

4. Advantages: In cloudy, foggy and rainy weather the truck compass enables the driver to keep track of directions easily and quickly. The same results of course could be obtained by means of an ordinary pocket compass but at a greater loss of time. In country where maps are non-existent or unreliable, road traverses can be run with the truck compass and speedometer at a considerable saving of time over other methods.

5. Disadvantages: The damping action on the needle circle is not positive enough. This I think is due to the design of this particular compass and may not be as troublesome with another type of compass. It is necessary to stop the truck momentarily when traversing in order to determine the bearing by means of the swing of the compass dial. This swing is influenced by every motion of the truck. An approximate direction can be obtained without stopping on a pavement or by slowing down on a dirt road.

6. Recommendation: This reconnaissance party feels that the truck compasses are well worth while, particularly for the younger men, and is requisitioning additional compasses for the other trucks.

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MAPPING FOR NATIONAL PLANNING

Abstract of paper presented before the Surveying and Mapping Division on January 16, 1935, and reprinted from Civil Engineering for March 1935.

By Frederick H. McDonald

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Consulting Engineer, Atlanta, Ga.

Under the leadership of the national administration, planning is apparently on the way to becoming an accepted basis for procedure in national and local government. The great advantages in economy and in the economic use of natural resources that result from the "considered use" of today's efforts in the light of future requirements become obvious.

The greater the assumption of responsibility for national progress by the Federal Government, the greater the need of those in government positions for the type of basic information that originates with and can be found only on carefully made base maps of our local areas and regions. It is unfortunate that each governmental and business agency, requiring maps and finding them not available, has had to undertake to create its own mapping organization, make its own surveys, and produce its own maps. Overlapping, duplication, and much needless expenditure of money characterize this method of procedure.

What is a Base Map?

A base, standard, or key map of a region or a country is one that shows to the most precise degree of practicable accuracy the horizontal, dimensional relationship of all the fixed features on the earth's surface, and their relative elevations referred to a fixed plane generally taken as sea level. The strength and value of such a base map lie in the completeness and the dependability of the information shown on it. Such maps require a type of initial accuracy that will practically dispose of subsequent reasons for corrections of distances or elevations. A base survey is located astronomically by

stellar observations, and though its controlling points may vanish or be destroyed, their geographic position is a matter of precise, indestructible knowledge, and the points can be replaced.

The Status of Mapping in the United States

In theory, the need for accurate maps has been recognized in the United States for several decades, and certain Federal agencies have been engaged at very inadequate rates of progress on the production of a standard map of the United States. However, a standard map is not yet available. It is commonly estimated that only about 45 per cent of the interior of the country has been covered by topographic surveys and that, of that 45 per cent, about half of the surveys, made 40 or 50 years ago, were originally of the reconnaissance type and of such a character that they are now entirely inadequate or out of date.

This means that only about 25 per cent of the country is accurately mapped, and that 75 per cent of it still must be surveyed to provide an accurate and reliable base map of the United States. The special information and commercial maps that are available are simply two-dimension maps, picturing relative but only approximate directions and distances. They lack accuracy and are of only approximate value, showing nothing of ground features and little of what is on the ground.

In response to a report made by the National Academy of Science, Congress created the U. S. Geological Survey in 1879. To function properly as a scientific fact-finder, the Geological Survey realized that a topographic base map that would accurately delineate physiographic and cultural details was a necessity. Accordingly, a plan to map the entire United States systematically was formulated and adopted. This resulted in the present topographic sheets, which have had a demand in excess of a million copies in recent years even though in many cases they are out of date and inadequate.

The U. S. Coast and Geodetic Survey is the sole Federal agency charged with establishing a control network throughout the United States. All other agencies now procure their initial control from the Survey. The control, or base triangulation of the United States, is computed on the surface known as the "Clarke Spheroid of 1866," and all geodetic positions are derived from that of a single station, namely, "Meade's Ranch" in Kansas, the adopted position of which on the Clarke Spheroid

fixes the geodetic datum. The governments of Canada and Mexico have agreed to employ this same datum for their triangulation, and since 1913 it has been called the North American Datum. It ensures a single, unified network of control for the entire North American continent.

Existing Federal Program

The topographic surveys made by the U. S. Geological Survey and the resulting maps are now dependent upon funds provided jointly through Federal and state appropriations. In the last ten years, however, only about $4,000,000 has been received from states for cooperative mapping. The inadequacy of such procedure is evident, and the Federal Government, necessarily, must assume the function of completing its own base map with Federal funds.

On February 2, 1925, Congress passed the Temple Act. This act authorized the President to complete the topographic map, including the necessary horizontal and vertical control, within a period of twenty years, and authorized the appropriations necessary for that purpose. From 1926 to 1932 the average appropriation for both control surveys and for mapping amounted to $765,000 per year. Now, ten years after the passage of this bill, the inadequacy of the funds actually made available can be visualized by considering the report of the Federal Board of Surveys and Maps, which recommends an average appropriation of $12,000,000 a year for the next ten years, based on estimated costs of $117,531,000 for completing the base map. This plan, released on January 14, 1935, by the National Resources Board, was published in detail in the February issue of "Civil Engineering".

For years the engineers of the country and those interested in the making of maps have realized the wastefulness and ineffectiveness of the present haphazard and miscellaneous efforts of numerous governmental departments to make their own surveys and maps. There is now being crystallized a sentiment for the centralization of these agencies, and it is hoped that this may be achieved by executive order before the expiration of the present Congress. The economies resulting from the elimination of overhead and the discontinuance of wasteful duplication of mapping are evident.

Characteristics Required for a National Program

Any conception of an efficient and economical method of handling not only the present emergency mapping situation, but also the long-range program of Federal surveying and mapping, should include the following:

1. A new centralized surveying and mapping agency or board should be created as a consolidation of existing surveying and mapping agencies. The function of such a mapping bureau would be to execute and provide all the base mapping requirements of the nation.

2. Periodically, the various Federal agencies should report their surveying and mapping requirements.

3. The mapping bureau should study these reports and arrange a program to be executed within whatever time limit their importance may justify.

4. Priority as to time of work and locality should be worked out in connection with the requirements of the several agencies served, but the standards of the work done should be such that each product automatically becomes a part of the standard map.

5. Air-photography should be used wherever practicable.

6. The geodetic control should be completed and adjusted as quickly as possible, in order that it may be available for any project.

7. Certain projects will be of such character as to require separate individual treatment by the agencies affected, but these projects also can contribute material for the standard map. Thus it should be required that they be tied into the geodetic control nets.

8. Certain Federal agencies would use the standard map, or material from it, as a base on which to show special information pertinent to their respective functions. The big saving to be expected comes from a general reduction of overhead and from the reductions in the cost of duplicated field work.

Feasibility and Requirements of a Large Mapping Program

A project for mapping the country in from 10 to 12 years is a large one, but not otherwise difficult. Mapping is a relatively simple engineering operation. There must be a nucleus of thoroughly trained engineers who understand the finer points of the work. However, such a nucleus already exists, and a large mapping organization can be built around it. Steps to be taken in the execution of such a program follow:

1. There should be a reorganization of the Federal mapping agencies.

2. A careful study should be made of the kind of map to be produced.

3. Funds should be secured for undertaking the work. The first step in the field work would be to spread networks of triangulation, traverse, and levels over the areas to be mapped. As soon as this work is under way the areas should be photographed from the air.

4. With these photographs and the results of the triangulation, traverse, and leveling surveys, large numbers of engineers can be employed in offices compiling planimetric maps, that is, maps without elevations.

5. Before the work can be considered completed, elevations must be shown by means of contours. As the two-dimension work sheets become available, the task of providing contouring should be undertaken.

6. The final drawing and publication of the results on the various standard scales necessary for convenient use by the public should be undertaken as soon as the contouring and topographic detail are completed.

Whether or not there is created a central bureau of surveying and mapping, to provide an able, disinterested, and responsible means of communication between the mapping agency, or agencies, and the users of maps, both business and governmental, there is need for a board of competent, technically equipped citizens of wide experience to act in an advisory capacity to the governmental mapping agency. Such a board could act as a judicial body to determine the various factors affecting mapping. It could also control the kinds of maps to be made, mapping standards, and the areas to be mapped at given periods. Such a board could be appointed by the proposed mapping agency itself or by the joint action of existing agencies in cooperation with various professional and technically representative groups.

Engineering Education and Surveying Methods

As a corollary to a ten-year program of making national control networks and mapping, the adequacy of the type of instruction given those who will use these newly available data must be considered. With the completion of the proposed mapping program, every state will have a great number of permanent monuments, requiring probably not over a five-mile maximum survey to reach any particular one. While the production of accurate base maps from these control monuments is important, the future surveys

for local development and for determining land boundaries are equally important. This prospect makes it necessary to consider the type of surveying instruction now available for engineering students. If permanent reference points are to be made the basis of a complete map of the properties in the country, future requirements will demand that every survey start and close on a first or second-order reference point for horizontal control, and on a precise bench mark for elevation control. To achieve this result it would be necessary that the curriculum of every educational institution teaching surveying include a definite and sufficient amount of instruction in precise surveying.

Until the standard base maps are complete, soil survey maps cannot be made fully available, and the agricultural opportunities of the nation are retarded. Only by having surveys of any property accurately made and tied into permanent reference monuments is it possible, indisputably and officially, to make easy and accurate relocations, and to make from these individual property surveys an accurate, mosaic, property map of the area, which can be used for tax purposes as well as for transfers of titles. The artillery in the U. S. Army would be useless for accurate indirect fire against an invading force, without the precise control and topographic data that can be afforded only by completed standard base maps. Topographic maps have proved to be an invaluable aid in the study and teaching of physical geography, both in the public schools and in the colleges. Areas of plant quarantine, which have been established to protect the agricultural resources of the country and the well-being of the whole people, can be shown. Also, bioclimatic areas can be readily outlined on topographic base maps without extensive field surveys.

Every department of the Federal Government has had occasion, and will continue to have occasion, to demand accurate, topographic maps. The structure of outcropping rocks must be studied in relation to the shape and elevation of the land surface, and such features are readily obtainable only from good maps. For the control of malaria and for studies of stream pollution and water resources, good topographic maps are essential. It has been said that enough money has been wasted in faulty highway construction due to inaccurate information to more than provide for the full cost of the completion of the base map of the United States. Because of insufficient information on watersheds, the flow of water has had to be assumed. This has resulted in periodic, expensive, and dangerous washouts as well as the frequent over-design of structures,

which has caused wasteful expenditure. All the factors influencing the sound location of industrial enterprises, including plant site, topography, water supply, drainage, highway and railroad transportation, power lines, and the relation of urban and rural areas as a source of labor supply, can be determined from topographic maps without detailed local surveys.

It has been stated that, through lack of maps, the oil industry alone has been losing on an average each year more than the total cost of making topographic maps for the oil-producing states. For the first time in the history of our country, the recent national census revealed a population preponderantly urban. This tendency brings with it such problems of future planning that nearly all the large communities in the country are becoming planning-conscious. Only with topographic maps can the details of community expansion be worked out effectively and with economy. Automobile tourists make extensive use of topographic maps, because no other maps in existence supply the motorist with so many valuable details. Public utilities generally make their own surveys - in many cases inadequate ones - because of the necessity for speed. Not only could the expenditure of considerable money be avoided if accurate base maps were available, but large expenditures for plant could be saved as a result of the more accurate design possible only when more accurate field information is available. Both of these costs enter into the rate base structures of utilities and will continue to be added until a base map becomes available. This means that every consumer of every utility continues to pay on this unnecessary investment.

National Mapping Plan

It is logical to assume that the National Mapping Plan of the Board of Surveys and Maps will be used as a basis for any expenditures arising out of the appropriation of funds for such purposes by the Federal Government. In view of the great need for maps, the impetus to planning for future improvement throughout the nation, and the great benefits that can come from the intelligent use of accurate information, it behooves every engineer and every citizen to support the Government in working out such a program and in securing the continuing appropriation of funds necessary for its completion.

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NEW JERSEY RECONGIZES THE STATE SYSTEM OF PLANE COORDINATES

An act designated, Assembly No. 209, State of New Jersey, and entitled "An Act to establish a system of land boundary descriptions" was introduced in the legislature of that State on January 28, 1935, passed both houses under a suspension of rules, and was signed by the Governor and became a law on March 25. This Act designates the system of plane coordinates established over New Jersey by the Coast and Geodetic Survey as the official survey base for that State, and recognizes geodetic control stations established in conformity with the standards adopted by the Survey as legally acceptable for use in relating property surveys to this official base. It is planned to devote the next number of the Geodetic Letter to a symposium on the subject of the use of geodetic control for private boundary surveys. Statements of experience and expressions of opinion based on study and experience contributed by prominent engineers in various parts of the country will make up the major portion of that number of the Geodetic Letter, which will include copies of the New Jersey Law both in its preliminary forms and as finally passed.

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AZIMUTHS AT TRIANGULATION STATIONS

In 1928 the observers on triangulation parties inaugurated the establishment of azimuth marks at each of the triangulation stations. The azimuth mark is designed to furnish to an engineer engaged on a local project, an easily obtainable bearing or azimuth from the station position. The azimuth mark is supposed to be placed some three to five hundred yards from the station depending upon the terrain and in such a place that it can be seen by the observer standing at the station mark. Of course, in some places there is brush between the station and azimuth mark which would prevent direct observation between the two monuments. In such cases the engineer on local work is supposed to clear the brush in order to make the azimuth mark visible from the station.

There have been a few cases reported by engineers who have visited our triangulation stations where the azimuth mark could not be seen by a man standing at the station mark. It is hoped that only a very few such unsatisfactory locations of azimuth marks have been made. The observers and the foremen of the building parties

should have clearly in mind the purpose for which the azimuth mark is intended and then the location should be selected which will best accomplish this purpose.

There are many cases where the ground is such that an azimuth mark must be less than three hundred yards from the triangulation station. This is especially the case when the station is located on a ridge or a rounded hill. When the distance between the station and the azimuth mark is short then more care must be exercised in determining the direction of the line. When a high tower is used, and the distance to an azimuth mark is a short one, then it is desirable to observe the direction on the azimuth mark from a stand set up over the station mark. While this might require some extra effort and time yet it is wise to go to this trouble in order to have an azimuth that is accurate. With a high tower and a close azimuth station the telescope is inclined at such a large angle as to lead to some inaccuracies in observations. A high tower can not be occupied without some slight eccentricity relative to the station mark and at a distance of one hundred yards even one millimeter eccentricity amounts to more than 2 seconds error in azimuth.

In cases like this where the observations on the azimuth mark are made from a stand placed over the station mark, some definite, distant object such as a point on a house or barn or something similar that can be seen from the ground should be cut in from the tower with a main scheme station as initial and then this object can be used as the initial for determining the direction to the azimuth mark.

The instructions for triangulation call for observations on houses, barns and other objects that may be visible from the ground even though they can not be observed from a second station. Such objects are good azimuth marks and supplement the data to regularly marked azimuth stations.

It is occasionally true that the reference marks can not be observed from the top of a tower because of their proximity to the station. In such cases the instrument can be set up over the station mark and the reference marks tied into the azimuth mark or to some object whose direction from the station has been previously determined.

The azimuth marks set at our stations have greatly increased the value of our triangulation to the engineering profession. Our observers should make every effort to to place the azimuth marks in the best possible places and to determine their directions or bearings with accuracy.

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SECOND-ORDER TRIANGULATION

There has been some discussion in the Division of Geodesy as to what the instructions for second-order work should be. It must be realized that the greater part of the work of triangulation consists of the following operations: reconnaissance to select points for the stations, monumenting of the stations, building towers and stands over them, traveling of the observing parties and lightkeepers to the stations, preparing the stations for observation, mounting and centering the instruments, and writing the descriptions of the stations. The remaining work consists of the observations of horizontal directions to the main scheme stations and to intersection and supplemental stations.

The amount of work is about the same for all classes of triangulation except that involved in making the observations on the main scheme lines. There are many cases on record where the first-order observations on a five-line station have been completed within one hour. It is seldom that more than two hours of observation are required. This involves the observing of sixteen positions over each line, each position requiring a new setting of the circle.

The specifications for first-order work have been prepared after a hundred or more years of experience in this and other countries with this class of work. We know just what must be done to achieve a certain degree of accuracy in geographic positions, azimuths and lengths.

We have done no great amount of second-order work in the interior of the United States. Generally, second-order work is considerably lower in accuracy than first-order triangulation. The officials of this Bureau have, however, used good judgment in deciding that it would be wasteful of effort to go through all of the operations of triangulation and then skimp the observations in order to save only a few minutes or, at most, half an hour of observing at each station. In consequence, the specifications for second-order work provide first that single triangles can be used more frequently than on first-order work. This aids the reconnaissance very greatly in certain character of country. It also means that the observing party does not have to hold up its progress when one of the diagonal lines of the quadrilateral is obstructed. Second, a larger allowable closing error of a triangle is used on second-order work than on first-order. This avoids the necessity of re-occupying the stations unless the closing error is greater than five seconds. The length angles of

second-order work can be somewhat weaker than on first-order work and the Laplace azimuths and base lines of the second-order arc can be somewhat more widely spaced. The specifications for second-order work now call for sixteen positions over each main scheme line but the observers are permitted to use a smaller number of positions on the rare occasions when bad weather or other circumstances prevent the completion of the sixteen. As low a number as eight positions is acceptable upon those infrequent occasions.

It is believed that the above specifications for second-order work involve no increase in the cost over that required if the specifications called for only eight positions over each line. The only reason for letting down on the number of observations on the second-order triangulation would be to expedite the work and to reduce the unit costs. Higher accuracy than second-order is desirable if it can be obtained without additional cost.

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U. S. COAST AND GEODETIC SURVEY CONTROL FOR ROWING COURSE

By John B. Babcock, 3d*

M.I.T. and Harvard crews on the Charles River Basin this spring will probably be the first crews ever to row on a course which has been laid out precisely and tied in to the official U. S. Coast and Geodetic Survey network of the United States. Extensive park development of the Boston shore of the Basin between the Longfellow and Cottage Farm Bridges made it necessary to lay out new rowing courses for the crews of Technology, Harvard and other rowing organizations. The intercollegiate course is 1-3/4 mile "straight-a-way"; shorter races are rowed for distances of 1 mile and the "Henley" distance (1-5/16 miles). Formerly the long and short races were rowed on different courses, but it was decided that in laying out the new ones they should all start at the same line and follow the same course direction - with different finish lines.

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* Professor of Railway Engineering, M.I.T., Cambridge, Mass.

A preliminary study indicated the need of an accurate "control" survey of the Basin between the Longfellow and Cottage Farm Bridges, a distance of about two miles. Plans were available showing the entire Charles River Basin but these had apparently been compiled from different sources and could not be used as a basis for a final location of the course. The shape and limited length of the Basin, the projecting bank on the Cambridge side near the 1/4 mile mark, the necessity of keeping outside of the anchorage basin above the Harvard Bridge, the piers of the Harvard Bridge, and the breakwaters and Longfellow Bridge near the finish line all served to limit the location of the course. For these reasons it was decided to make a survey which would not only give the necessary information for this purpose but would also serve as a control for a base map of the Basin.

The actual survey was carried out by the Civil Engineering Department of M.I.T., the work being done by F.E.R.A. students under the direct supervision of Professor Babcock. A base line was established on the sea wall on the Cambridge side of the river and the survey carried by triangulation methods between the limits of the Longfellow and Cottage Farm Bridges, a distance of nearly two miles. Through a fortunate coincidence the U. S. Coast and Geodetic Survey had a party at Boston on first-order triangulation work at the time the M.I.T. Survey was in progress. Arrangements were made with Captain F. L. Peacock, Inspector, U. S. Coast and Geodetic Survey at Boston to establish triangulation points at both ends of the Basin, one on the roof of the R. H. White Building at the Cambridge end of the Cottage Farm Bridge, and another on the roof of a building on Embankment Road near the Boston end of the Longfellow Bridge. The fieldwork of the U. S. Coast and Geodetic Survey was carried out by Mr. Herman J. Shea, scientific aide and a civil engineering graduate of M.I.T. The M.I.T. Survey was then tied in to the reference points which had been established by the Coast Survey in connection with its two new triangulation stations: "White" and "Nurse". By this means it was possible not only to secure an independent check on the length of the course as established but also to locate the course with reference to the U. S. Coast and Geodetic Survey triangulation network. The final check showed the M.I.T. and the U. S. Coast and Geodetic Survey work to agree almost exactly over a total distance of over 10,000 ft. It was obvious that the securing of this <u>exact</u> check was a coincidence; a check within a few inches over the entire length would have been considered satisfactory in view of the less precise methods used on the M.I.T. Survey. As a result of the cooperation with the U. S. Coast and Geodetic Survey it is possible to state the geodetic location of the course. The latitude and

longitude of the start and finish points (on the southerly edge of the course) are as follows: Start: Latitude 42° 21' 06".33, Longitude 71° 06' 25".14; Finish: Latitude 42° 21' 35".87, Longitude 71° 04' 28".70. The true bearing of the course is N 71° 07' E, this being the average of the forward and reverse bearings to the nearest minute.

Probably no other rowing courses have ever been established with the precision of these. Obviously no such precision is required for a rowing course; but in this case it seemed desirable to secure an adequate triangulation control of the Basin. The cooperation of the U. S. Coast and Geodetic Survey in bringing its triangulation directly to each end of the Basin and establishing reference points in readily accessible locations will make it possible to prepare accurate maps of this important area without any difficulty. When the triangulation stations of the M.I.T. Survey have been computed with reference to the basic U. S. Coast and Geodetic Survey points, it is the intention to furnish the data to the Metropolitan District Commission and to the cities of Boston and Cambridge. This information will be submitted to Mr. Houdlette, who is in charge of the cooperative work being done as an E.R.A. project by Massachusetts and the Coast Survey, in order that it may be included in their coordinate system.

Range markers have been set which show the location of the southerly (Boston) edge of the course, the starting line, the finish lines for the 1-mile, Henley (1-5/16 mile) and the 1-3/4 mile courses, and the 1/4, 1/2, 3/4, and 1-1/4-mile points on the course. The ranges for the quarter-mile points will provide an easy method of timing the crews at definite intervals along the course. The range markers are of two types: (a) targets mounted on 8-foot posts, and (b) boards attached to the fence rail on the sea wall on the Cambridge side. The target markers consist of circular disks 20-1/4" in diameter made of cadmium plated steel, painted white on the river side with a 3-inch black vertical stripe and painted dark green on the back. These are attached by special bronze fittings to 2-inch pipes about 8 ft. long; the pipes are painted dark green. The pipes are threaded at the bottom in order that they may be screwed into bronze castings of special design which are embedded in the concrete foundation posts. The concrete posts are 7 inches square and 3 feet long. Bronze cap nuts with recessed heads are also provided which may be screwed into the bronze castings when the pipes and targets are not set up. Since it may not be desirable to keep the targets up except during the rowing seasons in the spring and fall, the design and construction of these markers has been carried out in such a way that

either the disks alone may be removed or the pipe posts may be taken down. All parts except the standard pipe posts have been made of material which will resist corrosion and provide a permanent form of construction. The board markers are used at locations on the fence which extends along the sea wall on the Cambridge side. These boards are 39 inches high, 8 inches wide, and 2 inches thick, painted white on the river side and dark green on the back. They are attached by wire to the fence rails. The location of the point is indicated in large black letters or figures on the white face of the board. Similar markers will be used on the upstream side of the Harvard Bridge to indicate which spans are to be used by the different crews. The construction of the markers and foundation posts, with the exception of special castings, etc., has been carried out by F.E.R.A. students at M.I.T. under the direction of staff members of the Civil Engineering Department.

The entire project has been carried out by Technology for the benefit of all those organizations which are interested in rowing on the Charles River Basin. The effective cooperation of Technology and Harvard athletic officials in the preliminary planning has made it possible to lay out and mark the courses in such a way that they will be of the greatest service. Mr. William J. Bingham. Director of Athletics, and Charles J. Whiteside, rowing coach, represented Harvard University in the negotiations. Technology crew interests were represented by Allan W. Rowe, Secretary of the Alumni Council on Athletics, and William B. Haines, rowing coach. Dr. Rowe, who had been responsible for the bringing together of all the organizations interested in rowing on the Charles River Basin, died before the project had been completed. Mr. Ralph T. Jope, who succeeded him as Secretary-Treasurer of the Alumni Advisory Council on Athletics, served as a representative of M.I.T. during the latter part of the project. Professor J. B. Babcock of the Civil Engineering Department of M.I.T. had charge of the surveys, and of the design, construction, and placing of the markers.

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COAST AND GEODETIC SURVEY PERSONNEL

At the present time there are approximately 2400 men employed on the field and office work of the Coast and Geodetic Survey. This has been made possible by allotments received in accordance with the terms of the National Industrial Recovery Act.

Approximately 1400 of these men have had at least a partial college education and 700 are graduate engineers. Former students of 371 colleges, from every state in the Union, are at present engaged on temporary field and office work.

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EDITORIAL

According to the number of criticisms and suggestions received from the field lately, most of the wrinkles and problems that usually occur to field men must be straightened out. However, we do not believe this to be the case and we desire to solicit further criticisms and discussions of any kind from the field. Any new idea or gadget which may seem commonplace enough to the originator will, in all probability, be of great benefit to someone who has not had the same thought.

It is the purpose of this publication to simplify as far as possible, the field work of this Division and anyone, regardless of their station, is urgently requested to communicate to the editors of the Geodetic Letter any ideas or suggestions which, in their opinion, are new and are to the advantage of the service.

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ERATUM

In Geodetic Letter, volume 2, number 3, page 14, the "Editor's Note" should read as follows:

The Coast and Geodetic Survey found many years ago that it could not get good results with steel tapes on base measurements by daylight taping. Due to the low coefficient of expansion of invar this difficulty does not occur with invar tapes and it is recommended that engineers wishing to make accurate traverses use such tapes. Second-order accuracy, however, can be obtained by careful taping with standardized steel tapes corrected for temperature change.

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REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during January, 1935:

First-order - - - - - - - - - - - - - - - -	1,912
Second-order - - - - - - - - - - - - - - - -	0

Completed during February, 1935:

First-order - - - - - - - - - - - - - - - -	1,351
Second-order - - - - - - - - - - - - - - - -	215

Total miles of triangulation completed to February 28, 1935:

First-order - - - - - - - - - - - - - - - -	56,372
Second-order - - - - - - - - - - - - - - - -	3,536

Levels:

Lineal miles of levels completed in January 1935:

First-order - - - - - - - - - - - - - - - -	1,113
Second-order - - - - - - - - - - - - - - - -	11,240

Lineal miles of levels completed in February 1935:

First-order - - - - - - - - - - - - - - - -	867
Second-order - - - - - - - - - - - - - - - -	10,097

Total miles of levels completed to February 28, 1935:

First-order - - - - - - - - - - - - - - - -	102,128
Second-order - - - - - - - - - - - - - - - -	112,654

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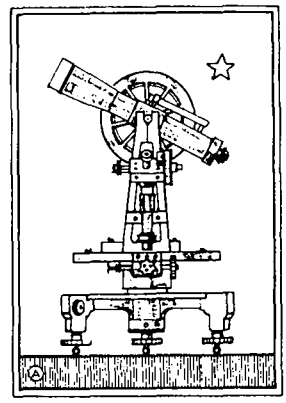

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U. S. Coast and Geodetic Survey
DIVISION OF GEODESY

GEODETIC LETTER

Volume 2 MAY, 1935 Number 5

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THE USE OF GEODETIC CONTROL FOR BOUNDARY SURVEYS

(A SYMPOSIUM)

Introduction

It is becoming more and more generally recognized that one of the greatest potential values of the national triangulation survey may result from its use to control and perpetuate boundary surveys. In surveys of International and State boundary lines this use has already been fully recognized; but in surveys of private boundaries full recognition through legal status has been given in only one State, Massachusetts, and in one Territory, Hawaii.

Several steps are necessary in the legal development of this use. The first step has already been taken in the establishment of systems of plane coordinates for the various States, and the computation (now in progress) on these systems of the coordinates of the stations of the national triangulation. This makes it possible for the land surveyor to utilize the data which such stations furnish without departing from standard practices - methods and formulae - of plane surveying. It gives him the benefits which come from having the many triangulation stations in a large area serve as witness marks to his surveys, thus insuring the easy replacement of lost corners. It also gives him the great benefit of having accurate positions for well-marked points to which he may adjust his surveys.

The second step in the development of the use of the national triangulation for the control of property surveys is to make such use formally legal, so that a competent engineer who appreciates the values of such use, and adopts it to enable him to make more accurate and lasting surveys, will not find himself at any disadvantage in a court of law because of having done something which is without precedent or beyond the previous knowledge of the court.

The time now seems opportune to at least make a study of this second step. Can not this step most easily be taken by enacting proper statutes legalizing the use of plane coordinates based on the national triangulation system in describing property boundaries? Already in one State, New Jersey, an appropriate bill has been introduced in the State legislature, passed, and enacted into law. Copies of this bill in its various forms and as finally signed by the governor will be found further on in this Geodetic Letter. There will also be found an outline draft for a

bill to take care of those cases where more than one system of plane coordinates has been established over a State.

A satisfactory use of the stations of the national triangulation and of the control stations established by State engineers under the direction of the Coast and Geodetic Survey naturally depends upon the accessibility of such stations. Engineers should have access to them even though they be on private property; the owner of the property should be protected against possible injury resulting from survey operations; and the station marks themselves should be protected against malicious damage. A draft for a bill to accomplish these things will be found also in this Geodetic Letter.

It does not seem desirable at the present time to even consider the question of making the use of the national triangulation and of any plane coordinate system based on it in any State mandatory. To do so would be unwise, premature, and would surely jeopardize the passage of any bill looking in that general direction. It is felt, moreover, that as engineers become familiar with the use of State plane coordinate systems in property surveys they will more and more be convinced of their great value, more and more willing to use such systems themselves, and eager to see them generally adopted for survey purposes. Thus, by educational processes, they themselves will pave the way to the third and final step leading to the complete recognition of the national triangulation and of State coordinate systems - the establishment of State land courts and the mandatory use of the national triangulation and of the State coordinate systems. State land courts are already functioning satisfactorily in Massachusetts and Hawaii, but the establishment of these courts antedate by many years the adoption of State-wide plane coordinate systems, and it is probable that such systems will greatly simplify the engineering work of these courts.

In order to secure a comprehensive view of authoritative weight on this matter, the letter and memorandum which come immediately after this introduction were sent to thirty-three correspondents throughout the country with the request that they give the memorandum their careful consideration, make a study of the papers which were sent with it, and prepare a critical review thereof. The following symposium was prepared from the letter and other papers sent these correspondents, and from the comments received from them.

The entire matter is now laid before the readers of the Geodetic Letter with the hope that each reader thereof will give it his careful consideration, and report any

comments he may desire to make. Constructive criticism is desired; but, as every engineer knows, such criticism should call attention not only to what are considered good points, telling, if possible, how they may be made better; but flaws also should be pointed out, and even where the critic is unable to suggest a means of correction, if the objection be valid, a remedy will surely be found.

Please address all communications to The Editor of the Geodetic Letter.

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Editor's Note:

All of the material in this number of the Geodetic Letter has been gathered together and prepared for publication by Hugh C. Mitchell, Senior Mathematician in the Division of Geodesy of the Coast and Geodetic Survey. Mr. Mitchell has had wide experience as a practical engineer, having been a member of the field force of the Coast and Geodetic Survey for a number of years, engaged on geodetic, hydrographic, and astronomical surveys. Later he served as a geodetic computer in the Washington office of the Survey. In 1912-13 Mr. Mitchell was engineer in charge of a precise geodetic survey of the city of Cincinnati, and of an engineering topographic survey based on that control. For the past fourteen years he has been a mathematician in the Division of Geodesy and is deeply interested in all phases of the use of geodetic control surveys.

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March 5, 1935.

(Letter sent to thirty-three correspondents throughout the country)

Dear Sir:

It is becoming more and more generally recognized that a great potential value of the national triangulation survey lies in its use for controlling and perpetuating boundary line surveys. In international and state boundary surveys this use is already fully recognized, but in private property surveys only recently has it been made practicable through the adoption of systems of plane rectangular coordinates in the various states; it has been further promoted in many areas by the breaking down of the major triangulation through traverse executed by state engineers under the direction of Coast and Geodetic Survey representatives.

For the purpose of finding out what interested persons think of this use of the national triangulation in making private boundary line surveys, and thus providing material for a study of the subject, the accompanying memorandum is being sent to a number of persons throughout the country with the request that they consider its contents carefully and send in any comments which they may care to make. From the material which may thus be gathered together, it is planned to prepare a special edition of the Geodetic Letter, a publication of the Division of Geodesy of this Office, and through this medium place the subject before a large number of persons who already are or may become interested therein.

It will be appreciated if you will give this memorandum your careful consideration, and send any comments you may care to make thereon direct to the signer of this letter. A prompt reply will be appreciated.

Sincerely yours,

Hugh C. Mitchell
Senior Mathematician.

Enclosure.

THE USE OF GEODETIC CONTROL IN PRIVATE BOUNDARY SURVEYS

One of the greatest potential uses of the national triangulation system is the controlling of private boundary surveys, thereby giving that insurance which comes from being able easily to replace a lost corner, with the added advantage of a higher degree of accuracy than is possible with the ordinary methods of land surveying. Until recently the fullest use of the data provided by the national triangulation system required the employment of geodetic formulae and methods, which was impracticable except where the extent and importance of the survey were so great (as of the boundary of a country or of a State), or the interests involved were so large (as the survey of a city), that the employment of experts and the purchase of special equipment were fully justified. For surveys of private boundaries a very limited use of the national triangulation data has been accomplished through the adoption of local systems of plane coordinates.

Now, however, the above limitations no longer prevail, and it is generally possible for any engineer to base his surveys on the national triangulation system by using one of the plane coordinate systems recently adopted for the various States, yet conduct his work according to standard methods of plane surveying.

It is the orderly development of this use of the national triangulation system in the making of private boundary surveys with which this paper is concerned, and in which it is hoped that we may have the benefit of the judgment and experience of those to whom it is being sent.

One thing which in the past has limited the use of the national triangulation for controlling plane surveys and the reduction of the results of such surveys to plane coordinate systems, has been the distance out from an origin or central meridian that computations based on a tangent plane or cylinder may be carried before untenable errors of scale develop. Another limitation has been the distance between stations of the national triangulation, which is sometimes so great that an engineer making a local survey even in an area included within an arc of triangulation has found the expense and technical difficulties incident to connecting his work with the triangulation so great as to be prohibitive, while many areas were so far removed from the national control as to make the desired connection practically impossible to an engineer with ordinary equipment and training.

Notwithstanding these difficulties there has been a slowly developing use of the data afforded by stations of the national triangulation for local surveys. This use has been facilitated by Coast and Geodetic Survey Special Publication No. 71, entitled "Relation Between Plane Rectangular Coordinates and Geographical Positions." But even this use has been unsatisfactory because the area over which a single survey could be accurately projected was limited, making necessary a number of plane coordinate systems in comparatively small areas (the triangulation of New York City executed in 1903-8 was computed on three such systems), and being productive of computational complexities in regions close to the common borders of adjacent systems.

The first obstacle named above has been almost completely removed by the adoption of systems of plane coordinates for the various States, usually consisting of one system, but sometimes of several for a given State; and by the computation and publication of the coordinates of the many triangulation stations of the national control net which is now well under way. Each such system will permit of plane surveys within the area which it covers being adjusted to the national triangulation control, errors arising from projecting the results on a plane being kept within acceptable limits. Where greater accuracy in the computation is desired, the scale error may be reduced through the medium of known scale factors.

The second obstacle, remoteness of local surveys from national control stations, is being rapidly eliminated. It will not be many years before there will be few, if any, points in the United States more than twelve to fifteen miles from a first- or second-order triangulation station. The national control is being further broken down and made more accessible to the local surveyor by the many traverse stations being established by State engineers under direction of the Coast and Geodetic Survey.

The time is not far distant (for many regions it is already here) when an engineer engaged on surveying and mapping areas of any size will be able to take advantage of the permanence and accuracy resulting from basing his work on the national triangulation, and if it is advantageous to start work on a large project in a number of places at the same time, or desirable to extend and join isolated surveys of separated areas, he will be able to fully coordinate and correlate such surveys, knowing that when junctions of separate surveys are effected, he will not encounter those bug-bears of the ordinary survey and map: overlaps, off-sets, and gaps.

Some engineering maps are already being made in this way, for such uses as State highway planning and construction; this use will be extended as engineers become informed of the existence of the adopted systems of plane coordinates for the various States, and familiar with the use of the national control survey. There is no real obstacle to such use. After all, an engineering map is frequently a means to an end; the engineer may make it according to such methods as seem best to him, though he may often be limited more by poor instrumental equipment than by lack of knowledge of methods. The map is used as a base for the making of plans, the plans grow into engineering structures, and the maps are filed away, perhaps for good - they have served their purpose. But such maps have a possible future utility for additional planning, and if of acceptable accuracy and detail might be used in building up county and state maps.

But the great potential use of the national triangulation and of State traverse systems already referred to, the control of cadastral or property boundary surveys, yet remains to be developed.

The logical way of promoting such use of a State system of plane coordinates would seem to be to provide for its legal recognition before such use occurs, and not to trust its promotion to the uncertain outcome of court tests as a means of educating property owners, title and financing companies, and State and county officials. Can not this be most easily done by an act of legislature, defining an adopted coordinate system, and approving the use of coordinates based thereon for describing property corners and cadastral survey stations? In one State, New Jersey, a bill for this purpose has already been drafted and introduced in the State legislature. Without waiting to profit by such discussion as may possibly attend its consideration by that legislature, would not the present seem an opportune time to at least consider the inauguration of similar measures in other States? To determine if such be the case, and if so, to expedite consideration of this matter, is the purpose of sending this memorandum to a number of persons who, it is felt, are interested in the matter, and willing to give it some constructive study.

There will be attached to this paper a copy of the bill designed to give legal recognition to the State system of plane coordinates as introduced in the New Jersey legislature. There is also attached a copy of that bill as originally prepared in this office; the changes were made by our State representative after consultation with State officials. A third form for a bill to care for the situation in a State having more than one system of plane coordinates is also

attached. This form was prepared before any return was had on the New Jersey bill. It will differ from the form for a State with only one system of coordinates in that Section 2 must be expanded to include a complete description of each of the systems of coordinates it is desired to approve. This will lengthen the section considerably, but not necessarily render it more complex. Perhaps the easiest way to define the area over which any given system may be legally used would be to name the counties in that area.

But in addition to this, there would have to be some way of taking care of surveys of a piece of land which extends into areas covered by two different systems of plane coordinates, and where the line on the ground separating the two systems is not a definite well-recognized line. The survey of such a piece of land would have to be on a single coordinate system, and a legislative act should recognize this and provide a way for taking care of it. One suggestion as to how this may be done is contained among the notes following the third-mentioned form for an enabling act.

Pertaining directly to the satisfactory use of triangulation and traverse stations established by or under the direction of the Coast and Geodetic Survey is the need of authoritative permission for a duly accredited surveyor engaged in the practice of his profession to have access to such stations as he must tie into his work. There should then be a second bill prepared authorizing such entry where the station is on private property; it should provide that no unnecessary damage be done in such entry; and it should also provide means of assessing damages and collecting them where any damage is done. In other words, it should make any such station completely available for the use of the surveyor, and at the same time fully protect the property owner from any resulting damage. The same bill should also carry a clause providing protection for the survey marks themselves. A form for such a bill has also been prepared and is submitted with this letter for your consideration. In studying it the main things to consider are: whether it permits the surveyor to do all necessary things and only necessary things in entering private property for the purpose of using a survey station thereon; whether the property owner is fully protected from damage in such entry; and whether the survey marks are insured as far as possible against malicious destruction. The actual form of this bill, particularly the sections which describe the methods of assessing damages, will have to be written to conform to the statutory requirements and legal practices already existing in the various States. With the desired content fully agreed upon this should not be such a difficult matter.

You are one of a small number of engineers and interested persons to whom this memorandum is being sent with the hope that you will give it and the attached papers careful study, and write fully just what you think of this matter. Consideration is now being given to publishing in one number of the Geodetic Letter a symposium of these various papers and comments thereon, and in this manner placing the matter before some six hundred or more engineers and other interested persons throughout the country, and inviting their study and comment. The basic material thus accumulated should make it possible for interested persons in any State to prepare Bills which would conform to the legislative regulations in that State and at the same time, if enacted, fully accomplish the desired ends.

Your cooperation in this matter is earnestly requested. Any comments which you should make, but are unwilling for the editor of the Geodetic Letter to include in a symposium on this subject, should be so indicated. Your statements may be as broad and as deep as you care to make them, and should take note of the need, values, form, content, etc. of the proposed Acts.

It will be appreciated if you will send your reply, as requested in the letter which accompanies this memorandum, direct to Hugh C. Mitchell, Senior Mathematician, U. S. Coast and Geodetic Survey, Washington, D. C.

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ORIGINAL DRAFT OF NEW JERSEY BILL

The following is the original draft of a bill prepared for introduction in the New Jersey legislature. It was modified to meet a rule that no reference could be made to a publication which was not copied in the bill.

An Act to establish the legality of land boundary descriptions expressed in terms of plane rectangular coordinates.

Section 1. Be it enacted by the General Assembly of the State of New Jersey, That for purposes of describing the location and boundaries of any parcel of land within this State it shall be considered a complete, legal, and acceptable description of such location and boundaries to give the positions of the corners of said boundaries in terms of coordinates on the system of plane coordinates established over this State by the United States Coast and Geodetic Survey, and defined in Section 2 of this Act.

Section 2. And be it enacted, That the legal and official name for the system of plane coordinates to which reference is made in Section 1 of this Act shall be "The New Jersey System of Plane Coordinates," said system being defined by the tables computed and published by the United States Coast and Geodetic Survey in 1934, which tables are based on a transverse Mercator projection having a central meridian 74° 40' west from Greenwich. In said system triangulation station Princeton southwest base has the coordinates: X = 1,983,410.45 feet; Y = 573,281.81 feet; and the grid azimuth to Princeton northeast base is 219° 16' 42".90. These correspond to the following geodetic values on the North American datum of 1927 as defined in the publications of the United States Coast and Geodetic Survey: Latitude = 40° 24' 25".929; Longitude = 74° 43' 34".449; and azimuth to Princeton northeast base = 219° 14' 23".73.

Section 3. And be it enacted, That any triangulation or traverse station established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first and second-order work, whose geodetic position has been rigidly adjusted on the North American datum of 1927, and whose plane coordinates have been computed on the system defined in Section 2 of this Act, may be used in establishing a connection between a property survey and the above mentioned system of rectangular coordinates.

Section 4. And be it enacted, That when a connection has been made by acceptable survey methods between a station of any boundary survey of any type whatsoever and any triangulation or traverse station established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first or second-order work, and whose geodetic position has been rigidly adjusted on the North American datum of 1927, such connection incorporated in any legal record shall constitute an adequate and legally acceptable description of said property survey station.

Section 5. And be it enacted, That this Act shall go into effect immediately after the passage thereof.

FORM OF ACT PROPOSED FOR STATE HAVING MORE THAN ONE SYSTEM OF PLANE COORDINATES

An Act to establish the legality of boundary descriptions expressed in terms of plane rectangular coordinates.

Section 1. Be it enacted by the General Assembly of the State of *, That for purposes of describing the location and boundaries of any parcel of land in this State it shall be considered a complete, legal, and satisfactory description of such location and boundaries to give the positions of the corners of said boundaries in terms of coordinates on that system of plane coordinates established by the United States Coast and Geodetic Survey and defined in Section 2 of this Act which pertains to the area in which said land is located.

Section 2. And be it enacted*, That the legal and official name for each of the systems of plane coordinates established over the different parts of this State by the United States Coast and Geodetic Survey and the areas to which each shall pertain shall be as follows:

(a) "The (State) System of Plane Coordinates No. 1"** shall be the standard for use in the Counties*** of and , and is defined by the tables computed and published by the United States Coast and Geodetic Survey in 1934, which tables are based on (describe the projection by name and standard meridian or standard parallels as the case may require). In said system triangulation station has the coordinates: X = ---,---.-- feet; Y = ---,---.-- feet; and the grid azimuth to triangulation station is --° --' --".--. These correspond to the following geodetic values on the North American datum of 1927: Latitude = --° --' --".--; Longitude = --° --' --".--; and azimuth to = --° --' --".--.

(b) "The (State) System of Plane Coordinates No. 2" shall be etc., etc., (For each system in the State there shall be a complete description as given under (a) above.)

Section 3. And be it enacted*, That any triangulation or traverse station established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first or second-order work, whose geodetic position has been rigidly adjusted on the North American datum of 1927, and whose plane coordinates have been computed on a system defined in Section 2 of this Act may be used in establishing a connection between said system of coordinates and any property survey within the area to which said system pertains.

Section 4. And be it enacted*, That when a connection has been made by acceptable survey methods between a station of a boundary survey of any type whatsoever and a triangulation or traverse station established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first or second-order work, and whose geodetic position has been rigidly adjusted on the North American datum of 1927, such connection incorporated in any legal record shall constitute an adequate and legally acceptable description of said property survey station.

Section 5. And be it enacted*, That this Act shall go into effect immediately after the passage thereof.

Notes on the foregoing.

* In each State these phrases should be made to agree with the standard legislative forms used in that State for an Act of this type.

** Where there are only two systems of coordinates over a State, the names of such systems might well take such forms as: "The (State) Eastern System of Plane Coordinates," and "The (State) Western System of Plane Coordinates." In fact, definite and characteristic names for the various systems may be better than numerals even where there are more than two systems.

*** The question naturally arises as to what to do in the case of the survey of a tract of land that extends into areas occupied by two systems of coordinates. The survey of a single tract of land should be made on a single system of coordinates, unless the boundary between the two systems which divides the land is a definite, well-determined line. Some additional clause will be required in the proposed Act to legalize the survey on a single system of plane coordinates of any tract of land that extends beyond the limits of such a system into the area where another system prevails. It is suggested that after the list of county names there be added the clause: "and in counties contiguous thereto for the survey of such lands as may extend partly into those counties."

ACT TO PERMIT ENTRY OF SURVEYORS ONTO PRIVATE PROPERTY

An Act to permit the entry of surveyors onto private property for the purpose of using survey stations established by or under the direction of the United States Coast and Geodetic Survey.

Be it enacted by the Senate and House of Representatives in Legislature assembled, as follows:

Section 1. That any person recognized as a qualified surveyor or licensed by this State to make surveys of private and public lands within the State, and his duly accredited assistant and representatives, may, in the execution of such surveys enter upon any private land whereon there is a marked survey station for which the horizontal and/or vertical position have/has been determined by or under the direction of the United States Coast and Geodetic Survey, said entry being for the purpose of utilizing the horizontal and/or vertical position data in controlling surveys of land for cadastral purposes, or for other engineering purposes, private and/or public.

Section 2. That the surveyor and/or his duly accredited assistants and/or representatives shall do no unnecessary damage to the property on which a survey station stands, and that the owner of the land shall be reimbursed for all damage done in so entering, amount of damages to be agreed upon beforehand and paid promptly upon completion of work at said survey station, and where amount of damages to be paid has not been or can not be agreed upon beforehand, then amount of damages to be paid shall be determined by the commissioners court of county in which property is located, or by a board of three commissioners appointed by the county judge, and the findings of such commissioners shall be final, and the costs assessed against the entering party except as noted in Section 3 of this Act.

Section 3. That where the entering party, that is the surveyor responsible for entry onto private property for the purposes stated in Section 1 of this Act, shall tender damages to owner of said property and said proffer is not accepted, and the amount of damages determined according to procedure stated in Section 2 of this Act shall not exceed amount of damages so proffered, then all costs in the matter shall be borne by the owner of the property.

Section 4. If any person shall wilfully injure, deface, or destroy the mark or monument at any survey station established by or under the direction of the United States Coast and Geodetic Survey, or shall offer any obstacles to the proper, reasonable, and legal use of any such station, such person shall forfeit the sum of not to exceed $ for each such offense, to be recovered for the use of the (school fund, road fund, poor fund, or etc.) of the precinct in which said offense is committed, and said person shall be further liable to the surveyor against whom the offense is committed for damages resulting from delaying, interfering with, and preventing the prosecution of his work, said damages to be recovered in a court of competent jurisdiction.

Section 5. This Act shall become effective immediately upon the passage thereof.

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ACT INTRODUCED IN THE NEW JERSEY LEGISLATURE

Below is the Act introduced in the New Jersey Legislature to establish a system of land boundary descriptions based on geodetic control and the State system of plane coordinates. It is followed immediately by the Act which became law on March 25, 1935.

ASSEMBLY, NO. 209

STATE OF NEW JERSEY

Introduced January 28, 1935
By Mr. McKean

Referred to Committee on Judiciary

AN ACT to establish a system of land boundary descriptions.

Be it enacted by the Senate and General Assembly of the State of New Jersey:

1. For purposes of describing the location and boundaries of any parcel of land within this State it shall be considered a complete, legal and acceptable description of such location and boundaries to give the positions of the corners of said boundaries in terms of co-ordinates, and the direction of said boundaries in terms of bearings or azimuths, on the system of plane co-ordinates established over this State by the United States Coast and Geodetic Survey, and defined in section two of this act.

2. The official name for the system of plane co-ordinates to which reference is made in section one of the act shall be the New Jersey System of Plane Co-ordinates, said system being defined as a transverse Mercator projection of Clarke's Spheroid of 1866, having a central meridian 74° 40' west from Greenwich on which meridian the scale is set at one part in 40,000 too small. All co-ordinates of the system are expressed in feet, the x co-ordinate being measured easterly along the grid and the y co-ordinate being measured northerly along the grid, the origin of the co-ordinates being on the meridian 74° 40' west from Greenwich at the intersection of the parallel 38° 50' north latitude, such origin being given the co-ordinates x = 2,000,000 feet; y = 0 feet. The precise position of said system shall be as marked on the ground by triangulation or traverse stations established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first and second-order work, whose geodetic positions have been rigidly adjusted on the North American datum of 1927, and whose plane co-ordinates have been computed on the system defined.

3. Any triangulation and/or traverse station established as described in section two of this act may be used in establishing a connection between a property survey and the above mentioned system of rectangular co-ordinates.

4. When a connection has been made by acceptable survey methods between a station of any boundary survey of any type whatsoever and any triangulation or traverse station established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first or second-order work, and whose geodetic position has been rigidly adjusted on the North American datum of 1927, such connection incorporated in any legal record shall constitute an adequate and legally acceptable description of said property survey station.

STATEMENT

The purpose of this act is to make available to the people and agencies of the State a simple and efficient system of describing property corners and boundaries. When a piece of property is described according to this method no matter what monuments or marks are destroyed or lost, its position can be regained with precision.

The system has only recently been made possible by the establishment of a plane co-ordinate system for New Jersey and a Local Control Survey of the State, both under the direction of the United States Coast and Geodetic Survey.

Besides permanency, many advantages are to be gained by its adoption. Property owners, both private and public, will be protected from many of the causes of boundary disputes and land values enhanced by better title. Property once described by this system can be surveyed more economically and accurately. When this system is used over areas of any extent tax maps may be compiled with ease and precision, with no opportunity of the omission of taxable lands. State agencies, including the Departments of:

1. Commerce and Navigation
2. Conservation and Development
3. State Highway Department
4. Institutions and Agencies
5. Water Policy Commission

will be enabled to acquire property at a saving in the avoidance of otherwise unavoidable mistakes or the necessity for extensive property surveys.

The adoption of the act is recommended by the United States Department of Commerce, as offering an important improvement to the methods now in use for property description.

The Act given below was signed by the Governor and became a law on March 25, 1935.

[SECOND OFFICIAL COPY REPRINT]

ASSEMBLY, No. 209

STATE OF NEW JERSEY

INTRODUCED JANUARY 28, 1935

By Mr. McKEAN

Referred to Committee on Judiciary

AN ACT to establish a system of land boundary descriptions.

BE IT ENACTED *by the Senate and General Assembly of the State of New Jersey:*

1. The official survey base for New Jersey shall be a system of plane co-ordinates to be known as the New Jersey System of Plane Co-ordinates, said system being defined as a transverse Mercator projection of Clarke's spheroid of 1866, having a central meridian 74° 40′ west from Greenwich on which meridian the scale is set at one part in 40,000 too small. All co-ordinates of the system are expressed in feet, the x co-ordinate being measured easterly along the grid and the y co-ordinate being measured northerly along the grid, the origin of the co-ordinates being on the meridian 74° 40′ west from Greenwich at the intersection of the parallel 38° 50′ north

10 latitude, such origin being given the co-ordinates x=2,000,000 feet; y=0 feet.
11 The precise position of said system shall be as marked on the ground by
12 triangulation or traverse stations established in conformity with the stand-
13 ards adopted by the United States Coast and Geodetic Survey for first and
14 second-order work, whose geodetic positions have been rigidly adjusted on the
15 North American datum of 1927, and whose plane co-ordinates have been
16 computed on the system defined.

1 2. Any triangulation and/or traverse station established as described in
2 section one of this act may be used in establishing a connection between a
3 property survey and the above mentioned system of rectangular co-ordinates.

1 3. No survey of lands hereinafter made shall have endorsed thereon any
2 legend or other statement indicating that it is based upon the New Jersey
3 System of Plane Co-ordinates unless the co-ordinates have been established
4 on that system as herein defined.

1 4. Nothing in this act contained shall be interpreted as requiring any
2 purchaser or mortgagee to rely on a description based wholly upon the afore-
3 said system.

1 5. This act is to take effect immediately.

RESPONSES

Hugh C. Mitchell
Senior Mathematician

In answer to the foregoing letter and memorandum very satisfactory replies were had. Of such importance and high constructive value do they appear that no attempt has been made to prepare a digest of them. Except for the deletion of a few formal introductory phrases and unimportant paragraphs they are quoted verbatim in the following pages. One has but to read carefully through those pages to realize further how futile would be any attempt at a detailed analysis thereof; not only how futile, but I am tempted to say, how valueless, - the story told in the words of the respondents themselves is clear and strong and simple - and the picture one gets from reading these pages will be a most convincing one of the value and desirability of utilizing the national geodetic control through the medium of the plane coordinate systems for purposes of controlling and perpetuating surveys of private boundaries. These replies come from all parts of the country, and represent the thoughts of men with backgrounds ranging all the way from that of the engineer engaged in private practice who is faced with an almost unlimited variety of survey problems and the State surveyor facing similar problems but with power to dictate methods and demand standard results, through the roll call of engineers interested primarily in surveys for highway and other engineering projects, on to the man of purely academic viewpoint and training.

If, when reading through these pages, one keeps in mind the question of whether legal recognition of the use of plane coordinates in describing private boundaries is worth while, he will naturally be impressed with the fact that the Commonwealth of Massachusetts has long used geodetic control and local systems of plane coordinates in its Land Court work, and will give careful reading to the statements of Mr. Humphrey (p.- 26), engineer of that court. One should also study carefully the statements by Mr. Ruediger (p. - 38) of Virginia, who faced and solved a survey problem more difficult than that which confronted the Egyptians of old when the Nile, overflowing, destroyed the bounds which marked the limits of their rich fields; the Egyptians had opportunity to drive stakes and measure to each corner before the waters came.

The statements of Mr. Halsey (p.-29) and of Mr. Ringwood (p.- 31) will interest those who desire to know more about the difficulties encountered by engineers in private practice: Mr. Halsey's statement shows most convincingly the need for extending a system of plane coordinates over a large area, while Mr. Ringwood tells how an engineer who appreciated and used plane coordinates in property descriptions established the legality of such use through court procedure. One can not fail to be impressed with a firm belief that a great cost in money and effort would have been saved for these two engineers had they had in advance a single system of plane coordinates for the part of the State in which they were working, and legal recognition accorded such system. Part of their difficulties have faded away, for the plane coordinate system established for Long Island by the Coast and Geodetic Survey embraces all of Long Island and New York City, and maintains a minimum scale accuracy of 1 part in 100,000. But the legality of property descriptions based on this coordinate system is yet to be established; Mr. Ringwood's pioneer work in this field should prove of great value when the engineers of that, and indeed of any other state, recognize the value of the state plane coordinate systems for property survey purposes, and ask legislative approval of that use.

The opinion of the engineer who uses geodetic control for obtaining a satisfactory degree of accuracy and of permanency in traverse surveys run for engineering purposes is surely of great value and interest to the engineer who is concerned with the perpetuation of property line monuments, for both rest on the same foundations: the accuracy obtainable by basing survey work on the national control net, and the possibility of replacing any station connected to that net should such station be destroyed. Note what Bishop Moorhead of Oregon says about accuracy (p.- 67), and Mr. Carpenter of Texas about permanency (p.- 58).

But there is no need to multiply references. When one has gone through the following pages, no doubt will remain in his mind as to the value of geodetic control for traverse surveys made for any purpose whatever. The engineer engaged in making surveys for private construction projects and the surveyor representing a state organization with power to make its own rules and establish its own specifications may go ahead without further thought and use the national control survey as a base for local surveys. But the land surveyor must give thought to possible challenges that may come from the uninformed or the misinformed, and protect his client by giving deed descriptions which are based on legal precedent or authority, or else be prepared to go to the expense of time and money required in proving up a new method.

That this is not a dilemma, and that there is a way to fully use geodetic control and state-wide systems of plane coordinates in property surveys has been clearly demonstrated by Professor Philip Kissam of Princeton University, sponsor of the first law established in the United States to give legal recognition to such uses. In this Geodetic Letter are given the form of this law as first drafted at the Coast and Geodetic Survey office in Washington, (p.-10), the bill as modified to meet certain legislative requirements, (p.-15), and the bill as passed, further modified to meet the objections of such responsible critics as title and mortgage companies (p.-18).

Departures from any model form of bill for the purpose under consideration will naturally vary with the legislative regulations and technical practices in the various states. The actual form which a bill should take for introduction into any state legislature is almost wholly a matter for determination by state officials, engineers, and other interested persons in that state. How much study should be given to a proposed measure before it is considered ready for introduction is well illustrated by the form proposed for such a law in the state of Florida (p.-44), and the discussion immediately following.

A practical procedure to secure such a law and thereby benefit from the many triangulation and traverse stations scattered throughout the land would be to have a committee of engineers make the first draft of such a law, and submit it for consideration to the various state engineering and legal societies, as well as to title and mortgage companies. From studies made by such people there should emerge an act which could be written into the laws of the state to the lasting benefit of all concerned.

There are several fundamental considerations which should be considered almost axiomatic by those preparing such a law. One of these is that recognition should be accorded only to a system of plane coordinates of wide extent; additional computations will be required and legal complexities may develop in the borderland between adjoining zones. The fewer such borderlands, the better. Another consideration is that the law should be optional, not mandatory. The use of geodetic control and plane coordinates will depend upon education to such use and the establishment of stations near enough to a surveying project for the use to be economical. Both are matters which are sure to accelerate; the national control survey is growing at a tremendous pace, and in a few years there will be few if any points in the country more than 12 miles from a station of that survey. For the present making the use of this control mandatory even under certain limited conditions may well be passed over.

The question of a law to permit entry of properly qualified surveyors onto private property for the purpose of using control stations located thereon requires little comment. Such a law is a natural corollary to a law legalizing the use of such stations. While detail control stations may be placed along highways in positions not requiring such a law, the very nature of the principal control is such that sites which are most suitable for triangulation stations will be away from the highways and on private property. Mr. Carpenter suggests (p.-58) that the two matters be combined in one law, and thus save one trip through the legislative mill. This would seem very worth while.

Several respondents have mentioned the need for a central office or repository where map and survey information may be assembled, filed, and made available to all having need of such data. Already, in Iowa, a bill has passed the senate enlarging the scope of the land office that it may give service of this kind. But this is a matter of such magnitude that it should be handled separately from that of the use of geodetic control and plane coordinates in cadastral surveying. Both are propositions of great value to the people, and each is made more valuable by the existence of the other, but each, by itself, will prove of inestimable value.

In placing a network of control stations over the country, and making it possible for the surveyor to use those stations by establishing systems of plane coordinates and computing the positions of the control stations on those systems, the Coast and Geodetic Survey has gone about as far as is consistent with its status as a federal bureau. From this point on its role must be that of advisor. In this number of the Geodetic Letter it has endeavored to show the value and desirability of using plane coordinates based on geodetic control for private boundary surveys. For such engineers as may desire to take advantage of the national geodetic control and of the state plane coordinate systems, the Coast and Geodetic Survey publishes as rapidly as available the data for the control stations; this includes geographical positions, plane coordinates, and descriptions of stations. Much data that are not yet ready for publication are available in the form of photostat or lithographed sheets.

The Survey has also published various manuals and tables required by the surveyor in extending the control surveys, and in coordinating and correlating detail surveys with the more basic ones. In the Washington office of the Survey are a number of scientists and engineers who are familiar with various aspects of making and using geodetic

control, and with matters pertaining to coordinate systems; the experience and advice of these men are available to interested engineers. The Coast and Geodetic Survey is deeply interested in this most important use of data which it secures.

While it is requested that all matters relating to the symposium contained in this number of the Geodetic Letter be addressed to the Editor thereof, all requests for information as to data, manuals, etc., should be addressed to The Director, U. S. Coast and Geodetic Survey, Washington, D. C.

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GENERAL RICHARD K. HALE

Associate Commissioner
Department of Public Works
Boston, Massachusetts

I received your letter of March 5, enclosing memorandum in regard to the use of geodetic control in private boundary surveys. This is a matter, as you know, in which we are very much interested. Under the direction of your Department we have adopted the Lambert Projection for the State surveys and are in the process of working out a rectangular coordinate system for a considerable portion of the State.

This Department has made considerable use of the National Triangulation Survey. We have connected all of the State, County and Town boundary points with this system and practically all of our river and harbor surveys have been tied in to it. There are a great many points scattered over the State which have been tied in with varying degrees of accuracy. We are in the process now of reducing many of these points to the rectangular coordinate system, but the points described have been determined on several different data and very few of them have been reduced to the 1927 datum. Within the last year or two we have been tying in all our State highway surveys to the Triangulation net and we expect that this work will be continued.

While we are in the process of transforming many points to the rectangular system, it seems unwise for us to pass any legislation in regard to this matter. My thought is that in another year or so when the system is more widely extended and our engineers are more accustomed to its use, we might submit a petition for legislation authorizing the use of this system in all private land surveys as has been done in New Jersey.

Personally, I should like to go a step further and require by law that all survey work of any extent done by public authority should be tied in to this system. I think it would be a great saving in cost of surveys if this could be brought about as it would be possible to tie in to these numerous monuments and save a great deal in the cost of back traverses.

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ELMER C. HOUDLETTE

Administrator and Certifying Officer
Emergency Relief Administration
100 Nashua Street
Boston, Massachusetts

The Massachusetts Land Court has adopted the Lambert Projection Coordinates for this state as the basis for all their future work, and we have at present engaged on this project five or six computers whose work consists solely of transferring the triangulation points that have been used by the Land Court on to the Lambert Coordinates on the 1927 North American Datum, and at the present writing we have completed for them on the Islands of Nantucket and Martha's Vineyard the two hundred fifteen triangulation stations that have been established there by the Land Court.

We have just had an inquiry from the Department of Conservation as to the possibility of establishing control for them for all the state forests in Massachusetts and the positions of all the fire towers.

Control has been completed in the following cities and towns:- Winthrop, Malden, Melrose, Fitchburg, Peabody, and Needham; and work is now under way in:- Winchester, Wakefield, Worcester, Lexington, Haverhill, Sharon, and Lynn. All of the above have been by special request from the Engineer or Board of Government of the respective cities and towns.

You can readily see that here in Massachusetts the various State Departments and the cities and towns are cooperating to the fullest extent in taking advantage of this control.

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CLARENCE B. HUMPHREY

Engineer for Court
Massachusetts Land Court
Boston, Massachusetts

The use of geodetic control for boundary line surveys, either public or private, is a subject that I have been interested in for many years. The time has long since passed when the natural topographical features of the country should be used to describe lands conveyed. Due to the Massachusetts Land Court, established in 1898, whereby boundaries, as well as the ownership of land, are adjudicated by the Court, and the boundaries so determined remain definitely fixed, we are, I believe, further advanced in the use of triangulation for control of private boundaries than in any other State.

The first triangulation in Massachusetts was made by Simeon Borden in 1846. He recognized the value of these points if reduced to a system of rectangular coordinates based upon a tangent plane, and his publication shows the state divided into five sections, with five separate origins and rectangular coordinates for all triangulation points in each section. This publication was made little use of.

Between the time of the Borden survey and the publication of the topographical maps and town boundary atlases in 1890, the Borden points where recomputed and many new points determined by the U. S. Coast and Geodetic Survey engineers, and all computations based upon the Clarke Spheroid of 1867. We thus at that time had a system which was available, upon which to connect all surveys, and more particularly a system that could have been used by engineers doing work for the government where the cost of the surveys would not be taken into account, as would necessarily be the case in private work. A few towns did avail themselves of these points and established a system of rectangular coordinates for their own locality, based upon an origin within their town.

Our Land Court plans, which, with their subdivisions now amount in numbers to about twenty thousand, are computed upon a rectangular system. While these surveys remained isolated and apart from each other no serious problems arose, but as they became contiguous or situated in the immediate vicinity and were connected by survey data it became necessary to reduce them to a system of rectangular coordinates having a common origin and a common meridian. As all cases are coordinated from an assumed origin relative

to locus, it became a simple matter by carrying the first system along and gradually connecting the other surveys with it. Thus we would have several distinct groups coordinating, but floating in relation to other groups. To enable these surveys to be coordinated relative to a common origin and a common meridian within each registry district, a small continuous appropriation was obtained in 1915 to enable new triangulation points to be established, and we were thus enabled to keep our registered land within one registry district upon one datum. The system is based upon a plane tangent to the earth's surface at a point, which point is approximately the center of each registry district, and all surveys are referred to this point on one common meridian passing through the origin. The area of each district is such that no appreciable error appears on the exterior lines. The reduction of geodetic coordinates to plane coordinates was first made using the L M Z formula, and later by using formula in special publication No. 71 issued by the United States Department of Commerce. Under this system we had twenty one origins as there are twenty one registry districts in our Commonwealth.

This system gradually became known to engineers working throughout the State, and more particularly to engineers working on the State Highways who gradually began to use it in connecting their traverses of new highways. Their difficulty in crossing from one district to another, which was necessary on account of the twenty one origins, resulted in April 1933 in the adoption of a new system whereby the State was divided into eight zones, still using the plane rectangular system and the datum plane as heretofore. Since December 1933, and which I charge up to the depression, there has been much activity in triangulation and survey work in connection with the United States Coast and Geodetic Survey in Massachusetts, and much work has been done, which will be of inestimable value in the future. The result of this work has been that in Massachusetts, at least unofficially, the 1927 North American Datum has been adopted, and furthermore a rectangular system adopted based upon the Lambert Conformal Conic Projection with two standard parallels and one origin for the whole state, which on account of its shape and area would show a maximum error on its extreme north and south boundaries of only one in twenty eight thousand.

Work is now being carried on under various projects connected with the Emergency Relief Administration reducing triangulation points in Massachusetts to this projection, and connecting the triangulation points by traverse, thereby establishing points in smaller areas, making them more available for private survey work.

The use of this system has enabled me to lay down a system of cadastral maps upon which may be plotted from time to time lands as registered and connected by triangulation. It is not necessary that these maps be of contiguous territories, and they are located in various parts of the Commonwealth, depending upon the activity of registered land in those sections. The basis for these maps are the fifty four topographical sheets of the State. These sheets are numbered from 1 to 54 consecutively. Each sheet covers an area equal to 15 minutes of latitude and 15 minutes of longitude. For our purpose of indexing, we have subdivided each sheet into nine lettered sections and each section into eight numbered plans. Thus we have seventy two plans to a topographical sheet, and the area covered by these plans is equal to 1' 15" of latitude and 2' 30" of longitude. The scale used is 300 feet to an inch, which adapts itself to standard double elephant paper, namely 27 by 40 inches. On these plans lines of latitude and meridian are carried for the border lines and the rectangular lines of the coordinate surveys plotted relative thereto. We have many hundreds of these plans upon which appear registered lands and town boundaries, and although detailed engineering data are not carried in every instance, they are useful in locating land as registered and the court number of the case itself, as well as in some instances the name of the party to whom a decree of the Court was issued.

I question whether anything would be gained by the adoption of an act to establish land boundary descriptions in Massachusetts at this time, although the act that you have suggested and which is being considered by the State of New Jersey does not make it mandatory that all surveys should be immediately connected with this system, but simply is the official adoption of a system which could gradually come into use. Everybody understands the value of a plane rectangular system covering the whole state, and its greater potential value, if those in charge of engineers working for State departments or other political subdivisions of the Commonwealth would gradually adopt the system and have all of their surveys connected with it.

In this State Land Court plans with corners determined in terms of coordinates referring to local bounds and referred to in our decrees are considered acceptable descriptions and are so recognized by the Court.

There must be some fountain head where one goes for information along these lines, and some time ago I wrote General Hale, Associate Commissioner of the Department of Public Works, with which department the Emergency Relief

Administration is closely allied, that I hoped if this work was discontinued by the federal government that a department might be created in Massachusetts to have charge of all triangulation and traverse data in connection with this new projection, and that the work be continued so that eventually we might have all of our town and state boundary corners, exterior lines of the Commonwealth and State Highways recomputed on this basis. If this was done I believe that railroads and other engineering work would easily fall into line.

We have not at the present time any act establishing a system of land surveying, but under our chapter 42 entitled "Boundaries of Cities and Towns" there is a section in which triangulation points as established by the Commonwealth shall be regarded as evidence of the location of town boundary lines. The monuments themselves, as a matter of law, determine the true corners and the coordinates represent the location of the monument referred to the survey system. If a monument was lost, then the theoretical point determined by the coordinates would be placed back upon the ground from points in the vicinity.

I believe that recognition of the value of this work will come from within, that is, by junior engineers in the various departments becoming acquainted with its use, and as the same is extended throughout the State it will gradually result in the introduction of an act similar to that now proposed in the State of New Jersey. With such an act established, some provision should then be made whereby, at the expense of the state, local control points could on request be established, and then subsequently other acts could be established whereby it would become mandatory that all surveys of a governmental nature be referred to this system of land boundary descriptions before the same could be accepted and filed.

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WALLACE H. HALSEY

Southampton, New York

My surveys of highways and village of Deering Harbor, Town of Shelter Island, Suffolk County, New York, made in 1909-10-11, were tied into the true meridian of the Coast Survey. My surveys of Quogue and Southampton Villages, made many years ago, were also directly tied into the triangulation net, which was then very expensive. But since the primary triangulation was run through this locality, supplemented with strong systems of second and third order,

it is comparatively simple to coordinate into the survey direct, using rectilinear coordinates as computed for Long Island by your survey.

I tied my ten-thousand-acre survey of Montauk into the old Montauk Station 2 in 1925, and in the same year I made a survey of Island Beach, Monmouth County, N.J., which I tied directly into the triangulation, as established by Major Hodgson, and field locations by Lieut. Bainbridge, as well as establishing my azimuth of many other surveys directly from the old stations. Therefore, I am heartily in accord with your work, and any little thing I can do to cooperate will be a pleasure.

The only fault I have to find with your system is that, had your work been established twenty or twenty-five years ago, it would have saved me many thousands of dollars, and my records would be more valuable, and more simple to use than they are today, instead of the maze of coordinates having all kinds of values and meridians.

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SUFFOLK COUNTY CHAPTER

New York State Society of Professional Engineers

By

R. E. Cook, Secretary

At our last regular Meeting, Mr. Thomas E. Ringwood of Montauk, a Director in our Chapter, brought to our attention the suggestions of your Department concerning the use of Geodetic control in private boundary surveys and also the proposed Legislation for the State of New Jersey. These items were discussed at considerable length with much interest.

By unanimous vote our Chapter has endorsed your efforts, and we will be glad to cooperate with you in every way possible so that the purposes as outlined may be legally accomplished. Your Department will recall that our Chapter also enthusiastically endorsed the adoption of a system of plane coordinates for Long Island.

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T. E. RINGWOOD

Montauk Beach Development Corporation
Montauk, New York

The following brief outline of our experience with the use of a plane coordinate system based on Geodetic triangulation control together with some of the legal obstacles we encountered in using this control for the conveyance of private property is submitted in the hope that it may be of interest.

In view of the following I believe that it is imperative that the general use of a standard plane coordinate control system based on geodetic triangulation be legalized in each state without delay. The ultimate objective should be the establishment and exclusive use of a national system for survey control, the authority of which would be established legally as being superior.

Our plane coordinate control system based on the U. S. Coast and Geodetic Survey triangulation was established some years ago and now contains some 900 monumented stations. It has been used exclusively in this area by the following agencies for the purposes indicated:

1. Army engineers in sounding operations in Fort Pond Bay.

2. Long Island State Park Commission in location of ten miles of parkway and topographic survey of 2,000-acre park.

3. Suffolk County Highway Department in relocating county roads.

4. Montauk Beach Development Corporation in layout and development and sales from 9,700 acres.

5. Gold Cup Race-course committee in layout of two and a half mile official race course in 1931-1932 on which world records were broken.

6. U. S. Army in preparation of fire of large coast artillery batteries.

The benefits derived from the use of a common control system by all agencies operating in a given area are too obvious to mention. We were fortunate in having ten U. S. Coast and Geodetic Survey stations in the area to start with but the advantages and economy resulting from the

establishment of a standard control in this relatively small area would necessarily attach to its use in a larger area and increase in direct proportion to the number and variety of projects in which such control was used.

The two general methods of describing and conveying property in this state are:

1. Including in the deed a metes and bounds description referring to some generally known prominent monument which may or may not have any well defined geographical location but which is generally recognized as a land mark.

2. The other method which is used considerably in the conveyance of small parcels is to file a map or plat of the entire tract showing the various lots and subdivisions in the office of the Clerk of the County in which the property is located. The description in the deed is then merely a reference to this map which includes usually the number or designation of the tract conveyed, number of the map and the date on which it was filed.

The method by which we finally established the legality of descriptions based on our plane coordinate system and the U. S. Coast and Geodetic Survey control was developed from suggestions of the late Mr. E. P. Clark of the Title Guarantee & Trust Company of New York who, incidentally, was one of the recognized title experts on both engineering and legal points in the New York area was as follows:

> We simply prepared a map showing the Coast and Geodetic Survey triangulation stations located on the property in which we were interested, together with our own intermediate triangulation stations and our traverse points, all of which were monumented with concrete monuments. On this map we also indicated the locations of certain of the old landmarks which had been used in previous surveys and which we had included in traverses. On one part of the map was a schedule showing the adjusted coordinate values for each point indicated. The zero of coordinates was a centrally located Coast and Geodetic Survey triangulation station.
>
> This map together with a legal declaration of intention was filed in the office of the County Clerk of this county and given a regular number. We then proceeded to convey property including in the deed a

metes and bounds description tied directly to one of the stations shown on this map including also a file reference to this control map.

Such portions of the property as had been previously subdivided were also tied into this system and from such legal advice as I have had in the matter there was no necessity for additional legislation in this particular instance.

The above is merely our experience in one county but we had some expensive litigation as a result of which the reference of the description to the Coast and Geodetic Survey system was sustained in the Supreme Court of this state but which litigation and attendant expense could have been avoided had the legality of such control been previously established.

From the above it is apparent that a system of control scientifically recognized as being superior is considered legally inferior and this situation should be corrected without unnecessary delay by the various states.

A further suggestion submitted for consideration would be an active program of expansion of a national control net-work and a plan to make Federal aid to highway projects conditional on the tying in of such highway projects to the national control system. This suggestion is based on the rather reasonable assumption that if the Federal government assists financially in these projects they would be entitled to an accurate determination of the location of such projects. State, county and town and private projects located on these highways would eventually be tied in. It is submitted that such a scheme would constitute one important step toward the ultimate objective of a national system of superior control with proper legal recognition.

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PROFESSOR PHILIP KISSAM
20 Nassau Street
Princeton, New Jersey

(The following comments were written by Professor Kissam on March 8, 1935. Assembly Bill No. 209 about which he writes was introduced on January 28th, and being signed by the governor became a law on March 25th, having passed both houses a few days earlier under a suspension of the rules.)

I have your letter dated March 5th, enclosing various items about New Jersey Assembly Bill No. 209.

As you know, of course, I am very much in favor of the system proposed. In the actual use of a system of this kind there are five items which occur to me which should be borne in mind:

1. I believe that in order to insure the proper operation of such a system, the coordinates of all monumented points should be made extremely accessible to the private engineer. I believe he should not be required to write for them nor to travel more than a few miles to get them. In this connection I feel also that he should be able to easily determine what coordinated points do exist in the locality in which he is working.

2. With the above idea in view, I believe that each state should establish a central office for the maintenance of records which can be distributed throughout the various counties to the county engineers and also throughout the metropolitan areas to the city engineers. I feel that this should be done without waiting for requests from these persons.

3. While the method of coordinates for describing property is still new I believe we should recommend changing the method of describing boundaries only by the addition of the coordinates for each property corner or other point described.

4. I believe that in various localities throughout the Country there should be maintained maintenance parties. Perhaps two in New Jersey, for instance, would be sufficient. This maintenance party should be equipped to travel quickly throughout the state, and its duties should be:

(a) To make a recovery of all points in the state at certain periods of time, perhaps every four years.

(b) To replace any points found to be missing.

(c) To replace points on a moment's notice when requests for them are received.

5. Like the telephone, the use of coordinates becomes greatly increased in value as other people use them. For that reason, it should be a duty of local offices to instruct the engineers of the existence of the points, the methods of using them, and proper methods for accurate surveying.

Just how these various ideas could be worked out in detail, I feel should be given thoughtful consideration. We have already had the objection raised to the bill that information was so hard to get that it would be a detriment rather than an asset to include the coordinates in the description of the property.

I can foresee the Coast Survey as a great organization in the future for the maintenance of known points. This will be a terrific task of inestimable value to the country. I feel that these valuable monuments must be backed up in an organization which will be immediately available for very detailed work for the public in many small isolated points.

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EDWARD C. WYCKOFF

Fidelity Union Title and Mortgage Guaranty Company
Newark, N. J.

Editor's Note:

Deeply concerned with any legislation that may affect existing methods of describing boundaries of private properties are companies engaged in examining and guaranteeing titles for trust purposes. On how sound a basis such interest rests, and how the opposition of one such company to the New Jersey bill (p.) was changed to endorsement is well illustrated by the following letter addressed by Mr. Wyckoff to Myron Hendee, Municipal Engineer, Hackensack, N. J., and by Professor Kissam's statement which follows immediately after.

I have your favor of February 15, 1935 in re Assembly Bill 209.

It appeals to me that surveying today upon the basis set forth in this bill will be found to be exceedingly disturbing and impracticable. No purchaser or mortgagee should be compelled to accept a deed or security based only upon a survey made under conditions defined in this act. The act should be wholly permissible if it is passed; but in my judgment it need not be passed. The surveyors who desire to encourage this method of surveying can educate their clients to it by making surveys in the usual manner and imposing on them the definition of beginning point designed by this act.

There is no thought on my part that a survey made on the basis described in this bill would not be technically correct. Had this system been the original basis of our surveying practice in connection with land titles; and had permanent monuments been planted on this basis throughout the State at such short intervals as would have made surveys based thereon economical, the chances are we would have had less trouble with erroneous and overlapping surveys.

It is very significant that leading surveyors and county engineers are not acquainted with the location of monuments planted in accordance with the Geodetic Survey made by the system of plane-coordinates. In making inquiry, it was necessary to contact the office of Professor Kissam at Princeton before any knowledge of the Geodetic Survey could be had. It develops that the monuments in existence are not numerous; and further, that if all monuments of intersections indicated by the Geodetic Survey maps should be planted, the nearest monument to another monument would be from 1-1/2 to 2 miles; and of course the location of two monuments is necessary to establish a base line from which to survey. This indicates that surveys in well established areas would become very expensive.

It is my understanding that state, county, and municipal highways, can not now be adequately defined under the system recommended by the term of this act without expensive additional surveying in the field.

When it comes to land surveys as a basis of title, the surveyor would need to do two things. Survey the plot according to recognized and established title lines and occupations; and then establish the beginning point according to the proposed system of plane-coordinates. No lawyer experienced in todays way of surveying could assume to pass upon a survey defined only in the manner defined in said act. He would need also the survey with

relation to existing street monuments and lines of occupation. If a technical description only were used in a deed or mortgage, a searcher would be unable to identify descriptions used since the beginning of our state without having the technical description established for him. When a man like James A. Bradley, who gave over 1500 deeds, is to be searched and you are only interested in one of his lots, and the only description the searcher has is a technical description, think of the confusion of the searcher.

No, for myself, I could not recommend to our association the passage of this act, I am, however, sending a copy of this letter to you and your letter to me, to the other members of our legislative committee. No act is required if the surveyors desire to impose upon any survey they make the additional data a survey under the act would show.

It is to be regretted that this state did not have the sound basic system this act contemplated at the beginning. In this respect our patented lands in the west have a much more simple system of conveying and surveying.

PROFESSOR PHILIP KISSAM

Princeton University

(Statement accompanying Edward C. Wyckoff's letter (above))

I am happy to say that I have had a long talk with Mr. Wyckoff and have discovered his real objection to the bill. Mr. Wyckoff felt that should the bill become a law, the title companies would be bound to accept a survey of a piece of property which consisted merely of eight co-ordinates, two for each corner. He explained that although he has been Title Examiner for one of the biggest title companies in the State for over 30 years, he would have no way of knowing where that particular property was, what were the lengths of the lines, and what were the angles in the survey. For these reasons he objected to the bill.

Mr. Wyckoff was, on the other hand, very much in favor of the coordinate system, and made many excellent suggestions for the future use of coordinates. I explained to him that my chief purpose for the bill was to make it possible to refer by name to the system of coordinates which was computed according to certain methods, marked in the field by certain methods, and which was standard in the State.

Mr. Wyckoff sat down and wrote out several amendments for the bill which eliminated his objection, and I understand that he and Mr. Aiken (Mr. Aiken is the engineer for the West Jersey Title & Trust Company) who form the Legislative Committee for the Title Company Association, would write a letter recommending the bill.

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FRED E. RUEDIGER

Engineer to Commission of Fisheries of Virginia,
Newport News, Virginia

WHY WE ACCEPTED GEODETIC CONTROL IN THE SURVEYS OF OYSTER PLANTING GROUNDS IN VIRGINIA

Surveys of oyster planting grounds in this state are generally made by the County Surveyor of the respective counties in which these grounds are located.

It has been the practice of the surveyor to run a base line for every single survey (very often a rather short one) at some convenient point on the shore opposite the ground to be surveyed, and to cut in the stakes or buoys at the corners of this ground often by compass bearings, but lately always by transit angles taken from both ends of such lines.

The law requires that reference angles be taken to prominent objects from the ends of the base lines, but after the lapse of years many of these would be destroyed, trees would die or be cut down, houses would burn, or be washed away, and even if enough reference points would remain to relocate the base line, it would often be found, that the stations could not be occupied because the shore had washed away and they were in deep water.

Now as nearly always a new base line was run for subsequent surveys, and as these surveys were made without reference to one another the natural consequence is, that many overlapped, but oftener left large bodies of planting ground between them, the rent of which is lost to the state.

We did not have, nor could we make complete maps from surveys of that kind.

We have a very extensive survey of the natural oyster beds in Virginia, made from stations established on the shores.

Stations were marked by terra cotta pipe, in most cases extending, according to the field notes, 12 inches out of the ground.

Any one knowing usual length of such pipe can readily see that this marking in the first place was a joke, and most of the pipes were used as chimneys for the oystermen's shanties shortly after they were planted.

Stations were not connected by triangulation, and their Geodetic positions were not determined, but the surveys were platted from assumed points under maps of the Coast and Geodetic Survey on a 1 - 20,000 scale.

Points down the river and up the river, points of woods and other such are given as reference points at times.

Where buildings are given as reference most of these have disappeared (since 1894), and only with the greatest difficulty and loss of time can these points be re-established, if at all.

And then most always the doubt of accuracy in the relocation remains, and quite a lot of money has been wasted in law suites on account of resurveys.

Possibly some engineer or surveyor would make a small net of triangulation, establish stations on the shore, but this is hardly an improvement, no more than changing from a compass survey of land to a transit survey of the same area, with deflection angles carefully measured and closing nicely.

Stations will wash away, people will destroy them, and all references made disappear, and all the tedious work of making such triangulation survey will be lost completely.

But, if, as we have done, these triangulation stations are connected with the triangulation net of the United States Coast Survey, their Geographical positions computed, and all surveys made from these stations, then, even if they are destroyed or washed away, new stations may be established.

Azimuth from these new stations can always be computed, to any point determined by surveys from the lost stations. Nothing is lost in the way of accuracy. We are always sure of our location.

We now have issued a pamphlet of Instructions to Surveyors, and all surveys of oyster planting grounds must be made to conform to its requirements by making surveys from or referring them in a satisfactory manner to triangulation points the geographic position and distance between which are furnished surveyors by request.

There is no other known method whereby a lost point can be accurately determined after all references and markers disappear.

Every point determined by Geodetic Control is permanent for all time, or as I have told people at times, there is only one very definite point in God's World, a location given by Geodetic Control will fit.

With Geodetic Control I have never failed to recover old Coast Survey stations by computing azimuth and distances to them from new stations established by me, when all surface markers were destroyed or the monuments had sunk in the soft marshes.

This shows the necessity for sub-surface as well as surface monuments.

The State of Virginia has benefitted to the extent of thousands of dollars in oyster ground rents by our surveys.

And there is no reason why the method of Geodetic Control could not be applied to property surveys on land with the greatest of benefit to all concerned, * * *.

In open country there would be no more difficulty than across water, in wooded sections and level land the difficulty might be the distance to, or access to the nearest two Geodetic Control points.

In such case the party who is having the survey, say of a farm, done, might object to paying for the time required to connect one line of the farm with the control points, especially if any great distance away.

But as most farms border on state or county roads control points naturally established on them should not be a great distance away in most cases, and I think, that after a few people had their lands surveyed by this new method their neighbors would not be satisfied if their surveys were not made in exactly the same way, and would insist that it be so done.

The time honored description by metes and bounds could easily be maintained and surveys made and relocated with the greatest amount of accuracy by referring the same, instead of to the magnetic meridian to the azimuth of the line this survey is referred to.

A survey made under the present system of referring it to the magnetic meridian may be very correct, as far as the area of the land surveyed, but if we go ad absurdum in this matter and suppose that every monument of such a survey should disappear leaving not even a known starting point, it will be vary plain that it is utterly impossible to locate the land so surveyed except by parole evidence, which is mostly after all a compromise and leads to expensive law suits.

With Geodetic Control it will be possible to relocate the corners of any and all tracts of land in any county of any state very accurately if all farm boundaries or even all the Geodetic Control stations would be destroyed.

Every survey would be permanent.

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O. B. BESTOR

Engineer of Permanent Surveys and Records
North Carolina State Highway and Public Works Commission
Raleigh, North Carolina

I have studied your memorandum with great interest and believe that one of the most valuable features of the Geodetic Control is its application to boundary surveys of land. The correct restoration of property boundaries which is made possible when tied to this control, can be appreciated by every land owner, especially those who have become involved in disputes and expensive litigation over lost corners. When the enormous aggregate value of property is considered it is apparent that this item alone would justify the cost of monumentation.

We are fortunate in having in this State a single system of plane coordinates based on the Lambert Projection. We are progressing with the establishment of a supplementary State monumentation at 5-mile intervals, and while this work is only about 10% completed, we have had two sizeable land surveys tied into the system, one town boundary survey, and a portion of a county boundary survey. Further we have tied into the State system the excellent monumentation

of the City of Greensboro, and are making a triangulation and traverse survey of the City of Raleigh, establishing monuments based on the State plane coordinates system. As the State monumentation progresses it will become increasingly available for use in private surveys. The engineers engaged on supplementary monumentation, who are all local men, will promote the use of the monumentation for they understand what they mean. I am convinced, however, that what is most needed is a central agency established in each State which will have all information concerning the geodetic monumentation, will gather and keep on record all available maps and plans that have been tied in, and make the information available to engineers and surveyors. This agency should also, by issuing bulletins and maps, encourage the use of the control.

I am particularly impressed by your suggestion to promote the use of the State system by providing for its legal recognition before such use occurs. It had been my thought that we should have to wait until the system was established, and then have legislation make its use obligatory; but by making its use optional and legal, as suggested by you, it is not necessary to wait until the system is completed.

The form of bill which has been introduced in the Legislature in the State of New Jersey appears to meet the first requirements and the statement attached to the bill is illuminating and effective.

It may be also desirable to have a second bill authorizing entry of licensed engineers and surveyors upon private property to reach the monuments; although practically all the monuments thus far established in this State are on railroad right-of-ways, or on highway right-of-ways, and other public lands.

It appears quite desirable that the bill should also carry a clause for the protection of the survey marks themselves, as we have already had a few of our monuments destroyed, and a number of the Government monuments have been destroyed unnecessarily.

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THE FLORIDA ENGINEERING SOCIETY
W. W. Fineren, Secretary

Resolutions adopted April 6, 1935

Whereas, the Board of Direction of this society in session on October 14, 1933 in Jacksonville, Fla., did instruct the Secretary to request the U. S. Coast and Geodetic Survey, through its Director, Captain R. S. Patton, stationed at Washington, D. C., to establish a system of Plane Coordinates for the State of Florida, and

Whereas, it was understood that this would be done upon application without cost to the State of Florida, and

Whereas, systems of Plane Coordinates have been worked out embracing the Lambert and Mercator systems of Plane Projections and tables for coordinates have been computed by the U. S. Coast and Geodetic Survey for the State of Florida, and are now available, therefore be it

Resolved that the Florida Engineering Society in annual session at Miami, Florida on April 4-5-6, 1935, go on record as approving the same and expressing their sincere appreciation for the work done in this connection by the U. S. Coast and Geodetic Survey, through its Director, Captain R. S. Patton, at Washington, and as outlined in the report of the Committee on Land Surveys and Subdivisions of the Society. And

Be it further Resolved that a copy of this resolution be sent to Captain R. S. Patton, Director, at Washington, by the Secretary of the Society. And

Be it further Resolved that this resolution be spread upon the minutes of the Society for the convention as now in session and as of the above date.

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H. A. ELMORE

Executive Engineer, Local Control Surveys
Gainesville, Florida

I have your letter of March 5 with the enclosed drafts of the bills suggested and introduced in the New Jersey State Legislature.

I also have your letter of March 28 enclosing copy of the bill which passed the New Jersey Legislature establishing a system of land boundary descriptions.

I am very much interested in the passage of a similar bill for the State of Florida. I am enclosing a copy of a letter which I am sending to the members of the Florida Mapping Authority, together with a proposed bill for the Florida Legislature, which was prepared by members of the staff of the Local Control Surveys. You will note by the comments, which are also enclosed, that many changes from the Act passed in New Jersey will be necessary for Florida.

- A -

BILL PROPOSED FOR FLORIDA

AN ACT TO LEGALIZE THE DESCRIPTIONS OF LOCATIONS OF LAND BOUNDARY CORNERS AND LINES IN TERMS OF PLANE RECTANGULAR COORDINATES AND TO ESTABLISH THREE DIVISIONS OR SYSTEMS OF SUCH COORDINATES IN THE STATE OF FLORIDA.

SECTION 1.

Systems of rectangular plane coordinates having been established by the U. S. Coast and Geodetic Survey for three Divisions of the State of Florida described in Section 2 of this Act, it shall be considered a complete legal and acceptable description of the location and boundaries of any parcel of land within this State to give the positions of the corners of said boundaries in terms of rectangular plane coordinates and the directions of said boundaries in terms of bearings or azimuths on the system of coordinates established for the Division of the State in which said parcel of land lies.

SECTION 2.

The official names and descriptions of the three Divisions of systems of rectangular plane coordinates in Florida established as provided in Section 1 are as follows:

The Northern Division (No. 1) of the Florida Systems of Rectangular Plane Coordinates shall cover the counties of Alachua, Baker, Bay Bradford, Calhoun, Columbia, Dixie, Escambia, Franklin, Gadsden, Gilchrist, Gulf, Hamilton, Holmes, Jackson, Jefferson, Lafayette, Leon, Liberty, Madison, Okaloosa, Santa Rosa, Suwannee, Taylor, Union, Wakulla, Walton and Washington, and counties contiguous thereto for the survey and location of such contiguous lands under the same ownership as may extend partly into these counties. The Northern Division (No. 1) is represented on maps and charts as a Lambert projection of Clarke's Spheroid of 1866, having a central parallel of 30° 10' north latitude. All coordinates of the Northern Division are expressed in feet, the X coordinates being measured easterly along the grid and the Y coordinates being measured northerly along the grid, the origin of the coordinates being on the meridian 84° 30' west from Greenwich at the intersection of parallel 29° 00' north latitude, such origin being given the coordinates X = 2,000,000 feet; Y = 0 feet.

The Western Division (No. 2) covers the counties of Charlotte, Citrus, DeSoto, Hardee, Hernando, Hillsborough, Lee, Levy, Manatee, Marion, Pasco, Pinellas, Polk, Sarasota and Sumter, and counties contiguous thereto for the survey and location of such contiguous lands under the same ownership as may extend partly into those counties. The Western Division (No. 2) is represented on maps and charts as a transverse Mercator projection of Clarke's Spheroid of 1866, having a central meridian 82° 00' west from Greenwich. All coordinates of the Western Division are expressed in feet, the X coordinates being measured easterly along the grid and the Y coordinates being measured northerly along the grid, the origin of the coordinates being on the meridian 82° 00' west from Greenwich at the intersection of the parallel 24° 20' north latitude, such origin being given the coordinates X = 500,000 feet; Y = 0 feet.

The Eastern Division (No. 3) covers the counties of Broward, Brevard, Clay, Collier, Dade, Duval, Flagler, Glades, Highlands, Hendry, Indian River, Lake, Martin, Monroe, Nassau, Okeechobee, Orange, Osceola, Palm Beach, Putnam, St. Johns, St. Lucie, Seminole, Volusia and counties contiguous thereto for the survey and location

of such contiguous lands under the same ownership as may extend partly into those counties. The Eastern Division is represented on maps and charts as a transverse Mercator projection of Clarke's Spheroid of 1866 having a central meridian 81° 00' west from Greenwich. All coordinates of the Eastern Division are expressed in feet, the X coordinates being measured easterly along the grid and the Y coordinates being measured northerly along the grid, the origin of the coordinates being on the meridian 81° 00' west from Greenwich at the intersection of the parallel 24° 20' north latitude, such origin being given the coordinates X = 500,000 feet; Y = 0 feet.

The precise positions in said systems of coordinates, northern, western and eastern Division (Numbers 1, 2, and 3 respectively) shall be as marked on the ground by triangulation or traverse stations established in conformity with the standards adopted by the United States Coast Survey for first and second order work, the geodetic positions of which have been rigidly adjusted on the North American datum of 1927, and whose rectangular plane coordinates have been computed on the systems and for the Divisions defined in this section.

SECTION 3.

Any triangulation and/or traverse station established as described in Section 2 of this act may be used in establishing connection or connections between a property survey and the above mentioned system of rectangular plane coordinates.

SECTION 4.

When a connection has been made by acceptable survey methods and with acceptable accuracy between a station of a boundary survey of any type whatsoever and a triangulation and/or traverse station established in conformity with the standards adopted by the United States Coast and Geodetic Survey for first or second order work, and whose Geodetic position has been rigidly adjusted on the North American datum of 1927, such connection, incorporated in any legal record shall constitute an adequate and legally acceptable description of said property survey station.

COMMENTS

TITLE

The constitutional requirement that each Act of the Legislature must contain in its title all the subjects treated in the Act, would require enlargement of the title from either of the other forms presented.

SECTION 1.

The fact that there are three systems of plane rectangular coordinates established in Florida requires direct establishment of each of the three.

SECTION 2.

As full description and assignment of coordinates is required for each of the three divisions of Florida Coordinates, this section is three times the length of Section 3 of the New Jersey bill and in addition the list of counties in each Division. It differs otherwise from the New Jersey model by providing for the extension from one Division to that adjoining in case property under one ownership lies partly in each one of two Divisions. This is at the suggestion of Mr. Mitchell of the U. S. Coast and Geodetic Survey.

SECTION 3.

This Section for Florida is shortened from Coast and Geodetic Survey Section 3 by transferring part of it to Section 2.

SECTION 4.

Provides for "acceptable survey methods" in all drafts. The Florida draft provides also for "acceptable accuracy". Otherwise there is no standard set for the accuracy of connections of land surveys with the monuments in the system of plane rectangular coordinates and any methods of surveying could be used and there would be no record showing what method was used or what the accuracy of the connection would be.

It will be noted that Section 1 provides for the connection of all corners of a parcel of land with the triangulation or traverse station and that the description

of these connections is a complete legal and acceptable description of the location and boundaries of any parcel of land. Section 4 provides in addition that when a connection has been made by acceptable survey methods between a triangulation or traverse station and a station of a boundary survey of any type whatsoever, in connection when incorporated in any legal record shall constitute an adequate and legally acceptable description of such property survey station. Section 1 indicates a standard survey and connection with the traverse station of every angle point in the survey of the parcel of land. Section 4 would require a standard survey of only one line of connection of one point in the boundary of the parcel of land with the traverse station and the rest of the survey of the parcel of land could be of "any type whatsoever" correct or incorrect. It would seem possible to the one point of a survey to the traverse station even though it had been made hundreds of years ago. One corner of a township section or quarter section could be connected in the same way if it could be shown to be the original corner, even though the survey of the parcel of land was the original survey by the U. S. Land Office. Since utilization of the Act is entirely voluntary, any one of these procedures or none at all is permissible. The words "and with acceptable accuracy" have been inserted in the Florida Act to emphasize accuracy in the connecting line even if the survey of the boundaries of the parcel of land is very inaccurate. Corners of Spanish and other grants are of similar nature but do not have the U. S. Land Survey system to aid in finding lost corners. The Act does not attempt to go into the determination of the correct locations of corners of the parcel of land or of township, section, or half-section corners. It has to do only with connections of such points with the established triangulation or traverse points, when these connections are presented for approval and for record.

The term "any legal record" is susceptible of many interpretations. Undoubtedly, recording in the usual offices for keeping record of property transfers and changes in counties would be necessary although record in other national, state, county or other political subdivision would be advisable in special cases.

GENERAL

The words "acceptable" and the like imply an authority to determine acceptability for official records. The Bills proposed by the Coast Survey authorities and that of the New Jersey Legislature do not set up such authority. The county office for recording documents seldom has technical attainments sufficient to judge what documents and methods

would be acceptable. So long as the recording of the proposed connections is voluntary there will probably not be much work to be done in examining plats and surveys and approving them, hardly enough to require a special office.

The only Board in existence which is technically fitted for the administration of the work is the State Board of Engineering Examiners, who already have control of the men who would make the surveys and maps, under the law requiring registration of Land Surveyors. This Board is therefore suggested to operate until the work shows tendencies toward becoming a full time job.

RULES AND REGULATIONS

It may be assumed that the Board will have authority to administer the law and to prepare rules and regulations for the conduct of its business. These may include such subjects as:

Qualifications of Engineers, which may be fixed under the law covering registration of land surveyors, with some rules for enforcing the special requirements of this Act.

Methods of Survey and of connection with established points in the plane rectangular coordinate systems.

Standards for making Maps and Computations and for making the entries on maps and other documents accurate, complete, and in standard form.

Regulation of times, places and forms for recording completed and approved documents for each case.

Control of survey of entire property. The connection of a township, section, or grant corner of any sort with the system of plane rectangular coordinates would be a connection of a single point with the system, and could be made without reference to surveys of parcels of land and should be made with the accuracy required for second order traverses, as provided in Section 4 of this bill. Should the map include the boundaries of the parcel of land, the entire survey should be made with the same accuracy as the connection of the one point with a traverse or triangulation station of the system, and the entire survey should be checked and approved by the Board before authority to make official record of the documents and maps is given. It may be claimed that the testing of the accuracy of the surveys need not be a function of the Examining Board. In such case the recording of an approved survey of the connecting line under Section 4 is sufficient and the

possible inaccuracies of the survey of the parcel of land may cause overlaps in locations of such parcels, hiatuses between surveys and other difficulties for the settlement of which the courts are open (with the expense of a suit). Boards and their employees are subject to mistakes and inaccuracies so that the courts may have some business in case the decisions of the Board do not agree with the ideas, or the facts developed in suits brought by property owners affected thereby. The survey of lands has never been an exact science and no system of surveys has been so complete and accurate that the results of individual surveys are safe from attack. Many devices for correcting irregularities in surveys and maps have been tried and the blanket provision that occupation for a term of years (7 years in Florida) sometimes confirms title to property. The Board, although expert in technicalities of surveying could not be expected to attempt the solution of the legal and personal problems involved in the approval of a survey. Responsibility of the Board should end, therefore, with the acceptance of the individual surveys and maps presented, whether of single points or of several points and lines in a survey of a parcel of land.

The approval of the location of the points on the survey demonstrates the accuracy of the methods and results of the survey but does not touch the validity of the selection of the point so located. This principle applies to points stated to be corners in the U. S. Land Survey in State or parts of States covered thereby as well as to all points in the boundary of a parcel of land in the survey whose approval is desired.

Special Office, as the survey of the State is extended the use of its results by the citizens of the state will increase in proportion to the area covered and to the recognition of the benefits of connections with its monuments. Ultimately a special office may be required with a staff of experts sufficient to keep in control the quality of surveys and of men making them, the permanency and location of records, cooperation with similar bodies.

As surveys of parcels of land are connected with the established triangulation and/or traverse stations, many locations of township, section, and grant corners will be recorded in forms used for many purposes. Recording only in county offices would require for large projects, visits to many counties, whereas the additional record in the central office suggested would put them all together and require a minimum of travel and search.

An important reason for the central office is the coordination of surveys and records in the various counties, especially those along the boundaries of Divisions where changes in the basis of the maps take place and those of properties extending across county lines anywhere.

Coordination of surveys and maps and compilation of them in State, County, City and District maps for various purposes, including therein maps and charts from all official surveys made by National Governmental organizations of all sorts, State organizations having charge of surveys of any sort, organizations needing maps for special purposes for public dissemination; in short extending and making definite as the system develops the work of the Florida Mapping Authority. This unofficial body might well be the sponsor and advisor for such work as this.

Publication of the results of the surveys in such compilations for special purposes as would not be covered by the general maps printed by the National organization may be an important part of the work of the State Board.

Compulsory Compliance with the Law is repugnant to the spirit of America. Practically the expense of connections of all property with a system of plane rectangular coordinates would be greater than the value of much property in almost any State. On the other hand the benefits of connections are very great and will be recognized by those owning and/or wishing to dispose of valuable landed property. They would be the first to recognize the benefits and to make use of the system. Later the same effect can be produced by requiring the connections to be made before a title to land property can be transferred. The administration of such a law would be quite expensive and would require large fees for efficient approval and recording if the central office must pay all the expenses of the examination and approval. This is a further reason for making compliance with the law voluntary.

Transfers of title to considerable areas of land or of real property of a certain value could be made to depend upon character of surveys and compliance with regulations established by the Board. The many results of such a plan of procedure would demand a central office for approval of such connections and a method of payment of the expenses of such an office.

The law now proposed is only a menas of calling attention of owners and prospective owners to the new method of establishing the positions of parcels of land. Its operation will gradually educate those interested in land and transfers of title to the value of the process

and of enlarging the field of the law the better to serve those interested. Additions to the law to meet the problems developing will undoubtedly be made from time to time as the value of the possibilities is recognized.

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PROFESSOR N. W. DOUGHERTY

University of Tennessee
Knoxville, Tennessee

I have read your story on the use of geodetic control in private boundary surveys. I am in very hearty agreement with the idea. I believe New Jersey is taking a step forward in considering tying land surveys to permanent markers. We should do the same thing in Tennessee.

With the limited control we have such descriptions would be limited to a comparatively small territory. In Knox, Davidson, and Hamilton Counties we have several miles of traverse with permanent markers established at from 1/2 to 3 mile intervals. We have suggested in a number of newspaper stories that these markers should be used in land surveying.

By 1937 I believe we can present such legislation to the Tennessee Legislature and get favorable consideration.

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A. T. DUSENBURY

2108 American Bank Building
New Orleans, Louisiana

From experience gained through many years in Louisiana and other states, I am in a position to fully realize the benefits which will accrue to the various states and all parties at interest if and when the Systems of Plane Coordinates recently developed by the U. S. Coast and Geodetic Survey are put into general effect and I am sure you are proceeding properly in endeavoring to secure State Legislation recognizing this new method of survey control.

I am highly pleased to learn of the progress made in New Jersey and I hope you will keep me advised of future legislative action in that state as well as such action as may be instituted elsewhere.

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PROFESSOR E. F. CODDINGTON

The Ohio State University
Columbus, Ohio

I am much interested in having all boundary monuments connected with the national triangulation system. Whether this connection can best be established by means of plane coordinates or by geographical positions might be open to debate.

I am inclined to the opinion that all state boundary monuments should be connected to the national triangulation by first order traverse and their positions defined by latitudes and longitudes. In Ohio national triangulation is already available to make this possible at relatively small cost.

I would prefer to have the positions of county boundary monuments also defined by geographic positions. Connecting these monuments to the national triangulation system may be readily done when all the proposed triangulation has been completed.

Thus I would have state and county monuments located by geographic positions. It will require some one who is capable of making the reduction from local plane coordinates to geographic positions, to connect these monuments to triangulation stations. These ties should be made by traverses with an accuracy of at least 1 in 25,000.

I am not ready to commit myself as to the type of plane coordinates which should be used to fill in between the boundary monuments and the triangulation stations. I am at present inclined to county systems, in which the convergence would not be sufficient to bother the local surveyor. The establishment of county systems might educate surveyors to the point where one or more state systems of coordinates might be substituted.

We have in this State the Ohio Society of Professional Engineers which is affiliated with the National Society of Professional Engineers. Branches of this society are being formed in many of the counties, especially in those counties having cities located in them. The membership of this society is made up almost entirely from civil engineers and surveyors.

Any bill introduced into the General Assembly of Ohio such as the one introduced into the General Assembly of the State of New Jersey would have to have the backing of the Ohio Society of Professional Engineers.

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MAJOR A. H. HOLT

The State University of Iowa
Iowa City, Iowa

Thank you for letting me see what is being done in New Jersey, in the matter of legalizing the use of coordinates for control of boundary surveys.

It seems to me that the suggestion of your office for a form for the New Jersey bill is an excellent one. I should prefer it to the one written into the suggested form for a state having more than one system. Of course, if there is more than one system, the extent of the use of each must be stated, and I think that such data for each as you suggested for the one system of New Jersey might well be stated, -- even if it involves some repetition, -- so that the statement for each system would be complete in itself. Except where such inhibition against references to publications or documents not quoted exists as is apparently the case in New Jersey, I think it would be simpler and consequently better not to put in too much material which would be "Greek" to the legislators, -- references to Clarke's Spheroid, etc. After all, there will, in general, be no other systems of coordinates with which the one being defined will be likely to be confused; nor will any legal question be likely to arise (say in a case in court) as to the basis or method of determination of coordinates of the control points; so it seems to me that the implication rather than the full statement of these facts will leave a more workable result. It is well, however, that the system be tied to the ground and to the geodetic positions to the extent that your proposed bill shows.

It seems to me that names rather than numbers will be much better to distinguish the several systems where a state has more than one. If there be but two, as in Iowa, it is easy to say the "Northern Iowa System of Plane Coordinates," or the "Southern Iowa System of Plane Coordinates." That is much more distinctive and descriptive than Number 1 or Number 2. Other names could be devised if a state has more than two systems.

With reference to the proposed bill permitting a surveyor to go on privately-owned land to reach a control station, it seems to me that the permission should be granted only to "a registered land surveyor of this state and his assistants," rather than to "any person recognized as a qualified surveyor, etc." The provisions of Section 4 of this proposed bill are substantially covered by code in this state at the present time (Sec. 5495); but the additional privisions not now law might well be included.

It seems to me that your discussion in the proposed Geodetic Letter might well go so far as to illustrate a proposed form of use of these coordinates in describing parcels of land. These illustrations should be of two sorts, -- one of a certain quarter-section, say; and one a metes and bounds description of an irregular tract.

Something over a year ago I proposed for purposes of local discussion a description of the latter type, of which a copy is inclosed. I now suggest by red-pencil changes certain modifications in form and terminology because of developments within the past year. The purpose in mind was to write a description from which all reference to coordinates could be deleted and still leave a complete metes and bounds description. Obviously, then, there are redundant data. If the coordinates of the ends of a line are known, the length and bearing or azimuth are of course thereby determined. This makes a bulky result but the excuse for the suggestion was to produce a description which would not be objectionable to those who are by long usage accustomed to bearings and distances and who are unaccustomed and perhaps opposed to the use of coordinates.

Quite a few of those attending an Iowa Surveyors' Conference this week expressed the opinion that the use of coordinates made a description too bulky, and offered too much opportunity for typographical or other mistakes to get in, in the course of necessary copying into records, etc. Their suggestion was to give by coordinates the location of a starting point for the description and then to write the description as they have always been written, -- not even using grid north as the meridian for bearings. That doesn't appeal to me, but I'd be glad to see how you would write a description.

(Following is the form to which reference is made in Major Holt's statement)

SUGGESTED FORM OF METES AND BOUNDS DESCRIPTION OF LAND

Using coordinates, referred to U. S. Coast and Geodetic Survey Triangulation, to define the positions of corners.

"A Parcel of land situated in Blank County, Iowa, and described as follows. The coordinates used to define the positions of corners are referred to the Southern Iowa System of Plane Coordinates. Bearings used are referred to the meridian of that system of coordinates:

"Beginning at a point marked by an iron pin set in concrete, whose coordinates are: Y, 571,001.4 feet, X, 2,461,271.3 feet, and which is on the north line of Section 00, Township 00 North, Range 0 West of the Fifth Principal Meridian, three hundred one and six tenths (301.6) feet east of the northwest corner of said section; thence south seventy-two degrees and forty-seven minutes east (S 72°-47'E) one thousand eight-three and four tenths (1083.4) feet along a fence line to an iron pin set in concrete, whose coordinates are: Y, 570,680.7 feet, X, 2,462,306.2 feet; thence south sixteen degrees and twelve minutes west (S 16°-12'W) fifteen hundred eighty-nine and three tenths (1589.3) feet, along and in prolongation of a fence line, to an iron pin, set on the center line of Blank road, whose coordinates are: Y, 569,154.5 feet, X, 2,461,862.8 feet; thence south sixty-six degrees and five minutes west (S 66°-05'W) twelve hundred ninety-two and one tenth (1292.1) feet along the center line of said Blank road to an iron pin whose coordinates are: Y, 568,630.7 feet, X, 2,460,681.6 feet; thence north thirteen degrees and fifty-eight minutes east (N 13°-58'E), to and along a fence line, twenty-four hundred forty-three and one tenth (2443.1) feet to the point of beginning; containing forty-eight and thirty-six hundredths (48.36) acres, more or less."

Note: The order of X and Y might well be interchanged.

It should sometime be practicable to refer to "the point 2461271.3--571001.4" without danger of being misunderstood.

J. C. CARPENTER

Senior Highway Engineer
Fort Worth, Texas

Geodetic control in private boundary surveys is the only truly permanent method of establishment of boundary line locations. Without doubt this method will ultimately be adopted for the entire country and engineers and surveyors should lead in an active campaign for its early adoption. Legislative action recognizing this practice as the correct and legal method of designating boundaries is the only satisfactory procedure to follow.

The present time is indeed opportune for consideration of the inauguration of State legislative acts for this purpose. State Planning Boards have been created, or are being created, in many of the states and there is much talk of the study and regulation of land use. This increased interest by recognized governmental Boards will serve to create a desire for better definition of boundaries. If a Planning Board does nothing more than establish the Coast and Geodetic Survey's network as a datum for all surveys, it will have rendered service to the citizens which will grow in value as time goes on.

The employment of large numbers of engineers on Geodetic Surveys in the past several years has served to familiarize not only the engineers but many business men and property owners with the existence of the Survey's excellent system of horizontal and vertical control.

There is a natural and justified objection, on the part of property owners, to the resurvey of tracts where no question now exists as to the location of boundaries. This is particularly true where boundaries are described by "metes and bounds" and a resurvey may involve the owners in an argument and possibly in court action. While the legislation as proposed does not make the adoption of this method mandatory, it would seem desirable to emphasize this fact in explanatory descriptions of the proposed procedure, in order to quiet any fears that may arise as to the probability of extensive boundary difficulties being stirred up by the introduction of such legislation. It might even be desirable to incorporate a paragraph in the model act, setting forth that the legislation will in no way disturb present boundaries as established and recognized by law, but rather will serve to perpetuate these boundaries and insure that they may be reestablished in exactly their former positions if lost or obliterated.

There are still in existence in the State of Texas many large tracts of land in single ownership. There is, also, a wholesome respect for any monument that bears the stamp of the United States Government and it would not be difficult to enlist the owners of these large tracts in a movement to have the boundaries permanently established by referencing them to the U. S. Coast and Geodetic Survey's network. With the exterior boundaries thus accurately established, the interior lines can be tied in on the same basis when the larger tracts are subdivided.

A movement is being started in Texas to have all highway surveys monumented and, where possible, tied in to the U. S. Coast and Geodetic Survey's network of horizontal and vertical control. It is proposed that a minimum accuracy of second order traverse and leveling be used in these surveys. This extension of the network will, if accomplished, permit the use of control for land subdivisions over a much larger area and undoubtedly bring the subject to the attention of many surveyors and land owners who would not, otherwise, know of its existence and value.

The second bill, to provide for the entry of surveyors on private property, should, I believe, be included in the first bill legalizing the use of coordinates in the establishment of the location of boundaries. This would make the legislation complete in one Act and render its acceptance by a legislature much simpler than with two bills.

The legislation as proposed is well phrased and should prove entirely satisfactory when revised to comply with special requirements of the Constitutions of the individual states where it is adopted. It is desirable that this movement be vigorously promoted as it has large potential value and its adoption will mean much to the citizens of this country.

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PROFESSOR N. E. WOLFARD

The University of Oklahoma
Norman, Oklahoma

I have given the separate typical bills some study and thought, and find no fault or major criticism to offer. By way of minor criticism it occurs to me that the following addition and insertion might be made in the memorandum entitled "An act to permit entry of surveyors . . . . . .".

Section 2. Add at end of paragraph " . . . provided that the costs so assessed, if not paid within thirty days, may be collected through due process of law."
Section 4. (line 4) Change to read " . . . or shall oppose, or offer any obstacles to . . ."

I have been very much interested in, and hopeful of securing early recognition of the Geodetic Control through coordinates as a legal structure to which to tie land descriptions, and will be glad at any time to assist in any way in bringing about and perfecting a uniform system of description and procedure.

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(The following paragraphs are from an article written by Professor Wolfard and entitled "Sufficiency of Title". It is expected that the entire article will appear in a future number of the Geodetic Letter.)

Conveyance of real property is, or should be, conditioned on clear title which is attested by abstract. Abstract is a summary of records financial, legal, and descriptive. Descriptive record is established by position, fixed or relative.

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* * * However the reader will agree, I am sure, that a point of reference determined or established by the rigorous procedure of Coast Survey methods will be more exact in position, more permanent, and more readily reestablished in case it becomes disturbed, than is the ordinary point of reference used in deed description.

The surveys set up as C.W.A. projects throughout the several states in December were mostly concerned with "second order" traverse and leveling. The general procedure was to execute traverse from previously established and computed arc triangulation stations. The traverse was to be run from one station to another along highway or railway and monuments carrying a standard bronze marker set from one-fourth mile to two miles apart, depending on topography and cultural demands. Thus were formed closed loops affording accuracy check. Levels were run along the traverse establishing elevation of each marker, together with intermediate bench marks on bridge heads, etc. These monuments afford convenient and accurate horizontal and vertical control reference points for future surveys and "check in" points for surveys already made.

A system of coordinates has been set up for Oklahoma and computers are now busy computing the coordinates of all triangulation stations within the state as well as the coordinates of each of the monuments set in the local control survey now in progress under C.W.A. The advantage of a state coordinate system of reference points is evident on a moment's reflection. With public and private surveys throughout the state referred to common position coordinates and elevation datum relative position, either vertical or horizontal, of control or objective points in a projected enterprise, great or small, could be readily determined without preliminary surveys.

In order to facilitate the usefulness of data resulting from the numerous surveys constantly being carried on by various governmental units, corporations, and individuals a clearing house in the form of a state survey bureau should be set up. The functions of this bureau would be various and far-reaching, and must needs be a subject of separate discussion in a future issue. Modification of procedure in legal surveys and public responsibility and license of surveyors should come up for study and analysis.

It is hoped that engineers and surveyors, as well as industrial and political leaders, will consider and analyze the coordinate basis for surveys in its various aspects of economy, utility, accuracy, and permanence.

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PROFESSOR WILLARD J. TURNBULL

University of Nebraska
Lincoln, Nebraska

In the following paragraphs are a few remarks with respect to your letter of March 5, 1935. These remarks concern the various phases in the development of the use of plane rectangular coordinates, which I believe to be pertinent.

I was very much interested in your resume of the present condition and stage of development in the use of plane coordinates under the heading "The Use of Geodetic Control in Private Boundary Surveys".

I am confining my discussion under various headings, each heading being self-explanatory.

1. PLANE COORDINATE SYSTEMS FOR NEBRASKA.

Two plane coordinate systems, a north and a south, have already been selected for Nebraska by the U. S. Coast Survey. These systems are Lambert Conformal conic projections, and have quite evidently been selected with the idea of keeping the scale error due to the projection as small as possible. As a rough estimate, the greatest scale error with these projections will probably be less than 1:10,000.

The plane coordinates of the intersections of the various degrees of latitude and longitude for Nebraska have recently been computed for the two previously mentioned systems. It is now possible to construct a projection for the entire state or for individual sections. An attempt is being made by a State F.E.R.A. mapping project to fit past state surveys to this projection. Considerable difficulty will undoubtedly be experienced due to the variable types of surveys and the variable accuracies obtained.

2. LEGAL RECOGNITION OF THE USE OF A SYSTEM OF PLANE COORDINATES.

A point of primary importance in introducing a system of plane coordinates for use in the description of boundary lines for public or private properties in a state in the enactment of a law by the state legislature establishing the recognition and legality of the system.

In the near future I will submit to you a draft of a bill for legal recognition of a state system of plane coordinates for Nebraska, modeled along the lines suggested by you. The allotted time for submitting bills to the present session of the Nebraska Legislature expired almost three weeks ago. Consequently, it will not be possible to introduce such a measure in Nebraska for some time.

I think that the draft of the bill which you have prepared concerning the "entry on private property", "payment of damages", "protection of survey marks", etc. covers all these points quite well. As I see it, the main purpose of this bill is to secure the maximum use of, and protection for, the survey monument without creating antagonism on the part of the property owner.

3. PRIVATE BOUNDARY CONTROL.

The final success of any measure is dependent on the backing of that measure by the people as a whole, and not on its acceptance by just a few specially trained people. The average individual must be made to see and feel that without great trouble and expense to himself he may receive a definite benefit from the measure under consideration. The average citizen might be inclined to question the value of geodetic control, as he might feel that it would benefit only the larger engineering projects. But if you were able to prove to that citizen that he could use such control to permanently mark the boundaries of his property for all time, with practically no cost to himself. he would probably be considerably more interested.

The establishment of permanent boundaries of private properties through the use of plane coordinates would then seem to be the logical way to approach the taxpayers of a state, and this would seem to be the greatest potential use of plane coordinates.

Since Nebraska is an agricultural state, the principal class of people to interest in this movement will be the farming population. Due to erosion and road construction, the mortality of the "buried corner-stone" marker has been very high. In many cases the ties to these markers such as trees and corner posts have also been removed, thus the actual locations of these markers are lost. When the farmer or property owner recognizes that plane coordinates ties to his boundary lines can never be lost, and that with a minimum effort on his part the boundary of his property can actually be traced at any time, he will probably become sympathetic with such a movement. He will also be free from possible boundary disputes which are often embarrassing and costly.

The above reasoning applies equally to the private urban property owners, especially those owners of high priced plots of ground in the business section of the city.

Thus, regardless of ownership or size of property, the boundary once established by a system of plane coordinates and legally described and recorded can never be lost.

4. GENERAL EDUCATION OF THE PUBLIC TO THE ECONOMY AND NEED OF PERMANENT AND UNIFIED SYSTEM OF CONTROL SURVEYS.

It should not be difficult to prove that the great part of our surveys to date have been expensive principally due to the fact that permanent monuments were not established, and the value of the survey even though possibly made with great care and accuracy is lost to all future needs which may arise in that particular area. Then too, we usually have as many different methods of surveys with as many different degrees of accuracy as there are private, city, county, state, or federal agencies which undertake surveying projects. With the establishment of this unified system, the maximum error of the survey could be held within prescribed limits.

I believe that I could name five or six federal agencies which have duplicated and often show conflicting elevations on the same monument. The same is equally true of local surveying agencies. This points out very definitely the need of a strong central agency whose duty would be to supervise or control all surveys carried on in the state. This central agency should be national rather than state, otherwise we might have 48 more or less individual systems of survey, and we would not be much nearer than before to a unified national system of control surveys. The Coast Survey is the logical national agency to supervise or control such a comprehensive system of first and second order surveys and the development of the various state systems of plane coordinates.

- A -

PROFESSOR A. S. CUTLER

University of Minnesota
Minneapolis, Minnesota

I have gone through the memorandum regarding control of boundary surveys which you sent me some time ago. Also, the members of this department have examined the statement, and are all agreed that this proposal is very desirable. In order to secure any definite action along this line by the members of the Legislature, it will be necessary, first, to do a large amount of educational work among the engineers and surveyors, as well as among the laymen. It has been only during the last year or two that even the local engineers and surveyors have taken any particular interest in the work of the Geodetic Survey and in precise methods of surveying. The work which was done through the C.W.A. project last winter, of course, received considerable interest from both the surveyors and the general public.

I think it would be desirable for your department to issue as often as is practicable bulletins or letters which could be used for publicity purposes. This information could be made the basis of papers to be presented before the various engineering society meetings and for articles to be published in the various state engineering papers.

The need for such a control of boundary surveys is not quite so evident in this part of the country as it is in the older New England states, as our sub-divisions are all on the basis of the public land rectangular system. I think perhaps one of the first objectives which we should attempt to accomplish is to require that the location of all township corners, as well as city and village boundary lines, be tied into the triangulation system. Assuming, however, that this triangulation net would be extended so that stations would not be great distances from each other. In this state we have a comparatively small number of precise triangulation stations so that it is a little more difficult to convince the public of the necessity of such a plan as you propose. I am assuming, however, that this net will be extended in the very near future so that these stations will be available. Of course, it would be very desirable to have the section corners located in their true positions - that is the final objective toward which we should move.

You refer in your letter to the fact that plane co-ordinates for these triangulation stations must be computed. Also, it will be necessary to have very definite specifications drawn for the conducting of surveys by local surveyors and engineers who would be tying into these triangulation stations. It might be necessary to draw up some definite regulations under which certain men would be licensed to make these surveys before they could be accepted for record. It is unfortunate that all of these stations and this information were not available several years ago when our state and federal truck highway systems were being projected, as the surveys which were made for that purpose would have formed a very complete network, covering the entire state. I should like to suggest also that it might be desirable to require surveys which are being made by state departments, such as, highway, water resource surveys, etc., to be tied into permanent bench marks, as well as to precise triangulation stations. I think that the difficulty we are having in this state is due to the fact that there has been no control of elevations for various surveys, so that it has been impossible to correlate all this information which might otherwise be valuable.

ROY M. BUCK

Supervising Engineer
Idaho State Geodetic Survey

(The following pertinent paragraphs are taken verbatim from a paper entitled "Land Surveys and National Welfare", in which is told the story of precise land surveys made in the Philippine Islands by the Bureau of Lands to meet the need for a wholesale quieting of titles to lands held by the people. It is expected that Mr. Buck's paper, which is based on ten years of experience with that bureau, will appear in its entirety in a future number of the Geodetic Letter.)

* * * * * * *

In the United States the old monuments and corner markings of original surveys were established from 40 to 200 years ago and in many cases are lost without a trace. Another 25 years will see a large percentage of them here in the West permanently obliterated. This situation is further aggravated by the fact that everybody and anybody is conveying titles to land based on descriptions wholly inadequate to identify the properties intended. Such deeds are made of record in the county where the land is located and there is no one at present with authority to insist upon definite, sufficient and accurate descriptions.

* * * * * * *

The plan to have special legislative sanction to the grid system of surveying is a step in the right direction. It might be possible to include with such a bill a provision requiring all title conveyances to be checked for description deficiencies by the county surveyors at a nominal fee where no field work is required.

A law providing a sound establishment of land titles is urgently needed in connection with the program because new surveys and new monuments are without bearing in old titles. Owing to their greater economy and absolute effectiveness the program at the proper time, should include cadastral surveys. Titles based on such a survey would save us a great deal of trouble that may well be expected in another generation.

V. G. SANDERS

Chief Computer
Joint Committee on Survey Control
Los Angeles, California

The testimony of courts crowded with land litigation should be evidence enough of the necessity of establishing property boundaries by methods which will make them permanent even though all their monuments may be destroyed. This can only be accomplished through the use of a co-ordinate system based on triangulation and the respective coordinate values of each point and the bearing of each line of the boundary incorporated in the legal description of the property. Legislation in each State is necessary to legalize this method of description writing.

Should not the necessary legislation, however, be more mandatory? The City of Toledo, Ohio, has a very interesting ordinance (No. 9098) making compulsory that the various surveys be connected and coordinated to the triangulation.

- Δ -

BISHOP MOORHEAD

206 Old Post Office Building
Portland Oregon

In reply to your communication of March 22, 1935, in regard to the Plane Coordinate System for Oregon. As you no doubt realize it has been unnecessary to convince the writer of the value of a uniform system of Plane Coordinates, as he has realized the importance of this work, and from experience in the army, has seen possibilities of such a development. It was only necessary for some important organization or bureau to make the initial step, which the Coast Survey has done. The State Highway Department has adopted the system of Plane Coordinates in so far as triangulation or traverse points are available from which the coordinates can be computed. Owing to the large spacing of triangulation stations in Oregon it is impossible to utilize the benefits that can be derived therefrom in all parts of the state, but wherever points may be obtained the system is being adhered to.

This office has computed the Plane Coordinates of all triangulation stations in Oregon that may be used for the initial of local surveys and these are furnished upon the request of any engineer, having use for them. In addition to this, we have completed approximately 450 miles of second-order primary traverse. About 3,000 more miles will be necessary to break the state up into units from which any local survey can be started. We have prepared a pamphlet of 60 pages, giving a full explanation of Lamberts Conformal Conic Projection where it pertains to field and office work; eliminating the derivation of the projection and stating the explanation in language that can be understood by the general engineer. We are now printing an additional supply of these pamphlets, which will be mailed to each county engineer, together with a questionnaire for them to complete, in regard to their reactions toward the system.

* * * * * * *

All people who have utilized the system state that it has increased the accuracy of the work done by their surveying crews, at least 25 percent; this being caused by the fact that their lines will be checked in place of left "hanging in the air."

Of course it is necessary to educate the surveyor and engineer in the use of this system; but to whomever we have explained the advantage of uniform plane coordinates; it has met with an enthusiastic approval and when our campaign in its favor is completed, you may rest assured that we will have the whole-hearted support of all parties concerned in the State of Oregon.

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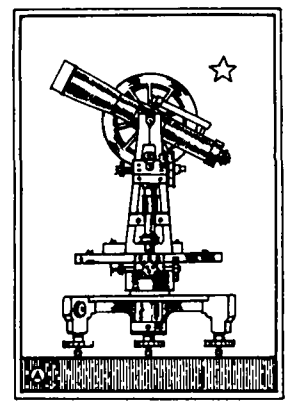

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EDITORIAL

It is truly remarkable how well the field and office work of the Division of Geodesy has been carried on during the past few years, with the great expansion in personnel that has occurred. It is only by good organization, planning, and a clear picture of what was needed that such excellent results were obtained.

There are still a few weak spots. Records come to the office that are not quite complete, and sometimes erroneous data or information are given. This applies especially to the descriptions of stations and the measurements of directions and distances to reference and azimuth marks. A number of items have appeared in Geodetic Letter calling attention of chiefs of parties, observers, and others, to the necessity of checking all measurements and other data before the records are sent to the office.

The names of chiefs of parties and observers who have been at all derelict in having accurate data furnished this office have been withheld. It has been thought that a statement of the problems involved would lead to their solution. Of course, if the records received from any one observer should continue to be unsatisfactory, undoubtedly the Director will communicate with the chief of party with a view to having the results of the particular observer improved or in the absence of ability to furnish correct information, the chief of party would be directed to relieve the observer from his duties and give him a less responsible assignment.

The observers are imbued with a fine spirit and the desire to get a great amount of work done in a given time in order to avoid holding back the other units of the party. Rapidity of observations and low unit costs are most important; yet about all that we have to show for field and office work are the monuments left in the field and the data for the stations. If the data, including the descriptions of stations, are not complete and accurate, then the results are not all that can be desired. Accuracy and completeness of data must be obtained even though the party is somewhat slowed down in progress and unit costs increased in consequence. The data secured by triangulation parties should be good for all time to come unless the stations are destroyed by the works of man or the forces of nature.

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STATE OF NEW JERSEY
EXECUTIVE DEPARTMENT

April 18, 1935.

Passaic County Engineering Society
North Jersey Country Club
Hamburg Turnpike
Paterson, New Jersey

Att: Mr. Vincent J. Scanlan.
President

Gentlemen:

I have just learned of the occasion of your annual meeting and of the importance the engineers of this State attach to the successful passage of Assembly bill #209. Remembering my visit to your Chapter about a year ago and mindful of your cordial reception, it gives me pleasure at this time to send you my sincere greetings.

I desire also to hand you herewith, in recognition of the splendid work accomplished by your group, particularly on behalf of Professor Philip Kissam, Head of the United States Coast & Geodetic Survey in this State and the men who worked so hard with him to secure passage of the above legislation, the pen with which this writer, as the Executive officer of the State, made your bill a law of this Commonwealth.

Accept my congratulations for your enterprise and my sincere felicitations upon this, the fiftieth anniversary of your original organization.

Sincerely yours,

Governor

REFERRED TO
1 Gen. Allen
2 P. S. FRIEND
Kissam
m:

LETTER FROM THE GOVERNOR OF NEW JERSEY

The letter given on page 3 requires no comment. A photographic copy of Assembly bill #209, to which reference is made in the letter, was published in the May number of this journal. This Act establishes a system of land-boundary descriptions for the State of New Jersey, the base of which is the system of plane coordinates established over that State by the Coast and Geodetic Survey. Governor Hoffman's letter is a splendid expression of commendation and appreciation for the work done by Professor Kissam and his associates.

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THE GEODETIC WORK OF THE COAST AND GEODETIC SURVEY AND ITS USES

By

William Bowie
Chief, Division of Geodesy

(Delivered at a meeting of the Iowa Engineering Society and the Engineering Extension Service.)

I really can not talk about the geodetic work of the Coast and Geodetic Survey without including many other things. Probably the most important of the other things is the topographic map. The map is a graphic representation of the earth's surface. By it we can secure more information in a brief time than could be gotten by months or years of travel, interviewing or reading.

Let us assume that each of a hundred men wish to engage in some activity between the cities of Philadelphia and New York. They must have a complete knowledge of the lay of the land, the highway systems, the railroads, rivers, streams, forests, villages, cities and other things. If there were no maps between those two cities, each of those hundred men would have to get this information himself. He could do this by traveling over the area, making notes as he went along; or by interviewing others who were familiar with the country between those points; or he could use a third method of reading books and reports on the country between Philadelphia and New York. The chances are that if he used any one of these three methods, he would have a very distorted idea of what really lies in that area. If, on the other hand, he had a topographic map, made with accuracy and kept up to date, he would be able in a very few minutes or hours, to learn just what he needed to know in order to plan and execute his projects.

The topographic map can not show everything, of course. If all details were given on it, the map would be so cluttered up

that it would be almost unintelligible. On the other hand, overprints can be made for each of a variety of data, such as forests, condition of crops, fertility of the soil, density of population, character of highways, and perhaps other things.

The map cannot be made with accuracy without good geodetic or control surveys. These control surveys consist of triangulation and traverse for the determination of positions, distances, and directions and leveling to furnish elevations.

There is no mystery about geodetic work. An engineer can go to a triangulation party for a few months and receive intensive training and can then make observations that will be satisfactory. The same is true of training in leveling. I do find that engineers have difficulty in performing a satisfactory job using geodetic instruments and manuals if they have only a short time of practice. We, in the Coast and Geodetic Survey, have been carrying on geodetic surveys for 118 years and no doubt have made every mistake that human beings could make in carrying on this class of work. We have tried to improve our methods and instruments with a view to eliminating the possibility of making mistakes and blunders. The engineer visiting our parties can see just how our engineers handle the instruments, equipment, etc., and in a comparatively short time can do a real job. Of course, with added experience he can improve his technique. As a matter of fact, even after a decade or more of doing geodetic surveys the engineer can still improve his work. The improvements would not involve big things but perhaps just minute details of operating the instrument.

The Coast and Geodetic Survey is now following a plan which calls for the spacing of arcs of triangulation and lines of levels at intervals of about 25 miles over the entire country. It is expected that by June 30 the 25-mile spacing of the lines of leveling will be completed. It will require about two and a half years at the present rate of progress to finish the 25-mile spacing of the arcs of triangulation.

There are now 76 leveling units and 51 triangulation units in the field. The instruments for these units are being operated with few exceptions by engineers who have been employed by the Coast and Geodetic Survey within the last two or three years. These engineers have been given training in all classes of the work. They act as lightkeepers, recorders, perhaps even truck drivers, and they are trained in the use of the instrument.

For a number of years the Coast and Geodetic Survey has been working on a very definite plan for its triangulation and leveling. Funds were low but it was realized that eventually geodetic surveys would be recognized as public works of importance. We thought that the best way of proceeding was to have great arcs of triangulation

and long lines of levels across the wide open spaces of the control survey nets. With a few of these great arcs and lines as the starting points for other arcs and lines, it was possible to break down the area into smaller pieces. This went on for some years at a comparatively slow rate of speed. The unit cost of the work was low, the engineers highly trained, and in consequence of this when funds became available in larger appropriations, starting in 1930, we were able to expand our parties quickly. We had anticipated greater activity in geodetic surveying and, in consequence, had been purchasing the necessary high-grade instruments, a few at a time.

The appropriation for geodetic surveys, which was $88,600 for the year 1929, was increased to $327,000 in 1930. Then, in 1932 we had an increase of some half million dollars by an appropriation in the so-called Wagner Bill. We were able to expand in such a way as to utilize that increased money. Then, in the late summer of 1933, we had an allotment of two and one-half millions from the Public Works funds. Even this great increase did not seriously disturb us. Of course, it meant more work, and more planning, but all of this was efficiently accomplished and we are today spending at a rate of more than $200,000 per month where five years ago the total appropriation for the year was less than $90,000.

At first we thought it would be a great accomplishment if we could eventually have the lines of levels and arcs of triangulation spaced at intervals of 100 miles over the entire country. This was a dream which we hoped might come true in the far distant future. Today, we have a plan which has been approved that calls for the spacing of the lines of levels and arcs of triangulation at intervals of 25 miles. Within the next five or six months the 25-mile spacing of the lines of levels will be completed. Already we are beginning a break down of the 25-mile net with subsidiary lines of levels. The triangulation net is now about half completed and, if we can maintain the present rate of progress, three years from now the 25-mile spacing of the arcs will be finished.

It is an ill wind that blows no one any good. So, while the country has been in the throes of an industrial depression worse than anything our people have ever experienced, geodetic surveying has been benefited by the depression as indicated by the great progress that we have made during the past few years. We have now on our pay roll approximately 500 engineers on our geodetic parties. In addition, we have more than a hundred engineers computing and adjusting the observations and preparing the resulting data for the printer.

It has been estimated that we must have horizontal and vertical control surveys spaced approximately seven miles apart in order

to furnish the basis for maps. Those who are conversant with photographic mapping say that with a spacing of 7-1/2 miles for the horizontal control points, the compiler can accurately transfer to the map the information shown on the photograph taken from the air. This brings up a very interesting question. How can the control survey stations be made to show on the aerial photograph? As a matter of fact, no attempt need be made to show them. It is far better to wait until the area has been flown over and photographed, and then have two men in an automobile with a transit and a tape go out to the field, visit the triangulation and traverse stations and tie in, by angle and distance, features that show on the photographs that can be identified on the ground. A two-man party should be able to tie in several stations per day. It is better and less expensive to do the work this way than for the triangulation and traverse parties to attempt to tie in many objects that the observers believe will show in the photographs. Of course, many features such as fence corners, crossroads, houses, and other objects may be very close to the triangulation and traverse stations and these can be tied to the station at the time the observations are made. Even if these objects do not show well in the photographs, they make splendid reference points for the survey stations.

The Board of Surveys and Maps of the Federal Government has outlined a plan calling for the completion of the topographic map of the United States within ten years. This plan has been adopted by the National Resources Board and is contined in a report that Board made to President Roosevelt. It is reasonably certain that the President will take steps to expedite the mapping of this country. He realizes that in making plans for the utilization of the land, water, forests, and other things a complete knowledge of the terrain must be available.

Only about fifty per cent of the area of the United States is now topographically mapped and hardly half of the existing maps are of any value in detailed planning. Either they are very old or they were done in such a sketchy way that they do not satisfy modern needs. We may, therefore, say that 75 per cent of this country is unmapped.

The plan of the Board of Surveys and Maps divides the country up into three classes of areas called first, second and third priorities. These areas were selected by the Board after every possible effort had been made to secure information as to the needs of federal, state, and other agencies. This priority map will undoubtedly be modified from time to time as needs increase for one area and decrease for another. Of course, everyone of us would like to see the country mapped within six months or a year but this is impossible. It can easily be done within ten years and if the necessity arose the country could be mapped within five years. The unit costs would be increased if the shorter period

were used. More equipment would be needed and there would be less average efficiency, but the work could be done.

The geodetic surveys of the Coast and Geodetic Survey are now so far along that it will be possible to supply the seven-mile spacing of the horizontal and vertical control survey stations in any area to the topographers and map compilers well ahead of their requirements. All we need is a few months notice that a certain area is to be flown and mapped and a geodetic party can go to that area and have the work done in time for the mappers.

Late in 1933 there was started in each one of the states what is called the Civil Works Administration local control project. The employment of fifteen thousand people was authorized by the relief administration for this job. The Coast and Geodetic Survey was allotted a fund for certain administrative purposes connected with these surveys. Representatives were selected in each state and in a remarkably short time many men were at work. By February 15, 1934, there were about 10,300 men on the pay roll of the CWA local control surveys. Of these, 5,000 were engineers or men who had had some engineering education. There is no job in the United States of which I know, where the percentage of engineers employed is larger. If that work had continued, the Director of the Coast and Geodetic Survey would undoubtedly have requested funds for the purchase of high-grade transits in order that the angles of the traverses could be measured with accuracy and speed. In actual practice the instruments used on the CWA work were borrowed from universities, colleges, technical schools, railroads, cities, highway departments of states and from individuals. The response to the request for the loan of instruments was remarkable. While many of the instruments were not in the best of shape, yet by following special methods, accurate results were obtained with them.

The work on the local control surveys in some of the states stopped on February 15, 1934, but for others it continued and is still going on. At present there are 23 states carrying on these surveys as relief measures and approximately 2,900 people are employed on them. Of these 2,000 are engineers or men who have had some engineering education or college work.

Professor J. S. Dodds of Iowa State College was selected by the Director of the Coast and Geodetic Survey as his representative on the CWA project in Iowa. He was exactly the right man for the job. He accomplished much in a very short time. I am sure that if the work had not stopped in Iowa on February 15, 1934, he would by this time have many thousands of miles of traverse and leveling of high degrees of accuracy that would be of inestimable value to the people of your state.

If the President adopts the plan proposed by the Board of Surveys and Maps for the mapping of the country, it is expected that approximately five millions of dollars will be made available to the Coast and Geodetic Survey for control surveys for the first year of the program. In six years, the horizontal control surveys will be completed and in seven or eight years the leveling will be done. Necessarily, the control surveys must precede or should precede the topographic mapping.

In addition to the control with the seven-mile spacing for the aerial photographs there is much other control work needed in this country. In triangulation the stations are spaced at intervals of 7 to 10 miles along an arc but these stations are in many cases, especially in rugged areas, on ridges and hills which are not readily accessible to the engineer engaged on a local project. He wants his control stations somewhat closer at hand. I am in favor of continuing the local control surveying that was started in the different states more than a year ago. Around every city there should be a network of lines of levels and traverse. Close to the city the lines might be spaced only a mile apart, while at a distance of 10 or 15 miles from the center of the city, the spacing might be three miles. The net might be somewhat like a spider web with circles around the city and radial lines extending out along the highways and railroads. The stations along these lines should be closely spaced at intervals of not more than a mile. They should be set in pairs in most cases in order that the engineer wishing to use the data can set up his instrument on one station and sight on the other for azimuth. Eventually, perhaps ten or twenty years from now, these detailed control surveys could be extended out into the sparsely settled areas. The data secured would be invaluable in making cadastral surveys. Property lines should be tied into the horizontal control stations of the country. When this has been done, there will be no difficulty at any future date in recovering the boundary with exactness.

It may be said by some that these surveys are expensive. That is true, but when we balance the cost of the surveys against the benefits that are derived from them, I think we can conclude that the spending of the money on good surveys is an investment that will bring large returns ever afterward.

The Coast and Geodetic Survey has been working on plane-coordinate systems to facilitate the use of triangulation data on local projects. Publications of the Bureau explain the use of plane coordinates for a city or a county. More recently we have realized the need of plane coordinates over a whole state. To make a plane-coordinate system cover a large area involves a number of problems, which, however, we believe we have solved.

It has been found that a strip of the earth's surface not more than 158 miles wide can be flattened out without causing a distortion of more than 1 part in 10,000. We believe that this scale factor, as it is called, is so small as not to interfere with the use of triangulation and traverse data. In local survey work, of course, 1 part in 10,000 is six inches per mile and there are many surveys that have to be better than that. Where high-grade surveys are to be made and based on a plane-coordinate system, scale factors can be used which will make the plane-coordinate system just as accurate as the spherical-coordinate one. Simple rules enable the engineer to apply these factors.

Plane-coordinate systems have been devised for every state in the Union. Some states are narrow and one system can be used for the whole state. This applies to such states as Connecticut, Rhode Island, Delaware, New Jersey, Maryland,Tennessee and some others, while in the State of Iowa it was necessary to have two systems. In Texas there are five systems and in California six.

It has been thought by many that the plane-coordinate systems devised for the states should be used in cadastral surveys. If this were done it would be necessary to have the legislature in each state legalize the use of the horizontal control system of the county and the state plane-coordinate systems as the bases for cadastral surveys. Already thought has been given to the preparation of bills to be submitted to state legislatures legalizing the use of the control survey stations in cadastral work.

Another piece of legislation should be enacted in each one of the states, to protect survey monuments of all kinds, whether established by agencies of the Federal Government, states, counties, cities or individuals. Authority should be granted to engineers to go on private property and occupy with instruments survey monuments that have been established. It is impossible to have all the survey stations of the control nets on public lands, that is on right-of-ways or highways. Sometimes it is necessary to establish them on hills or other points outside the right-of-ways. In such cases the engineer must go on private land to get his starting point. Provision, of course, should be made in the legislation to protect the property owner against damages if trees are cut to open lines or if crops are destroyed by men walking over the fields. In such cases property owners should have compensation for their loss, but usually engineers are exceedingly careful, with the property of others and little or not damage is done. The engineer should always settle immediately with the property owner for any damage that is done.

I am very much in favor of the use of inscribed metal tablets for station marks. In the early years of the Coast and Geodetic Survey, blocks of stone or concrete were used as station marks with perhaps a copper plug in the top. Letters, such as U.S.C.S. were sometimes cut or moulded into the top of the monument. Years afterward the finder of such a monument often had visions of buried treasure being at hand and would dig up the mark and destroy the station. We have lost hundreds, perhaps thousands, of stations along the southern coasts of our country because the discoverer of the marks did not know just what they represented. Now-a-days, with a tablet in the top of the mark telling just what it is, there is no further curiosity about it and no one will take the trouble to dig it up. Of course, marks are occasionally destroyed by people with malicious intent and other marks are destroyed thoughtlessly in industrial expansion. The road scraper has destroyed many bench marks and the steam shovel has lifted many of them out of place. Today, however, the highway engineers of the states and counties appreciate the value of control survey stations. They warn their employees to protect the marks as construction proceeds. In many cases new stations are set off to the side of the widened road.

In addition to what the Federal Government has done in extending the control surveys of the country, some fine work has been done by other organizations. Some of the states and counties have made splendid control surveys of their areas, but much remains to be done. I should like to see the highway departments of all states and counties do their surveying with greater accuracy. This can be accomplished with little added cost, provided modern types of instruments are obtained. A survey made for a special purpose, if well done and permanently monumented, will serve many other purposes for years to come. It is wasteful to do the work only well enough for the immediate object in view.

I have been astounded to find much poor equipment used in surveying by Federal, state, city and county organizations and by private corporations and individuals. In most educational institutions the number of modern instruments is exceedingly small or such instruments are not found at all in the stock rooms. In every class of engineering except surveying and mapping the engineers insist upon the very finest and most up-to-date instruments and equipment. In construction engineering, accurate apparatus is used for testing structures for strain. Instead of the pick and shovel we use steam shovels, tractors and great trucks for moving material; we mix concrete by machinery instead of by hand; we carry concrete, bricks, mortar, etc., to the tops of skyscrapers in elevators instead of by the old method of the hod carrier. But in surveying and mapping we seem to be content to use the same kind

of instruments that were supposed to be up-to-date at the time of our grandfathers. Why is this so? I do not know, but I must say it is a wasteful way of doing things. We have had engineers come to the Coast and Geodetic Survey from bridge companies, asking us to lend them theodolites and engineers to do some triangulation and base measuring for the location of bridge abutments and piers. They say they have no instruments adequate for the job and they have no engineers who are skilled in triangulation.

Is this situation regarding instruments due to the attitude of the professors of civil engineering or is it because so little surveying and mapping is done that the engineers in charge of projects feel that the old equipment will be adequate? In any event, I think it is only just to the students of civil engineering that they have access to the very finest and most up-to-date theodolites, levels and other surveying instruments in their courses. I believe that any corporation can well afford to buy some modern instruments. Those instruments should be serviceable for thirty or forty years or longer and the jobs done with them will have lower unit costs than if the work were done with poor instruments. Some of the theodolites used in the Coast and Geodetic Survey are seventy or more years old. Four of them, made in the early '90s, have been constantly in use for forty years. Surely, a corporation or city or highway department of a state can afford to buy a ten-second transit for use on its surveying work. In leveling, tilting levels should be employed, for with them far greater accuracy can be obtained and the work can be done very much more rapidly. We must balance the cost of the pay roll against the cost of a good instrument.

Surveying and mapping are coming to the front. No longer is an engineer engaged on surveying considered a boob. There is no branch of engineering where keener intellect or more ingenuity are needed than in surveying and mapping. I am sure that if a student is given a very fine course in surveying and mapping he will be a better designer and construction engineer than if he did not have the surveying and mapping education. I am not in favor of more surveying in the curriculum of the civil engineering department of a university or college, but I am in favor of the best education in these lines. I believe that if the student is told of the high-grade work that is done by engineers in surveying for the Federal Government, in tunneling mountains for railroads, in surveying street railways, in tunneling cities and in many other lines, he will realize what a great field this is for the engineer. It is rather remarkable that surveying and mapping have furnished employment for more engineers during the depression than has any other line of engineering. Today, the Federal Government wishes additional engineers to be employed in order to keep them in their professions for use when prosperity returns. There is nothing better to do than to open up more surveying jobs.

Perhaps every county should have its boundary properly surveyed and monumented and the surveys tied into the horizontal control net of the country. In any event, surveying and mapping are now recognized as very highly technical branches of engineering and they are, in consequence, given the respect that is due them.

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COMMENTS FROM HOME AND ABROAD

The excerpt given below is from a letter to the Director, U. S. Coast and Geodetic Survey, from Associate Professor Earl Church of Syracuse University.

"I have just received my copy of the February number of the Geodetic Letter. I have already read it from cover to cover, as I have each preceding number. I wish to express my gratitude to your bureau for being so kind as to include my name on the mailing list for this periodical.

"In these days when the profession of surveying and mapping seems to be coming into its own, as it were, and when the interest of surveyors and engineers in general is being directed more and more to geodetic surveys and their uses in connection with property surveys and countless other kinds of surveys, this little periodical indeed comes to have considerable value. If it is not out of place for me to advance the idea, I would like to venture the suggestion that it would be a splendid thing if this Geodetic Letter could actually be published in magazine form and given a wider circulation. I feel certain that it would meet with wide-spread interest and approval.

"With best wishes for the continued eminent success of your bureau in which my own interest will never cease to be very profound indeed, I am . . ."

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The following is quoted from a letter dated March 20, 1935, addressed to the Chief of the Division of Geodesy by Dr. J. J. A. Muller, President of the Geodetic Commission of Holland. It should interest the readers of Geodetic Letter.

"It is a splendid work you are performing now to complete the geodetic operations in the United States in so short a time. I do not doubt that with your energy you will reach the happy end and obtain a well merited success. I receive regularly the Geodetic Letters which I read with great interest. It is a

happy idea to give the whole personnel of the Survey an opportunity to express their ideas on technical or scientific matters and give their meanings about improvements. It makes them clear that they are mot merely human machines but real cooperators. Nothing could be more suited to stimulate their zeal, particularly in a period when every one must strive to give the outmost of his forces."

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Colonel Sir Gerald P. Lenox-Conyngham, Professor of Geodesy at the University of Cambridge, England, and formerly Superintendent of the Trigometric Survey of India, wrote a letter dated January 8, 1935, to the Chief of the Division of Geodesy, U. S. Coast and Geodetic Survey, in which were the following statements which it is believed will be of interest to the readers of Geodetic Letter:

"I have been interested in the geodetic letters which you have so kindly caused to be sent to me. Especially in some passages which showed signs of an awakening of appreciation of the value of good maps and good leveling on the part of local surveyors, engineers and municipal bodies. It has often surprised me to see how little use is made of trustworthy maps by people whom one would have expected to appreciate their value.

"Your situation in having an expanding programme of geodetic work as a part of a cure for economic difficulties is very interesting and surprising. The usual thing is to see survey activities cut down and surveyors discharged as soon as there is felt to be need of retrenchment."

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TENNESSEE VALLEY AUTHORITY ADOPTS STATE PLANE COORDINATE SYSTEMS

George D. Whitmore, Chief of Surveys,
Engineering Service Division,
Tennessee Valley Authority

After thorough consideration of the future usefulness and advantages of state-wide plane coordinate systems, the Tennessee Valley Authority has adopted the policy of basing all of its horizontal survey computations upon these plane coordinate projections, as originated by the U. S. Coast and Geodetic Survey. This is a matter of considerable importance to the Authority, as it so happens that the surveys of four large reservoir areas have already been largely completed and results calculated upon local coordinate systems. These four reservoirs total perhaps 2,000 square miles in area covered by control surveys, include more than

1500 miles of traverse control already completed and computed, not to mention numerous topographic, hydrographic and cadastral maps plotted upon these local coordinate bases. Another reason why such a change had to be thoroughly considered is that some of these reservoir areas fall in more than one state. For example Pickwick Reservoir originates in Tennessee, the lake extending into Mississippi and Alabama. Wheeler Reservoir area, about 100 miles in length and all in Alabama, nevertheless requires the use of two systems, one for western Alabama and one for eastern Alabama.

It is recognized that in order to gain the advantages of a state-wide plane coordinate system it is necessary to lose some of the advantages of the smaller local systems. The matter of greater scale distortion because of the larger area covered is, of course, already well recognized. The small local systems have had one other advantage, however, not so widely recognized, and that is they can be projected to a datum plane which represents the average elevation of the area covered by the local system. For example, the city of Pittsburgh in 1923 adopted a local plane coordinate system which was based upon a projection at elevation of about 1000 feet above sea level, this elevation representing the average for the Pittsburgh metropolitan area. Obviously it is not practical to adopt such a datum plane, or reference spheroid, for the plane coordinate projection for an area as large as a whole state.

The reasons which make it advisable to change from local plane coordinate systems to the state systems are, briefly:

1. It is felt that the use of these state coordinate systems by the Tennessee Valley Authority will tend to give them an official status sooner than might otherwise occur.

2. The state systems appear to be sufficiently accurate for all purposes except possibly cadastral surveys of city areas. In special cases of this sort it may still be advisable to use purely local coordinate schemes.

3. It is desirable that the surveys executed by the Tennessee Valley Authority be in agreement with and quickly convertible to surveys which are being made or will be made by other large organizations, such as U.S.C. & G.S., U.S.G.S., state highway departments, U.S.Corps of Engineers, railroads, and others. It is our firm conviction that it is only a matter of a few years until all of these and similar organizations will be using these state coordinate systems. If that is so, then any survey by any organization will be immediately available to all of the others, without the trouble and bother of converting from one origin to another.

4. It is highly desirable to get surveys of local property tracts, by local surveyors, upon a permanent and recoverable basis. Local plane coordinate systems would accomplish this result, but they lack the official standing which the state systems will soon acquire. Geographic positions would also accomplish the same result,

but the somewhat involved mathematics makes the average engineer shy away from their use. State-wide plane coordinates seem to be the means to this end.

The changing over from local plane coordinate origins to state systems will necessarily have to be done at the most convenient opportunities. It is now expected that some time during the present calendar year all of the local-origin surveys will have been recomputed. In the meantime all new surveys which are being made in new areas, such as the Aurora Reservoir area in western Tennessee, Guntersville Reservoir in northeastern Alabama, Chickamauga Reservoir extending upstream from Chattanooga, and others, are being computed immediately upon their respective state coordinate systems.

Surveys along the Hiwassee River in southwestern North Carolina are being computed upon the Tennessee plane coordinate system as well as that of North Carolina. This particular area is a great deal closer to the central meridian of Tennessee than that of North Carolina. Further, the Tennessee system has less scale distortion, and the developments in this area logically will be connected to projects in Tennessee. There are many similar areas where it will be advisable to compute more than one set of plane coordinates, as in the case of Guntersville Reservoir which lies mostly within Alabama, but the head of the lake extending perhaps 15 miles into Tennessee; Pickwick Reservoir, extending into three states, etc.

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SUGGESTIONS FOR RECONNAISSANCE

The following suggestions for reconnaissance for 7-1/2 -mile spacing of level lines is given by A.C. Thorson:

"In the short time that I have spent in preparing for this program, I have learned quite a bit about obtaining information about feasible routes. To run over all the lines would require a long time and most of the information can be obtained with a minimum loss of time in the field if all sources of information are exhausted.

Maps may be obtained from the following:

Geological Survey	-	Quadrangles
U.S.Engineers	-	Quadrangles Flood Control Sheets
U.S.Forest Service		Forest Reserves (Important as many new roads are being built by CCC camps.)
State Highway Departments		
County Highway Departments		
Abstract Offices -(County and Local)		

U.S.Post Office Department State maps showing location of Post Offices and rural mail routes
Coast and Geodetic Airway Section Maps (If flight checked)

"In inland areas where road information is difficult to obtain I have used the following method:

A sketch was traced from the lines projected from all existing maps of the particular area in doubt. These sketches were sent to a Postmaster of a town located in the center of the area explaining that information is desired as to what roads are passable by truck, team, etc., and also to change the roads to their approximately correct location and to add any roads not shown and specify what roads are not in existence. When the data was transferred from old maps, many changes have been made.

"This type of reconnaissance has been necessary here as continued rains and swollen streams have made a large number of the country roads impassable.

"If the 7-1/2-mile spacing is to become general, I am offering this as it may help expedite reconnaissance in other sections of the country."

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SOLAR OBSERVATIONS ON RECONNAISSANCE

H. M. White

When reconnaissance for a scheme of triangulation is being run in unmapped or inaccurately mapped territory the problem of locating the positions of points selected for stations is sometimes rather difficult. Often, existing maps are so sketchy that when stations are located with reference to roads, rivers, hills or towns as shown on the maps, the progress sketch prepared upon completion of the triangulation is likely to differ decidedly from the reconnaissance sketch. The difference may be so great that the figures will be seriously weak. Sometimes the positions of the stations as shown on the reconnaissance sketch will be so inaccurate that lightkeepers and observers will be materially delayed in picking up their lights.

In the process of reconnaissance, when certain prominent objects have been located with reasonable accuracy, it is often possible to locate other points with reference to them by compass bearings, three point fixes, etc. But when the country is flat and heavily wooded so that even from the tops of the tallest trees nothing can be seen that will be of use in locating one's position, a traverse of compass bearings and speedometer distances is often run to some known point. In many cases, however, traverses eight, or ten. or twenty miles in length are required, and

such traverses, if the roads followed are very crooked, consume a great deal of time.

Under such circumstances solar observations for latitude and longitude have been found to be both satisfactory and expeditious. The requirements are clear weather and accurate time, and since one second in time corresponds to fifteen seconds in longitude or almost a quarter of a mile, the latter is almost as important as the former. Latitude, of course, can be obtained without accurate time by an observation at noon. It is rarely convenient to make one observation at noon for latitude, and another observation at the same station for longitude, as the latter should be made as much as two hours before or after noon. But if the observer has checked his watch against Western Union time in the morning and can check it again that night, one set of observations during either the morning or the afternoon will be sufficient to give both latitude and longitude, with a fair degree of accuracy. When the latitude can not be determined by a separate observation at noon, an approximate latitude may be estimated and used in the formula for computing the longitude, then the computed longitude may be used in the formula for computing the latitude. The time spent in the field for such an observation need only amount to a few minutes though more time is required on the computation.

In recent reconnaissance operations in the heavily wooded coastal plain of South Carolina where no maps of any kind were available for certain counties, such observations were frequently employed to locate the positions of stations. Experimental observations made over previously established stations showed that results thus obtained checked the true latitude and longitude to within about half a minute of arc.

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GEOGRAPHIC AND OTHER PROPER NAMES

In a recent letter sent out by the Director, emphasis was placed on the importance of paying a great deal of attention to obtaining and verifying geographic names which are placed on topographic and hydrographic sheets. This need is no less apparent in connection with such names when they occur in triangulation records, observations of horizontal direction, and descriptions of stations. In such records, however, it may often be more important to have proper names well authenticated, as for instance, those of land owners and tenants.

No one can foresee how far-reaching an error may become when the records show a certain station is said to be on the property of Mr. Blue when in reality it is just over the line on the property of Mr. Green, or when a station is given the name of Blue, implying that it has been so named after the owner of the land on

which it stands, when, according to custom, it should be given the name of Green. No immediate effects may result from such an error, but when a generation has passed away, and the land has become so valuable that the heirs of Blue and Green resort to the courts to determine the actual location of the property line between their lands, a published report issued by a Federal bureau some 20 years earlier in which it is stated that such-and-such a station was at that time on the land of Mr. Blue, or was named Blue (with the implication that it was on Blue's property), will be very important evidence before a court interested in determining the ownership of land nearby.

This difficulty might be overcome by ignoring or avoiding anything that would serve as evidence in later years. But to do this would be to neglect an opportunity of making a station of considerable value to a community through service to its taxpayers. It is far better to secure and give accurate data as to the ownership of the land on which the station stands, and if possible, to relate it directly to such ground evidence of boundary lines as survey monuments, fences, hedges, etc. But such data should be made as nearly correct as possible without undue research. Simple inquiry and a careful statement of the result thereof will usually provide all the data that may be required for future reference.

If the owner of the land is unknown, say so; if the name of the occupant of the land is unknown, say so. But see to it that what is said is reasonably correct.

Great care should be taken in determining the correct spelling of a proper name used in a triangulation record. And it will greatly simplify the task of the office editor who may be charged with preparing such records for publication, if the original record shows a consistent spelling of such a name when it occurs more than once.

As regards geographic names, our records should be as accurate as reasonable care and effort can make them. Having the name of a geographic feature correct may not always be as important as having the name of a property owner truly given, but often the difficulties attending the former will be the greater. This is particularly true when stations established a half-century or so ago are recovered and redescribed. Sometimes the name is based on original ownership of the feature, as Miller's Point, and the possessive form was at one time correct; but with the passing years and changing ownership the possessive form may have been dropped and the name changed to Millers Point or Miller Point. But this is not always the case, and there are examples where the possessive form has been retained, due to local usage, continued ownership, or for some other reason. There is no rule to follow in such cases, but the evidence of local usage, particularly as expressed on maps, is valuable.

Sometimes, in mountainous country, at the time a station was established, one name was used to designate quite a large region, as a ridge with a number of summits on it, and the station established on one of these summits was given that general name. Later, as the country becomes more settled and separate names are given to the various summits and other features, it may be found that the name given the station is attached to a summit some distance therefrom, and a wholly different name given the summit on which the station is located. A little inquiry will discover the history of these names, and a simple statement in the description of the station make the matter clear. If this is not done, the office editor is confronted with the task of harmonizing a station of one name with its location on a feature having a different but well-recognized local name.

Sometimes there may be a choice between naming a station after a person(owner or occupant) and giving it the name of the land or geographic feature on which it is located. As a general rule the latter is to be preferred; it will have greater value as an aid in the future mapping of the region; in placing old maps in correct position with reference to new maps; and in other studies pertaining to the geography of the region. And of course, the name of the owner or occupant of the land (or of both) may be incorporated in the description of the station with full value resulting therefrom.

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SUGGESTIONS OF AN OFFICE MAN TO THE FIELD

The story about the battle being lost for want of a horseshoe nail was probably meant to convey the importance of little things that count a lot. Little details, which on the surface seem unimportant, can increase the efficiency of a large organization working at high speed if given proper attention.

Triangulation and level parties are in keeping with the times by breaking all speed records for work produced. As a matter of necessity, the rate of reconnaissance for triangulation has also been increased. In short, the progress of geodetic surveys is moving forward faster on a broader front.

In order that the machinery will work smoothly, the office personnel who supply data to the field parties, welcome any suggestions pertaining to the supplying of the said data.

They would also like to make a few suggestions on their own account. Recently, during the migration from the south to the north, data were prepared and sent to the address of a field party in the south the day before a telegram arrived requesting

that the data be sent to the new field of operations in the north, as the party was leaving the south that day. The telegram received in Washington shortly before closing time, reached the proper person the next morning. The data were on their way south and the party was on its way north. There was nothing to do but for the party to wait until the data could be forwarded. A chief of party usually knows at least a few days in advance of the time he is ready to travel to a new working area, and should immediately notify the Office of the contemplated move especially if he is expecting material to be sent him.

An attempt is being made to furnish data to the parties in such form that each party may easily determine if it has everything necessary. The writer makes no excuse for having omitted an important portion of data the absence of which was discovered several months later just as it was needed. The Office would appreciate immediate notification of any necessary, missing data.

About twice a year each party "cleans house" by returning its accumulated maps and data to the Office. If these data were returned by the reconnaissance parties as soon as they are no longer needed, it would save assembling duplicate data for the triangulation party, which, in a number of cases, follows on the heels of the reconnaissance party, and it would make the truck load a few ounces lighter in weight and a few cubic centimeters less in volume.

At least one photostat copy of the description of each bench mark and triangulation station must be made in order to guard against possible loss of the information. Until the information is published, or provided in some other more economical form, further photostats must be made to supply the official and public demand. This involves certain problems in photography that may be lightened by observing the following rules:

Use new typewriter ribbons.
Use black and not blue ink.
Take care in making check marks so that they will not be confused with nor obliterate original cipers on a photostat.

A number of descriptions received recently indicate that worn-out ribbons were used on typewriters. They could not be photographed and new typewriten copies had to be made. False economy is obvious.

Check marks on the original are rarely confused with other matter, because they are made in pencil or in colors. Such is not the case with photographic copies. A check mark appears with the same weight (for certain colors) as for the other matter. They should be made small, entirely detached from the thing checked, and preferably in colors at the blue end of the spectrum.

The colors in order of their effect in photography are: red, orange, yellow, green, blue, violet. This is not the same as the effect on the eye; for yellow, which is faint to the eye, affects the plate in almost the same degree as red and black.

Sketches of triangulation reconnaissance must be on a scale large enough to be useful to the observing parties. While the standard scale is approximately 4 miles to the inch, the final sketches of the triangulation do not need to be so large. Eight miles to the inch would be sufficient. We do have a few sketches of completed triangulation on the large scale of 2 miles to the inch but as there is not enough room in the files nor working area on our desks for such huge sketches, the smaller ones showing completed triangulation are desirable.

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SURVEY MONUMENTS DO NOT MARK BURIED TREASURE

(Press release of April 20, 1935)

Recent reports from Coast and Geodetic Survey engineers at work in Virginia, state that many survey monuments are being used to form chimneys for oystermen's shanties, according to Captain R. S. Patton, Director.

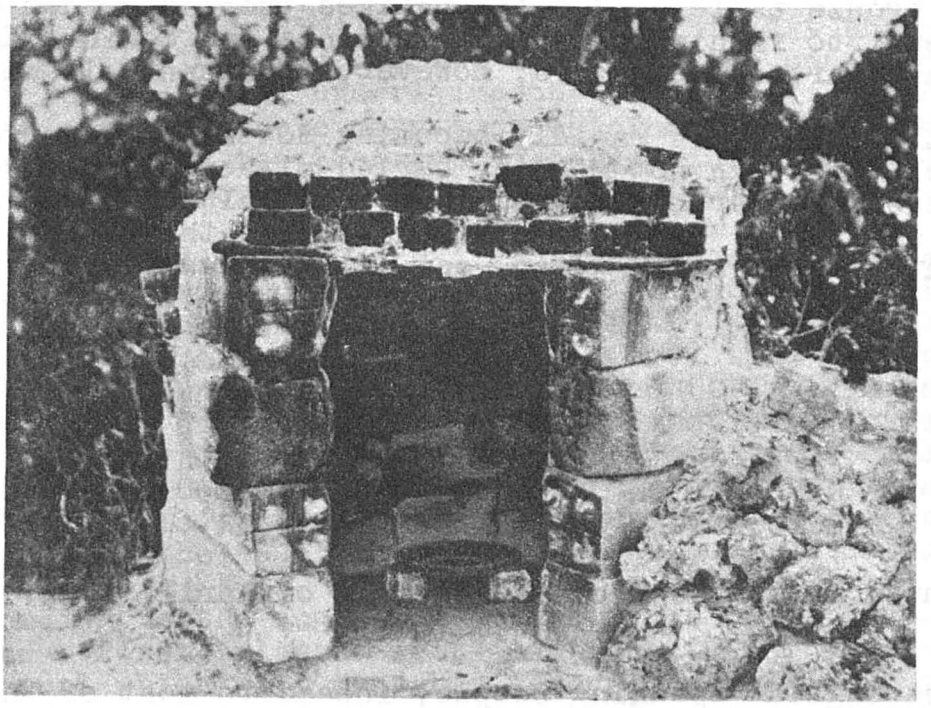
These monuments, marking survey stations established many years ago, are all as valuable for reference points today as the date they were placed. The oystermen, while not malicious, were in need of the drain tile used at that time for station marks and dug them up for what they considered a more practical use. Persons little realize that such removal completely destroys a station, necessitating its replacement at considerable expense by the Federal Government, it was stated.

The Coast and Geodetic Survey engineers in making their surveys always bear in mind the normal uses to which these stations are to be put, namely: as a basis for charts and maps; for the location and perpetuation of boundary lines of states, counties, cities, parks, and private property; and for many other engineering operations. While these engineers thought they know most of the uses for such station marks, they are forced now and again to add to their list.

A review of the files in the Washington office discloses instances where station monuments consisting of large stones or blocks of concrete weighing 100 or more pounds, have been dug up and used to anchor boats off shore or as weights for fish traps and lobster pots.

Going still further in his ingenuity, man has utilized these monuments as headstones for the graves or as steps to his cabin.

Even here his inventiveness did not stop: Years ago when indoor cooking was not so universal, it was not uncommon to find outdoor bake ovens constructed from triangulation station monuments, according to official records. (See picture shown below.)



Until the last few decades, such station monuments have been inconspicuous objects, partially hidden to reduce their mortality. They were usually set flush with the top of the ground and the letters "C. & G.S." (Coast and Geodetic Survey) cut into the stone or concrete. A nail hole or the projecting end of a nail marked the exact point over which the instrument had been set. But the very inconspicuousness of the marks rendered them more exciting to the finders. Persons stumbling upon them accidentally, at once became convinced that they had discovered Captain Kidd's buried treasure boxes. Along the southern coasts in particular, where pirates were supposed to have operated extensively, the station marks have been dug up and carried away in great numbers, according to Captain Patton.

A better system of marking the stations is now employed. Into the top of the stone or concrete a bronze tablet is set bearing an inscription reading in part: "For information write to the Director at Washington, D. C.". Information is thus disseminated, and many are now proud to have a station of the national control survey net in their vicinity. On each of the tablets is stamped the name of the station and year of its occupation. The latitudes and longitudes of the stations and the bearings between contiguous ones are computed by the mathematicians at the office in Washington, and as

rapidly as possible these data, including descriptions of the stations, are printed, so that engineers and others may make use of the products of this great national survey.

It has been necessary in the Philippines to discontinue the use of the bronze tablets, for the natives there dig them out and melt the metal to fashion personal ornaments and bowls. In this country, this particular hazard, however, is absent, it was stated.

Thus the country is rapidly becoming dotted with survey monuments which, although not marking buried pirate hoards, do indicate points on the earth's surface directly valuable to planners, surveyors, engineers, and property owners, and therefore, indirectly important to every man, woman, and child in our country.

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DEFORMATION OF EARTH'S SURFACE DUE TO WEIGHT OF BOULDER RESERVOIR

(Reprinted from "The Reclamation Era" of April, 1935)

To most English speaking people, indeed to most of the peoples of the earth, such expressions as "eternal as the hills" or "as solid as a rock" mean what they say. Such expressions convey one's ultimate thought as to things firm and substantial. On the other hand, the interest of the geophysicist, structural geologist, and engineer is not in the rock's permanence and immobility but rather in its impermanence as it is broken down by climatic influences and in its movements as it continually adjusts itself to the various loads imposed. On a knowledge of these factors do the permanence and safety of the more monumental of man's work depend. It is true that for most structures their life and size are such that the popular view of the earth as rigid and eternal may be accepted. But in the case of the Boulder Dam the loads involved are such that the rigidity and permanence of the rock cannot be taken for granted without investigation.

The study, at present being reviewed, is one of several dealing with possible rock deformations caused by the building of Boulder Dam. It concerns only the possible general settlement of the land under and surrounding the Boulder Reservoir due to the huge weight of the new lake which will be formed, a weight of 41,500,000,000 tons. While the bending of the earth's crust under the weight of the dam and reservoir proves to have little bearing on the security of the dam as the bending over the length of the dam will be so slight that it will be difficult or impossible to measure, it is computed that the maximum settlement of the territory over a large area will be appreciable. This fact is of great interest to the geophysicists in connection with their study of isostasy.

Among geophysicists it is tolerably well established that the granitic continental shields, which popularly may be understood to mean the surface of the earth as we know it, floats upon a heavier lower material which is probably in a plastic state. The condition is much like a woven raft of logs floating in a lake. If a heavy weight be placed on a portion of such a raft it partially submerges. Similarly it is thought that the weight of mountains partially submerges the bottom of the granitic shield in the plastic material underlying the crust. If, therefore, a new weight of appreciable magnitude be placed on the earth at any point, according to the theory of isostasy the crust will give until the submergence restores the equilibrium.

It is evident that ordinarily no weight added by man to the earth's surface is great enough to give measurable settlement since it is probable that the crust is 12 to 75 miles thick so that most weights are insignificant compared with that of the crust itself. Therefore, the truth of the theory has had to depend on indirect evidence. Now for the first time possibly direct evidence may be obtained. Careful bench marks will be established by the Coast and Geodetic Survey over the area which is expected to settle. After Boulder Reservoir is filled new levels will be run and the results compared with previous calculations.

According to the engineers, three types of settlement may take place - first, elastic settlement due to compression in the earth's crust which will probably take place in 2 or 3 years; secondly, settlement in accord with the theory of isostasy, the time required being unknown; and third, settlement due to plastic flow in the crust. Maximum elastic settlement is estimated to be 0.6 foot over an area of 12 square miles; the isostatic compensation may be 2.0 feet over an area of 150 square miles.

To the ordinary person these computations may seem to have little practical value except for the immediate problem investigated. However, it is only through greater knowledge of all physical phenomena within our reach that advance in civilization is possible. Who knows but that the results of these measurements may not lead to a better prediction of the cause of earthquakes or to a clearer understanding of structural geology which will directly benefit mankind?

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LAND SURVEYS AND NATIONAL WELFARE

Roy M. Buck

This is a story of precise land surveys made in the Philippine Islands. To an engineer who has seen the wild and wooly insurrecto turn into a prosperous and neatly shaven farmer, the talk of better land surveys has more than a passing significance. Such metamorphism is a good testimonial to the American form of government. However, the credit is really due to a wholesale method of quieting titles which was invented by Americans but has never been officially adopted in any state in the Union.

The feeling of insecurity in the mind of the adverse occupant of land is so inescapable that he cannot be a good citizen. Whether he be white or black or brown, he cannot behave like a member of the firm unless he has a share in the business. On the other hand a man who is secure in his real property rights, secure in the knowledge that whatever he saves to improve his property will be safe unto himself and his dependents,will generally be the kind of citizen to keep the boat of democracy on an even keel.

A good example of the above principle is found in the experience of Uncle Sam in the Philippines. As an example, not only the malady but the cure is demonstrated. The writer was connected with the Philippine Bureau of Lands for ten years and entertains the belief that this country is getting into a condition with respect to its land titles that the Islands were in at the time they were ceded to the United States by Spain.

It is a peculiar feature of land title that to be valid it must properly identify the boundaries of the property. Spain in her government of the Islands failed to provide a system wherein the common people might be secure in their ownership of land. There was, however, no scarcity of titles. A great many people had "royal grants" but they were so weak on boundary descriptions as to be a source of continual irritation. And there are still in existence a great many such grants that fail to indicate where the land may be found.

In the United States, the old monuments and corner markings of original surveys were established from 40 to 200 years ago and in many cases are lost without a trace. Another 25 years will see a large percentage of them here in the West permanently obliterated. This situation is further aggravated by the fact that everybody and anybody is conveying titles to land based on descriptions wholly inadequate to identify the properties intended. Such deeds are made of record in the county where the land is located and there is no one at present with authority to insist upon definite, sufficient and accurate descriptions.

Since the customs of the country gradually change to meet existing conditions, and customs weight heavily into the interpretation of law, the condition approaches in which the mere possession of land will have undue weight before the law in determining ownership. Under such a condition the strong oppress the weak and therefore, the very basic purposes of government becomes confused. It was this kind of confusion that Spain ceded, with other things, to the United States.

The first thing to bring peace to the Islands after subduing the rebellion and establishing schools was to set up local units of government including the courts. And the next was the establishing of more courts; everybody seemed to have a job for the courts. An analysis of the situation showed that a high percentage of the cases were either boundary disputes or trouble growing out of adverse possession of land. In many cases the courts were

a year behind schedule. Without surveys the courts have nothing to work on. Even when court was held on the disputed ground, without surveys there was nothing to tie a decision onto. This condition made recourse to law generally a futile consideration. The result was general unrest.

In dealing with conditions vacated by the Spaniards it must be stated that Americans had some advantage that they do not have in their own country. They had a clean slate in some respects and were able to start some things right instead of stumbling along with prejudices and premature ideas of things. The metric system was retained. School children are not retarded by having to remember whether a rod is 16 or 66 feet.

In line with the idea of starting right there was established a system of guaranteed titles under what is known as the Torrens system. Such a title was made available by the government to anyone who would bear the expense of survey and who could establish certain requirements of ownership. The potency of this measure was so plainly evident that after a few years a law was passed providing for the cadastral survey of the Islands. The cadastral law required the land claimants to bear the expense of the survey and adjudication of titles. Therefore, it has not been made in the sparsely settled areas. But it covered most of the densely populated areas from which most of the litigation came. A feature of the cadastral law was that it did not cost the government any money but the greatest peculiarity was its legal aspects. The action was started by the government under the presumption that the land occupied was public land. Land occupants were therefore, forced into a defensive position, regardless of whether they had, or had not, valid titles, regardless of whether or not they wanted the survey. Strangely enough the beneficent results of the survey were never questioned, but that is explained in part by the fact that the general survey was not started until petitioned by a large percentage of the owners.

The Bureau of Lands was charged with making all cadastral surveys. The problems incidental to fitting a plane surface onto the surface of a spheroid were readily solved. Each project covered a taxing unit about the size of an average county. A central meridian was established through the principal town of each project and the grid system used. The line of normal scale coincided with the central meridian. There was not much distortion on the smaller areas but what there was fell in the eastern and western extremities of the projects.

The survey in each case was founded on a precise control of triangulation and primary traverse. The primary traverse encircled the project. Secondary traverse lines crossed the project at intervals of about every two miles while tertiary traverse between secondary points completed the network. All corners were shot from tertiary stations and grid coordinates of each corner figured from the coordinated tertiary stations. Technical descriptions for court use and as embodied in the title did not show coordinates,

it being considered preferable to compute bearings and distances from the coordinates. Each town and village was provided with location monuments in pairs intervisible so that the grid azimuth was subsequently available to surveyors. Grid coordinates of these points as well as of all lot corners were available in the Bureau of Lands to licensed surveyors.

Upon conclusion of the field and office work of the cadastral survey, a special land court opened in the project to settle adverse claims and issue titles, neatly engrossed certificates to those who met the requirements of ownership. Such a title could not be indorsed and recorded as a means of conveyance. The buyer must get a new certificate with a technical description checked by the Bureau of Lands.

At the present time the Islands have a very effective means of quieting title to land and it is inexpensive and could be adapted to the United States with no reasonable grounds for opposition.

The plan to have special legislative sanction to the grid system of surveying is a step in the right direction. It might be possible to include with such a bill a provision requiring all title conveyances to be checked for description deficiencies by the county surveyors at a nominal fee where no field work is required.

A law providing a sound establishment of land titles is urgently needed in connection with the program because new surveys and new monuments are without bearing in old titles. Owing to their greater economy and absolute effectiveness the program at the proper time, should include cadastral surveys. Titles based on such a survey would save us a great deal of trouble that may well be expected in another generation.

- O -

Truck Accident Damage Claims

Since all claims for damage as a result of accidents involving trucks belonging to this Bureau have to be submitted to the office of the Solicitor to determine their validity, it is requested that the following points be noted:-

1. Chief of party or man in charge of immediate unit operating truck involved, should make <u>thorough</u> investigation and report findings to the Office at once.
2. Signed statements from all witnesses together with their names and addresses should be secured.
3. Form No. 27 is to be filled out by investigating officer.
4. Form No. 26 is to be filled out by the truck driver.

- O -

EXCERPTS FROM PARTY PAPERS

"SPUR LINE"

WHEN IS A MAN A SUCCESS?

When is a man a success? He may be a failure financially, but when is he a success? A man is a success:

When he refuses to slander even his enemies.
When he does not expect to get good pay for poor service.
When he spends more time on fixing his own faults than on trying to mend the mistakes of his neighbors.
When he does not wait until tomorrow to do the things that should be done today.
When he is loyal to his employer and not false to the ones with whom he works.
When he intelligently cooperates with the other members of the organization.
When he is studying and preparing himself for a higher position with better pay.

- - - - - - -

"HOOFERS EXCHANGE"
Seventh Edition.

RECORD

One record established the past month made history. One observing unit under the able leadership of Joe Lyman, ran 22 miles of levels in 8 hours and 24 minutes. The personnel of that unit are heartily congratulated not only by the chief of party, but by all members of our organization. That was a pretty piece of "track work". Call Taylor recording.

Not to be overlooked was Gibson's 220 miles for the month which was made with road and weather conditions for the most part in the negative.

- - - - - - -

"HOOFERS EXCHANGE"
Eight Edition.

SETTING OF BENCH MARKS

There have been some unfavorable comments on location of posts. The LOCATION of the bench marks is the FIRST consideration for well executed work. They are all that remains when we are gone. It is better to set fewer posts and set them well than

to set a large number of poorly located posts. There are so many considerations for proper placing that the bench mark parties must often do some reconnaissance to find the proper spot. When setting marks in highway bridges, especially on the guard rail, place them at the far end of the bridge in the direction of traffic. This is so that if someone runs into the bridge the mark will not be endangered. In going over the lines that have been set I have found that for the most part the bench marks are well located. However, in some cases they are exposed to danger. Observers should also note the locations and cooperate with the bench mark parties by constructive criticism.

- 0 -

CIRCULAR LETTER TO CHIEFS OF TRIANGULATION PARTIES

Reports reaching this Office indicate that a number of the triangulation parties are encountering difficulties particularly in the mountainous regions where instrument stands are usually all that are required. It is possible that a number of the difficulties may be caused by lack of proper attention in preparing the station for the observations.

When using low, wooden stands it is particularly important that the stand be so prepared and the instrument mounted on it as to prevent any possibility of it being disturbed during observations. A good procedure is to require that each observer follow a definite program, somewhat as follows:

1. Inspect the stand to see that it has been set into the ground at a sufficient depth to give it stability. Usually an 8 to 12 inch depth will suffice unless the soil is very sandy, in which case it should be considerably more--as much as 2 or 3 feet. The soil immediately surrounding the legs should be dug away so that there is no possibility of pressure being transmitted by the observer to the stand while making his observations. Ordinarily, the tripod legs should be set from 8 to 12 inches into the ground, and the hole up to within about 5 inches of the surface should be carefully filled in and the earth well tamped.

2. All of the nails should be well set up and, if necessary, additional nails should be driven in order to make the stand rigid throughout.

3. It has always been considered good practice to have the stand loaded with rocks, bags of sand or other material, so as to hold it solid on its footings.

Of course, platforms serve a very useful purpose and are the most certain means of preventing disturbances to the stand while observing, but in mountainous regions where the stations cannot be reached by truck, there is a considerable amount of additional work for the lumber has to be carried to the station. In fact, where the country has sufficient relief to permit the use of stands, it is rather common to have stations where it is impossible to drive the trucks.

There is nothing new in these suggestions and undoubtedly you have them in mind right along. However, the main point is to see that they are not overlooked by the various observers in your party and that they receive constant attention at each station visited.

Undoubtedly, you have other points of view on this subject and we at the Office would be very glad to have letters or short items from you or your observers giving us your reaction to the above, also calling attention to any procedure which you practice or recommend for other observing parties.

- 0 -

WARNING AGAINST DANGER OF FOREST AND PRAIRIE FIRES

As the parties move north and the dry summer season approaches, it is perhaps not inopportune to sound a note of warning against the danger of fire.

Such a warning is unnecessary to many of the members of our field parties, for they realize the damage that can be done by a small spark from a cigarette or from a camp fire not entirely extinguished. But our present parties are considerably enlarged and many of the new members are not experienced woodsmen. It is mainly to them that this warning is addressed.

It requires only a moment to satisfy oneself that a match is put out or that there is no spark of fire left on a cigarette. The best practice however, is to throw away no burned matches or cigarettes but to put them in some receptacle which can be emptied later in some safe place.

Camp fires should be carefully put out either by throwing water on the ashes or covering them with fresh earth.

In burning rubbish or garbage, a hole should be dug large enough to contain the refuse which is to be consumed and the ground around the hole should be cleared of brush and grass to avoid a fire being started from possible sparks. Upon leaving the camp site, all fire in this hole should first be quenched and then the hole filled with earth again.

Great care should be taken upon leaving camp that no stumps, logs or other rubbish be left smoldering for when a wind comes up they may burst into flame and cause serious damage.

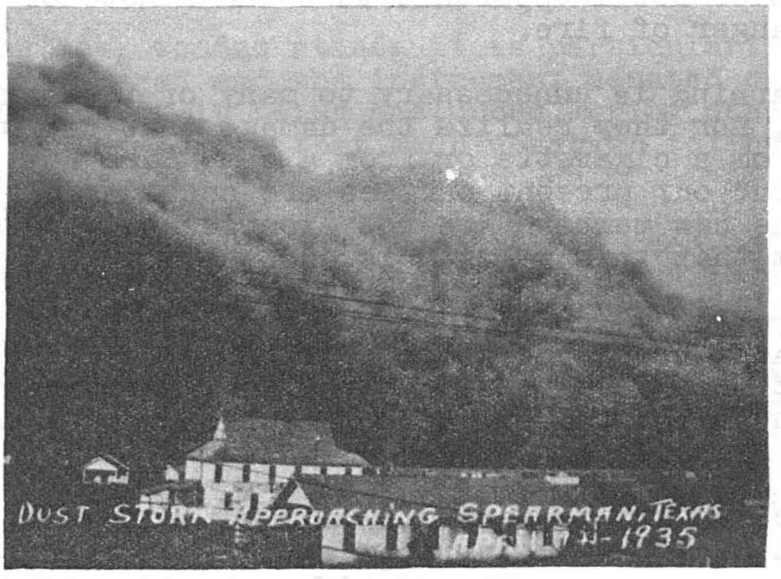
These few simple precautions may save a great loss of timber or even life in the wooded or prairie sections of our country.

- 0 -

NOTES AND NOTICES

The following notes copied from reports of field parties working in Texas show the conditions with which the parties have had to contend during this winter in the lower middle west.

"On or about April 17 the U. S. Weather Bureau forcasted the end of the dust storms or at least that these storms would be greatly diminished. Since this date there have been but two days free of dust storms. Our trucks, especially those used for building, are suffering. It has been found impossible to keep the sand out of the motors. Although to date no member of the party has suffered ill health from the dust, it is feared that if exposure to these storms is continued much longer sickness must result. There is a great deal of dust pneumonia in this area."



"Texas is a good state, but I was glad to leave it this time. Our work was considerably delayed by severe dust storms. These came on the average, twice a week, and one day we had two, morning and afternoon. Their duration is variable, but usually visibility was very low for two or three days following one, and then another came. They come up almost without warning. At one time, I parked the truck in clear atmosphere and walked about half a mile through the woods to find visibility had been reduced to a quarter of a mile. Another time a dust cloud that stopped all work for two days, arrived unnoticed while I was driving through the business district of Fort Worth. However, American humor won't be

denied, and they are referred to as "West Texas Rains" and "Vitamin K", the latter founded on the assumption that the dust comes from Kansas. Up in Kansas though, they say it comes from Texas."

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Messrs. Elmer C. Houdlette and R. H. Baldock, State Representatives of Massachusetts and Oregon, respectively, have both compiled interesting and useful publications for their states that are to be used for computing plane coordinates on the U. S. Coast and Geodetic Survey Grid System. The one for Oregon consists of 53 pages of mimeographed material, including the necessary Plane Coordinate Projection Tables, while the one for Massachusetts consists of 72 pages of matter lithographed from an exceptionally neat job of free hand lettering throughout. It contains sample field notes, computation of geodetic positions and computation of grid coordinates with tables. These State Representatives are to be commended for compiling and producing these useful publications.

- - - - - - -

Employees of field parties should inform their correspondents that in addressing mail to them they should address it in care of the chief of party. This will prevent confusion when several field parties are working in the same locality.

Attention is again called to the bad practice of some chiefs of party in requesting the postmaster to forward <u>all</u> mail addressed "c/o U. S. Coast and Geodetic Survey" rather than furnishing him with a list of the members of the party for whom mail should be forwarded. This matter was also the subject of an editorial in the January 1935 number of the Geodetic Letter.

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The following new U. S. Coast and Geodetic Survey publications are now available for issuance:-

Special Publication No. 193 - Manual of Plane Coordinate Computations - By Oscar S. Adams and Charles N. Claire. Price: 35¢.
Computation of Plane Coordinates - By J. H. Brittain. Price: Free upon request.

- - - - - - -

A "Biographical Memoir of John Fillmore Hayford" by Professor William H. Burger, Department of Engineering of Northwestern University has just been issued by the National Academy of Sciences.

Dr. Hayford for ten years was the Chief of the Division of Geodesy of the Coast and Geodetic Survey and accomplished work of great scientific value. After leaving the Coast Survey in 1909

he became the Director of the College of Engineering at Northwestern University, Evanston, Illinois. Professor Burger, who had been with the Coast Survey since 1899, accompanied Dr. Hayford to Northwestern University to accept a professorship at that institution.

- 0 -

CUBAN GRAVITY EXPEDITION

Harold E. McConnell

The gravity party of the U. S. Coast and Geodetic Survey has just returned from a season's work in the island of Cuba. With the cooperation of various interests, including that of the Cuban government, a total of 84 new gravity stations were established in various parts of the island. Three stations were occupied which had been previously established in 1933, and five reoccupations were made during the course of the season to test the integrity of the pendulum.

The work was divided into four groups of stations in widely different areas, in the provinces of Matanzas, Santa Clara, and Oriente. The Emilia group, near the town of Jaguey Grande, in Matanzas, represents an attempt to work out a previous geophysical picture which had been made with the torsion balance, and is the most detailed gravity study of a single geophysical feature yet undertaken by this Bureau. Thirty-six stations were placed in an area of approximately 200 square miles. Almost exact agreement was found with the previous pictures, with several clarifying concepts added, and it is a particularly good example of the peculiar significance and relation of gravity studies to an isolated geophysical feature. Anomaly differences were found in this area ranging from about plus 18 to minus 5 milligals.

The almost complete lack of roads made it necessary to put the gravity truck and companion car to unusual hardships, over country so rough and rocky that tires were soon worn and cut to pieces, bodies were bent and crank cases were continually being cracked. The gravity truck was spared as much as possible by leaving it under the care of some farmer while the party returned to the base. At one time it was found necessary for the observers to ride in on horseback daily as the roads were completely impassable to the lighter car.

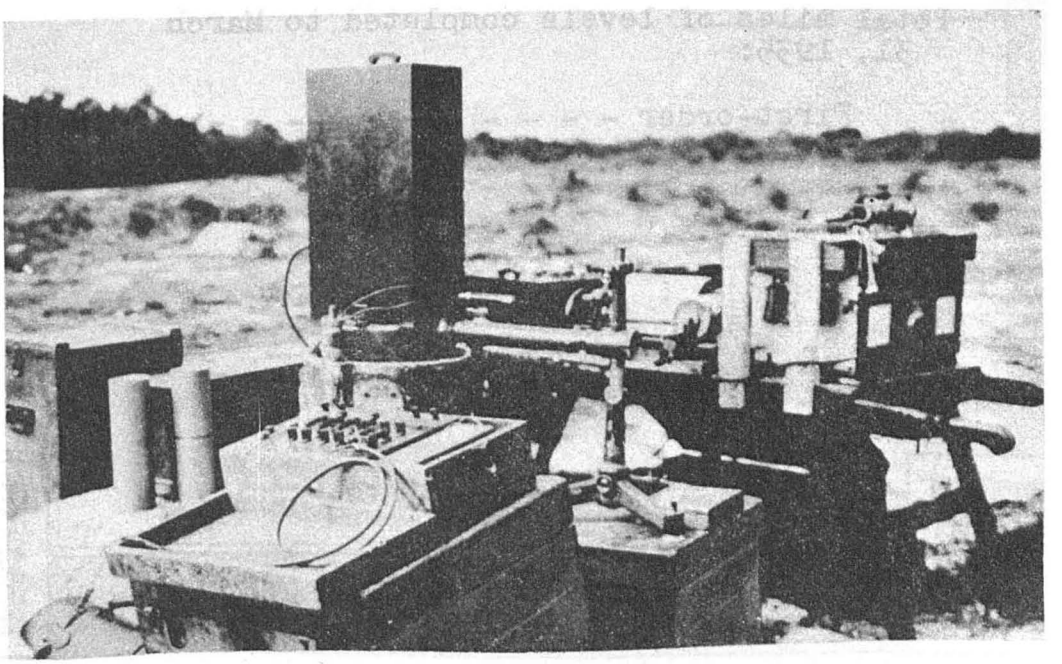
The Cauto work, in Oriente, consisting of 7 stations, was an attempt to get additional information on a high gravity area of considerable magnitude and importance, isostatically, just to the north of the Sierra Maestra mountains and the Bartlett Deep. An anomaly of plus 116 (Bowie method), which is probably the highest land anomaly yet discovered on our continent, was disclosed, in addition to more accurately defining the limits and trend of this area. Here again the party was greatly hampered by lack of roads.

For a part of the stations a freight car and motorized engine was secured, through the cooperation of an American sugar company. The gravity truck was loaded on the freight car and hauled to sidings on the company cane line railroad, where it remained during the time of observation.

The Rodas group of 19 stations, in Santa Clara to the east of the Emilia group, though surveyd in less detail over a territory of 400 square miles, represented in general an attempt to arrive at a correlation between two known high gravity areas and a known low gravity area on the north. The anomalies ranged from plus 36 to minus 54 milligals. The roads were in much better condition here and the work progressed rather smoothly in the regular way. It was while we were working in this area that an attempted political uprising or revolution of some proportions took place in Habana. It did not, however, have popular support or sympathy in the outlying areas and was quickly put down by the government. The party was unmolested.

The Keys group consisted of 22 stations placed along the coast line and islands off the coast of Santa Clara province about 225 miles east of Habana. A 40 foot yacht was obtained, and through the use of some previously constructed equipment the gravity recording instruments were transferred to the yacht with a minimum of external connections or delay. This equipment was transferred to the shore at each station by the use of a small boat, where a few connections were quickly made and observations started. The boat was well manned and we were able to maintain a progress of a station per day, which is the maximum progress on inland stations with the present truck and equipment.

(Shown below is a picture of the gravity apparatus set up at station Pueblo Viejo.)



REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during March, 1935:

First-order - - - - - - - - - - - - - -	1,474
Second-order - - - - - - - - - - - - - -	428

Total miles of triangulation completed to March 31, 1935:

First-order - - - - - - - - - - - - - -	57,846
Second-order - - - - - - - - - - - - - -	3,964

Levels:

Lineal miles of levels completed during March, 1935:

First-order - - - - - - - - - - - - - -	1,243
Second-order - - - - - - - - - - - - - -	8,763

Total miles of levels completed to March 31, 1935:

First-order - - - - - - - - - - - - - -	103,371
Second-order - - - - - - - - - - - - - -	121,417

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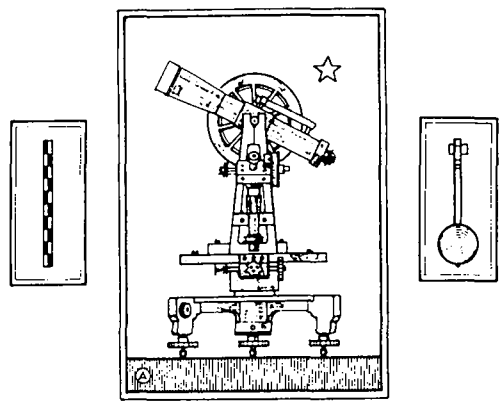
FILE COPY

GEODETIC LETTER



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R.S. PATTON · Director

G E O D E T I C L E T T E R

JULY - AUGUST, 1935

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BANNER YEAR FOR GEODETIC SURVEYS

The fiscal year beginning July 1, 1934 and ending June 30, 1935, was by far the most important one for geodetic surveys in the United States of America. More work was done during those twelve months than for any previous period of that length.

For many years the geodetic surveys were carried on in a very small way. Prior to 1916 the appropriation for field expenses was $31,000 a year. This was increased by varying amounts until in 1920 it had reached $100,000 and it was continued at about this amount for 10 years.

In 1930, the appropriation for field expenses was increased to $327,000 and in 1932, through funds obtained from the so-called Wagner Bill, the total amount available for geodetic work was approximately $500,000.

In 1933, a large amount was allotted by the Public Works Administration for geodetic or control surveys. This fund of over $2,500,000 was practically exhausted early in January 1935 when an additional allotment of $900,000 from public works funds was made to take the work up to June 30, 1935.

During the past few years the regular appropriation for the geodetic surveys has been gradually reduced until for the fiscal year 1935 it was only $131,970. However, this reduction was not felt because of the great amount of public works money made available for the control surveys.

Not only has a larger amount of money been spent on geodetic surveys during the past twelve months, but the unit costs have been reduced. We do not have available the unit costs for the fiscal year ending June 30, 1935, but the average cost per mile of progress in the triangulation and leveling for the past two years is 12 percent less than for those classes of work during the fiscal years 1931 and 1932.

We also have the very fine record of having maintained the accuracy of the work. Our standards are high and have always been so. They are at least equal to the standards for geodetic surveys set by the International Geodetic Association.

We wish here to pay a tribute to the personnel that is now engaged on geodetic work, both office and field. There are 1400 persons now engaged on this work. Most of them scarcely knew three or four years ago that the Coast and Geodetic Survey existed. The new personnel has supplemented the small nucleus of

what we generally term the regular force. The new personnel, office and field, has been given intensive training by the chiefs of party and chiefs of sections. Practically all of the observing in the field is now done by the new engineers and others. The chiefs of party have their hands full in training personnel, planning the work, managing the accounts, equipment and many other things. They have no time to spend at the instruments but they have been very clever and able in imparting their knowledge of the observing to their assistants.

Not only have these new men made the observations but they are able to take off at some distance subunits of the large geodetic parties and handle the job independently of the chief. They only have occasional inspection from him.

In the office there have been many of the new personnel who have learned to make the least square adjustments and even to lay out the equations for such adjustments. They are preparing intricate data for publications which will furnish the results of the geodetic surveys.

At the time of writing this, we are working on an emergency allotment sufficient to carry the field and office work through the month of July, 1935. It is hoped that during this month final decision will be made as to the amount of funds that will be allotted by the President or his advisors for the coming twelve months.

Since the geodetic or control surveys are now going along somewhat faster than the topographic mapping, it may be asked whether this is desirable. While the control surveys done by this Bureau form the basis for all topographic mapping, the data secured have many other uses. There is scarcely an engineering operation that does not depend for its proper execution upon a knowledge of position, distance, direction and elevation. This information is furnished by the control surveys. In addition to furnishing such a vast quantity of material which is of value in carrying on the many activities of our people, we are keeping many engineers and others employed who otherwise would be seeking work. They are being trained in higher surveying and when times become normal and many of them go back to private work, they will be better engineers as a result of their training and experience, and they will never be willing to do a poor surveying job.

Whether the geodetic surveys carried on now on a large scale will be continued in the years to come as the depression ends, no one knows; but in any event, it is an "ill wind that blows no man to good" and the country is better off for having had funds spent on these geodetic surveys primarily to relieve unemployment.

THE BEGINNING OF THE COAST SURVEY

Richard West

(Reprinted from the United States Naval Institute Proceedings of May, 1935, by courtesy of the Editor.)

The year 1935 marks the centenary of one of the Navy's greatest peace-time services; a service which was a considerable contribution to science, and one which, because it immediately saved the mercantile interests of New York the estimated $50,000 per annum they were accustomed to lose in shipwrecks on their own coast and promised similar savings to other coastal regions in the near future, quite naturally gained widespread good will for the Navy generally. This important service was the discovery in 1835 of the "main ship channel" or the "Gedney Channel" into New York Harbor by Lieutenant Thomas R. Gedney, U. S. Navy, attached to the Coast Survey schooner JERSEY. Since the new channel was 2 feet deeper than any previously known, its discovery meant that larger merchantmen could now cross the bar into New York. After Lieutenant Gedney and his assistants had buoyed out their deeper channel, such inbound sailing vessels as happened to be caught by heavy southeast winds had at least a sporting chance to make their way safely into port. The convergence of the coasts of Long Island and New Jersey and the scanty depth of water in the previously known channels had exacted a good-size toll from shipping, and the shore lines leading to the busiest port in half the globe were regularly strewn with wrecks. With the growth of America's Merchant Marine the casualties had increased; and the sudden prospect of staunching this steadily growing loss made an irresistible appeal to the mercantile interests. The grateful merchants influenced their Congressmen; and the latter were led to grant additional favors to the Coast Survey, which happened at this moment of its hectic career to be a child by adoption of the Navy Department. The discovery of the Gedney Channey in 1835 acted like cod-liver oil upon the struggling and anaemic infant, the Coast Survey, as a brief resume of its early history under its erratic Superintendent Ferdinand Rudolph Hassler will reveal.

On February 10, 1807, the Congress that voted President Jefferson's notorious gunboats and his embargo and non-intercourse acts also passed a very creditable law authorizing the President to establish a coast survey. Why President Jefferson requested the law is not known. The unfortunate grounding of the U.S.S. Philadelphia on the Kaliusa reef off the coast of Tripoli in October, 1803, which had so woefully embarrassed America in her war against the Barbary corsairs, might have offered the suggestion. Perhaps while he was Ambassador to France, Jefferson had learned of the advanced state of geodesy in that country, for the French

were so highly conscious of the value of surveys that competent technicians with compasses and theodolites had moved out beyond the French frontiers in the wake of the Revolutionary armies. At any rate Jefferson requested the law and Congress gave it to him, along with entire responsibility for executing it.

Through his Swiss Secretary of the Treasury, Albert Gallatin, Jefferson got in touch with Professor Hassler, also a Swiss, who had recently been driven to America by the revolutions in his native land. Hassler was a learned jack-of-all-trades. Educated in astronomy in Paris and Göttingen, he had risen high as a lawyer and judge in his fatherland; applying his mathematical knowledge, he had in 1791 laid down the primary base line for the triangulation of Switzerland. Hassler's plan for triangulating the Atlantic coast was approved by President Jefferson, and he would have been sent at once to England to purchase surveying instruments and technical books on the subject had not H.M.S. Leopard insulted the United States on June 22 by pouring a number of angry broadsides into the ill-prepared U.S.S. Chesapeake a few miles off Lynnhaven.

War between the United States and Great Britain seemed imminent. His trip to England indefinitely postponed, Hassler became a professor of mathematics at West Point and at Schenectady until 1811 when President Madison sent him to London to get his surveying equipment. The War of 1812 hedged the unlucky professor about with difficulties, chiefly financial, and kept him in London until the fall of 1815, when he was compelled to borrow money at 20 per cent to get his equipment out of the country.

When he got home in 1816, Professor Hassler made his financial arrangements with Secretary of the Treasury Dallas and moved his equipment to Newark. New Jersey. It had been decided to run the first base line in New Jersey because of its central position, after which the survey could be extended to the north and to the south. To expedite the work Professor Hassler had also moved his domestic establishment to Newark. Secretary Dallas had assured him that his place of residence would not matter. But Professor Hassler had scarcely left Washington before Secretary Dallas left the Treasury. Mr. Crawford, his successor, according to Hassler's account, "immediately began by refusing any funds to set the work in activity, so that I had to begin it with my private means."

If the new Secretary was slow in meeting the obligations incurred by his predecessor, Professor Hassler was too wrapped up in his own work to bother greatly about such mere details as money. He spent his own money and assumed that everyone was as anxious as he to get the Coast Survey started. One of the expenditures he incurred was for a monstrous box-like carriage for transporting his theodolite and other instruments, his books and journals, his trunk full of clothing and blankets, his Swiss wines and cheeses,

and his tinkling music box that could play only foreign tunes. As he traveled through rural New Jersey he gained notoriety as a "character". Winter and summer he wore white woolens, which he stoutly argued were as good for warding off heat as cold. He needed spectacles but refused to get them, preferring to stimulate his vision with pinches of snuff, which he carried in the pockets of his vest. Although the government allowed him $2,000 for his extra expenses, he was continually haggling with innkeepers over exorbitant prices. More than once he argued himself into a lawsuit. Along with his surveying, he indulged his flair for astronomy, and made elaborate preparations for observing eclipses. For two seasons (1817 and 1818) the professor worked in the obscurity of the Jersey coast and his home in Newark. To assist him he had three army officers one of whom had been a favorite pupil at West Point, one or two drivers, and woodsmen to clear away trees and brush. Under the circumstances the work progressed very slowly. By the beginning of the second season no maps had been published, and officials in Washington became impatient. On April 14, 1818, while Professor Hassler was giving the finishing touches to his annual report, Congress suddenly took matters in hand and amended the law of 1807 so that only officers of the Army and Navy could be employed in the Coast Survey. President Monroe tried to soften the blow to Professor Hassler by appointing him to the commission to survey the northeastern boundary line. The professor nursed his wrath in public and in private during the remaining 25 years of his life; but when Andrew Jackson entered the White House and the Coast Survey law in 1832 was modified to permit Professor Hassler's return to his old job, he took up the work with unabated zeal; he exulted in the fact that the fledgling democracy had been compelled to recall old-world science to her assistance.

During the period from 1818 to 1832 both the War and the Navy Departments had co-operated in the survey of the coast, and for lack of highly specialized scientists, both had failed to produce reliable results. Secretary of the Navy Southard in April, 1828, reported to the House Committee on Naval Affairs:

Of the whole of the maps and charts in possession of the Government, it may be remarked, that they do not furnish a satisfactory survey of the coast for the following reasons:

(1) They exhibit detached parts, unconnected with each other.
(2) Are generally confined to the shores, and do not extend sufficiently far into the ocean.
(3) Many of them were made by incompetent men, with incompetent means.
(4) They were governed by no fixed and certain principles or guides, in ascertaining the latitude and longitude of the principal points and positions.
(5) They do not embrace the whole coast.

For these and other reasons, they are unsafe, and in many instances, useless and pernicious.

While to a certain extent the law of 1832 marked a return to the original law of 1807, it was not a complete return. Responsibility for the Coast Survey was placed with the Treasury Department rather than the President. In March, 1834, however, it was transferred back to the Navy. Professor Hassler, a stubborn and unbending gentleman of 62 years, regarded this change with disfavor, and continued to manage the affairs of his office as he had formerly done, and with no very polite regard for the Secretary in whose department he was now placed. Without consulting the Secretary he purchased for the survey the outlandish carriage which he had had constructed in 1816, and had it repaired. Repairs for the 16-year-old vehicle were necessarily extensive; and this, along with the fact that the professor himself had been the owner of the contraption, caused anxiety in the office of the fourth auditor in the Treasury Department. Without consulting the Secretary, Professor Hassler hired drivers for his pet vehicle and in it made long trips between his home in Washington and the scene of his labors in the field. He was amazingly impolitic in proclaiming the virtues of his ugly carriage. The few miles of railroads, of which Americans were inordinately proud, were uncomfortable and unsafe, according to Professor Hassler, and on one occasion had jolted all the screws loose in his surveying instruments. The steamboats, which offered the cheapest transportation available, were manned, according to Professor Hassler, by thieves and rascals. At Baltimore they had lost a trunk containing his personal effects, and he was determined not to risk the precious instruments and notes of the survey in their charge unaccompanied by a responsible member of his staff. Apparently in the eyes of the old Swiss nothing American was good. When he insisted on importing Swiss wines and cheeses he infuriated native American producers of those articles. When he sent to Hungary for copper plates for his engravings he infuriated the merchants of Philadelphia; and when he sent to Hamburg for skilled engravers he aroused the ire of native American engravers in Washington who were accustomed to receive the patronage of the government. Washington overlooked Professor Hassler's idiosyncrasies for the simple reason that he was indispensable to the survey.

By 1832, the markers along the original base line in New Jersey had almost entirely disappeared and a new base line was begun on Long Island. Professor Hassler himself performed the primary triangulation, which consisted of laying out triangles of from 10 to 50 miles in length; and parties of assistants filled in the large triangles with secondary triangulation. Each party of assistants was under a naval lieutenant especially selected by Professor Hassler and detailed by the department to the Coast Survey. The parties included from four to six midshipmen, as well as drivers, woodsmen, and messengers who were temporarily hired for the work as needed. Rear Admiral B. F. Sands, who as a midshipman spent several years in the survey, gives an interesting account of the nomadic, outdoor life of the surveying parties in <u>From Reefer To Rear Admiral.</u>

Lieutenant Gedney, assigned to the Coast Survey in October, 1834, as commander of the Survey steamer Jersey, gave before a congressional committee of investigation in 1843 a concise description of the work of the parties ashore. A system of flag signals was devised. As soon as the shore party had fixed three stations, and measured distances along the land bases, two officers aboard the ship would be prepared to measure the angles between the points on shore. Simultaneously, when the signal was given, soundings would be taken and angles would be measured. Work in the field was carried on from April or May to November or December, depending on weather conditions; then during the winter months the surveyors would go to their respective homes, each being assigned by Professor Hassler a certain amount of work to do in plotting and co-ordinating the data secured during the months in the field.

Up to 1835 the annual appropriation varied from $20,000 to $30,000. The work was seriously handicapped for want of sufficient funds. Professor Hassler's allowance of $2,000 in 1816 for extra expenses had been pared down in 1832 to $1,500; and according to his own testimony he regularly spent $3,000 for this purpose. The survey had no established quarters wherein to carry on the enormous amount of mathematical work during the winter. And every spring when field work was resumed the surveyors would find that the people of the countryside had removed some of the markers so that much of the previous year's work had to be redone in the process of checking the winter's plotting. Under these circumstances it is not surprising that the Survey failed to publish maps and give tangible justification of its existence. Moreover, Professor Hassler's relations with the Navy Secretary and the fourth auditor were extremely cool. Quite naturally neither of the officials appreciated the professor's classroom manner of treating them as ignorant schoolboys. In 1834, when Secretary Levi Woodbury made a tour of New York he ignored Professor Hassler's earnest invitation to inspect the progress of the survey of Long Island. In a letter complaining of this slight it appears that Professor Hassler had been much interested in impressing the people of the countryside with the importance of his work so that they might be induced not to molest his signals.

The discovery of the Gedney Channel into New York Harbor in 1835 marks the real beginning of the Coast Survey, for it was this discovery which "sold" the survey to the merchants of New York, to members of Congress, and to the American public generally. At once Congressmen from the other coastal states requested that similar surveys be undertaken immediately in their states. Maryland offered to defray the expenses of surveying parties on shore if the national government would detail a naval party to perform the maritime part of the task. A Congressman from North Carolina made strenuous overtures to have the harbor of Beaufort accurately mapped.

The doors of the Treasury Department were suddenly unlocked for the impecunious Professor Hassler. His allowance for personal expenses in 1835 was $1,500. In 1836 it was doubled, his total compensation, $6,000, being equal to that of the Secretary of the Treasury himself. At the beginning of 1835 the Coast Survey had not even a house for its winter headquarters; after Gedney's discovery Professor Hassler was allowed to lease two houses, two row houses in Washington adjoining the Bureau of Weights and Measures, of which Professor Hassler had been chief since the beginning of President Jackson's rule. For 1835 the total appropriation for the Coast Survey was $30,000; in 1836 it jumped to $80,000, two years later to $90,000, and in 1840 to $100,000. The Coast Survey had now become a fad as much as the post roads or the canals of the period, which appealed so strongly to the commercial instincts of the American public.

Professor Hassler was even indulged in another of his whims which he had long agitated. The Survey, to whose success the Navy Department had contributed so largely, was transferred from the Navy Department to the Treasury; although naval officers and naval vessels continued to be detailed to its service. The red tape of the Navy Department, Professor Hassler had contended, was peculiarly demoralizing to a scientific enterprise so non-military in character.

Unfortunately, the much anticipated scientific results did not, or could not, keep pace with the favors Congress had so quickly bestowed upon the Coast Survey. Professor Hassler was now 65 years old, and more set in his ways than ever. Year after year went by. The survey stretched northward beyond New Haven and southward to the head of Chesapeake Bay, but no maps were published.

In 1841 Congress became restive and ordered an investigation. Professor Hassler wasted most of the summer writing refutations of charges of irregularities made by the fourth auditor, and charges of unnecessary delay which were made by impatient Congressmen.

As a matter of fact, many of the charges against Professor Hassler were well grounded. His faculty for argument enlarged with age and became a sort of "defense mechanism". After 1835, Professor Hassler's health had begun to break. He lost more and more time because of illness, and the swampy tidewater country disagreed with him more and more. In 1841 he boasted proudly that the secondary triangulation had now extended over 11,000 square miles of coast line; but he minimized the fact the primary triangulation, which he allowed no one but himself to perform, had covered only 3,700 square miles, about a third of the area already covered by his assistants in charge of the secondary triangulation.

When the old man's eyes began failing him, he had an assistant look through the telescope for him and refused to allow anyone else to share this part of the work. Since the primary triangulation provided the check for the secondary, the work of making maps was unnecessarily delayed.

In 1842 Congress appointed a committee to investigate the Coast Survey. Professor Hassler regarded the move as a personal affront to himself. The chairman of the committee sent one Mr. W. J. Stone, an engraver of Washington, to request Professor Hassler to send the maps of New York Harbor for the committee to examine. Regarding Stone as a competitor, and perhaps the chief instigator of his troubles, Professor Hassler abused him, as well as the committee, with great violence, and if he had not been restrained by his assistants would undoubtedly have kicked Mr. Stone downstairs out of his office.

Cross-questioned by the committee the professor proved an unruly and incommunicative witness. What the committee could not understand was why the professor should delay all publication till the whole was completed; why he had to measure the ellipticity of the earth before allowing a practical mariner's chart of New York Harbor to be printed.

The investigation was exceedingly painful and the members of Congress rubbed Professor Hassler decidedly the wrong way when they assayed to measure his imported copper engraving plates with a carpenter's rule! The struggle between the lawmakers and the beligerent and incommunicative scion of old-world science was terminated by the death of the latter in 1843. For all his personal stubbornness, Ferdinand Rudolph Hassler had laid the basis for one of the most important scientific agencies of the government. Throughout the turbulent years of Professor Hassler's superintendence of the Coast Survey, the peace-time Navy had participated nobly in the enterprise. Many naval officers had received a scientific training which was to be immeasurably useful to them in the war between the states. One of these fortunate officers was destined to become admiral, one vice admiral, and two others rear admirals of the Navy.

When Professor Alexander Dallas Bache became superintendent of the Coast Survey in 1843, the organization had passed its period of hectic experiment; its foundations had been well laid. Much of the work performed in these early years was so carefully done that it has retained its authoritative character throughout the hundred years of progress which have followed the first gala year of the Coast Survey.

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IDENTIFYING AND NAMING OLD SURVEY STATIONS

One of the important uses of the national control surveys is the coordination and correlation of detail surveys, past, present and future. For future surveys the burden of use rests upon the engineer making the detail surveys. It is his duty to know and make use of the control stations that have been established in the region in which he is working. For surveys under way at the present time, the engineers working on the different classes of surveys,- control and detail, must get together and cooperate to the fullest extent. Where old surveys are to be benefited by the control surveys of the country, as a rule, it is incumbent on the geodetic engineer executing the control surveys, to recover, identify and properly tie in the marks of the old surveys. Of course, it cannot be considered practicable for the observing party to delay too long while search is made for marks set by other organizations, but the reconnaissance man usually has data needed for recovering and identifying marks set by other bureaus of the Federal Government in the territory in which he is working, and he should make a thorough search for them. Such marks are often recovered in positions near stations of the new or control survey which makes their determination a matter of ordinary routine.

However, the records received at the office do not always show a proper appreciation of the importance of accuracy both in identifying such survey stations and in connecting them to our triangulation stations. Possibly the engineer in the field makes what he considers a close recovery of the old station and if it be a U. S. Geological Survey station, he evaluates the recovery in terms of the scale unit of one inch to the mile, considers the recovery perfect for use on the base topographic map of the country, and calls it an unqualified recovery. He may give it the name of the characteristic topographic feature of the locality, and put the initials (U.S.G.S.) after it to indicate the recovery of a Geological Survey station. As far as such reasoning goes, he may be correct; but when the topographic engineer wishes to adjust a traverse of a previous year to a standard position of his station, a discrepancy of a few feet may make his closure untenable and put him "up in the air" insofar as being sure of his detail control. So what the geodetic engineer has determined is really a new station, which is, in his opinion (backed by some evidence and good judgment), very close to the position of an old station. This being so, he should give it a new name, and let the description carry the story of approximate recovery.

The reconnaissance engineer is supposedly furnished with complete data relating to old stations of other bureaus within the area in which he is working. This is especially true with reference to stations of the U. S. Geological Survey, and it is with the editing of descriptions of these stations that many of the

difficulties of identification and proper naming are encountered. These difficulties take the form of such questions as, "Is this a U. S. Geological Survey station or a new station?" If the answer is that it is a Geological Survey station, then comes the next question, "By what name did the Geological Survey call it?" The reconnaissance man probably knew, and perhaps he put it in his description. If he did, and indicated that such was its true name, all should be well, but if the name he gives it is different from the old name and he adds (U.S.G.S.) to it, then some unscrambling will have to be done. What should the reconnaissance man do if he does not know the original name with sureness? It is here suggested that he give the station a new name, and in his description state that it is identical with a U. S. Geological Survey station, name unknown.

The observing party should remember that the reconnaissance descriptions are written only for the use of the observing party, and should take care that the descriptions and recovery notes sent to the office contain all the necessary information furnished by the reconnaissance party. It is not sufficient to say, "Recovered as described by the reconnaissance party". Often a description or recovery note of an old station is received in the office with no mention at all of the old marks which were found, yet an examination of the reconnaissance description reveals that it contains a complete description of the old marks. This often leaves doubt as to whether the observing party re-marked the station, or established a new station.

As to accuracy of the connection of the old station with the new or control station:- If the connection is worth making at all, it is worth making with a certain degree of accuracy. Because a cairn is the only mark discovered at the site, to pace the distance and estimate the direction or determine it with compass, is valueless as a connection. It will help one recover the newer station if he finds the older one, but it will not satisfactorily coordinate the old and new surveys. It is recommended that one flag the center of the cairn, and determine the distance and direction of the flag from the control station with the same precision that is used in making reference mark connections. But describe the cairn with care, and look for more definite marks under and around it.

IN ALL CASES OF RECOVERY OR APPARENT RECOVERY OF AN OLD STATION, DESCRIBE WITH CARE AND EXACTNESS WHAT OLD MARKS ARE FOUND, AND IF ANY CHANGES ARE MADE IN THOSE MARKS, EQUALLY ACCURATE AND COMPLETE DESCRIPTIONS OF THOSE CHANGES SHOULD BE MADE. IT IS OFTEN OF AS GREAT IMPORTANCE TO KNOW WHAT MARKS WERE FOUND AT AN OLD STATION, AS IT IS TO KNOW WHAT MARKS WERE LEFT THERE.

POINTS TO BE CONSIDERED IN SELECTING A LAPLACE AZIMUTH STATION

C. A. Whitten

When a member of a triangulation party recommends that a certain station should be used as a Laplace azimuth station, there are certain things which he should bear in mind. Of course, it is not expected that the ideal place will ever be found, but it is possible to choose stations which will fill many of the suggested requirements listed below.

The station should be accessible by truck. The equipment of an astronomical party is heavy and cumbersome. Any pack would only add expense and delay the operation of the party.

The station site should be on cleared land. It should never be close to buildings. Air currents moving about buildings cause unusual refraction. Frequently stations have been selected at which the line of sight to Polaris is not clear. The observer should be able to see Polaris from the ground at the station. The line of sight to the star should never pass over any buildings in the immediate vicinity of the station.

The selection of an azimuth mark is very important. When possible, a main scheme station should be used. When this is not possible without excessive building, an additional mark is set. It must be kept in mind that the astronomical party is working from the ground and that lines of sight along highways or railroads, should generally be avoided because of possible refraction. An ideal place for the azimuth mark is a light posted on a water tower or other permanent object that is visible from the ground at the station. A drill hole is sufficient to mark the point.

The mark should not be less than one mile from the station and should preferably be two or three miles away. In rare cases it has been found necessary to place the marks at distances less than that. In such instances great care should be used in collimating the instrument. It should be needless to state that the light used at the azimuth mark should be carefully centered. However, recently an azimuth mark was recovered which showed that the light had been carelessly set. The light keeper had apparently set the light on the mark while the concrete was still soft. When another light of the same size as that used by the triangulation party was set in the imprint left on the mark, it was found that the center of the light was off-center three-sixteenths of an inch. In this case the mark was only a mile from the station.

It is preferred that the azimuth mark be placed so that it

is easily accessible. On one occasion it was necessary to drive 65 miles over very rough roads for a round trip to the azimuth mark. In some instances it has been necessary to hire boats to reach the points. This not only delays the party but adds to the expense.

The description furnished the office should clearly state the height of stand needed at each mark. If any clearing is necessary it should be stated in this description. When the description says a 4-foot stand is sufficient, the party takes material for such a stand to the mark. Recently the party occupied a station at which a 4-foot instrument stand and 15-foot light stand were required according to the description. When the two points were recovered, it was found that a 30-foot instrument stand and a 40-foot light stand would be needed. At the same station it was possible to see a water tower from the ground. The latter could have been easily used as an azimuth mark. The description should contain a list of directions, including the Laplace azimuth mark and the reference marks. In case the azimuth mark is a main scheme station, the direction to the Laplace station should be included in the description.

The accuracy of the observations made by the triangulation party is important. Since the special mark is not observed from more than one station, there are no checks on the observation. It is suggested that the sum of the residuals of the individual positions should not exceed 26.0 if 16 positions are used. If 24 positions are observed, the sum should not exceed 44.0. If this rule is followed the observations will have about the same accuracy as those made by the astronomical party.

The members of the astronomical party are not looking for soft jobs but are only seeking more efficient ways of operating the party. With the cooperation of the triangulation parties along the lines suggested above, the astronomical party will make greater progress and the cost per station will be much less.

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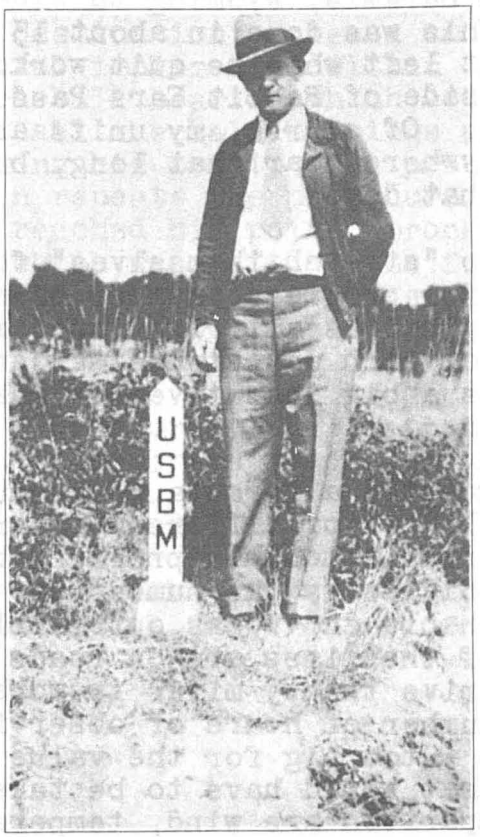
STATE HIGHWAY DEPARTMENTS ERECT GUARD POSTS BY COAST SURVEY BENCH MARKS

As an indication of the growing interest in the perpetuation of the level bench marks, the State Highway Departments of Iowa and Oregon have erected guard posts by each mark along the highways to protect them from passing cars. These bench marks are of especial value to engineers but they are also of interest to motorists and others who desire to know how high they are above sea level. These elevations in most cases are shown on the marks. However, if the elevation has not yet been stamped on the mark, this information can be obtained by writing to the Director of the U. S. Coast and Geodetic Survey, Washington, D. C.

Since these guard posts do not in any way mar the scenery, it is hoped that the highway departments of other states will follow the example set by Iowa and Oregon.



Oregon State Highway Department
Standard Bench Mark Guard Post.

The 116 foot leaning tower.

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THE LEANING TOWER

The April, 1935, issue of the Geodetic Letter carried an article about a steel tower, 116 feet high at POST-1933 (Washington, North Carolina) which, after remaining in collimation for two days, began to lean due to the soft mud giving way under the footings. The picture shown at the right above will give an idea of the extent to which the tower was out of the vertical position before its tilt was finally checked.

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LEVELING NOTES

A. L. Wardwell

What is believed to be a leveling record of some sort was made on my party last summer by S. Y. Symns. On July 14, 1934, observing on the first-order line from Laramie, Wyoming to Sidney, Colorado, he made 417 set-ups. This was done in about 13 hours, there being one hour of daylight left when he quit work. That part of the line was on the west side of Rabbit Ears Pass on an even grade about nine miles long. Of course, my units are not in the habit of putting in days anywhere near that long, but these boys made a special effort for that day.

I do not encourage my observers to "stretch themselves" for the purpose of hanging up some record for progress, number of set-ups, etc., on this second-order work. That is all right on first-order work where a check must be made of each day's running, and I think that the idea of checking in is a big incentive for making properly careful readings.

Last year one of my recorders suggested a formula for securing a comparison of the respective abilities of different observers. His idea was to multiply an observer's monthly progress by his number of instrument set-ups, and divide by the number of days actually worked. It sounds reasonable and works out fairly well, but in this region, where some of the lines are on roads where it takes two or three hours to drive twenty miles to work, it would seem necessary to count the number of hours of observing, instead of days, and that is a big job - too big for the value of the results obtained. Other matters that would have to be taken into account for a really accurate comparison are wind, temperature, and the condition of the line underfoot; whether railroad bed, paved road, muddy road, or trail. In fact, there are so many variable factors that I have given up trying to make a mathematical comparison of observer's abilities. I would like, however, to see what other chiefs of leveling parties have to say about any such method.

The bad roads and the great amount of time lost on account of rain and snow here in California this past winter make my progress for the last several months look like "small potatoes" when compared to the reports from parties working in flat and easily accessible regions.

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BALL BEARINGS AS TURNING POINTS IN LEVELING

The letter given below was received from Mr. E. J. Helin, who is attached to the party of Mr. W. W Studdert. Mr. Studdert has been instructed to try out the method outlined and report on it. Comment from the field is invited.

"I am herewith offering a suggestion which may be of value in adding to the efficiency of the level units.

"My idea is to eliminate leapfrogging when working along certain types of highways with the aid of a ball bearing turning point. The ball bearings are placed in smooth cut grooves or perforations by the front rodman.

"This would work as follows: The front rodman when reaching his destination, makes a smooth cut groove with the aid of a special implement. Within this depression he then places a sizable steel ball bearing which acts as a turning point. It is understood that all the ball bearings are of the same size. The rodman after marking his point, will proceed forward to his next point where he again repeats the procedure. In the meantime, the rear rodman having reached his point, proceeds holding his rod on the ball bearing which was left by the front rodman. As soon as the back rod is read, the rodman picks up the ball bearings and proceeds to the next point. Obviously therefore, the front rodman must carry several ball bearings.

"Of course, this method can only apply to first grade roads, such as concrete roads, or any other roads in which indentation can be made.

"At the end of the section the rear rodman, having in his possession all of the ball bearings, can go ahead and repeat the procedure as the front rodman . . ."

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FEDERAL SURVEYS IN OKLAHOMA

(Address before the Oklahoma State Section A. S. C. E., March 30, 1935, by N. E. Wolfard, Assoc. Prof. of Civil Engineering, University of Oklahoma, State Representative U. S. Coast and Geodetic Survey, Norman, Oklahoma.)

. . . . . .

I want to ramble all over the world for a time, and then get closer home. I don't know just how much you remember of your college courses in geodetic surveying. . . . .

Geodetic surveying has to do with measurements of the earth, such as shape, dimensions, isostasy, etc. Geodetic surveying was born about 200 years B. C. when a Greek mathematician by name of Eratosthenes computed the circumference of the earth. . . . .

You realize, of course, that in order to coordinate measurements and observations made at different points on the earth's

surface it is necessary to assume a definite mathematical formula on which to compute and project these data. During these years of development in geodesy, several spheroids and ellipsoids have been proposed. The two most generally used are the Bessel Spheroid computed in 1841, and the Clark Spheroid of 1866; the latter being used in America since 1880 and the former more generally used in Europe. In 1909 Mr. John H. Hayford, then Chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, computed a spheroid using a much larger number of observations than had been available to the previous mathematicians. Only recently Mr. Hayford's spheroid has been adopted as the "International Standard Spheroid". Just how many countries are now computing data to this spheroid I am unable to say. You will understand, of course, that these spheroids are computed to represent very closely the shape or form of the earth at mean sea level.

Returning from my globe-trotting to our own shores, the U. S. Coast and Geodetic Survey was organized in 1807. An engineer and mathematician by the name of Hassler formulated the system which has been consistently expanded very closely to the scheme as originally proposed. As the name implies, our coasts were first surveyed and charted, the transcontinental arc of triangulation being pushed inland as rapidly as appropriations were made available...

Coming now to our subject, federal surveys in Oklahoma, I shall confine my discussion to the work of the U. S. Coast and Geodetic Survey, and cooperative relief agencies. You are aware, of course, that a great deal of valuable work is being carried on by other federal bureaus. . . . .

I have here on the wall a number of maps. This one shows the first-order triangulation network; you will observe that the first arcs approximately bisect the states east and west along the thirty-fifth parallel, and north and south along the ninety-eighth meridian. During the controversy over the Red River and the one-hundredth meridian boundaries triangulation was executed to control this work. Within the last year first-order arcs have been run along the 95° 30", 99th, 101st and 102d meridians. Reconnaissance is now under way for additional first-order and a considerable program of second-order triangulation work within the state.

This map indicates the lines of first and second-order leveling carried on by the Coast Survey at various periods. A considerable amount of second-order leveling has been accomplished within the past two years. There are some ten or twelve level parties at work within the State at the present time. Reconnaissance is also being made looking toward third-order leveling to a grid spacing of approximately seven miles. You thus will realize the scope and completeness of the base net control as originally proposed by the U. S. Coast and Geodetic Survey, and as has been consistently and unfaulteringly prosecuted throughout the past century. You will realize that within the boundaries of our own State, this work is now being prosecuted on a rather extensive scale . . . . . .

You who are members of the American Society of Civil Engineers, have received recently, the reports of our Committee on Surveying and Mapping, Division of City Surveys, published in circular form and entitled, "Technical Procedure for City Surveys". The recommended procedure and accuracy criteria conform very closely to the specifications of the U. S. Coast and Geodetic Survey for the respective orders of surveys. . . . . .

Now, what I wanted to talk to you about for three hours was Local Control Surveys which we have been executing as a relief set-up. I wish to read you the letter that set the ball rolling. (Letter from the U. S. Coast and Geodetic Survey regarding work of local control surveys.)

This letter was received on the morning of November 27,1933.. I wired acceptance about noon. On the evening of the 27th I received a wire advising me of my appointment as State Representative. I wish to direct your attention specifically to the statement in the letter of the first objective, which was "to put men to work". If you recall, this was the watchword of the early days under CWA.

We began immediately to recruit instruments and men, and you would be very much amused to know some of the instruments that were presented by ambitious job seekers. A news article carried the information that engineers with surveying equipment would carry an advantage in early employment. Within the next few days men reported at my office bringing historical models of engineer's and surveyor's transits, levels and three or four terracing levels of very cheap design were offered the service. We had some difficulty in securing instruments in sufficiently good condition to turn out the type of work demanded. The University of Oklahoma furnished the larger portion of transits used on this work. . . .

Our men were organized into parties of ten men each, which provided for carrying on concurrently the angle work, level work and taping. The work was executed under rigid specifications from the moulding and setting of monuments to the chaining operations.

It was a little difficult to get over to these men the fact that all we have to show for our work is a monument net. In the first instance, if monuments are not properly moulded they are short-lived, and of no value. Second, if they be not located where they are safe from future disturbances through construction of land improvements, they are apt to be destroyed and are worthless. Third, if the descriptions of these monuments are not sufficiently clear to enable future recovery by surveyors and engineers, they are of no value even though they be in perfect condition, accurately tied in, by position and elevation; they must be available to future craftsmen to be of any permanent value....

It will be necessary that we endeavor to protect these markers in future construction work. I see my friend Mr. McFerron, of the State Highway Department sitting across the way. I am glad to say that the heads of the several departments of our State highway organization have cooperated to date, and have assured me that they will continue to cooperate in the preservation of these monuments, many of which have been located along main State Highways.

In the earlier days leveling followed railroads, and indeed a large portion of the present leveling is carried on along railroads; however, in most instances, we have chosen to follow highways in our work for two reasons; first, because of better facilitation of executing the traverse; and second, we believe that monuments will be more readily available for future use from highway margins than if set along railroads.

I wish now to describe briefly our routine methods of executing this work. These monuments are first set in pairs with interspacing varying from one-fourth mile to three miles. It is necessary, of course, that these monuments be in pairs in order that future tie-ins may be made.

In some instances we made use of intermediate stations where our route followed winding roads or wooded areas, restricting sight distances, in which instance permanent markers were set in pairs as required by specifications, and our traverses carried across the intervening distances by means of temporary or intermediate stations. Our permanent markers consist of a precast concrete pyramid frustum with 8" by 8" base, 6" by 6" top and 3' high carrying a bronze marker such as is on the table in the rear of the room. At a later date, when elevations shall have been adjusted, the elevations will doubtlessly be stamped on the markers. These monuments were set so that they would project from 2 to 4 inches above the surface of the ground, depending on whether the location was on a hill or in an area where drifting sands and dust might tend to obliterate it. In setting monuments a few shovels of concrete were thrown into the hole and filled around the monument to a height of from 6" to 8" in order to prevent "heaving" by frost action.

Angle measurements conform to second order specifications which means that at any given station the horizon closure must not exceed 6", and preferably should be 4" or less. At each station there are two main angles to measure, or as we term them, "the angle" and "the explement"; "the angle" being turned from the back tangent in a clock-wise direction to the forward tangent, and "the explement", of course, turned from the forward tangent in a clock-wise direction to the back tangent. Each of these angles are measured six times with the telescope direct and six times with the telescope inverted, making twenty-four angles in all, which is termed a set. In every instance two sets are run and if these sets do not agree within the specified limit of 6", additional sets are run until this agreement is obtained. In

order to secure this accuracy you will realize that the transit must be in fairly good order and adjustment, and that a high degree of caution and attention to detail must be exercised by the observer. In working along highways and railroads, stations are staggered, that is, are placed alternately on opposite sides of the right of way in order to eliminate possibility of lateral refraction as far as possible. On sights up to two miles ordinarily hexagonal lining flags are used, such as are exhibited in the far corner of the room. On long sights, or occasionally on days when vision is mediocre, we have used 1" by 4" batting with alternate sections painted black and white or red and white. In order to facilitate quick pointings bright colored flagging is ordinarily attached to the top of pole signals.

Leveling is carried on with ordinary Dumpy or Wye Levels. I should say here that our levels are of third-order and not second-order grade. The criterion of accuracy is 0.05 times the square root of the length of the circuit in miles. In order to secure this accuracy it is necessary that the rods be in good condition. The graduations should be checked with a steel tape and if and when "long rod" is used, extreme caution must be exercised, lest error will creep in. In some instances the rod was read directly by the levelman, in others the target was set and the readings taken by both the rodman and levelman. The latter procedure was ordinarily followed by the less experienced levelman.

Distance measurements are made with ordinary steel tape atop tripods, using dressmaker's pins for chaining pins. I have here the type of tripod used. You will note it is rather simple in construction, yet rigid and serviceable. Tension balances are used and the temperature is read and recorded for every tape length. The tape is compared with the Master Tape for two conditions, that of total support and for end supports only; eleven pound tension is applied under total support and twenty-two pounds with end support only.

Before starting the measurements of a section, intermediate lining flags are set sufficiently often so that two flags will be in sight of the party at all times. Lining of tripod is done "by eye". The complete chaining party consists of at least seven men, preferable eight, comprising head and rear tapemen, head and rear contact men, two tripod carriers, and the chief, who acts as recorder.

Four tripods are used, making it possible to have three tripods always in position so that in case the rear tripod should be disturbed in process of executing the measurement the party could drop back and reset the pin and the work thus far in the section would not be nullified or lost. . . . .

The difference of elevation between successive tripods is

observed, either by hand level or clinometer and recorded. The hand level observer should preferably take his position midway between the tripods on reading, thus errors of the hand level are eliminated or compensated, and also better vision of the staff is had than when he attempts to read the entire length of station.... In order to insure against errors, check taping is necessary. In starting a new taping crew we will check measure with tripod until we have established confidence in our workmen, and the workmen have builded confidence in themselves; then we will measure the line only in forward direction by tripod, check taping with a 300' tape. You will see that if all operations are carried out with precision and care there is no chance of an error greater than 1 in 10,000 occurring in the taping. The only chances for error are in erroneously reading, calling or recording "set-ups", or possible error in losing or adding an entire station.

Regarding night observations, ... you will observe to the left an ordinary automobile headlight ingeniously mounted atop a 1-1/2" gas pipe section. This type of signal was used in several instances. In which case pipe sections of 5' length were used to build a signal 30' above the ground. This is about the limit for which we could anchor conveniently such type of signal. The other type is the standard U. S. Coast and Geodetic Survey transformed automobile headlight signal mounted atop an ordinary instrument tripod. (These lights were set respectively on El Reno East Base station and on one of our traverse stations, while an ordinary mining transit was set over Caddo Triangulation Station and the azimuth thus determined. . . .)

All field records on coming into the office are indexed and filed, and then the routine checking and double checking and approximate closures computed. If these results indicate that the work is correct, all notes are then abstracted and final computations made.

This orange, wearing the dunce cap, has caused some comment and wonderment, so I will endeavor to explain its significance. You all know that a spherical or spheroidal surface cannot be represented on a plane without employment of some form of projection. The particular form of projection in our work is known as the Lambert conformal projection. In the development of this projection a cone is presumed to be placed tangent to the spheroidal surface at two parallels of latitude not too widely distant. You will observe that I have peeled a belt from this orange, which, let us assume, was severed by passing this cone as indicated. Now suppose I take a pin and puncture this peeling at different points, holding the pin parallel to the radii of the spheroid. Indentations will be made on the surface of the cone in the true relationship in regard to direction, however the distance between successive points on the cone and on the surface of the peel will be slightly different everywhere except at the circles of tangency on which they will agree. Within the peel belt the surface distances will be greater than the respective distances on the cone, while just beyond the tangent parallels the cone distance will be greater than

the respective surface distances. Now I will take my knife and sever the cone along an element. You observe that the cone will now lay in or conform to a plane. You observe that the parallels are represented as concentric circles about the apex as a center, while the meridians appear as converging straight lines, conforming to elements of the cone. Without going into mathematics and details of computations you will readily see that a definite relationship exists between the measurements on the orange surface and the projected representation on the cone.

The geodetic positions of all triangulation stations have been computed and are made available by the Coast Survey. Geodetic positions are represented by latitude and longitude, which coordinates are rather cumbersome for use of the surveyor in ordinary field work, hence a system of rectangular coordinates has been adopted, and we are computing the coordinate positions not only of our traverse stations, but also of all triangulation stations in the State. I am calling your attention now to the circulars placed at your plate, entitled,"Plane Coordinate Systems". I am asking that you read carefully these circulars and ponder over their contents, and then decide for yourselves the value and adaptability of rectangular coordinate control. . . . Some of you were present at a recent meeting of the A. A. E. in Oklahoma City, when Mr. J. C. Carpenter, Senior Engineer for the U. S. Bureau of Public Roads, gave us a talk on "Planning", and you will recall, he stressed the desirability of coordinate control in connection with every sort of planning, as well as for the convenience, facilitation and execution of field surveys, investigatings and construction work.

Did time permit, I would like to go into some detail regarding the application of coordinate control in commercial, industrial and social enterprise, and I should not omit military maneuvers. You may feel this last remark a little far-fetched. You may feel that the interior of our great country may never be invaded or may never know the horrors of war, but we should not be too optimistic. At any rate, we can use this control to a great advantage in our civil and economic life, and if we need it for military purposes we will have it.

In closing, I want to leave this thought with you. It is my hope that we may continue directly these control surveys, and that state organizations, both private and public, may add to the expansion of this control nucleus by executing their surveys according to second order specifications, thereby adding materially to the control net. The cost of such procedure would not be greatly in excess of the present methods, and the lasting value of the notes and data thus collected would far exceed the extra cost of execution. Again, granting that the highway department and other organizations should execute surveys which would fit into this control they would not serve their full potential value unless nor until the results should be computed, adjusted to the Clark's

Spheroid and the records made available for reference and usage by practicing engineers. A division of surveys might well be set up in conjunction with our department of highway surveying and mapping where these records, together with the records from the various national surveying agencies, could be collected, cataloged and held available for ready reference.

I hope that we as individuals, and as an organization, may seriously ponder the value of this base control survey to organized industrial, commercial, civic and social enterprise, and lend our efforts toward the establishment of this uniform rigid control for all and every type of surveying.

It is said that speeches as well as operations, should conform to specifications. We are prone to think of the Englishman as slow to take a joke, however, a recent debater from Oxford gave this definition or specification for a speech. He said that it should be patterned somewhat along the lines of a lady's skirt; short enough to hold the interest, but long enough to cover the subject. I leave it to you to judge whether I have met the specifications.

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DISTRIBUTION OF FEDERAL MAPS

Henry J. Sherman,
Consulting Engineer, M. Am. Soc. C.E.

(Reprinted from Civil Engineering for May 1935)

To the Editor: The article on "State Surveying and Mapping Bureaus" by Professor Dodds, in the April issue, is particularly timely in view of the fact that there will be much new material in this field as a result of the greater number of maps now being produced by Federal agencies. These maps will have much wider use than can at present be foreseen and should be procurable through many sources. In the field of air transport alone accurate land charts, based on contour maps, are indispensable. Apart from the need for maps for technical purposes, the public now has increased leisure for such diversions as motoring, hiking and other outdoor activities that necessitate the use of maps. The popular demand for such maps in Europe is enormous, with the result that there are governmental agencies engaged in preparing topographic sheets for use by hiker, hunter, fisherman, camper, and the devotee of winter sports. Distribution agencies advertise their stock so well that almost every motorist and sportsman has his pockets bulging with maps of the territory he proposes to cover.

Under the present administration a new impetus has been given to state and Federal planning, and those engaged in this field know that the basis for such work is accurate topographic maps. Planning entails a knowledge of highways, land classification and use, parks and parkways, water and mineral resources, forests, rivers

and harbors, flood control, ground-water supplies, sanitary investigations, public water supplies, and pipe and power lines. In these and other engineering fields a great deal of time and expense may be saved through the use of standard topographic sheets.

In addition to state bureaus, there should be in each county seat all the data relating to that county so that local engineers can procure them quickly without sending to the state capital, or going there. It should be the duty of the state agency to keep the county offices supplied immediately with all new information.

Furthermore, now that the U. S. Coast and Geodetic Survey is establishing control points in each municipality, the data covering these should be available at municipal headquarters, preferably in the city engineer's office. All surveys should be tied in to these control points, and a copy of the plan should be filed in the city engineer's office.

The present notices of Government maps ready for distribution are sent on cards about 5 by 6 in. in size, and the current information on the subject of maps is printed on these cards in type so small as to necessitate the use of a magnifying glass for comfortable reading. Thus it is obvious that Government methods of map distribution are in need of a radical change. Professor Dodds has made a distinct contribution in the direction of facilitating the distribution of technical map material in this country.

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A WORD TO LIGHTKEEPERS

Requisitions for instruments and supplies received at this Office, as well as the accounts of the various chiefs of party on triangulation, indicate that an unusually large number of batteries and signal lamp bulbs, as well as flashlight batteries and bulbs, are being used by our parties. Much of the expense involved is evidently excessive and can be avoided by a little study and care with regard to the proper use and the method of handling. Our lightkeepers could render a real service to the Bureau, and it is requested that they do so, by studying how adequate light may be furnished to the observer as required at the minimum cost to the government.

In this connection it is well to again repeat the information just passed on by one of our employees who was a lightkeeper a number of years ago, to the effect that batteries will last a long time if the rate at which the energy is taken from them is small; whereas, a battery which is forced to the limit when it is first put in use will render only a few hours of service and be of very

questionable value after that time. Ordinairly, our signal light bulbs require only three batteries in a series to produce the brilliancy necessary to furnish a light to an observer over the lines in most common use today.

When the lightkeeper has communicated with the observing party and placed his lamp in true orientation, he should reduce its brilliancy so that the observer can barely see his light with the unaided eye. This is sufficiently bright for all purposes of observation and generally requires only a few batteries. While the lamps will operate on three batteries connected in series, much better service may be obtained from them by using a set of twelve batteries connected in series parallel. Then, when a powerful light is required, connection may be made to the whole set so as to obtain voltage as furnished from three batteries connected in series, while the energy will come from a reservoir of twelve batteries. This feature of utilizing to the best advantage the energy from dry cell batteries has been well covered in the instructions to lightkeepers. Incidentally, it is the intention that this manual be revised and republished in the very near future, and chiefs of triangulation parties, lightkeepers and others are requested to furnish any information which in their opinion will make it more generally adaptable and useful for the efficient operation of our field parties.

With regard to the use of the bulbs, it is felt that too frequently the lightkeepers strain these to the point of failure merely as a means of saving a few minutes time in locating the observer. This is entirely unnecessary. The majority of our triangulation stations are located on sufficiently commanding points that it is possible for a lightkeeper to see automobile lights or those in houses, towns, etc., at sufficient distances away so that he can quite accurately estimate the amount of light which is required for the observer to locate him. Then he should connect his lamp, increase its brilliance somewhat over what he considers adequate to merely pick up the observing party, and call until he has been definitely identified and communicated with by the observing party.

Care and attention to such details as those outlined above would without question, save the government hundreds of dollars annually for this one item alone.

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USE OF TRIANGULATION STATIONS IN ESTABLISHING AIRPLANE SPEED TRIAL COURSES

For a number of years triangulation stations have been used for controlling topographic maps, for the location of federal, state, and country boundaries and for the control of various engineering operations in cities and the location of private property.

A valuable and rapidly increasing use to which these stations are now being applied is that of determining airplane speed trial courses. Some years ago when the stations were not very well distributed over the counties and states, it was necessary after making numerous computations to execute considerable field work to determine the location of points for the terminals or turning points of the trial courses which must have definite lengths.

With the rapid extension of the triangulation net under the program of providing control so that no point in the United States will be more than 25 miles from a triangulation station, so many stations have been established that in most cases very little if any additional field work is necessary for the determination of the terminals or turning points of the trial courses.

Recently a request was received by the Bureau from the National Aeronautic Association for assistance in the determination of a triangular racing course of 1000 kilometers between New York, N.Y., Washington, D.C., and Norfolk, Va. The Coast and Geodetic Survey has established a number of triangulation stations in the vicinity of each of these cities, so that after several inverse computations were made, three stations were found which fulfilled almost exactly the requirements for the 1000 kilometer course. The stations selected were Bennett in Floyd Bennett Field, New York; Insane Asylum near Bolling Field, Washington; and Willoughby Beacon near Langley Field, Norfolk. The lengths of the three legs of the course are given below.

		kilometers	miles
New York -	Washington	328.343	204.02
Washington -	Norfolk	218.731	135.91
Norfolk -	New York	453.189	281.60
	Total	1,000.263	621.53

In the tests made over this trial course the theodolite checking method was used for the first time. At each of the turning point stations, a theodolite was set up and as the pilot approached each point he established radio contact with the pylon observers, and the plane was then picked up by the theodolite and followed during the course of its turn.

Since it was impossible to place theodolites at our triangulation stations on the Insane Asylum and on Willoughby beacon, it was necessary to determine new stations to serve as turning points at short distances from these two stations.

A few months ago the Bureau was requested to assist in establishing in the vicinity of New York, an airplane speed trial course which consisted of six legs for a total distance of 500 kilometers. We were able to use six of our triangulation stations as turning points and the length determined by them was 500.02 kilometers.

There have also been a number of requests for trial courses with lengths of 50 kilometers. In all cases triangulation stations had been established in the vicinity of the turning points and very little field work was necessary to determine the courses.

Since the demand for commercial airplanes is rapidly growing, there will be increased need for speed trial courses, and consequently greater use for our triangulation stations.

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USE OF RAILROAD FILLS AS WINDBREAKS FOR LEVELING PARTIES

Charles M. Thomas

With our twelve leveling parties, comprising about seventy-six leveling units, most all the new "wrinkles" that tend to improve the accuracy and expedite the progress of their work have very probably been tried out by now. However, to some of the observers on our leveling parties who have not already tried it, the following method, used occasionally by me in the windy Dakotas, should prove helpful.

When the wind began to blow exceptionally hard, so that the rodmen could hardly keep their rods on top of the T.P. spikes, and the umbrella boy was having a time trying to keep the sudden gusts from causing him to bump the level and also trying hard to remain master of his "charge", it was then that I dropped down into the leeward ditch for my setups. In this section of the country, similar to many of our other flat states, most of the railroad beds are built up a few feet above the bottom of the wide ditches on each side from which the required amount of material was excavated for making the fills. Setups were made in the leeward ditch and near the foot of the low fill, or on the side of the fill where it was too high for both rods to be read from a setup in the ditch as the rodmen were continuing to use the track spikes for turning points. By this method the entire tripod was shielding from the wind, and the exposed level escaped most of the wind, which was deflected over the top of the level due to the slope of the fill on the windward side. After a little practice, quick setups can be made on the side of a fill with practically very little delay. (While speaking of hillsides, no attempt will be made to settle the old argument as to which is the best and quickest setup, with one tripod leg downhill or two. The former has always been preferable to me, but there are arguments on both sides. However, from an instrument's point of view there is no doubt as to which shoulder it should be carried on, and that is the downhill shoulder of the carrier when he is walking along a hillside. In case the carrier's feet should suddenly slip out from under him, the instrument would have a soft landing spot on the carrier. Had it been on his upper shoulder, the instrument would have hit the ground first with the carrier landing on top of it, which would be quite a lowly and unbecoming predicament for a delicate and sensitive instrument to find itself.)

By using the foregoing method when the wind is too strong for the observer to setup between the rails, very accurate levels can be run in spite of the wind, provided it is not blowing parallel to the track. However, this method has its advantages in this case too, as the readings near the bottom of the rods are practically free from small errors due to the rods slightly vibrating in the wind, these errors being in proportion to the height of the rod readings.

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THE USE OF GEODETIC CONTROL FOR CADASTRAL SURVEYS

The May number of the Geodetic Letter was devoted wholly to a symposium on the use of geodetic control for private boundary surveys. In it was included a form of bill proposed to meet survey conditions in the State of Florida. This bill, with explanatory comments on its various provisions, was distributed for study and comment to members of the Florida Mapping Authority by H. A. Elmore, Executive Engineer of Local Surveys in that State.

From Mr. Elmore there has been received a splendid digest of points raised and comments made. This paper is a most valuable contribution to the subject, and though in parts it may deal with survey conditions peculiar to Florida, it should be very helpful to students of this subject in other states and it is hoped that it can be published in its entirety within the next few months. For the present it has been deemed proper and useful to select for immediate publication a few paragraphs which have fundamental and general application. These are given below. - Editor.

"If a land tract should in future be conveyed for the first time by coordinate description alone, the county officials and others would have no means of knowing the relationship between the new description by coordinates and the old description by land divisions."

An index map showing (1) the township lines and the boundaries of grants and other areas not conforming with the U. S. Land Survey, and (2) lines showing latitudes and longitudes in degrees and minutes, would serve as a general index to the descriptions of titles under the old and the new systems and for tracts not subdivided into numbered lots would probably be sufficient to locate any such descriptions close enough to serve for both systems, whatever the old system for that tract may have been. Plots of subdivisions into numbered lots are usually indexed in a separate section of the index book or in a separate book, with cross references to the alphabetical index of plots and the index by township and range. The addition of a line or column with cross reference to degree and minute of latitude and of longitude would add but little to the volume of the index. The index map referred to would aid in the general location.

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"To locate the tract described would require a knowledge of the coordinates of some established land corner near by. If these were not known, and most of them would not be known at first, either the conveyor or the county would have to establish them."

Neither the establishment of the survey monuments nor the statement of the plane coordinates of those monuments assumes to locate land survey corners or to determine the accuracy of their location by others. A survey monument is a convenience for a property owner in locating, exactly, a point or points on the boundary lines of the property concerned, with such connections and references as will enable him to replace a corner of the property or even a plane coordinate survey monument, should it be lost or destroyed.

Many original section corner marks in Florida can still be found, but if used as evidence in a case in court their validity is subject to attacks. Corners which have been replaced, using the rules of the U. S. Land Office in recovering them, are subject to attack and require more definite proof. And any stake or pin which has been assumed to be a section corner must meet the charge that its location is a matter of hearsay. To these attacks on the validity of a corner must be added the statute provision that a general acceptance for a fixed number of years of a property corner or a property line, if properly proven makes it legal in the absence of proof to the contrary acceptable to the Court. It is evident that the connection of a given stake or monument with a plane coordinate survey monument cannot fix the validity of that stake as a property line marker. In other words, the plane coordinate survey monuments are a convenience and a safeguard to property owners connecting with them and do not in any way displace the original U. S. Land Survey markers or guarantee the accuracy of points or markers claimed to be such markers or the valid substitutes for them. This last question is a question of property rights, for the decision of which there is at present no resort except the common courts of law. The property owner, or in case of dispute between adjoining property owners, the court is the only authority by whom the location of a property corner or property line can be settled. The question arising in suits for trespass or to determine contesting claims to real property are so often technical and not clear to the usual judge or attorney that the establishment of a special land court or courts would improve the value of court decisions on property boundaries and relieve the local courts of many time-consuming cases.

The system of plane coordinate monuments will reduce the number of land boundary cases in court or to be settled out of court as rapidly as the number of connections of property corners with the monuments of the plane coordinate system increases. This is especially true if, when such connections are made, all persons interested in that connection agree upon the validity of the corner or corners to be connected.

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"I do not believe the average land surveyor will get much out of the Mercator and Lambert projections used as the basis for rectangular plane coordinates in districts in Florida."

In practical surveying of land, the system of rectangular plane coordinates in the district in which the tract surveyed is located is all the surveyor is directly interested in. He need know nothing of the theories on which the computations of the rectangular plane coordinates are based so long as the area to be located is in one district. The general statements regarding the maximum deviations of the rectangular plane coordinates from the geographical coordinates of the same points give maximum differences within the limits of error in making good land surveys and in many cases within the limits of error of second order traverses. They may have such accuracy as is required for detailed surveying of large cities and of individual properties located therein.

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"I believe that the system of rectangular plane coordinates will prove very useful. I doubt the wisdom of passing any legislation at the present time requiring engineers to tie their surveys to these monuments as I do not think sufficient monuments have been set so far. When we get enough monuments in Florida so that coordinates of every section corner are shown, it will then be time to urge such legislation."

None of the forms of statute proposed thus far have compulsory provisions. Lack of monuments, the comparatively small proportion of the state in which any reasonably large number of monuments have been set, and the far-reaching effect of any compulsory features, have been the principal reasons for the restriction of the proposed provisions to purely voluntary action on the part of property owners, engineers and surveyors, in taking advantage of the provisions of the statute.

The declaration by the statute of the legality of the system authorizes its use and gives opportunity through such use for demonstrating its convenience, its efficiency in reducing the number of difficulties in coordinating surveys and improving their accuracy, and in facilitating preparation of deeds which will make it possible to locate such property on the ground exactly. It facilitates all the operations connected with the transfer of titles and the location of the ground whose title is conveyed. The principal sources of delay in putting the system into immediate use are the lack of monuments and the lack of familiarity with the advantages of the system.

Practically it would be impossible to make compliance with such a system compulsory at present. Theoretically, compulsory provisions are contrary to the present legal practices in reference to property transfers and probably they will not be considered advisable until familiarity with the system with experience in its voluntary use have shown its advantage to the public to such an extent

that they demand compulsory extention of its benefits to all real property.

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These monuments and the accuracy of their locations fill the gaps in the U. S. Land Survey permanently and should relieve the properties within the areas of those surveys of the numerous attacks upon the accuracy of their locations and sometimes of their descriptions. When connections have been made to the monuments of the rectangular plane coordinate systems, the locations within the U. S. Land Survey areas will be made permanent and sure.

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NEWS NOTES FROM HOME AND ABROAD

A publication issued by the Corps of Engineers of the War Department, entitled, "Triangulation Along the Mississippi River, Cairo to Barfield to Memphis", has been received by the U. S. Coast and Geodetic Survey.

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"A Working Outline of Engineering Astronomy" by Dr. Jerry H. Service, has just been received by this office.

Dr. Service is now Associate Professor of Mathematics and Physics at the Michigan College of Mining and Technology, Houghton, Michigan. From 1923 to 1928, he was a commissioned officer of the U. S. Coast and Geodetic Survey during which time he was co-author with Captain N. H. Heck in a Special Publication of the Bureau entitled, "Velocity of Sound in Sea Water".

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A recent letter from Professor Robert L. Sumwalt, Professor of Civil Engineering, University of South Carolina, Columbia, S. C., addressed to the Chief, Division of Geodesy, contained the following paragraphs regarding his visit to one of our base line parties:

"Recently Mr. H. E. Breen, Chief of Party, U. S. Coast and Geodetic Survey, invited me to bring my students to visit his base line party which was operating approximately 5 miles from Columbia.

"It was my pleasure to accept his invitation and to take thirty students, together with Professor E. R. Cary, Professor of Civil Engineering, Rensselaer Polytechnic Institute, who is now spending the winter in Columbia. Mr. Breen explained his work in detail and gave us a splendid demonstration of base line measurement. We followed the party along as they measured the line and noted with much interest the precision which was exercised in the work."

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A copy of Leaflet 77-June, 1935, issued by the Astronomical Society of the Pacific, entitled, "Astronomical Work of the United States Coast and Geodetic Survey", by William Bowie, Chief of the Division of Geodesy, has been received by the Library of the Coast Survey.

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The following letter from the National Aeronautic Association has been received by the Director:-

"Please accept our sincere thanks for the very excellent services of the U. S. Coast and Geodetic Survey in connection with the establishment of the 1,000 kilometer speed course between New York, Washington and Norfolk, Va., recently established for the world record speed trials of D. W. Tomlinson.

"We are pleased to say that Commander Tomlinson established nineteen records over this course during his recent flight, eight of which were international performances.

"We also appreciate very much your cooperation in entrusting Lieutenant R. L. Pfau of your New York office to assist in the establishment of an official 100-kilometer course from the Newark Airport to Long Branch, N. J. Major E. E. Aldrin, we are glad to say, established a new world 100-kilometer amphibian record over this course on May 16."

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Colonel Mo Tsao, Chief of the Division of Geodesy in China, was a visitor of our Bureau for several months this spring. He made an intensive study of the methods employed in the Division of Geodesy, and while in the office, divided his time between the different sections, working awhile in each and making computations, notes, and gathering all information that would prove of benefit to his colleagues in China. Colonel Mo Tsao was also greatly interested in the section of aerial photography as he hopes to employ this same method of surveying in China where it should prove very beneficial in the mapping of such an extensive country.

A program was laid out for Colonel Tsao to visit some of the geodetic parties in the field engaged in various classes of our work. During this time of the year, early spring, all the east coast parties were working in the southern states. It was possible for Colonel Tsao to visit these parties with a minimum amount of travel. In the State of Georgia, visits were made to the reconnaissance party of Mr. T. J. Mitchell, the steel tower triangulation party of Lieut. John Bowie, Jr., and the leveling party of Ensign William R. Tucker. Colonel Tsao then proceeded to Florida where he visited the astronomical party of Mr. Charles A. Whitten and the base measuring party of Mr. H. Edward Breen.

The visits to these parties proved of great interest to Colonel Tsao as he was able to assemble much information concerning the methods and organization of our parties in the field and he felt certain that his geodetic parties in China would greatly profit by his experiences.

Colonel Mo Tsao made many friends while in this country and his visit was enjoyed by all those with whom he came in contact.

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An article entitled, "Support Given to Geodesy by the Government of the United States of North America", by William Bowie, Chief of the Division of Geodesy, appeared in the January 28, 1935, number of the Comptes Rendus of the Academy of Sciences of Paris, France, a copy of which journal is on file in the Library of the Coast Survey.

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In a letter received by the Chief of the Division of Geodesy from Professor Alan F. C. Pollard of the Imperial College of Science and Technology of London, is the following paragraph:

"I particularly wish to thank you for the copy of your informal journal. It is most interesting and if quite convenient to you I think the Science Library here should receive it regularly. I too, would like to receive it regularly, but if there is any difficulty in mailing copies to the Science Museum and to myself, it would be more important for the former to receive it."

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The April 1935 issue of DE INGENIEUR IN NEDERLANDSCH-INDIË contained an article by J. H. Meursinge, Civil Engineer, Huntington Park, California, entitled, "The Bilby Tower for Triangulation Measurement". This article carried three illustrations; one of a Bilby steel tower completed, another in process of erection and a picture of a Parkhurst 9-inch theodolite.

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In an address to the National Committee of Geodesy and Geophysics held at the Royal Academy of Sciences in Brussels, Belgium, General Seligmann discussed the copies of the Geodetic Letter which he had received.

General Henri Seligmann is President of the National Committee of Geodesy and Geophysics; Secretary of the Belgian National Research Council; Chairman of various Committees in the Association of Geodesy; formerly Director of the Military Cartographic Institute at Brussels, retiring from active service in 1928. He was formerly a member of the executive committee of the Association of Geodesy

and was Acting President of the Lisbon General Assembly in 1933.

After a detailed discussion of the different topics given in each issue of this informal journal, he said:-

"In reality, there is a bit of everything in these Geodetic Letters and this publication accomplishes its principal aim which is to instruct the field personnel, to keep it interested, to acquaint it with what others are doing, to help it in its work and also to derive from the work all information possible.

"Besides all this, there are, at the same time, questions and information which are of general interest and which may be of use to geodesists of all countries.

"Finally, in following the reading of this publication, one is kept up-to-date almost from day to day with the progress of the work and the innovations as well as with all events, and this to a much greater extent than one is able to learn from the general reports which appear only annually and naturally are a little behind the times . . . . .

"These Letters are addressed to the whole personnel from the most humble to the chief of party, and it is especially in this that they are useful. Considered from the practical point of view, most important or most essential, is the advice, remarks on the instruments, on their use and on the special cases which present themselves. The questions raised by the field men which are not taken care of by the instructions, even though very complete, and which are answered in the Letters, are questions which will benefit all field personnel not only the personnel of the Coast and Geodetic Survey, but also that of all other countries which are carrying on triangulation and level work. The bulletin "Geodetic Letter" is collecting a mass of information which may be of service to all."

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It is requested that members of our field parties exercise extreme caution in seeing that no debris of any kind is left to remind property owners unpleasantly of their visits. The following card has recently been received at this Office:-

"Please instruct your field men to leave no boards full of nails upturned in pastures where they may injure the work horses or cattle. This has been done in my pasture where the field men tore down and rebuilt wigwam or signal posts."

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REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during April, 1935:

First-order - - - - - - - - - - - - - -	1,065
Second-order - - - - - - - - - - - - - -	899

Completed during May, 1935:

First-order - - - - - - - - - - - - - -	1,121
Second-order - - - - - - - - - - - - - -	253

Total miles of triangulation completed to May 31, 1935:

First-order - - - - - - - - - - - - - -	60,032
Second-order - - - - - - - - - - - - - -	5,116

Levels:

Lineal miles of levels completed in April, 1935:

First-order - - - - - - - - - - - - - -	933
Second-order - - - - - - - - - - - - - -	9,030

Lineal miles of levels completed in May, 1935:

First-order - - - - - - - - - - - - - -	811
Second-order - - - - - - - - - - - - - -	9,057

Total miles of levels completed to May 31, 1935:

First-order - - - - - - - - - - - - - -	105,115
Second-order - - - - - - - - - - - - - -	140,526

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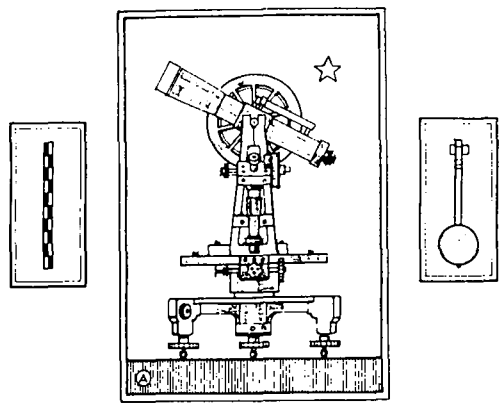
GEODETIC LETTER



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WASHINGTON D.C.

R.S. PATTON · Director

G E O D E T I C L E T T E R

September - October, 1935

Volume 2 Number 8

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PLEA FOR UP TO DATE MAPS

There is a widespread interest in topographic maps for carrying on the various activities of our country and especially by officers of the Army who must prepare for warfare by studying and using maps. If they have maps, military operations can be carried on with greater effectiveness.

There is quoted below an article which appeared in the San Francisco "Call", which should interest readers of the Geodetic Letter.

New Maps for California

A few weeks ago a group of officers attached to a regiment stationed in California were given a problem to work out.

It was a simple problem, consisting merely of establishing a line of outposts in familiar, inhabited territory. And for use in determining the location of the posts, they carried one of those familiar contour maps that the United States government produces, and that are popularly believed to be the best in the world.

But within half an hour, using that map, they found themselves completely bewildered. It showed plainly enough the larger topographical elements of the country, but for any detailed work it was worse than useless. Roads did not lie where they were shown on the map. Some highways marked on the map did not exist at all on the terrain. Others, not shown on the map, were wide and plain on the landscape. A road that ran to the RIGHT of a railroad on the map, really ran to the LEFT. Finally one of the officers said, "Let's see the date of that map!" and it was discovered that it had been made by the government in 1885 and had never been adequately brought up to date.

It had been a perfect, a useful map fifty years ago, but in the last half century men have made enormous changes in California. We have dug tunnels and canals, we have laid down railroads and hundreds of thousands of roads and highways. And in the thickly populated sections of the state, a government topographical map that is out of date is nearly useless.

For ordinary purposes such a map is at the worst a serious inconvenience. But for military purposes it is positively DANGEROUS.

We do not contemplate war in California, on the Pacific Coast. We hope and pray that war will never be waged along this

coast, but we should realize that in time of war accurate maps are as valuable as armament and troops, and are essential to the maneuvering of forces.

At the beginning of the world war, the French army was tragically handicapped by the lack of accurate maps of its own eastern terrain. The French general staff had never dreamed that the war, when it came, would be fought in France. So, although they had excellent maps of Germany, they had none of their own territory. The British, also, had maps of Germany and Belgium, but none of France. As a result the allies lost valuable time and thousands of lives. French engineers immediately began the making of accurate maps and by the close of the war they were well equipped, but a fatal mistake had been made for which France paid heavily.

Here on the Pacific Coast we are in the same state of unpreparedness. Some areas are adequately mapped. Others are tragically out of date. The government engineers have been working for more than half a century on the mapping of the state, but we have been changing the face of the land almost as fast as they have mapped it.

Here, therefore, is an opportunity for the government to employ thousands of civil engineers in useful, necessary work. Instead of using a small corps of engineers on one quadrangle at a time, the government could use hundreds of groups and bring every section of the state up to date in a comparatively short period of time.

A tremendous number of engineers have no employment at present.

Tremendous areas of the Pacific Coast are dangerously and inadequately mapped.

Let the federal government put those private engineers to work on this urgently needed project.

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CONTROL SURVEY MONUMENTS ARE LASTING LONGER

Of all developments in surveying and mapping in this country, it is believed that the improvement in the monuments used on federal, state, county, city and private surveying is outstanding. There have been in the past, many control surveys made by different kinds of organizations with little or no thought given to the perpetuation of the survey stations. In most cases the control surveys were designed to serve some immediate objective. The thought that these field stations could be of value to

others for future operations never seemed to have been given due consideration.

Along the coast we have been carrying on triangulation for more than a hundred years, and it is only in recent years that the coast triangulation stations have been monumented in an adequate way. There are cases on the coast where the station mark was a brick with a drilled hole set a foot or more below the ground with a wooden peg above the brick. One can imagine the difficulty in finding the brick.

As a matter of fact along parts of our coasts there are no natural features to which the station can be referred. About the only way to find the brick is to have another station established somewhere in its general vicinity. Then with the position of the hole and the new station known, the brick can probably be found. But what is the use of finding the brick if you have to establish a new station in order to do so? In general, it is better not to waste time hunting the old station where it is very inadequately marked.

The bench marks set on the level lines run in the interior of the country were very poor affairs prior to about thirty years ago. In the early days the bench marks were squares cut in culverts, along railroads, or on the steps of banks, schools and similar buildings, abutments of bridges and other highway structures. In nearly all cases those structures were replaced or destroyed and the bench marks were lost. Prior to about 1900 there were very few special concrete bench marks set.

Now all bench marks are inscribed metal tablets usually set into specially poured blocks of concrete or outcropping rock. They are still placed in the outer walls or steps of buildings and other more or less temporary structures, but such bench marks are supplemental to the regular distribution of marks along a line of levels.

In the days of the ox and wagon, the ideal place to put a bench mark for a triangulation station or a leveling mark was in the corner of a field at the intersection of two roads. Now with the automobile and the development of our highways, such a position is the very worst for a control survey station. The corners are cut off by the highway engineer in order to ease the curves in going from one road to another. Another ideal place for a survey monument was alongside the highway. It didn't make much difference whether the station was placed just outside of the traveled road or on the edge of the right-of-way of the road. But with highway development the roads are widened and straightened. In consequence, many of the control survey stations have been destroyed during the improvement of highways.

At the beginning of the highway extension in this country, the engineers and others engaged on highway work paid very little attention to the control survey stations. They were dug up and thrown away. But there has been a gradual increase in the appreciation by highway workers of the value of control survey stations. Frequently letters come to the Washington office of this Bureau from highway engineers in various states, saying that a certain monument is in the way of the development and asking what shall be done about it. In most cases the station is preserved by putting in another one nearby and tying it to the one that must be removed. Sometimes this is done by highway engineers; in other cases, if a party of this Bureau is near the region, a unit of the party is sent to do the work.

The thoughtfulness of the engineers in preserving these monuments is deeply appreciated. They are performing a real service whenever they can save the marks. One is reminded of the old story that we read in the school books on "Woodman, Spare that tree". The tree of course is nice to look at and it may be valuable for shade, but its greatest value is when it has been cut down and used for lumber. We should have another story and that might be entitled, "Engineer, Save this Survey Mark". The mark is of no value except as it remains absolutely undisturbed and it can be used over and over again for a hundred or a thousand years. Each time it is used it becomes more valuable for it is the starting or reference point for local surveys.

Any one coming to the Washington office of the Bureau, should see the number of station marks of various kinds mounted on the board in the office of Mr. H. S. Rappleye, Chief of the Section of Leveling of the Division of Geodesy. This array of station marks shows clearly that engineers making control surveys believe it pays to perpetuate the survey stations. The inscribed metal tablet conveys definite information to visitors at the station. Their curiosity is allayed and therefore the mark is not thoughtlessly dug up in a search for buried treasure nor is it considered worthless by the engineer or others who may be carrying on some kind of a development in its vicinity.

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VISIT TO TRIANGULATION PARTY

The following interesting letter to the Chief, Division of Geodesy of this Bureau, was received from Mr. George D. Whitmore of the Engineering Service Division, Tennessee Valley Authority:

Dear Major Bowie:

I believe you will be interested in knowing of a visit

made by some of the Tennessee Valley Authority engineers to your triangulation observing party under Ensign Maurice A. Hecht, now stationed at Livingston, Tennessee. On June 6, Mr. Ned H. Sayford, Director, Engineering Service Division, also Tennessee Valley Authority representative on the Board of Surveys and Maps, and the writer drove to Livingston and contacted Mr. Hecht for the purpose of becoming better acquainted with the sort of equipment and methods of your observing parties. We were very cordially received by Mr. Hecht, who showed us in considerable detail the camp equipment. In fact, all of the members of the party were exceedingly courteous and seemed to thoroughly enjoy demonstrating to us their equipment and methods.

We then drove to Cookeville, Tennessee, and watched a tower building party erect a 55-ft. steel tower. The remarkable speed and efficiency with which this tower was erected was nothing short of astonishing. The anchor holes were started at about 3:00 P.M., and shortly after 6:00 P.M. the tower was complete and could have been occupied. Any organization which develops tower erecting parties as efficient as the unit we observed, deserves a good deal of credit.

It was not convenient at this date to visit an observing party, because all such parties were situated on mountain tops several miles distant, requiring a two or three hour hike to reach them. On June 17, therefore, Mr. Harry Wiersema, Assistant Director, Engineering Service Division, and the writer went to Livingston again, arriving there about 6:00 P.M., for the purpose of spending the evening with an observing party and observing the present day technique. Mr. and Mrs. Hecht gave us what they called a camp meal, which I shall have to confess equaled or excelled most hotel dinners in quality.

As soon as it became dark, we ascended the 77-ft. steel tower at Livingston, which happens to be a subsidiary station, and watched the observer complete eight positions on two stations, as well as the signaling of results to the principal observing party. The speed and efficiency of the observing parties is remarkable. It so happened that the party which we visited was the extra observing party and did not have a Parkhurst theodolite. We were told that the results would have been secured even faster had a Parkhurst instrument been available. We were especially impressed with the feature of signaling the results to the principal observing party so that the triangles could be tested for closure before leaving the tower.

Mr. Sayford, Mr. Wiersema, and I were extremely well impressed with the efficiency of the methods used, the high grade equipment and the high character of the personnel engaged upon the work. We feel that you and your organization should be complimented upon your field representatives, and upon the development of the field procedure to its high state of efficiency. Mr. Hecht especially was unusually courteous, and if all of the party chiefs

are of this grade, you certainly have a first-class field organization of which you may well be proud.

With kind personal regards, I am

Very cordially yours,

(Signed) Geo. D. Whitmore

Geo. D. Whitmore
Engineering Service Division.

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MAGNETIC WORK BY FIELD PARTIES

and

STATE REPRESENTATIVES OF THE COAST AND GEODETIC SURVEY

E. W. Eickelberg

Excellent response has been obtained from both those in charge of the state control surveys and from our own reconnaissance and triangulation parties in reporting on the condition of magnetic stations.

Complete or nearly complete information has been received from the following states: California, Colorado, Florida, Georgia, Indiana, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, Oklahoma, South Carolina, and Washington.

In addition to making these complete reports, some of the state representatives have made declination observations at many of the old magnetic stations and have established new stations to replace those that were lost or of no further use due to some local attraction having been introduced since the station was established. The instrument used for this work (Compass Declinometer) was loaned to the state representative for such time as was necessary to complete the work.

Professor Philip Kissam has made observations at all of the New Jersey magnetic stations and in addition has established compass testing stations at a number of New Jersey airports.*

* The Military Engineer, No. 153, May-June, 1935, pp 174-177, Compass Corrections in Military Aviation; Philip Kissam.

(Magnetic field party making observations with compass declinometer.)

The importance of this latter work can hardly be overemphasized. In aircraft, the complete gyro compass will not function due to centrifugal accelerations, and in its place the directional gyro is used, which on account of friction in its bearings has to be reset by the magnetic compass every twenty minutes. Radio compass homing devices, radio ranges, radio phones all fail or their range becomes greatly impaired when they are most needed, that is, in thunder storms, snow, fog, etc., when visibility is reduced and under bad conditions of static. Under favorable conditions, radio ranges in the United States are good for a distance of one hundred miles, but under bad conditions of static, etc., as low as thirty miles. In case of a thunder storm, they are of no use since the pilot is then forced to ground his antenna to prevent the plane from being struck by lightning. He is then entirely dependent for his course on the magnetic compass.

It is for these reasons that an airport should be equipped with a compass testing table for a convenient and rapid method of compensating and calibrating the compasses of airplanes. The magnetic compass should be tested at frequent intervals because the magnetic condition of the plane's steel members changes from time to time and as the result of being struck by lightning.

Other state representatives who have established magnetic stations at airports are C. J. Tilden, of Connecticut, Frank H. Prouty of Colorado, E. C. Houdlette of Massachusetts, Edmond W. Bowler of New Hampshire, and T. C. Hamby of South Carolina in cooperation with Coast and Geodetic Survey magnetic field party.

This office is ready to cooperate in furnishing instruments

and instructions for establishing compass testing tables at airports in other states or for making observations for declination at various county seat magnetic stations.

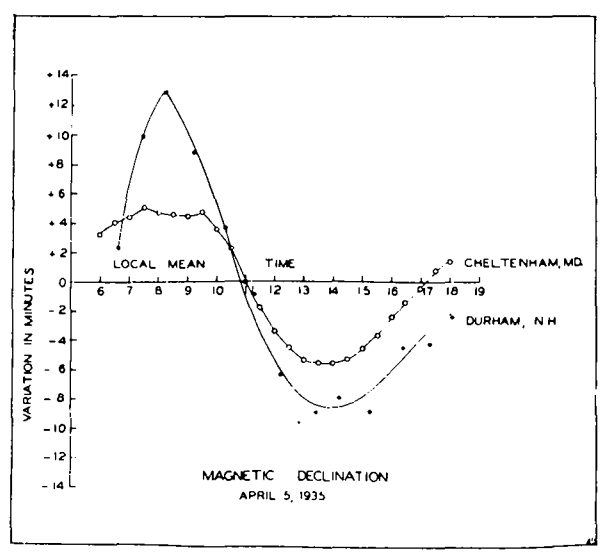
Professor Bowler of New Hampshire has an interesting program under way for observing declination at all of the New Hampshire magnetic stations and in addition expects to make continuous observations throughout several days for the purpose of obtaining the diurnal variation in declination for that locality.

The Coast and Geodetic Survey records these variations continuously at its observatories in Alaska, Arizona and Maryland, so that observations at other places can be corrected for these diurnal variations by interpolation. However, observations such as those made by Professor Bowler enable this office to make better interpolations by having a direct comparison.

Many states are finding the Coast and Geodetic Survey magnetic stations of value in referring local magnetic prospecting surveys to them as a standard. Notable examples are Missouri, Arkansas, Illinois and Michigan.

Such surveys are of value not only in locating mineral resources, but also of assistance in some cases in the location of ground water and coal, and particularly in delineation of geologic structure.

Our own field parties in triangulation and reconnaissance are cooperating in furnishing accurate positions and azimuths at many of the existing magnetic stations at county seats. Thus the local county surveyor is furnished a station with accurate latitude, longitude, azimuth and declination all at the same station, and usually very close to his headquarters.



Curves showing diurnal variation of magnetic declination at Durham, N.H., and Cheltenham, Md., on April 5,1935; the range at Durham should be greater than at Cheltenham on account of the higher magnetic latitude.

CONSTRUCTIVE CRITICISM

Andrew L. Breckenridge

During the past winter in the course of my duty, I contacted many civil engineers engaged in private practice and on public work. As a group, they held the work of the Coast and Geodetic Survey in high regard, but in individual instances, they took advantage of the chance to tell me as a representative of the Survey of some error which they had discovered or about some detail which they felt should be changed for their benefit. The criticisms may be summarized as follows:

1. Some of the information published by the Survey, especially the descriptions contained in Publication No. 181, (Leveling in Mass., R.I., and Conn.) is obsolete before the date of issue. It is my understanding that supplements are to be issued in the near future, which will bring the descriptions up to date. I would also suggest that if Congress will appropriate the necessary funds that all marks should be inspected periodically. Two methods suggest themselves. One is to have an observer attached to the Survey assigned to recover and report on each mark at some stated regular interval, two consecutive inspections not being made by the same observer. The other method, while maybe not as efficient, would tend to increase the knowledge of the work of the Survey by engineers in general. It would be to appoint a local surveyor or engineer as custodian of the Survey's marks, it being his duty to make periodic inspections of the marks in his community and report.

2. Many inaccuracies in the descriptions were brought to my attention. I would suggest that every description of a station or bench mark should be checked in the field before publication.

3. Reports forwarded to the Survey by private engineers are acknowledged but ignored in publications issued subsequently. You are right in not wishing to note a mark as "destroyed" until positive proof is furnished. The value of the rule is proved by my recovery of two marks which engineers had informed me that they had reported as destroyed. To keep the engineers friendly to the Survey, I would suggest that in cases where an engineer had reported that he is unable to recover a mark and the mark is later found, the Survey should notify him that the mark had been restored and was available for his use.

4. My attention was called to a map recently published by the Survey. The engineer who purchased it pointed out features in the topography which have not been as shown for over forty years. He inquired "How do I know what information on this map is correct?" I would suggest that where maps are republished and not entirely resurveyed, that the new work on the map should

be printed in heavy lines and the old or copied work in faint lines.

5. Complaint was received that the published elevations of many of the old bench marks marked with the U.S.C.& G.S. and U.S.G.S. disks have never been republished in agreement with the 1929 General Adjustment.

6. The marks are not set as securely as they could be. This criticism is justified, I believe, only in certain types of setting. Marks set in shaly rock have disappeared, not through fault in the regulation of the Survey, but because of poor judgment upon the part of the man who selected the spot. Marks set at the top of tile pipes show a high rate of disturbance both from natural causes and from the deviltry of trespassers. Posts set near the shore should be both deeper and higher. Where it is necessary to locate a station in a sand dune, in an earth bluff or on a beach, I would suggest that the bottom of the concrete post should be cast in the form of a tripod and placed with two legs away from the water. Such a post should be buried well in the ground with a surface mark which should extend at least two feet above the ground. A post should be large enough in cross section to make it difficult for souvenir collectors to remove the disk.

7. An engineer engaged in private practice states that he would like to tie his surveys into Government points, but that he cannot afford the time as he has to set his price for surveys in competition with other surveyors, and suggests that the Government stations and bench marks should be more conspicuously marked. The public utility companies, in some regions, mark their underground work with white concrete posts set so as to be visible above high grass, leaves, and ordinary snows. The Survey might well adopt this type of post for reference marks, the actual point being the intersection of two lines cast in the top of the post. A disk similar to ones now used could be cast into the face of post.

* *

10. A drill hole or a copper pin in a rock is not ample description, I found. The rocks are full of drill holes other than those made by the Survey. Where a distinguishing mark such as a triangle or square has not been chiseled around the hole or pin, the size (diameter and depth) should be cited. Possibly the surest way to preserve a point is to mark the station and the reference point in dissimilar fashion. Hunters of souvenirs may destroy the station where both station and reference marks are marked with disks, but they will not disturb drill holes. On the other hand, the inscription of the Survey on a disk commands respect from those having at heart the common weal. Such a person might unwittingly destroy a rock containing a copper pin or drill hole, but would not dynamite or move one containing a disk.

I might add a suggestion in regard to describing stations. At first, I spent considerable time in checking on proper names of places and of natural features. When I learned that the U.S.

Geographic Board had published an Official Gazetteer, I purchased a copy and followed its recommendations as to choice of names and spelling. I would suggest that every party chief working in Rhode Island should be supplied with a copy of this publication.

The descriptions would be more uniform if the Survey adopted a glossary of such terms as may be variously defined by different individuals. Then those whose duties involve the composition or revision of descriptions would all use the same word for the same thing. Especially have I in mind such terms as bridge and culvert, boulder and rock ledge, barn and shed, dome and cupola, tower and spire and steeple and pinnacle, belfry and bell cote.

In a state like Rhode Island, where the people think in terms of town boundaries and where the counties are merely judicial districts, it would be more convenient for local engineers to have the descriptions include the names of the towns as well as of the counties. In addition to the General Index, an index by towns would assist the local engineer.

In the list of geographic positions, stations which have been positively determined to have been destroyed might be indicated by italics. It would also help to have added to this list an extra column in which would appear the page number on which the station is described. . . . . .

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GLEANINGS OF EXPERIENCE

(Excerpts from letters of a party chief)

"They say the longer one lives, the more he learns and I have just learned something about a truck that should be self evident to a beginner. I was disgusted at the way my old car labored on the hills and how the gas mileage went down. Then I thought about back pressure and put on a new exhaust pipe and cleaned the muffler. The change was revolutionary and the car now runs like a straight eight. I wouldn't be surprised if many of the old trucks in service are not in the same condition. It seems to take very little scale in the pipes and muffler to make a great difference. I plan to put on a complete new muffler as soon as I can afford it."

- △ -

"A partially idle man, especially at the same pay as the other men, is bad medicine on any party."

- △ -

"One of our aversions has been the recovery of stations of recent date and making arrangments for new work. We are so often met by a shotgun or a hard luck story about unsettled damages and unfulfilled promises, that I feel like leaving the motor running. However, a letter received from one of the members of our party presents a refreshing contrast and I shall quote from it.

'____ must have a real good bunch of fellows on his building party. I have recovered all the old stations and every one remarked on the lack of damage, how well the men did the job and minded their own business. They were all glad to hear that another party would come through to do some more work. One fellow at station _____ said that he gained a lot of knowledge as the members of the party answered all his questions even though he did ask a lot of them.

'The only comment I could make, and this is only my own opinion, is on the type of marks. The marks are good, but in setting the disk, it has been countersunk about an inch, which causes it to hold a lot of water which will permeate the concrete and, I would think, cause freezing and tend to crack the top of the mark in cold weather. I did not find any trace of freezing on the marks visited and of course, the countersinking would prevent anyone from breaking off a little of the concrete and removing the disk. I would think that if the mark were set flush with the concrete, it would leave a good place for a topo rod to be set, (if ever that happens), and which would not be full of water and dirt when a fellow wanted to set up over it, and would finish the top off better. I think they showed good judgment in setting the reference marks as to position for intersections and for lasting qualities. All in all it was a good job. It is not bad to recover stations when they are left as these were.'

"There are many ways a reconnaissance party can aid the triangulation party and this is certainly one way that they can help. I think it unnecessary to report the many sources of irritation such as driving across the alfalfa when wet, etc., but, since the reconnaissance party is always placed in the position of asking a favor of the property owner, I sincerely wish that everyone connected with the survey would act as befits one receiving a privilege. I often have to make quasi-promises of care being taken by the men that follow, and I regret very much when such promises are broken by those out of my control. I know the building parties are a hard working crew but perhaps a half hour more spent at the station cleaning up and putting better workmanship on the marks would be well invested.

"Regarding the marks, I am inclined to agree with the

extract given from the letter above. Also, I am in favor of a wooden collar form instead of the circular steel ones in use on some parties. These latter soon become deformed from being forced down into the concrete requiring that they be pried off and bent out of shape. The result is that the marks are oval, irregular, and not of uniform batter. Perhaps this does not appear pertinent, but I feel that a mark is judged by other engineers much as is a person, - by its appearance. I will say that the quality of concrete is generally better than it was a few years ago but still, the marks are not heavy enough, nor deep enough in the ground. The round collars have shrunk in many cases to 1 foot diameter, which is much less in volume than the specified 14 inches square and I have yet to find a mark 42 inches deep, even in northern states with severe frost action. In fact, at one place in Minnesota, a road cut of slightly over 3 feet had completely erased all trace of the sub-mark. I was advised by authorities in Texas, that marks placed in the black lands must be deep and well belled at the bottom, so that I would advise building parties to get something longer than a D-handled shovel for digging holes.

"Another thing I have stressed before is symmetry of marks. It quite frequently happens that vandals break off the top of a mark and remove the disk. If the concrete is symmetrical with the disk the center can be recovered from the stub for all practical purposes. However, if the disk is set in one side, or the collar slapped on crooked, it becomes necessary to excavate to the sub-mark. When I see a sloppy job at the surface, I always wonder about the accuracy of centering the sub-mark, too. Since our bureau does work of precision, why can't we expend a little more care in workmanship on marks which, after all, are our ultimate contact with the public?

"As chief of party I have found it difficult to maintain a high standard of marks and have come to the conclusion that this vital feature of our work is intrusted to a laborer too far down the scale of responsibility, and that an officer, signalman or trusted foreman with a conscientious desire to do things right, should be in charge of marking stations."

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VERTICAL CONTROL FOR RIVERS

W. M. Gibson

It seems that a great amount of attention is now being directed toward the rivers and waterways of this country with an eye to future developments. The Ohio River seems to be a good example and has afforded considerable opportunity for study lately.

As near as can be ascertained, the control of the river is dependent upon a precise traverse and level line running along the south and east bank. Since 1900 many improvements have been made along the river in the way of locks and bridges, and there is a twenty-year plan under contemplation which calls for raising the water level back of the dams in many places. It seems entirely possible that most of the remainder of these precise traverse and level bench marks may disappear within a few years.

The precise control is more or less unsuited for Ohio and Indiana on account of the width of the river, and the following general plan regarding vertical control for an important river is offered for comment:

1. Lines of first-order accuracy crossing the river at right angles every fifty miles.

2. Lines of leveling consisting of a single running crossing the river at right angles half-way between the first-order lines.

3. Lines of leveling consisting of single running along each bank of the river and paralleling it throughout.

4. Short connecting lines of leveling of single running across bridges (or river crossings) at twenty-five mile intervals to divide the twenty-five mile spacing into 12-1/2-mile spacing.

By altering the specifications regarding length of sights and balancing the sights (as well as proximity of sights to bottom or top of rod) considerably more than second-order accuracy might be obtained on lines of single running.

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PARTY ORGANIZATION

John Bowie, Jr.

The personnel of the first-order triangulation party in my charge numbers 112 men. The party is divided into 3 separate double observing parties, one consisting of 34 men and two with 36 men each. The two extra men on the 2 parties are due to our having steel towers over 90 feet in height which require 2 trucks for the transportation of each tower instead of 1. The remaining 6 men: signalman, mechanic, supply foreman, accountant, mathematician and computer, are stationed with the office trailer or divide their time between the 3 parties depending on where they are needed most.

The parties are modeled after the old time double observing parties of Lieut. H.W.Hemple and William Mussetter. All the

men live in tents. The building parties locate near a town where they can readily obtain sand, cement, lumber, water, and other materials. The observing parties, lightkeepers, and take-down parties camp on their stations except in certain sections of the country where it is impracticable to do so.

Each double observing party has 2 modern first order theodolites and a third theodolite of older make and design. The 2 best instruments are used for the main scheme stations while the third instrument is used for reobserving, for central points and for supplemental stations. Each observing unit consists of 3 men and 1 truck. There are 5 lightkeepers, 2 on the forward stations, 2 on the rear stations, and the fifth one to post lights and go where most needed. One of the forward lightkeepers drives a truck and moves the other forward lightkeeper each day to his new station. The same system is used by the rear lightkeepers. The take-down party, consisting of 4 men and 1 truck, camp with the rear lightkeepers and receive their take-down signals from the rear lightkeeper. The double observing party and the triple observing party signal their angles to the observing party, which closes the triangles while still on the tower and then signals instructions for the next night's work. No attempt is made to work a side equation test on the quad before giving a take-down as the loss of time thereby incurred is not justified. Instances of the sides failing to check, within the prescribed limits, when the closures are good, have been very rare in the parties with which I have been connected. With good observers, good instruments, good runs, careful centering of the instruments, lights, and measuring all eccentricities, however small, there should be no reason why the sides shouldn't check.

With each double observing party are 2 building parties, each consisting of 1 foreman, 5 men, 1 screen body truck and 1 express body truck. An assistant signalman is in charge of the 2 parties. His duties are to plan the work of the building parties, put out bids for supplies, interview property owners at each station in advance of the erection of the tower, check the reconnaissance description and to locate Laplace azimuth stations.

The take-down party consists of 1 foreman, 3 men, and 1 truck. This unit takes down 2 towers a day. The steel haulers number 2 or 4 depending on whether the towers are over 90 ft., in which case a follow truck is needed with each semi-trailer.

During the past several years, vandalism has increased to such a point that it has now become necessary to have a watchman with the building party camp to keep government equipment and supplies from being stolen during the daytime while the men are out at work. Besides watching the camp, the watchman also helps prepare the meals for the building parties.

There are now 52 trucks on the party. Several are over 5 years old and will have to be replaced soon but most of them are new and in fine condition. During the year 1934, truck No. 276 (sedan delivery) averaged 17-1/2 miles per gallon of gasoline and towed the office trailer on every move. The truck is now 1-1/2 years old and the only repairs it has ever needed have been two tires and one radiator cap. The speedometer now reads 27,000 miles.

The present system of having an office trailer is a big improvement over the old 9 by 9 foot tent. All records, accounts, etc., can now be kept inside and it is a pleasure to work without the danger of losing records or valuable papers. Everything can be filed systematically so that finding what you want no longer requires a big search through papers kept in a box, suitcase or some similar contraption.

I am strongly in favor of the large parties of the present being organized into small double observing parties. I consider that the small party of the double observing type has many advantages over the large party for the reasons given below:

1. Accuracy.

In a large party, the lightkeepers and observers stack 4, 5 or 6 lights on top of each other. If the bottom light is not perfectly level, the top lights are going to be eccentric, thus making large closing errors. If all of the lights in a quad are this way, very poor closures and length checks will result. Also, the wind will have a tendency to blow the lights out of plumb when a large number has been stacked up. With a double observing party, only 2 and sometimes 3 lamps are stacked up so it is readily seen that the top light will be more closely centered and therefore better results will be obtained.

2. Progress.

I believe also that more progress can be obtained by using double observing parties.

If the reconnaissance is faulty, only a small party is held up instead of a large one. The same applies to the weather and especially on those nights when it clears up unexpectedly. By camping on the stations, each man will be on the job when the weather clears instead of being miles away in a town. The reverse also applies to prevent observers from being discouraged too easily by adverse weather, for a camp in town has a lot of magnetism and this will be eliminated by camping on the station. Last month, the three double observing parties in my charge occupied and completed 142 stations and one party made a 600 mile move during the month.

3. Cost.

By making the maximum progress, naturally the cost per station is low and operating expenses are less. With reference to trucks, it is an undisputed fact that they will run less miles per month by camping on the station than they would if operated from a central camp. In running less miles per month, less gas and oil will be used and the truck will last a longer period before being expended. This is especially true of the steel trucks. A double observing party uses 12 towers while a 4-way party uses 18. This makes 6 quads against 9. Thus each steel truck, in moving towers from the rear to the front, travels 3 quads more one way, or 6 quads more a round trip per day on a 4-way party than on a double observing party. Thus if the quads average 15 miles, the steel truck on the double observing party will each save 90 miles per day. Supplies are also purchased in large quantities with substantial saving as a result. By having reobserving at a minimum, partially due to not stacking up many signal lights, the unit cost of the party is kept low.

4. Efficiency.

I believe a double observing party operates more efficiently. Certainly less moves by the building parties are required. A building party cannot move and build a tower on the same day regularly and as the progress of the observing party is reflected directly by the number of towers the building units build, it is obvious that the less moves the building parties have to make per month the more towers they will build. If the building parties do build on the move, the steel trucks will have to be used to move the camp equipment and this amounts to no steel being moved forward that day unless steel haulers work overtime. It has been my experience during the past year, that it is quite a job to find a camping space for a large party, especially in the more thickly settled parts of the country such as Virginia, Maryland, and Pennsylvania.

I believe also, that the double observing party system helps develop engineers faster which will be of great benefit to themselves and the Coast Survey. Should any expansion occur in the future, I have 2 men who are capable of being placed in charge of a triangulation party. These men are now sub-chiefs on the double observing parties.

Another point which cannot be taken too seriously is "night driving". From personal experience I would say that two-thirds of our truck accidents happen at night. If night driving could be eliminated, two-thirds of the accidents would be prevented. Serious injury or loss of life to members of the party is always a possibility whenever an accident occurs. All this could be avoided and night driving placed at a minimum by camping on the station instead of operating from a central camp.

Reports such as truck reports, monthly personal reports, etc., are rather slow coming in but this has no direct bearing on the progress of the party.

The office trailer is located as near to the center of the field of work as possible in order that the parties can be reached easily. In this way the office trailer can be located in one place for two or more months. I inspect the observing units at least once a month and sometimes more often. Mart Braden, signalman, does the same with the building parties. The assistant signalman and sub-chiefs also come to headquarters quite often to talk over various things, get expense money, turn in sub-receipts, records, computations, etc. Although correspondence is rather heavy, I really have more time to myself than when I was in charge of a large party operating as one unit.

Six-month contracts for gasoline and oil at service stations are made. Also six-month contracts for bolts, nuts, and batteries. This makes the accounts smaller and at the same time the obtaining of supplies on short notice is made possible. All the truck drivers have courtesy cards for service station purchases on charge account which eliminate sub-receipts for gas and oil and enable me to keep my cash balance under $500.00 by not having to supply truck drivers with expense money.

Speed Notes:

J. W. Stirni, Junior Engineer, observed a five line first-order station in 38 minutes.

William Bragg, building foreman, built a 103 ft. steel tower in 2-1/2 hours. This included digging holes and setting all marks. Dean B.R.Van Leer, Florida State Representative, did the timing.

Albert Cook, building foreman, built a 90 ft. tower in 1-3/4 hours. This did not include the holes which were dug the previous day. Colonel Mo Tsao of China, witnessed this building.

Foremen J.M.Harris and Elmer Holford have each taken down a 103 ft. tower complete in one hour flat. Colonel Tsao witnessed one of these.

. . . . . .

I enjoy reading the "Geodetic Letter" as do all the men working with me. I believe it is to the advantage of the Survey for each man to know the other fellows' ideas and problems, and I even recommend the "Geodetic Letter" to the personnel of the Accounting Division.

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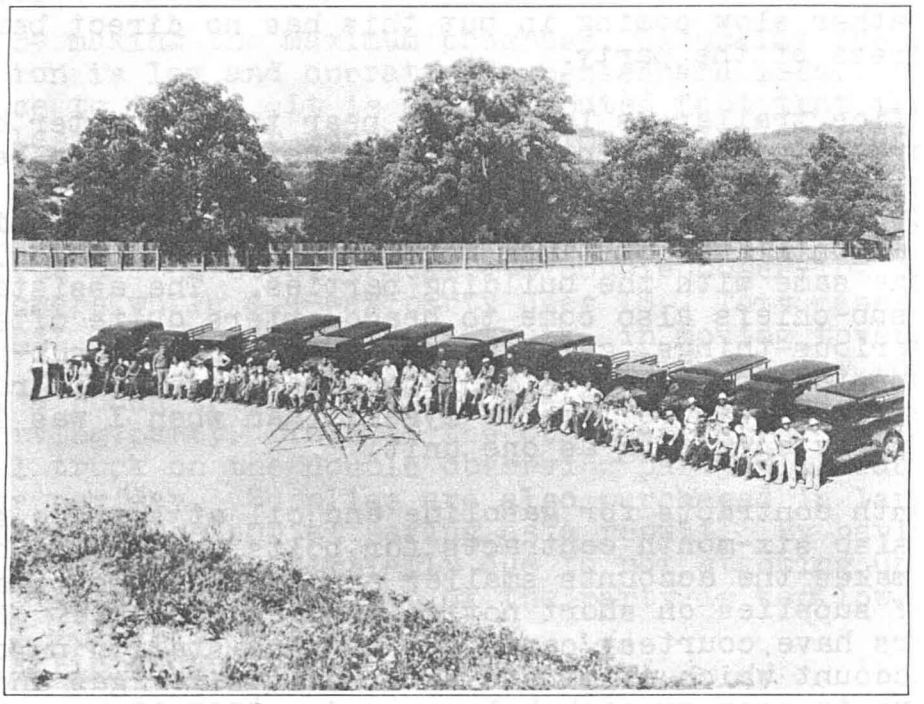


LEVELING PARTY UNITS

W. M. Gibson

As far as I am aware, the organization and equipment of a leveling party unit has never been the subject of very much discussion. In 1931 this party consisted of an observing unit with one truck, and a bench mark unit with another truck. Later, an extra observing unit with a third truck was added. Bench marks for this double observing unit were set by a bench mark unit of two men with the third truck. At that time, most of the leveling was of first-order accuracy.

The plan of one bench mark unit for two leveling units seems to be pretty well fixed. Some improved methods were necessary to allow one bench mark unit to set bench marks for two leveling units engaged on second-order leveling. The addition of a third man was made to the bench mark unit, and precast posts were used instead of posts cast in place.

It is thought that this ratio is about the best that can be expected. At maximum strength, on this party, there were eight 6-man leveling units and four 3-man bench mark units in operation. If one of the leveling units had any extensive first-order leveling to do, an effort was made to reduce the size of the leveling party by one man, and divert some of the bench mark setters to recovery operations.

However, the point most open to discussion in my opinion, is the organization and equipment of the leveling units. The

old double parties were much less efficient than two single parties. When the double parties were in operation, the chief of party was observer on one unit. At times it seemed that the double party made a combined progress as great as two single parties, but it is believed that a chief of party cannot find time to exercise enough supervision under this arrangement to insure the best results. Of course, the chief of party was also burdened with accounts.

With this in mind, some hesitation was felt in assigning a double unit to an observer. It was thought that the ordinary observer does not stand out enough to efficiently manage two units and do the observing on one of them. However, the addition of the sixth man to each second-order unit may have changed this.

The following plan is advanced for comment:

Double Leveling Unit - 12 men - 1 truck.

Surveyor, in charge

1. Plans work for two units each day.
2. Pays or verifies all bills.
3. Closely supervises all data.
4. Supervises field work of each unit.
5. Observes in case of emergency.
6. Supervises care and upkeep of equipment.

This differs considerably from the old double observing unit, which was as follows:

Double Observing Unit - 12 men - 3 trucks.

Chief of party, in charge

1 to 4, and 6 above.
7. Observed on one party.
8. Submitted accounts.
9. Supervised bench mark unit.

In the above suggestion for the double unit, considerable saving would be effected in the elimination of one truck. However, there would be days when the work of both units would be broken up by ending of a line or some other mix-up. The present trucks are equipped with small bodies that would hardly accomodate 11 or 12 men with their instrumental equipment. It is thought that in the future purchases of trucks for level parties a much larger truck could be specified. The jitney seats in the bodies take up too much room and are of little value. Regardless of whether or not trucks are ever purchased for use of a double observing unit, it is thought a body should always be specified which will at least be as long as the leveling rod boxes. Another disadvantage to the use of one truck for two leveling units

is that no one truck could carry all the men and their camp equipment.

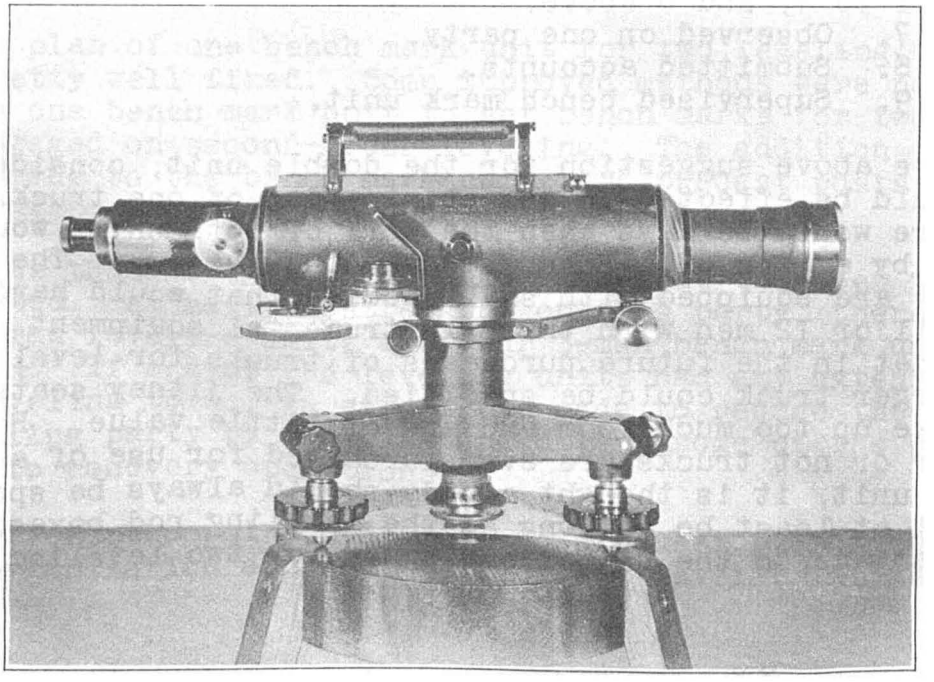
While working on a project, two trips could be made on moving day, but in long trips from one project to another, the bench mark setter's truck would have to carry a large load of camp equipment. It usually works out that the bench mark setters must move several days ahead of the leveling units. The only alternative in this case seems to be to ship the camp equipment by freight or express or discontinue camping.

With the present arrangement, most of the time of the chief of party is taken up with coordination of the work of the twelve independent units, verifying the lines, repairing the equipment, etc., and by grouping the eight observing units into four double units, this coordination could be cut in half, as the Surveyor in charge would necessarily have to coordinate the work of his two units. The number of interparty accounts would be reduced from twelve to eight (perhaps lower if a grouping of the bench mark units were also effected).

This would allow the chief of party more time for field inspection and institution of desirable changes in order to improve the quality of the work. It is thought, however, that more frequent field inspections would be necessary for double units than for single ones.

On the double unit, one recorder would have to observe and one rodman work as recorder.

In view of the fact that such an arrangement would eliminate four trucks from the present equipment of a party of this size, it seems that a lower unit cost might result and this saving more than offset the slight decrease in progress.



BALL BEARINGS AS TURNING POINTS

E. J Helin

On May 6, I wrote you suggesting the idea of using ball bearings as turning points in leveling along concrete highways At that time there was no opportunity of trying it out. Early in June, however, this method was used successfully by level parties under Mr. W. W. Studdert on a concrete highway between Oil City, Penna. and Tionesta, Penna.

The rodmen were equipped with some 3/8 inch steel ball bearings and the standard hammer used in driving staples. A single stroke was sufficient to produce an indentation in the concrete for the ball bearing to set in a secure position. The ball bearing was used as a turning point for the rods, in place of the bulky and awkward foot pins.

The points were conspicuously marked with keel around the indentation to call attention to the location of the point. Any rejection of a turning point because of grade or interval was shown by drawing a cross through the indentation.

Because of constantly changing grades, the rodmen held their points in order that the observer might select the proper interval. However, when constant grades are encountered, the rodmen move ahead in the same manner as along the railroad. In this case the front rodman would need a supply of ball bearings sufficient for the length of the section. The rear rodman would pick up the ball bearing at the end of each set up, and at the completion of each section he will have in his possession all the ball bearings. He can then go forward and repeat the procedure as the front rodman.

It has been found advisable not to strike twice at the same point due to danger of making a hole in which the ball bearing will not have a firm position. Rodmen should blow out what little dust there is in the indentation.

It has been found that the ball bearing makes an excellent turning point, much easier to turn a rod on than a foot pin. As all steel ball bearings of good quality are manufactured to a high standard of precision, they can be replaced or substituted at any point with no loss of accuracy.

The use of ball bearings as turning points on concrete highways has the following advantages:

1. Elimination of carrying and driving foot pins.
2. Elimination of "leapfrogging" on highways, saving time by having the front rodman on his point and ready by the time the instrument is set up. The rodman also are relieved of the necessity of having to run while "leapfrogging".

3. Transpositions can easily be checked in the field without re-running a section.

4. In seven miles of first-order work the closures were much smaller than those ordinarily found in using foot pins. Thus proving that ball bearings have a much larger foundation area in the concrete pavement than is ever found in the 1-1/4 inch cross section area of the foot pin.

I find that in the units of our leveling party both the rodmen and the observers prefer this method as it speeds up the work and better closures are acquired.

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THE RED ROD

(Report by W. W. Studdert)

In an effort to eliminate transpositions in precise levels, the following method was devised. For obvious reasons, this method has been designated as the "Red Rod".

On the back of one rod, in line with the 1/3 meter divisions, a 1/2-inch bright scarlet stripe has been painted the full length of the rod. When the observer reads the back of this rod, he calls out "RED", in addition to the back of rod reading. The recorder enters this "RED" reading as "R", just above the 1/3 meter reading in the back of rod column. The other rod is read and entered in the usual manner, as no color is to be found.

When the rodmen drift, as along railroads, the "R" entries will all be in one column, showing that the "Red Rod" was either in front throughout this section or in the rear, as the case may be. When the rodmen leapfrog or hold their points as along highways, the "R" entries will be alternating in each of the back of rod columns. Thus, when the recorder is taking the readings, he can tell at once by noting the comsistency of the "Red Rod" entries, if a transposition has been made and catch the mistake before the instrument is moved to the next setup.

Should a transposition be made and go undetected by a new recorder, it can be found by the observer at the end of the section by merely glancing at the consistency of the "R" entries. Observers on this party have learned the wisdom of being "R" conscious, being sure to note any inconsistencies in the "R" entries while checking all of the arithmetical work of the recorders at the end of the day's work.

The advantages of the "Red Rod" are numerous. It not only gives identity to that rod but to the other rod also, as the plain rod could easily be called the "White Rod". Besides identifying the rods, it also identifies the point where each rod

is held. As the rodmen use the same rods daily, it also calls attention to which rodman held each point.

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Editor's Note: Upon receipt of the above report on the "Red Rod" the following circular (abstracted) was issued to all leveling parties:

. . . . . .

"The method outlined in Mr. Studdert's report appears to be capable of application to the leveling work of this Bureau without any increase of cost and bids fair to very materially reduce the amount of rerunning necessary to detect blunders resulting from transposed sights.

"Upon receipt of this letter and the mimeographed copies of the report, you will at once instruct your observing units to follow the method outlined in the report when doing single-line leveling. Whether this method is to be used on double run lines or not will be left to the judgment of the chief of party.

"After this method has been used for a month or six weeks, I would appreciate it if you would forward to this Office your comments concerning the method and any suggestions concerning changes or modifications which you deem it advisable to make."

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COMMENTS ON NATIONAL PLANNING

C. J. Tilden

(Reprinted from Civil Engineering for July 1935.)

To the Editor: The article by Mr. McDonald in the March issue, is an effective summary of the needs for a national mapping program. He points out the vital importance of the basic triangulation and precise level work of the U. S. Coast and Geodetic Survey. The extension of this work in the various states was one of the first steps taken by Congress, in November 1933, to relieve the unemployment situation among professional engineers.

The Federal Emergency Relief Administration asked the U. S. Coast and Geodetic Survey to undertake this work as part of the drive for economic recovery. It was stated that the two principal objectives were to give immediate employment to the largest possible number of engineers and others, and to have the employment result in high-grade work of permanent value. A quota was established for each state, and field parties, labor gangs, and

clerical and computing staffs were rapidly organized. Many competent engineers, who had been out of work for some time, eagerly accepted such positions of responsibility as supervisors or chiefs of party, at rates of pay far below those to which they had been accustomed in better times. The Survey directed the work through a representative in each state.

In the middle of February 1934, all the work was shifted to the Civil Works Administration, a short-lived agency, which was followed by the various state emergency relief administrations. These receive federal funds directly from Washington and disburse them within the state according to relief needs. In some states certain groups were found to be in greater need of relief than were the surveyors, so the triangulation work was stopped.

Connecticut has had the sympathetic cooperation of the State Emergency Relief Administration. In this state the fundamental character of the state-wide local control surveys, based on the work of the U. S. Coast and Geodetic Survey as first set up, has been recognized as of prime public value. Unemployed engineers in many widely separated localities were set to work. Advice and assistance have been given to local town surveys, which have been started with relief funds. This assistance included instruction in approved methods, the calibration of tapes and instruments, and similar services.

Mr. McDonald makes the interesting suggestion that, with the increase in mapping activity which he favors, a related change be made in curricula of engineering schools. He advocates more instruction in triangulation, precise leveling, astronomy, and geodesy. This at once raises the question, what can be left out of the already crowded four-year course to give time for such instruction? Our engineering students are given sound training in the fundamental theory of surveying operations, supplemented by summer field work which, while elementary, is basic and highly instructive. This familiarizes students with the ordinary instruments of surveying, their uses, and the way in which the results obtained in the field are used in the preparation of maps. It is doubtful if it would be wise to carry formal technical instruction much beyond this point, at least for undergraduate students. To build a bridge or complete a primary survey an organization of specially trained men is needed, and this training can be obtained only through apprenticeship on actual work. Instruction given in school, including the few weeks of summer field work, puts the student in a position to absorb quickly and efficiently the details of field practice. It is only through months of such field work, supplemented by further reading and study and office experience, that one may reach the rank and dignity of a geodetic engineer.

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MAPPING THE COUNTRY

(The following article written by Mr. Waldemar Kaempffert, Science Editor of the New York Times, appeared in that paper under date of July 7, 1935.)

Without accurate topographic maps it is impossible to extend highways, prevent floods, lay oil, water and gas pipes in lines that are straight for hundreds of miles, run a telegraph, telephone or electric power line with equal accuracy, dig irrigation and drainage ditches that cover a whole country in accordance with a carefully developed geometric pattern. And accurate topographic maps are possible only with accurate triangulation and leveling. The surveyors of the United States Coast and Geodetic Survey are therefore doing work that is indispensable to every engineer who builds a bridge, digs a canal or plans a railway.

Five years ago the Survey spent only $150,000 a year on such work. Then came the depression. It seemed as if triangulation and leveling must stop, and this although a complete, detailed map of the United States was not in existence. With the chance of employing thousands of technically trained men in surveying there came first an appropriation of $400,000 in 1930, then one of $500,000 in 1932 (under the Wagner bill) and this year one of $2,500,000, later increased to $3,500,000.

Probably no money ever spent by the government has done more good. Engineers and college men were given not only a chance to earn a living but intensive training in a branch of science of which they had but a smattering. Nearly all of the seventy-six leveling and fifty-one triangulation parties now in the field are composed of men who, while they had a good basic training, scarcely knew of the Coast and Geodetic Survey.

The government has been accused of wasting the public funds in its effort to create employment. But there has been no waste here. According to the Engineering-News Record the unit costs for the years 1933 and 1934 are 12 per cent less than in 1931 and 1932. Moreover there has been no lowering in the standards of accuracy - standards which are as high as any in the world.

The funds that the Survey has received from the PWA were exhausted on June 30. Luckily the work can go on because last week Secretary Ickes pledged $350,000 to the Coast and Geodetic Survey. But only July is provided for. It has been no easy task to recruit 1,500 men to work on geodetic surveying. An organization that is doing necessary work is threatened with disruption if adequate funds are not provided for the future.

GEODETIC CONTROL AND PRIVATE BOUNDARY SURVEYS

Hugh C. Mitchell

Considerable interest has been evinced in the May number of the Geodetic Letter which contained a symposium on the use of geodetic control for private boundary surveys. An edition of about three times the size of the normal edition of this journal is already practically exhausted.

A specific item commented upon by several of our correspondents to which we would like to call attention at the present time is the proposed act permitting surveyors to enter upon private property for survey purposes. Surprising as it may seem at first, these comments, written from a background of experience, suggest that some attention be given to the surveyor's need to occupy public space - streets, roads, etc., - in making such surveys. One correspondent, writing from Boston, says:

"Why not include the right to work in public streets? At present, I understand that a surveyor has no legal right to occupy space in a public way while making a survey although usually in city work, and frequently in country work, it is the only way that a proper survey can be made. Automobiles have made this matter very important. I believe that there is no Supreme Court decision." - (Letter from William S. Crocker, Civil Engineer.)

The following comes from Chicago:

"As to the suggested act to give the right to any qualified or licensed surveyor in the practice of his profession to enter private property for the purpose of finding monuments subject to the paying of any damages he may cause, I think this would be a wonderful law but I see no reason why it should be confined to the finding of the monuments placed by the U. S. Coast and Geodetic Survey." - (Letter from W. D. Jones, Land Surveyor and Civil Engineer.)

In a letter in the May, 1924, number of the Bulletin of the Illinois Society of Engineers, Mr. Jones tells of one incident when such a law might have been very helpful, for without it a day's work was lost, his survey party was put under arrest, and a jury trial resulted from the cutting into a road to occupy a section corner mark which lay beneath it - a necessary operation in the survey he was making.

Our attention has been called to a law enacted in the State of New Jersey in 1887. One section of this law permits entry onto land adjacent to that which is under survey for such purely public purposes as street and road work, and for quasi-public purposes such as the drainage of swamps and meadows. A second section of the same law permits entry onto private property for the running of doubtful or disputed lines and the searching for monuments, but this authority is granted only after a

court action has been commenced, and then only on an order from the court. Is it not possible that free access to survey monuments and the right to enter upon adjacent lands in the beginning might make unnecessary a court action with all its unhappy incidents, and costs often wholly out of proportion to the interests involved?

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Considerable reaction and comment was to be expected from surveyors in the Public Land States where the laying out of lands into sections and townships has made possible the simplest type of property description. The description of a parcel of land under the public land survey system makes unnecessary a description of the actual boundaries thereof. No one questions the extreme simplicity and clarity of such a description, nor has it ever entered our thoughts that this method of description should be abandoned. But is it any more than a method of relative description, an excellent index system? Had the original surveys of the public lands been made with a satisfactory degree of accuracy, then the descriptions would have had as a base a very fine coordinate system. That this is not the case is easily seen from conditions in the northern parts of Illinois and Indiana, where township lines on opposite sides of the State line are of the order of two miles apart. And when one considers that these township lines were set from the same base line, some 200 miles distant, one realizes the surveyor must be called upon to reestablish a lost corner and is dependent upon either recovering old survey marks nearby or in being able to retrace the footsteps of the original surveyor, using the evidences of witnesses, occupation, and the like; and that if he has to go back far in the surveys and rely upon the system as one of coordinates, he is going to have a difficult time getting anywhere near the original corner. If he has to go back to the base line he will have to reproduce a survey the original accuracy of which may not have been better than 1 part in 100. If his corner is tied into the first-order control net of the country and he has to go back the same distance before he picks up a base, he at least has the comfort of knowing that the survey he has to reproduce had an accuracy of better than 1 part in 25,000.

But there is no more chance of it being necessary for the public land surveyor having to go back to the base line for a starting point, than for a surveyor in Texas to have to make the historical research involved in determining the size of cigarro and speed of horse involved in old deeds which I am told are on file in San Antonio, giving a man as much land as he could ride around while smoking so many cigarros. The early surveyors left too many footprints for this, but in identifying these, the present-day surveyor has had to develop a technique that might be described as little short of marvelous. He must be a man of high technical skill, a student of natural history, be possessed of a great amount of patience, considerable legal skill, and a sixth sense of survey location which would make Holmes exclaim in

wonder, "Let's go back to Baker Street, Watson, this is too much for me".

After the cadastral engineer has shown conclusively just where the old corner stood, and there of course, is where the true corner belongs, what then? Will a monument forever after hold the point free from disturbance, or should the simple form of insurance provided by a connection with the national control survey be used so that ever after the replacement of this corner will be a simple undertaking in which the fine art of the cadastral surveyor is replaced by the exact science of the geodetic engineer, and time is conserved and money and effort saved?

But if this is done should not the work of the geodetic engineer be given legal recognition by some form of legislative enactment so that his coordinates will be accepted in a court as complete and sufficient evidence as to the location of a corner? Engineers may be fully satisfied that the corner once determined by cadastral methods and while still existent, tied into the triangulation net of the country, can always be replaced by geodetic methods, but acceptance of this evidence should be general and approval should begin with those bodies of highly trained men to whom we must look for the enactment of our laws.

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SUGGESTIONS FROM THE FIELD

Mr. W. G. Hodder, recorder on the party of W. W. Studdert, engaged on first and second-order leveling, writes to Mr. Studdert as follows:

"I would like to suggest a different color arrangement for our umbrellas. During the hunting season many of the leveling units will be working in the wooded sections where careless and nervous hunters are apt to mistake part of our olive drab umbrella for some wild animal. It seems there are enough accidents in hunting country even when some precautions are taken with bright colors. I believe an umbrella made up of black and grey, the Coast and Geodetic colors, or some other combination fanning or radiating out alternately from the center would be a great help in the safety of our field men."

Undoubtedly there is some danger in working through wooded roads and trails with sunshades of olive drab, tan or brown. It would seem advisable during the hunting season, to use some other color that could not readily be mistaken for a wild animal by an excitable hunter.

It would seem that a solid color would be satisfactory such as green or blue. If such a color should be satisfactory, perhaps the umbrellas that are now at the Washington office for

issue to the field could be dyed. Future orders from umbrella factories could specify the new color desired.

It is hardly probably that any of the umbrellas now in use in the field would last until the hunting season which in most states does not open until sometime in September.

The readers of Geodetic Letter are requested to write the editor and give him the benefit of their suggestions on this matter.

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AN APPRECIATION OF COAST AND GEODETIC SURVEY WORK

The following letters received from Mr. W. D. Tyler, Vice President of the Clinchfield Coal Corporation, Dante, Va., show an appreciation of the work of the Coast and Geodetic Survey and the uses to which it can be put in the location of property boundaries, outcrop lines, etc.:

"I have just received from the office of the Coast and Geodetic Survey the Geodetic Letter #5 of Volume 2 for the month of May, 1935 and because it contains a letter from Mr. Fred E. Ruediger, Engineer of the Virginia Commission of Fisheries, I have been particularly interested in it.

"It so happens that for some ten years or more I have served with Mr. Ruediger as a member of the Virginia State Board for the Examination and Certification of Professional Engineers, Architects and Land Surveyors. His article on the acceptance of geodetic control in the surveys of oyster planting grounds in Virginia is interesting in the extreme and is just what could be expected from an engineer of Mr. Ruediger's ability and exactness. I have frequently discussed some of the problems that he refers to in this article with him.

"There is in the extreme southwestern corner of Virginia, a condition that, while it is not similar to the oyster bed situtation of the State, is in some senses, unique.

"The writer took charge of the real estate of what is now the Clinchfield Coal Corporation on the first day of February, 1906, and one of the first undertakings to be seriously considered was the making of a triangulation survey of their property comprising some 300,000 acres of fee simple and mineral ownership located in the Counties of Buchanan, Dickenson, Russell and Wise. Early in the program it was decided that it would be wise to secure as consulting engineer in connection with this work, the late Colonel R. A. Marr, formerly connected with your survey and later Professor of Civil Engineering at Virginia Military Institute, and still later at Virginia Polytechnic Institute where he was serving in 1906.

"Colonel Marr arranged with your Coast and Geodetic Survey for a loan of theodolites with which to do the instrumental work. This, upon condition that the results of the survey should be given to your office.

"In making search for a proper base off of which to start the survey it was finally decided to take a line between the Clinch Station and the Big Knob Station, Clinch Station being located just northeast of Little Moccasin Gap on Clinch Mountain and on the boundary line between Russell and Washington Counties, while Big Knob Station is located about twenty-six miles further to the southwest and in Scott County near Big Moccasin Gap and a short distance from Gate City. This base line was the extreme existing line of the oblique eastern arc of the Coast and Geodetic Survey. Beginning in 1906 and continuing through the next two or three years this survey was prosecuted, the primary points in addition to those on the base line were on Big A Mountain, on the Cumberland Mountain on the Virginia-Kentucky line, on High Knob near Norton and the east butte of State Line Spur near the headwaters of Powell's and Guests River and including a central point on a spur off of Sandy Ridge at Dante. The area included was about nine hundred square miles.

"This survey with its secondary and tertiary points was concluded after some interruption in a period of about three years and during two years of this time Colonel Marr was on the ground during vacation periods as consulting engineer.

"Upon the completion of the field work the usual computations were made and these were submitted to Mr. O. H. Tittman, then in charge of the United States Coast and Geodetic Survey and by him referred to Mr. John F. Hayford, in charge of the Computing Department, who had the computations checked and reported them to be satisfactory. Copies of these results were then furnished to both the United States Coast and Geodetic Survey and the United States Geological Survey.

"Some years later the Geological Survey, using Clinchfield Coal Corporation work as a base, further extended the investigations and mapping of the coal counties of southwestern Virginia and for the counties named above and geological and contour maps of a large part of the area covered by Clinchfield Coal Corporation surveys were then prepared.

"During the time that our triangulation survey was in progress a complete resurvey of Clinchfield Coal Corporation's properties was undertaken including the real estate boundaries, stream lines, the outcroppings of the several coal seams, location of roads, and on lands owned by the Corporation in fee simple, the boundaries of the clearings and the location of the buildings thereon.

"The property of the Corporation is roughly rectangular in shape, about twenty-five miles long and twenty-three miles wide. The area to be mapped was, therefore, so great that it was felt that it would be necessary to use the polyconic method of projection and maps were laid out covering the entire area using this system. All field work of whatever nature was tied into primary triangulation points where possible and finally to secondary and tertiary points; even the outcrop lines being tied into triangulation base with ties nowhere more than two and one-half miles in length. This tying up of the outcrop lines proved to be of great advantage for the reason that in order to determine the coal value of the property on the subsequent mapping, we were compelled to plot the outcrop lines even ahead of the real estate boundaries and because of our system of ties to triangulation, this proved to be easily done. Subsequently, practically all of our lands in Russell County as well as in Wise County and a large percentage of the lands in Dickenson County have been completely resurveyed and mapped.

"In preparing for the mapping of real estate boundaries we worked out what we called "triangulation-land line traverses" embracing areas from one to two thousand acres in extent and worked out spherical coordinates for all the points on these traverses. These circuits were then laid down on our permanent maps. When an area had been so plotted, we then prepared separate plots of the several land tracts lying within the circuit computed and put these down, using the lines of the triangulation-land line traverses to control their location. As a result we have a very accurate set of maps of the territory.

"One outcome of this work has been that in the purchase and sale of properties acquired or disposed of by our Corporation since the surveys were begun, we have referred our descriptions to the astronomical meridian and the deeds of conveyances whether to or from the Corporation, carry a statement of this fact in connection with the descriptive matter. The timber corners of the thousands of tracts owned have, of course, been gradually disappearing and to care for this situation and preserve accurately the location of the boundaries, many of their corners have been marked by a concrete monument and for this purpose we have taken a four inch tile sewer pipe set bell down in the ground bedded in concrete and filled with concrete. The top of the monument is flush or just below the ground. This makes a monument that is permanent even though the terra cotta pipe should deteriorate. We first centered these monuments with copper centers, but later we discovered that there was so often occasion to mend a still with copper that there was a disposition on the part of the citizens of the country to break up the top of the monument and take the copper center out. As a consequence, we abandoned the use of copper for centers and used instead a six penny wire nail set with the head down so that only the point was exposed. Within a period of a few years this nail rusts out and leaves simply a hole in the concrete which is, of course, an accurate mark.

"The monuments so set are tied in either directly or indirectly to triangulation base so that at any time in the future it will be relatively easy to replace them even though they might be completely destroyed.

"Another feature of our work has been that in the neighborhood of our operating mines we have broken down a tertiary triangulation and have set permanent monuments near the mine mouths for the use of our mining engineers to enable them to have at all time an accurate azimuth and location checks for their underground work. A recent check of real estate boundaries from such a base as this, extending for a distance of three miles or more from the mine mouth station resulted in a naught naught azimuth check in a land line at that distance.

"One of the results of this whole system of work is that there are now being recorded in the counties where our properties lie, deeds whose descriptions are based on astronomical azimuth and a foundation is thus being laid for much better control for the future.

"The difficulties mentioned by Mr. Ruediger in his paper are multiplied many times in the mountainous country of the southwest by the inaccuracies of incompetent surveyors who have been responsible for the descriptions contained in most of the deeds of record going back even to the latter portion of the eighteenth century.

"I have written what precedes because I thought that possibly you might be interested to know that in more than one corner of Virginia methods have been adopted which will in the future lessen controversies as to the correct locations of lands of quite as much value as Virginia's oyster beds."

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After the above letter from Mr. Tyler was acknowledged, he wrote as follows:

"Possibly I should have added in my original letter to you that Clinchfield Coal Corporation has furnished to the Virginia Coal and Iron Company of Big Stone Gap, Virginia, the Virginia Iron, Coal and Coke Company of Roanoke, Virginia and Toms Creek, Virginia, the Consolidation Coal Company of Jenkins, Kentucky, and I believe also to the New River Pocahontas Coal and Coke Company (Berwind White interests) sufficient of our basic triangulation data to enable each of these large land-owning corporations to establish astronomical control of their real estate surveys. This additional information I am sure will be of interest to you."

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SHADOWS

(Observer on the party of Ensign A. L. Wardwell, leveling across one of the dry alkali lakes in the desert of Nevada.)

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--- AND SUDDEN DEATH

J. C. Furnas

(Reprinted from the Reader's Digest by special permission of the Publishers.)

Publicizing the total of motoring injuries - almost a million last year, with 36,000 deaths - never gets to first base in jarring the motorist into a realization of the appalling risks of motoring. He does not translate dry statistics into a reality of blood and agony.

Figures exclude the pain and horror of savage mutilation - which means they leave out the point. They need to be brought closer home. A passing look at a bad smash or the news that a fellow you had lunch with last week is in a hospital with a broken back will make any driver but a born fool slow down at least temporarily. But what is needed is a vivid and sustained realization that every time you step on the throttle, death gets in beside you, hopefully waiting for his chance. That single horrible accident you may have witnessed is no isolated horror. That sort of thing happens every hour of the day, everywhere in the United States. If you really felt that, perhaps the stickful of type in Monday's paper recording that a total of 29 local citizens were killed in week-end crashes would rate something more than a perfunctory tut-tut as you

turn back to the sports page.

An enterprising judge now and again sentences reckless drivers to tour the accident end of a city morgue. But even a mangled body on a slab, waxily portraying the consequences of bad motoring judgment, isn't a patch on the scene of the accident itself. No artist working on a safety poster would dare depict that in full detail.

That picture would have to include motion-picture and sound effects, too - the flopping, pointless efforts of the injured to stand up; the queer, grunting noises; the steady, panting groaning of a human being with pain creeping up on him as the shock wears off. It should portray the slack expression on the face of a man, drugged with shock, staring at the Z-twist in his broken leg, the insane crumpled effect of a child's body after its bones are crushed inward, a realistic portrait of an hysterical woman with her screaming mouth opening a hole in the bloody drip that fills her eyes and runs off her chin. Minor details would include the raw ends of bones protruding through flesh in compound fractures, and the dark red, oozing surfaces where clothes and skin were flayed off at once.

Those are all standard, everyday sequels to the modern passion for going places in a hurry and taking a chance or two by the way. If ghosts could be put to a useful purpose, every bad stretch of road in the United States would greet the oncoming motorist with groans and screams and the educational spectacle of ten or a dozen corpses, all sizes, sexes and ages, lying horribly still on the bloody grass.

Last year a state trooper of my acquaintance stopped a big red Hispano for speeding. Papa was obviously a responsible person, obviously set for a pleasant week-end with his family - so the officer cut into papa's well-bred expostulations: "I'll let you off this time, but if you keep on this way, you won't last long. Get going - but take it easier." Later a passing motorist hailed the trooper and asked if the red Hispano had got a ticket. "No," said the trooper, "I hated to spoil their party." "Too bad you didn't," said the motorist, "I saw you stop them - and then I passed that car again 50 miles up the line. It still makes me feel sick at my stomach. The car was all folded up like an accordion - the color was about all there was left. They were all dead but one of the kids - and he wasn't going to live to the hospital."

Maybe it will make you sick at your stomach, too. But unless you're a heavy-footed incurable, a good look at the picture the artist wouldn't dare paint, a first-hand acquaintance with the results of mixing gasoline with speed and bad judgment, ought to be well worth your while. I can't help it if the facts are revolting. If you have the nerve to drive fast and take the chances, you ought to have the nerve to take the appropriate cure. You can't ride an ambulance or watch the doctor working on the victim in the hospital, but you can read.

The automobile is treacherous, just as a cat is. It is tragically difficult to realize that it can become the deadliest missile. As enthusiasts tell you, it makes 65 feel like nothing at all. But 65 an hour is 100 feet a second, a speed which puts a viciously unjustified responsibility on brakes and human reflexes, and can instantly turn this docile luxury into a mad bull elephant.

Collison, turnover or sideswipe, each type of accident produces either a shattering dead stop or a crashing change of direction - and, since the occupant - meaning you - continues in the old direction at the original speed, every surface and angle of the car's interior immediately becomes a battering, tearing projectile, aimed squarely at you - inescapable. There is no bracing yourself against these imperative laws of momentum.

It's like going over Niagara Falls in a steel barrel full of railroad spikes. The best thing that can happen to you - and one of the rarer things - is to be thrown out as the doors spring open, so you have only the ground to reckon with. True, you strike with as much force as if you had been thrown from the Twentieth Century at top speed. But at least you are spared the lethal array of gleaming metal knobs and edges and glass inside the car.

Anything can happen in that split second of crash, even those lucky escapes you hear about. People have dived through windshields and come out with only superficial scratches. They have run cars together head on, reducing both to twisted junk, and been found unhurt and arguing bitterly two minutes afterward. But death was there just the same - he was only exercising his privilege of being erratic. This spring a wrecking crew pried the door off a car which had been overturned down an embankment and out stepped the driver with only a scratch on his cheek. But his mother was still inside, a splinter of wood from the top driven four inches into her brain as a result of son's taking a greasy curve a little too fast. No blood - no horribly twisted bone - just a gray-haired corpse still clutching her pocketbook in her lap as she had clutched it when she felt the car leave the road.

On the same curve a month later, a light touring car crashed a tree. In the middle of the front seat they found a nine-months-old baby surrounded by broken glass and yet absolutely unhurt. A fine practical joke on death - but spoiled by the baby's parents, still sitting on each side of him, instantly killed by shattering their skulls on the dashboard.

If you customarily pass without clear vision a long way ahead, make sure that every member of the party carries identification papers - it's difficult to identify a body with its whole face bashed in or torn off. The driver is death's favorite target. If the steering wheel holds together it ruptures his liver or spleen so he bleeds to death internally. Or, if the steering wheel breaks off, the matter is settled instantly by the steering column's plunging through his abdomen.

By no means do all head-on collisions occur on curves. The modern death-trap is likely to be a straight stretch with three lanes of traffic - like the notorious Astor Flats on the Albany Post Road where there have been as many as 27 fatalities in one summer month. This sudden vision of broad, straight road tempts many an ordinarily sensible driver into passing the man ahead. Simultaneously a driver coming the other way swings out at high speed. At the last moment each tries to get into line again, but the gaps are closed. As the cars in line are forced into the ditch to capsize or crash fences, the passers meet, almost head on, in a swirling, grinding smash that sends them caroming obliquely into the others.

A trooper described such an accident - five cars in one mess, seven killed on the spot, two dead on the way to the hospital, two more dead in the long run. He remembered it far more vividly than he wanted to - the quick way the doctor turned away from a dead man to check up on a woman with a broken back; the three bodies out of one car so soaked with oil from the crankcase that they looked like wet brown cigars and not human at all; a man, walking around and babbling to himself, oblivious of the dead and dying, even oblivious of the dagger-like sliver of steel that stuck out of his streaming wrist; a pretty girl with her forehead laid open, trying hopelessly to crawl out of a ditch in spite of her smashed hip. A first-class massacre of that sort is only a question of scale and numbers - seven corpses are no deader than one. Each shattered man, woman or child who went to make up the 36,000 corpses chalked up last year had to die a personal death.

A car careening and rolling down a bank, battering and smashing its occupants every inch of the way, can wrap itself so thoroughly around a tree that front and rear bumpers interlock, requiring an acteylene torch to cut them apart. In a recent case of that sort they found the old lady, who had been sitting in back, lying across the lap of her daughter, who was in front, each soaked in her own and the other's blood indistinguishably, each so shattered and broken that there was no point whatever in an autopsy to determine whether it was broken neck or ruptured heart that caused death.

Overturning cars specialize in certain injuries. Cracked pelvis, for instance, guaranteeing agonizing months in bed, motionless, perhaps crippled for life - broken spine resulting from sheer sidewise twist - the minor details of smashed knees and splintered shoulder blades caused by crashing into the side of the car as she goes over with the swirl of an insane roller coaster - and the lethal consequences of broken ribs, which puncture hearts and lungs with their raw ends. The consequent internal hemorrhage is no less dangerous because it is the pleural instead of the abdominal cavity that is filling with blood.

Flying glass - safety glass is by no means universal yet - contributes much more than its share to the spectacular side of accidents. It doesn't merely cut - the fragments are driven in as if a cannon loaded with broken bottles had been fired in your face, and a sliver

in the eye, traveling with such force, means certain blindness. A leg or arm stuck through the windshield will cut clean to the bone through vein, artery and muscle like a piece of beef under the butcher's knife, and it takes little time to lose a fatal amount of blood under such circumstances. Even safety glass may not be wholly safe when the car crashes something at high speed. You hear picturesque tales of how a flying human body will make a neat hole in the stuff with its head - the shoulders stick - the glass holds - and the raw, keen edges of the hole decapitates the body as neatly as a guillotine.

Or, to continue with the decapitation motif, going off the road into a post-and-rail fence can put you beyond worrying about other injuries immediately when a rail comes through the windshield and tears off your head with its splintery end - not as neat a job but thoroughly efficient. Bodies are often found with their shoes off and their feet all broken out of shape. The shoes are back on the floor of the car, empty and with their laces still neatly tied. That is the kind of impact produced by modern speeds.

But all that is routine in every American community. To be remembered individually by doctors and policemen, you have to do something as grotesque as the lady who burst the windshield with her head, splashing splinters all over the other occupants of the car, and then, as the car rolled over, rolled with it down the edge of the windshield frame and cut her throat from ear to ear. Or park on the pavement too near a curve at night and stand in front of the tail light as you take off the spare tire - which will immortalize you in somebody's memory as the fellow who was mashed three feet broad and two inches thick by the impact of a heavy duty truck against the rear of his own car. Or be as original as the pair of youths who were thrown out of an open roadster this spring - thrown clear - but each broke a windshield post with his head in passing and the whole top of each skull, down to the eyebrows, was missing. Or snap off a nine-inch tree and get yourself impaled by a ragged branch.

None of all that is scare-fiction; it is just the horrible raw material of the year's statistics as seen in the ordinary course of duty by policemen and doctors, picked at random. The surprising thing is that there is so little dissimilarity in the stories they tell.

It's hard to find a surviving accident victim who can bear to talk. After you come to, the gnawing, searing pain throughout your body is accounted for by learning that you have both collarbones smashed, both shoulder blades splintered, your right arm broken in three places and three ribs cracked, with every chance of bad internal ruptures. But the pain can't distract you, as the shock begins to wear off, from realizing that you are probably on your way out. You can't forget that, not even when they shift you from the ground to the stretcher and your broken ribs bite into your lungs and the sharp ends of your collarbones slide over to stab deep into each side of your screaming throat. When you've stopped screaming, it all comes back - you're dying and you hate yourself for it. That isn't fiction either. It's what it actually feels like to be one of that 36,000.

And every time you pass on a blind curve, every time you hit it up on a slippery road, every time you step on it harder than your reflexes will safely take, every time you drive with your reactions slowed down by a drink or two, every time you follow the man ahead too closely, you're gambling a few seconds against this kind of blood and agony and sudden death.

Take a look at yourself as the man in the white jacket shakes his head over you, tells the boys with the stretcher not to bother and turns away to somebody else who isn't quite dead yet. And then take it easy.

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FAILURE OF STEEL TOWERS

In South Dakota recently, four towers were blown over and demolished during a sudden wind twister. Four men were injured and two theodolites smashed.

The following circular was issued by this Office and sent to all triangulation parties, in the hope that similar accidents might be prevented:-

"During the last two years quite a number of our steel towers have blown over as a direct result of anchors pulling out of the ground. Aside from the property loss involved, amounting in each case to approximately $400 for each tower and $2,000 for each of three first-order direction theodolites which were destroyed when the towers went down there has been injury to personnel and it is fortunate that no deaths have so far resulted. It is only under the most fortunate of circumstances, as otherwise some of the injuries certainly would have been fatal.

"Apparently the weakness in anchoring the towers is due to two reasons: (1) Less work is involved to the building party where anchors are not set at a sufficient depth or where the earth over them is not carefully tamped. (2) Less work is involved also to the tearing down party where the anchors are not deep or well tamped. It would appear, in this connection, that the foremen of the building parties have lost sight of the danger to lives involved in this very careless method of work, which cannot be further tolerated. This is a condition which must not continue and immediate measures will be taken by all building foremen to see that towers are anchored securely so that, regardless of the sources of failure, the tower itself will collapse before any anchor gives way.

"It is believed that if the parties adhere rigidly to the practice of placing a number of boards across the anchor boards, after the latter are set in place, the anchors will not pull out. The anchor hole should be made larger at the bottom than at the top and the cross boards long enough so that the ends will become embedded in the side walls when the anchors have a tendency to lift.

"After the receipt of this notice, any building foreman in charge of steel tower work where the anchor of a tower gives way before the tower collapses, will be immediately removed from his position as foreman by this Office, unless the report by the investigating officer indicates that the failure of the anchors to hold was due to a cause or causes, other than faulty construction or negligence by the foreman in charge of the building unit."

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SCENE CHANGES ALONG

A LEVELING LINE

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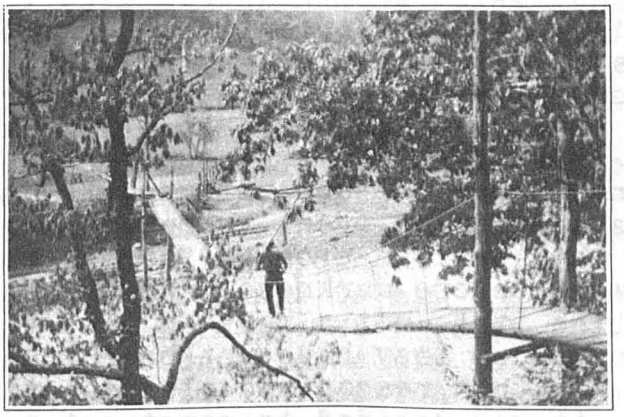

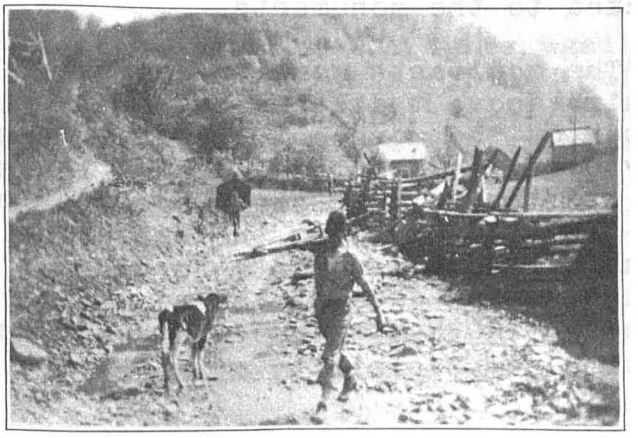

(From report of W.M.Gibson)

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EXCERPTS FROM FIELD REPORTS

(Base line furnished for resurvey of boundary lines of the Cuyamaca State Park.)

"At the time we were working here (Jacumba, California) Mr. John M. Lyle, of the National Park Service was carrying on a resurvey of boundary lines of the Cuyamaca State Park and requested that we furnish him with a base line from which he could control his surveys. Stations Rattlesnake and Mesa were located with second-order accuracy giving him a base line, and azimuth from which his desired ties could be made. He assisted in furnishing men, clearing trail, and furnishing assistant lightkeepers for this work and was greatly pleased that we could offer this cooperation. In his own words our extra night's work saved him at least one month's work and gave him data which he could not hope to get with the equipment he had on hand."

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(Special arrangement for holding lights.)

"The reconnaissance work called for numerous ties to the U. S.-Mexican boundary monuments by intersection and as practically all of these monuments were located on rough terrain, requiring packs up to one hour, and as towers were required over these monuments at the least the height of the monuments, it was apparent that targets would not be satisfactory for observing points. This conclusion was reached from the results of our past experience with targets on first-order triangulation where locating supplementary points. There is a relatively short period from slightly before sun down until darkness when the observing party can observe eight positions on targets and in the event there are several of these objects to locate, it is a serious problem for the observing party to accomplish this work before darkness. Also when these targets are not on the sky line it is not always an easy task to pick them up and in several instances they have not been found from the stations before dark. For this reason and also due to the fact that the lines were long, it was decided to construct a special rig for holding lights mounted directly over monuments, the controlling factor being the design of a light wooden frame that could readily be packed to the monuments.

"The monuments were in general, four sided shafts about eight feet high above the stone bases, terminating in a spired point at the apex of the monument. A frame was built so that it would fit snugly over the sloping sides of the monument, and about a foot above the top, with a small base for holding the lights and a cantilever shelf for holding the batteries. A ladder was built and left at each of these monuments for use of the lightkeeper in setting his lights. At each of the monuments so located by intersection, a regular lightkeeper was assigned and the program worked out very well with no possibility of observers sighting on wrong monuments

or not seeing the monuments in case of confusion of identifying monuments."

..... From Season's Report of Lieut. Charles Pierce.

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NOTES AND NOTICES

A new Special Publication No. 194, "Manual of Traverse Computation on the Lambert Grid", by Dr. Oscar S. Adams and Mr. Charles Claire, has just been issued by the U. S. Coast and Geodetic Survey. Copies may be obtained from the Superintendent of Documents, Washington, D.C. Price, $ .20.

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Mr. Carroll F. Merriam and his associates of the Pennsylvania Water and Power Company, Baltimore, Md., who are doing such excellent cooperative work with the engineers of the Coast and Geodetic Survey, makes the following suggestion in a letter dated April 9, 1935:-

"I think it would be a fine thing if, in approaching a property owner, the Chief of Party could have a bulletin somewhat similar to Serial 529 attractively printed on glazed paper with a few illustrations such as Figures 1, 3, and 5. Such a publication might be useful, first, in establishing the confidence of the landowner that he is really dealing with a duly authorized agent of the government; second, it would give him some idea of what to expect when the building party starts erecting the tower, and third, it would show him the type of marker that is to be placed on his property. A section should be devoted to his rights with respect to removal of a monument which proves an actual detriment, as well as the advantages which may accrue to him in providing a definite reference for his property. It might be explained to him that once his land was referenced to this mark, all landmarks in that vicinity could then be destroyed, and yet his boundaries could be re-established thus giving permanence to his claim. A section might be devoted to the care which your parties are required to exercise in respecting the property of the owner, and it could be made clear that any complaint should be addressed to the Director.

"A section might be devoted to cautioning the owner against wild rumors as to the purposes of this survey, explaining that it is for mapping only, and not in connection with any railroad, roadway, public works, or anything which would enhance the value of his property from this point of view. I find on visiting some of these stations that there is a misunderstanding on the part of the owners in regard to the purpose, and also how to get in touch with the Survey in case these markers prove a detriment to the property. I have in mind a specific case at CHANNEL where the people living at this site said that the question had arisen with the Road Commissioner whether they would have the right to bury the marker under a proposed road.

"Such a booklet as I would suggest, should be comparatively short, but attractive, and written particularly for the rural landowner. I believe its use would pave the way to even more cordial relations between the landowners and the Survey.

"Another thought is that local surveys would not have to uncover the station monument when buried underground provided the two reference points can be seen one from another. It might be well to publish the true bearing for these reference marks as well as their coordinates. In many cases I believe this would be a help to the local surveyor, for although data are given for determining these facts, it would be one step towards assisting him in his work. In any case, the use of the two reference marks would avoid need for uncovering the monument itself."

Following Mr. Merriam's suggestion, there is now being prepared a pamphlet for the use of triangulation and leveling parties which it is hoped will be of use in approaching property owners for permission to establish monuments on their land.

- Δ -

Attention of all field officers is invited to Bureau Circular No. 12, dated August 2, 1932 which required that all truck drivers employed by this Bureau should have permits from some state or from the District of Columbia, except that parties employed in states which do not issue permits or licenses would not be required to obtain permits until they move into some state that did require them. A single license from the District of Columbia or any state issuing permits or licenses is acceptable. Chiefs of party are again instructed, in accordance with that Circular, to require that all operators of motor vehicles of this Bureau obtain permits. Copies of the Circular may be obtained on application to this Office.

- Δ -

The Office is in receipt of information that there is now available on the market a traction device which can be readily installed on any dual-wheel truck.

It is believed that trucks subjected to duty under extremely trying road conditions will be materially aided by the use of this device.

Any chief of party desiring further information regarding this equipment may obtain it through this Office.

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REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during June, 1935:

First-order - - - - - - - - - - - - - - -	1,260
Second-order - - - - - - - - - - - - - - -	170

Completed during July, 1935:

First-order - - - - - - - - - - - - - - -	1,611 (Est.)
Second-order - - - - - - - - - - - - - - -	120

* Total miles of triangulation completed to July 31, 1935:

First-order - - - - - - - - - - - - - - -	60,620
Second-order - - - - - - - - - - - - - - -	5,527

* These figures have been corrected to June 30, 1935, to agree with an accuract scaling of the triangulation completed during the year.

Levels:

Lineal miles of levels completed in June, 1935:

First-order - - - - - - - - - - - - - - -	731
Second-order - - - - - - - - - - - - - - -	6,938

Lineal miles of levels completed in July, 1935:

First-order - - - - - - - - - - - - - - -	434
Second-order - - - - - - - - - - - - - - -	6,994

Total miles of levels completed to July 31,1935:

First-order - - - - - - - - - - - - - - -	106,280
Second-order - - - - - - - - - - - - - - -	154,458

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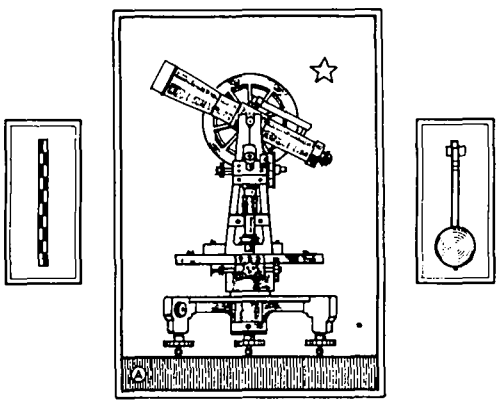
GEODETIC LETTER



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G E O D E T I C L E T T E R

November, 1935

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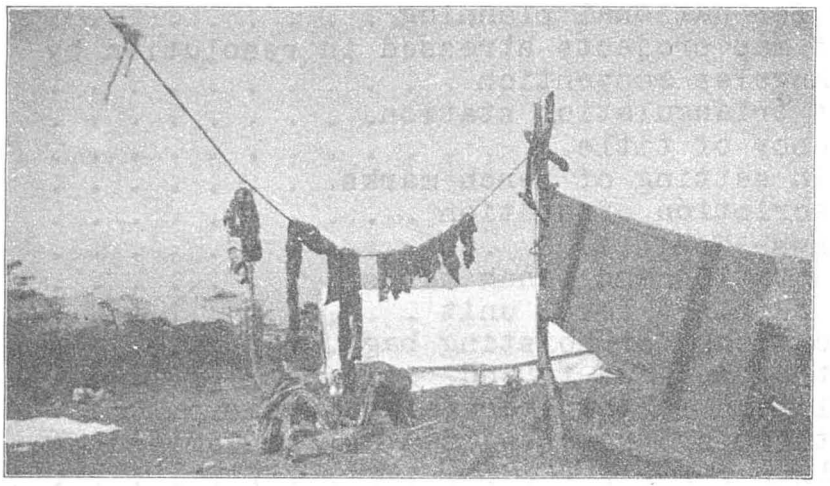
G E O D E T I C L E T T E R

November 1935

VARIETY OF DIET



Strips of fresh mule meat drying in the sun. Owing to a serious shortage of food experienced at one time by J. P. Lushene, observer on the Guatemala-Honduras Boundary assignment, it was necessary to slaughter one of the pack animals.

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SAFEGUARDING SURVEY MARKS IN CALIFORNIA

The State Highway Engineer, State of California, has notified his district engineers that all maintenance crews should be informed of the value of bench marks established by the United States Coast and Geodetic Survey and other federal bureaus, and that steps should be taken to prevent their disturbance. The following is quoted from his instructions:

> "It is desired that the value of these marks be brought to the attention of all maintenance employees, and it is suggested that, where such action seems advisable, a 3 inch by 8 inch marker post be installed near (not closer than 18 inches) each bench mark or other permanent survey

mark set by Government crews in order that their location will be evident to the men handling equipment, and that instructions be given that under no circumstances are such marks to be disturbed."

If this procedure were followed by all state highway engineers, they would render a very valuable service to the engineering profession.

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MAPPING FOR NATIONAL PLANNING

(The two articles which follow are reprinted from "Civil Engineering" for August, 1935.)

In order to emphasize the value of present and proposed mapping activities throughout the country, a pamphlet entitled, "Mapping for National Planning" has recently been issued by the Society. This 58-page publication, based on a program presented before the Surveying and Mapping Division of the Society last January, at which time a paper by Frederick H. McDonald, M. Am. Soc. C.E., was read and discussed, dwells upon the important relations of mapping to other national projects. It presents a forceful argument for the beneficial use of mapping in developing national and community planning, in utilizing natural resources, and in everyday commercial progress. In addition, the helpful effects on employment in engineering and planning work are emphasized.

How important this phase of employment may become will be evident to any engineer who can see the possibilities of putting to work untrained men in minor positions, such as rodmen, recorders, and chainmen. Already the government has had unusual success in this type of work, as reported by William Bowie, M. Am. Soc. C.E., chairman of the Surveying and Mapping Division, which has sponsored this report. In his own department of the Coast Survey Major Bowie has employed, in addition to his regular staff as many as 350 engineers with degrees and over 400 who are graduates in some other field or who have taken college work. In fact, more than half of the 1,560 emergency men employed were engineers or college men. There is also a large group in the U. S. Geological Survey, which has likewise provided a great deal of worth while emergency employment. Because such a large proportion of the work requires the employment of white collar personnel it is apparent that this field presents an unusual opportunity. The pamphlet discusses the possibility of such work and the extent of the planning and mapping that may reasonably be undertaken.

While the pamphlet is intended primarily for the use of governmental officials - federal, state, county, and municipal - it will also make interesting reading for business and professional men. The edition is limited and not for general distribution, but a number of copies have been set aside for the use of those members who may especially desire to study this important topic. Requests for complimentary copies will be filled at Headquarters as long as the supply lasts.

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VALUE OF MAP PROJECTS STRESSED IN RESOLUTION BY LOS ANGELES CONVENTION

Whereas, effective planning for the conservation and development of the nation's resources must be based on fundamental data secured through physical surveys and recorded on maps; and

Whereas, at the present time there is, unemployed, the necessary technical personnel to gather and record such data; therefore,

Be it resolved by the American Society of Civil Engineers in Convention assembled at Los Angeles, California, July 3, 1935, that those organizations of the Federal Government charged with the allotment of funds, appropriated under the Emergency Relief Appropriation Act of 1935, be requested to support liberally in a financial way the Federal, State, and Local Agencies (including planning commissions) concerned with the gathering, assembling, and correlation of all data relating to topographic and geodetic surveys and maps; and

Be it further resolved and recommended that the requests for funds which have been presented by the U. S. Geological Survey and the U. S. Coast and Geodetic Survey be approved and prompt allotments made, and;

Be it further resolved, that the purpose of this resolution be urgently presented to the proper Federal authorities.

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NAMES OF TRIANGULATION STATIONS

G. C. Mattison

The June issue of the Geodetic Letter contains an article regarding the naming of triangulation stations, and mentioned the possibilities of title disputes in case the stations are named after the owners of the property. Most of our triangulation surveys have been over valuable land, and we have noted several incidents, which combined with the possibilities mentioned in the Geodetic Letter, would indicate that it is inadvisable to name a station after

the land owner or tenant.

Case # 1. A station was established on a rock ledge in back of a home after first obtaining permission from the house owner who stated the property included the ledge. Her name was stamped on the marks. A few days later, the observing party had a difficult time of it when another claimant to the rock ledge put in an appearance and objected to the name on the disks. The lady was highly elated that the Government had marked the property as hers, as she said there always had been a dispute regarding the boundary. Needless to say, the name of the station was changed.

Case # 2. A recovered station, named after the owner (1875) was remarked. The present owner objected strenuously to having the name of the former owner stamped on the disks, and it was necessary to explain the reason why the former name should be retained. The explanation was accepted without enthusiasm.

Case # 3. Special incidents have occurred where it was necessary to place azimuth marks, and occasionally reference marks on adjoining property. Invariably there is objection to having the neighbor's name stamped on them.

It is very evident that property owners consider the marking of these stations as of considerable importance. Connecticut property and property rights at the present date, represent to us a picture of future conditions in other localities. Our experience has been such that we now deem it advisable to name a station with a non-controversial name.

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SUFFICIENCY OF TITLE

N. E. Wolfard

Conveyance of real property is, or should be, conditioned on clear title which is attested by abstract. Abstract is a summary of records financial, legal and descriptive. Descriptive record is established by position, fixed or relative.

Today we are much concerned with reestablishment of boundary lines and reference points. The relative position of two or more reference points controlling the boundaries of adjacent properties not infrequently causes enmity, strife, or oral combat between neighbors. A venerable old pioneer engineer and surveyor remarked to me not so long ago that he had made his last land survey. He said that a survey which he had made some twenty years before occasioned fatal altercation between the contesting parties. I dare say, the reader can recall similar cases in his own experience, possibly not so extremely tragic.

It is somewhat difficult for some property holders to understand why a surveyor with his compass or transit cannot readily reestablish with exactness old boundaries from deed description. Equally puzzling to them is the fact that two competent surveyors may not establish a given boundary in the same position. To understand the former difficulty it is only necessary to investigate the equipment and methods used in establishing early boundaries. The latter condition frequently arises from the fact that descriptions of adjacent tracts are often tied to different reference points, the record relative position of which is in error. Consequently there may be an overlapping of boundary or else a "devil's lane" or "no man's land" between nominally abutting properties.

In these days of intensive commercialism and consequent soaring property values pioneering methods of survey and monumenting are no longer adequate. Exact position, horizontal and vertical, is desirable and often essential. There is but one way to secure exact position ---- that is to "tie your property to a star". Were the earth a perfect sphere astronomic observation at any point would give at once the exact and relative position of the observer as referred to other points so determined.

Geodetic control of position on the earth's surface, however, is not so simple. The spheroidal form of the earth necessitates certain adjustment of observed position by latitude and longitude to establish truly relative positions. It is also necessary for the purpose of mapping and charting to reduce all distances to arcs of a common surface of equal elevation. Mean sea level has been chosen by the U. S. Coast and Geodetic Survey for this common surface, as well as datum for vertical control.

A certain definite spheroid which fits the North American continent very closely was computed by A. R. Clarke, an eminent British geodesist, about the middle of the nineteenth century. A single point of reference, referred to this spheroid, located in west central Kansas, has been adopted by the United States, Canada, and Mexico as initial control for position and mapping. This point, called Meade's Ranch, is known as North American datum.

Triangulation arcs girt most of our coast line and articulate with transcontinental arcs. Position and azimuth of the stations are computed with reference to the above datum in high degree of precision. It is contemplated that these precision, or "first-order" arcs, shall eventually form about a fifty mile mesh grid over the entire nation. By way of information "first-order" surveying implies angular closure of triangles or of the horizon with a maximum error of 3 seconds, while the average error will be 1 second or less; linear closure shall be 1 in 25,000 or better. "Second-order" work implies angular closure of 3 seconds to 6 seconds and linear closure of 1 in 10,000. "Third-order" work calls for angular closure of 6 seconds to 10 seconds and linear closure of 1 in 5,000. "Fourth-order" work comprises stadia surveys and filling in of map details.

The rigid control scheme proposed by the U. S. Coast and Geodetic Survey early in the nineteenth century has been slowly but consistently expanded. The precise triangulation arc grid mentioned above constitutes the basic control scheme. This grid is to be supplemented with "second-order" triangulation and traverse which, in turn, will be expanded by "third-order" traverse, furnishing control for detail mapping. Now we are, nominally at least, back to the point where we started; that of position. However, the reader will agree, I am sure, that a point of reference determined or established by the rigorous procedure of Coast Survey methods will be more exact in position, more permanent, and more readily reestablished in case it becomes disturbed, than is the ordinary point of reference used in deed description.

The surveys set up as C.W.A. projects throughout the several states in December, were mostly concerned with "second-order" traverse and leveling. The general procedure was to execute traverse from previously established and computed arc triangulation stations. The traverse was to be run from one station to another along highway or railway and monuments carrying a standard bronze marker set from one-fourth mile to two miles apart, depending on topography and cultural demands. Thus were formed closed loops affording accuracy check. Levels were run along the traverse establishing elevation of each marker, together with intermediate bench marks on bridge heads, etc. These monuments afford convenient and accurate horizontal and vertical control reference points for future surveys and "check in" points for surveys already made.

A system of coordinates has been set up for Oklahoma and computers are now busy computing the coordinates of all triangulation stations within the state as well as the coordinates of each of the monuments set in the local control survey now in progress under C.W.A. The advantage of a state coordinate system of reference points is evident on a moment's reflection. With public and private surveys throughout the state referred to common position coordinates and elevation datum, relative position, either vertical or horizontal, of control or objective points in a projected enterprise, great or small, could be readily determined without preliminary surveys.

In order to facilitate the usefulness of data resulting from the numerous surveys constantly being carried on by various governmental units, corporations, and individuals, a clearing house in the form of a state survey bureau should be set up. The functions of this bureau would be various and far-reaching, and must needs be a subject of separate discussion in a future issue. Modification of procedure in legal surveys and public responsibility and license of surveyors should come up for study and analysis.

It is hoped that engineers and surveyors, as well as industrial and political leaders, will consider and analyze the coordinate basis for surveys in its various aspects of economy, utility, accuracy, and permanence.

CHANGE IN SETTING OF BENCH MARKS

From time to time there has been considerable discussion regarding the change in elevation of bench marks caused by frost action. It is very rare that, except in marshy land or where there is quicksand, any question has been raised with regard to the settling or rising of monuments from any other action but that of freezing, thawing and earthquakes.

However, the following is quoted from a letter received from Mr. William Mussetter, under date of July 15, 1935, concerning disturbance to station marks in certain black soil which shrinks and cracks open during dry weather and consequently goes through the opposite process during wet weather:

> "Some time ago I remarked that station marks in Texas black lands should be especially deep, and you asked for the reasons. The explanation is that this land has a peculiarity of shrinking and cracking open during the hot dry summers. The cracks are often large enough to lose a fence rail in, and probably go 10 feet or more deep. They partially fill with dust and debris, and when rain falls, the soil expands and has a tendency to heave and creep, similar to frost action. Some of the 98th Meridian marks were so disturbed, one reference mark I remember, having been forced about half way out of the ground. My attention was called to this in 1930 by some State engineers who reported that several of our bench marks between Vanderbilt and Kingsland had been disturbed. Apparently, a deep, well-rooted mark resists the action. The 98th Meridian marks were unsuited, as they had a wide rim at the surface, with minimum diameter at the bottom. Some old Hydrographic and Topographic marks found were about the size and shape of a boarding house wash bowl. Without exception, they had been disturbed. This action does not occur in sandy, gravelly soil, or the red clay of East Texas. It seems to be less in cultivated or wooded lands than in bare pasture, although the reference mark mentioned was in a mesquite thicket,(station Kaleta)."

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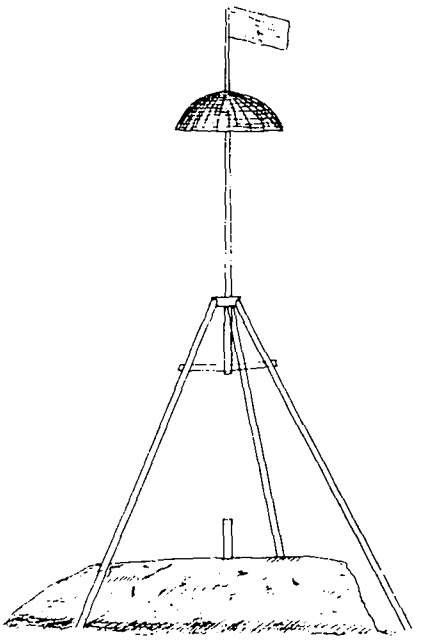
1876 DESCRIPTION OF STATION

The following description of a triangulation station was found recently in the Coast and Geodetic Survey records. It is not offered as model description but as a sidelight showing how a humerorous moment influenced this one.

"New Lump (Plaqueimines Parish, La., H. L. Marindin, 1876). -- On a convulsion of nature, toward the point (from that great triumph of the 19th century of art over nature known as the West Jetty) where the great luminary retires after completing his fiery course through the etheral arches, stands a structure designed to assist in the scientific researches of the Coast Survey. To preserve it to fame and the future a hollow iron cylinder will be forced into the bosom of Nature by repeated blows from a lusty Celt. Extensive ravages by old Ocean have reduced the size and glory of this little isle and now it rears its head only about 2 feet above the fullness of the waters. To an observer gazing N. 3/4 W. will appear Kipp; while if he turns his vision NE. by N. 1/2 N. Parmelee will meet his averted eye. Gentle reader, contemplate a sketch of the subject."



New Lump

- Δ -

PATHE NEWS--TOPIC NO. 1

A 3-minute sound reel titled "The Invisible Roadways to the Sea", prepared by Pathe News with the cooperation of Lieut. Comdr. George D. Cowie of this Service, known as Topic No. 1, will be released throughout the country this month. An accompanying talk described an observing party on one of Lieut. (j.g.) McCarthy's triangulation towers in the Navesink Highlands; a topographic party working along the beach (with a closeup of a plane table sheet); a launch hydrographic party of Lieut. I. E. Rittenburg; a view of the Surveyor in Alaska (copied from a film loaned by this office to Thomas Chalmers, Editor of Pathe News); and a composite animated section showing the operation of echo sounding, i.e., the sound travel by means of dashed lines from the oscillator to the ocean bed and thence to the hydrophone, with a closeup of a fathometer and the flashes of its dial.

A copy of this film was furnished the Bureau and a preview showing, attended by all interested members of the Washington office, was held in the Commerce Building auditorium on the afternoon of October 29, through the courtesy of the Chief Clerk of the Department.

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PLACING STATION AND BENCH MARKS

A recent letter from Mr. Harold N. Carey, formerly of the Coast and Geodetic Survey but now employed by the South Dakota State Highway Commission, offers a valuable suggestion for the placing of future station marks and bench marks. Extracts from the letter are given below:-

"Since the Coast Survey work closed down in August, I have been working with the South Dakota State Highway Commission.

"The Commission seems to have standardized on 100-foot rights of way for state highways. That means, when a road is regraded, on a stretch where there is not a great deal of cut or fill, that the ditches are cut back to a point 48 feet from the center line.

"I would suggest then, that on reconnaissance for triangulation, or for levels, the points selected for marks be kept at least 50 feet back from the center lines of main roads. It would also be a good idea to keep them away from intersections of main roads, for one can never tell how much right of way may be used at the intersections. Quite often there may be curves put in to cut off the sharp corners, and these vary as to the amount of land taken in.

"The above would apply to the main county highways as well as to the state highways."

Other states will undoubtedly adopt similar standards of width for new construction and chiefs of party should bear this in mind when instructing their mark setters so that our stations may survive.

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SIX-MAN COMBINED LEVEL UNIT

W. W. Studdert

I cannot be too enthusiastic over the operation of the six-man combined level unit, with the sixth man setting bench marks for the unit. Having worked with both methods, the other method being where the bench mark setter is in another truck, operating many miles and weeks ahead, I find that greater cooperation, economy and speed can be had where all functions are close together in a compact group.

The bench mark setter, when operating in the same truck as the level party, should at all times keep one full day's work ahead of the level party. This can always be done with ease.

On second-order levels along railroads, this means that the bench mark setter should be about 10 miles in advance with his work. As this 10 miles has to be travelled in excess of the observing party, it means that the bench mark setter will travel 20 miles farther in the truck each day than the level party. Therefore, his hours of actual work will be only 40 minutes less than the level party.

On arriving at the scene of work in the morning, the observer in charge of the unit instructs the bench mark setter to contact the level party at a certain point at a certain hour, usually 4:00 P.M. At 3:30 P.M. the bench mark setter starts back along the line and picks up the observing party. An hour's trip is about the maximum ride that the units are allowed to work away from camp. Excess speed is not allowed as our trucks are old, and in mountainous country, high speeds might prove disastrous.

The truck's mileage on second-order levels along railroad tracks, for a unit of six men in a combined party, working 25 miles from camp would be:

With complete party out.	25.0 miles.
Full day's work previously bench marked.	10.0 "
Day's work to be bench marked.	10.0 "
Total trip out.	45.0 miles.
Total trip in.	45.0 "
Total distance for truck with work now 35 miles from camp.	90.0 miles.

If this same day's work were done by separate bench mark and observing units, the truck mileage would be:

Observing party.

Trip out with all members of observing party.	25.0 miles.
Truck moved ahead to pick up observing party.	10.0 "
Return trip to camp.	35.0 "
Total for observing party truck.	70.0 miles.

Bench mark party.

Morning trip out and day's work.	45.0 miles.
Return to camp.	45.0 "
Total for bench mark party truck.	90.0 miles.

The above figures show that only 20 extra miles of truck travel were used by the combined party over a straight observing party, whereas 70 miles of truck travel were saved by the combined party over the separate bench mark and observing party. Another feature that must be considered is that a 5-man observing party is at a disadvantage in moving ahead their truck when running second-order levels.

From the viewpoint of a bench mark setter, I have found that they would prefer a truck of their own in order that they might be more free of supervision. I know from actual bench mark setting experience that they have plenty of time in six hours to set eight bench marks of varied types, therefore, it is not time that they need.

From an observer's viewpoint, I find that the extra convenience of having a man along who already knows the roads is of great aid in promptly reaching the scene of work. The additional responsibility of bench mark supervision and coordination of the work sobers most young observers. Not being hindered in his actual leveling by having to send one of his men ahead for the truck is of assistance, as his truck will call at 4:00 P.M.

The party chief finds his party expenses falling into more desirable limits. He has also a more compact and mobile party.

There is no need for the one-truck-six-man combined unit to cause long hours. Both groups have ample time to do their work, both having the same working hours in an eight hour period. The level party assists the bench mark setter in loading his precast concrete monuments and the bench mark setter helps the level party by being prompt at 4:00 P.M. Nothing is more discouraging to a five-man level unit than, after a hard day's work to have to match to see who goes back on a long 10 mile stretch, by walking or hitch-hiking, to bring up the truck in order that all may ride back to camp.

It is my belief that all parties could quickly reform their units to the one-truck-six-man combined unit. I have used the above unit organization since November 1934, and greatly prefer it to having separate observing and bench mark parties. Were additional trucks made available for this party, it would be my desire to use the additional trucks only as supply trucks in hauling precast bench mark posts to more strategic points.

Disregarding the economy in the combined unit, it is my belief that better bench mark monuments can be had where the monument setter is closely associated with the observer. The observer is usually a technically trained man whereas the monument setter is rarely so. An exchange of ideas at all times will greatly improve our monuments.

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SPECIFICATIONS FOR HOISTING BAG

C. I. Aslakson

I am submitting herewith, the specifications for the hoisting bag which has been used on this party with most satisfactory results ever since its organization.

I strongly advise that the pigtail be run through all four rings and securely tied instead of using snap rings. My experience with snap rings shows them to be unsafe as they may become twisted and fail.

Specifications for Canvas Hoisting Bag

MATERIAL:
Good grade #4 white duck.

DESCRIPTION:
Bag to be 2 ft. wide, 2 ft. long and 2 ft. 10 in. deep with a 1 inch double hem at the top. Edge of this hem to have small cord hemmed in.
Bag to have double bottom, this double bottom to extend 6 inches up side.

STRAPS:
Bag to have two 2-1/4 inch straps, 7 ft. 6 in. long doubled and stitched onto the bag as follows: Straps are to be crossed at bottom on outside and in center of bag and stitched up sides to a point 12 inches from upper edge of bag where they will be firmly reinforced. The loose ends of each strap shall have a heavy 2 in. harness ring sewed into the loop. The web straps shall be reinforced with leather on inner side at the front where this ring is fastened.

WORKMANSHIP:
Workmanship must be of the best. Seam to be sewed with good strong thread.

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- - - STRETCHED END TO END

1. If all the walking incident to the extension of this leveling were put together, it would be the equivalent of two round trips between New York and San Francisco or, roughly the distance from New York to Singapore.

2. If all recorded observations and computations were typewritten on a standard typewriter, without spacing, and in a single line, the line would extend about 31.7 miles, or would completely cover a four-foot strip on one side of the Washington Monument from the base to the tip.

3. If all the numbers and letters on the abstracts and in the record books were printed on a single-spaced eight-column calculator, they would require a strip of paper 57.2 miles long.

--(From Season's Report of W. M. Gibson.)

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TRIANGULATION IN THE ATCHAFALAYA BASIN

The topography of the areas surveyed varied from rolling farm land in Iowa and Missouri to mountainous regions in Arkansas and Oklahoma, to rolling pastures and woodlands in Texas, to densely wooded swamps in the Atchafalaya Basin.

The greater part of this project was just another routine assignment of triangulation using steel towers. The survey of the Atchafalaya Basin was unusual in that the only possible means of transportation for this area were boats. This survey was made at a time of very high water. Inasmuch as nearly every station in the scheme was located between the protection levees of the Atchafalaya River it was very difficult to find ground of sufficient height above the prevailing water level to permit the location of a station and the erection of a tower. Several stations called for in the reconnaissance had to be omitted due to the flooded condition of the proposed station site. Several towers were built where it was necessary to throw up dams to prevent water from running into the anchor holes. Some stations were located on isolated knolls just large enough for a tower. In such cases azimuth and reference marks were wedged into drill holes in firm cypress trees that were crooked enough to more or less eliminate the possibility of their being cut down for lumber.

--- (From Season's Report of Charles A. Schanck.)

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ROAD METHOD FOR TRAVERSE USED ON THE TAMIAMI TRAIL

H. Edward Breen

This method is a cross between the rail and stake method. The measurements are made with the tape supported at 0, 12-1/2, 37-1/2, and 50 meters. Along a road, however, each tape end, and the intermediate supports must be lined in, thus including part of the stake method. Where the road work would continue along a true tangent, and an offset from the edge of the road could be used, the lining in might be eliminated. This could not be done on the Tamiami Trail.

Kilo points were made by a spike similar to the turning pin driven into the road bed flush with the surface of the road. The kilo points were held by 3 nails driven into the road.

Over the tar road, mixed with small gravel, the friction tape would not stick. This necessitated finding a substance that would stick and also keep the mark. Artist's model clay, called, "Plasteline" or "Permaplast" was used. The putty-like substance seemed to work satisfactorily.

A few slight changes were necessary on the rail equipment. The flange on the rail stretchers would have held the spring balance a trifle high. A new set was made at a tinner's shop of heavy sheet metal without the flange. The handles were interchangeable. The intermediate supports' guards had to be smoothed level with the base of the support in order to have the tape six inches above the road.

The method is much slower than the rail method and not as satisfactory as the stake method. The maximum kilometers run in one day were seven and one-half. Traffic along the highway slowed the work to some extent.

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EXCERPT FROM "MAPPING AUSTRALIA"

In a young country, the first necessity is to place the settler on the land, but as land becomes valuable, and the density of population greater, the responsible authorities must give consideration to surveys and maps of an accurate character which will show the exact locations of topographical features, private and political boundaries, as well as the configuration of the earth's surface. There is scarcely any human activity of an extensive nature whose successful operation is not dependent to a greater or less extent, on an accurate knowledge of the configuration of the surface of the earth, and of what is upon the surface. This knowledge can only be obtained by what is called topographic surveying and mapping, which, over a large area, can only be successfully carried out with the aid of a geodetic survey. To accurately map our country, therefore, is not only the goal of the surveying profession, but is a state to be achieved and highly desired by the many professions who require and use maps as a basis of their operations.

- -(From "The Australian Surveyor", June 1, 1935.)

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This excerpt from an article appearing in the Australian Surveyor of June 1, 1935, is interesting in that it points out the value and importance of topographic mapping in Australia, but which can easily be applied to any country which has not been thoroughly mapped. It is truly remarkable that practically every activity engaged in by man which is related to land, requires maps of some form. Engineers are well aware of the advantages to be gained by obtaining accurate maps of the country as a means of conserving natural resources, eliminating duplication and waste, and furnishing much desired information for all major construction projects. It seems strange that work of this character should not have been appreciated in the past, but now that people are becoming map conscious and actually find use for maps in nearly all of their daily activities, their great value is becoming more and more known. The situation in this country in many ways is quite comparable to that in Australia.

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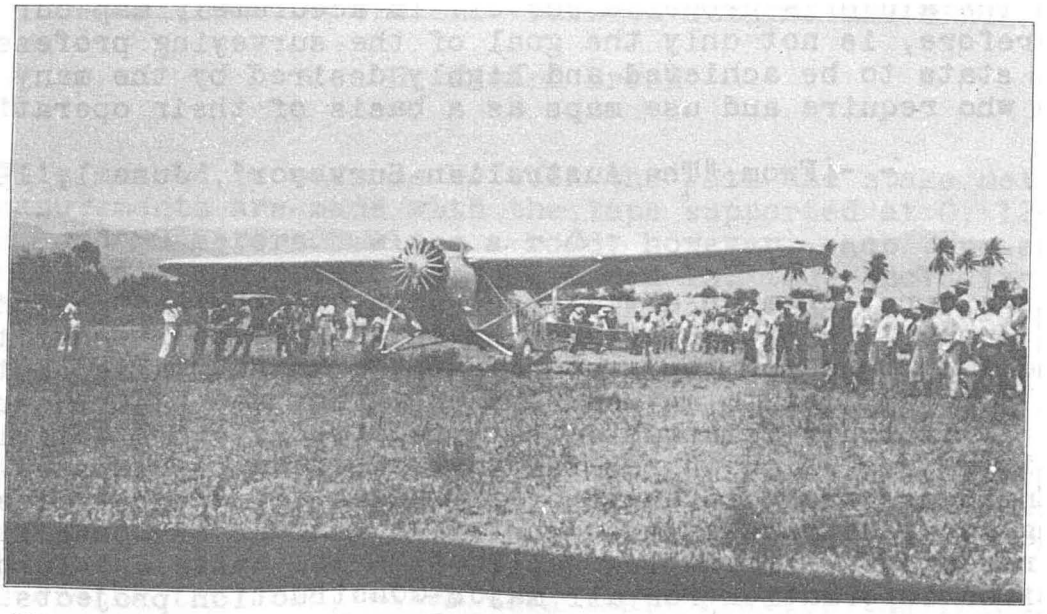
GUATEMALA-HONDURAS BOUNDARY

Joseph P. Lushene

In September, 1821, the Spanish colony now known as Central America, declared its independence from Spain and formed the Republics of Guatemala, Salvador, Honduras, Nicaragua and Costa Rica. Since this area was largely an unexplored jungle and consisted of only a few isolated settlements the descriptions of boundaries were indefinite and vague. No special stress was placed upon the exact limits of the various Republics. In later years as the countries developed and more settlements were made, boundary disputes arose between the adjacent countries.

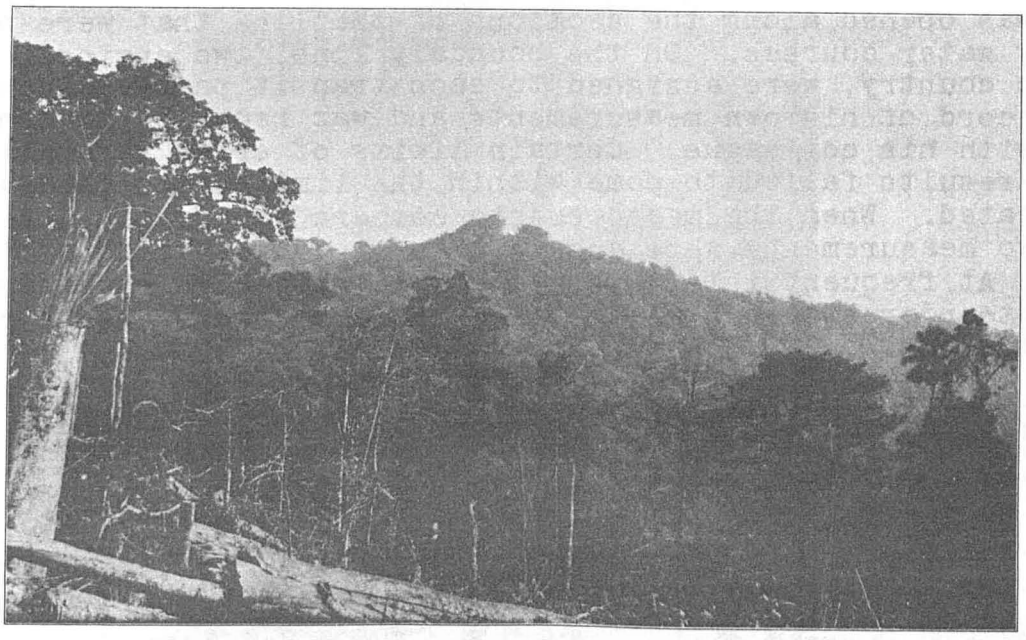
Many attempts have been made to settle the dispute between Guatemala and Honduras with no results other than the stirring up of additional hard feelings. However, in July, 1930, a treaty was signed and a Special Boundary Tribunal set up which consisted of the Chief Justice of the United States Supreme Court, an arbitrator from Costa Rica and one from Chile. An aerial map of the territory in dispute was made and the Tribunal made the award. After the award, it was necessary to mark the boundary line and a Technical Commission was formed for the demarcation. The U. S. Coast and Geodetic Survey was requested to carry first-order triangulation along the boundary since this method is considered the most satisfactory one for surveying a boundary. The writer was very fortunate in being detailed to undertake the control surveys.



Plane chartered to carry astronomical equipment into Honduras for the establishment of a station.

The boundary line is about 161 miles long. It follows water

courses, water divides, and in some sections, straight lines from one topographic feature to another. In general the line passes through highly mountainous country. The northern part of the line extends through sparsely inhabited country timbered heavily with tropical growth. There are practically no trails in this area and the few trails that do exist are very poor and impassible over the long rainy season. There are numerous areas that are absolutely uninhabited. Most of the traveling was done afoot and the equipment, food, and supplies were carried by natives. Trails had to be cut through the jungle growth to all stations and members of the party had to be armed against the wild animals. In the lowlands enroute to the stations, the temperature was hot and uncomfortable but at the stations it was very cold due to the high altitude of the mountains. The southern part of the line passes through fairly well settled country having numerous trails and in many cases, direct access to the boundary was possible. Most of the traveling was done by muleback and supplies were transported by pack mules.

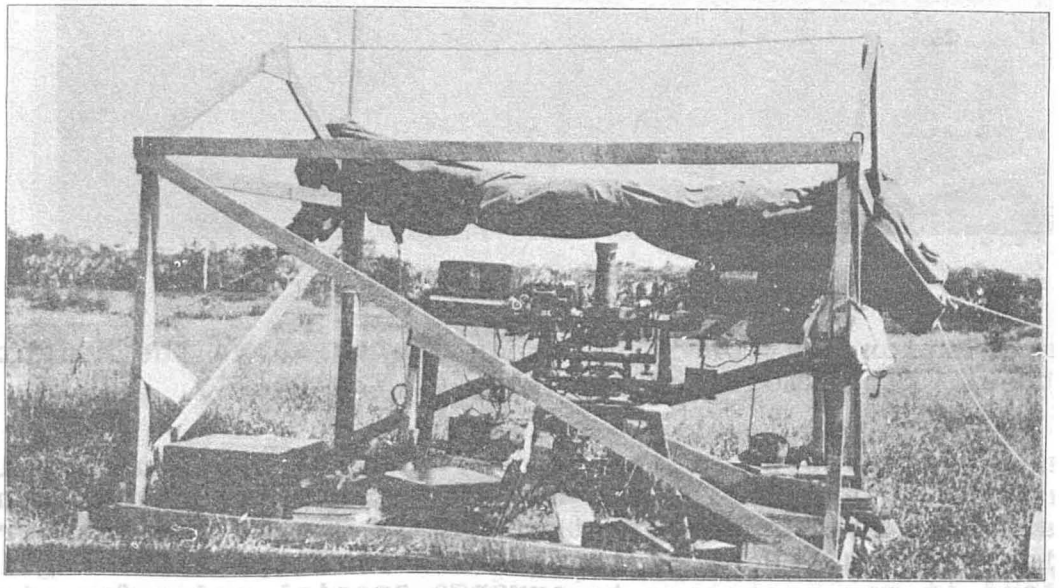


Triangulation station in distance. Notch shows the height of trees, also amount of cutting for visibility.

A base was measured at the southern end of the boundary in a valley and the triangulation ran northward from this line. The first few weeks the work progressed rather slowly due to the inexperience of the lightkeepers. None of the lightkeepers spoke the English language and it was necessary to arrange special codes for signaling at night. A double observing party was used on this work. Mr. Philip Welker, a computer from the U. S. Coast and Geodetic Survey, was in charge of the observing party which operated on the Guatemala

side and the writer was in charge of the other observing party in Honduras. Four-foot stands were used at nearly all the stations since the reconnaissance party had cut the heavy growth on all high mountain points which were to be used as stations. The greatest delay to the work was caused by cloudy weather which kept most of the stations in the clouds for long periods of time. Directions were taken to all boundary points wherever possible. Large tripods painted white were set up over the boundary points and directions taken during the day. Six to eight directions were taken on each boundary point and the positions computed so as to control the work of the stadia traverse parties running the boundary line. Thirty first-order points were occupied, and some thirty-three secondary points were established along the actual boundary. Very difficult field conditions were encountered throughout the work. At the majority of stations 10 or more days were required to complete the observations due to bad weather. A base was established at the northern end of the boundary as a distance check.

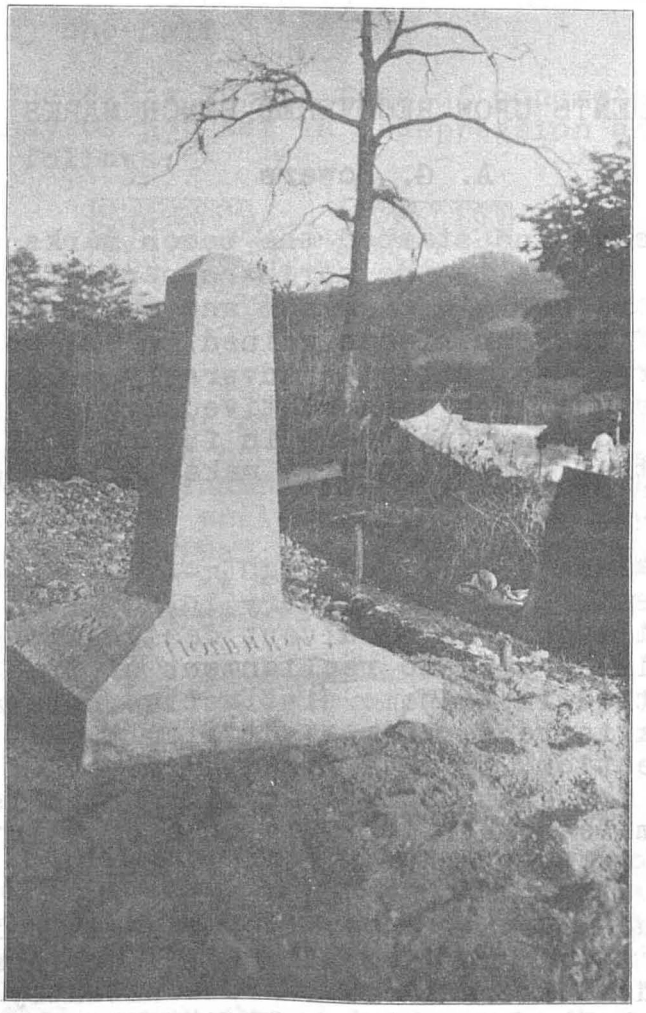
The actual boundary line was measured with transit and stadia. A vista was opened along the sections of the line that were not marked by water courses. On the boundary line, two engineers, one from each country, were assigned to each transit party. Each engineer made a record of his own measurements and was required to compare his results with his colleague. Certain limits of error were allowed and when the results failed to come within the limits, the observations were repeated. When the measurements compared favorably, the average of the two measurements were accepted as the final value of the measurement. At frequent intervals, points were located by intersection from first-order stations so as to control the measurements of the local engineers.



Astronomical Station

Upon completion of the triangulation work, astronomical observations were made at each end of the arc. At the northern end a

railroad passed very close to the station and the transportation of equipment was an easy matter. Latitude, longitude, and azimuth were observed. Since this astronomical station was in Guatemala the Commissioners from Honduras requested that astronomical observations be made also in Honduras. This problem became serious as no transportation facilities were available. The equipment for astronomical work is not only heavy but very bulky and could not be carried by mules over the poor trails. The problem was solved by chartering an aeroplane. The plane picked up the equipment at Chiquimula, Guatemala and landed in a cow pasture in Honduras at the southern end of the boundary line where the observations were made. The trip by plane was made in 30 minutes whereas it would have taken at least 4 days by mule travel. Having astronomical determinations at each end of the line made it possible to compute a temporary datum for the triangulation.



Guatemala-Honduras Boundary Monument

The forty-eight triangles along the arc had an average closure of 0.90 seconds and a maximum of 2.73 seconds. No difficulty was

experienced in closing the triangles. The work was carried on with a high degree of accuracy as it is the only system of precise triangulation in Central America and it was a means of training the engineers of the locality. Since the arc extends more than two-thirds of the distance from the Atlantic to the Pacific Oceans, it affords an ideal base for future extension of first-order control in this area. Various countries sent engineers to view the work in progress. When the computations are completed on this project, El Salvador will undertake to measure its boundary line with Guatemala. It is believed that this arc of triangulation will be connected with the precise net of Mexico, within the very near future, and also extended southward to Panama, thus giving all of Central America the North American Datum for control. A gratifying result of this short arc of triangulation is that Central America has become geodetic-minded. It is believed that much geodetic activity will soon be seen in this section.

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COMMENTS UPON RECOVERED BENCH MARKS

A. G. Bowers

Having recovered and stamped the bench marks on approximately 2,200 miles of levels in the northern part of California, it is thought that perhaps certain comments and suggestions may be in order as a result of the experience gained in the work. There is no intention, of course, to criticize adversely or destructively; my sole aim is to venture such constructive suggestions as I think might be of value to the Department in future work, and it is with that end in view that I respectfully make the following observations.

Bench marks along a railroad right-of-way should be tied in to some natural feature of the country in addition to the culvert designation and mileage. Both culvert designations and mile posts are changed sometimes owing to realignment of track, etc., and unless the mark is tied in to some distinctive natural object, recovery of the mark is rendered most difficult. It might be wise, too, in this connection, to have a standard way of designating the mile markers, as, for example: If the mile board is on a telegraph pole, call it a "mile pole", if it is on a post set especially for that purpose, call it a "mile post".

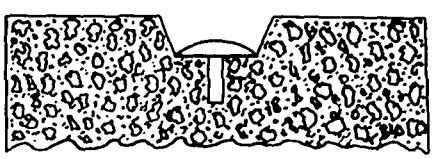
Listing of such elevations as "top of west rail opposite the station at - - -" should be discontinued, I believe. On practically all railroads the track crews are constantly going over the lines tamping the ballast, making ballast raises, etc., and the rail elevations may vary as much as half a foot. In such cases the elevations are worse than useless; they are misleading. If, however, it is decided to retain these elevations it is suggested that they be spotted very accurately and be tied in to some natural feature. Many of the small stations are on skids to facilitate

their removal from one spot to another, -- and a difference of 50 feet in distance on a 1.5 percent grade makes quite a difference in elevation.

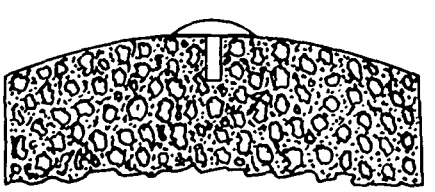
Along public roads the monuments should be set well out of the way of tractors and showplows. I came across a number of posts that had been tilted and even torn out. They should be in sheltered locations, yet free from likelihood of being covered by caving banks or slides. These precautions are especially advisable in mountainous country where the snowfall is heavy and snowplows operate regularly through the winter.

In setting the disks in culvert headwalls, would it not be wise to adopt a standard location, such as the center of the wall? Headwalls are frequently covered with earth or ballast, and if the center of the headwall is standard location the work of recovering the disk is reduced by one-half.

In setting the disks in the tops of concrete monuments it is suggested that they be <u>not</u> set in a depression as now seems to be the practice, as follows:



This, it seems to me, is the worst possible way to set them. Water can seep in under the disk, and when it freezes, can exert a disruptive force that is bound in time to heave the disk. If the top of the monument were chamfered this condition would be done away with, and in addition would make the disk more "get-at-able". In a number of marks examined difficulty would be experienced in getting a wide stadia rod on the disk because of its being sunk in a depression. The following sketch shows what I mean:



In nearly all instances the disks of the Geological Survey seemed more solidly set than did those of the Coast and Geodetic Survey. This, however, I think is inherently a matter of the shape of the Geological Survey disk which is flat and therefore bears on the concrete at all points of its under surface. In setting Coast and Geodetic Survey disks care should be exercised. They should be forced down into the mortar so that every part of the concave under surface is in contact with it. This will prevent water from seeping into what otherwise would be a cavity, in addition to making a much

more solidly set disk.

Some of the designating numbers and letters on disks are very lightly stamped, as can be seen in some of the rubbings. It is suggested that they should be deeply stamped.

In the mimeographed list of descriptions there is great difficulty in distinguishing a "3" from a "5" if there is any blurring. Of course, the elevation in feet can be worked out from the meter elevation and vice versa, but if both are blurred, inconvenience results. It is suggested that a different type, one that has the "3" and the "5" easily distinguishable and different from each other, be employed. It is a small matter but it usually is the most important figure that is blurred and hard to make out.

Beyond the small and relatively unimportant matters referred to above, I have no criticism of any kind to offer. My work convinces me that the Coast and Geodetic Survey well deserves its fine reputation for skill, care, precision, and foresight, and to say that I have enjoyed working in such an organization is putting it very mildly, indeed.

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COMMENTS ON ABOVE

H. W. Hemple

I think that you are misinformed as to the type of mark which is in use by this Bureau for bench marks and triangulation stations. While the surface of the mark is convex, the underside is flat, and there should be no reason why these marks should not be set as solidly as those of the Geological Survey. Our experience has been that it is advisable to countersink the mark slightly, but not to the extent, however, that the top of the mark will be below the surface of the concrete. If this is done, there is no question about the adherence of the other side of the mark to the concrete and no possibility of seepage underneath. I have had no complaints regarding our marks being uprooted in the concrete by freezing due to seepage underneath.

Regarding the light stamping of the numerals, the bronze alloy we use is very resistent to corrosion and abrasion. It is, therefore, quite hard, and unless the man setting the marks takes sufficient trouble to strike the die quite hard, it will result in a very shallow number. It is the opinion of this office that it would be inadvisable to use a softer alloy because such would be more susceptible to corrosion. There is no reason why the man establishing the mark should not strike the steel die sufficiently hard so that the number will be quite legible. There may be isolated cases where this criticism holds, but I do not think that throughout the country there is much difficulty on the score mentioned by you.

Regarding the location of monuments along public highways and railroads, the instructions for leveling specify that the location should be such that it will not be disturbed by highway or railroad activity. We realize, of course, that marks may occasionally be set along unimproved highways, and as the road is rebuilt it may possibly be widened, with the consequence of the destruction of the marks. This is something which cannot be adequately foreseen at the time the marks are established.

Marks set in culverts or bridge heads should be so located by distances from the corners of the structure that it will be possible to locate the marks without much difficulty.

In the more recent typewriter purchases made in this office the machines have what is known as billing numerals. In this the lower part of the figure is open and the 3 and the 5 are easily distinguishable. Of course, ultimately the data furnished to you on the mimeographed list will be published in printed form and the difficulty mentioned by you will not appertain.

This office is always glad to receive constructive criticism such as advanced by you, and if at any time in the future any suggestions occur to you which might improve our work, I shall be glad to hear from you.

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FURTHER COMMENTS UPON DESCRIPTIONS OF BENCH MARKS

Howard S. Rappleye

I believe the comments concerning descriptions of bench marks located along railways, as mentioned in the second paragraph of Mr. Bowers' letter, are good though I am not so sure that we are justified in making the fine distinction between "mile poles" and "mile posts". This has been discussed considerably in the past and I am a little doubtful as to the value of this rather fine distinction.

With special reference to the third paragraph of Mr. Bowers' letter, the elevations of the top of the rail opposite railroad stations are not and never were intended to be used as bench mark elevations. We know that the top of rail is constantly being changed in elevation and anyone using a rail elevation as a bench mark for accurate leveling would be simply asking for trouble. There are, however, a number of uses for these rail elevations which perhaps have not occurred to Mr. Bowers. A great many people are interested in the elevation of places throughout the county from a casual or non-technical viewpoint. Rail elevations serve their purpose better perhaps than our standard bench marks, unless the standard bench mark happens to be located near some station or public building with which they are thoroughly familiar. There is also a use for rail elevations which perhaps has not occurred to Mr. Bowers, and that is in connection with mapping by means of air photographs.

Elevations at road crossings, opposite railroad stations and at important bridges can be used in making maps from air photographs without the necessity of putting a signal on the ground at the bench mark while the photograph is being taken as would be necessary with most bench marks. These rail elevations are practically ground elevations and are what the persons using air photographs need. There are other uses for rail elevations and, in spite of the fact that rail elevations are not accurate, except perhaps to the nearest foot or so, nevertheless, they do serve a useful purpose and form a valuable by-product resulting from our leveling.

Mr. Bowers' comment concerning the necessity of using care in locating bench mark posts so as to be out of the way of tractors and snowplows and also keeping them in locations where they will not be covered by caving banks is a good one. These points have been stressed in the past in writing various circulars concerning the desirable locations for bench marks.

With regard to the adoption of a standard location for the disks in headwalls, this might be advisable but very frequently it will be found that it is inconvenient or impossible to place a disk in a particular location adopted as standard and there would, undoubtedly, be numerous variations from this standard practice should it be adopted. It is certainly undesirable to place all bench marks which occur in culvert headwalls on the same side of the track. If they are staggered alternately first on one side of the track and then on the other, a double tracking operation cannot bury more than half of them, where it is possible that a double tracking operation might cover them all if they were on the same side of the track.

With special reference to the matter of countersinking the disks, it is true that disks are occasionally loosened as a result of water seeping under the disk and then freezing, but the loss of bench mark disks in the past from this cause has been nothing like as great as the loss resulting from vandals knocking them out if they are not countersunk. A disk which is not countersunk is rather easy to remove, provided one goes about it with a cold chisel or pick.

Mr. Bowers' comment concerning the Geological Survey disk being flat on the underside and ours being hollow underneath may apply to some of the marks which he recovered or found dislodged on the older lines, but the standard disk in use by this Bureau for a considerable number of years past is flat on the underside. Mr. Bowers' comments in this connection are undoubtedly correct insofar as his experience is concerned, but he is not in possession of all of the facts in this particular case.

Concerning Mr. Bowers' comment regarding the light or shallow stamping of the disks, I see no reason why the designation and the year of establishment could not be stamped deeply in the disk, but it is not too fantastic an idea to assume that the elevations may have to be changed in the future as a result of movement from natural causes or the necessity for some readjustment, either local or general, and in this case a lightly stamped elevation would be much

easier to cut out preparatory to restamping than an elevation stamped deeply as he suggests.

His comments concerning the quality of the mimeographed lists, especially as regards the distinction between the numerals three and five, is probably justified. We cannot, however, always choose the particular typewriter that we have to use and it is not always possible to get the very best mimeographing done on every single job. I believe that the number of cases where trouble has been caused through faulty mimeographing is relatively slight considering the mass of information which has been sent out in that form in the past two or three years.

Mr Bowers' suggestions, made as he says as a result of his experience in recovering bench marks along approximately 2,200 miles of lines, certainly deserve careful consideration, and where I have, in the above paragraphs, taken exception to his suggestions, it has been either because his experience has been limited to one particular section; he has not been in possession of all pertinent facts or we have found from experience that certain ideas which are theoretically sound from a certain viewpoint do not work out to the best advantage in actual practice.

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UNUSUAL LOCATION OF BENCH MARKS

John Laskowski

(Two bench marks were established for the U. S. Weather Bureau at San Francisco, California, one on the top floor and the other on the roof of the New Federal Office Building.)

In view of the unusual locations of these bench marks, it was necessary to follow an out of the ordinary procedure for the necessary leveling. After encountering several delays in locating suitable turning points, the leveling was carried to a point at one of the winding stairways of the building. A standardized steel tape was then used in carrying the elevation to the top floor by having the divisions of the tape coincide with the respective divisions on the invar tape of a rod which was held plumb by one of the party members, and then reading the tape on the top floor as it was stretched taut by other members of the party. Through this means a difference in elevation of approximately twenty-one meters was obtained with one setting of the instrument. This process was repeated in two steps to determine the elevation of the mark located on the roof of the building. As checks were obtained between the first forward and backward runnings of the section, the procedure is recommended for use in future similar instances.

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FLICKERING LIGHTS MYSTERY SOLVED

There is quoted below a brief article that appeared in the Oregonian of Portland, Oregon, on July 3, 1935. -

Geodetic Survey Under Way Here; Lights from Hilltops Explained.

The mystery of the strange lights flickering recently from the hilltops in the vicinity of Portland has been solved. A survey party of the United States Coast and Geodetic Survey is responsible.

For many years the United States Coast and Geodetic Survey has been carrying out a program of precise triangulation.

Due to better atmospheric conditions, the work is done at night with lamps resembling automobile headlights. These lamps are centered accurately over bronze disks set in concrete, which constitute the survey monuments and from which latitudes and longitudes are determined.

This is the cause of the flashing lights that have aroused local curiosity. Geodetic survey light tenders are flashing messages to the engineers operating the delicate measuring instruments, which are known as theodolites.

A theodolite is something like the surveyor's transit, except that it is more elaborate. It is an ordinary instrument with a college education.

In measuring angles in triangulation it is necessary to use a theodolite that will measure accurately to one second of arc.

The survey party which is extending triangulation through northwest Oregon is working under Norman Sylar and includes about 20 young engineers. Permanent stations have been reoccupied or established on Barnes Heights, Mount Scott, Rocky Butte, Vancouver, Chehalem Mountains, Mount Sylvania, Portland postoffice, Hillvilla and other points.

A great many secondary stations, including tips of smokestacks, water tanks and flagpoles, also have been observed on.

At a later date exact latitudes and longitudes will be available for all these points. These are necessary for map production and a wide variety of surveys.

The U. S. Coast and Geodetic Survey has another party in Oregon under Lieutenant Robert W. Knox at Astoria and is making a new series of charts of the Columbia River. It is also carrying on triangulation work close to the borders of the river. Work of the two parties is closely coordinated.

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SOME PROBLEMS IN ESTABLISHING TRIANGULATION STATION MARKS

Some time ago a series of questions were submitted to this office by a chief of party with the request that they be answered in the Geodetic Letter. The questions and answers follow:

1. In the case of a new station, should the azimuth mark be marked "Azi" or R.M. No. 3?

Answer: New marks have been designed and purchased for use as azimuth marks. In the future these will be used for all azimuth marks.

2. In the case of occupation of stations marked by other organizations;

(a) Should the station be remarked if not in good condition or should a new mark be established and a tie made to the other station?

(b) If the station is sufficiently well marked what stamp, if any, should be placed upon it?

(c) If additional reference marks are established, how should they be stamped?

Answer: (a) Station marks that are not in good condition should be remarked regardless of what organization established them. It is preferable to occupy the old station rather than to establish a new station and make a tie to the old one as connections by distance and direction often cause confusion.

(b) Stations of other organizations that are sufficiently well marked should not be stamped at all.

(c) Additional reference marks should be stamped with the name of the station followed by the initials (in parenthesis) of the organization which established the station and each reference mark should be given a number as in marking reference marks for our own stations.

3. Where old U. S. Coast and Geodetic Survey stations have only two reference marks marked respectively R.M. # 1 and R.M.# 2, one of which was used as an azimuth mark;

(a) What should be stamped on new reference marks placed?

(b) Should the azimuth mark be stamped "Azi"?

Answer: (a) New reference marks should be stamped with the name of the station followed by the next consecutive number as # 3 and # 4 and dated with the year the station was established, followed by the year the reference mark is established.

(b) The azimuth mark should be stamped "Azi".

4. Where old stations with # 1 and # 2 reference marks are recovered with one of the reference marks established, what numbers should be given the new reference marks?

Answer: They should be numbered # 3, # 4, etc., followed by the year in which the station was established and the year the new reference marks are established.

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REACTIONS TO GEODETIC LETTER NO. 5, MAY, 1935

(The full letters from which these extracts are taken will probably appear in a future issue of this publication.)

"I appreciate receiving a copy of the Geodetic Letter for May, 1935, on the use of geodetic control for boundary surveys.

"The twelve land banks under the supervision of the Farm Credit Administration are vitally interested in private boundary surveys in connection with loans on farm lands in all parts of the United States and it occurred to me that you might wish to send copies of your Geodetic Letter to the banks for their information in this matter. Accordingly, I am attaching a list of land banks with the names of the heads of the engineering departments for all except Districts Nos. 1 and 2 which have no engineers attached to the banks . . . ." (Mr. Thomas Hawthorne, Senior Hydraulic Engineer, Land Bank Division, Farm Credit Administration, Washington, D.C.)

- △ -

"The Geodetic Letter received and hope its contents will take legal place of beginning in our Texas survey matters.

"In early Texas history when surveying methods were under discussion, it was proposed to adopt the U. S. Land survey method, but when it was not done, one man said then, "Gentlemen, we will have to educate all our boys as attorneys to take care of the litigations" and so those of us who have made any degree of success as land surveyors, first had thorough legal training.

"I have put in several hundred miles of County Boundary lines during the past two years and have referenced to triangulation stations where I knew about them . . . . . " (Mr. A. L. Harris, County, District and State Surveyor, Lubbock, Texas.)

- △ -

"I was greatly interested in your recent Geodetic Letter containing a symposium on the use of plane coordinates and the legislation in the State of New Jersey. It is very well written and the matter convincingly presented, and I hope that you will be able to give it a wide circulation.

"It is most important in getting this method of describing property generally adopted to make it at first legally permissible without being mandatory. Most of the smaller property surveys and descriptions are made by surveyors whose knowledge of geodesy and geodetic surveying is very limited, and they will not study the subject or change their methods except as they see by actual demonstration that the old system is being superseded by a better one. They will have to see the new system in use to be convinced of its advantages, and the sooner its use is allowed the sooner will its superiority be recognized; but to make it mandatory before they are thoroughly familiar with it would result in much confusion and in many errors. . . . ." (Mr. Gordon Macleish, Civil Engineer, Santa Barbara, California.)

- △ -

"We wish to thank you for the copy of the "Geodetic Letter, No. 5, Volume 2, of May 1935". The subject matter presented has been read thoroughly and we wish to place ourselves on record as desirous of receiving any further letters that may be written along these lines.

"The matter of using the national triangulation system for control of local and private surveys and descriptions, is of great importance to the Rancho, and we only regret that such control was not made compulsory by California legislation years ago.

"Within the rambling boundaries of this old Spanish Grant, comprising some 203,000 acres, no sectionizing was done by the United States. Consequently, we have had nothing in the way of monumentation upon which to hang numerous maps, surveys and lease descriptions other than the exterior boundaries and corners of the

Grant. Some of these maps are quite extensive, the compilations of thousands of dollars worth of survey works, accurate within themselves no doubt, but uncorrelated, tied to little or nothing, and floating in space. Triangular control with rectangular coordinates tied into the national system, applied to these surveys in the first place, would have made of each map a piece of complete mosaic fitted accurately to its place.

"Having of late come into possession of the geodetic data of the U. S. C. & G. S. Stations strung along the coastal boundary of the Rancho for some twenty-five miles, we are now endeavoring belatedly to achieve such correlation with the old maps and insisting that all future surveys shall be properly tied to the national system unless too remote to be practical." (Mr. Harry L. Heffner, Manager, Rancho Santa Margarita, San Diego County, California.)

- Δ -

"Your Geodetic Letter No. 5 Vol. 2, of May, 1935, received and read with great interest.

"I am glad something in this line has been done, and hope it will awake the Engineering profession as a whole to the many advantages we would gain by having most of our work tied in to the U. S. Coast and Geodetic Survey, and thereby it would "pave the way" for us in getting a bill passed, in establishing a system of plane coordinates for our State, and to start with, have our system of State Highways and all new resurveys by the General Land Office, tied in to the U. S. Coast and Geodetic Survey. Thus we would gradually work up to having most of our important work tied in to the above system.

"If we only could get started in the right direction, so that people would have a chance to become educated to the permanence of this work, they would begin to demand it, and by that time the Geodetic markers would be closer together, and it would become comparatively easy to make the required ties. . ." (Mr. J. A. Gjelhaug, C.E., Chippewa National Forest, Cass Lake, Minnesota.)

- Δ -

A FEW TRICKS IN RECONNAISSANCE

L. G. Simmons

In profiling a line or determining the relative position and elevation of a proposed triangulation station or prominent object, particularly in fairly open country, there are some short cuts available to the reconnaissance engineer which not only reduce the time but also increase the accuracy in obtaining this data. Fol-

lowing is a description of some methods used in the field to this end. Instruments required are a hand azimuth-compass, transit with vertical circle (reading to one minute is sufficient), a tape at least 100 feet in length, and a slide rule. The last mentioned is not necessary, but is of great convenience.

Many times each day, during the course of triangulation reconnaissance, the knowledge of the distance and relative elevation of a water tank, hill, tree, house or some other object, becomes highly desirable, either in determining the position and elevation of the object itself, or the reverse; i.e., the determining of the position and elevation of the observation point from a known object.

The distance and relative elevation of an object not more than 12 miles or so away can be determined in 5 or 10 minutes with an accuracy of about 0.2 mile and 5 to 10 feet of height. No mathematical tables are needed. All that must be known is that the earth's curvature in feet equals 0.574 times the distance squared (in miles) and that an arc of one minute is subtended by $1.53\frac{1}{2}$ feet at the distance of one mile.

Figure 1.

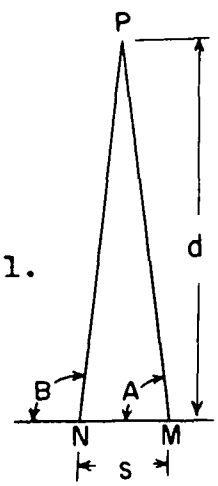
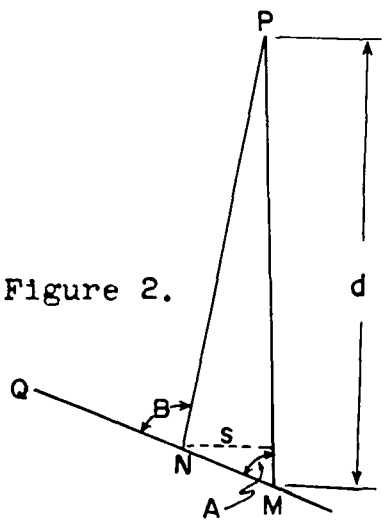


Figure 2.



Consider Figure 1. Required the distance (d) from the instrument position at "M" to an object at "P". (The angle in this figure is greatly exaggerated.) Select a point "N" at a distance of "s" feet from "M" and at about a right angle from "P". Measure angle A; then set over point "N" and measure angle B. Angle P then is equal to B minus A. In other words a distance of "s" at the observation point subtends an angle of "P" at the distance "d" of the object concerned. The distance "d" then becomes $s/1.53\frac{1}{2}$ P; "d" being in miles, "s" in feet and "P" in minutes. The principle involved here is, of course very simple. Difficulties arise, however, in actually accomplishing this measurement in the field in a reasonable time and with an accuracy sufficient to make the result of any value. It will readily be seen that the instrument must be very accurately centered over M and N, which, in windy weather would take considerable time. This difficulty is overcome by first selecting a second distant object "Q" anywhere from about 1/4 mile on up - the further, the better. And this

object does not necessarily have to make a right angle with "P" but any angle - say from 35 degrees to 145 degrees. The nearer this angle is to 90 degrees, however, the more effective will be the base.

The instrument is now set up over M and sighted toward Q (see Figure 2) and the point N lined up with Q at a distance of, say, an even 100 feet. Angle A is now measured using Q and P as sights, and, leaving the plates still reading angle A, the instrument is set over N and the angle B is "unwound" from P to Q, and what remains on the plates (negative in this case) is angle P. In case angle B is measured first, then the value P on the plates will be positive after the mechanical subtraction. If a minute transit is used and the distance "d" is very great, angle A should be "wound up" three times at M and "unwound" three times at N, leaving a value of 3P (negative) on the plates. The 100 foot base (MN) is reduced to the effective base "s" by multiplying by sin A (slide rule). If "d" is about 10 miles, an error in the base of one foot will affect the result only about 0.1 mile; and an error of several inches in the alignment of point N, if Q is at a considerable distance, will have no appreciable effect in the result. Point M need not be marked on the ground at all, and N only with a rock or stick until the instrument can be placed over it. No plumb bob is needed. The instrument can be placed over N by eye closely enough. If one man is working alone, the point N can be occupied with the instrument first and M then lined up with N and Q by eye, hooking the tape to the instrument over N and backing up, say 100 feet, and dropping a rock in line at this distance.

For distances "d" up to about 5 miles, an accuracy of better than 1/4 mile can be determined merely by setting up at M, measuring A, picking up the instrument and pacing 100 feet toward Q and "unwinding" angle B at N. Points P and Q may be the top of a water tank, gable of a house, branch of a tree, rock on a hill or any object on which a fine pointing can be made. A greater accuracy can be obtained by increasing the length of the base, but 100 feet is sufficient for distances up to about 12 miles, and is convenient when a 100 foot tape is used. The relative elevation of P can easily be determined, of course, from the vertical angle to it, after the distance is known. Many times during the profiling of a line the elevation and distance of an intervening possible obstruction are desired. These can be determined with sufficient accuracy by the "pacing" method mentioned above, in about two minutes of time.

In open country, relative elevation of all stations can easily be determined from prominent objects such as water tanks, grain elevators, hills, etc., and in sectionized country where all points can be plotted accurately, there is no need for the measurement of distances, merely of vertical angles. This reconnaissance party has been supplying elevations of all stations after making ties to known sea-level elevations. At times it has been as much as 200 miles between ties, but the elevations have never failed to check

better than 25 feet except once when the error was 40 feet.

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Once the relative elevations and distances between stations of the reconnaissance are known, there is a very rapid method (in open or fairly open country) in determining the height of signal that will be certain to clear the line. The field work consists only of taking the maximum vertical angle to anything on line from each end of the line; i.e., set up at one station, point the telescope to the other by means of a compass, and tilt the telescope upward until the center horizontal hair just clears everything on line, allowing, of course, for small errors in horizontal pointing, and read the vertical angle. This process is repeated at the other end of the line. The point where these two verticals meet represents the worst possible obstruction in the line, and if signals are computed and erected to clear this point, an obstructed line cannot result. However, if the objects to which these vertical pointings were made from each station are at a considerable distance along the line, the computed signal height will be too great. The nearer these two objects are, the more closely the computed signal heights will represent those necessary to just clear the line. It very often happens that the two verticals are taken to the same intervening ridge, line of trees, buildings or other obstacles; or, if not the same, to obstacles fairly close together. When this is true, no better determination of the necessary signal height can be made. It also happens very often that the signal heights computed in this way are equal to or lower than those needed over other lines, and further investigation of the line in question is automatically eliminated.

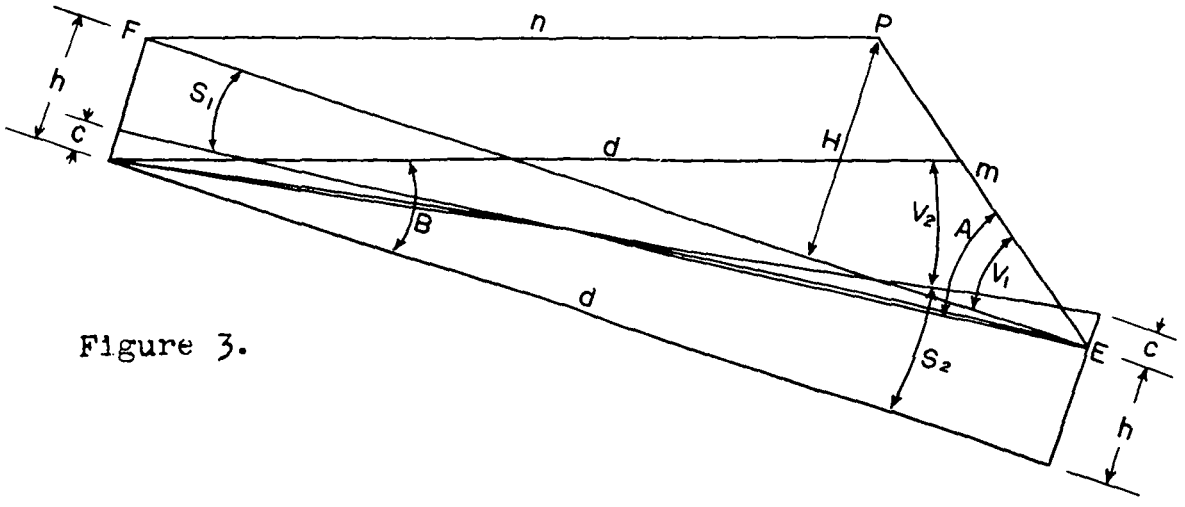

Figure 3.

The solution of this problem is indicated below. Consider Figure 3:

E and F are the stations at each end of the line in question.
d is the length of the line in miles.

V_1 and V_2 are the maximum verticals in minutes taken from E and F respectively.

S_1 and S_2 are the actual slopes of the lines EF and FE computed at E and F respectively, taking into consideration the difference of elevation between E and F and the curvature over the line EF. It will be seen that these slopes (expressed in minutes in this problem) are different, as the curvature will have a negative effect in one case and positive in the other.

P is the point at which the two maximum verticals meet.

H is the vertical distance between P and the line EF, in feet, and is the signal height necessary at both E and F to clear P.

m is the distance, in miles, from E to the point P.

n is the distance, in miles, from F to the Point P.

A is equal to V_1 minus S_1 and B is equal to V_2 minus S_2. Both A and B are in minutes.

The curvature over the line EF is $.574d^2$.

Assuming "h" to be the difference in elevation between E and F, (F the higher station) expressed in feet, then

$$S_1 = \frac{h - .574d^2}{1.53\frac{1}{2}d} \quad \text{and} \quad S_2 = \frac{-h - .574d^2}{1.53\frac{1}{2}d}$$

A and B then can be readily computed from the above formulae.

Now, as A and B are relatively very small angles, we have

$$\frac{A}{B} = \frac{n}{m}, \quad \text{and } m + n = d.$$

m and n can quickly be solved on the slide rule, by setting up the ratio $\frac{A}{B}$ and running the glass along the rule until two quantities are found which add up to d.

H then equals $1.53\frac{1}{2}$ mA or, for a check, also equals $1.53\frac{1}{2}$ B.

The height of signal needed to clear P then is H feet at both E and F. In case equal signals are not desired (a higher signal may be needed at one station for some other line, thus making it possible to reduce the signal at the other station) then, for example, if the signal at E is raised 26 feet, the signal at F may be reduced $\frac{n}{m} \times 26$ with safety.

The above solution may appear a bit too formidable for field use, but a very small amount of practice has proven that it can be done easily in three minutes of time. This method of computing signal heights makes it unnecessary to get on the intermediate point for instrument work, and as the maximum verticals taken are to the top of the obstruction, no separate measurement or guessing of tree heights or building heights need be made.

Of course, there are types of country where these methods will be of little use, but it will very rarely occur where at least a modified form of one or all of these methods cannot be employed to advantage.

- Δ -

MONTANA EARTHQUAKE OF OCTOBER 18, 1935

In Japan and the western part of the United States, surface movement is a not uncommon accompaniment of severe earthquakes. In Japan geodetic work almost automatically follows such an earthquake. In the Idu shock of 1930, precise levels were in progress in the epicentral region and rerunning of the lines was almost immediate and was carried on while strong aftershocks were still in progress.

The geodetic parties of the Coast and Geodetic Survey have during the past ten years, made geodetic surveys in regions of seismic activity to determine the movement of the ground when an earthquake occurs and to secure data that could be used in making studies of earth movements of future earthquakes. Levels were repeated after the Long Beach earthquake of March, 1933. In addition, levels were rerun in the central region of the northern Utah earthquake of July, 1934, and levels were run in the region of the Cedar Mountain earthquake of December, 1932, though there were no previous levels for comparison.

From October 12 to 18, 1935, there were more than 200 shocks of varying intensity which were felt most strongly in the vicinity of Helena, Montana. The one on October 12, was particularly strong but the main shock was on October 18 and resulted in the loss of several lives and $3,000,000 damage to property. Cracks in the ground were reported to the northwest of Helena. Mr. F.P. Ulrich, in charge of the strong motion work of the bureau in California, proceeded with his assistant, Mr. D. S. Carder, on the day following the principal shock and by the night of October 21, he had two instruments for recording strong motion set up in the Federal Building at Helena. He recorded a considerable number of aftershocks. He also made other investigations in connection with the earthquake, among them, an attempt to outline the area over which geodetic work might be called for. The first epicenter as determined from telegraphic reports was about 40 miles northeast of Helena but with more reports it became evident that it was within ten miles of the city. This was confirmed by the distribution of the damage and by the records of the aftershocks which indicated that the point of origin could not be far away.

Immediately after the earthquake, Mr. Francis A. Thompson of the Montana Bureau of Mines and Geology, requested the bureau to repeat geodetic work in the vicinity. While no such work has been done in the vicinity of Helena for the main purpose of laying a foundation for earthquake studies, there are many lines of levels in the region and also triangulation. There is, therefore, ample opportunity to obtain useful results by repetition of either class of work. However, it is not likely that the work can be done in the near future unless additional funds are provided.

- Δ -

REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during August, 1935:

First-order - - - - - - - - - - - - - - - - -	157
Second-order - - - - - - - - - - - - - - - - -	0

* Completed during September, 1935:

First-order - - - - - - - - - - - - - - - - -	0
Second-order - - - - - - - - - - - - - - - - -	0

Total miles of triangulation completed to September 30, 1935:

First-order - - - - - - - - - - - - - - - - -	61,357
Second-order - - - - - - - - - - - - - - - - -	5,527

* Most field work ceased in August due to lack of funds.

Levels:

Lineal miles of levels completed during August, 1935:

First-order - - - - - - - - - - - - - - - - -	61
Second-order - - - - - - - - - - - - - - - - -	318

* Lineal miles of levels completed during September, 1935:

First-order - - - - - - - - - - - - - - - - -	260
Second-order - - - - - - - - - - - - - - - - -	29

Total miles of levels completed to September, 30, 1935:

First-order - - - - - - - - - - - - - - - - -	106,601
Second-order - - - - - - - - - - - - - - - - -	154,805

* All progress for September is releveling.

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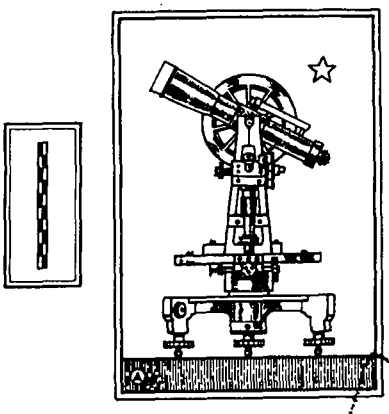

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G E O D E T I C L E T T E R

December, 1935

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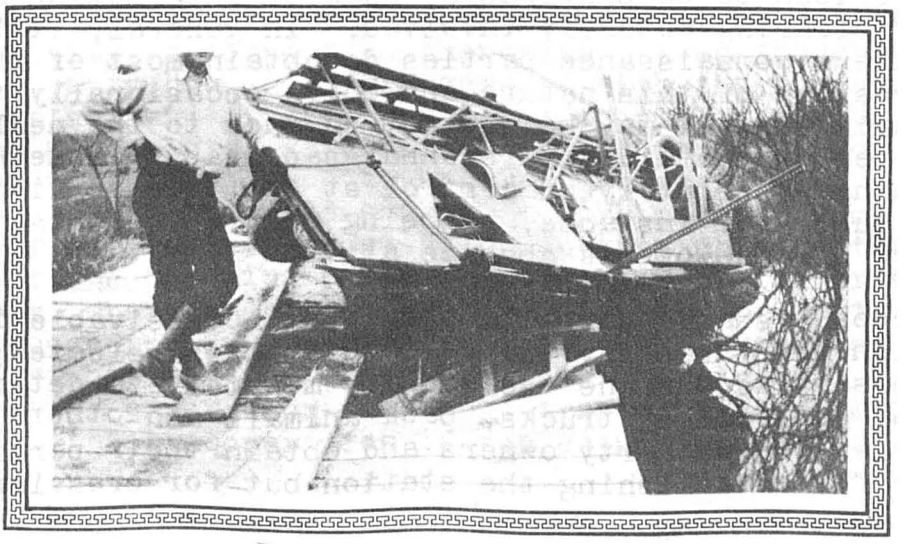
JUST ONE OF THOSE THINGS

Failure of private bridge 26 miles from nearest habitation in Encinal, Tex. Truck driver had to walk back for assistance. Bridge was torn down, truck eased into the stream then pulled out with winch truck. The bridge was then rebuilt.



COOPERATION BETWEEN RECONNAISSANCE AND TRIANGULATION PARTIES WITH ESPECIAL REFERENCE TO CONTACTS WITH THE PUBLIC

C. L. Garner

Chiefs of reconnaissance and triangulation parties frequently make recommendations to this office with regard to the necessary details of work which they say should be accomplished by the other organization so as to facilitate their own part of the field work.

Because of this it seems important to contrast the character of the work of the reconnaissance and triangulation parties for the purpose of bringing out the essential features which should be performed cooperatively by each of the parties in order to avoid duplication and to accomplish the completed field work with the least effort and cost. It must be borne in mind constantly that once the survey work is completed, the station marks are the only tangible results remaining from it, and in order that the greatest use may be obtained from these marks it is necessary that they be of service to the greatest number of people for the greatest possible length of time.

Triangulation parties sometimes complain that their building parties and lightkeepers have been delayed in reaching the stations for want of accurate descriptions of the routes to the station; lack of information as to the availability of pack animals and supplies; whether boulders or outcropping bedrock will make it possible to install the marks in them or if concrete marks will be required; whether the stations may be reached by pack animals the entire way or only partially so; lack of specific estimates of the heights of signals required or, if clearing is decided to be preferable, lack of information as to the amount of clearing actually involved. In general, it is believed that the reconnaissance parties do obtain most of the essential information of this nature and while occasionally there may be some omission, it may be due not so much to the negligence of the person who did the reconnaissance as to something over which he had absolutely no control at the time he visited the station; such, for instance, as being unable to contact the property owner because of his absence at that time.

For a reconnaissance party to obtain all conceivable information which might be of value at each station selected, it would be necessary to examine the country minutely to determine every route of approach by trucks, pack animals and otherwise, and to interview the property owners and obtain their permission not only for establishing the station but for crossing the

land in getting to the station. Many times people are not at home and for the reconnaissance party actually to interview and obtain the necessary permission for every possible operation might require as much as several days for a station. The triangulation party rarely needs all of such information because, in the majority of cases, the approach to the station described by the reconnaissance party is the only one that is practical and the remainder of the work would be useless.

Reports from triangulation parties indicate that there were a few stations which apparently were not visited by reconnaissance parties. The reports came from parties working in the west where most of the stations were on mountains or hills which did not require the use of towers. No station can be properly described unless it has been visited, and a poor description may easily result in the loss of a day's time to the building party and perhaps to the observing party as well. The average triangulation party, as compared to the reconnaissance unit, is composed of a large number of men who are working on a definite schedule and any interruption in their program causes delays which are expensive. All points therefore, regardless of how conspicuous or obvious their selection may be, should be visited by the reconnaissance man and an adequate description written covering the approach and other conditions so that there will be no possibility of the triangulation party being delayed. It seems particularly important that those in charge of both the reconnaissance and triangulation parties should have as their objective the completion of the entire project in the most efficient manner and with the lowest unit costs.

The matter of interviewing property owners for the purpose of obtaining permission for establishing the stations, entering or driving across their property, etc., is something which the reconnaissance party will never be able to do so thoroughly that the triangulation party will be relieved of responsibility in connection therewith. Even though the reconnaissance party has made arrangements with the property owner for the establishment of the station it will never be able to make such a complete explanation of what is to be done that the owner will be willing to have the triangulation party proceed through his premises and start work without some additional word of explanation. Ordinary courtesy demands that the foreman of the building party or the chief of the triangulation party, where practicable, interview the property owner before proceeding to the station. In such matters as these, property rights must be observed because it is only by contact with property owners and courteous treatment of them that we can obtain their cooperation in the establishment and protection

of our stations. Fences must be left in as good condition as when our parties entered the property. Gates should be closed and trucks should not be driven over the land any more than is absolutely essential. Ruts formed by driving trucks in soft land should be filled in on completion of the work since if they are left unfilled they become the beginning of washes at the first heavy rain.

Some of those engaged on triangulation recommend that the reconnaissance parties should select and temporarily mark the exact location of the station marks, reference marks and azimuth marks. Perhaps the reason behind this suggestion is the fact that frequently the station and azimuth marks are on land which is not owned by the same person. In such case, naturally, separate permission for the establishment of the azimuth mark is required and, since the reconnaissance party is smaller, the cost of the extra time required to obtain this permission would be considerably less if this particular part of the work were done by the reconnaissance unit. This difference in the cost of operation between reconnaissance and triangulation parties should never be forgotten by the reconnaissance man. However, it does not seem necessary or reasonable that the reconnaissance man should be required to definitely select the positions for all of the marks. Temporary marks are frequently disturbed or moved and this might easily lead to confusion or cause the building party to misplace the permanent marks.

It is always well for the foreman of the building party to proceed to the station slightly in advance of the building party in order to interview the property owner and explain that he is prepared to establish the station, build the tower, etc., and to initiate the triangulation for which the reconnaissance man previously obtained his permission. Such a contact is appreciated by the owner of the property because his rights are respected and he is impressed by an organization which proceeds systematically and explains reasons for and benefits of the work.

This question of contact with property owners is a very important one as it involves the protection and therefore the permanency of our stations. Chiefs of party who approach the owner in a courteous businesslike manner impress him with the valuable nature of the work and create in him a desire to cooperate heartily in maintaining the station. Where the triangulation party does not follow the reconnaissance party within a period of two or three months, it becomes necessary for the property owner to be interviewed all over again and be given a further explanation of the necessity of the work for many of them may have changed their minds or at least may need to be reminded of the previous contact by the reconnaissance man.

Some parties have a system of interviewing all property owners in advance of the building party and also use a form for reporting this interview. This same form passes through the hands of the building party, observing party and tearing down party and is initialed by each foreman or observer in turn. The use of this form by one party was very successful and no damage claims have been received.

Repeated contacts with property owners or other interested parties must not be considered as duplication of effort but as something essential in educating the public to the value of our work. In fact, the little extra time spent in explaining the purposes of our work and the value of our stations often gains a friend for the Survey.

The relations of our field parties with local people in these matters may be the deciding factor as to whether the Coast and Geodetic Survey will be regarded in a friendly or hostile way in that community. A single dissatisfied person can influence many people to his point of view, particularly when our parties have moved elsewhere and there is no one to come to our defense.

The same thing is true of correspondence between the chiefs of party and outside people, particularly property owners. Letters should be courteous, and should be written with the view to securing cooperation with the public through friendly dealings rather than by any brusque attempt to show the authority of the Government.

Many citizens undoubtedly feel that the Federal Government has the right of eminent domain and therefore they are hesitant to refuse our employees entry on their land or permission to establish stations on their property. But it is much to be preferred that permission for the station be granted because of a desire to cooperate with the Government rather than from a feeling of compulsion.

We know that eventually every property owner on whose land one of our stations or bench marks is located, will be benefited by it, and the work of our parties should be such as to educate them to this fact. When they see this, the information will be passed on to their neighbors and, from then on, our field officers will have very little difficulty in obtaining entrance onto private property for the purpose of extending our control work.

These sidelights on the relation between the reconnaissance and triangulation parties and the desire for more thorough cooperation between them in the accomplishment of the final task, is published with the hope that it will be read and studied by all of our field personnel. Comments are invited in order to obtain all viewpoints on the subject. Constructive criticisms will be printed in the Geodetic Letter.

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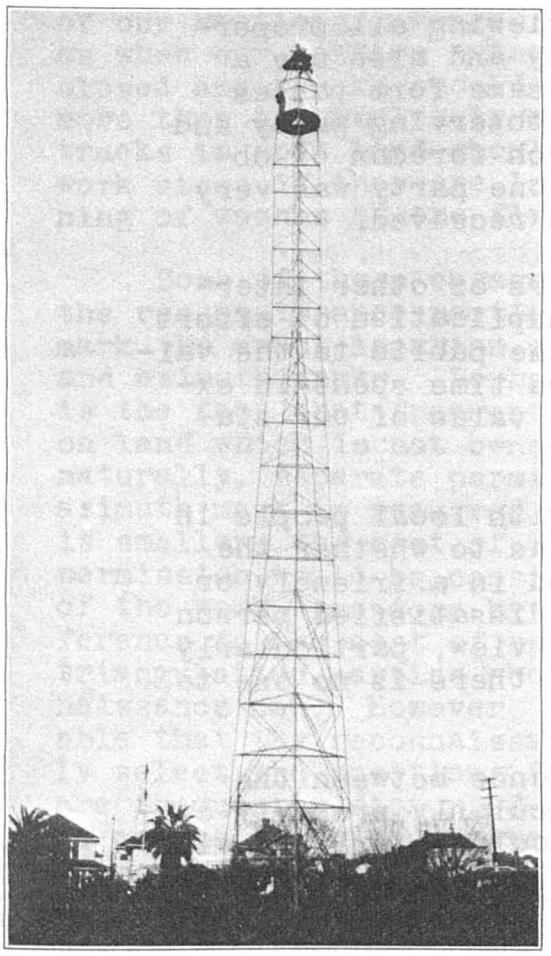
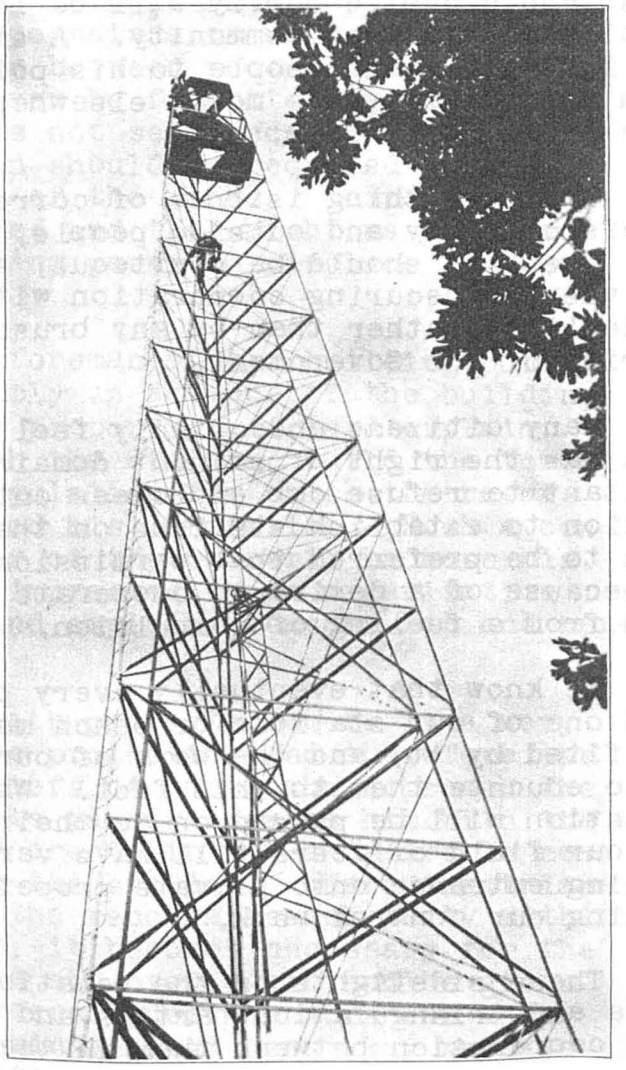


UP IN THE AIR

Steel tower, 123 feet high erected to see over obstructing tree tops at South Base, Palo Alto, California.



On the right is shown a Bilby steel tower giving a view of the intricate, detailed structure of the inner and outer portions of the tower as it nears completion.

THE COAST SURVEY

Under the general heading of "The Coast Survey" there appeared in the Princeton Review for April, 1845, a splendid article describing in some detail the purposes and methods of such a survey. While that article is too long to permit its being reproduced here in its entirety, the following excerpts should prove of interest to the readers of the Geodetic Letter. They form an excellent commentary on the firm foundations upon which our first Superintendent, Ferdinand Hassler, built this great organization. We are indebted to Prof. Philip Kissam of Princeton University, for calling attention to this article. ---Editor.

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"Our readers who are in the habit of perusing the proceedings of congress, must have seen frequent notices of the important work now in progress in our country, called the coast survey. Yet from the tenor of the frequent inquiries we have heard in reference to this work, we are led to believe that there exists in the public mind generally no very definite idea of its nature and importance. We have therefore thought that a few pages of our review devoted to a popular exposition of the objects, the method of operation, and the history of the survey, would not be uninteresting to our readers; and perhaps be of some service in the way of enlisting public opinion more generally in favor of the work, and of a liberal appropriation of means for its proper and speedy completion.

"The principal object of the coast survey, is the formation of an accurate map of the outline of our extended seaboard, from its northern extremity in the state of Maine, to the limits of our possessions on the Gulph of Mexico; giving the latitude and longitude of the principal points, a minute delineation of the line of the shore, a sketch of the topography of a strip of the country parallel to the coast, an exact determination of the form of the bottom of the sea, within the space limited by the depth accessible to the ordinary sounding-line, the nature of the bottom, whether of clay, sand, or gravel, the position of bars, channels, and harbours, the direction and velocity of currents, the depth and temperature of the water, the bearings of the magnetic needle, and all other particulars immediately connected with the wants and improvement of navigation. In the accurate determination of these points of immediate practical utility, a number of results in the highest degree interesting to science will also

be obtained. Such as the data for a new determination of the form and magnitude of the earth; the variation of terrestrial gravity; additions to our knowledge of the phenomena of terrestrial magnetism, and other determinations of a purely scientific nature, which are regarded with the highest interest by the learned in every part of the world.

"The importance of such a survey must be evident to every one who reflects on the nature of the art of navigation, and its connexion with the commerce, and consequently with the prosperity of our nation. It is not, however, a work in which this country is alone interested, but one which affects the whole civilized world. It is a duty which every nation owes to every other, and to humanity in general, to furnish the mariner with an authentic delineation of its coast. The dangers which threaten the sailor in the midst of the wide ocean, are nothing in comparison with those which beset him as he approaches the land. With 'a seaworthy' vessel, and a wide space for unobstructed motion,he can laugh at the ordinary force of the winds and the waves. These, however,formidable they may appear to the inexperienced landsman, are formed of yielding materials, and usually spend their force in merely changing the direction of the vessel, or in urging it more rapidly on its way; but the mere suspicion of a sunken rock, the position of which is not precisely known; or the unexpected appearance of a breaker, is sufficient to strike with terror the mariner who would brave unflinchingly the lightning and the tempest. The alternatives of life and death, of wealth and poverty, are almost every day unavoidably staked by some one on the accurate determination of the position of a head-land, a sand-bank, or the true direction of the needle; and culpable must that nation be in the eyes of the world, who boasts of civilization, and yet does not furnish the data for these determinations...

"The ordinary methods of land surveying, are entirely inapplicable to a work of this kind. It is impossible to combine together the partial determinations of small districts so as to produce an uniform and consistent whole. The length of a line of forty or fifty miles, extending from one jutting point to another, across the water, is often required within a limit of error which does not exceed a few feet, or perhaps inches; and the position of points must be determined at the distance of many miles from land, to serve as the bases of sounding operations. The only method which can be employed to obtain accurate results of this kind, is one in which lines and angles are measured by means of trigonometry, combined with astronomical observations at the more important points. This method constitutes a branch of physico-mathematical science, to which the name of geodesy has been applied. Its origin is to be referred to the various labours which have been instituted since the time of the astronomers of Alexandria,

to determine the form and dimensions of the earth; but it has only been brought to any degree of perfection since the middle of the last century, by the labours principally of the English and French surveyors . . . . .

"It might appear, at first sight, that the process here described, is one of no great difficulty of execution, and that it could be safely intrusted to men of ordinary scientific acquirements. Indeed, such an opinion has been expressed in congress: but nothing can be further from the truth; and any line of policy in reference to the coast survey, founded on this opinion, would be attended with the most disastrous consequences to the success of the work. Every error of measurement or of observation, every fault of calculation or omission of circumstances, is increased and multiplied as the survey is extended, until they amount to discrepancies utterly inadmissible in an operation of this kind. To insure, therefore, the requisite degree of accuracy, all the resources of physical science, and all the appliances of the mechanic arts, must be brought into requisition to meet the difficulties which present themselves from time to time, under the constantly varying circumstances. The truth of these remarks will be evident from a more minute examination of some of the processes of the operation. . . ."

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AFTER THE STORM

Camp at Columbus, Nebr., after a tornado. No towers in this vicinity were wrecked.

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NEW JERSEY ADOPTS PLANE-COORDINATE SYSTEM

Philip Kissam

(Reprinted from Civil Engineering for November, 1935.)

On March 25, 1935, Governor Hoffman signed a bill that had just been passed by both houses of the New Jersey state legislature. This bill defines and adopts the plane coordinate system which has been devised for the state by the U.S. Coast and Geodetic Survey. Its enactment is one of the most important forward steps that has been taken in many years in the very old art of describing boundaries.

The idea of describing property by metes and bounds instead of relying entirely upon boundary markers like fences and streams, is believed to have developed in ancient times in Egypt, where the fertile lands bordering the Nile were cultivated after the annual flood had subsided and after all marks showing the boundaries of individual properties had been destroyed by the inundation. A crude form of surveying was developed which made it possible to re-run these boundary lines annually. When the compass became an instrument of some precision, the use of metes and bounds became an acceptable aid in the description of property. Owing to the various inaccuracies of the compass, its chief use was to aid in the recovery of old points marking the boundary, and for that reason it never became an acceptable primary method of finding the land.

With the development of the transit and the steel tape, a peculiar condition arose in regard to property descriptions. Over small areas an ordinary transit survey will locate the property as accurately as will markers. Thus descriptions by taped distances and transit angles were more and more relied upon by surveyors required to stake out property corners. However, the old custom persisted of describing the location of a property by reference to a point of beginning difficult or impossible to find, with resulting disagreements in the actual location of the land. Persons transferring property were advised to include in the description references to adjoining properties. Moreover, legal advice often indicated to the person selling the property that he would be more certain in his guaranty of title if he sold the property according to the description of it given in the deed by which he originally acquired it. Thus, partly owing to poor points

of beginning and partly to old recopied descriptions which were not accurate enough for the type of real estate involved, there has grown up in this country a peculiar situation -- there is no lack of the surveying skill needed to accurately locate property but the results are vitiated by improper methods of application.

Problem of Finding the Point of Beginning

Another factor that has had an unfortunate effect on the accuracy with which property is located is the importance attached to long and careful search of title. This factor accounts for the fact that descriptions of property have been worded so as to facilitate following the chain of title back to the original grant. This has also encouraged the tendency to use, not a modern description of property, but the original description as provided to the buyer of that particular division of land.

The land surveyor has thus been confronted with the problem of locating property by an old description and without proper points of beginning. Where the land is in a town, the point of beginning is usually described as being at a given distance and in a given direction from a street intersection. Usually no worse point could be chosen. Street intersections, being on public land and not subject to adverse possession, are not carefully watched, are poorly described, and are seldom officially marked. The determination of a street line becomes almost an impossible feat. Thus land surveyors have been forced to locate property by means of descriptions which do not agree with ground conditions.

A special technic has been developed, and it has become necessary to have especial information for each particular locality. Surveyors have often been obliged to do a large amount of research merely to lay out one piece of property. In order to get returns on this research, they found it necessary to resort to private marks to make it impossible for other surveyors to reap the rewards of their expenditures. More confusion developed. Title companies were obliged to employ staffs of surveyors so that it would be possible to locate property consistently over large areas.

With modern surveying skill, this sort of confusion, resulting in expensive boundary litigation as well as costly errors in the location of buildings and other structures, can be eliminated. If the confusion is to be entirely eliminated, however, one important principle must be followed. Throughout large areas points must be established and carefully marked by permanently set and thoroughly described monuments, completely

interconnected by surveys, so that the monuments can be replaced, when lost, by surveys from other monuments in the system. The lines and distances coordinating such monuments must be measured by surveying methods of the highest type. Rigid, accurate control for these surveys is essential.

Work of the U. S. Coast and Geodetic Survey

Starting well over a hundred years ago, the U. S. Coast and Geodetic Survey established a nationwide network of triangulation. To this system Canada and Mexico also tied in their triangulation, thus rigidly connecting all points throughout North America. In 1927 the geographic positions of all stations in the vast network were adjusted and established on a final datum. The positions of the stations resulting from this adjustment are referred to as being on the North American datum of 1927.

The arcs of first-order triangulation of which this network is composed average 10 miles in width and are generally spaced in the form of a grid system at intervals of 50 miles in each direction. Between these primary arcs are arcs of second-order triangulation reducing the distance between triangulation control stations to about 25 miles. Other work of the Coast and Geodetic Survey has further enlarged the areas controlled by triangulation. The State of New Jersey is particularly fortunate in having several thousand triangulation points within her boundaries, and within the next year the entire state will be property controlled by this net.

Employing men temporarily out of work, and initially through the use of Civil Works Administration funds, the Coast and Geodetic Survey established local control survey projects under its direction in every state of the Union, thus increasing the number of control points available. With the discontinuance of the Civil Works Administration program, these surveys were continued in a number of states under the Emergency Relief Administration. The Coast and Geodetic Survey does not now have control of these projects but acts in an advisory capacity to ensure that the results obtained are in accordance with the high standards of accuracy necessary for such work.

The greater part of these local control surveys have been made by transit traverses, with results having a ratio of error of less than one part in 10,000. The traverses are run from one triangulation point to the next, azimuth control being determined by special azimuth points set by the Coast and Geodetic Survey at every triangulation station. The field results are adjusted first for proper angular closure and second for traverse closure. In this way very accurate positions are determined for all points in the traverse. Monuments to mark

the traverse points are set in pairs, the monuments in each pair being spaced approximately a quarter of a mile apart, so that surveys starting from them will have adequate azimuth control. The pairs of monuments are set at two-mile intervals or less along important highways and important streets in towns.

Thus there is gradually developing throughout many states a complete control net of monumented points cohveniently and accurately located. The use of geographic coordinates for these points is too complicated to appeal to the local engineer. Since such coordinates are employed mostly for surveys of large areas, few engineers are familiar with their use. The necessity of developing some simpler system therefore became apparent. As plane rectangular coordinates are well understood and are easy to use, it was felt desirable to develop an adequate system of such coordinates.

The Coast and Geodetic Survey has adopted systems of coordinates for every state in the Union. The Lambert projection was used for states having the longest dimension east and west. Where the area was very large, two or more of these projections were used.

Transverse Mercator Projection for New Jersey

For states having the longest dimension north and south, the Coast and Geodetic Survey developed a novel and ingenious projection having many advantages. This has been called the "transverse Mercator projection". For New Jersey the meridian of 74° 40' west longitude has been used as the great circle which corresponds to the equator in the ordinary Mercator projection. Distances along this line have been computed from a point just south of the southernmost land in Cape May, actually the point where the parallel of latitude 38° 50' north intersects this meridian.

As the scale of a Mercator projection increases with the distance from the great circle assumed as the origin, it was arbitrarily made one part in 40,000 too small at the central meridian of 74° 40', in order to reduce the scale correction to a negligible factor. Thus, as the scale increases, the error becomes zero at lines drawn parallel to this meridian approximately 28 miles east and west of it. Beyond these lines, the scale of error runs up to approximately one in 40,000 too great at the easternmost point of the state on the Hudson River, and to approximately one part in 20,000 too

great at the westernmost point in Salem County on the Delaware River. The meridian of 74° 40' west has been given an east or x coordinate of 2,000,000 ft, and the intersection of this line with latitude 38° 50' north has been given a north or y coordinate of zero feet, thus placing all points in the northeast quadrant, where all coordinates are plus. The x and y coordinates can be distinguished by the number of digits.

Having arranged such a projection for the State of New Jersey, the Coast and Geodetic Survey computed the plane coordinates of nearly all triangulation points within the state boundaries for which the geographic positions had been determined on the North American datum of 1927. The geographic positions were not determined for the traverse monuments of the local control survey, plane coordinates being used instead.

In the greater part of the state, that is, between the 28-mile lines previously described, an accurate measurement in the field will give a distance slightly greater than that given by the coordinates of the triangulation points, whereas east or west of these lines it will give one slightly less than that given by the coordinates. For all but a few square miles in Salem County, the measured and computed distances agree within one part in 40,000 or better. As the accuracy of surveying work is seldom required to be better than that represented by an error of one in 40,000, this projection is a very happy one. The projection, or grid bearing of a straight line on this projection, is the same throughout the line, but the true bearings of such a line vary approximately one minute per mile for every mile traversed in an easterly or westerly direction.

Advantages to be Secured

The advantages of such a system are immediately apparent. Throughout the entire state, a surveyor making a connection with points on this system, and computing the coordinates of his stations by the usual method of latitudes and departures, will arrive at the correct coordinates, based on the New Jersey system. Given a pair of coordinates at each end of a line, the length of the line can be computed by taking the square root of the sum of the squares of the differences of the coordinates. The tangent of the bearing of the line can be computed by dividing the difference between the east coordinates by the difference between the north coordinates.

Thus there now exists in New Jersey a system of monumented points interconnected by surveys with their positions given on a plane-coordinate system extending throughout the state. When a property corner is described by coordinates based on this system, not only is the position of that particular corner capable of precise relocation but its position can never be lost. It is inconceivable that so many points in the system would be destroyed that no method would remain for accurately locating a particular corner.

France had a system of plane coordinates in the war zone, based on her triangulation net and computed by means of the Lambert projection. The landmarks destroyed during the war were reestablished after the cessation of hostilities by lines precisely located in their original positions as controlled by the remaining triangulation points.

The desirability of this arrangement is apparent to the most casual observer. The mechanics of its use for property descriptions involves certain considerations. The first essential is that it should be unnecessary for the surveyor to describe in detail in each deed the method by which the coordinate system was established. It was to satisfy this condition that the New Jersey legislature passed the act defining the basic system and giving it a name.

Because of considerations involved in search of title and the unfamiliarity of the system in general, it was thought unwise at first to describe property solely by coordinates. Until title examiners become familiar with the system and can compute lengths of sides and grid bearings from the coordinates of the ends of a particular boundary line, and until they become familiar with the coordinates of well-known landmarks, like streets in towns and old lines in the country, so that they can easily find a particular property and adjoining plots from the coordinates alone, it is recommended that the old form of description be continued with the addition only of the coordinates of each corner of the land described, and the following note included in the description: "Coordinates based on the New Jersey system of plane coordinates".

Besides the great advantage of permanency of location of property, several other major advantages of this system are apparent. With ordinary instruments magnetic bearings can be measured only very roughly, and variations in the direction of magnetic meridians are not charted with the degree of accuracy necessary for this type of work. True bearings based on astronomical observations are likewise not a

solution. The necessity of giving bearings more accurately than to the nearest minute of arc has long been realized. Unfortunately, because of the convergence of meridians, an east-and-west line 1,000 ft long in New Jersey would have a bearing at one end differing by as much as 12 seconds from that at the other end. The use of two bearings for the same line would require intricate computations and unnecessary detail in the work. Nevertheless, in order to reestablish a line of true bearings and observations on the North Star, just such computations would be required.

Grid bearings computed from the plane-coordinate system, however, are constant throughout the entire length of any line contained within the boundaries of the state. For the first time, bearings will have a definite meaning as well as being merely an adjunct to the description of angles. Deeds for adjoining properties having a common line will now give the same bearing for that particular line.

There are many reasons why the compilation of deed descriptions is necessary in certain areas. Tax maps, title examination, the acquisition of property by public agencies, all necessitate the preparation of a mosaic of lands made up from recorded descriptions. Because of different and inaccurate points of beginning and a lack of consistency in bearings, these descriptions seldom fit each other. The mosaic requires a degree of guesswork that often seriously vitiates its accuracy. Should old properties in such an area be described by plane coordinates, the compilation of such a mosaic would be a simple matter, and in many cases would be unnecessary.

A simple illustration will be given. When lots in the same block are supposed to abut along their back lines it is difficult to determine, by the use of present deed descriptions, whether the back lines do actually coincide. As a rule, the lots are described as fronting on their particular street, while the distance between the streets is usually a matter of question. Often a survey encircling the entire block is necessary, and even then guesswork enters into the final location of the common back line. When coordinates are used, this difficulty will be obviated.

Again, when rights of way are to be secured for the development of state highways, the vast cost of property surveys prevents proper study of the parcels of land to be acquired. Mistakes of a serious nature sometimes result. The state may actually acquire land that is never used and may fail to acquire some through which the highway passes. If

the properties along the route are described by plane coordinates, it will be necessary only for the center line of the highway to be properly tied to points on the coordinate system. The exact size and shape of the parcels to be acquired can then be obtained with facility. Modern planning calls for the acquisition of land by public bodies to a greater extent than ever before. Forest reservations, parks, riparian lands, highways, and public institutions are instances of the need for publicly owned areas. As this method of describing land is more widely adopted, the taxpayers of New Jersey will be saved large sums of money each year.

Full Use of System to be Attained Gradually

It is generally conceded that the full use and development of the plane-coordinate system must be attained by degrees. The advantages gained by the owner of property thus described should be pointed out by every thoughtful land surveyor. If a property is within a quarter of a mile of control points, it is believed that the necessary survey connections can be made without undue cost to the land owner. Areas of property described by coordinates will thus develop around the control points. Undoubtedly, in making these surveys, the surveyors will establish points that can be used as a basis for extension of the system.

When the public becomes aware of this system, there will be a demand for the use of coordinates in describing properties acquired. This will force private and public surveys to be run, extending the system even further. Many towns in New Jersey are already considering municipal ordinances requiring that the plane coordinates of property corners in new subdivisions be stated on the approved plans. Modern ordinances are being developed with the general idea that all subdivisions within a quarter of a mile of control points will be required to show coordinates of corners on the filed plan. Those subdivisions lying more than a quarter of a mile from these points will be prohibited from using standard coordinates, according to the present plan.

The law described provides a method for establishing official control points by any surveyor if he uses the method adopted by the U. S. Coast and Geodetic Survey for second-order traverse or triangulation work. Thus, subdivisions which wish such coordinates and which lie within a quarter of a mile of the present monuments can make use of them by establishing a traverse according to these requirements. In this way the use of the plane-coordinate system will be extended.

It is unnecessary to point out that the control points form a basis for all types of engineering surveys, not only providing a convenient and accurate method of checking and controlling these surveys, but also providing a horizontal datum which will automatically interconnect all surveys and maps based on this system. The engineering advantages of such a control system are sufficient to require its establishment. New Jersey has had the foresight to facilitate its use in property descriptions.

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CONTRAST IN CAMPS
BEFORE AND AFTER TRAILERS CAME INTO USE

1934

1935

Above 4-unit camp, April, 1934, Alexandria, La.
Below, 4-unit camp, May, 1935, Benjamin, Tex.

TESTING PRECISION INSTRUMENTS

Among the duties of the engineers of the Coast and Geodetic Survey is the testing of the extremely delicate precision instruments used in the various types of work of the Bureau.

The actual work of testing the instruments and standardizing them is complicated by the difficulty of finding a place stable enough for the work. Even a building as firm as the Department of Commerce Building, Washington, D.C., is not sufficiently rigid for the nicety of the results required. The ideal place for testing a theodolite or a gravimeter would be a large cave such as the Mammoth Cave or the Luray Cave. In a cave there would be no tremors from passing vehicles to disturb the instruments nor would there be any distortions of the form of the cave as the sun moved across the heavens, as is the case under present conditions.

In order to overcome the effect of any shaking of the building caused by passing trucks, or heavy machinery in the building, special piers that are entirely separate from the concrete basement of the Commerce Building, have been set deep into the ground. They are separated from the ground floor of the building by means of plastic material. With this arrangement the effect of the vibrations of the building are eliminated.

One especially difficult piece of work is the standardization of the gravimeter. With this apparatus the value of gravity is determined at hundreds of points in the United States for use in chemical and physical laboratories and in the search for buried geological structures - a matter of great importance in the location of petroleum, minerals, ores and underground water. The pendulum makes one oscillation in about one-half second of time, but the observations must be made so accurately that the actual time the pendulum takes to make an oscillation may be calculated to the ten millionth part of a second. One can readily see that the smallest tremors in the pendulum support would seriously affect such observations.

The other operation that requires great stability or rigidity of form is the testing of the theodolites used in triangulation. A special pier, somewhat similar to the one used for the gravimeter, has been erected in a room in the basement near the west wall of the building as a support for the theodolite. This pier is also entirely independent of the concrete floor. Instruments known as collimators, which are telescopes with cross wires and an electrical illumination to make the wires visible to the observer, are

arranged on brackets fastened to the walls of the building to serve as fixed points for the theodolite observations. Three of these brackets are fastened to the inside of the west wall. In spite of the fact that this wall is 37 inches in thickness, it actually changes its shape as the sun shines on it in the afternoon. The observations made in the forenoon of a cloudy day, or at night, are very consistent with each other and seem to show that the collimators remain fixed in position. On the other hand, the observations made in the afternoon of a sunny day have a progressive change in value and differ materially from those made under the ideal conditions described above. Therefore, the engineers of the Coast Survey have abandoned their efforts to test theodolites in the afternoon of sunshiny days.

The theodolite is an instrument similar to the ordinary surveyor's transit except that it is of more refined workmanship with superior optics and has a circle ordinarily 9 inches in diameter instead of 5. The position of any pointing of the telescope with reference to the graduations of the circle, is determined by micrometer microscopes which are read to single seconds of arc. One can realize what accuracy is obtained with this instrument when he considers that the two sides of an angle of 1 second diverge only 12 inches at a distance of 40 miles. In making the field triangulation observations which involve great chains of triangles extending in many directions over our country, the sum of the errors in the three angles of each triangle average about 1 second of arc. Usually, any one angle is accurate to one-half second which is equivalent to a relative error in the two sides of an angle of 6 inches at a distance of 40 miles.

The distance from the theodolite to the collimators fastened to the wall of the Department of Commerce Building is about 20 feet. Therefore, an error of 1 second of arc would be caused by a movement of the wall of approximately 1/1000 of an inch. The actual maximum movement in the Department of Commerce Building is approximately 6/1000 of an inch - an amount which would not disturb anyone except some of the engineers in the Coast and Geodetic Survey.

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THE MODERN TOUCH

The addition of Model T tires to his ox cart enables this traveling storekeeper, near Wrens, Ga., to make his rounds in comparative comfort.

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ONE HUNDRED YEARS AGO

(Editor's note: The following letter written more than a century ago by Ferdinand R. Hassler, Superintendent of the Coast Survey, (U. S. Coast Survey, Reports 1816-1848), indicates that then, as now, a need for topographic surveys and maps was felt by the various states; that the value of geodetic control for such surveys was recognized; and that it was felt that the major control surveys should be made by the Federal bureau, while the detailed surveys should be a state responsibility. When one considers that less than half the area of this country has been mapped to date, and that many of our maps are hopelessly out of date, one realizes that our first superintendent was just about a century ahead of his time when he wrote :

Washington City, January 9th. 1834

MOST HONORED SIR:--In the course of last summer, Professor Ducatel, of Baltimore, informed me that he and Mr. Alexander had been appointed by the legislature of Maryland to make a topographical map of that state, and inquired of me for a

plan of execution of the topographical part and its junction with the Coast Survey.

Mr Alexander visited me upon one of my stations, to witness my mode of operating.

When in 1816 I first began the Coast Survey, a similar desire was in the legislature of New Jersey, and Governor Dickerson offered cooperation by the interest he took in it; having, however, been elected a member of the Senate of the United States before I received the (too long delayed) authorization from the Treasury Department to treat upon the subject, and his successor, Governor Williamson, not entering into the same view, the whole was lost.

If you should find proper, in the present instance, to authorize such a mutual co-operation, the plan I then had would be equally applicable in this case as in the Jersey; a considerable part of the state lies equally in the necessary limits of the Coast Survey. This plan was - that I should be allowed, at the proper time in my work, to extend my main triangulation, at the expense of the Coast Survey, over the other parts of the state equally, and that, in compensation, the detail surveys should be made at the expense of the state, (as it would have to do at all events,) and dependent on my main triangles, in the manner that I would direct, and therefore communicated for the use in the Coast Survey.

Such a proposition on the part of the state, so nearly imbedded in the work of the Coast Survey, would evidently be of considerable economy for both parties, and could be made use of advantageously for the acceleration of the works; I shall therefore be glad if you will please to communicate to me your wish and direction in respect to it.

The state of Maryland having to provide instruments for their works, I also offered, if it should meet your approbation, to cede for their work, against cost price, two nine-inch theodolites from the Coast Survey collection, which in the present state of the work, are not needed, having been originally intended for the reconnoitering work, which is now carried on in a different manner, the amount to be received for them would be more advantageously applied for some other instrument actually needed for my work in the course of next summer.

The favor of your decision upon both these points, for my direction in respect to them, will oblige me.

I have the honor &c.
F. R. HASSLER.

Hon. R.B.Taney, Secretary of the Treasury of the U.S.

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GEOPHYSICAL EXPLORATION

Although the Coast and Geodetic Survey has never done any direct geophysical prospecting, some of its gravimetric and magnetic measurements have proved very useful in studies of underground geological structure, and the results have therefore frequently been of considerable economic importance. Because of this fact it was thought that readers of the Geodetic Letter would be interested in the following brief article which appears under the above heading in a pamphlet issued by the Gulf Research and Development Corporation.

It will be noted that the article states that the gravity apparatus "is essentially an exceedingly accurate clock". We believe that this statement should be qualified by stating that it differs from a clock in one important respect, namely, it has no driving mechanism. In the next paragraph it is stated that the torsion balance is an older field instrument than the gravity pendulum apparatus. Although it came into use later for geophysical exploration the gravity pendulum is certainly an older field instrument than is the torsion balance. Except for these minor criticisms the article is an excellent one in showing very briefly why the three methods discussed have been found useful for underground exploration.

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"Geophysical prospecting is a relatively new but important activity of a large oil corporation. Geophysics seeks, by the application of scientific principles, to accomplish the dreams and claims of the douser who used a forked stick to locate water, oil, gold, buried treasure or anything else of value hidden below the surface of the ground. The diviner walked across the ground, made certain mysterious motions, was secretive about just what caused his choice when he said "this is the spot", and told his client with perfect confidence that the desired material was directly underneath. Geophysical prospecting uses a crew of from a few to as many as fifty men with thousands of dollars worth of scientific equipment to make elaborate surveys and then says "conditions under this area appear to be favorable for an oil field". In general, one may be sure that the value of a scheme for finding things below the surface is inversely proportional to the secretiveness as to method and the certainty of success which is claimed by its proponent.

"Oil used to be found where it seeped out of the ground (the original Drake well of 1859 was drilled on Oil Creek, so named from many oil seeps). Later, geologists learned the prin-

ciples of oil accumulation and that a dome or anticline forms a trap or "structure" in the rocks within which the oil is imprisoned. Great areas were mapped to find the structures which made themselves evident by deformation of the surface rocks. But many good structures are buried beneath hundreds to thousands of feet of undisturbed rock laid down since the earth movements causing the structure were completed. Surface geological work gives no hint of their presence. It is the success in finding these buried structures that has made geophysics so important to the oil industry.

"Any conceivable physical property of the rocks of the earth's crust that could be measured at the surface through a cover of from hundreds to thousands of feet of sediments might be made the basis for a method of geophysical prospecting. Many schemes have been suggested and tried, but practically all present day methods of geophysical prospecting for oil are based on three fundamentally different physical properties of the rocks of the earth's crust. These are the magnetic, depending on differences in their state of magnetization, the gravitational, depending on differences in their density or specific weight, and the seismic, depending on differences in their rate of propagation of artificial earthquake waves.

"The gravitational method requires the measurement of very small differences in gravitational attraction. These differences are caused by irregularities in mass distribution which in turn are caused by warping or folding or rock layers of different density. By mapping the gravitational field to high precision, we may infer certain things about the nature and configuration of the rocks below the surface.

"One instrument used for measuring the gravitational field is a pendulum, which is essentially an exceedingly accurate clock, capable of measuring time to about one ten-thousandth of a second. The period of vibration of the pendulum is affected by the gravitational attraction of the earth including masses near the surface. By measuring very carefully the changes in the period of vibration from one locality to another, a map of the gravitational field can be constructed and from it the distribution of mass beneath the surface of the earth can be determined.

"An older and more common field instrument is the torsion balance. This very sensitive instrument measures the gradient or rate of change of the force of gravity. Knowing the rates of change at numerous places, one can calculate the mass distribution beneath the surface and thus infer the presence of oil structures as in the case of the pendulum. This instrument is so sensitive that the gravitational attraction of a man standing nearby is easily recorded and yet the instrument is so well built that it can withstand transportation over the worst roads in existence.

"The magnetic method uses a "magnetometer" which measures small differences in the intensity of the earth's magnetic field. This field is influenced by rocks that are slightly magnetic, which include nearly all of the igneous or basement rocks lying below the sedimentary rocks within which oil is found. Careful magnetic measurements when properly interpreted will reveal the depth and configuration of the basement rocks to give a measure of the sedimentary thickness available for the accumulation of oil, and to give indications of basement topography which may cause favorable folding or "structure" in the overlying sedimentary rocks.

"The seismic method depends upon the propagation through the earth of artificially induced small earthquake waves. Careful measurement of the time of travel of these waves can be interpreted to reveal the depth and nature of the underlying rocks. In the "reflection" method the time for an echo from a deeply buried rock layer is measured and the depth of the reflecting layer calculated.

"A seismic field outfit is a veritable traveling laboratory. A truck contains intricate electrical apparatus, connected by long cables to a series of very sensitive seismic detectors distributed at various distances from the truck. Another connection, either by wire or radio is made with the point at which the explosion is set off. A photographic laboratory in the same truck enables the development of the record of each shot immediately after it is made.

"By careful reflection seismic exploration, it is often possible to make a map of the configuration of a rock layer many thousands of feet below the surface on which differences of elevation can be shown accurately to within a few feet. At the present time the reflection seismic method is the most actively used, there being well over 100 such parties in the field in this country."

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CHECK MARKS ON LISTS OF DIRECTIONS

Repeated efforts have been made to induce computers to prepare lists of directions carefully and neatly. The response to these pleas has been gratifying. An example of what may happen through carelessness is illustrated here. This mistake would have gone into the final publication of triangulation data had not the typesetter made another mistake which attracted the attention of the proof-reading mathematicians.

Figure 1

GEOGRAPHIC POSITIONS

Accession No. of Computation:

lity San Luis Obispo, Northeastward Datum North American 1927 State California

STATION	LATITUDE AND LONGITUDE	SECONDS IN METERS	AZIMUTH	BACK AZIMUTH	TO STATION	DISTANCE LOGARITHM (METERS)	DISTANCE METERS	DISTANCE FEET
en, 1932	35 24 02.943	90.71	129 16 40.88	309 13 49.63	Barren	3.9833346	9623.53	31573.2
d.m.	120 29 24.346	614.3	209 46 11.78	29 48 07.59	Grassy	4.0060322	10139.86	33267.2
			244 06 43.32	64 09 26.75	Highland	3.8980087	7906.95	25941.4
			295 11 45.11	115 19 26.55	San Jose	4.3475456	22261.05	73034.8
			25 14 05.38	205 11 38.20	San Luis	4.1785074	75083.68	49487.0

The distance in meters from station Green to station San Luis as given in Figure 1 is apparently 75,083.68 meters. The typesetter copied it as 7,508.68 meters (see Figure 2) as he also copied the distance 22,261.05 above as 2,226.051 which mistake attracted attention to these two numbers.

Figure 2

Green, 1932	35	24	02.943	129	16	40.88	309	13	49.63	Barren	3.9833346	9,623.53	31,573.2
	120	29	24.346	209	46	11.78	29	48	07.59	Grassy	4.0060322	10,139.86	33,267.2
				244	00	43.32	64	09	26.75	Highland	3.8980087	7,906.95	25,941.4
				295	11	45.11	115	19	26.55	San Jose	4.3475456	2,226.051	73,034.8
				25	14	05.38	205	11	38.20	San Luis	4.1785074	7,508.68	49,487.0

Looking up the antilog of 4.1785074 it was found that the distance from Green to San Luis should be 15,083 meters. The horizontal bar of the apparent 7 was a check mark for the preceding logarithm, which, when photographed seemed to combine with the digit "one" to form the digit "seven". The point should be obvious.

It is again requested that all check marks be made with blue pencil for the reason that blue will not photograph and there is therefore, less danger of confused figures such as shown above, when the table is photostated or otherwise photographed.

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USE OF AERIAL PHOTOGRAPHS ON BOUNDARY SURVEYS

The Chief, Technical Commission for the demarcation of the boundary line between Guatemala and Honduras, Mr. Sidney H. Birdseye, states that the aerial photographs and maps from which the boundary line was selected and described, have saved one or more years of work and have permitted the accurate mapping of the frontier zone at a very nominal cost.

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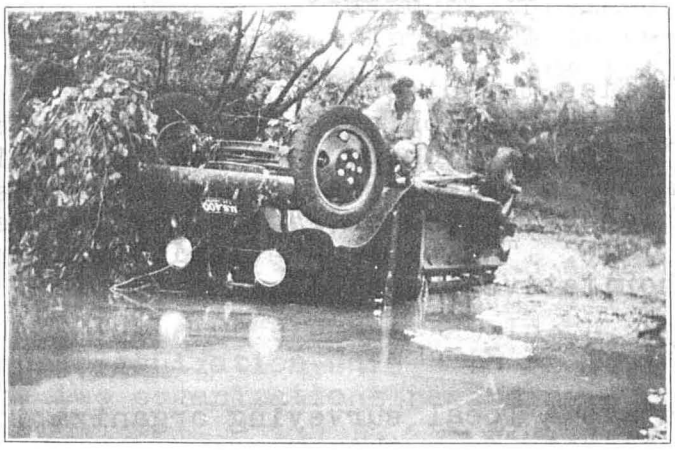
ANOTHER ONE OF THOSE THINGS



Near Cadiz, Ky. - The result of a sudden freshet (10 foot wall of water) racing down a dry creek bed where three Coast Survey trucks were stuck. While one of the drivers went in search of mules the other members of the party heard the rushing of the water and succeeded in anchoring two of the trucks to trees on the bank before the water reached them. The third truck was overturned by the force of the water and floated 200 yards down the creek where it lodged against a tree.

REPLACEMENT OF SURVEYING MONUMENTS

H. W. Hemple

(This article amplifies the discussion in regard to Question 2a - "In the case of occupation of stations marked by other organizations; should the station be remarked if not in good condition or should a new mark be established and a tie made to the other station?" which was given on Page 27 of the Geodetic Letter for November, 1935. The procedure indicated herein, should be considered authoritative practice. --Editor.)

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Several years ago a local surveying organization, without receiving prior authority from this Bureau, remarked a number of Coast and Geodetic Survey first-order triangulation stations and placed their own type of discs on the monuments. Many of these marks had been established in the early days of the Coast Survey, but they were all in good condition and there was no excuse for their being remarked at that time. This Bureau protested very strongly against this remarking, and legitimately so.

During the past few years it has come to the attention of this office that some of our own triangulation parties are replacing monuments of other organizations with new monuments in which our standard discs are placed. Even though the new mark may be placed in the exact position of the original monument there will always be a question in the minds of subsequent users as to the exactness of the replacements. Should a local engineer or surveyor have only the description of the original mark, he may not know that it has been replaced with our monument and may conclude that the original station is lost. This is apt to be particularly confusing if an attempt is to be made to rerun surveys based on the original station mark. Considerable embarrassment may be caused this Bureau as a consequence.

In 1928, the Federal Board of Surveys and Maps adopted a report of which the following excerpt is pertinent to this discussion:

> "Where a station of third-order or higher accuracy, originally established by another organization, is definitely recovered, but is found to be inadequately marked, it should be remarked in a permanent manner, and the character of the new mark described in the recovery note. If the station was originally marked by a tablet, the tablet should be reset

in the new mark. If the station was not marked by a tablet, then a tablet such as is now used by the organization which established the station should be secured by the field party from its own headquarters and used as the new station mark. If there is not time to secure the tablet, a copper bolt may be stamped with the initials of the organization which first established the mark, and this bolt should be used as the station mark. If the original station cannot be exactly recovered or if, for any reason, it is not desirable to re-occupy it, a new station may be established near by and marked, and the old station should be connected with the new one and used as a reference mark for it. In general, no survey monument established by one organization of the Government should be changed or replaced by another organization unless there is an agreement between the two organizations regarding such replacement.

"However, a station established by another organization should never be remarked unless it had a subsurface mark and this was definitely recovered or unless the tablet was established in rock and its original location can be definitely and accurately determined. The recovery note should describe the present condition of the surface, subsurface, and reference marks in sufficient detail to make the record clear as to the certainty of recovery of the station."

Where it is impossible to remark a station in accordance with the above recommendations, a new station marked with our standard discs should be established in close proximity and a direction and distance measured to the mark of the other organization. The original mark should not lose its identity, unless there is a prior agreement between the two organizations concerned.

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CONCERNING "CONSTRUCTIVE CRITICISM"

Charles J. Clifford

The September-October issue of Geodetic Letter has an article entitled "Constructive Criticism" by Andrew L. Breckenridge who recovered and stamped bench marks in Connecticut and Rhode Island for the Coast and Geodetic Survey during the winter of 1934-35. This Bureau always appreciates suggestions looking toward the improvement of its service to the public. At the same time, it should be pointed out that the standardized procedure which has been adopted must appear at times to overlook certain local conditions.

In this article Mr. Breckenridge summarized criticisms and suggestions which he received from engineers with whom he came in contact. Some of the criticisms are justified and some are not, but in many cases both the criticisms and suggested remedies are viewed wholly from a local standpoint, and the fact is overlooked that, in planning a program of field work and of publication, the country must be considered as a whole, and this may result sometimes in a conflict with local conditions.

> "A bench mark is useful only as long as it is recoverable. When changes occur, as they often do, in the surrounding natural and cultural features with relation to which the mark is described, it becomes increasingly difficult to find the mark by means of the published description. Engineers and others who have occasion to visit any bench marks established by this Bureau, or other Government organizations will be doing a public service if they will report the condition of the marks and make suggestions as to needed changes in the descriptions."

All recent leveling publications of this Bureau contain the three sentences quoted above. They serve to emphasize the dependence which must be placed upon the cooperation of the public in keeping description files up to date. It is impractical to make a complete field check of the descriptions of bench marks in a state before preparing them for publication. Not only are time and funds lacking, but there is the added drawback that in large states having from 4,000 to 6,000 marks, the field check itself might be partially obsolete before it was completed. Such being the case, the most satisfactory method of securing reports has been found to be the one now in use. Descriptions and elevations of bench marks on each line of leveling are published in small editions of "ditto" or mimeographed lists. When requests for information are received, these lists are sent out together with a supply of the form, "Report on Condition of Bench Marks". Results have been very gratifying, although a very considerable number of the forms are never returned.

With especial reference to Connecticut and Rhode Island, it was stated in the above article that some of the information in Special Publication No. 181 was obsolete before it was published. This is perfectly true, and it was realized at the time of preparing the manuscript that many of the descriptions would not fit present conditions, but since up-to-date information was lacking it was necessary to use the descriptions we had on file. A glance at the publication will show that the greater part of the leveling in Connecticut and Rhode Island was done in 1922 and 1923, although in Connecticut one short line

was run in 1916 and various others were run between 1925 and 1932 by the Columbia Summer School of Surveying. Prior to the issuance of the publication early in 1934, engineers not in the government service had sent in only 63 reports on condition of bench marks for Connecticut and 16 for Rhode Island. Reports had been received from the U. S. Geological Survey in 1924 for a part of the lines in Connecticut and they were used in the revision of the descriptions, but changes during the following ten years could easily have rendered the descriptions untrustworthy.

Reports stating that marks are destroyed would not be ignored in the preparation of publications if the persons making the reports would give some definite reason for making the statement. Merely saying that a mark could not be found and that it is recommended that it be marked "Destroyed" is not sufficient evidence to designate it as "Destroyed" in the records of this Bureau. The suggestion that engineers be notified when a mark reported by them as destroyed is later recovered, is not quite practical. Although it would be a friendly gesture, it would involve a large amount of correspondence which could possibly become unduly burdensome.

With regard to the complaint that "published elevations of many of the old bench marks marked with the U.S.C. & G.S. and U.S.G.S. disks have never been republished in agreement with the 1929 General Adjustment", this Bureau has never published the results of the Geological Survey leveling in either Connecticut or Rhode Island. The only Coast and Geodetic Survey marks in those states which were omitted from Special Publication No. 181 were tidal bench marks which were not connected to the geodetic level lines. Tidal bench marks are made the subject of separate publications.

Special marking of bench marks by states or otherwise, while commendable, has never been undertaken by this Bureau, although a few state organizations have so marked our bench marks within their particular jurisdiction.

In the office revision of descriptions, the reports of the United States Geographic Board are used with regard to the choice of names and their spelling. Also a standardized list of descriptive terms is used, but it is sometimes difficult to determine what is meant by the original description. The word "pier" for example, sometimes means pier in the description but very often means abutment.

The use of township names instead of counties is again a purely local problem. Outside of New England only a few states consider the township of more importance than the county. For this reason, the county has been adopted as the smallest division used in descriptions.

TRIANGULATION GOING NATIVE

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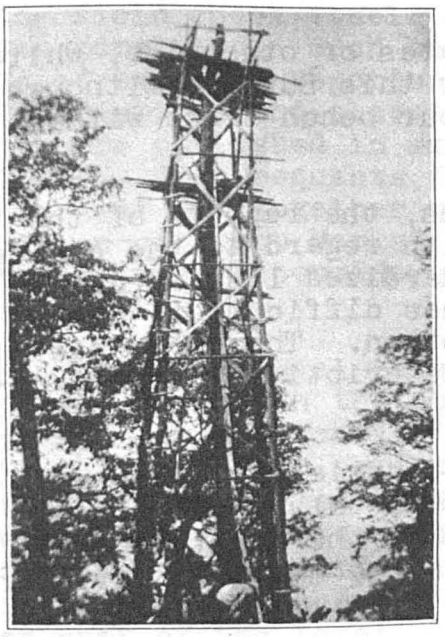
Above is shown the beginning of a 60 foot tower on Pine Mountain, Near Logan, W.Va., where a standing tree trunk was used for the tripod. Until the tower was completed, the light was shown from the board nailed across the top, the lightkeeper perching on the limb about 10 feet below.



The completed tower built entirely of native poles. As the poles were short and crooked, it was necessary to splice them 3 and 4 times in order to get the required 60 feet of height. The tripod (a standing tree trunk) was braced with split rails which were bowed to give greater rigidity.

This station was occupied with a 9-inch direction theodolite and in spite of a strong wind, 16 positions were taken on 7 lights without a rejection, the usual 5-second run of this particular instrument being maintained.

GEODETIC CONTROL FOR CADASTRAL SURVEYS

Hugh C. Mitchell

The May, 1935 number of Geodetic Letter was devoted wholly to a symposium on the use of geodetic control for cadastral surveys. From the correspondence which resulted from the wide distribution of that number, the following pertinent excerpts have been selected for publication. As each of these statements is complete in itself, it is believed that not the slightest misinterpretation can result from not publishing the letters in their entirety. It is hoped, however, that the letters as a whole may be published in a future number of the Geodetic Letter which will be devoted largely, if not entirely, to this important subject.

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From a letter received from Mr. E. H. Owens, of Kansas City, Missouri, an engineer with wide experience in surveying in and around a large city, the following has been taken:

"In your letter of July 6, 1935, you ask; 'If you have a direct tie from one of your triangulation stations to a recognized section corner ... corner becomes lost ... who do you believe would come nearer to reproducing original position ... you ... or another surveyor of equal ability working according to ... rules ... General Land Office ... and which of you would win in a Court decision?'

"This is of course problematical. It might be said that I also know the rules of the General Land Office and the Triangulation Information is additional and exclusive information. If it was given preference over a relocation according to General Land Office rules, it would be because the court classed it as local evidence, which takes precedence over admeasurement. I would like to amplify this by a concrete illustration.

"A corner of the public land survey becomes more or less lost . That is, the marker is gone. It was known to be about in the center of the crossroads and witnesses will testify to that fact. The original Land Office survey, as usual, was inaccurate. A proportional remeasurement to nearest corners would place the corner entirely outside the crossroads or at least ten feet from known position according to all witnesses. I believe the triangulation tie, which substantially agrees with testimony would satisfy the owners in 999 cases out of 1000 without suit and would win in the suit in the other case. It should properly be put in the class of measurements to witness trees, which were sometimes erroneous, but which will prevail over admeasurement from distant corners if confirmed approximately by testimony.

"With reference to use of streets for survey work, I have never met with any objection; in fact, the public seems over-generous to surveyors where proper warning is given. Even with legal authority it would be necessary to give reasonable warning to fast traffic. I have never hesitated to temporarily halt traffic to measure across streets in a reasonable length of time and frequently use a car as a barrier in traffic to protect an instrument and have never been arrested for blocking traffic. If legal authority were asked, a bond would probably be required as the city, having granted permission, would be jointly liable."

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Acknowledging receipt of the special number of the Geodetic Letter to which reference is made above, Mr. W. D. Jones, of Chicago, well-known in Illinois and neighboring states as an authority on land surveying and particularly on the practices of the General Land Office, writes as follows:

"I have no doubt that in the original 13 states and in Kentucky, Tennessee and Texas where the descriptions of boundary lines are by metes and bounds, your suggestion for new descriptions based upon coordinates of the U. S. Coast and Geodetic Survey would be of material benefit in descriptions of private property and of boundary lines in general. It may be a serious legal question as to whether the laws you suggest will be enforceable for, as I understand the law, a description of any boundary line which would change the location thereof, as the same was created by the original monuments, would not be a good law as neither the State nor the United States can take any man's land without due compensation and to change his boundary line might have the effect of taking some of his land. Of course, adjoining owners can in fact change the location of their boundary by agreeing that the same is located in a certain place, whether or not they know they have changed the said boundary from its original location. Therefore, I suppose that if the owners acquiesce in the location of the boundaries as fixed by this system of coordinate descriptions, they will in time be bound by them.

"Just how simple your proposed descriptions would be I do not know, but I feel very certain that they cannot be any more simple than are our descriptions of land in the U. S. where the sectional survey system is in use, which is practically all of the U. S. except the original 13 states, Kentucky, Tennessee and Texas; and even parts of some of these states have the sectional survey system or something that amounts to the same thing. It seems to me that our sectional survey system is itself a system of coordinates. There are no overlaps or gaps unless by error and/or lack of knowledge as to the location of the section lines.

"In Niles Weekly Register published at Baltimore July 24, 1819, I find an article, signed J. Meigs, general land office, June 29, 1819, telling about the absolute perfections of our Sectional Survey System, in which he states 'This wise system takes away all temptation to incur the curse pronounced by Moses on him "who removeth his neighbor's landmark". The landmark is indeed immovable; for, though the marked trees at any one corner may be burnt or destroyed yet at the distance of half a mile east, west, north or south, there are other marked trees by which the true corner may be found'. Experience has shown that Mr. Meigs was grossly in error in making this statement, however, that was not on account of any fault in the system (if there had been trees to mark at every half mile) but because the original surveys were not accurately executed. However, the system with all its imperfections is so much better than any existing elsewhere in the world, and there are so many advantages to the simple and few words that we need to use, to describe any fractional part of a section any place in the U. S. that it seems to me it would be a crime to abandon the system.

"This does not mean that we could not gain help in preserving the location of our section corners, by tying in the location to any monuments made available by the U. S. Coast and Geodetic Survey Department. This I think is an objective toward which we should direct our efforts; that is, preserving the locations of the section corners by tying to any monuments made available or to any system of surveys made with the care taken by the U. S. Coast and Geodetic Survey Department. While many of our acts help us in preserving the location of our monuments we are at the same time very certain that many of our acts carelessly destroy the actual physical monuments which are so very important to us; especially so in connection with the construction of our comparatively new system of concrete highways.

"As to the suggested act to give the right to any qualified or licensed surveyor in the practice of his profession to enter private property for the purpose of finding monuments subject to the paying of any damages he may cause, I think that would be a wonderful law but I see no reason why it should be confined to the finding of the monument placed by the U. S. Coast and Geodetic Survey; and as to the destruction of monuments there is already an Illinois and a U. S. Statute providing for a fine and imprisonment for 6 months to one year for any one who wilfully and maliciously injures or removes any such monument."

To Mr. Jones' letter the following reply (in part) was made:

"I would use it (your letter) to illustrate the fact that you and I are in complete agreement in the matter recognizing the simplicity and permanent value of the General Land Office method

of describing property. It has never been in my mind that it should be discarded; nor has it ever occurred to me that any engineer could, by geodetic methods, recover or re-establish a corner of a public land survey unless that corner had previously been tied into a geodetic control net, and its coordinates on that system known.

"The General Land Office itself recognized this value of geodetic control surveys, and for several years triangulation parties of this Bureau operating in public land states were accompanied by cadastral engineers from the General Land Office, whose mission it was to recover and identify marks of the land survey so that the geodetic engineer could tie them into his triangulation.

"What I have seen and read of Land Office surveys thoroughly convinces me that it takes an exceptionally well trained man - a specialist in his field - to recover or restore the marks of those surveys. This makes it all the more desirable, so it seems to me, to give complete protection to such marks, often recovered as they are at a considerable expenditure of time and effort (both of which cost money), and such protection can be given by connecting those marks to the national control survey, and determining their positions on the datum thereof.

"However, it is no longer necessary for the engineer to use geodetic formulas and make geodetic computations in utilizing the national control survey for referencing and controlling his local property surveys. This is now a fairly simple operation, provided stations of the national control survey are at hand (as they eventually will be), since in a very little while there will be available coordinates of all triangulation stations on state-wide plane rectangular coordinate systems, and the engineer may continue to use the methods of plane surveying, yet secure the advantages of accuracy and permanency which come from basing his surveys on the national triangulation net . . ."

If asked to single out from the foregoing a paragraph to receive special emphasis, I would unhesitatingly select the one in which it is stated that no engineer could, by geodetic methods, recover or re-establish a corner of a public land survey, unless that corner had previously been tied into a geodetic control net and its coordinates on that system were known. This statement may be made even stronger by saying that when such connection has been made and the position of the corner is known on a geodetic datum, then its position on the ground can be reproduced by a competent surveyor by reference to recoverable stations of the control net. And it may be quite evident that if the geodetic datum used is the one on which the national triangulation survey is based, then the land corner can never be truly lost, as it is inconceivable that more than a very small percentage of the stations of that net will ever be completely destroyed.

Furthermore, (and this is most important from a practical standpoint), since the positions of stations of the national triangulation net are now being made available in the form of coordinates on state-wide plane coordinate systems, any surveyor who desires to make use of this very valuable feature of the national triangulation may do so without having any training or experience as a geodetic engineer, since he may carry on all desired operations and secure satisfactory results through the use of the methods and formulas of plane surveying.

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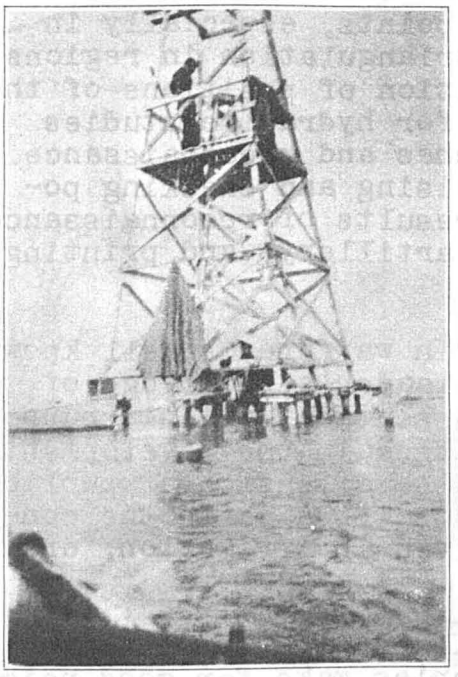

STATION UNDER WATER

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Triangulation station Middle Shoal - Key West Arc. Station mark under water at all times.

To collimate, it was necessary to make form to put over mark and pump water out in order to get plumb bob over center of disc.

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KNOWLEDGE OF TOPOGRAPHY

A knowledge of topography is essential in the modern conduct of war, according to Prof. Roberto Muller of Argentina, in his recent article "Importancia de la Tecnica Topografica en la Moderna Conduccion de la Guerra", which appeared in the Revista Militar for July, 1935. The topographic branch is an extremely important part of the Geographic Service of War of his country. In the artillery where accurate firing is essential, the map is called the vertebra of the artillery.

An outline of the daily work of the Service includes increasing the density of trigonometric points, especially in zones of intense artillery activity; triangulation in regions of fundamental public works; determination of positions of the various pieces of artillery; leveling for hydraulic studies and for elevations of positions; sketches and reconnaissance for accurate tactics; aerial maps; revising and checking positions of existing maps; publishing results of reconnaissance and aerial surveys; making charts for artillery; and printing of charts and maps.

The value of accurate elevations in warfare is well known. Many a battle has been decided by the leader's knowledge of the terrain. The topographic map is essential for this purpose. Not only is it an aid in warfare, but also in the development of natural resources of all kinds, in the extension of public works, in the building of highways and railroads, in the construction works of various kinds involved in irrigation, drainage, flood control, etc.

In the perpetuation of boundary lines, the topographic map plays a leading role. Good boundaries make for good neighbors and peace is the result.

With good maps it is easy to arrange campaigns, expeditions and exploration work. Accurate artillery fire can be planned and executed with greater precision with a knowledge of the terrain. In reconnaissance work and determination of positions for certain types of combat, aerial photography is invaluable, and the topographic map is the basis for the photo-topographic map.

The principal classes of work necessary for artillery work in the Geographic Service of War are triangulation of first and second order, additional determinations of important points, elevations for civil and military works, and magnetic determinations for correction of azimuth compasses and magnetic surveys.

The map is constantly being changed and revised as new public works, railroads, highways, farm areas and river changes are added to it. Maps are not only indispensable in war but also in peace. The Geographic Service of War is an aid to both civil and military engineers - it is invaluable in training personnel for defense of the nation during war and for developing natural resources during peace.

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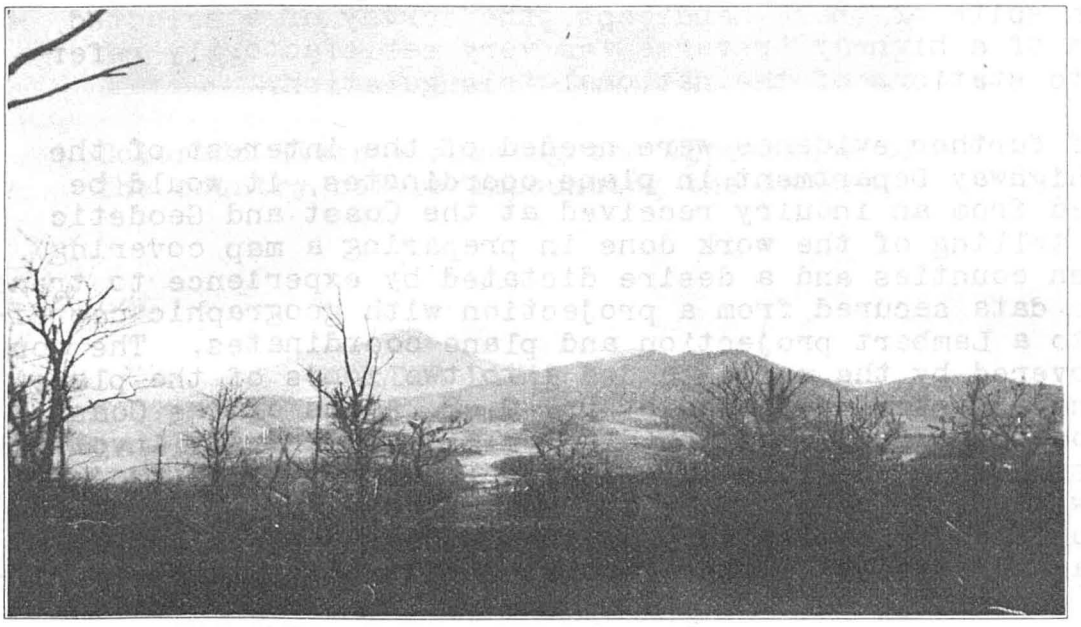

Looking northwest towards the Smokies from the end of the Appalachian Trail on Mount Oglethorpe, near Atlanta, Ga.

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GEODETIC CONTROL FOR TEXAS HIGHWAY SURVEYS

(From the Military Engineer for November-December, 1935.)

A very interesting test of the use of geodetic control in highway surveys has been made during the past summer in the southern part of Texas. Fully convinced of the economic advantages of controlling highway traverses and maps by reference to the national control survey, the Senior United States Highway Engineer and the Division Engineer of the Texas Highway Department arranged to connect the survey of a highway across Kenedy County to stations of the 98th meridian triangulation.

In many ways this was pioneer work. It was executed under considerable difficulty. In the computation of grid positions on the plane coordinate system recently devised for that portion of the State by the Coast and Geodetic Survey, considerable difficulty was encountered in securing the proper logarithmic tables for the work. Even in making studies of computational methods and formulas involved, the manual for such purposes which had been prepared by the Coast and Geodetic Survey was so new that an advance copy in the form of a page proof had to be sent for guidance.

In spite of these handicaps, the survey of a selected section of a highway traverse was very satisfactorily referenced to stations of the national triangulation.

If further evidence were needed of the interest of the Texas Highway Department in plane coordinates, it would be obtained from an inquiry received at the Coast and Geodetic Survey telling of the work done in preparing a map covering some ten counties and a desire dictated by experience to transfer the data secured from a projection with geographic coordinates to a Lambert projection and plane coordinates. The counties covered by the map extended into two zones of the plane coordinate system developed by Dr. O. S. Adams of the Coast and Geodetic Survey, but the difficulties ordinarily involved in passing from one zone or system to another in map projections will prove no obstacle in such cases as this, since the transposition is easily made on the Lambert projection, even where an adjustment is made involving control stations in different zones.

A further and conclusive evidence of the appreciation in Texas of the value of well-controlled highway surveys is had from a request for information as to the standard way used by the Coast and Geodetic Survey in monumenting its survey stations. Such a request is but a corollary to the others, for a full appreciation of the value and uses of an accurate and well-controlled survey surely involves having such surveys monumented in as permanent a manner as is possible with a reasonable expenditure for concrete monuments and metal tablets.

The Texas Highway Department is doing a splendid piece of engineering in its studies looking to the establishment of well-controlled and permanently-monumented highway surveys, and there is every reason to hope that other states will follow this example. Such surveys will have many uses and pay for themselves many times over.

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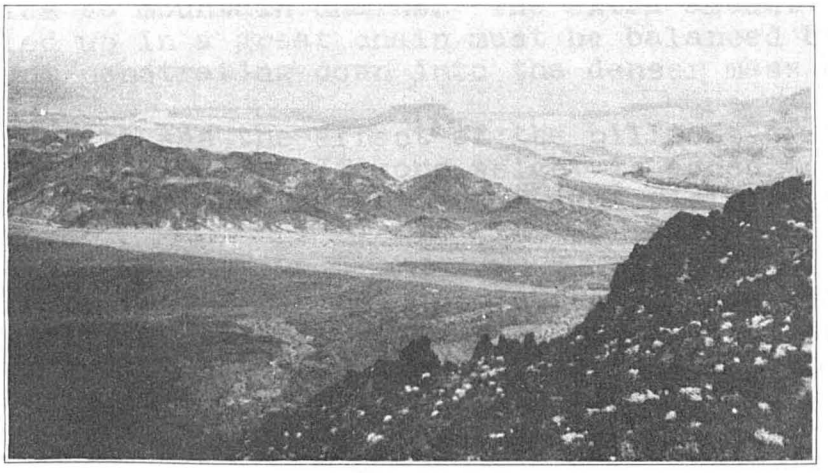

Colorado River - showing the appearance of the country before impounding the waters.

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BOULDER DAM'S WATERS

(Reprinted from the New York Times, August 4, 1935.)

Eventually 41,500,000,000 tons of water will be impounded to form a hugh lake behind Boulder Dam. The weight may bend the earth's crust. By how much?

Already the Unites States Coast and Geodetic Survey is preparing itself to answer the question. Bench marks are to be carefully placed over the area which is to settle. Measurements will be made. When the reservoir is filled new leveling will be established. By comparing the results of the two determinations the amount of settling will become known.

The surface of the earth as we know it consists of granite layers that float on heavy, sticky material below, much as an iceberg floats in water. This view has made it necessary to create a special branch of geology called isostasy.

According to the theory of isostasy, wherever equilibrium exists on the earth's surface equal masses underlie equal surface areas. Thus a huge granitic mass with an average surface elevation three miles above the mean depth of the oceans must be lighter than the material of the ocean floors. Moreover, in order to compensate for its greater mean height this lighter material must extend downward to some distance under the continent and below the ocean floor so that unit areas beneath oceans and continents may remain in stable equilibrium. The same rea-

soning applies to mountain chains. The extra amount of lighter material piled up in a great chain must be balanced by a proportionate amount penetrating down into the denser mass beneath.

It is easy to see the effect of the billions of tons of water in Boulder Reservoir. If more weight is added to that which nature placed at Boulder Dam the crust must yield until equilibrium is restored.

No ordinary weight can have any effect on a crust supposed to be from twelve to seventy-five miles thick. But this is an extraordinary weight - a weight which makes it possible to test the theory of isostasy directly for the first time.

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NOTES

In the October number of the Publications of the Astronomical Society of the Pacific is an interesting note by Dr. Hamilton M. Jeffers, on some latitude observations made at the Lick Observatory with a Bamberg transit which was loaned by the Coast and Geodetic Survey to the Observatory in 1933 for use in the International Longitude Campaign of that year. Latitude observations were made on six different nights with probable errors ranging from ± .04 to ± .09. The number of pairs observed on each night varied from 7 to 14.

It is interesting to note that the computations of the latitudes were based on the new Albany General Catalogue. This catalogue has not yet been published but Dr. Jeffers was able to obtain the positions of the stars he used by correspondence with the Albany Observatory. The small probable errors obtained by Dr. Jeffers not only showed very accurate observing but they also indicate that the star places are excellent. As soon as this new catalogue has been published the Coast and Geodetic Survey intends to use it for its latitude work. In the meantime we are still using the Boss Catalogue although better star places undoubtedly are available in some of the modern catalogues.

It has been thought advisable to keep all of the latitude results on the same basis until the change could be made to the new Albany Catalogue. It is hoped that at that time, the previous results can be corrected to correspond with the better star places.

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The November 9, 1935, issue of "Nature" published in London, England, carried a very complimentary write up on a recent radio talk given by Prof. S. S. Steinberg, of the University of Maryland, on the subject of highways in the United States. Prof. Steinberg was formerly the State Representative of the U. S. Coast and Geodetic Survey in the State of Maryland.

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The Pan American Institute of Geography and History held its second assembly in Washington, D.C., the week of October 14-19, 1935.

Captain William Bowie, who is the Honorary President of the Institute, was appointed by the Secretary of State as one of the National Committee of the United States to cooperate with the Institute. One of the papers presented was entitled, "Importance of Geographical Maps" by Mr. Octavio Bustamante of Tacubaya, Mex., Assistant Director of the Pan American Institute, in which he stressed the need and importance of having good maps in the development and extension of the activities of a nation. The bulletin which published this paper, also contained an article by Captain Bowie entitled, "Working with Maps", a copy of the address given by him at the meeting of the South Carolina Society of Engineers on June 15, 1934.

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The Division of Surveying and Mapping of the American Society of Civil Engineers held two sessions in connection with the fall meeting of the Society at Birmingham, Ala., October 16-18, 1935.

In the absence of Dr. William Bowie, who has been chairman of the Division since its organization in 1926, Prof. Philip Kissam of Princeton University, presided at both sessions. The following paragraph about the meeting appears in Civil Engineering for November:-

"Morning and afternoon sessions on Thursday provided opportunity for some excellent engineering programs developed by the Division, six separate sessions in all. Notable among these were the double sessions of the Surveying and Mapping Division. An enthusiastic group utilized both morning and afternoon to the limit of time in discussing surveying in its practical application in the Tennessee Valley and in Alabama, Mississippi, and Louisiana."

The program in part is given below:

"Surveying and Mapping in the Tennessee Valley" - N. H. Sayford, Director, Engineering Service, Tennessee Valley Authority, Knoxville, Tenn.

"Permanent Value for Highway Surveys Through Geodetic Control" - J. C. Carpenter, Senior Highway Engineer, U. S. Bureau of Public Roads, Fort Worth, Tex.

"Local Control Surveys of the U. S. Coast and Geodetic Survey in Alabama" - J. A. C. Callan, Head Professor, Civil Engineering, Alabama Polytechnic Institute, Auburn, Ala.

"Locating the Southern Natural Gas Pipe Line by Aerial Maps" - N. R. McKay, Esq., Southern Natural Gas Corporation, Monroe, La.

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At the recent meeting of the National Academy of Sciences held at Charlottesville, Va., November 18-20, Captain William Bowie spoke on "The National Mapping Plan of the National Resources Board". He also gave an address at the Engineers Club of Baltimore on November 13, on "United States Coast and Geodetic Survey Helps to Map Nation".

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At the regular monthly meeting of the American Institute of Consulting Engineers held in New York City on November 6, 1935, the Secretary of the Council presented a letter from Dr. William Bowie dated October 1, 1935, in regard to surveying and mapping as a means for relieving unemployment. After due consideration it was decided to send the following resolution to the American Engineering Council:-

"WHEREAS, American Institute of Consulting Engineers has four objects, one of which is 'to increase the usefulness of the profession to the public at large,

WHEREAS, membership in the Institute is limited to Engineers who are engaged in Consulting Engineering work, it is

RESOLVED, that the Council of the Institute reiterates its endorsement of the purposes of The Temple Act, Public Law No. 498 of the 68th Congress which provides for the completion of a standard topographic map of the United States.

RESOLVED, that the expenditures of public funds for this work would be in the nature of an investment in durable goods because standard maps of the United States could be used for decades and probably for centuries in the public interest.

RESOLVED, The Council of the Institute requests American Engineering Council to bring this matter to the attention of appropriate governmental agencies."

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REPORT OF PROGRESS

Triangulation:

Lineal miles of triangulation through axis of schemes completed during October, 1935:

First-order - - - - - - - - - - - - - - - - - -	65
Second-order - - - - - - - - - - - - - - - - - -	0

* Lineal miles of triangulation completed during November, 1935:

First-order - - - - - - - - - - - - - - - - - -	0
Second-order - - - - - - - - - - - - - - - - - -	0

Total miles of triangulation completed to November 30, 1935:

First-order - - - - - - - - - - - - - - - - - -	61,422
Second-order - - - - - - - - - - - - - - - - - -	5,527

* Most field work ceased in August due to lack of funds.

Levels:

Lineal miles of levels completed during October, 1935:

First-order - - - - - - - - - - - - - - - - - -	294
Second-order - - - - - - - - - - - - - - - - - -	118

Total miles of levels completed to October 31, 1935:

First-order - - - - - - - - - - - - - - - - - -	106,895
Second-order - - - - - - - - - - - - - - - - - -	154,923

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