DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

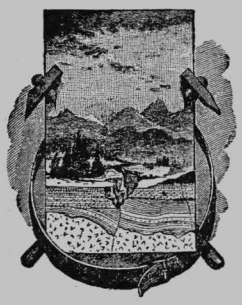
COOPERATION

BETWEEN THE

UNITED STATES AND VARIOUS STATES

IN

TOPOGRAPHIC, HYDROGRAPHIC, AND GEOLOGIC WORK



WASHINGTON

GOVERNMENT PRINTING OFFICE

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COOPERATION IN TOPOGRAPHIC, HYDROGRAPHIC, AND GEOLOGIC WORK.

INTRODUCTION.

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.

The Geological Survey has for many years cooperated in this way with other bureaus of the Federal Government, particularly the Coast and Geodetic Survey, the Weather Bureau, and the Engineering Corps of the Army, thus avoiding in many instances expensive duplication of work. Assistance in various forms has also been received each year from many individuals and corporations, and much valuable information has been made available which otherwise could not have been readily obtained. In return for this, maps and other publications have been furnished to those assisting.

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 of the United States Geological Survey, Maj. John W. 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 of the United States Geological Survey and State officials of Alabama, Arizona, California, Colorado, Connecticut, Georgia, Idaho, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan,

Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Rhode Island, Texas, West Virginia, and Wisconsin. The object on the part of the State was to direct and promote topographic mapping, geologic investigations, or hydrographic surveys, 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 more 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 investiga-

tions, and by the study of mineral, water, and timber resources, for which the topographic maps are primarily prepared as bases.

The Federal Survey benefits by the great increase in funds available for the extension of its legitimate operations. This Survey 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 are mutually prepared and a report of operations and results is submitted to the State officials 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 to stop work on important areas or subjects in order that cooperation with individual States may be extended. The Director is willing to enter a into 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 by him 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 University, at whose instance an appropriate bill was introduced in the Massachusetts legislature and 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 final 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.

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 average cost of this work was $12.90 per square mile.

At the time the cooperative survey was begun 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. The work of the State survey of New Jersey was commenced independently of the work of the United States Geological Survey, but 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, the State of New Jersey, following the example of Massachusetts, asked the National Survey to cooperate in completing the map of the State. The Federal Survey took up the work, but on lines different from those on which cooperation has been conducted elsewhere. About half 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 average cost of mapping the State was $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 W. Bacon, and James H. Chapin, commissioners. It was completed in 1891, the total expense having been $24,599.21, and the average cost per square mile $9.79. The commissioners in their final report to the governor, after commenting on the completion of the work within the time and sum estimated, made the following statement:

> 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 about $8.97 per square mile.

Cooperation with the State of New York for topographic surveys was commenced in 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, the total expenditure having been $492,138, of which the Federal Survey has provided $284,638, and the State $207,500. The work has been conducted by the United States Geological Survey in cooperation with State engineers Martin Schenck, Campbell W. Adams, Edward A. Bond, and the present incumbent, Henry A. Van Alstyne. The average cost of this work to date has been about $11.95 per square mile, including triangulation.

Cooperation with the State of Maryland for topographic surveys was commenced in 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 1898 the State legislature appropriated $5,000 toward this work, and in succeeding years sums which aggregate $30,050; the total expenditure by the Federal Survey in the same time was $42,450.

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

work, the total to date being $6,000. The Federal Survey has expended $20,500 on this work in the same time.

Cooperation with the State of Pennsylvania for topographic and geologic surveys was commenced in 1899 by the appropriation of $40,000 for the two years 1899 and 1900, to be expended under the supervision of State Survey Commissioners George W. McNees, F. D. Barker, and Simon Harrold. Of this sum $38,000 was allotted to topographic surveys and $2,000 to geologic surveys. In all, $98,000 have been expended on topographic surveys by the State, and a like sum by the Federal Survey. To geologic surveys the State has allotted $22,000, while the Federal Survey has expended an equal amount on the same work.

Cooperation with the State of Maine for topographic surveys was commenced in 1899 under Commissioners Leslie A. Lee, C. S. Hichborn, and William Engel. The legislature appropriated $2,500 per annum for the four years 1899 to 1902, inclusive. For 1903 and 1904 the same sum per annum was appropriated for topographic surveys, and in addition provision was made for geologic and hydrographic work. To date the total allotment by the State to topographic surveying has been $15,000, the Federal Survey having expended an equal amount. For the years 1903 and 1904 the State appropriated $1,500 for geologic surveys and a like sum for hydrographic surveys. The expenditure by the Federal Survey on geologic work has been $1,560 and on hydrographic work in excess of $5,000.

Cooperation with the State of Ohio for topographic surveys was commenced in 1901 with the appropriation by the State of $25,000, to be expended under the direction of the governor. Subsequent appropriations have been made for the same purpose, aggregating to date $97,600. The Federal Survey has expended an equal sum on this work.

Cooperation with the State of Michigan for topographic surveys was commenced in 1901, through the allotment by State Geologist Alfred C. Lane of $2,000. Subsequent allotments to a total of $4,700 have been made by the State for this work, while the Federal Survey has expended $9,700 upon it in the same time.

Cooperation with the State of North Carolina was carried on during the years 1901 and 1902 through the allotment of $17,027, by Governor Charles B. Aycock, from the funds of the State agricultural commission. The Federal Survey spent $20,000 on the same work. The State is represented in this cooperation by State geologist J. A. Holmes.

Cooperation with the State of West Virginia was entered into March 7, 1901, as the result of an appropriation by the State legislature of $30,000 for the years 1901 and 1902. In March, 1903, the legislature appropriated an additional $30,000 for the years 1903 and 1904. The total expenditure by the State and the Federal Survey has been $60,000 each. This money is being expended under the general direction of Dr. I. C. White, State geologist.

Cooperative topographic surveys were made in the State of Mississippi in 1902, through the allotment by W. L. Hutchinson, director of the State experiment station, of $1,400. The Federal Survey expended upon the same work during that year an equal sum. There was also a limited cooperation in geology in 1903, the State and the Federal Survey each expending $500 for this purpose.

Cooperation with the State of Kentucky was commenced in 1902 through the allotment by the curator of the State geological department of $2,025 for geologic work. This was increased by $5,500 in 1903 on account of topographic work. In 1904, by act of legislature, the State geologist, C. J. Norwood, allotted $5,000 to topographic surveys. The Federal Survey has expended an equal amount upon this work in the same time.

Cooperation with the State of Louisiana for topographic surveys was carried on during the years 1903 and 1904 through the allotment by Dr. W. C. Stubbs, director of Louisiana experiment station, of $2,500. The Federal Survey has expended to date $5,000 upon the same work.

Cooperation with the State of California was commenced July 1, 1903, as a result of the appropriation by the State legislature of 1903, of $60,000 for the two years 1903 and 1904, of which $20,000 was for topographic surveys. This money is being expended under the general direction of the State board of examiners.

Cooperation with the State of Texas was carried on during the years 1903 and 1904, through an allotment of $2,500 by Dr. William B. Phillips, director of the University of Texas mineral survey, the amount allotted by the United States Geological Survey being in excess of the above.

Early in 1905 the legislature of Oregon appropriated $2,500 for cooperation in topography and the same amount for cooperation in hydrography.

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 the United States Geological Survey 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. The United States Geological 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 cooperation 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 the appropriation of $40,000 made by Pennsylvania for the years 1903 and 1904, $15,000 was devoted to topographic mapping and $5,000 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 chiefly for actual field work, in which are included the services of temporary employees, who are usually residents of the State, and for the living and traveling expenses of the field force. It may be used in paying office salaries only in so far as is necessary to equalize the expenses of both parties to the cooperation. Thus the larger part of 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 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.

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 outside of the work of the General Government, since there is so little opportunity for steady employment in this line of work 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 States bench marks or permanent monuments which furnish datum elevations for the future determinations of height in connection with all public or private engineering works. The magnetic declination is frequently determined, and this aids local and county surveyors in determining the declination of their compasses and thus greatly facilitates 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 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, including roads, lanes, paths, railroads, streets, dams, 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 table on the facing page shows the States in which cooperative surveys have been completed or are in progress. The scale of all work completed under cooperation, except that in California, is 1:62,500, and the contour interval is from 10 to 20 feet. In California some areas have been surveyed on the scale of 1:125,000 with 100-foot contours, and some special maps have been made on the large scale of 2 inches to the mile with contour intervals of 5 feet. In the column "Area mapped," only those areas mapped since the inception of cooperation are enumerated:

Cooperative topographic surveys in various States.

State.	Area.	Area mapped.	Total cost to June, 1905.	Appropriated by State.
	Square miles.	*Square miles.*		
Alabama	51,540	3,455	$26,500	$6,000
California	158,360	1,704	40,000	20,000
Connecticut	4,990	All.	48,555	25,000
Kentucky	40,000	852	23,000	11,500
Louisiana	45,420	1,110	7,500	2,500
Maine	33,040	2,614	30,000	15,000
Maryland	12,210	9,585	72,500	30,050
Massachusetts	8,315	All.	107,845	40,000
Michigan	57,430	1,687	14,400	4,700
Mississippi	46,340	196	2,800	1,400
New Jersey	7,815	All.	54,744	19,670
New York	49,170	34,623	492,138	207,500
North Carolina	52,250	3,637	37,027	17,027
Ohio	42,050	11,097	195,200	97,600
Pennsylvania	45,215	9,746	196,000	98,000
Rhode Island	1,250	All.	9,732	5,000
Texas	262,290	1,620	----------	5,000
West Virginia	24,780	5,534	120,000	60,000

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 $12 and $18 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 countour interval of 50 to 100 feet varies between $8 and $12 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.

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 gaging 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 geologic, topographic, and hydrographic branches 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 $750 for each of the years 1903 and 1904 has been allotted for hydrographic investigations from the State appropriation, which provided also for topographic and geologic surveys.

In New Hampshire an appropriation was made by the legislature in 1903 to provide for an investigation of forest conditions in the White Mountain region. There was allotted from this appropriation $1,000 to be expended by the United States Geological Survey in a study of the hydrographic conditions of this region, especially as affected by forestation.

In New York the legislature has appropriated $1,500 for each of the years 1903 and 1904, and $1,000 for each of the two years prior to 1903.

In Maryland, Georgia, and Alabama cooperation has been secured

through the State geologist in each case, along the general lines followed in other States, excepting that in each case the appropriation has been made for the geological survey of the State without specific allotments for hydrographic work.

In Ohio, North Dakota, and Nevada State officials have been either specifically instructed or allowed to assist in hydrographic work under the direction of the United States Geological Survey.

Early in 1905 the legislature of Oregon appropriated $2,500 for cooperation in hydrographic surveys.

In California, the following bill was passed by the legislature of 1903:

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. The State board of examiners are hereby empowered to enter into contracts with the director of the United States Geological Survey for the purpose of making topographic maps, to the extent of twenty thousand dollars; also for the purpose of gauging streams, surveying reservoir sites and canal locations, for the conservation and utilization of the flood or storm waters of the State, to the extent of fifteen thousand dollars: *Provided*, No work of the nature heretofore stated shall be done where the same will interfere with water already appropriated or in reservoirs or now in use for irrigation or domestic purposes under the laws of this State; also with the Chief of the Bureau of Forestry of the Department of Agriculture, for the purpose of studying the forest resources of the State and their proper conservation, and especially with a view of formulating a proper State forestry policy, to the extent of fifteen thousand dollars; also with the Director of the Office of Experiment Stations of the Department of Agriculture, for the purpose of ascertaining the best methods of distributing and using the water, to the extent of ten thousand dollars: *Provided, however*, That these expenditures for such purposes shall not be in excess of the amounts to be expended by the various departments of the Federal Government in collaboration with the specific work named above: *And provided further*, That in case any of the departments of the Federal Government above mentioned do not contribute these funds for said cooperation, that the State board of examiners shall have power to enter into such contracts as may seem best to them with the lawfully authorized representatives of any of the departments of the Federal Government for the expenditure of said remaining balance: *And provided further*, That said last-mentioned expenditure for such purpose shall not be in excess of the amount to be expended by that department of the Federal Government in collaboration with the State.

SEC. 2. In order to carry out the purpose 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 of such persons.

SEC. 3. The sum of sixty thousand dollars is hereby appropriated for the purposes specified in this act, and the controller of State is hereby authorized and directed to draw warrants upon such funds from time to time, upon the requisition of the State board of examiners, and the State treasurer is hereby authorized and directed to pay

such warrants: *Provided*, One-half of the appropriation herein shall be available in the fifty-fifth fiscal year, and the remaining one-half of said appropriation shall be available in the fifty-sixth fiscal year.

SEC. 4. It is hereby made the duty of the surveyor-general and the engineer of the board of public works to render any assistance desired by the State board of examiners in furtherance of the aims of this act.

SEC. 5. This act shall take effect and be enforced on and after July 1, 1903.

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 arrangement was made 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, while the Federal Survey should map the comparatively small but very complex area of the older metamorphic rocks, the results obtained by each organization being available for publication by the other.

In Missouri an informal arrangement has been made with the State geologist whereby the State survey furnishes the results of detailed areal mapping for folio publications while the Federal Survey carries on the necessary paleontologic investigations for the discrimination and correlation of stratigraphic horizons.

In the case of Pennsylvania, already referred to (see page 8), 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 geologic work began in 1900. For the years 1899 and 1900, of the State appropriation of $20,000, $2,000 was alloted for geology. Since then $5,000 of the $20,000 has been allotted for the geologic work. As a result of this cooperative geologic work since 1899, portions of twenty-one counties have been covered and will be included in twenty-three geologic folios. The area so mapped covers over 5,000 square miles. The cost to the State has been close to $2 per square mile. Of these folios ten have already been published; five are in press, and the others are in various stages of preparation.

In 1902 a cooperative agreement was made with the curator of the State geological department of Kentucky for geologic work. The sum of $2,025 was allotted by the State and an equal amount by the Federal Survey. Under this agreement an investigation was made of the lead, zinc, and fluorspar deposits of western Kentucky and of the Cumberland Gap coal field. The latter investigation was continued

in 1903 under an added allotment from the State, of $1,100. Preliminary and final reports on both of these investigations have been published or are now in press.

In 1903 an agreement was effected with the State geologist of Colorado for the resurvey of the Cripple Creek mining district, and an allotment of $3,500 was made for this purpose from funds in his hands, to meet an equal amount alloted by this survey. Owing to the loss of $480 of State funds in a bank failure and certain exceptional expenses connected with the work an added allotment was made by the United States Geological Survey, making the total cost borne by the latter $4,462, against $3,019 borne by the State. A preliminary report on the results of the investigation has been published and a full report is in preparation.

During 1903 and 1904 a cooperative agreement including geologic work has been in force with the State of Maine survey commission. The allotment from State funds for this purpose has been $1,500 and an equal amount has been allotted by the Federal Survey. These funds have been expended both in areal work, the results of which will be published in geologic folios, and also in the investigation of special economic problems in which the people of the State were particularly interested.

A limited cooperation in geology generally for the investigation of some specific area or problem has been entered into with several other States, notably New York, Virginia, North Carolina, Mississippi and Alabama.

Without formal cooperation the officers of the United States Geological Survey frequently confer with State geologists with a view to producing uniformity of action among State and Federal geologic surveys, particularly in matters relating to classification and nomenclature. They always welcome such informal cooperation and conference, which at least prevents useless duplication of work.

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