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U. S. DEPARTMENT OF COMMERCE
JESSE H. JONES, Secretary
COAST AND GEODETIC SURVEY
LEO OTIS COLBERT, Director

ANNUAL REPORT

OF THE

DIRECTOR, UNITED STATES COAST AND GEODETIC SURVEY

TO THE

SECRETARY OF COMMERCE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1943

UNITED STATES
COAST AND GEODETIC SURVEY
WASHINGTON 1944

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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A REVIEW OF THE YEAR

As has been the case since the beginning of the war, all activities of the Coast and Geodetic Survey during the fiscal year 1943 were directed to supplying essential needs of the armed forces, merchant marine and other war agencies.

The marine charts published by the Bureau are necessary for the navigation of all United States coastal waters, and the great expansion of our Navy and merchant marine naturally has resulted in a constantly increasing demand for these charts. The distribution of over 1,900,000 charts in 1943 exceeded the issue of the previous year by some 900,000 copies and was over 5 times the number required annually before the war. The nautical charting program included the production of a considerable number of special charts for use in the antisubmarine campaign and other naval operations.

To supplement its nautical charts the Bureau publishes annual tables of predicted tides and currents, and 13 coast pilot volumes. The latter contain descriptions of the coasts, sailing directions and other information required for navigation. Over 128,000 copies of these publications were supplied in 1943. The annual issue before the war was about 45,000 copies.

The growing importance of airpower in warfare has had a marked effect on the work of the Survey in the production of aeronautical charts. These charts, published for all land areas of the United States and possessions, are required for air navigation and for use in the extensive training programs of pilots and navigators now in progress. The demand for these charts during the year totaled over 4,000,000 copies--nearly 12 times the prewar requirements. Activities in this branch of work included the continuation of an extensive charting program of areas outside the United States for the Army Air Forces. This project involved the compilation of several different types of charts and required a total production of about 7,500,000 charts.

Facilities available for all classes of field operations were employed for the execution of a large number of projects required by the armed forces, ranging in variety from hydrographic and topographic surveys of military and naval bases to vibration measurements for the installation of high-precision machine tool equipment in war plants.

TRANSFER OF PERSONNEL AND EQUIPMENT

Under the law which authorizes the transfer of personnel and equipment of the Coast and Geodetic Survey to the War and Navy Departments in time of national emergency, 56 commissioned officers were on military duty at the beginning of the fiscal year. During the year 14 additional officers were transferred and three were returned. At the end of the year 593 civilian members of the Bureau were also serving in the armed forces.

In addition to five survey ships previously transferred, the new ship PATHFINDER was assigned to the Navy Department upon completion in September 1942, at a west coast yard.

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TRAINING OF PERSONNEL

Many changes in personnel were made during the year due to the additional staff needed and the replacement of employees who went into the armed services. Since very few experienced persons were available for employment, considerable effort was made in formulating a program of training and in so arranging duties that a new employee could begin productive work with a minimum amount of training. In most cases new employees consisted of persons not subject to induction. These were women; physically handicapped men; married men with families; and personnel made available through the Civilian Public Service Camps, commonly known as conscientious objectors. The latter have been employed on field work in an isolated section of the country.

Women have been placed in positions which in normal times were filled almost exclusively by men. These are offset-printing-press helpers gradually being trained as operators; folding-machine operators; binders and finishers; photographers; hand-type compositors; draftsmen; cartographic engineers; artistic lithographers; mathematicians; computers; and in the field, recorders and engineering aids on survey parties and in the photogrammetric offices, and accountants and watchmen on triangulation and leveling parties. In all cases, except for draftsmen, the new employees are given "on the job" training since the number of new employees at any one time is small enough to be absorbed gradually and trained under the direct supervision of an experienced employee.

Lack of experienced topographic draftsmen and the large number needed required special measures to obtain and train recruits. Persons skilled in other types of drafting, such as statistical and mechanical, and later, those with art and design experience, were employed. It was necessary to train these in topographic drafting and, since they were obtained in large numbers, it was found to be more economical to establish a training unit whereby they could be trained in a group rather than to have the various supervisors devote time to "on the job" training. Later, when this source of recruitment was exhausted, the Civil Service Commission, with knowledge of the successful results obtained in the Bureau's training unit, established a trainee draftsman examination to meet the needs of all Government agencies. Since the examination was limited to eligibles within a radius of fifty miles of Washington, personal interviews were possible and a mechanical aptitude device was constructed in the Bureau to test the applicants' aptitude. This device determines steadiness of hand, the coordination of hand and eye, and depth perception, or the ability to see stereoscopically. The value of this device was demonstrated by the fact that for ten employees who had successfully completed the training course and been graded, the five having the highest marks had obtained the highest ratings in the aptitude test.

Many trainees were obtained as a result of this examination and, since most of them had no drafting experience whatsoever, the training course was made more comprehensive and extended in time to cover about four weeks. Each employee is graded upon completion of the training and in general the grades agree very favorably with those obtained in the Civil Service examination. Up to the end of the

fiscal year over 400 persons, mostly women and many without previous experience, had been successfully trained as topographic draftsmen.

The work of map making in the Bureau on which these draftsmen are engaged has been broken down into what might be called an assembly line; that is, rather than have one person carry along a complete job, the work has been subdivided into a number of operations such as projections, selection and evaluation of source material, compilation of culture, drainage and relief, nomenclature, smooth drafting, assembly and review. The employees assigned in the training section are given training along each phase of this work and, upon completion of training, are assigned to the unit in which they show the greatest aptitude; also, during training their work is carefully watched and training along their particular aptitude is intensified.

As an additional item of training for incentive purposes and for morale building, a series of twenty-minute weekly lectures was inaugurated in which each phase of the Bureau's activities is described. This is supplemented by guest speakers from the Army and Navy who, in telling of the importance of the Bureau's products in actual warfare, bring a realization to the employees of the direct contribution they are making to the war effort.

COOPERATION WITH AMERICAN REPUBLICS

Under the sponsorship of the Department of State, which made all necessary diplomatic arrangements and secured the needed funds, the Coast and Geodetic Survey continued to participate in the program for cooperation with the American Republics. These projects have resulted in a large number of favorable contacts with engineers and scientists in the American Republics and have been very effective in creating local interest and in developing mutually cordial relations.

Field parties serviced instrumental equipment at the 14 tide stations previously established in various Central and South American ports. Records from these stations are being utilized for the calculation of tide predictions and tidal datum planes and thus provide information of immediate value to mariners and engineers. Daily predictions for six additional ports have been included in the tide tables, making a total of 12 ports, distributed from the Gulf of California to Magellan Strait, for which predictions are now available as a result of this program.

Magnetic surveys were carried on in 10 South American Republics. Work was commenced in Venezuela and continued through the west coast republics as far south as Punta Arenas, Chile; thence to Cordoba, Argentina, and through Uruguay and Paraguay to Brazil where work was in progress on June 30. Instrumental comparisons and standardization observations were made at Huancayo Observatory, Peru (operated by the Carnegie Institution of Washington), at the Argentine national observatory at Pilar, and at the Brazilian national observatory at Vassouras. Special diurnal observations were made at Arica, Chile. The distribution of the magnetic observations in South America is included in the table under "Magnetic Investigations."

During the course of the magnetic surveys, seismological observatories were visited and numerous seismologists

interviewed in preparation for a proposed cooperative seismological project in these countries. The facilities of an American airline were used extensively. This company contributed materially to the success of the project by making its radio stations available for time signals, by making advance plane reservations and by exercising extreme care in handling the delicate instrumental equipment.

A rare geophysical phenomenon occurred in Mexico when in February a new volcano developed in a farmer's field and grew to over a thousand feet in height. This offered an unusual opportunity to obtain valuable information about the effects of new volcanic action on the earth's magnetic field as well as about possible correlation of volcanic with seismic activity. Magnetic observations for these purposes were made over the immediate area around the volcano. The project was part of the program of cooperation with the American Republics for magnetic surveys, and its execution was assisted by the State Department, the Mexican Government, the Pan American Institute of Geography and History, and numerous prominent scientists.

CHART PRODUCTION

The rapidly growing needs of the Navy, merchant marine and air forces for nautical and aeronautical charts necessitated considerable expansion of personnel and equipment for chart productior, most of which was employed on a two- or three-shift basis. The major results attained are shown in the following table which gives the annual issues of navigational charts and related publications during the past four years.

Charts and Publications Issued	1940	1941	1942	1943
Nautical Charts	407,186	621,663	1,081,072	1,916,599
Aeronautical Charts	463,917	912,339	3,145,516	11,773,464
Coast Pilots	11,132	15,030	19,094	35,661
Tide Tables	30,993	32,755	35,496	56,109
Current Tables	12,975	16,007	21,826	36,698

The number of individual nautical charts published at the end of the year was 840. To produce the 1,920,000 copies printed during the year there were 1,504 printings, as follows: 14 new charts, 116 new editions, 848 new prints, and 526 reprints. Of the 14 new charts, 11 were constructed for the Navy. Fifteen special nautical charts were prepared to provide information required for combatting submarines.

Although a considerable portion of the charts were reprinted at least twice during the year it was necessary, due to rapid changes in important navigational information, to apply 7,680,944 hand changes to correct the charts to the date of issue. Items covering chart changes, dangers requiring hand corrections and other navigational information were supplied to the U. S. Coast Guard and the Hydrographic Office of the Navy for publication in weekly Notice to Mariners.

During the year the standard series of aeronautical charts of the United States and its possessions was increased from 126 to 131 charts. In addition, 1,486 new charts were com-

piled and printed for the Army Air Forces. To produce the 11,928,161 charts printed during the year there were 2,147 printings, as follows: 1,246 new charts, 360 revisions, 318 reprints, and 223 base printings. These figures do not include 114 new charts and 62 revisions which were compiled by the Coast and Geodetic Survey but printed by the Army Map Service. In addition to the routine work of maintaining and issuing aeronautical charts of the United States and its territorial possessions the Bureau has contributed to the production of practically every type of aeronautical chart used by the air forces in all theatres of the war. The new aeronautical charts produced for the Army Air Forces include a wide variety of projects ranging from small-scale planning charts to large-scale target charts for bombing and other tactical operations over enemy territory.

Continuation of the compilation, drafting, and reproduction of special maps and charts intimately connected with the war effort, constituted a substantial portion of chart production work. Among these were airport approach and landing charts and war mapping quadrangles. The former consist of a series of 447 charts of the major airports of the United States, both military and civil, designed principally to assist the aviator in making safe landings during unfavorable weather.

The war mapping program involves the drafting and reproduction of approximately 359 standard 7-1/2 minute quadrangles of strategic areas within the United States. A considerable amount of reproduction was done for other war agencies, principally the Civil Aeronautics Administration and the Maritime Commission.

Heavy demands continued for photographic reproduction of the detailed hydrographic and topographic surveys contained in the files of the Bureau. These are used extensively by the military services and war agencies in connection with war construction projects, dredging of waterways, training of amphibious troops for invasion landings, research in connection with submarine detection, and many other projects requiring detailed knowledge of coastal regions and waters.

Numerous outstanding contributions to developments in cartography and lithography have been made by personnel of the Bureau for improving the efficiency and speed of production and, at the same time, maintaining the quality required. Due to rapidly changing conditions of war and changes in requirements for charts, brought about by actual experience in foreign theatres, it has frequently been necessary to alter certain designs of special purpose maps and charts more rapidly than would have been possible by older methods of cartography and lithography.

Throughout the entire emergency the policy has been followed of keeping methods and organization as flexible as possible, so that a shift in the design of a chart could be made rapidly to meet the emergency conditions faced by the armed services. This need of flexibility of organization has confronted every manufacturer or producer of war materials and is a logical corollary of modern warfare.

The great increase in the production of maps and charts brought about by the war, not only in this Bureau but in other Federal mapping agencies as well, has carried with it a proportionate amount of expansion in the operational facilities needed to support the primary job of chart making, such

as the computation of projection tables, geomagnetic studies, analysis of isogonic lines on nautical and aeronautical charts, and geographic research for source material.

Close liaison has been maintained between the various Federal mapping agencies. Contracts for chart printing were maintained throughout the year with several of the largest map lithographic plants to take care of printing above the capacity of the Bureau's plant. Commercial map lithographers are to be commended on the excellent work they are doing in the emergency.

In order to assist in the effort to avoid overcrowding in Washington and still make use of the services of additional engineers and draftsmen, branch units for the compilation of aeronautical charts were established in several cities in connection with other Bureau operations. Results of this action have been very satisfactory.

The printing of charts has been increased materially through acquisition early in the year of a new two-color printing press. This type of press is particularly effective in printing the sectional and regional aeronautical charts used in large quantities by the air forces of both the Army and Navy for training and operations within the United States. Production will be further increased and the quality of all charts improved with the completion of an adequate humidity control system necessary for proper registration on multicolor charts.

COASTAL SURVEYS

Activities in hydrography, topography, and coastal triangulation were continued with three survey ships, eleven smaller vessels, and several shore-based units. Six major survey vessels have been transferred to the Navy and two vessels in the Philippine Islands are no longer in service. All field operations were directed to complying with requests from the Army and Navy for surveys and investigations in strategic areas. A summary of results accomplished is given in the following table:

Locality	Hydrography				Topography		Coastal triangulation		
	Sounding lines	Area	Wire drag	Area	Shoreline	Area	Length of scheme	Area	Geographic positions
	Miles	*Square miles*	*Miles*	*Square miles*	*Miles*	*Square miles*	*Miles*	*Square miles*	*Number*
Coast of Maine	4,888	114	130	31	*513	*77	—	—	—
Atlantic Coast: Massachusetts to Cape Charles	876	176	36	6	*4,672	*2,888	12	67	17
Chesapeake Bay	2,704	115	—	—	18	4	5	12	23
James River	356	16	—	—	—	—	13	39	69
Atlantic Coast: Cape Charles to Florida	841	89	—	—	*705	*1,841	17	50	23
Florida and Gulf of Mexico	6,558	640	—	—	*947	*737	15	75	19
Interior United States areas	—	—	187	34	—	—	—	—	—
San Francisco Bay	—	—	—	—	*505	*285	—	—	—
Puget Sound	1,098	34	—	—	7	7	3	9	6
Strait of Juan de Fuca	1,114	99	45	16	48	14	60	289	81
Alaska	12,823	1,234	211	126	99	16	121	772	188
Total	31,258	2,467	569	213	7,514	5,819	246	1,263	426

* Air photographic compilation.

On the Atlantic coast the LYDONIA was engaged on hydrographic surveys along the coast of Maine, including extensive wire-drag investigations. The launches MITCHELL, OGDEN, MARINDIN, and RODGERS assisted in this work. A winter project of hydrographic surveys was completed by the LYDONIA in the Gulf of Mexico, in the vicinity of Cape San Blas, Fla.

The GILBERT, assisted by the launch FARIS, was engaged on hydrographic and wire-drag surveys in Nantucket Sound and Buzzards Bay, and on special triangulation in the Long Island Sound area. During the winter months the GILBERT, with the assistance of the new wire-drag launches HILGARD and WAINWRIGHT, was engaged on surveys in the lower James River and in Chesapeake Bay.

The COWIE conducted special hydrographic investigations off the south Atlantic coast, and executed hydrographic surveys in Chesapeake Bay and triangulation surveys along the James River, between Hopewell and Richmond. During the spring of 1943 this vessel completed current surveys in Block Island Sound with the new radio-current-meter buoys and began similar surveys in Narragansett Bay.

The motor vessel FARIS completed hydrographic and topographic surveys in the vicinity of Lookout Bight, N. C., a hydrographic survey at the north end of Roanoke Island, and triangulation and hydrographic surveys in Hampton Roads. The launch ELSIE III was engaged on hydrographic and topographic surveys of Ocracoke Inlet, N. C.

During the winter months the launches MARINDIN and OGDEN were engaged on hydrographic and topographic surveys along the eastern shore of Chesapeake Bay. The launches HILGARD and WAINWRIGHT conducted a resurvey of the entrance to Montauk Harbor, and special investigations in Block Island Sound. A wire-drag party completed special surveys of inland lakes and reservoirs.

On the Pacific coast, during the period between Alaska field seasons, the EXPLORER and PATTON continued hydrographic surveys in the vicinity of the San Juan Islands, and completed wire-drag investigations on Hein Bank and other shoals. A topographic survey of Neah Bay was made. The SURVEYOR engaged in a hydrographic program in the vicinity of Port Townsend. The motor vessel WESTDAHL was engaged on hydrographic and topographic surveys of the Admiralty Inlet area. The motor vessel E. LESTER JONES continued radio-current-meter surveys in Puget Sound. The motor vessel PATTON completed a triangulation project in the Strait of Juan de Fuca, and executed additional triangulation in Haro Strait.

In Alaska, the ships EXPLORER and SURVEYOR and the motor vessels E. LESTER JONES and PATTON were engaged on surveys of combat areas. The WESTDAHL continued surveys in southeast Alaska in the approaches to the naval base and for purposes of Coast Artillery fire control. Later, with the assistance of the motor vessel PATTON, this ship engaged in wire-drag investigations in Wrangell Narrows.

Processing offices were continued at Norfolk, Va., and Seattle, Wash. The operation of these offices at the principal bases of our field parties not only expedites the transition of field surveys to finished charts, but permits close cooperation between the field engineer and the office draftsman. By being relieved of a great amount of office work, survey units are able to engage in a year-round program of field work.

Air photographs of selected coastal areas in Massachusetts and Florida, and of extensive areas in southeastern Alaska and the Alaska Peninsula were made with the Bureau's 9-lens camera. Field inspection of air photographs was in progress in Maine, Virginia, and Florida. Photogrammetric offices continued in operation in Baltimore, Md., and Tampa, Fla., where planimetric maps were compiled of coastal areas in Maine, Massachusetts, Florida, James River, Va., and San Francisco Bay.

With funds provided by the War Department, an extensive mapping program was continued to provide 359 topographic map quadrangles, covering 15,939 square miles, of previously unmapped or inadequately mapped areas in Maine, New Hampshire, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, and Florida. Approximately two-thirds of the area was photographed with the Bureau's 9-lens camera.

The field stations of the Bureau, located in the principal maritime ports, continued to render valuable service in supplying information for the correction of charts, in disseminating nautical and engineering data in response to requests from local public and official sources. The personnel of these stations were consulted by naval and military representatives on matters pertaining to confidential plans of proposed operations. Through these local conferences, there was a definite improvement in our cooperation in the war effort. The experience and data of the Survey were made immediately available and in each instance effected due expedition of the action.

The 13 United States coast pilot volumes contain a wide variety of important information supplemental to that shown on nautical charts. These volumes are kept current by annual supplements and revisions. New editions of the coast pilots are published as often as is warranted by the number of changes that have been made and the amount of new information available. Nine supplements were issued during the year, a new edition of the Pacific Coast Pilot was published, and the manuscript for the Alaska Coast Pilot, Part I, was prepared.

The new survey ship PATHFINDER was completed in September 1942 and was immediately transferred, with full equipment, to the Navy Department. Two 65-foot, diesel-powered, wire-drag boats, the HILGARD and WAINWRIGHT, were completed in November 1942 and assigned to field work on the Atlantic coast. Two 30-foot wire-drag tenders were received from the builders in July.

GEODETIC CONTROL SURVEYS

Since early in the war, all geodetic activities have been restricted to projects requested by military authorities, and for the most part paid for with funds furnished by them. The Bureau's appropriation for this work in 1943 was contributed to the program in order to maintain continuity of field operations and because the additional triangulation and leveling are valuable increments to the national control-survey nets and are of great economic value to many Federal and state public works projects. The exigencies of war have greatly accelerated the demand for control, which is used for mapping priority areas, for training topographic battalions of the Corps of Engineers, for the coordination of coastal and

island defenses, for artillery fire control for the Coast Artillery Corps, and for other related problems. Activities during the year are summarized in the following tables:

Locality	Length of scheme	Area
First-order triangulation	*Miles*	*Square miles*
Seattle to Bellingham, Wash.	30	360
Redfield to Alder Creek to Lowville, N. Y.	55	650
Alexandria Bay to Cranberry Lake to Massena, N. Y.	180	2975
Milford to Ravena, N. Y.	60	800
Blue Mountain Lake to Salem, N. Y.	90	900
Vicinity of Madawaska, Maine	55	1150
Western Connecticut	65	800
Lowville to Rouses Point, N. Y.	140	2260
Fort Deposit, Ala., to Cuthbert, Ga.	110	1950
Tallassee to Geneva, Ala.	110	1100
Waco to Lexington and Lampasas to Normangee, Tex.	210	2100
Giddings to Tivoli and Wallis to Stockdale, Tex.	225	2500
Kent, Texas, to Texas-N. Mexico Boundary	195	2620
Port Huron to Owosso and Caro to Pontiac, Mich.	105	1600
Ruby to Unalakleet, Alaska	175	3920
Alcan Highway	110	575
Total	1915	26260
Second-order triangulation		
DeRuyter to Leonardsville, N. Y.	50	400
Reading to Quakertown, Pa.	35	800
Warwick to Phoenicia and Marlboro to Narrorsburg, N. Y.	80	1245
Arcata to Crescent City, Calif.	70	720
Margaretsville to Greenville, N. Y.	75	960
Utica to Gloversville, N. Y.	50	1550
Garberville to Willits, Calif.	75	1675
Fairbanks to Broad Pass, Alaska	160	1460
Syracuse to Utica, N. Y.	55	800
Albany to Stony Creek, N. Y.	65	1980
Grafton, N. Y., to Brandon, Vt., and Benning to Brattleboro, Vt.	100	2090
Nenana to Ruby, Alaska	210	8760
New Haven to Norwich, Conn.	60	350
Ellicott City to Bowie, Md.	30	275
Syracuse to Waterloo, N. Y.	70	1370
Reedsport to Bandon, Oregon	65	895
Brookings to Roseburg, Oregon	150	2180
Au Sable Forks to Chestertown, N. Y.	40	865
Big Bend Area, Texas	60	2020
McHenry to Hurley, Miss.	115	1170
Quantico, Va., to Poolsville, Md.	70	1055
Menard to Leakey, Texas	95	950
Comstock to Mertzon, Texas	85	1020
Picayune to Hattiesburg, Miss.	120	1755
Madrid to Opelika, and Newville to New Brockton, Ala.	150	1500
Vicinity of Huntsville, Texas	30	330
Vicinity of Camp Hood, Texas	60	1120
Vicinity of Bryan, Texas	55	750
Beaumont, Miss., to Calvert, Ala.	60	1180
Madera to Tracy, Calif.	225	4200
Laurel to Frederick, Md.	65	835
Prince Frederick to LaPlata to Marlboro, Md.	50	470
Waterloo to Rochester, N. Y.	85	1300
Leon Powell to Ft. Stockton, Texas	100	900
Chestertown, N. Y., to Burlington, Vt.	130	2430
Total	2995	51360
First-order base lines		
Clear, Alaska	11.1	–
Summit, Alaska	1.7	–
Carlisle, N. Y.	6.0	–
Colchester, Conn.	2.5	–
Gabriels, N. Y.	5.3	–
Bandon, Oreg.	3.4	–
Anderson, Ala.	3.7	–
Yoakum, Tex.	4.6	–
Carcross, Yukon Territory, Canada	2.5	–
Takhini, Yukon Territory, Canada	3.0	–
Total	43.8	–

Locality	Length of scheme	Area
First-order reconnaissance	*Miles*	*Square miles*
Redfield to Alder Creek to Lowville, N. Y.	50	600
Greenwich to Long Lake, N. Y.	90	900
Albany to Stony Creek, N. Y.	60	1660
Danbury to Warren to Bristol, Conn.	65	800
Port Huron to Owosso and Caro to Monroe, Mich.	160	2700
Yoakum Base Net, Texas	12	100
San Antonio Base Net, Texas	15	150
Wharton to Pettus to Bayside, Texas	170	1700
Stockdale to Pearsall and Pettus to Dilley, Texas	135	1350
Dunkirk, N. Y., to Renovo, Pa.	140	3150
Total	897	13110
Second-order reconnaissance		
Syracuse to Utica, N. Y.	55	800
Florence, Oreg., to California Boundary	150	1800
Kerby to Sutherlin and Myrtle Pt., to Medford, Oreg.	170	4000
New Haven to Norwich, Conn.	60	350
N. Y.-Vt. Boundary and Bennington to Bellows Falls, Vt.	90	1580
Wells to Brandon, Vt.	35	630
Chestertown N. Y., to Burlington, Vt.	170	3290
Rochester to Syracuse, N. Y.	95	2720
Frederick to Laurel, Md.	85	1200
Roseville, Va., to Poolsville, Md.	70	1050
Santa Clara Valley, Calif.	120	2480
San Joaquin and Stanislaus Valleys, Calif.	160	3990
Nenana to Unalakleet, Alaska	385	12680
Poplarville to Bay St. Louis, Miss.	65	970
Salinas to San Luis Obispo, Calif.	115	2045
Leon Powell to Fort Stockton, Texas	100	900
San Diego to Donna, Texas	165	1575
Vicinity of Camp Hood, Texas	60	1120
Hattiesburg to Baxterville, Miss.	50	675
Cameron to Normangee to Bryan, Texas	90	1320
Vicinity of Huntsville, Texas	30	330
Beaumont, Miss., to Calvert, Ala.	55	980
Rincon to Mayhill, N. Mex., and Alamogordo, N. Mex., to El Paso, Texas	220	3485
Encinal to Lopeno and Pescadito to Realitos, Texas	110	1100
Ozona to Harper, Texas	120	1440
La Plata to Marlboro, Md.	20	120
Kerrville to Leakey, Tex.	55	385
Total	2900	53015

State	First-order	Second-order
Leveling	*Miles*	*Miles*
Alabama	134	1252
Arkansas	14	—
California	585	1814
Delaware	2	74
District of Columbia	14	—
Florida	100	706
Idaho	85	—
Louisiana	—	2
Maine	255	220
Maryland	43	1095
Massachusetts	—	5
Mississippi	14	876
New Hampshire	15	233
New Jersey	1	145
New Mexico	—	82
New York	290	3528
Oregon	170	915
Pennsylvania	—	59
South Carolina	84	88
Tennessee	17	—
Texas	1659	6209
Vermont	21	262
Virginia	99	858
Washington	241	84
Yukon Territory, Canada	5	—
Total	3798	18456

State or region	Determinations		
	Latitude	Longitude	Azimuth
Astronomy			
Alabama	-	-	1
California	1	1	1
New York	1	1	1
Washington	-	1	1
Alaska	4	5	5
Canada (Yukon)	3	3	3
Total	9	11	12

On account of the great expansion of military activities in Alaska it has become necessary to carry on geodetic work in that region on a much larger scale than has ever been attempted in the past. A project of unusual importance for this purpose was initiated in April. It consists of first-order triangulation and leveling which, when complete, will extend from White Pass, north of Skagway, along the White Pass and Yukon Railway to Whitehorse, Yukon Territory, and thence along the Military Highway, crossing into Alaska at the International Boundary on the 141st meridian and latitude 62° 40'. These surveys will connect with previously established geodetic control along the Richardson Highway in the vicinity of Big Delta, Alaska.

This work is being done at the request of the Chief of Engineers, U. S. Army, as a means of coordinating horizontal control surveys in Alaska. At present there are a number of different survey datums in Alaska. Most of these will be reduced to a single datum (the North American datum of 1927) after the completion of this arc of triangulation. The leveling will determine elevations of bench marks referred to the mean sea level datum.

The project is considerably reduced in difficulty and cost by the use of the Alaska Military Highway which it follows for the most part. Without the highway, the problems of transportation would be exceedingly difficult. The progress of the work is further aided by the excellent cooperation of field personnel of the Canadian Government, the International Boundary Commission, United States, Alaska and Canada, and the Corps of Engineers, U. S. Army. These organizations are greatly interested in the early completion of these surveys.

Another project of importance to Alaska is the arc of triangulation westward from Nenana along the Yukon River via Ruby to Unalakleet on Norton Sound, and thence north and west on Seward Peninsula nearly to Bering Strait. The eastward section of this work between Nenana and the coast of Norton Sound had been completed at the end of the year. This work is being expedited by the use of air transportation.

The Bureau also engaged in a number of special survey projects requested by the military authorities for coastal defense purposes and for control of outlying island bases and other regions.

Variation of latitude observatories at Ukiah, Calif., and Gaithersburg, Md., were continued in operation throughout the year in accordance with an international program begun in 1899.

Besides the processing of field data, the office force in Washington handled a number of special projects related to the war effort. These included the computation of several projection tables for use by the Army Air Forces in the world-wide aeronautical charting program; computation of azimuth errors, due to projections, for correcting compass roses on nautical charts; mathematical research relative to the use of certain map projections as applied to the solution of navigational problems; a study of the effect of gravity on barometric readings; and the computation of special star tables for use by the Marine Corps in the rapid determination of azimuths in equatorial regions.

Computing offices at New York and Philadelphia were discontinued as WPA projects in July and September, respectively. Subsequently both were operated as Bureau projects with reduced forces made up from the most efficient employees from the original organizations. The Philadelphia office was closed entirely on June 30, 1943.

TIDE AND CURRENT WORK

Complete adaptation to war needs marked the tide and current activities of the Bureau during the year. Such services as were not performed directly for the armed forces were concentrated on aiding the war effort. Detailed tide and current surveys were made and special tide and current data calculated for the military services under specific requests. Correlated assistance was provided to industry engaged in the development and utilization of coastal property for war production, including the compilation of tidal data and information pertaining to tidal bench marks for use in the construction and operation of shipyards, airfields, emergency housing projects, and other port developments.

Warranting special mention is the work carried out at the specific request of the War Department. With funds provided by the Army Air Forces early in the fiscal year a new unit was organized to make the necessary investigations and research for the preparation of comprehensive reports on tides and currents for probable operational areas. Under this program 22 reports were supplied covering various strategic areas throughout the world.

During the fiscal year, 45 primary and 30 secondary tide stations were in operation; 38 on the Atlantic coast, 22 on the Pacific coast and 15 in Central and South America.

Forty of these stations were conducted in collaboration with other governments and agencies, including the Republics of Mexico, El Salvador, Costa Rica, Colombia, Ecuador, Peru, Chile and Venezuela; the U. S. Engineers; the Navy Department; Territory of Hawaii; City of Santa Monica; Los Angeles Harbor Department; Oxnard Harbor district; Woods Hole Oceanographic Institution; Chesapeake Biological Laboratory; and the Oceanographic Laboratories of the University of Washington.

Observations from these stations supply data essential for the prediction of tides, the reduction of soundings in

hydrographic surveys, the study of coastal stability, the determination of mean sea level for geodetic leveling, and the determination of datum planes required in the development of coastal property. Shorter periods of observations at approximately 53 additional stations were obtained in connection with hydrography and other activities.

The tide survey of the Columbia River, carried out in cooperation with the U. S. Engineers at Portland, Oregon, was completed in August. Tidal surveys, prosecuted under the direct supervision of trained personnel, have been most successful but, due to war conditions, for the first time since 1933 no such surveys are now in progress.

The comprehensive current survey of Puget Sound, started in 1942, was continued, 13 additional current stations having been occupied during the year. To secure information requested by the military services and by war industries, current surveys were conducted in a number of other important waterways. At the end of the fiscal year a special survey party was engaged in securing current data required for use of the Navy.

Reciprocal agreements for the exchange of tide predictions between the United States and Great Britain, Canada, and India were continued in effect and arrangements were completed for a similar exchange with Argentina.

MAGNETIC INVESTIGATIONS

The earth's magnetic forces vary from place to place and are constantly changing at any one place. Comprehensive magnetic information is essential for navigation on the sea and in the air. Such information also has a number of applications in military operations and is used extensively for other purposes by land surveyors, oil and mineral prospectors, radio and telegraph companies and scientific investigators.

Continuous records of the magnetic elements were obtained throughout the year by magnetic observatories at Cheltenham, Md.; Tucson, Ariz.; Honolulu, T. H.; Sitka, Alaska; and San Juan, P. R. These records were supplemented by observations of magnetic declination and other magnetic elements, at numerous points throughout the country.

Several special field projects were carried on to meet the needs of the armed forces. Ionosphere observations were continued in San Juan, P. R., for radio communication research in cooperation with the University of Puerto Rico. Investigations were made of reported local magnetic disturbances along airways in South Dakota, Minnesota, and Washington, and magnetic meridians were established at 57 airports in 27 states.

In the Washington office, a special section organized to study declination continued to furnish magnetic data for nautical charts and military maps. These data were furnished to other government mapping agencies engaged in the military project, including the Army Map Service, the Army Air Forces, the Army Signal Corps, the Geological Survey, the Forest Service, the Soil Conservation Service, and the Bureau of Agricultural Economics. This unit also furnished isogonic lines for several series of world-wide aeronautical charts.

Manuscript was completed for Alaska Magnetic Tables and Charts for 1940; Earth's Magnetism and its Utilization; and six volumes of Observatory Results, of which four were published.

There was a material exchange of data and instruments with the Department of Terrestrial Magnetism, Carnegie Institution of Washington, and the following geophysical activities were continued in cooperation with that organization: Operation of a cosmic-ray meter at Cheltenham Observatory; maintenance at Cheltenham Observatory of international magnetic standards; and observation of atmospheric and earth electric currents at Tucson Observatory (with the Bell Telephone Laboratories cooperating for about nine months).

Directions were prepared for the use of engineers in the establishment and testing of compass rose sites at airports, for the purpose of detecting artificial magnetic disturbances, and for determining the deviation of airplane compasses.

The distribution of magnetic observations during the year is shown in the following table:

Location	Repeat stations				Other stations	Total
	New		Old			
	Complete	Declination only	Complete	Declination only		
Alabama	-	-	-	-	2	2
Arizona	1	3	1	-	3	8
California	2	-	1	-	19	22
Connecticut	-	-	-	-	1	1
Florida	-	-	-	-	10	10
Georgia	-	-	1	-	3	4
Idaho	-	-	1	-	-	1
Illinois	-	-	-	-	5	5
Indiana	-	-	-	-	1	1
Iowa	-	-	-	-	2	2
Kansas	-	-	-	-	2	2
Louisiana	-	-	-	-	1	1
Maine	-	-	1	-	10	11
Massachusetts	2	-	4	-	5	11
Minnesota	-	-	-	-	4	4
Mississippi	-	-	-	-	2	2
Missouri	-	-	-	-	2	2
Nebraska	-	-	-	-	1	1
Nevada	-	-	-	-	6	6
New Hampshire	-	-	-	-	1	1
New Mexico	4	2	3	-	-	9
New York	-	-	1	-	5	6
North Carolina	2	-	4	-	3	9
North Dakota	-	-	-	-	1	1
Oregon	-	2	-	-	7	9
Rhode Island	-	-	2	-	-	2
South Carolina	-	-	-	-	3	3
South Dakota	-	-	-	-	2	2
Tennessee	-	-	-	-	3	3
Texas	2	-	3	-	5	10
Utah	-	-	-	-	3	3
Vermont	-	-	-	-	1	1
Virginia	-	-	1	-	1	2
Washington	6	-	1	1	17	25
Wisconsin	-	-	-	-	1	1
Wyoming	-	-	-	-	1	1
Alaska	-	-	1	-	18	19
Bermuda	-	-	2	1	5	8
Canada	-	-	-	-	1	1
Argentina	-	-	1	-	-	1
Bolivia	2	-	2	-	-	4
Brazil	7	-	5	-	-	12
Chile	1	-	7	-	-	8
Colombia	2	-	3	-	-	5
Ecuador	-	-	2	-	-	2
Paraguay	1	-	-	-	-	1
Mexico	3	-	-	-	-	3
Peru	1	-	2	-	1	4
Uruguay	-	-	1	-	-	1
Venezuela	1	-	1	-	2	4
Total	37	7	51	2	160	257

SEISMOLOGICAL WORK

The seismological work of the Coast and Geodetic Survey is designed to locate all significant earthquake areas in the United States and its possessions, to determine the destructive effects, as well as the nature of earthquake motions, and to safeguard life and property by giving to the engi-

neer data which will enable him to determine where and to what degree earthquake-resistant designing of structures is needed. Information of this character was furnished during the year to scientists, engineers, and other individuals, as well as to special organizations and to the military forces.

Seismographs were operated at observatories in Tucson, Honolulu, Sitka, San Juan, and Ukiah. The operation of seismographs in the Lake Mead region was continued as a joint undertaking of the National Park Service, of the Bureau of Reclamation, and of the Coast and Geodetic Survey. The two last-named bureaus cooperated in completing and maintaining seismograph stations at Shasta Dam and at Grand Coulee Dam. Assistance was given to nine colleges in the maintenance of seismographs and to seven independent stations through study and interpretation of their records or readings. Temporary arrangements for interpreting the seismograms from Ivigtut and Scoresbysund, Greenland, were continued.

Sixty-two strong-motion seismographs were in operation at the close of the year at 54 stations in California, Nevada, Utah, Montana, and the Canal Zone. Thirty-seven strong-motion records were obtained for nine severe earthquakes.

Vibration tests included: The study of earthquake effects on buildings; a series of ground vibration observations in connection with blasting operations; a special building test; and a series of observations at five war plants to investigate the effect of heavy machinery on equipment used for high precision work. The final report of the accelerometer shaking-table tests, conducted at the Massachusetts Institute of Technology in cooperation with the Coast and Geodetic Survey, was completed and published in the Bulletin of the Seismological Society of America. Vibration instruments were loaned to the Woods Hole Oceanographic Institution for war work. Others were loaned for a study of the vibrations of the Potomac River (Morgantown) Bridge.

Four tilt meters were operated near earthquake faults, in cooperation with the University of California and with the City of Long Beach, California, to detect tilt effects which may precede or follow earthquakes in the vicinity of these faults.

In the investigation of engineering problems relating to the mitigation of earthquake damage, cooperation was continued with the Engineering Departments of the Massachusetts Institute of Technology, the California Institute of Technology, and Stanford University. Special information regarding earthquake frequency in connection with proposed construction was furnished the Federal Power Commission.

Earthquake investigation in the United States is a highly cooperative undertaking, involving about 40,000 persons and participated in by the Weather Bureau, the Post Office Department, several universities, public utility organizations, insurance companies, and seismological societies. During the past year the Department of State rendered valuable assistance in effecting improved telegraphic earthquake-reporting service with friendly countries in the Pacific war zone. Cooperation with Science Service was continued, thus permitting the immediate location of important earthquakes through instrumental data collected by that organization. Fifty-four earthquakes were located and the results furnished all cooperating agencies. Questionnaire coverage was made for 11 earthquakes which approached destructive character. In all, about 1,700 reports were received for some 200 earthquakes.

INSTRUMENTAL WORK

In addition to maintaining the extensive instrumental equipment required for the Bureau's operations, the Instrument Division effected further improvement of the signal lamps for night triangulation observations, and undertook the experimental development of a sextant constructed of Dow metal and duralumin which will be much lighter and more easily manipulated than the instrument now in use. Several gun pointers of a design suggested by a member of the Bureau now serving in the Army, were constructed for the Ordnance Service of the War Department. Assistance was also afforded to other Government agencies in effecting repairs to instruments.

To meet special needs of the Navy, improvements were made in the Dorsey chronograph, developed in the Bureau's Electrical Laboratory, so that time intervals of 0.002 second can be easily and accurately measured.

Two new instruments for measuring the vertical intensity of the earth's magnetic field were developed in cooperation with the Department of Terrestrial Magnetism, Carnegie Institution of Washington. One is a new type of marine magnetometer and the other a high-frequency, quartz-suspension type variometer. New methods were developed in the use of "alnico," an alloy especially suitable for magnets used in observatory variometers. Three improved magnetograph recorders, complete with special lamps and time-marking equipment, were constructed. Special devices were provided for recording automatically high and low frequency radio time signals on seismograms.

PERSONNEL AND FINANCES

Acquisitions by the library and archives included 123 hydrographic and 46 topographic sheets; 221 air photographic maps, representing new Bureau surveys; 781 blueprints (mostly by the U. S. Engineers); 32,509 maps; 5,913 charts; 10,935 field, office, and observatory records; 207 negatives; 1,053 prints; 73 lantern slides; 1,018 books; and 2,599 periodicals.

The number of persons serving in the Coast and Geodetic Survey at the close of the year was 2,772, distributed as follows:

	Commissioned	Civilian	Total		Commissioned	Civilian	Total
Washington office:				Field service:			
Regular appropriations	19	390	409	Regular appropriations	103	484	587
Working funds	-	962	962	Working funds	-	814	814
				Total	122	2650	2772

Collections covering miscellaneous receipts, including nautical and aeronautical charts and related publications, totaled $167,881, as compared with $158,126 during the preceding year.

The following funds, from the sources indicated, were available to the Bureau during the fiscal year 1943:

Regular appropriation	$4,129,400.00
First Deficiency Appropriation Act, 1943	181,000.00
Urgent Deficiency Appropriation Act, 1943	144,800.00
Total appropriations	$4,455,200.00
Transfers and reimbursements to credit of appropriation for:	
Salaries, office	6,578.27
Aeronautical charts	47,438.04
Office expenses	5,322.20
Coastal surveys	3,001.36
Magnetic and seismological work	100.00
Traveling expenses	7,407.48
Total transfers and reimbursements	69,847.35
Working funds received from:	
Bureau of Reclamation (seismological work, Boulder, Grand Coulee and Shasta Dams	10,000.00
War Department (control surveys)	725,500.00
War Department (aeronautical charts)	2,481,282.00
War Department (control surveys in Alaska)	246,000.00
War Department (compilation of tidal data)	20,000.00
War Department (topographic mapping)	513,500.00
War Department (special surveys)	7,700.00
Navy Department (magnetic work)	4,000.00
State Department (globe construction)	800.00
State Department (cooperation with American Republics):	
Tidal investigations	12,500.00
Magnetic observations	25,000.00
Printing of hydrographic manual	12,200.00
Printing of manual of tide observations	2,300.00
Total working funds	4,060,782.00
Allotment from:	
Department of Commerce (travel)	20,563.00
Department of Commerce (printing and binding)	52,400.00
Department of Commerce (contingent expenses)	3,550.00
Total allotments	76,513.00
Total funds available	8,662,342.35