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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

COOPERATION

BETWEEN THE

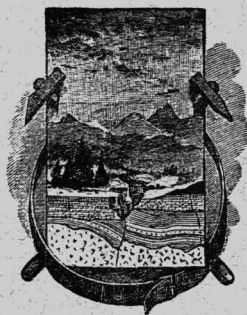


UNITED STATES AND VARIOUS STATES

IN

TOPOGRAPHIC, HYDROGRAPHIC, AND
GEOLOGIC WORK

EXTRACT FROM THE TWENTY-SECOND ANNUAL REPORT OF THE DIRECTOR



WASHINGTON
GOVERNMENT PRINTING OFFICE
1901

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CHARLES D. WALCOTT, DIRECTOR.

INTRODUCTION.

The work of the Geological Survey during the fiscal year 1900-01 was mainly a continuation of that of previous years, described in former reports. The organization was changed somewhat (see p. 48), but in a general way similar results were reached, which added materially to the sum of geologic and geographic knowledge. The detailed record of accomplishment, both in field and in office, will be found on later pages, under the heading "Work of the year" (p. 53). In this introduction some subjects of special interest will receive consideration.

COOPERATIVE SURVEYS.

Cooperation in scientific work may consist in a mutual understanding or exchange of information or in the expenditure by both parties of certain sums of money for the advancement of investigation or work in which both are interested. Understandings to promote the common purpose of advancing knowledge and aiding development have existed between State geologists and the Federal Survey since the latter was organized. The results of the United States Survey's work have always been at the disposal of State officials at proper times and under reasonable conditions relating to publication, and these courtesies have generally been returned in kind.

Some more definite agreements were entered into early in the history of the Federal Survey. Thus in 1884 it was

agreed between the Director, Major Powell, and the board of commissioners of the State of Massachusetts that the topographic work in the State should be divided; that the State should pay one-half the expense of field work and the Federal Survey one-half, the latter to engrave the maps and give transfers of the plates to the State commissioners.

Under terms varied to suit the conditions of each special case, agreements involving cooperation of some sort have been made between the Director and State officials of Maine, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, West Virginia, North Carolina, Georgia, Alabama, Ohio, Wisconsin, North Dakota, Colorado, Nevada, Idaho, and Arizona. The object on the part of the State was to direct and promote topographic mapping, to procure scientific information which it was not equipped to obtain, or to avail itself in some other way of the special facilities of the Federal Survey; while the object of the Director was to maintain cordial relations among organizations having an essentially common purpose, to encourage the development of scientific work of value to the people of the country, and to supplement the appropriations made by Congress by additional sums from the States, in order that the work might be expedited and be given greater detail in areas where the public interest was greatest.

The States benefit by cooperation in geology and allied scientific activities by the resulting reduction in expense of administration and the possibility of a specialization in detail otherwise unobtainable. In order that the exploitation of the economic resources of each State may be kept as prominently as possible before the eyes of its citizens and the industrial world, a number of States have provided their own bureaus for such purposes. On the other hand, since such resources are not limited by State boundaries, and since the broader geologic facts on which the development of the economic problems is necessarily based must frequently be looked for and studied through a number of States, each has an interest in knowing what its neighbors possess, and such knowledge will enable the different States to avoid duplication of research into fundamental

facts. Since each State possesses a considerable range of natural resources, it is usually impossible for the State geologists to discuss all of these in the most full and satisfactory manner. The best work results from the investigations of specialists, and the individual States can rarely afford to obtain the services of a considerable number of experienced and high-priced experts. There has thus naturally followed a method of cooperation in geologic work whereby the States have devoted their energies to the exploitation of such economic resources as might prove of greatest immediate benefit to their citizens, while the United States Geological Survey has been employed in general areal mapping and in studying the more specialized problems whose solution has had to be sought through several States.

Upon the completion of the field investigations or surveys, for which alone cooperation is accepted, the resulting reports and maps are published by the Government, and thus become available to the State. If cooperation be, for example, for a topographic map only, the State benefits by the fact that this will surely be followed more promptly than otherwise would be the case by the geologic map and investigations, and by the study of mineral water and timber resources, for which the topographic maps are primarily prepared as bases.

The Federal Bureau benefits by the great increase in funds available for the extension of its legitimate operations. This Bureau is charged with the duty of making a topographic and geologic map of the entire area of the United States, as well as of studying its water resources and reporting on its other economic products. The expense of this work to the Federal Treasury is reduced by the amount appropriated by the various States for cooperative surveys. All agreements for cooperation being on the basis of equal expenditure, they necessarily reduce by one-half the cost to the Federal Government of conducting its operations. An additional benefit of cooperation is the hastening of the completion of the topographic map, which thus renders it available at an earlier date as a base for the further studies of economic resources—geology, hydrography, and the classification of lands.

From the experience gained, certain conditions essential to the success of cooperation have been established. All work which is in part paid for by the Federal Survey and which may be published by it or on its authority must be controlled by the Director. He selects assistants to perform such work, or approves their selection. In its execution the work is subject to the supervision and approval of the appropriate chief of division of the Federal Survey. Payments for continuous service on account of State cooperation can, under civil-service rules, be made to a State official only in case he also receives a Federal appointment. Each year plans and estimates for the season and a report of operations and results are requested, as is customary in the United States Survey. All agreements for cooperation are drawn in such manner as not to conflict with the organic law of the Survey in regard to collections, furnishing information, or giving expert testimony.

One important point to be considered in all such work is that the general plans and methods of the Federal Survey can not be set aside on account of State cooperation. At the present time the funds available for cooperation are so limited that its further extension is dependent upon increase of appropriations by Congress. It is against the policy of the Survey that work on important areas or subjects should be stopped in order that cooperation with individual States may be extended. The Director is willing to enter into a cooperative agreement only when the interests of the country as a whole will be benefited. In the execution of the work certain features must necessarily be taken up first, and if this order is in line with what the State desires cooperation may be had to the greatest advantage both to the State and to the Federal Government. The general policy and work of the Survey can be changed only by direction of Congress.

History of Cooperation.

The idea of cooperation in public surveys between the Federal and State governments originated in connection with a plan to make a topographic map of the State of Massachusetts, and it is believed was first suggested by Mr. Henry F. Walling, topographer of the United States Geological Survey, and

later elaborated in a paper read before the American Society of Civil Engineers at the Buffalo meeting in 1884. The suggestion was followed up by Prof. Nathaniel S. Shaler, of Harvard, at whose instance an appropriate bill was introduced in the Massachusetts legislature, which was passed in the same year. The first topographic survey commissioners appointed by the governor of Massachusetts were Gen. Francis A. Walker, Prof. N. S. Shaler, and Mr. H. L. Whiting. In their report to Governor Oliver Ames, dated January, 1888, the commissioners state, among other things:

In conclusion, your commissioners would repeat the statement that the topographical survey of the State has been completed within about three years, the time originally estimated, for \$40,000, the amount originally appropriated; and by the successful cooperation with the organized Federal department of the Geological Survey, the cost to the Commonwealth has been but \$4.80 per square mile, a result unparalleled in the history of such work.

It is pertinent to state in this place that there has been some misunderstanding in recent years, as shown in public print and otherwise, as to the relation between the town boundary survey of Massachusetts and the topographic survey. The former is a successor of the latter. As shown above, the cooperative survey was completed within the time estimated by this Bureau, though since its completion the State of Massachusetts has continued to make appropriations, large in the aggregate, for the purpose of determining and marking the town boundaries, a work which has no relation to the topographic survey.

The total cost of mapping the State of Massachusetts was \$107,845. This is exclusive, however, of much of the primary triangulation, which was executed by the United States Coast and Geodetic Survey. The total average cost of this work was at the rate of \$12.90 per square mile.

At the time of the inauguration of the cooperative survey in Massachusetts the State of New Jersey was engaged in making a topographic map of its area, under the direction of Mr. George H. Cook, State geologist. Commenced independently of the work of this Bureau, the State survey of New Jersey was conducted on similar lines and with all desirable accuracy. From

small and desultory beginnings in 1872, it attained systematic form and method under the supervision of Assistant Geologist John C. Smock, and under the immediate direction of Mr. C. C. Vermeule, topographer in charge, in the year 1882. On July 15, 1884, following the example of Massachusetts, the State of New Jersey asked the National Survey to cooperate in completing the map of the State. This Bureau took up the work, but on lines different from those on which cooperation has been conducted elsewhere. About half of the area of the State having been accurately mapped, the results were turned over to the Federal Bureau, which took charge of the organization and of the personnel and carried the work to completion in 1887, under the direction of Mr. Vermeule, who followed the methods employed prior to the arranging of cooperation. The State geologist reports that the total expense of making the topographic survey was \$54,744.58. Of this sum the United States Geological Survey expended \$35,073.98. The total cost of mapping the State was at the rate of \$6.93 per square mile, exclusive, however, of three-fourths of the primary triangulation, which had been previously executed by the United States Coast and Geodetic Survey.

The cooperative survey of Connecticut was commenced in July, 1889, under Messrs. William H. Brewer, John Bacon, and James H. Chapin, commissioners. It was completed in 1891, the total expense having been \$24,599.21 and the average rate per square mile \$9.79. Among other things, in their final report to the governor, the commissioners state, after commenting on the completion of the work within the time and sum estimated:

We believe that the maps are in more detail and are more nearly correct than any other maps heretofore prepared in this country at so small an expense.

The topographic survey of Rhode Island was provided for by act of general assembly passed March 22, 1888, and immediately thereafter Governor John W. Davis appointed as commissioners Messrs. Winslow Upton, John W. Ellis, and David W. Hoyt. Field work was commenced in June, 1888, and the survey of the entire State was completed in the fall of

the same year. The total cost of this work was \$9,732.51, or at the rate of about \$8.97 per square mile.

Cooperation with the State of New York was commenced in the year 1892 by an allotment of \$3,000 from the general survey fund of the State engineer and surveyor. This work has been continued without interruption since that date by the following appropriations:

1893-94	\$24,000
1895	4,000
1896	15,000
1897	15,000
1898	25,000
1899	19,500
1900	19,500
1901	25,000

The work has been conducted by this Bureau in cooperation with State Engineers Martin Schenck, Campbell W. Adams, and the present incumbent, Edward A. Bond. The average cost of this work to date has been about \$11.95 per square mile, including triangulation.

Cooperation with the State of Maryland was commenced in the year 1896, through the allotment by State Geologist William Bullock Clark of the sum of \$1,000. The same amount was allotted by him in 1897. In each of the years 1898, 1899, and 1900 the State legislature appropriated \$5,000 toward this work.

Cooperation with the State of Maine was commenced in the year 1899 under Commissioners Leslie A. Lee, William Engel, and S. C. Hichborn. The appropriation for the two years 1899-1900 was \$5,000, and the same amount has been appropriated for the two years 1901-1902.

Cooperation with the State of Pennsylvania was commenced in the year 1899 by the appropriation for the two years 1899-1900 of the sum of \$40,000, which has been expended under the supervision of the State commissioners, George W. McNees, Simon Harrold, and F. D. Barker.

Cooperation with the State of Alabama was commenced on March 11, 1899, by allotment from the funds of the State geological survey, by Eugene A. Smith, State geologist, of the amount of \$1,000. The same amount has been annually allotted since that date for this work.

Cooperation with the State of Ohio was commenced during the current year by the appropriation of the sum of \$25,000 for the year 1901, which is being expended under the supervision of Governor George K. Nash.

Cooperation with the State of North Carolina was commenced during the current year by the allotment of \$20,000 for the two years 1901-1902 by Governor Charles B. Aycock from the funds of the State agricultural commission. The State is represented in this cooperation by State Geologist J. A. Holmes.

Cooperation with the State of West Virginia was commenced during the current year as a result of the appropriation by the last legislature of the sum of \$30,000 for the two years 1901-1902. The same is being expended under the general direction of State Geologist I. C. White.

Methods of Cooperation.

In the establishment and conduct of cooperative surveys certain methods which have been developed through an experience of eighteen years are followed.

The Director is requested by citizens of a State which may be interested in procuring topographic, geologic, or hydrographic surveys to inform them as to his ability to accept such offers of cooperation as the State may be prepared to make, it being understood that efforts to secure cooperation must originate with the residents of the State. This Survey furnishes such information concerning the details of previous cooperative arrangements as may be sought, and in other ways assists the State officials and legislators to attain the object desired by them. This usually consists of the introduction of a special bill or an item in the general appropriation bill providing for a cooperative survey to be conducted under the supervision of a State official or commission, who (1) shall have control of the expenditure of the money appropriated, (2) shall make agreements with this Bureau as to the methods of conducting the work, and (3) shall recommend the order in point of priority in which various portions of the State shall be surveyed. It is invariably stipulated that the field operations

shall be under the supervision of the Director of the Geological Survey. This Survey furnishes expert assistants, who take charge of the work and who discuss the results for publication or draft the manuscript maps. All details of the work are performed by them under rules and by methods which experience has shown to be the most economical and judicious, and which tend at all times to maintain a uniformity of treatment for the whole of the United States. This Survey accepts the recommendations of the State officials for the employment of such temporary assistants as may prove qualified for the work, thus insuring the employment of residents of the State, so far as practicable. The law usually specifies that a sum equal to that appropriated by the State shall be expended in the same time by the United States Geological Survey. Neither time nor money is wasted in preliminaries. There is no organization to create. Immediately after the appropriation is made and the contract is signed, work is commenced along the desired lines, without the delays consequent on procuring men and determining upon methods and machinery.

The following sample legislative act provides a lump appropriation for the complete topographic map of a State. In this case a commission was created to conduct the work. The general assembly of Connecticut at its general session of 1889 passed the following resolutions :

Resolved by this assembly, That the governor be, and he is hereby, authorized to appoint a commission, to consist of three citizens of this State, qualified by education and experience in topographical science, to confer with the Director or representative of the United States Geological Survey and to accept its cooperation with this State in the preparation and completion of a contour topographical survey and map of this State, which is hereby authorized to be made, and it is hereby provided that said map shall accurately show all town and county boundary lines in this State as existing at the time of its completion. Said commission shall serve without pay, but all its necessary expenses shall be approved by the comptroller and paid out of the State treasury. Said commission shall have power to arrange with the Director or representative of the United States Geological Survey concerning the survey and map herein provided for, its scale, method of execution, form, and all details of the work in behalf of this State, and may accept or reject the work presented by the United States Geological

Survey. Said commission may expend, in the prosecution of this work, a sum equal to that which shall be expended therein by the United States Geological Survey, but the total cost to this State of said survey shall not exceed the sum of twenty-five thousand dollars.

An example of a law to secure cooperation with this Bureau in a State where there was an existing official who could be charged with the work, and where the appropriations could be provided only for each legislative session, is the following:

LAWS OF NEW YORK.

CHAPTER 96. An act authorizing the State engineer and surveyor to continue to cooperate with the Director of the United States Geological Survey in making a topographic survey and map of the State of New York, and making an appropriation therefor.

Became a law March 17, 1899, with the approval of the governor. Passed, three-fifths being present.

The people of the State of New York, represented in Senate and assembly, do enact as follows:

SECTION 1. In order to continue the execution and speedy completion of a topographic survey and map of this State the State engineer and surveyor is hereby authorized to confer with the Director of the United States Geological Survey and to accept the cooperation of the United States with this State in the execution of a topographic survey and map of this State, which is hereby authorized to be made; and that said State engineer and surveyor shall have the power to arrange with said Director or other authorized representative of the United States Geological Survey concerning the details of such work, the method of its execution and the order in point of time in which these surveys and maps of different parts of the State shall be completed: *Provided*, That the said Director of the United States Geological Survey shall agree to expend on the part of the United States upon said work a sum equal to that hereby appropriated for this purpose. In arranging details heretofore referred to, the State engineer and surveyor shall, in addition to such other provisions as he may deem wise, require that the maps resulting from this survey shall be similar in general design to the West Point sheet edition of October, eighteen hundred and ninety-two, made by the United States Geological Survey, and shall show the outlines of all counties, towns, and extensive wooded areas, as existing on the ground at the time of the execution of the survey; the location of all roads, streams, canals, lakes, and rivers, and shall contain contour lines showing the elevation and depression for every twenty feet in vertical interval of the surface of the country; that the resulting map shall wholly recognize the coop-

eration of the State of New York, and that as each manuscript sheet of the map is completed the State engineer and surveyor shall be furnished by the United States Geological Survey with photographic copies of the same, and as the engraving on each sheet is completed the State engineer and surveyor shall be furnished by said Director with transfers from the copperplates of the same.

SEC. 2. The sum of twenty thousand dollars, or so much thereof as may be necessary, is hereby appropriated for the purposes specified in this act out of any moneys in the treasury not otherwise appropriated, to be paid by the treasurer upon the warrant of the comptroller to the order of the State engineer and surveyor.

SEC. 3. This act shall take effect immediately.

STATE OF NEW YORK,

Office of the Secretary of State, ss:

I have compared the preceding with the original law on file in this office, and do hereby certify that the same is a correct transcript therefrom and of the whole of said original law.

JOHN T. McDONOUGH,
Secretary of State.

In some cases, as that of the State of Ohio, an item in the general appropriation bill, similar to the following, was considered sufficient:

For cooperation with the United States Geological Survey in the preparation and completion of a contour topographic survey and map of this State, to be paid upon vouchers approved by the governor, the governor is hereby authorized to arrange with the director or representative of the United States Geological Survey concerning this survey and map, its scale, method of execution, form, and all details of the work in behalf of this State, and may accept or reject the work executed by the United States Geological Survey, the sum of twenty-five thousand dollars.

It is hereby provided that said map shall accurately show the outlines of all townships, counties, and extensive wooded areas in this State as existing on the ground at the time of the execution of these surveys; the location of all roads, railroads, streams, canals, lakes, and rivers, and shall show by contour lines the elevation and depression of the surface of the country: *Provided further*, That the State shall pay not to exceed one-half of the cost of survey as completed.

In the case of Connecticut, on the passage of such an act the governor of the State appointed a commission, on June 19, 1889. An agreement was signed and field work was immediately commenced. The report of the commission to the

governor, dated January, 1893, four years later, contains the following statements:

The maps are now practically finished; the copperplates are engraved and the atlas sheets are all printed and in the hands of the commissioners. * * * The area of the State is 4,674 square miles * * * and the total expenditure on behalf of the State was \$24,599.21. * * * It will be perceived that the cost of the survey to the State is at an average of a little less than \$5 per square mile.

The agreement signed between the Director of this Bureau and the governor of North Carolina furnishes an example of such contracts, all of which are essentially alike:

AGREEMENT BETWEEN THE GOVERNOR OF NORTH CAROLINA AND THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY FOR THE EXECUTION OF THE COOPERATIVE TOPOGRAPHIC SURVEY OF THE STATE OF NORTH CAROLINA.

(1) The preparation of the map shall be under the supervision of the Director of the United States Geological Survey, who shall determine the methods of survey and map construction.

(2) The order in which, in point of priority, different parts of the State shall be surveyed shall be agreed upon in detail by the governor of North Carolina, or his representative, and the Director of the United States Geological Survey.

(3) The work shall be based upon the triangulation of the United States Coast and Geodetic Survey, and wherever such primary control is deficient it shall be supplemented by the cooperative topographic survey, which shall permanently monument all important positions.

(4) The survey shall be executed in a manner sufficiently elaborate to prepare a map upon a scale of 1:125,000, exhibiting the hydrography, hypsography, and public culture, and all township and county boundary lines, as marked upon the ground at the time of its completion, in form similar to the sheets already completed in this State; said maps to be sufficiently detailed to serve as base maps on which may be represented the character of the soils and forests of the areas surveyed. The preliminary field maps shall be on such scale as the Director of the United States Geological Survey may select to secure accuracy in the construction of the final map.

(5) The hypsography shall be shown by contour lines with vertical intervals of 10 to 100 feet, as may be hereafter mutually agreed upon.

(6) The heights of important points shall be determined and furnished to the governor of the State.

(7) The outlines of wooded areas shall be represented upon proofs of the engraved map, to be furnished the governor of the State.

(8) For convenience the United States Geological Survey shall, during the progress of field work, pay the salaries of the permanent employees engaged thereon, while the traveling, subsistence, and field

expenses shall be paid for the same time by the State. For office work on the map the salaries shall be divided between the two agreeing parties in such a way as to equalize all expenses, provided that the total cost to the State of North Carolina of the field and office work from date until June 30, 1903, shall not be more than twenty thousand dollars (\$20,000), and provided that the United States Geological Survey shall expend an equal amount upon the same work during the same period of time, subject to appropriations to be made by the Congress of the United States.

(9) During the progress of the work free access to the field sheets and records of the topographers and draftsmen shall be afforded the governor of North Carolina, or his representative, for examination and criticism; and should the said governor of North Carolina deem that the work is not being executed in a satisfactory manner, then he may, on formal notice, terminate this agreement.

(10) The resulting map shall fully recognize the cooperation of the State of North Carolina.

(11) When the work is completed, the governor of the State of North Carolina shall be furnished by the United States Geological Survey with photographic copies of the manuscript sheets; and when the engraving is completed, and at all times thereafter when desired, he shall be furnished by the said Survey with transfers from the copper plates of the map for use in printing editions of said maps.

CHARLES B. AYCOCK,

Governor State of North Carolina.

RALEIGH, N. C., 1901.

CHARLES D. WALCOTT,

Director United States Geological Survey.

WASHINGTON, D. C., March 15, 1901.

In the case of the State of Pennsylvania the appropriation act provided for cooperation in making geologic as well as topographic surveys and determining "the location of the coal, oil, natural gas, clay-bearing and other geological formations." Of a total annual appropriation of \$20,000 made by Pennsylvania for the years 1899 and 1900, \$18,000 was devoted to topographic mapping and \$2,000 to geologic mapping and research.

The acts of appropriation made by the legislature of the State of New York providing for cooperation in hydrographic surveying are typical of such arrangements. The act of the legislature was as follows:

The people of the State of New York, represented in senate and assembly, do enact as follows:

The treasurer shall pay on the warrant of the comptroller, for the State engineer and surveyor, one thousand dollars, to be used with the

United States Geological Survey in hydrographic work connected with the measurements of the volume of streams and flow of water in the State of New York.—*Act of legislature, April 13, 1900, par. 11, chap. 420, Laws of 1900.*

Cooperation in Topographic Surveys.

The appropriations made by the States for cooperative surveys are accepted only for actual field work, in which are included the services of temporary employees, who are usually residents of the State, and the living and traveling expenses of the field force. Thus the amount appropriated by the State is returned to the people thereof. The appropriation of the Federal Government is devoted chiefly to paying the salaries of the permanent employees, a small portion of it being expended on general administration and a considerable portion on field and office work. The field work of the cooperative topographic surveys is invariably in charge of topographers or assistant topographers of the United States Geological Survey, who are appointed, on the recommendation of the United States Civil Service Commission, by the honorable Secretary of the Interior. All assistant surveyors, as levelmen, transitmen, etc., and such helpers as rodmen, teamsters, and cooks, are employed, under regulations of the Department of the Interior, in the locality in which the work is being done and under the terms of a signed application and agreement, which they must file when seeking such employment.

TOPOGRAPHIC MAPS.

The topographic map is the base upon which the field investigations of the geologists and hydrographers are recorded, and which makes possible a broader and more general study of the results than is otherwise practicable. It was at once realized by State officials to whom such investigation had been assigned that an accurate and comprehensive performance of their duties was impossible without an adequate topographic base map. The expense of making such maps, however, was found to exceed in most instances the resources procurable from State aid, and the lack of skilled men required in making such surveys was a barrier not easily surmounted. Competent topographers are rare, and there is little inducement for young engineers of ability to make this their profession out-

side of the work of the General Government while there is so little opportunity for steady employment elsewhere. By cooperating with the Federal Survey it was apparent that the opportunities for systematic mapping would be greatly increased in the States availing themselves of the personnel and administrative knowledge of the Survey.

Accordingly, the first important step in the development of the existing system of cooperation was in connection with the extension of topographic mapping. The benefits to the State from cooperation are numerous. It gains a complete topographic map of its area, which is of importance to the development of its numerous economic resources and greatly facilitates the study and perfection of all engineering plans and works. Among other uses of the topographic maps are the following:

1. *Educational*.—(a) By promoting an exact knowledge of the country; (b) by serving teachers and pupils in geographic studies.

2. *Practical*.—As preliminary maps for planning engineering projects. Highways, electric roads, railroads, aqueducts, and sewerage plants may be laid out on them, and the cost of preliminary surveys may be saved. Areas of catchment for water supply, sites for reservoirs, and routes of canals may be ascertained from these maps.

3. *Political*.—In all questions relating to political or legislative matters. For these purposes they afford accurate information as to the relations of boundaries and towns to natural features.

4. *Administrative and military*.—In all questions relating to Federal or State administration of public works, as canals, reservations, parks, highways, and as military base maps on which to plan works of offense, defense, camps, marches, etc.

5. *Statistical*.—As base maps for the graphic representation of all facts relating to population, industries, products, or other statistical information.

6. *Economic*.—As a means for showing the location, extent, and accessibility of lands, waters, forests, and valuable minerals. In this respect these maps are indispensable to State and Federal bureaus, and to owners, investors, and corporations.

In addition, as an incident in the making of a topographic map, monuments are established throughout the State, the positions of which are accurately determined by geodetic methods and which serve as datum points for all other Government, private, and cadastral surveys. There are also established throughout the State bench marks or permanent monuments which furnish datum elevations for the future determinations of height in connection with all public or private engineering works. Meridian marks are established at each county seat, which aid local and county surveyors in determining the declination of their compasses and which thus greatly facilitate the search for old property lines.

The Geological Survey is engaged in mapping the United States on two scales, dependent on the degree of detail in the topography, the amount of habitation, and the subsequent probable use of the maps for geologic and engineering purposes. The scale generally employed throughout the country is 1:125,000, or about 2 miles to 1 inch. The slopes and shapes of the surface forms and all differences of elevation are indicated by lines of equal elevation, called contour lines, with intervals varying between 25 and 100 feet, according to the ruggedness of the surface. The other scale, which is double the above and gives practically all the detail desirable in the general map of the region, is that usually adopted where cooperation is in force. This is the scale of 1:62,500, or about 1 mile to 1 inch, the contour interval varying between 10 and 20 feet, according to the slopes. These topographic maps are based upon geodetic determination of positions, either by means of an accurate system of primary triangulation or by primary traverse based upon astronomic locations. The fundamental positions so determined are marked by monuments of stone or by metal posts bearing suitable bronze tablets. Spirit levels of a high degree of accuracy are run with such frequency as to permit of the establishment of permanent metal bench marks in every 3 to 6 linear miles, while numerous elevations of less accuracy are obtained by levels run in all directions.

The maps that result from these cooperative surveys show, in different colors, both in the manuscript and in the published edition, the following principal facts:

1. Public culture, printed in black, which includes the exact plan of every road, lane, path, railroad, street, dam, public boundaries, names, etc.

2. The hydrography, or water, printed in blue, including all lakes, rivers, streams, swamps, marshes, reservoirs, springs, etc.

3. The relief, or surface forms, printed in brown, including the shapes of the hills, valleys, and ravines, their elevations and depressions, and the slopes of every rise or fall in the surface of the land.

The topographic maps produced by cooperative surveys are engraved on copper and printed from stone. The cooperating States have the benefit of this publication without further expense, and the residents of the State, as well as its officials, may purchase the maps at rates of 5 cents per sheet or \$2 per hundred.

The following table shows the States in which cooperative surveys have been completed or are in progress, the scale of all work completed under cooperation being in every instance 1:62,500, and the contour interval 10 to 20 feet. As indicated by the column "Area mapped," in some cases large portions were mapped prior to the inception of cooperation. A considerable portion of the amounts in the column "Total cost" was expended by the Federal Bureau prior to the making of cooperative arrangements.

Cooperative topographic surveys in various States.

State.	Area.	Area mapped.	Total cost to June, 1901.	Appropriated by State.
	<i>Square miles.</i>	<i>Square miles.</i>		
Massachusetts	8,315	All.	\$107,845	\$40,000
Connecticut	4,990	All.	48,555	25,000
Rhode Island	1,250	All.	9,732	5,000
New Jersey	7,815	All.	54,744	19,670
Pennsylvania	45,215	10,785	130,260	38,000
New York	49,170	25,502	303,936	151,000
Maine	33,040	4,767	38,985	10,000
Maryland	12,210	10,307	57,250	17,000
Ohio	42,050	1,864	12,000	25,000
North Carolina	52,250	12,252	20,000
West Virginia	24,780	17,227	30,000

Though not clearly shown in the above table, because of the facts already stated, it is estimated that the cost of mapping any considerable area, as a State, on the scale of 1:62,500 and with a contour interval of 20 feet will vary between \$10 and \$15 per square mile, according to the ruggedness of the country. The average cost of mapping on a scale of 2 miles to 1 inch and with a contour interval of 50 to 100 feet varies between \$5 and \$8 per square mile, according to the character of the country. In every case where cooperation is in force the cost to the State and to the Federal Government each is only half of the above amounts.

Cooperation in Hydrographic Investigations.

In the preceding paragraphs principal attention has been given to cooperation in the preparation of topographic maps, since this has been longest continued and larger sums have been expended for this purpose. In the hydrographic investigations, however, various States have asked for assistance, and correspondence has been had with others, indicating that in the future there will doubtless be considerable activity along this line. This is particularly the case in the arid portions of the United States, where the Government is the great land owner, and to a less extent in the mountainous sections of the East, where water power is being rapidly developed.

In the investigation of the water resources of the United States excellent results have been obtained through cooperation, especially in those States where water is practically the only mineral of economic value. In the arid regions water is recognized as the foundation of land values, since there is more land than can be judiciously used with the limited supply of water. In certain humid States water has great value, through the development of power and for municipal uses. A number of States have awakened to the fact that their continued development and increase in population is to a large extent dependent upon the more complete utilization of their water resources for power and the protection of their streams from pollution. Cooperation, in making known the facts, is therefore welcome, as by this means skilled and impartial examinations are made possible on an economic basis.

The methods by which cooperation is being had in the investigation of the water resources are similar to those followed in topographic mapping. The funds furnished by the State legislature or by State officials are supplemented by an equal amount allotted from the appropriation for gauging streams and determining the water supply of the country. The field work is carried on under the general system which has resulted from an experience extending over many years. The engineers or hydrographers are especially trained for this work. At the same time the details of the field work are intrusted as far as practicable to local men, economy of time and effort being assured by following established methods and precedents.

In cooperating with the various States separate items of appropriation and a distinct agreement are usually made for the hydrographic investigations, in order to simplify the correspondence and bookkeeping, since in the Geological Survey the Divisions of Geology, Topography, and Hydrography are separate in their administration and bookkeeping. The following paragraphs give briefly the present condition of the cooperation in the more important localities:

In Maine the sum of \$500 has been secured by private subscription and placed at the disposal of the governor's council for cooperation in measuring the rivers of chief importance in the development of water power.

In New York the appropriation by the legislature is quoted on pages 25-26.

In the State of Pennsylvania the following act was introduced in the legislature:

AN ACT MAKING AN APPROPRIATION TO THE HYDROGRAPHIC DIVISION OF THE UNITED STATES GEOLOGICAL SURVEY.

SECTION 1. *Be it enacted by the senate and house of representatives of the Commonwealth of Pennsylvania in general assembly met, and it is hereby enacted by the authority of the same, That the sum of two thousand dollars, or so much thereof as may be necessary, be, and the same is hereby, specifically appropriated to the Hydrographic Division of the United States Geological Survey for the two fiscal years beginning the first day of June, anno Domini one thousand nine hundred and one, for the prosecution of its work in this Commonwealth in gathering data and determining the volume of water carried*

and the commercial value thereof to this Commonwealth of the Delaware, Susquehanna, and other important streams.

Said appropriation to be paid on the warrant of the auditor-general, on a settlement made by him and the State treasurer, upon vouchers signed by the person in charge of the hydrographic survey in the Commonwealth of Pennsylvania; but it is hereby provided that these expenditures shall not be in excess of the amounts expended upon the same work by the Hydrographic Division of the United States Geological Survey from its own funds within the limits of this Commonwealth, and the results obtained from this work shall be made available by publication to the citizens of this Commonwealth.

In North Carolina cooperation has been had with the State geologist along lines similar to those followed in other cases.

In North Dakota the act authorizes the board of trustees of the agricultural college to cooperate in executing certain surveys and to arrange the details of the work on a basis of equal expenditure, and makes the professor of geology of the college the State director of such surveys.

In Colorado cooperation is had with the State engineer.

In Nevada the legislature created a State board of irrigation, consisting of the governor, surveyor-general, and the attorney-general, and authorized this board to expend \$2,000 in stream measurements and investigations. In accordance with this act the following agreement was made:

AGREEMENT BETWEEN THE STATE BOARD OF IRRIGATION OF THE STATE OF NEVADA AND
THE HYDROGRAPHIC DIVISION OF THE UNITED STATES GEOLOGICAL SURVEY FOR
COOPERATION IN THE INVESTIGATION OF WATER SUPPLIES AND IRRIGATION POSSIBILITIES
IN NEVADA.

For the year 1901 the United States Geological Survey hereby agrees to conduct investigations upon the Truckee, Carson, Walker, and Humboldt rivers in accordance with the attached plan; and for this investigation will expend for field work during the year 1901 not less than one thousand dollars (\$1,000) from the appropriation made by the Congress of the United States for its use.

The State board of irrigation also agrees to contribute to the expense of this investigation under the provision of an act of the legislature of the State of Nevada to provide for the measurement of streams, the survey of reservoir sites, the determination of irrigation possibilities, and the best methods of controlling and utilizing the water resources of the State of Nevada, in cooperation with the United States Geological Survey and the United States Department of Agriculture and the Nevada Experiment Station (approved March 16, 1901), the sum of one thousand dollars (\$1,000), the sum to be contributed by

the State of Nevada to be available for the purpose of this investigation when this agreement has been signed by the governor of the State of Nevada and the resident hydrographer of the United States Geological Survey.

REINHOLD SADLER,
Governor of Nevada.
L. H. TAYLOR,
Resident Hydrographer.

Approved:

CHAS. D. WALCOTT,
Director, U. S. G. S.

In Arizona an agreement has been entered into with the commissioners of Maricopa County, representing the largest interests in the Salt River Valley.

In California the following bill was passed by the legislature, but failed to become a law:

AN ACT TO PROVIDE FOR THE JOINT INVESTIGATION WITH THE FEDERAL GOVERNMENT OF THE WATER RESOURCES OF THE STATE, AND OF THE BEST METHODS OF PRESERVING THE FORESTS THEREOF, APPOINTING A BOARD OF WATER AND FOREST COMMISSIONERS TO CONDUCT SUCH INVESTIGATIONS ON BEHALF OF THE STATE, AND MAKING AN APPROPRIATION FOR THE EXPENSES OF SUCH INVESTIGATIONS.

The people of the State of California, represented in senate and assembly, do enact as follows:

SECTION 1. There is hereby constituted a board of water and forest commissioners composed of three citizens of the State, who shall be appointed by the governor on or before April 1, 1901. No two of such commissioners shall be residents of the same county.

SEC. 2. Such commissioners shall hold office for the term of two years.

SEC. 3. Before entering upon the discharge of the duties of his office, each of said commissioners shall take an oath or affirmation to support the Constitution of the United States and of this State, and to faithfully and honestly discharge his duties as such commissioner, and shall execute and file with the secretary of state an official bond, with good and sufficient sureties, to be approved by the governor, in the penal sum of \$20,000 conditional for the faithful performance of his duties under this act.

SEC. 4. Such commissioners shall receive no salary. They shall have power to employ a secretary at a salary of not exceeding \$100 per month, and shall be allowed a contingent fund of not exceeding \$200 per month to defray office and actual traveling expenses, and shall at the close of their term account to the governor for all moneys received and disbursed by them. Such commissioners may receive

donations to assist them in carrying out the purposes of this act, accounting as such commissioners for such donations.

SEC. 5. Said commissioners shall have power to enter into such contracts as may seem best to them with the lawfully authorized representatives of any department of the Federal Government for the purpose of making topographic surveys and a joint investigation of and report on the water resources of the State, the best methods of developing the same, and the best methods of preserving the forests: *Provided, however,* That their expenditures for such purposes shall not be in excess of the amounts to be expended by the department of the Federal Government in collaboration with which any specific work is done. They may also in like manner and subject to the same conditions make such experiments for preserving the forests of the State as may seem best to them and to the representatives of the branch of the Federal Government authorized to undertake such experiments.

SEC. 6. In order to carry out the purposes of this act, any person or persons employed hereunder are authorized to enter and cross all lands within this State, provided in so doing no damage is done to private property; it shall be a misdemeanor, punishable as provided in such cases, for any person or persons to willfully and maliciously remove or destroy any permanent marks or monuments made or erected by any such persons.

SEC. 7. The sum of \$107,200 is hereby appropriated as a special fund for the purposes specified in this act, and the controller of State is hereby authorized and directed to draw warrants upon such fund from time to time upon the requisition of two of such commissioners, and the State treasurer is hereby authorized and directed to pay such warrants.

SEC. 8. This act shall take effect immediately.

Cooperation in Geologic Surveys.

Cooperation in geologic work has been of less extent than for topography. In one form or another, however, cooperation in geologic surveys has recently been urged upon the Federal Survey by a number of States, and it seems probable that wide relations of the kind will be established.

In 1890 an understanding was had between the Director and the State geological board of New Jersey, that the State survey should map the later rock formations, which occupy much the larger area, but are readily mapped on account of the simplicity of the geologic structure, whereas the Federal Survey should map the comparatively small but very complex area of the earlier metamorphic rocks.

In the case of Pennsylvania, already referred to under another heading (see page 25), a new departure was made, inasmuch as financial cooperation on the part of the State was conditioned by the stipulation that the Federal Survey should carry on geologic as well as topographic work. The State survey having been discontinued, the scientific control rests wholly with the Director, while the State's interest is guarded by a commission.

A limited cooperation in areal geologic mapping has also been established with the State of New York.

The Geologic Branch has occasionally conferred with State geologists with a view to producing uniformity of action among State and Federal geologic surveys. The result has been, in some instances, the establishment of a closer system of cooperation between the Federal and State surveys, providing a financial and administrative basis upon which to extend the geologic surveys and investigations of this Survey over certain portions of the State.

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