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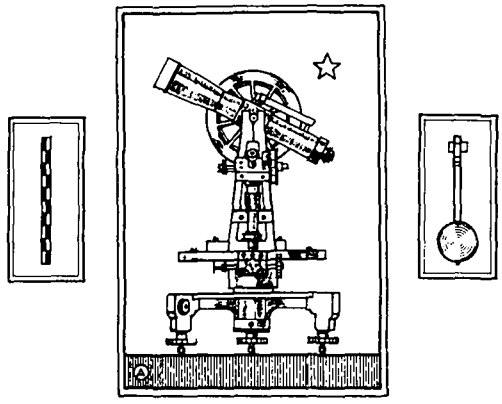
GEODETIC LETTER



U.S. COAST & GEODETIC SURVEY
Lib...
MAY 4 1935
Acc. No.

No. 4
Vol. 2

APRIL
1935

ISSUED BY

DIVISION • OF • GEODESY
UNITED · STATES · COAST · AND · GEODETIC · SURVEY ·
WASHINGTON D.C.

R. S. PATTON · Director

M-115

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 APRIL, 1935 Number 4

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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

-=O=-

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

Member American Society of Civil Engineers
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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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