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COAST AND GEODETIC SURVEY

SCOPE OF ACTIVITIES

The past year has been a difficult one for the Coast and Geodetic Survey.

The background for an understanding of the history of 1933 is the appropriation for 1932. That appropriation was $3,075,933. That amount was fixed after a careful study, and represented the minimum sum necessary to place the Survey on an efficiently functioning basis with respect to the projects upon which it was then actually engaged. No new projects were included, and the rate of progress contemplated for existing projects was a moderate one, designed to spread the work over reasonable periods of years.

One important new project was reluctantly deferred. The Bureau repeatedly has stressed the growing obsolescence of its charts of the Atlantic and Gulf intracoastal waterways. The importance of these waters is partly indicated by the facts that for the section from Norfolk to Florida, by 1929 the Federal Government had spent or authorized some $62,540,354 for improvements and that its freight traffic in that year amounted to 52,517,693 tons, exclusive of the ocean freight to and from the larger ports of Norfolk, Charleston, Savannah, Jacksonville, and Miami.

The bureau proposed a 16-year program for modernizing its charts of these Atlantic and Gulf waters, but owing to the economic situation the proposal was not adopted. The 1932 appropriation, therefore, represented less than the minimum amount which under normal conditions would have been required to carry on urgently needed work.

The regular appropriation for 1933 was $2,399,813. This involved a large reduction in field work. Plans for this reduction were made, but before it became necessary to execute them the situation was relieved by the inclusion of an item of $1,250,000 for work in the Emergency Relief and Construction Act.

The primary purpose of this special appropriation was to provide work of public value as an aid in relieving unemployment. Every effort was made by the Bureau to conform to that purpose. A large fleet of condemned post-office motor trucks was overhauled by that Department to put them in shape for another year's service and turned over to this Bureau without charge. Many colleges and engineering schools loaned surveying instruments. Free office space was furnished in various places, a conspicuous example being in New York, where, through the cooperation of the American Society of Civil Engineers, the McGraw-Hill Publishing Co. furnished valuable space rent free for a period of about 9 months.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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By these and other means the abnormal overhead expenses usually incident to a suddenly expanded engineering program were kept to a very small total. About 71 percent of the money spent was paid out directly as wages.

These wages were paid to 1,652 men employed for various periods. Cooperation was solicited from relief agencies in every State, and from the resulting deluge of applications preference was given to men having dependents, who were most urgently in need of work, and who could give full value in service for the money paid them.

About half of the emergency money was devoted to surveys of the intracoastal waters and to similar work on the Pacific coast. Surveys were made in a number of regions where the need was particularly urgent. There remains the task of applying the resulting data to the charts. When this has been accomplished, during the present fiscal year if possible, the results will be a notable improvement in this service to mariners.

The other half of the money was used chiefly for control surveys in the interior. Control surveys consist of triangulation and levels which give accurate distances and directions between, and accurate elevations of, permanently marked points. This information is essential to map making, highway construction, irrigation and reclamation, flood control, maintenance and building of railroads, power and pipe-line extensions, and various other engineering operations which require exact knowledge of the surface of an extensive region. There is scarcely an extensive engineering enterprise throughout the United States to which this work is not an important prerequisite. The work, while technical in character, is of such importance that in spite of the recent depression three States—North Carolina, California, and New Jersey—have voluntarily contributed State funds in order that the work within their boundaries might be completed more promptly than would otherwise be possible.

The regular appropriation made for the fiscal year 1934 is $2,205,090. This involved an even greater reduction of operations than the one deferred a year previously. However, an additional allotment of $2,600,000 of national industrial recovery funds is expected to be made.

These large fluctuations in the funds provided are an inevitable consequence of the abnormal national situation. They are recognized as unavoidable. However, they emphasize the need for the earliest possible adoption of long-range programs of work, which consider the projects in their entirety, so that the planning and execution of the parts contemplated for any one year can be based on reasonable certainties as to what can be undertaken in succeeding years. Such planning is one of the important essentials to the most efficient and economical execution of Survey work.

The Survey is saddened by the loss of its Assistant Director, Capt. Robert Lee Faris, who died suddenly on October 5, 1932. His profound technical knowledge is sorely missed. His attitude and example contributed largely to the maintenance of a high service morale. With him the work always ranked first. Every other consideration was subordinated to his desire for its efficient and economical performance. Yet in his daily applications of that desire his

obvious integrity of purpose, his sense of justice, and his kindly consideration for the personnel won him a lasting place in the affections of his associates. He was a man to whom the Federal service can point with pride.

FIELD OPERATIONS

HYDROGRAPHIC AND TOPOGRAPHIC WORK

Topographic and hydrographic surveys, including the necessary triangulation, were made on the Atlantic, Gulf, and Pacific coasts, in Alaska, and in the Philippine Islands. No work was done in the Hawaiian Islands, the curtailment of regular appropriations having necessitated the withdrawal of the *Pioneer*. Emergency relief and construction act funds permitted the employment of additional shore parties along the coasts of the United States.

Atlantic and Gulf coasts.—The survey of Georges Bank, begun in 1930, was completed in October of 1932 by the *Hydrographer*, *Oceanographer*, *Lydonia*, and *Gilbert*. These vessels thereupon proceeded to Norfolk for annual overhaul and reduction of field records before starting other work.

Early in 1933, the *Lydonia* took up the project of supplementing the first-order Atlantic coast arc of triangulation with second-order work and coordinating all existing schemes between Charleston and Edisto Island, S.C. A current survey was made of Charleston Harbor during the course of this work. Hydrographic work off the coasts of Maryland and Delaware was started in April, where the *Lydonia* was joined by the *Oceanographer* and *Gilbert* in May. This undertaking was in progress at the end of the fiscal year.

During the first part of January the *Hydrographer* took up hydrographic work in the Gulf of Mexico eastward from Calcasieu Pass, La. This project was in progress at the end of the year. The *Oceanographer* cooperated with the *Hydrographer* for several months before taking up the work off the Maryland-Delaware coast with the *Lydonia*. En route to and from the Gulf working grounds the *Oceanographer* ran offshore sounding lines along the Atlantic and Gulf coasts.

Before joining the *Lydonia* and *Oceanographer* the *Gilbert* revised the triangulation along the inland waterway on the North Carolina coast and established control for the reduction of aerial photographs.

A hydrographic and topographic survey of Wicomico River, Md., started at the close of the preceding fiscal year by the *Mikawe*, was completed in August of 1932 and was followed by resurveys in the vicinity of Kent Island, Md. The party then proceeded to North Carolina and took up work similar to that of the *Gilbert*. In the spring of 1933 the party started resurveys of the South, West, and Rhode Rivers, Md., on which it was engaged at the end of the fiscal year.

The *Natoma* made complete new surveys of the Hudson River, from Tarrytown to West Point, necessary to meet the needs of the deeper-draft vessels accommodated by the increased depths now being maintained to Albany. This was interrupted during the winter months, while this party extended triangulation northward from

Beaufort, S.C., connecting with the same class of work extended southward from Charleston by the *Lydonia.*

In November of 1932 three shore parties began coastal triangulation operations coordinating all existing triangulation and establishing control for the reduction of aerial photographs. One party operated in Pamlico, Albemarle, and Roanoke Sounds, N.C.; another between Savannah, Ga., and Jacksonville, Fla.; and a third from Lake Charles, La., to the Gulf of Mexico at Calcasieu Pass and thence westward along the coast to Atchafalaya Bay. The triangulation last named controls the surveys of the *Hydrographer.* The third party also took up similar work between Orange and Sabine Pass, Tex.

Revised surveys in the vicinity of Sandy Hook, N.Y., to correct charts for extensive changes, were executed by a small party in the fall of 1932.

A shore party was engaged on a hydrographic and topographic survey of New River, N.C., between November and March and then began operations on a resurvey of Shinnecock and Moriches Bays, Long Island, to obtain data for the reconstruction of charts based on surveys of some 50 years ago.

A party operated near the western end of Long Island Sound until November to obtain data for modernizing three charts of that area. Work was again taken up on this project in March and was in progress at the close of the year.

Surveys were started early in March in Great South and Peconic Bays, Long Island, to correct charts based on surveys made between 1870 and 1890.

From December 1 of 1932 to July 1 of 1933, a party in New York City was engaged on the compilation of air photographs of the San Joaquin and Sacramento River Delta, Calif., for the construction of new charts of that region.

During the first half of the fiscal year, a small field party was engaged in locating landmarks and coordinating triangulation in the vicinity of Bridgeport and New Haven Harbors, Conn.

Prior to the beginning of work by the three vessels operating off the Maryland-Delaware coast, a shore party established the necessary control, and at the end of the fiscal year was engaged in revising and coordinating all previous triangulation along this section of the coast.

The triangulation party which was engaged on the control net in the vicinity of New York City, started in 1930, completed this entire project in April. This furnishes a comprehensive control scheme for the entire New York district, essential in coordinating the extensive surveying and mapping operations conducted by Federal, State, municipal, and private agencies in this important area.

During March a hydrographic and topographic survey was made of Shark River Inlet, N.J., to correct the chart of that locality.

Two small shore parties operated in the Massachusetts Bay area during the latter part of the fiscal year, under the general supervision of the inspector of the Boston field station. One was engaged in recovering and revising descriptions of triangulation stations in the vicinity of Boston, and the other on hydrographic and topo-

graphic surveys in the vicinity of Cape Cod, for the purpose of constructing a new chart to replace the charts of Wellfleet and Provincetown Harbors.

From the middle of November to the end of the fiscal year a party was engaged on a hydrographic and topographic survey of Galveston Bay and approaches, for the reconstruction of the chart for that area.

From April to the close of the year, a party was engaged in field work covering a topographic survey along the new ship channel leading from the Gulf of Mexico to Lake Charles, La.

Pacific coast.—The *Guide* extended complete new surveys along the California coast, from Pigeon Point southward to Point Sur. This work extends 60 miles offshore and furnishes final data for modernizing the chart from Point Sur to San Francisco. During the last 3 months of the fiscal year, visual ship hydrography was carried southward from Point Sur to Point Piedras Blancas, and preparations made for offshore radio acoustic ranging work, to revise the chart from Point Conception to Point Sur.

The party on the *Guide* discovered and surveyed thoroughly several submarine features of value to the mariner for position determination. One consists of a plateau 6½ miles long about 20 miles west from Point Sur, covered by 450 fathoms of water and sloping rapidly to 600 fathoms. A second feature is a narrow gorge indenting the continental shelf a distance of over 3 miles. As all coastwise steamer tracks along this stretch of coast pass over or close to this gorge, its charting furnishes an excellent submarine landmark in thick weather. A third feature is a large submarine mountain about 45 miles off the Farallon Islands, the summit of which is covered to a depth of about 900 fathoms. It is surrounded by depths greater than 1,400 fathoms and on the seaward side slopes steeply to 1,800 fathoms.

At the beginning of the year, the *Pioneer* was laid up because of the shortage of funds, but in December work was started in the vicinity of San Nicholas Island, Calif., and extended westward to the 2,000-fathom curve, to modernize the chart of that region. A submarine mountain was discovered and surveyed, rising from depths of 10,000 feet to a ridge 6½ miles long and 1,800 feet deep. This feature is 15 miles westward of the general 2,000-fathom curve and 75 miles offshore from San Nicholas Island.

A shore party was engaged throughout the fiscal year on a hydrographic and topographic survey of Santa Barbara and San Nicholas Islands, Calif., obtaining the data necessary for the construction of large-scale charts desired by the Navy. This party established triangulation control for and made photographic compilations of the coast from San Pedro Harbor to Newport Bay, Calif.

Two triangulation parties were engaged the entire year in establishing coastal control along the California coast.

One shore party made hydrographic and topographic surveys in November of 1932 along the California coast in the vicinity of Ventura, for a new large-scale chart of that area, and then extended work eastward toward Point Conception.

A shore party was engaged for the entire year on the field inspection and control for the reduction of air photographs of the San Joaquin and Sacramento River Delta in connection with the data necessary for the construction of new charts.

Alaska.—At the beginning and close of the year, the *Explorer*, *Discoverer*, and *Surveyer*, were operating in Alaska. They returned to Seattle in the late fall for overhaul and completion of field records.

The *Explorer* carried on surveys in the vicinity of Revillagegido Channel and Dixon Entrance. The *Surveyer* and *Discoverer* were engaged on the east coasts of Kodiak and Afognak Islands during the 1932 season. In the spring of 1933, the *Discoverer* returned to that region while the *Surveyor* was assigned to unsurveyed areas in Prince William Sound and approaches.

Philippine Islands.—Two vessels, the *Pathfinder* and *Fathomer*, continued operations throughout the fiscal year. The *Pathfinder* made surveys on the northwest and north coasts of Luzon and on the west coast of Palawan. The *Fathomer* surveyed the entrance to San Bernandina Strait, in Albay Gulf, and on the west coast of Palawan.

At the beginning of the year, the *Marinduque* engaged in surveys in the vicinity of Sibutu Island, Sulu Archipelago. Field work was closed August 31, 1932, and the vessel returned to Manila, investigating en route a reported shoal in the Visayan Sea. On September 20 the vessel was decommissioned because of age and sold by the Philippine Government.

On account of the curtailment of the regular appropriations for the 1934 fiscal year, the *Pathfinder* was laid up at Manila for an indefinite period, with a sufficient crew retained to protect the vessel.

The survey of the more important areas of the Philippine Islands is now between 85 and 90 percent completed. The hydrography yet to be done consists of a comparatively small area along the northeast coast of Luzon and about 85 percent of the west coast of Palawan. About 10,000 square miles remain to be surveyed off the north coast of Borneo between the International Boundary and completed work in the southern part of the Sulu Sea.

United States Coast Pilots.—A field examination was made by one party for a new edition of the Coast Pilot series covering the Atlantic coast from the St. Croix River to Cape Cod, to replace the 1927 edition.

Another party made a field examination from Cape Cod to Sandy Hook, for a new edition of the publication for that area, previously issued in 1926.

Manuscripts for these two United States Coast Pilots, together with the manuscript for the United States Coast Pilot the Hawaiian Islands, field data for which were secured the previous fiscal year, were sent to the Government Printing Office.

After plotting the records of the 1932 Alaskan season in Seattle and prior to sailing north with the *Discoverer* this spring, the *Westdahl* made a field examination of Puget Sound to obtain data for use in a new edition of the Pacific Coast Pilot, covering California, Oregon, and Washington, previously issued in 1926.

Hydrography, topography, and triangulation accomplished

Locality	Hydrography			Topography		Coastal triangulation		
	Sounding lines	Area	Soundings	Length of shore line	Area	Length of scheme	Area	Geographic positions
	Miles	*Sq. mi.*	*Number*	*Miles*	*Sq. mi.*	*Miles*	*Sq. mi.*	*Number*
Provincetown, Mass	399	26	9,599	75	31			
Georges Bank, Mass	12,659	16,630	83,470			3	5	4
Nantucket to Bridgeport, Mass. and Conn						9	50	74
Long Island Sound, Conn. and and N.Y	[1] 100 608	[1] 25 41	[1] 187 23,244	169	26	14	12	20
Hudson River, N.Y	927	39	31,142	158	122	34	310	160
Long Island, N.Y	2,949	201	139,415	401	103	90	370	143
New York Harbor, N.Y. and N.J	49	1	1,902			50	300	415
Sandy Hook, N.J	273	22	7,459	23				
Delaware River, N.J						178	2,000	509
Shark River, N.J	34	2	2,581	12	2	4	10	23
South River and Kent Island Narrows, Md	108	37	26,939	102	24	17	49	56
Wicomico River, Md	175	3	16,803	36	19	33	305	82
Fenwick Island Light to Cape Charles, Md. and Va	3,455	3,164	27,402	43	4	80	320	60
Yorktown, Va				2		2	4	
Albemarle Sound to Cape Fear River, N.C	301	16	13,803	320	69	421	2,447	586
Charleston to Port Royal Sound, S.C						210	534	441
Savannah, Ga., to Jacksonville, Fla						214	989	544
Atchafalaya Bay to Port Arthur, La. and Tex						223	1,639	258
Vicinity of Calcasieu Pass, La	6,332	16,543	40,014	77	46			
Lake Charles to Calcasieu Lake, La				107	42			
Galveston, Tex	3,824	339	94,451	204	55	109	716	174
Oceanside to Point Sur, Calif						296	926	549
Newport Bay to Naples, Calif	3,752	382	58,498	310	208	76	520	139
Santa Barbara Islands, Calif	6,415	9,448	33,511			4	3	2
Point Piedras Blancas to Point Anò Nuevo, Calif	11,785	8,033	93,589	105	72			1
San Francisco Bay, Calif. (air-photo reduction)				89	88			
San Joaquin-Sacramento Delta (air-photo reduction and control)				877	704		900	250
Seattle to Eagle Harbor, Wash				2		15	30	9
Revillagigedo Channel, Alaska	3,023	371	55,542	311	246	110	274	163
Prince William Sound, Alaska	2,046	906	8,842	170	138	115	510	101
Afognak Island, Alaska	7,166	2,308	81,466	262	171	5	110	55
Kodiak Island, Alaska	10,956	4,777	105,703	222	142	75	165	145
Oahu Island, Hawaii	688	25	44,954	36	3	7	3	26
North, and northwest coasts, Luzon Island, P.I	6,788	3,708	92,717	97	110	44	154	26
Manila Harbor, Luzon Island, P.I	95	2	5,525					
North coast, Samar Island, P.I	4,575	796	53,632	122	63	38	203	44
West coast, Palawan Island, P.I	12,020	8,596	202,314	68	43			
Sibutu Islands, P.I	1,842	215	32,323	7	5			7
Total	103,344	76,656	1,387,027	4,407	2,536	2,476	13,858	5,066

[1] Wire-drag.

GEODETIC WORK

More geodetic work was done during the fiscal year 1933 than in any other year in the history of the Coast and Geodetic Survey.

As a result of these geodetic activities, 3,625 miles of first-order triangulation, and 11,324 miles of first-order and 2,940 miles of second-order leveling were added to the control nets of the country. In addition, 29 first-order base lines, with a total length of 196 miles, were measured; 147 gravity stations were occupied; and astronomical observations were made at 129 stations. This work was done by 5 triangulation parties, 11 leveling parties, and 1 party each on gravity, astronomy, and base measurements.

The arc of first-order triangulation being extended along the Atlantic coast was continued southward from the vicinity of New York City to Norfolk, Va., and thence along the James River to a connection with the eastern oblique arc triangulation near Charlottesville, Va. Connections with the eastern oblique arc were made also in central New Jersey and Delaware Bay.

The eastern shore of Lake Michigan arc of first-order triangulation, in progress at the beginning of the fiscal year, was completed, and an arc extended southward from Traverse City to Hillsdale, Mich., to a connection with the triangulation of the Lake Survey. Spur lines were run east and west at latitude 43°30′ and eastward to Detroit, where connection was made with the Lake Survey triangulation along the Detroit River. During the course of this work, additional triangulation stations were established in Detroit for the use of the city engineer.

First-order triangulation work was done from the vicinity of Augusta, Ga., to a connection with the Atlantic coast arc at Beaufort, S.C.; from a point south of Brunswick, Ga., continuing the Atlantic coast arc to Jacksonville, Fla.; westward to Tallahassee and thence northward to a connection with existing triangulation in the vicinity of Columbus, Ga.; and southward and eastward from Jacksonville, Fla., through St. Augustine, Palatka, Coala, and Dunnellon, following the route of a proposed cross-State canal and thence up the Florida west coast to a connection in the vicinity of Tallahassee.

Other arcs of first-order triangulation were extended from the eastern oblique arc, in the vicinity of Mount Airy, N.C., southeastward across that State to Jacksonville, N.C.; from Kinston southwestward to Dillon, S.C.; from Little River, N.C., along the North Carolina-South Carolina boundary to Statesville, N.C., thence via Charlotte to a connection with the eastern oblique arc in the vicinity of Morganton; and from Clarkesville, Va., toward Richmond, Va.

In the west, first-order triangulation was extended from Redondo, via Antelope Valley, to the vicinity of Bakersfield, Calif. This work was supplemented by second-order triangulation for use in earthquake studies. An arc was extended from Pendleton, Oreg., southwestward across that State through the mountains southwest of Bend, where the work was abandoned because of heavy snows and other unfavorable weather conditions.

A scheme of first- and second-order triangulation was extended from Taft, Calif., for the purpose of investigating earth movements. Additional observations at triangulation stations where the previous observations were incomplete were also made in the vicinity of San Francisco.

At the end of the year, an arc of first-order triangulation was in progress from Loop City, Nebr., westward to Pocatello, Idaho.

Lines of first- and second-order leveling were run in 35 States, including the District of Columbia. They were Alabama, Arizona, Arkansas, California, Colorado, District of Columbia, Florida, Georgia, Idaho, Illinois, Iowa, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Washington, and Wyoming.

In cooperation with the North Carolina State Highway Commission, in pursuance with an agreement which contemplates the completion of control work in that State within the 50-mile spacing, triangulation and leveling work were carried on in North Carolina through most of the year.

At the request of the State of New Jersey, 44 triangulation stations were established on the ocean side of the intracoastal waterway at intervals of about 2½ miles, between Bay Head and Cape May, in connection with the Atlantic coast arc. The cost of the additional observations was assumed by that State.

The Survey cooperated with the State of California, which contributed toward the cost of the work, in extending a number of first-order level lines.

The Jacksonville, Fla., Office of the Corps of Engineers, United States Army, cooperated with this Bureau by advancing $11,600 for the extension of triangulation along the route of the proposed cross-State canal, to coordinate other surveys preliminary to the selection of the final route.

Geodetic work accomplished

Locality	Length of scheme	Area covered
TRIANGULATION, FIRST ORDER		
	Miles	*Sq. mi.*
East shore Lake Michigan, Mich	95	1,150
New York City to Norfolk, N.Y., N.J., Md., Del., and Va	300	3,900
San Fernando to Bakersfield, Calif	110	1,550
Grand Traverse Bay to Hillsdale, Mich	470	4,700
Augusta to Beaufort, Ga. and S.C	120	1,250
Brunswick to Jacksonville, Ga. and Fla	70	550
Jacksonville to Tallahassee, Fla	170	1,350
Tallahassee to Columbus, Fla. and Ga	150	1,500
Norfolk to Gordonsville (James River), Va	170	1,700
Arlington to Bend, Oreg	125	2,750
Vicinity of Taft, Calif	15	65
Vicinity of Big Sur, Calif	60	250
Oblique arc to Jacksonville, N.C. and Va	230	2,300
Goldsboro to Little River, N.C. and S.C	130	1,150
Marietta to Lincolnton, N.C. and S.C	140	1,500
Jacksonville to Port Inglis, Fla	140	1,100
Loup City to Laramie, Nebr. and Wyo	330	5,100
Mt. Airy to Murphy, N.C	210	3,800
Pasco to Orofino, Wash. and Idaho	165	2,950
Colfax to International Boundary, Wash	135	3,350
Dunnellon to Tallahassee, Fla	160	1,450
Roxboro to Weldon to Richmond, N.C. and Va	130	1,300
Total	3,625	44,715
BASE LINES, FIRST ORDER		
Howard, Mich	7.4	
Pittsville, Md	6.2	
Norfolk, Va	6.6	
Richmond, Va	4.4	
Rocky Mount, N.C	9.5	
BASE LINES, FIRST ORDER—COD.		
	Miles	*Sq. mi.*
Durham, N.C	4.6	
New Bern, N.C	6.0	
Southport, N.C	6.3	
South River, N.C	10.0	
Dillon, N.C. and S.C	7.9	
Charleston, S.C	5.9	
Augusta, S.C	5.5	
Ogeechee, Ga	5.1	
Duval, Fla	5.5	
Live Oak, Fla	4.9	
Colquitt, Ga	10.9	
Dunnellon, Fla	5.8	
Titusville, Fla	6.7	
Delray, Fla	6.4	
Tamiami, Fla	9.1	
Estero, Fla	6.9	
Santa Ana, Calif. (remeasurement)	1.0	
St. Petersburg, Fla	8.2	
Okeechobee, Fla	7.6	
Salem, Fla	7.2	
McIntyre, Fla	6.0	
Point Washington, Fla	10.4	
Union City, Ohio	8.4	
Smiths Grove, Ky	5.6	
Total	196.0	
BASE LINE, SECOND ORDER		
Taft, Calif	0.7	
RECONNAISSANCE, FIRST ORDER TRIANGULATION		
Roxboro to Kinston, N.C	140	1,350
Goldboro to Little River, N.C. and S.C	130	1,150
Marietta to Lincolnton, N.C. and S.C	140	1,500
Mt. Airy to Murphy, N.C	290	5,600
Washington to Pamlico Sound, N.C	85	880
Newport to Core Sound, N.C	25	215
San Fernando to Bakersfield, Calif	60	850
Grand Traverse Bay to Hillsdale, Mich	470	4,700

Geodetic work accomplished—Continued

Locality	Length of scheme	Area covered
RECONNAISSANCE, FIRST ORDER TRIANGULATION—continued		
	Miles	*Sq. mi.*
Charleston to Bristol, W.Va., Va., and N.C	75	1,350
Pocatello to Loup City, Idaho, Wyo., and Nebr	485	11,000
Lewiston revision, Idaho	110	2,100
Arlington to Klamath Falls, Oreg	250	6,100
Jacksonville to Miami, Fla	360	2,800
Miami to Estero, Fla. (traverse)	100	--------
Estero to Port Inglis, Fla	205	1,600
St. Augustine to Port Inglis, Fla	110	850
Port Inglis to Tallahassee, Fla	160	1,450
Sarasota to Fort Pierce, Fla	140	1,350
One hundred and seventeenth meridian, Oreg., Idaho, and Nev	30	750
Ogallala to Perryton, Nebr., Kans., and Okla	305	3,800
Vicinity of Taft, Calif	15	65
Delaware River, N.J., Pa., and Del	100	1,200
Belen to Las Cruces, N.Mex	170	5,000
Colfax to International Boundary, Wash	135	3,350
Pittsburgh westward, Pa., and Ohio	125	1,500
Richmond to Washington, Va., Md., and D.C	110	900
Lander to Pocatello, Wyo	95	3,370
Lynchburg to Christianburg, Va	40	900
Total	4,350	64,585
LEVELING, FIRST ORDER		
Ithaca to Elmira, N.Y. (part)	23	--------
Salida to Bishop, Calif. (part)	192	--------
Redding to Alturas, Calif	155	--------
Cape Girardeau to Hoxie, Mo., and Ark	140	--------
Sacramento to Oakland, Calif	154	--------
Hopland to Albion, Calif	60	--------
Knoxville to Dillsboro, Tenn. and N.C	124	--------
Spartanburg to Lynchburg, S.C. and Va	327	--------
Atlanta to Dillsboro, Ga., and N.C	157	--------
Cedar Keys to St. Augustine, Fla. (releveling)	143	--------
El Paso to Vaughn, Tex. and N.Mex	238	--------
Junction to Fort Stockton to Monahans, Tex	262	--------
Robstown to Laredo, Tex	147	--------
Bristol to Hickory, Va. and N.C	150	--------
Port Jervis to Reading, N.Y. and Pa	165	--------
Chillicothe to Jericho, Tex	124	--------
Cornelia to Spartanburg, Ga. and S.C	132	--------
Desert Center to Salome, Calif. and Ariz	117	--------
Dumbarton Bridge to Skyline Boulevard, via Palo Alto, Calif	31	--------
Fort Pierce to Punto Gorda, Fla	132	--------
Fort Stockton to Sanderson, Tex	68	--------
Hamlet to Chadbourn, N.C	94	--------
New Smyrna to Tampa, Fla	157	--------

Locality	Length of scheme	Area covered
LEVELING, FIRST ORDER—con.		
	Miles	*Sq. mi.*
Palatka to Dunnellon and Port Inglis, and Dunnellon to Archer, Fla	154	--------
Sweetwater to Bowie, Tex	266	--------
Whiteland to Big Spring, Tex	162	--------
Yuma to Needles, Ariz. and Calif	176	--------
Anderson to Denmark, S.C	170	--------
Washington to Baltimore and Annapolis, D.C. and Md	91	--------
Ludlow to Beatty, Calif. and Nev	168	--------
Mayport to Dunnellon, Fla	834	--------
Reedsport to Newport, Oreg	96	--------
Columbus to Selma, Ga. and Ala	151	--------
Roswell to Tularosa, N.Mex	107	--------
Jacksonville to Crowder, Tex. and Okla	276	--------
Chadbourn to Savannah, N.C. and Ga	283	--------
Fort Smith to El Reno, Ark. and Okla	258	--------
Beatty to Olanoha, Nev. and Calif	134	--------
Wood River to Julesburg, Nebr. and Colo	206	--------
Bowie to Clemenceau, Ariz	286	--------
San Jose to Santa Margarita, Calif. (releveling)	204	--------
Forrest City to Hazen, Ark. (releveling)	63	--------
Van Buren to Russellville, Ark. (releveling)	86	--------
Seligman to Fort Smith, Mo. and Ark. (releveling)	106	--------
Vicinity of San Antonio, Tex. (releveling)	63	--------
Vicinity of Houston, Tex. (releveling)	73	--------
Santa Ana to San Diego and Fall Brook, Calif. (releveling)	120	--------
San Francisco to San Jose to Oakland, Calif. (releveling)	101	--------
Vicinity of Elmira, N.Y	26	--------
Vicinity of Watertown, N.Y	35	--------
Aberdeen to Twin Rivers, Wash	154	--------
Sterling to Crawford, Colo. and Nebr	183	--------
Ithaca to Cayuga, N.Y	40	--------
Oakland to Hamburg, Ill. and Iowa	525	--------
Albuquerque to Mears Junction, N.Mex. and Colo. (part)	263	--------
Duluth to International Falls, Minn. (part)	35	--------
West Point to Clarksdale, Miss	211	--------
Bridgeport to Riverton, Ala	261	--------
Green River to Laurel, Wyo. and Mont. (part)	321	--------
Perth Amboy to Port Jervis, N.J. and N.Y	118	--------
Bemidji to Cass Lake, Minn. (releveling)	33	--------
Pipestone to St. Cloud, Minn	172	--------
Springfield to Troy, Mass. and N.Y	114	--------
Bonners Ferry to Shelby, Idaho and Mont. (part)	96	--------
Omak to Springdale, Wash	137	--------
Table Rock to Wolcott, Wyo. and Colo	237	--------
Puntenney to Flagstaff, Ariz	121	--------

Geodetic work accomplished—Continued

Locality	Length of scheme	Area covered
LEVELING, FIRST ORDER—con.	*Miles*	*Sq. mi.*
Mack to Green River, Colo. and Wyo. (part)	73	--------
White River Junction to Dover, Vt. and N.H. (part)	53	--------
Hamburg to Hastings, Iowa and Nebr. (part)	65	--------
Mina to Battle Mountain, Nev. (part)	125	--------
Total	11,324	--------
LEVELING, SECOND ORDER		
Lines on Long Island, N.Y	221	--------
Truckee to Sacramento, Calif	170	--------
Westwood to Keddie, Calif	39	--------
Red Bluff to Flanigan, Calif. and Nev	173	--------
Doyle to Reno, Calif. and Nev	53	--------
Reno Junction to Richvale, Calif	155	--------
Dillsboro to Spartanburg, N.C. and S.C	127	--------
Beeville to Gardendale, Tex	116	--------
Gilroy to Chowchilla, Calif	84	--------
Granbury to Goldthwaite, Tex	158	--------
Hebbronville to Rio Grande, Tex	79	--------
Lampasas to Mason, Tex	100	--------
Salisbury to Chester, N.C. and S.C	167	--------
LEVELING, SECOND ORDER—con.	*Miles*	*Sq. mi.*
San Lucas to Goshen, Calif	120	--------
Statesville to Max Meadows, N.C. and Va	130	--------
Wadesboro to Hamlet, N.C	24	--------
West Point to Placedo Junction and Kenedy, Tex	162	--------
Atlanta to Bushnell, Ga. and N.C	180	--------
Mammoth Springs to Shirley, Ark. (releveling)	101	--------
Newport to Forrest City, Ark. (releveling)	72	--------
Wheatley to Helena, Ark. (releveling)	98	--------
Globe to Tucson, Ariz	114	--------
Tempe to Wenden, Ariz	118	--------
Matthie to Prescott, Ariz	80	--------
Roosevelt to Maricopa, Ariz	99	--------
Total	2,940	--------
SUMMARY		
First-order triangulation	3,625	44,715
First-order base lines	196.0	--------
Second-order base line	.7	--------
First-order triangulation, reconnaissance	4,350	64,585
First-order leveling	11,324	--------
Second-order leveling	2,940	--------

TIDE AND CURRENT WORK

The work of this division included the operation and inspection of primary tide stations, furnishing tidal control for the various regions, and the operation for short periods of numerous secondary tide stations and miscellaneous current observations, for use in hydrographic surveys.

Tide and current surveys.—The tide and current survey of New York Harbor, begun in 1932 in cooperation with United States Army Engineers, was completed. Tide gages were established at 18 stations, 3 of which were maintained the entire season. The engineer office established 139 gages, mostly staff. Pole and meter current observations were obtained at 85 stations for 50-hour periods, at which density and temperature observations were also secured. The United States Engineers secured observations at 29 stations for approximately 10-day periods. In connection with this survey, 31 new standard disk bench marks were established, and 28 bench marks recovered.

A tidal survey of the coast of Oregon was started during the year. Standard gages, to be operated 12 months, have been established at Newport, Walport, Florence, Gardiner, Brighton, Coos Bay Jetty, Bandon, Brookings, Port Orford, Garibaldi, and Taft, in Oregon, and at Crescent City, Calif. Portable gages were installed at Nehalem and Bar View. Another will be established at Tillamook Bay at the request of the Tillamook County Chamber of Commerce, for

use in establishing property boundaries. In connection with the proposed ship canal between the Columbia River and Puget Sound, Wash., portable gages were established in Bakers and Willapa Bays. These data are required in slope studies, for determining the necessity for a lock or sea level canal between these two places.

A tidal survey of the west coast of Florida was also commenced. Standard gages were established at St. Marks, Aripeka, Anna Maria, South Boca Grande, Punta Rasa, and Naples, and will be maintained for approximately 1 year. A portable gage was installed at Apalachicola.

These surveys, giving complete and up-to-date information relative to the more important harbors of the country, are made as funds become available, to meet the urgent and constantly growing demand from navigators, engineers, scientists, and the public generally, for they supply needed datum planes and are used in computing predictions.

Tide stations.—Of the 32 primary tide stations in operation at the close of the year, 19 were located on the Atlantic coast, 4 on the Gulf of Mexico coast, 6 on the Pacific coast, 2 in Alaska, and 1 in the Hawaiian Islands. Their locations are shown in the following table, in which stations maintained in cooperation with other agencies are indicated by an asterisk (*):

Eastport, Maine	Annapolis, Md.*	Galveston, Tex.
Portland, Maine	Washington, D.C.	San Diego, Calif.*
Portsmouth, N.H.*	Hampton Roads, Va.*	La Jolla, Calif.
Boston, Mass.	Southport, N.C.*	Los Angeles, Calif.*
Woods Hole, Mass.*	Charleston, S.C.	San Francisco, Calif.
Newport, R.I.*	Mayport, Fla.*	Astoria, Oreg.
Bridgeport, Conn.	Jacksonville, Fla.*	Seattle, Wash.
New York, N.Y.	Miami Beach, Fla.*	Ketchikan, Alaska.
Atlantic City, N.J.	Key West, Fla.	Seward, Alaska.
Philadelphia, Pa.	Pensacola, Fla.	Honolulu, Hawaii.*
Baltimore, Md.	Mobile, Ala.*	

Three of these stations were established during the year on a cooperative basis: One at Woods Hole, Mass., with the Woods Hole Oceanographic Institute, and the others at Mobile, Ala., and Southport, N.C., in conjunction with local United States Engineers.

The data secured from observations are essential for the determination of accurate datum planes, for the reduction of the results of short series of observations to mean values, for the determination of secular changes in relation of land to sea, and for hydrographic control.

Inspections were made of the following stations, where levels were run between the tide staff and adjacent bench marks:

Rockland, Maine	Bridgeport, Conn.	Southport, N.C.
Eastport, Maine	New Bedford, Conn.	Charleston, S.C.
Portland, Maine	New York, N.Y.	Mayport, Fla.
Portsmouth, N.H.	Oyster Bay, N.Y.	Jacksonville, Fla.
Boston, Mass.	Willets Point, N.Y.	Miami Beach, Fla.
Woods Hole, Mass.	Atlantic City, N.J.	Key West, Fla.
Newport, R.I.	Philadelphia, Pa.	

A total of some 281 secondary tide stations were also in operation for short periods in connection with hydrographic and tide and current surveys on both coasts of the United States, in Alaska, Hawaii, and the Philippines.

The Survey is appreciative of the cooperation of other organizations engaged in carrying on tide and current work. The value of such assistance was emphasized in connection with the curtailed appropriations. A number of tide stations are operated on this basis, whereby the tide station and observer are furnished by another agency and the instructions and supervision furnished by this Survey. These stations are subject to the usual inspection and the records given this Bureau for its archives. Similar data are also exchanged with individuals and organizations of other countries.

Cooperation with the United States Engineers has been helpful to both organizations, especially in connection with the tide and current survey of New York Harbor. Tide stations were maintained at Southport, N.C., Miami Beach, Fla., Jacksonville, Fla., and Mobile, Ala.

The Navy Department has likewise rendered valuable assistance, maintaining tide stations at Newport, R.I., Annapolis, Md., Hampton Roads, Va., San Diego, Calif., Portsmouth, N.H., and Bellevue, D.C.

Interested research institutions and universities have assisted by maintaining cooperative stations at Woods Hole, Mass. (Woods Hole Oceanographic Institute); Friday Harbor (Oceanographic Laboratory of the University of Washington); and St. Georges, Bermuda (Biological Research Bureau). Gages have been loaned the American Geographical Society for tide observations along the east coast of Greenland, where such information is very meager.

Other stations are at this time maintained at Mission Bay, Calif., by the State park commission, to secure accurate datums in an area of increasing land values; Berkeley and Richmond, Calif., by the Berkeley Waterfront Co.; Bladensburg, Md., by the Washington Suburban Sanitary District, for the study of sewage disposal in the metropolitan area of Washington; Santa Monica, Calif., by State authorities, for datum studies in connection with State road building close to the ocean beach; Nassau, Bahamas, by the public works department; Santa Ana and Los Patos, Calif., by the Orange County authorities; Los Angeles by the Los Angeles Harbor Department; and Honolulu, Hawaii, by the surveyor of that Territory.

Miscellaneous current observations.—Short series of current observations were made in connection with hydrographic surveys in Long Island Sound; Georges Bank; Behm Canal and Revillagigedo Channel, Alaska; Wicomico River, Md.; and Charleston Harbor.

Density and temperature observations.—Water density and temperature observations were taken daily at 19 primary tide stations. Observations were also taken at each of the current stations in connection with the tide and current survey of New York Harbor.

MAGNETIC AND SEISMOLOGICAL WORK

Magnetic work.—The magnetic survey of the United States can never be finished. Although observations have been made at some 6,000 places in the United States, including nearly every county seat, the observations are not final because at each of these places the direction of the magnetic needle and the forces acting on it are changing constantly.

That is the reason why continuous photographic records are being made at 5 magnetic observatories and also, since these are so limited in number, why "repeat observations" are made at many places at regular 5-year intervals. The primary object of these data is to keep the magnetic information on charts and airway maps revised, that they may show authoritatively the conditions at the date of issue and changes that occur from year to year.

Largely as a result of the use of relief money, many triangulation stations are being added to the control net in all parts of the United States, at many of which azimuth marks are established, from which it is easy to obtain the direction of true north, a factor necessary in magnetic observations. Earlier magnetic stations were placed in towns, convenient to county surveyors in checking their compasses and transits. The development of power plants, improvements in sewage systems, new roads, and the automobile, however, have brought influences disturbing magnetic conditions near town stations, and various developments have destroyed magnetic station marks and the prominent objects whose true bearings are determined.

Triangulation stations in the country, usually free from these objections, are used to good advantage as magnetic stations. This means, however, that for repeat station purposes a selected triangulation station and a former magnetic station in the same general region must be occupied simultaneously, that the records of change may be continuous.

Observations at repeat stations, placed about 200 miles apart, give the direction of measurements and forces acting on the magnetic needle. Declination stations are established at some 50-mile intervals along the route followed, for the ready access of county surveyors. Observations at the latter, which give only the direction of the magnetic needle with regard to true north, afford widely scattered values for the use of the mariner, the aviator, and the local surveyor. A special effort is also made to replace needed stations requested. This work was carried into the States listed below:

Alabama	5	Missouri	3
Alaska [1]	68	New Mexico	12
Arizona	9	Oklahoma	3
Arkansas	3	Philippine Islands	16
California	11	Puerto Rico	1
Georgia	1	Tennessee	4
Illinois	3	Texas	42
Indiana	1	Virginia	5
Kentucky	2	Washington	1
Louisiana	3	Wisconsin	5
Maryland	1		
Michigan	2	Total	203
Mississippi	2		

At the five observatories, the photographic recording of the magnetic elements is unending. At the Cheltenham, Md., observatory, designated by international organizations as the standard observatory of the United States, field instruments are standardized and new and improved instruments and methods are developed and tested. At the San Juan, Tucson, Sitka, and Honolulu stations the continuous recording is the chief work, although at Tucson atmospheric

[1] Special examination was also made of an area of local attraction in southeastern Alaska.

electric and earth current observations, closely related not only to magnetism but to disturbances in cable, telegraph, and telephone transmission, are made in cooperation with the Carnegie Institution of Washington and the Mountain States Telegraph & Telephone Co., a subsidiary of the Bell Telephone System.

The specialized observatory buildings were erected by this Bureau. They contain no magnetic material whatsoever. Through the use of emergency relief funds, disasters which might have resulted in the suspension of operations and the loss of instruments, were averted both at Cheltenham and San Juan. One of the Cheltenham buildings, seriously damaged by termites, was so reconstructed as to make the structure more secure for future work. The San Juan buildings, damaged by the hurricanes of 1928 and 1932, were incased in concrete reinforced by the novel use of nonmagnetic trolley wire brought down by the hurricanes. This use of copper reinforcing is practical only in the Tropics, where the temperature remains uniform, since copper does not change with temperature at the same rate with concrete.

The second polar year program.—The "polar year" for 1932–33 was the natural outgrowth of the first polar year of 1882–83, in which the United States took active part at Point Barrow, and also in Greenland by the ill-fated Greely expedition.

The present polar year, participated in by 33 nations occupying 98 stations, in polar regions and other parts of the earth, was organized by the International Polar Year Commission, of which the chief of this division is a member. The active participation is through the establishment of a polar-year station at College, near Fairbanks, Alaska, which in cooperation with Government and other organizations, is one of the most complete of all the stations.

Through the cooperation of the Naval Research Laboratory, Signal Corps, Bureau of Standards, Rockefeller Foundation, Carnegie Institution of Washington, and Alaska Agricultural College and School of Mines, the very complete program includes observations of the earth's magnetism by four different types of instruments, newly developed for this work; of atmospheric electricity; earth currents; the measurement of the height of the Kennelly-Heaviside layer; and other allied matters that affect radio transmission. This is all in addition to the extensive program of the United States Weather Bureau.

The important point is that all these phenomena, many of which are interrelated, have never heretofore been measured at the same places at the same time, at points widely scattered throughout the earth.

The construction of the necessary buildings was carried on expeditiously although presenting unusually difficult problems, caused by Arctic conditions and perpetual ground frost. The numerous piers supporting the instruments had to be carried to a depth of 13 feet below the surface, 70 tons of earth had to be removed, 50 tons replaced, and 20 tons of concrete laid.

Seismological work.—The seismological program naturally divides into several parts: The collection and compilation of reports from witnesses of earthquakes, the location and study of earthquakes

distant from recording instruments, and the recording of strong earth motions that can damage buildings and other structures.

Reports are collected from some of the 25,000 cooperative observers whenever a quake occurs. Many of these are employees of large corporations, public service, railroad, and others. For the western United States they are collected at the San Francisco field station, while for the balance of the country, including Alaska, they come to the Washington office. Most valuable information is immediately available through these reports.

As a result of the operation of seismograph stations, directly operated by the survey at San Juan, Tucson, Ukiah, and Sitka; through cooperative arrangements at Columbia, S.C., Chicago, Ill., Bozeman, Mont., and Honolulu, Hawaii, and through reports from six other stations, all earthquakes occurring in or near the United States, as well as the more important disturbances in other parts of the earth, are accurately located and facts about them made available for study.

During the year 42 instruments for recording strong earth motions were installed in 20 cities in California and 1 in the Panama Canal. These are well distributed, principally with regard to cities in regions where history shows destructive earthquakes occur. This is a new field of study, not heretofore investigated except in Japan. Japanese results, however, cannot well be applied in this country, because of the differences in types of buildings and geological ground structure.

In cooperation with the Bureau of Standards, Massachusetts Institute of Technology, and the University of Virginia, automatic, self-contained, instruments were developed and installed. The electrical operation is independent of any local electrical disturbance that might be cut off. They are inert until stimulated into action by a strong earth motion, when they write a record far more comprehensive than can possibly be obtained from the impressions of observers. In fact, they give the only absolutely accurate measures of the earthquake intensity.

The installation program in California was made possible through the help of many persons and organizations. Sites were tendered in suitable buildings and the plans aided in many other ways. Three of these instruments were in the vicinity of the Long Beach earthquake of March 10, 1933; two in the midst of the destruction.

There were no failures in operation. Engineers have offered the opinion that the records of these instruments, the installation and maintenance of which is comparatively small, provided the only absolutely accurate information resulting from the total loss of over $40,000,000.

Interesting effects of a distant earthquake were recorded in the San Francisco Bay region on the occurrence of the Nevada earthquake of June 25, 1933, over 200 miles away, to which 8 of the California instruments responded.

Records of this type are necessary in the establishment of proper building codes and have been used and are essential to the proper design of such structures as the control towers of Boulder Dam, the Oakland Bridge, and the Golden Gate Bridge in the San Francisco Bay region.

Tilt meters, developed in cooperation with the Bureau of Standards, which measure the tilting of the ground as a possible and a very probable means, according to Japanese experience, of predicting earthquakes a few days or hours in advance, have been installed at the University of California, along the Hayward fault.

WASHINGTON OFFICE

The number of persons in the service at the close of the year is shown in the following table:

Staffs	Commissioned	Civilian				Total
		Classified	Unclassified			
			Laborers	Seamen	Hands	
Washington office	14	245	4			263
Field service	157	71		567	824	1,619
Total	171	316	4	567	824	[1] 1,882

[1] Does not include 40 civilian employees of the Manila field station, nor 102 members of crews of the *Fathomer* and *Marinduque*. While paid by the insular government, they are under the jurisdiction of officers of the Coast and Geodetic Survey. There is, therefore, a total of 2,024 actually serving with the Survey.

There were received in the library and archives 102 hydrographic and 82 topographic sheets, representing new surveys accomplished by the Survey. Other additions included 2,459 charts; 1,280 maps; 1,017 blueprints (mostly of surveys by engineers of the United States Army); 8,133 field, office, and observatory records; 152 photographs and negatives; 341 prints; 69 lantern slides; 837 books; and 4,280 periodicals.

DIVISION OF ACCOUNTS

The regular annual appropriations for the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1933, totaling $2,413,013, were supplemented by $1,377,850, covered by the following special appropriations and transfers from other departments:

Party expenses, 1933, emergency construction	$1,250,000
Air navigation facilities, 1933	65,000
Second polar-year program (State transfer to Commerce, Coast and Geodetic Survey), 1932–34	30,000
Working fund, Department of Commerce	15,350
Topographic survey of United States, contributions	17,500

These additional funds aggregate $3,790,863. By reason of transfers of appropriations, however, this sum was reduced by $62,753.36, leaving a net amount of $3,728,109.64 available.

Actual disbursements during the period of the fiscal year, totaling $3,422,263.95, were distributed among the various appropriations, as follows:

Party expenses, 1931	$12.50
General expenses, 1931	27.33
Pay, officers and men, vessels, 1931	.33
Repairs of vessels, 1931–32	1,004.64
Party expenses, 1932	152,435.98

General expenses, 1932	$14,454.11
Pay and allowances, commissioned officers, 1932	66,991.75
Pay, officers and men, vessels, 1932	115,079.13
Repairs of vessels, 1932	16,365.28
Air navigation facilities, 1932	27,389.66
Salaries, 1933	487,053.94
Party expenses, 1933	451,563.15
General expenses, 1933	42,301.88
Party expenses, 1933, emergency construction	873,252.10
Pay and allowances, commissioned officers, 1933	557,969.33
Pay, officers and men, vessels, 1933	450,890.19
Repairs of vessels, 1933	51,694.07
Air navigation facilities, 1933	57,258.25
War transfer to Commerce Department	9,159.38
Topographic survey of United States, contributions	11,376.33
Second polar year program (State transfer to Commerce Department), 1932–34	21,225.83
Working fund, Department of Commerce	13,823.76
Chicago World's Fair Centennial Celebration	935.03
Total	3,422,263.95

Receipts from the sale of nautical charts, publications, and from all other sources, deposited in the Treasury Department to the account of miscellaneous receipts, totaled $51,269.48.

INSTRUMENT DIVISION

The functions of the instrument division are peculiarly vital to all activities of the Survey, for it provides all the instrumental equipment and much of the general property; designs new instruments; and purchases, services, and issues these materials as needed by field parties and the Washington office.

Some of the most notable accomplishments of the division during the past year are:

A new and extremely rigid tripod designed for precision instrument use. The instrument is attached to this tripod by means of a flat leaf spring, in such a manner that no stress is introduced into the instrument itself to disturb the accuracy. The metal parts are made principally of a light, strong, aluminum alloy to reduce the weight, and the tripod has been designed in such a manner that it may now be used for three different types of instruments, thus avoiding duplication and lessening the quantity to be stocked. It is planned to adapt other instruments to this design of tripod.

Progress has been made in standardizing level vials, so that fewer sizes need be carried. A number of the newer instruments now use interchangeable level assemblies.

A new magnetograph recorder cylinder was developed, in conjunction with the division of terrestrial magnetism and seismology, making use of the same general design as is used in the portable tide gage.

A pendulum starting accelerometer was devised for use with strong motion earthquake-recording apparatus. A number of these have been installed and the device was instrumental in successfully recording the initial waves of the Long Beach earthquake, this being the first time such a record has been obtained.

Improvements were made in the method of constructing and graduating level rods. The time required to make rods was very materially reduced.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

This division has charge of the hydrographic and topographic surveys of the Bureau and for administrative purposes is composed of the sections of field work, vessels and equipment, and coast pilot. The training section was discontinued, since the present law prevents new appointments.

Extensive studies were made in the section of field work for a systematic planning of field operations. Detailed instructions were issued the various field parties for hydrographic, topographic, and control work.

An officer continued the planning and supervision of air photo-topographic projects, and the reduction of photographs to the finished maps. Considerable time was allotted to improvement of methods and instruments in this comparatively new field. Photographs of the coast of southern California and of several sections of the Atlantic coast were being compiled at the close of the year.

Two electrical engineers were responsible for the upkeep and improvement of the echo-sounding apparatus and other electrical devices used on surveying ships. Satisfactory work was accomplished in connection with the construction of a shoal water fathometer for use on launches as well as ships. This, if successful, will provide another means of expediting inshore hydrography, with a further decrease in unit costs.

Research was done to improve the radio acoustic sound ranging used in offshore hydrographic surveying. This system has been developed to a high state of efficiency and is largely responsible for the large amount of hydrography accomplished during the year.

The section of vessels and equipment has general supervision over the construction and repair of vessels, including boats and launches and special equipment such as sounding machines. The pilot houses and chart rooms of the *Oceanographer* and *Lydonia* were rebuilt and enlarged from plans drawn in the section. Plans for the 30-foot launches were revised to provide a canopy of stainless steel instead of wood. Six launch sounding machines purchased were constructed from plans prepared in this section. A large quantity of other equipment was also purchased or transferred from other Government services.

DIVISION OF GEODESY

This division plans the geodetic field work, makes computations and adjustments of field observations, and prepares information for the use of the public. It also assists engineers, scientists, and others, to interpret the vast quantity of results for scientific studies.

The program that is being followed, after conference with officers of the United States Geological Survey, is to cover the country with a comprehensive network of geodetic control, well broken up into comparatively small areas, so that triangulation and leveling data may be secured on short notice wherever topographic mapping is undertaken. The country is now so well covered with trunk lines of triangulation and leveling that intermediate shorter arcs and lines are readily fitted in without distorting any of the old work.

These data had accumulated faster than they could be prepared for public use, due to the lack of technical and clerical personnel. As a result of the employment of a number of computers in New York City from relief funds, however, the division is more nearly current than it would be otherwise, in spite of the mass of records received from field operations.

Perhaps three times as much office computation and adjustment of geodetic observations were made as during any previous year in the history of the Survey.

DIVISION OF CHARTS

The increased activity in the field divisions was not immediately reflected in the chart division, as field results are just beginning to flow into the Washington office. They will continue for months to furnish material from which existing charts are modernized and improved and new charts constructed.

Heavy demands for new harbor charts, occasioned by local needs for stimulating business, resulted in a series of three new charts of the Houston Ship Channel from Houston to the sea. With the completion of a ship channel and harbor at Stockton, Calif., a preliminary chart was issued of the main channel following the San Joaquin River in advance of a comprehensive chart of that river and the network of navigable sloughs on either side.

A new chart was issued, especially designed for the use of fishermen, embracing the eastern end of Georges Bank, 150 miles from the New England mainland but nevertheless in such detail that commercial fishermen can determine therefrom with their fathomer equipment whether the bottom is suitable for trawling operations. With the issuance of a companion chart to the westward, now in process, this important fishing ground will be adequately covered. Because they show only a relatively small area far from land, a radio location plotted on each chart indicates the course to steer to port.

Several phototopographic sheets were printed from aerial photographs, making it possible at nominal cost to furnish exact copies of the original data to scale and on durable paper instead of photographic copies at five times the cost. The value of these maps to engineers and contractors for development projects is fully attested by the increasing calls.

There has been a decided advancement in the office practice of directing chiefs of parties relative to their field work. Instead of forwarding copies of former surveys as a basis for their work, the interpretation is made at the Washington office, conforming to one standard for all in the field. Party chiefs are supplied a projection of the region, laid down to the scale called for in the instructions, on which are plotted the triangulation and shore line; the channels, soundings, shoals, and obstructions to be investigated; the areas to receive the additional development required in modern marine surveys; and any other points revealed by the critical examination of all previous surveys on file. While this exacts additional time of the office personnel in preparation, the resulting field sheets require less research and are of a quality warranting classification as basic surveys behind which it should be unnecessary to go for charting data.

Sectional airway maps now adequately cover continuous passage by many of the more heavily traveled routes. The sales of these maps and comments on their value by airmen have been most gratifying. The number of new maps published was greater than in any previous year. The many changes in aids, requiring frequent new editions, necessitated an increasing proportion of time spent on maintenance.

Construction and maintenance

Items	Nautical charts	Airway maps	Items	Nautical charts	Airway maps
New	21	12	Reprints	67	----------
New editions	152	12	Cancelations	7	----------
New prints	277	----------	Hand corrections	[1] 1,668,148	237,967

[1] Does not include Manila field station.

Charting material received

Items	1933	1932	1931	1930	1929
Topographic field sheets	82	62	75	176	80
Hydrographic field sheets	99	102	102	134	146
Blueprints of surveys from other organizations	1,223	1,271	701	724	645
Letters containing charting data	816	894	651	722	668

Nautical charts and books and airway maps issued by Washington office

Items	1933	1932	1931	1930	1929
Nautical charts	216,936	249,311	259,862	258,286	231,741
Coast Pilots	4,116	5,825	6,480	7,651	6,288
Intracoastal Pilots	1,399	2,255	1,909	2,208	1,756
Tide and current tables	31,609	49,014	50,306	42,737	37,378
Tidal current charts	958	635	1,784	326	[1] 1,453
Commerce airway maps	29,369	19,402	17,468	[2] 12,004	----------

[1] First issued in 1929. Good for any year.
[2] Previously distributed by Aeronautics Branch.

DIVISION OF TIDES AND CURRENTS

The past year has shown a steady increase in the demand for accurate tidal and current information.

Owing to the importance of New York Harbor and its ever-changing waterways, a comprehensive tide and current survey of this region was undertaken in cooperation with the United States Engineers, the results of which are being reduced and correlated for publication when funds are available.

Owing to the curtailment of printing appropriations, no new bench mark or tide and current survey publications were printed, although the work of reducing and correlating the records on hand and bringing them up to date from new surveys has been continued.

The establishment of additional primary and secondary tide stations has increased the amount of records to be reduced and tabulated. Records from the United States Engineers and the State

Engineers of California covering observations in San Francisco Bay were worked up in connection with a study of the salt-water barrier. Datum planes were determined at 90 places, and the elevations and descriptions of 135 bench marks established along our coasts compiled.

The annual tide and current tables were issued. The consolidation of the three volumes of tide tables into two under the titles Tide Tables, Atlantic Ocean, and Tide Tables, Pacific Ocean and Indian Ocean, has simplified the preparation of the manuscript, expedited printing, and resulted in an annual saving of approximately $1,000. The pamphlet Tide Tables, United States and Foreign Ports is, therefore, no longer issued.

The tide tables for 1934 include daily predictions for 96 reference stations, and differences and constants for 3,900 stations. Daily predictions for Los Angeles, Calif., and Zanzibar, Africa, are given for the first time. In addition to cooperation with Federal, State, and municipal agencies, predictions for these tables are exchanged with the following foreign organizations: British Admiralty, 21 stations; Canadian Hydrographic Service, 4 stations; Deutsche Seewarte, 6 stations; Service Hydrographique, France, 4 stations; and Geodetic Branch, Survey of India, 5 stations.

The 1934 current tables contain daily predictions for 24 reference stations, and differences and constants for approximately 1,200 other places. A new table for obtaining the velocity of the current at any time and a revised current diagram for Puget Sound are included.

A new edition of Tidal Current Charts, New York Harbor, was published from revised material.

Records received	Stations	Months	Days
Automatic tide gage	313	2,050	
Current	202		651
Level	146		
Density and temperature	108	235	240

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Terrestrial magnetism.—Magnetic data were furnished for 154 nautical charts and 28 airway maps. Requests from a large number of local surveyors were met for information needed in relocating old surveys.

While the publication of needed information from the observatory and field results was discontinued because of lack of funds, certain urgently needed data were furnished in mimeograph form. This, of course, is only a makeshift, as many important investigations are handicapped by the delay in publishing these data.

The observatory records are in immediate and constant demand by those studying geology by geophysical methods, especially in connection with the search for oil and minerals. Activities in the entire Southwest are aided and controlled by observations at Tucson.

Records of all the observatories are regularly furnished radio-broadcasting and commercial-communications organizations. It is

interesting to note that international broadcasts of special importance are now scheduled in advance with regard to the probability of favorable conditions as based on the study of Survey magnetic observatory records.

At the request of the International Scientific Radio Union, the daily conditions of the magnetism as observed at Tucson, Ariz., are telegraphed to Washington where they are included in the daily naval radio broadcast in regard to solar and other conditions that affect radio transmission.

Seismology.—The publication, United States Earthquakes, 1931, was issued, and work on the 1932 edition well advanced. Mimeographed instrumental reports were prepared and distributed to cooperating organizations.

Reports of witnesses of earthquakes are not only studied at the Washington office, but copies are furnished the University of California and the Seismological Research Laboratory at Pasadena, where important local investigations on nearby earthquakes are centered.

While the Survey has previously published an earthquake history of the United States, the Pacific coast area was excluded. The earthquake of March 10, 1933, aroused so much interest and demand for authoritative information, however, that a list of destructive and near-destructive earthquakes, from the earliest known records to the present time, was compiled and issued in mimeograph form to those interested in serious studies.

Earthquakes are located from the records of the various seismological stations. In the case of the more important quakes this is done immediately from telegraphic reports, through the cooperation of news and scientific agencies, and the epicenters are broadcast by naval radio. With reports received through a large area extending eastward to Europe and westward to China, earthquakes in remote regions, from which no news can arrive in several months, are located in a few hours.

The records of strong earth motion, which in their original form are somewhat complex, are analyzed and the information summarized for use by engineers and architects interested in the designs of buildings and other structures. Such information is promulgated by press releases and the publication of articles of interest to magazine readers.

Considerable information was compiled for the American Red Cross, representatives of which organization visited the Washington office for several months to obtain data vital to their studies.

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