

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

COOPERATION

BETWEEN THE

UNITED STATES AND VARIOUS STATES

IN

TOPOGRAPHIC, HYDROGRAPHIC, AND
GEOLOGIC WORK



WASHINGTON
GOVERNMENT PRINTING OFFICE
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INTRODUCTION.

Cooperation in scientific work may consist in an exchange of information between two or more parties or in the expenditure by them of money for investigation or work in which they are mutually interested.

The United States Geological Survey has for many years cooperated in this way with other bureaus of the Federal Government, particularly the Coast and Geodetic Survey, the General Land Office, the Reclamation Service, the Bureau of Soils, the Forest Service, the Weather Bureau, and the Corps of Engineers of the Army, thus avoiding much expensive duplication of work. It has also received each year assistance in various forms from many individuals and corporations, and has thus acquired much valuable information which otherwise could not have been readily obtained. In return for this aid it has furnished maps and other publications to those assisting.

Cooperation to promote the common purpose of advancing knowledge and aiding development has existed between state geologists and the Federal Survey since the latter was organized. The results of the Survey's work have always been at the disposal of state officials at proper times and under reasonable conditions relating to publication, and the courtesies thus extended 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 Survey 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, Arkansas, California, Colorado, Connecticut,

Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin.

The object of the State in these agreements was to direct and promote topographic mapping, geologic investigations, and study of water resources, to procure scientific information which it was not equipped to obtain, to insure completion of work at an earlier date than would be possible with the federal or state appropriations alone, or to avail itself in some other way of the special facilities of the Federal Survey; 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 expedite the work and carry it on with more detail in areas where the public interest was greatest.

The States benefit by cooperation in geologic investigation 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 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, inasmuch as such resources are not limited by state boundaries, and as the broader geologic facts on which the development of economic problems is necessarily based must be looked for and studied through a number of States, each State 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. Each State possesses a considerable range of natural resources, and it is usually impossible for the state geologists to discuss all of these resources in the most full and satisfactory manner. The best work results from the investigations of specialists, and few of the individual States can afford to obtain the services of a considerable number of experienced and high-priced experts. By the method of cooperation in geologic work which these conditions have developed 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 special problems whose solution has had to be sought by work in several States.

On the completion of the field investigations or surveys, for which alone cooperation is accepted by the Federal Survey, the resulting

reports and maps are published by the Government and thus become available to the State. If, for example, the cooperation covers even no more than the preparation of a topographic map, the State benefits by the fact that this will surely be followed more promptly than otherwise would be the case by the geologic investigations and mapping, 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 extension of its legitimate operations made possible through cooperation with the States. 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 area that can be covered within a given time is increased by means of the greater funds available through cooperation, and the completion of the work is thereby hastened. This advantage is of especial importance in the work on the topographic map, which forms the base for the studies of economic resources, geology and hydrography, and the classification of lands.

GENERAL POLICY IN COOPERATIVE WORK.

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 whose results 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 branch 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 well as to 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 making or disposing of 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. 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 into a cooperative agreement only when the interests of the country as a whole will be benefited. In the execution of the work intrusted to the Survey certain features must necessarily be taken up first, and if the desires of the State fall into agreement with

this order cooperation may be had with the greatest advantage both to the State and to the Federal Government.

For several years after the adoption of the plan of cooperation, it was the general policy of the Federal Survey to meet whatever amounts were offered by the various States with equal amounts from the Survey's funds, so far as was consistent with an equitable distribution of the federal appropriation over the entire country. The number of States offering funds for cooperation, especially in topographic mapping, has steadily increased until at the present time it is found that the funds of the Federal Survey are inadequate to fully meet the amounts offered and at the same time preserve a just distribution of work in the various portions of the United States. It has therefore become necessary to fix upon a plan of apportionment for topographic work that will best serve the interests of the Federal Survey and the cooperating States, to be in force until specific provision for cooperative work is made in the federal appropriation. Two general factors have been adopted as furnishing a basis for this plan of apportionment, as follows:

First, the special claims of the public-land States, where the federal interest in adequate mapping is paramount by reason of public ownership of land.

Second, the progress of the topographic map of the United States as a whole. In this connection it is to be noted that the percentage of area surveyed in the States offering cooperation is already higher than that in noncooperating States—40 per cent as contrasted with 32 per cent—and this difference is by no means wholly due to the amount of work done under cooperation.

The policy which has been determined upon will fix maxima for cooperative allotments and grade such allotments on the basis of percentage of area already surveyed.

A maximum of \$20,000 will be permissible for cooperative allotments in States of which less than 35 per cent has been surveyed, this being the percentage for the whole United States. For States 35 to 70 per cent of whose area has been already surveyed \$15,000 will be the maximum amount permissible, and for States with over 70 per cent surveyed \$10,000 will be the maximum. In States where the cooperative surveys are made on a larger scale than is necessary for the topographic map of the United States, the federal allotments will be adjusted on a basis other than that stated above. Even under this arrangement the cooperative allotments by the Federal Survey in 1909 aggregated over \$160,000.

The federal allotments to meet state cooperation will bear their proportionate share of the expenses necessary in connection with the proper execution of the field and office work, namely, charge for maintenance of the building occupied by the Geological Survey,

exclusive of rent; for use of the library; for correspondence and records; for disbursements and accounts; for distribution of maps; for internal administration of the topographic branch; for repair (but not for purchase) of instruments; for map editing; and for stationery, including field notebooks—a total charge of 12½ per cent. It is to be noted, however, that the assessments for these expenses are levied on only the federal allotment for the cooperative work, although it is obvious that the field work paid for by the state funds necessitates a corresponding increase in most of these administrative expenses.

METHODS OF COOPERATION.

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

The Director is requested by citizens of a State that 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. The object desired is usually attained by the introduction in the state legislature 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 shall (1) have control of the expenditure of the money appropriated, (2) make agreements with the United States Geological Survey as to the methods of conducting the work, and (3) recommend the order in which various portions of the State shall be surveyed. It is invariably stipulated that the field operations shall be conducted 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 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 United States. The Federal 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, passed by the legislature of Washington at its session of 1909, provides a lump appropriation for the complete topographic map of a State:

An act to provide for the making of topographic maps within the State of Washington and the investigation of its water resources in cooperation with the United States Government; also for geologic investigations within the State of Washington, and appropriating moneys therefor.

Be it enacted by the legislature of the State of Washington:

SECTION 1. In order to complete the topographic map of the State of Washington, and for the purpose of making more extensive stream measurements and otherwise investigating and determining the water supply of the State, there is hereby appropriated the sum of thirty thousand dollars (\$30,000), for cooperation with those branches of the United States Geological Survey engaged in this work. This appropriation, however, shall be contingent upon, and not become available unless the United States Government apportion an equal amount to be expended for similar purposes within the State. The Board of Geological Survey is hereby authorized and directed to enter into such agreements with the Director of the United States Geological Survey as will insure that the said surveys and investigations be carried on in the most economical manner and that the maps and data be available for the use of the public as quickly as possible.

SEC. 2. In order to enable the Board of Geological Survey to carry on investigations authorized by law, there is hereby appropriated the sum of twenty thousand dollars (\$20,000) for the use of said board in the geologic and other investigations provided for in chapter 165 of the session laws of the State of Washington for 1901, and as amended in chapter 157 of the session laws of 1903.

SEC. 3. In order to carry out the purposes of this act, all persons employed hereunder are authorized to enter and cross all lands within the State: *Provided*, That in so doing no damage is done to private property.

SEC. 4. The sum of fifty thousand dollars (\$50,000) herein appropriated for the purposes specified in this act shall be available in the following manner: One-half during the first twelve months after this act takes effect, and the unexpended balance during the second twelve months after this act takes effect.

An example of a law to secure cooperation with this Survey 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 author-

ized 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 States 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 Connecticut the governor of the State appointed a commission on the passage of such an act, 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.

In other States cooperation is arranged through some bureau having specific authority from the legislature, as shown in the Illinois law:

An act to establish and create, at the University of Illinois, the bureau to be known as a State Geological Survey, defining its duties and providing for the preparation and publication of its reports and maps to illustrate the natural resources of the State, and making appropriation therefor.

SECTION 1. *Be it enacted by the people of the State of Illinois, represented in the general assembly,* That there be, and is hereby, created and established at the University of Illinois a bureau, to be known as a State Geological Survey, which shall be under the direction of a commission, to be known as a State Geological Commission, composed of the governor, who shall be ex officio chairman of said commission, the president of the University of Illinois, and one other competent person to be appointed by the governor, who shall hold office for the term of four years and until his successor is appointed and qualified.

* * * * *

10. The said commissioners are hereby authorized to arrange with the Director or the representative of the United States Geological Survey in regard to cooperation between the said United States Geological Survey and the said Geological Commission in the preparation and completion of a contour topographic survey and map or maps of this State, and said commission may accept or reject the work of the United States Geological Survey.

11. In order to carry out the provisions of this act it shall be lawful for any person or persons employed hereunder to enter and cross all lands within this State, provided in so doing no damage is done to private property.

12. The commission may expend in the prosecution of such cooperative work a sum equal to that which shall be expended thereon by the United States Geological Survey: *Provided,* That not more than ten thousand (\$10,000) dollars be expended in this work in one year.

In Pennsylvania the appropriation act provided for cooperation in making geologic as well as topographic surveys and in 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 1900 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.*

HISTORY OF COOPERATION IN TOPOGRAPHIC SURVEYS.

The idea of cooperation in public surveys between the federal and state governments originated in 1884, in connection with a plan to make a topographic map of the State of Massachusetts. The work was conducted under the direction of three topographic survey commissioners appointed by the governor. In their final report to the governor, dated January, 1888, the commissioners state:

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 sum, however, does not include the cost of much of the primary triangulation, which was executed by the Coast and Geodetic Survey. The average cost of the completed 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 the 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 in a similar way and with all desirable accuracy. From small and desultory beginnings in 1872 it attained systematic form and method in 1882. On July 15, 1884, the State of New Jersey, following the example of Massachusetts, asked the United States Geological Survey to cooperate in completing the map of the State. The Federal Survey took up the work, but proceeded 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 Survey, which took charge of the organization and of the personnel and carried the work to completion in 1887. 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 Coast and Geodetic Survey.

The cooperative survey of Connecticut was commenced in July, 1889, under a board of three commissioners, and was completed in 1891. The total expense to the State was \$24,599.21 and the Federal Survey contributed a like amount. The average cost per square mile was \$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 an act of the general assembly passed March 22, 1888, and immediately thereafter the governor appointed three commissioners to represent him in the work. Field work was commenced in June, 1888, and the survey of the 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, through an allotment of \$3,000 from the general survey fund of the state engineer and surveyor and one of the same amount by the United States Geological Survey. This work has been continued without interruption since that date, the total expenditure having been \$544,338, of which the Federal Survey has provided \$310,738 and the State \$233,600. The average cost of this work to date has been about \$14.40 per square mile, including triangulation.

Cooperation with the State of Maryland for topographic surveys was commenced in 1896, when the state geologist allotted the sum of \$1,000 for this work. The same amount was allotted by him in 1897. In 1898 the state legislature appropriated \$5,000 and in succeeding years other sums toward this work, the aggregate of the state appropriations being \$46,550. The total expenditure by the Federal Survey in the same time was \$57,950.

Cooperation with the State of Alabama for topographic surveys was commenced on March 11, 1899, the state geologist allotting \$1,000 for this work from the funds of the State Geological Survey. The same amount was allotted annually for six years, 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 surveys was commenced in 1899, when an appropriation of \$40,000 was made for cooperative work in the two years 1899 and 1900, to be expended under the supervision of a State Survey Commission. Of this sum \$38,000 was allotted to topographic surveys. In all

\$147,500 has been expended on topographic surveys by the State and a like sum by the Federal Survey.

Cooperation with the State of Maine for topographic surveys was commenced in 1899 under a board of commissioners. The legislature appropriated \$2,500 per annum for such work in the years 1899 to 1904, inclusive. To date the total allotment by the State for topographic surveying has been \$26,700 and the Federal Survey has expended an equal amount.

Cooperation with the State of Ohio for topographic surveys was commenced in 1901, the State appropriating \$25,000 for this work, to be expended under the direction of the governor. Subsequent appropriations have been made for the same purpose, the aggregate to date being \$183,200. The Federal Survey has expended an equal amount on this work.

Cooperation with the State of Michigan for topographic surveys was commenced in 1901, when the state geologist made an allotment of \$2,000 for this purpose. Subsequent allotments to a total of \$13,700 have been made by the State for such work, on which the Federal Survey has expended \$18,700 in the same time.

Cooperation with the State of North Carolina was carried on during the years 1901 and 1902 through the allotment for topographic surveys of \$17,027 by the governor from the funds of the State Agricultural Commission and of \$20,000 by the Federal Survey. The total sum spent by the State to date is \$29,200 and by the Federal Survey \$30,900. The State is represented in this cooperation by the state geologist.

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 cooperative topographic work in the years 1901 and 1902. In March, 1903, the legislature appropriated an additional \$30,000 for similar work in the years 1903 and 1904. The total expenditure by the State for this purpose has been \$117,000 and by the Federal Survey \$114,000. This money is being expended under the general direction of the state geologist.

Cooperative topographic surveys were made in Mississippi in 1902, through the allotment for this purpose of \$1,400 by the Director of the State Experiment Station and of an equal sum by the Federal Survey. In 1907 an allotment was made by the state geologist of \$3,000 and by the Federal Survey of \$3,613. In 1908 an additional allotment of \$27,000 was made by the Tallahatchie Drainage Commission and the Federal Survey expended \$9,000. The total amount expended in the State from various sources is \$45,413.

Cooperation in topographic mapping with the State of Kentucky was commenced in 1903, when an allotment of \$5,500 was made for

such work by the curator of the State Geological Department. In 1904, by authority of an act of the legislature, the state geologist allotted \$5,000 to cooperative topographic surveys. The amount expended on this work to date by the State is \$37,500 and by the Federal Survey \$37,900.

Cooperation with the State of Louisiana for topographic surveys was carried on during the years 1903 and 1904, through an allotment of \$4,000 by the Director of the Louisiana Experiment Station and of \$6,500 by the Federal Survey for this work.

Cooperation with the State of California was commenced July 1, 1903, as a result of the appropriation by the state legislature of \$60,000 for cooperative work in the two years 1903 and 1904, of which \$20,000 was for topographic surveys. Other appropriations have since been made. This money has been expended under the general direction of the State Board of Examiners and the state engineer, and to date aggregates \$80,000; the Federal Survey has expended an equal amount.

Cooperation with the State of Texas was carried on during the years 1903 and 1904 through an allotment for such work of \$5,000 by the director of the University of Texas Mineral Survey and a larger amount by the United States Geological Survey.

Early in 1905 the legislature of Oregon appropriated \$2,500 for cooperation in topographic work, to be expended under the direction of the state engineer. The amount expended to date for such work by the State is \$10,000 and by the Federal Survey \$12,900.

Cooperation with Oklahoma was begun in 1905, the legislature appropriating \$5,000 for cooperative topographic surveys, to be expended under the direction of the Board of Agriculture. The total amount expended to date has been \$28,000, of which the Federal Survey has contributed one-half.

Cooperation with the State of Illinois was commenced in 1905, when an appropriation of \$10,000 for cooperative work was made by the state legislature, to be expended under the direction of the state geologist. The sum expended to date is \$73,300, of which the State has contributed \$36,000.

Cooperation with the State of Iowa was begun in 1907, an allotment of \$1,750 for such work being made from the funds of the state geologist. The State has expended \$3,500 for this work and the Federal Survey an equal amount.

The State of Missouri entered into cooperation in 1907, making an allotment for the work of \$5,000 from the funds of the Bureau of Geology and Mines. In 1908 an additional allotment of \$1,000 was made. Both sums were met by equal amounts by the Federal Survey.

Cooperation was commenced in Virginia in 1908, an appropriation of \$1,750, to be expended in cooperative work, under the direction of the state geologist, being made by the state legislature. The Federal Survey has expended an equal amount on the same work.

VARIOUS STYLES OF COOPERATIVE AGREEMENTS.

Below are given a few examples of cooperative agreements of different styles:

This agreement, made and entered into this, the 20th day of June, 1908, between the Director of the United States Geological Survey, of Washington, D. C. (as authorized by act of Congress of March 3, 1879, Stat. L., vol. 20, p. 394, and act of June 11, 1896, Stat L., vol. 29, p. 435, and related acts) and the Department of Engineering of California,

Witnesseth: The purpose of this agreement is to obtain cooperative topographic surveys of California, under a law passed by the legislature of California, approved March 11, 1907, and in accordance with a subsequent act of the legislature of California, approved March 11, 1907, creating a Department of Engineering, and for the purpose of carrying out the terms of that act, this contract is hereby entered into between the above parties, upon the following basis:

1. The preparation of the maps 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 Department of Engineering of California, or their representative, and the Director of the United States Geological Survey, or his representative.

3. The surveys shall be executed in a manner sufficiently elaborate to prepare maps upon scales which may be agreed upon for different localities, exhibiting the hydrography, hypsography, and public culture, and all public-land and county boundary lines, as marked upon the ground at the time of its completion, in form similar to the sheets already completed in the 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.

4. The hypsography will be shown by contour lines with vertical intervals of 5 to 100 feet, as may hereafter be mutually agreed upon.

5. The heights of important points shall be determined and furnished to the Department of Engineering of the State.

6. The outlines of wooded areas shall be represented upon proofs of the engraved maps, to be furnished the Department of Engineering of the State.

7. For convenience, the United States Geological Survey shall, during the progress of the field work, pay the salaries of the permanent employees engaged thereon, while the traveling, subsistence, and field expenses may 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 California of the field and office work from July 1, 1908, to June 30, 1909, shall not be more than twelve thousand dollars (\$12,000) and provided that the United States Geological Survey shall expend an equal amount upon the

same work during the same period of time, accounts to be rendered monthly and to be in conformity with the rules and regulations of the United States Geological Survey.

8. During the progress of the work free access to the field sheets and records of the topographers and draftsmen shall be afforded the Department of Engineering of California, or their representative, for examination and criticism; and should the said Department of Engineering of California deem that the work is not being executed in a satisfactory manner, then they may on formal notice terminate this agreement.

9. The resulting maps shall fully recognize the cooperation of the State of California.

10. When the work is completed, the Department of Engineering of the State of California 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, said Department shall be furnished by the said Survey with transfers from the copper plates of the maps for use in printing editions of said maps.

11. In all cases where a dispute may arise as to the meaning of this contract, the provisions of "An act to provide for the joint investigation," etc., approved March 11, 1907, and "An act to create for the State of California a Department of Engineering," etc., approved March 11, 1907, hereby referred to and made a part hereof, in as far as applicable, shall control the construction of said contract.

12. It is hereby agreed between the parties that this contract terminates on the 30th day of June, 1909, and becomes void and of no effect, and that time is of the essence of this contract.

Memorandum giving areas proposed for survey under this contract by the topographic branch of the United States Geological Survey in cooperation with the Department of Engineering of the State of California for the period beginning July 1, 1908, and ending June 30, 1909:

The areas between longitude $121^{\circ} 20'$ and $121^{\circ} 40'$ and latitude $38^{\circ} 00'$ and $38^{\circ} 15'$ and between longitude $121^{\circ} 00'$ and $121^{\circ} 45'$ and latitude $38^{\circ} 30'$ and $39^{\circ} 00'$, to be published by engraved sheets on a scale of 1:62500 (1 mile to 1 inch), with 10-foot contour interval; the flat valley lands to be on a scale suitable for reproduction by photolithography or otherwise on a scale of 2 inches to 1 mile (1:31680), with a 5-foot contour interval.

Upon the execution of this contract by the Director of the United States Geological Survey and the Department of Engineering, or their representative, the preliminary agreement dated April 15, 1908, between the Director of the United States Geological Survey and the Department of Engineering of the State of California, shall become void and of no effect.

(Signed) GEO. OTIS SMITH,
Director, United States Geological Survey.

(Signed) NATHANIEL ELLERY,
State Engineer, State of California.

Agreement between the Governor of the State of Mississippi, the President of the Tallahatchie Drainage Commission of the State of Mississippi, and the Director of the United States Geological Survey for the execution of the topographic survey of the Tallahatchie drainage district.

Witnesseth: The purpose of this agreement is to obtain a cooperative topographic survey in the Tallahatchie drainage district under a law passed by the legislature of the State of Mississippi, March 2, 1908, and for the purpose of carrying out the terms of that act, this agreement is hereby entered into between the aforesaid parties upon the following basis:

1. This agreement shall be in force and effect from June 15, 1908, to June 30, 1909.

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

3. The order in which, in point of priority, different parts of the Tallahatchie drainage district shall be surveyed shall be agreed upon in detail by the Tallahatchie Drainage Commission, or their representative, and the Director of the United States Geological Survey, or his representative.

4. The surveys shall be executed in a manner sufficiently elaborate to prepare maps on scale of 2,000 feet to 1 inch, exhibiting the hydrography, hypsography, and public culture, and all public-land and county boundary lines, as marked upon the ground at the time of its completion, in form similar to the sheets already completed in the 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 5 feet.

6. The heights of important points determined in this survey shall be furnished to the Tallahatchie Drainage Commission and the State of Mississippi.

7. The outlines of wooded areas shall be represented upon proofs of the photographic maps to be furnished the Tallahatchie Drainage Commission and the State of Mississippi.

8. The resulting map shall fully recognize the cooperation of the Tallahatchie Drainage Commission and the State of Mississippi.

9. All state accounts shall be approved by a representative of the United States Geological Survey before payment.

10. When the work is completed the Tallahatchie Drainage Commission and the State of Mississippi 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, the Tallahatchie Drainage Commission and the State of Mississippi shall be furnished by the United States Geological Survey with transfers from the copper plates of the maps for use in printing editions of said maps.

11. The areas to be surveyed by the topographic branch of the United States Geological Survey is that fully described in the act of the legislature of the State of Mississippi, passed March 2, 1908, known as the "drainage law"—an act creating the Tallahatchie drainage district in the State of Mississippi and incorporating the Tallahatchie Drainage Commission and for other purposes.

12. The area to be surveyed is approximately 1,800 square miles, and the estimated cost of completing it will amount to about \$36,000.

To provide the necessary funds to complete the aforesaid area, the following amounts are mutually agreed upon: The Director of the United States Geological Survey hereby agrees to expend \$9,000, and, in addition thereto, to furnish free of charge the camp equipment now in use by the Tallahatchie Drainage Commission, the estimated value of which amounts to \$6,500, and all the necessary instruments. The governor of the State of Mississippi and the president of the Tallahatchie Drainage Commission, on behalf of the Tallahatchie Drainage Commission, hereby agree to expend \$9,000 to meet the amount to be expended by the United States Geological Survey. It is further provided that, owing to the inability of the Director of the United States Geological Survey to meet in full the amount of \$18,000 offered in cooperation by the Tallahatchie Drainage Commission to complete the topographic survey of the Tallahatchie drainage district, and because the scale of 2,000 feet to 1 inch is a larger scale than is desired for the purposes of the United States Geological Survey, thereby entailing an unnecessary cost to the United States Geological Survey for the field work, the Tallahatchie Drainage Commission further agrees to expend \$18,000, or as

much more or less than this amount that is necessary to complete the Tallahatchie drainage district, making the total amount to be expended on the part of the Tallahatchie Drainage Commission \$27,000, more or less, and on the part of the Director of the United States Geological Survey \$9,000 and the use without charge of equipment now in the Tallahatchie drainage district.

13. The line of precise levels along the east boundary of the Tallahatchie drainage district, authorized by the Tallahatchie Drainage Commission May 18, 1908, and approved by the Director of the United States Geological Survey May 22, 1908, becomes a part of this agreement, but is not included in the estimates for the topographic survey, nor is it considered a part thereof. The entire cost of running this line is to be paid by the Tallahatchie Drainage Commission, the Director of the United States Geological Survey agreeing only to furnish competent assistants, the necessary instruments, and to assume the responsibility for the work.

14. The tentative agreement signed May 11, 1908, by the Director of the United States Geological Survey, and signed May 25, 1908, by the governor of the State of Mississippi and the president of the Tallahatchie Drainage Commission, ceases to be operative on June 15, 1908.

(Signed) GEO. OTIS SMITH,
Director, U. S. Geological Survey.

(Signed) H. W. CRENSHAW,
President, Tallahatchie Drainage Commission.

(Signed) E. F. NOEL,
Governor.

Supplemental agreement between the governor of the State of Mississippi, the president of the Tallahatchie Drainage Commission on the one part, and the Director of the United States Geological Survey on the other part, for the continuation of the topographic survey of the Tallahatchie drainage district of Mississippi.

In accordance with the provisions of an agreement entered into between the above-named parties on June 15, 1908, the terms of which are hereby extended to cover this further cooperation, it is agreed and understood that the governor of the State of Mississippi and the president of the Tallahatchie Drainage Commission shall further expend for cooperative topographic surveys the sum of \$6,500 per month or as much thereof as may be necessary to maintain the field forces that are now in the field or any addition thereto as may be deemed advisable by the cooperating parties. This cooperative work to extend until a discontinuation of the field work is deemed advisable on account of unfavorable weather conditions, or until the president or the chief engineer of the Tallahatchie Drainage Commission shall give to the Director of the United States Geological Survey, or his representative, ten days written notice to discontinue these operations because of lack of sufficient available funds to continue same.

It is further understood that this agreement in no way interferes with the terms of the agreement entered into by the aforesaid parties on June 15, 1908, and that an amount not exceeding \$6,000 shall be reserved from the amount of \$27,000 agreed upon in the agreement of June 15, 1908, for the purpose of paying the salaries of the topographers in the drawing of the final sheets. Whatever balance remaining of the \$6,000 after the payment of the above-named salaries is to be expended in further field work during the season 1909.

(Signed) E. F. NOEL,
Governor of Mississippi.

(Signed) H. W. CRENSHAW,
President, Tallahatchie Drainage Commission.

(Signed) GEO. OTIS SMITH,
Director, U. S. Geological Survey.

NOVEMBER 14, 1908.

NOVEMBER 30, 1908.

Supplemental agreement between the Director of the United States Geological Survey and the state engineer and surveyor of New York for the continuation of cooperative topographic surveys in the State of New York for the fiscal year ending June 30, 1909.

In accordance with provisions of agreement entered into between the above-named parties, signed in May, 1904, and in extension of the terms of a supplemental agreement entered into between the same parties June 30, 1905, the terms of which agreements are hereby extended to cover this further cooperation, it is agreed and understood that the State of New York shall expend for such cooperative surveys prior to June 30, 1909, an additional sum of not less than \$8,000, providing that the United States Geological Survey shall expend, prior to the same date and for the same purpose within the State, an amount at least equal to the sum expended by the State of New York.

WASHINGTON, D. C.,
June —, 1908.

(Signed) GEO. OTIS SMITH,
Director, U. S. Geological Survey.

ALBANY, N. Y.,
—————, 1908

(Signed) FREDERICK SKENE,
State Engineer and Surveyor, New York.

Agreement between the governor of Ohio and the Director of the United States Geological Survey for the continuation of the cooperative topographic survey of the State of Ohio, as provided for in an act passed by the seventy-seventh general assembly, second session, May 1, 1908. Signed by the governor May 11, 1908.

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 the point of priority, different parts of the State shall be surveyed, shall be agreed upon in detail by the governor of Ohio 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 the United States Lake 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 1:62500, exhibiting the hydrography, hypsography, and public culture, and all town and county boundary lines, township and section lines, as marked upon the ground at the time of its completion, in form similar to sheets already completed in this State. 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 a vertical interval of 20 feet.

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 to the governor of the State.

8. For convenience the United States Geological Survey shall, during the progress of the 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 Ohio of the field and office work shall not be more than nineteen thousand dollars (\$19,000), and provided that the United States Geological Survey shall expend an equal amount upon the work.

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 or his representative for examination and criticism; and should the said governor of Ohio deem that the work is not being executed in a satisfactory manner, then he may on formal notice terminate this agreement.

10. The resulting maps shall fully recognize the cooperation of the State of Ohio.

11. When the work is completed, the governor of the State of Ohio 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 copper plates of the map for use in printing editions of said maps.

WASHINGTON, D. C.,
June 3, 1908.

(Signed) GEO. OTIS SMITH,
Director, U. S. Geological Survey.

COLUMBUS, OHIO,
June 8, 1908.

(Signed) ANDREW L. HARRIS,
Governor of the State of Ohio.

Supplemental agreement between the Director of the United States Geological Survey and the Topographical and Geological Survey Commission of the State of Pennsylvania, for the continuation of the cooperative topographic and geologic survey of the State for the year 1908-9.

In accordance with the provisions of an agreement entered into between the above-named parties on July 12, 1899, the terms of which are hereby extended to cover this further cooperation, it is agreed and understood that the State of Pennsylvania shall expend for cooperative topographic surveys a sum of not less than \$12,000, and for cooperative geologic surveys a sum of not less than \$4,500, for the fiscal year ending June 30, 1909.

Providing, That the United States Geological Survey shall expend for the same purposes and for the same periods of time amounts at least equal to the above.

WASHINGTON, D. C.,
June —, 1908.

(Signed) GEO. OTIS SMITH,
Director, U. S. Geological Survey.

JUNE 23, 1908.

(Signed) G. W. McNEES,
(Signed) ANDREW S. MCCREATH,
(Signed) RICHARD R. HICE,
Pennsylvania Survey Commissioners.

BENEFITS OF 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. They may be used in paying office salaries only in so far as is necessary to equal-

ize the expenses of both parties to the cooperation. Thus the larger part of the amount appropriated by the State is returned to its people. 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, assistant topographers, or junior topographers of the Federal Survey, who are appointed under the rules of the United States Civil Service Commission by the Secretary of the Interior. Topographic aids performing the duties of levelmen or transitmen or filling other positions requiring technical skill and the use of surveying instruments are appointed from the United States Civil Service register by the Director of the Federal Survey, for the field season only. Rodmen, recorders, tapemen, etc., are employed, under the regulations of the Department of the Interior, in the locality in which the work is being carried on, under the terms of a signed application and agreement which they must file when seeking such employment and a formal contract when entering upon duty. Teamsters, packers, cooks, laborers, etc., are employed in the locality in which the work is being done, under the regulations of the Department of the Interior, in accordance with the terms of a signed contract which they must file when beginning work.

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 of their work than is otherwise practicable. It was at once realized by state officials to whom such investigations 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 localities the resources procurable through state aid, and the lack of the 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, as there is so little opportunity for steady employment in this kind of work elsewhere. It was apparent that in the States availing themselves of the personnel and administrative knowledge of the Federal Survey the opportunities for systematic mapping would be greatly increased.

Accordingly, the first important step in the development of the existing system of cooperation was taken in connection with the extension of topographic mapping. The benefits to the State from cooperation of this kind are numerous. It gains a complete topographic map of its area, which is of importance to the development

of its economic resources and greatly facilitates the study and perfection of all engineering plans and works within it. Among other uses of the topographic maps are the following:

1. As preliminary maps for planning extensive irrigation and drainage projects, showing areas of catchment for water supply, sites for reservoirs, routes of canals, etc.
2. For laying out highways, electric roads, railroads, aqueducts, and sewage systems, thus saving the cost of preliminary surveys.
3. In improving rivers and smaller waterways.
4. In determining and classifying water resources, both surface and underground.
5. In making plans for the disposal of city sewage, garbage, etc.
6. In determining routes, mileage, location of road-building material, and topography in country traversed by public highways.
7. In selecting the best routes for automobiling tours and intercity runs.
8. As guide maps for prospectors and others in traveling through little-known regions.
9. As bases for the compilation of maps showing the extent and character of forest and grazing lands.
10. In classifying lands and in plotting the distribution and nature of the soils.
11. In compiling maps in connection with the survey and sale of lands.
12. In making investigations for the improvement of the plant and animal industries, and in a comprehensive study of physical and biological conditions in connection with the stocking of interior waters with food fishes and the locating of fish culture stations.
13. In locating and mapping the boundaries of the life and crop zones, and in mapping the geographic distribution of plants and animals.
14. In plotting the distribution and spread of injurious insects and germs.
15. As base maps for the plotting of information relating to the geology and mineral resources of the country.
16. In maneuvers of the national guard, in the development of military problems, and in the selection of routes for road marches or strategical movements of the troops, particularly of artillery or cavalry.
17. In connection with questions relating to state, county, and town boundaries.
18. As a means of promoting an exact knowledge of the country and serving teachers and pupils in geographic studies.
19. As base maps for the graphic representation of all facts relating to population, industries, and products or other statistical information.
20. In connection with legislation involving the granting of charters, rights, etc., when a physical knowledge of the country may be desirable or necessary.

In addition, as an incident in the making of a topographic map, monuments are established throughout the State, and as their positions are accurately determined by geodetic methods, they serve as datum points for all other government, private, and cadastral surveys. The work includes also the establishment throughout the State of bench marks or permanent monuments which furnish datum elevations for the determination of height in connection with all future public or private engineering works. The magnetic declination is frequently determined, and this work aids local and county surveyors in determining the declination of their compasses, and thus greatly facilitates the search for old property lines.

SCALES AND GENERAL CHARACTER OF TOPOGRAPHIC MAPS.

The Geological Survey is engaged in mapping the United States on three general scales, dependent on the degree of detail and relief in the topography, the amount of habitation, and the subsequent probable use of the maps for geologic or engineering purposes. The scale of 1:250,000, or about 4 miles to 1 inch, is used only in the very sparsely inhabited portions of the West, such as the desert regions of Nevada and other districts where similar conditions exist. The scale of 1:125,000, or about 2 miles to 1 inch, is used chiefly in the mountainous districts of the West. The contour interval in these small-scale maps ranges from 50 to 200 feet, depending on the amount of relief and the importance of detail. The usual scale adopted for areas where cooperation is in force is 1:62,500, or about 1 mile to 1 inch, the contour interval ranging from 10 to 50 feet, according to the relief and degree of slope. In California and one or two other States a still larger scale has been in use, with a contour interval of 5 feet, to meet the requirements of unusual local problems.

These topographic maps are based on geodetic determination of positions, either by means of an accurate system of primary triangulation or by primary traverse based on 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 the establishment of permanent metal bench marks in every 3 linear miles, and 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 features:

1. The 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 the rate of 5 cents a sheet or \$3 a hundred.

The following table shows the States in which cooperative surveys have been completed or are in progress. In the column headed "Area mapped" only those areas mapped since the inception of cooperation are enumerated.

Summary of cooperative topographic surveys in various States.

State.	Total area.	Area mapped in cooperation to June 30, 1909.	Total cost to June 30, 1909.	Amounts appropriated by States.
	<i>Sq. mi.</i>	<i>Sq. mi.</i>		
Alabama.....	51,998	3,455	\$26,500	\$6,000
California.....	158,297	7,059	160,000	80,000
Connecticut.....	4,965	4,965	48,955	24,599
Illinois.....	56,665	3,845	73,300	36,000
Iowa.....	56,147	371	7,000	3,500
Kentucky.....	40,598	3,798	75,400	37,500
Louisiana.....	48,506	1,835	10,500	4,000
Maine.....	33,040	3,706	53,400	26,700
Maryland.....	12,327	11,275	104,500	46,550
Massachusetts.....	8,266	8,266	107,845	40,000
Michigan.....	57,980	2,840	32,400	13,700
Mississippi.....	46,865	1,039	45,413	31,400
Missouri.....	69,420	838	12,000	6,000
New Jersey.....	8,224	8,224	54,744	19,670
New York.....	49,204	37,686	544,338	233,600
North Carolina.....	52,426	4,886	60,100	29,200
Ohio.....	41,040	23,722	366,400	183,200
Oklahoma.....	70,057	2,614	28,000	14,000
Oregon.....	96,699	2,545	22,900	10,000
Pennsylvania.....	45,126	14,874	295,000	147,500
Rhode Island.....	1,248	1,248	9,732	5,000
Texas.....	265,896	1,620	5,000
Virginia.....	40,262	3,500	1,750
West Virginia.....	24,170	11,636	231,000	117,000

COOPERATION IN WATER-RESOURCES INVESTIGATIONS.

It has been clearly shown that industrial development in any community depends more largely on the proper utilization of its water resources than on almost any other single factor. The various States have within recent years come to realize more clearly this fundamental fact. In the arid West agricultural development is dependent on irrigation and throughout the country other industries are being more and more markedly affected by the presence or availability of water power. In some parts of the country the matter of flood prevention has taken a high economic importance; in still other parts the drainage of swamp lands is a great feature of industrial growth. In order to carry on all these improvements in a purposeful way it is necessary to have the results of investigations of water supplies. It is necessary to know the amount of water flowing in the rivers at various points, the slope of the river channels, and the facilities for reservoir construction; also the amount of water available in the ground and the methods by which it can be procured and used. The appropriations made by Congress during past years have not been sufficient to prosecute investigations of this kind with the rapidity and thoroughness that are demanded by the interests of the various States and, as a result, many States have undertaken cooperation in order that the final results may be in hand at an earlier date than that at which they could be obtained with federal funds alone.

Cooperative arrangements have been altogether successful, and the methods by which the work is conducted are similar to those already described for topographic mapping. Formal agreements are made in accordance with the provisions of state statutes, some of which have already been reviewed. The following table gives the present condition of cooperation in the various States:

Status of cooperative work in the investigation of water resources.

State.	Date of cooperation.	Amount contributed by State.	Character of work.
Alabama.....	1906-1909	\$994.00	Payment of salaries of certain river gage observers by state geologist.
California.....	1900, 1904-1910	79,486.73	Determination of amount and quality of surface waters and investigations of location and depth of underground waters, authorized by state law.
Colorado.....	1907, 1909-1910	1,487.97	Payment of salaries of certain river gage observers by state engineer.
Idaho.....	1910	2,000.00	Stream-flow investigations, authorized by state law.
Illinois.....	1907-1910	8,675.94	Stream-flow investigations in cooperation with Illinois Improvement Commission.
Kansas.....	1908	413.03	Investigation of quality of surface and underground waters, with State Board of Health.
Maine.....	1904-1910	37,505.07	Stream-flow investigations, river-profile surveys, and reservoir surveys authorized by state law.
Maryland.....	1895-1909	3,400.00	Payment of salaries of certain river gage observers by state geologist.
Massachusetts.....	1910	1,050.00	Stream-flow investigations, authorized by state law.
Minnesota.....	1905, 1908, 1910	18,400.00	Stream-flow investigations, river-profile surveys, and reservoir surveys authorized by state law.
Montana.....	1907-1910	1,405.00	Payment of salaries of certain river gage observers by state engineer.
Nevada.....	1901, 1908	1,250.00	Do.
Nebraska.....	1907-1910	1,700.00	Stream-flow investigations in cooperation with state engineer.
New Hampshire.....	1904-1906	1,300.00	Stream-flow investigations in cooperation with State Board of Forestry.
New Mexico.....	1910	2,500.00	Stream-flow investigations, authorized by state law.
New York.....	{ 1901-1905	} 21,373.91	{ Stream-flow investigations in cooperation with state engineer and State Water Supply Commission.
North Carolina.....	{ 1907-1909		
Ohio.....	1905-1906	576.25	Payment of salaries of certain river-gage observers by state geologist.
Ohio.....	1905-1906	1,800.00	Investigation of quality of surface and underground waters, with State Board of Health.
Oregon.....	1905-1910	15,000.00	Stream-flow investigations, authorized by state law.
Pennsylvania.....	1902-3, 1907-8	2,188.35	Do.
Rhode Island.....	1907-1910	1,800.00	Investigation of quality of surface and underground waters and stream-flow investigations in cooperation with State Conservation Commission.
Utah.....	1907, 1909-10	2,950.00	Stream-flow and underground-water investigations in cooperation with state engineer.
Virginia.....	1906	987.56	Stream-flow investigations and river-profile surveys in cooperation with state geologist.
Washington.....	1910	6,150.00	Stream-flow investigations, river-profile surveys, and reservoir surveys, authorized by state law.
Wisconsin.....	1906-7	3,361.00	River-profile surveys, authorized by state law.
		217,754.81	

The following texts of contracts illustrate typical conditions under which the work is performed:

Whereas, an act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1910, and for other purposes, duly passed by the Senate and House of Representatives of the United States of America in Congress assembled, provides among other appropriations for the maintenance of the United States Geological Survey the following:

“For gauging the streams and determining the water supply of the United States and for the investigation of underground currents and artesian wells, and the prepa-

ration of reports upon the best methods of utilizing the water resources, one hundred thousand dollars;”

And whereas, the Director of said United States Geological Survey has given due consideration to the demands and needs of the various parts of the United States for such investigations, and to the amount of money made available therefor by said act of Congress, and has made what he believes to be an equitable distribution of said money according to said demands and needs;

And whereas, as a result of said distribution there has been allotted the sum of one thousand dollars for investigating the water resources of the State of Vermont;

And whereas, the people of the State of Vermont, appreciating the value of said water-resources investigations and being desirous of securing the completion of said investigations at a date earlier than such completion would be possible with the funds provided by Congress, to the end that the full benefits thereof may speedily be realized, have through their duly accredited representatives in general assembly passed the following act:

“An act to provide for investigation of the water resources of the State of Vermont and to make the records of such investigation available to the authorities of the State, and to all the people thereof.

“It is hereby enacted by the general assembly of the State of Vermont:

“SEC. 1. That, as the Director of the United States Geological Survey is authorized to cooperate with the properly constituted authorities in the several States in making investigation of and reports upon the water resources of these States, the governor of the State of Vermont is hereby empowered to enter into contract with the Director of the United States Geological Survey for the purpose of making such investigation and report for this State, provided that such work shall include, first, the completion of the surveys of river basins already partially investigated; and provided further, that the Director shall agree to expend for this purpose, and from funds placed at his disposal by the Government of the United States, sums equal to those hereinafter appropriated;

“SEC. 2. That, for the purpose set forth in section one of this act, the sum of one thousand dollars for the year 1909, and a like sum for the year 1910, is hereby appropriated to be expended by the State, in accordance with the laws relating to, and the regulations of the United States Geological Survey in such case provided, payment to be made on vouchers audited and approved by the Director of said Survey, when presented to the auditor of accounts.”

And whereas, it is believed that greater economy and efficiency will result if the work contemplated by both appropriations aforesaid be conducted under common agreement with respect to location, methods, and administration:

Now therefore shall the following agreement issue:

This agreement, made and entered into this first day of April, 1909, by and between George Otis Smith, Director, for and on behalf of the United States Geological Survey, party of the first part, and George H. Prouty, governor, for and on behalf of the State of Vermont, party of the second part, witnesseth:

That there shall be maintained in the State of Vermont a cooperative survey to determine the water resources of said State, and that, for the purpose of carrying out the terms of the acts authorizing the parties hereunto to enter upon the investigations aforesaid, this agreement is hereby entered into between said parties upon the following basis:

1. The investigations shall be under the supervision of the Director of the United States Geological Survey, who shall be represented in all work, negotiations, and disbursements involved in the performance of this agreement by a duly accredited representative, whose agency shall be formally certified to for the information and guidance of the party of the second part; the methods of investigation shall be those

usually followed by the party of the first part, and they shall be subject to such modification or improvement as may be suggested by the party of the second part and approved and confirmed by said Director, for and on behalf of the party of the first part.

2. During the progress of the work all notes, maps, measurements, gagings, and other material shall be open to the inspection of the party of the second part, and if the work is not being carried on in a manner satisfactory to said party of the second part, he may, on formal notice, terminate this agreement.

3. Whereas, the fiscal year of the party of the first part begins on July 1 of each calendar year, and whereas, the appropriation of the party of the second part, by the terms of the act herein quoted, is available in the amount of one thousand dollars during the calendar year 1909 and in a like amount during the calendar year 1910, the following plan for the expenditure of the amounts contributed by the parties hereto is hereby adopted.

First, this agreement shall terminate on June 30, 1911.

Second, the sum of one thousand dollars contributed by the party of the second part shall become available on April 1, 1909, and from that date until July 1 of the same year the investigations herein provided shall be maintained from the appropriation of the party of the second part, the entire contribution of said party of the second part for the year 1909 to be expended on or before December 31 of that year; the sum of one thousand dollars contributed by the party of the first part shall become available on July 1, 1909, and shall be expended on or before June 30, 1910; the sum of one thousand dollars to be contributed by the party of the second part during the year 1910 shall become available on April 1 and shall be expended on or before December 31 of that year, while the similar contribution of the party of the first part shall become available on July 1, 1910, and shall be expended on or before June 30, 1911: *Provided*, That this agreement shall become void on July 1, 1910, in case the Congress of the United States fails to make provision for the water-resources investigations of the United States Geological Survey for the year beginning on that date, in which case no portion of the contribution of the party of the second part authorized for the calendar year 1910 shall be expended.

4. Accounts of expenses incurred in the performance of the work herein provided shall be rendered monthly, in the manner required by the laws and regulations of the parties hereto, and shall be paid in accordance therewith.

5. The work contemplated under this agreement shall be the determination of the flow of rivers, together with allied investigations concerning the water resources of the State of Vermont, including all necessary field work, travel and subsistence, computations and estimates.

6. The results of the investigations, surveys, observations, measurements, computations, and other matters acquired in the due performance of this agreement shall be furnished to the party of the second part on demand; the original notebooks, computation sheets, records, maps, etc., duly attested, shall ultimately be deposited in the office of the party of the first part and shall become a part of the records of said office, certified copies of the same being furnished to the party of the second part on demand.

7. The results of the work contemplated in this agreement, together with interpretations thereof, shall be published under the authority of the party of the first part as soon as possible after the termination of the contract period herein specified, and said publications shall contain full and complete statements of the cooperative relations of the parties hereto, but the cost of publication shall not be included in the contributions herein provided by the parties to this agreement; and it is hereby understood and agreed that, although the records and results of the work contemplated in this agreement shall be considered the property of the party of the first part, so far as first rights of publication are concerned, this reservation shall not act to prevent

the party of the second part from compiling and arranging for publication any of the results collected under this agreement, should it choose to do so, provided that in such publication the relationship of the party of the first part thereto shall be clearly stated.

In witness whereof, we have hereunto set our hands and seals this first day of April in the year one thousand nine hundred and nine.

GEORGE OTIS SMITH,
*Director (for and on behalf of the United States
Geological Survey, party of the first part).*

GEORGE H. PROUTY,
*Governor (for and on behalf of the State of Vermont,
party of the second part).*

Whereas, an act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1910, and for other purposes, duly passed by the Senate and House of Representatives of the United States of America in Congress assembled, provides among other appropriations for the maintenance of the United States Geological Survey the following:

“For gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and the preparation of reports upon the best methods of utilizing the water resources, one hundred thousand dollars.”

And whereas the Director of said United States Geological Survey has given due consideration to the demands and needs of the various parts of the United States for such investigations and to the amount of money made available therefor by said act of Congress, and has made what he believes to be an equitable distribution of said money according to said demands and needs.

And whereas, as a result of said distribution, there has been allotted the sum of two thousand five hundred dollars for gaging streams in the Territory of New Mexico.

And whereas the people of the Territory of New Mexico, appreciating the value of said gaging of streams to the various interests in said region, and being desirous of securing the completion of said measurements at a date earlier than such completion would be possible with the funds provided by Congress, to the end that the full benefit thereof may speedily be realized, have through their duly accredited representatives in legislature assembled passed the following act:

“HOUSE BILL No. 172.

“Be it enacted by the legislative assembly of the Territory of New Mexico:

“SEC. 1. That the sum of twenty-five hundred dollars annually be and the same is hereby appropriated for the purpose of paying the expenses of gauging the streams of the Territory of New Mexico, said sum to be paid, upon the order of the territorial engineer, on the warrant of the auditor out of any moneys in the treasury of the water reservoirs for irrigating purposes income fund.

“SEC. 2. This act shall take effect and be in force thirty days after its passage, and all acts and parts of acts in conflict herewith are hereby repealed.”

And whereas, it is believed that greater economy and efficiency will result if the work contemplated by both appropriations aforesaid be conducted under common agreement, with respect to location, methods, and administration.

Now, therefore, shall the following agreement issue:

This agreement, made and entered into this first day of July, 1909, by and between George Otis Smith, Director, for and on behalf of the United States Geological Survey, party of the first part, and Vernon L. Sullivan, territorial engineer of the Territory of New Mexico, party of the second part, witnesseth:

That there shall be maintained in the Territory of New Mexico a cooperative survey to determine the amount of water flowing in the rivers of said Territory, at chosen points, during a period of twelve (12) months from the date of this agreement, and that each party hereunto shall provide for the purposes of said survey the sum of two thousand five hundred dollars (\$2,500), the party of the second part being hereby given credit for expenditures made as provided in paragraph three, page three, of this agreement, and that, for the purpose of carrying out the terms of the acts authorizing the parties hereunto to enter upon the investigations aforesaid, this agreement is hereby entered into between said parties upon the following basis:

1. The investigations shall be made under the supervision of the Director of the United States Geological Survey, who shall be represented in all work, negotiations, and disbursements involved in the performance of this agreement by a duly accredited representative whose agency shall be formally certified to for the information and guidance of the party of the second part; the methods of investigation shall be those usually followed by the party of the first part, and they shall be subject to such modification or improvement as may be suggested by the party of the second part and approved and confirmed by said Director, for and on behalf of the party of the first part.

2. During the progress of the work all notes, maps, measurements, gagings, and other material shall be open to the inspection of the party of the second part, and if the work is not being carried on in a manner satisfactory to said party of the second part he may, on formal notice, terminate the agreement.

3. For convenience and for the purpose of starting the work prior to the flood season, it was understood and agreed that, since the territorial fund was available in April, 1909, certain hydrographic surveys were started in April, 1909, and the total expense of carrying on such new surveys was borne by the party of the second part, and it was understood and agreed that said party of the second part should be given credit for the amount paid out for such new surveys during April, May, and June, 1909. Hereafter, that is, beginning July 1, 1909, the party of the first part shall during the progress of the work pay such portion of the salaries of gage observers and the salaries, traveling, subsistence, and field expenses of employees that all expenses shall eventually be divided between the two agreeing parties in a manner satisfactory to both, so that they shall be equalized: *Provided*, That the total expenditure by the party of the second part for all work herein contemplated during the term of this agreement shall not be more than two thousand five hundred dollars (\$2,500): *And provided*, That the party of the first part shall expend an equal amount upon the same work during the same period of time; statements to be rendered monthly in the manner required by the rules and regulations of the United States Geological Survey.

4. The work contemplated under this agreement shall be the determination of the flow of rivers, together with observations and investigations necessary or related thereto, for purposes of development of irrigation, municipal water supply, and water power, the work to include all necessary computations and estimates.

5. The order in which the different streams and localities shall be investigated shall be agreed upon by the party of the second part, or his representative, and the Director of the United States Geological Survey, or his representative.

6. The results of the investigations, surveys, observations, measurements, and computations, and all other matter acquired in the due performance of this agreement, shall be furnished to the party of the second part if so desired; the original notebooks, computation sheets, records, maps, etc., signed by the hydrographer and other assistants detailed upon the work, shall be deposited ultimately in the office of the party of the first part, certified copies being furnished to the party of the second part upon request.

7. The results of the work contemplated in this agreement, together with interpretations thereof, will be published under the authority of the party of the first part,

in the form of water-supply and irrigation papers, and said publications shall contain full and complete statements of the relation thereto of the party of the second part, as set forth in this agreement. These publications shall be made as soon as possible after the conclusion of each calendar year, and the costs of publication shall not be included in the allotments made by each party hereunto. It is hereby understood and agreed that, although the records and results of the work contemplated under this agreement shall be considered the property of the party of the first part, so far as first rights of publication are concerned, a copy of the manuscript prepared for publication by said party for any calendar year shall be furnished to the party of the second part for publication, but no special manuscript or report shall be prepared on account of this cooperation by the party of the first part, other than herein specified; but none of the reservations herein specified shall act to prevent the party of the second part from compiling and arranging for publication any of the results collected under this agreement: *Provided*, That in such publication the relationship of the party of the first part shall be clearly stated.

In witness whereof, we have hereunto set our hands and seals the day and year first herein written.

GEORGE OTIS SMITH,
*Director United States Geological Survey, for and on
behalf of the Party of the First Part.*

VERNON L. SULLIVAN,
*Territorial Engineer of New Mexico, for and on
behalf of the Party of the Second Part.*

An act providing for topographic surveys and investigations of the water resources of the State and making an appropriation therefor.

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

SECTION 1. The department of engineering is hereby empowered to carry on topographic surveys and investigations in the matters pertaining to the water resources of the State, along the lines of hydrography, hydro-economics, and the use and distribution of water for agricultural purposes, and to that end, where possible and to the best interest of the State, shall enter into contracts for cooperation with the different departments of the Federal Government in such amounts as may be an equitable and necessary division of the work. The state engineer, with the consent of the governor, may maintain and continue such investigations where there is available money not covered by cooperation contract. For the permanent maintenance of such surveys and investigations, there is hereby continuously appropriated out of the general fund of the state treasury for each and every fiscal year, commencing with the date upon which this act becomes effective, the sum of thirty thousand dollars.

SEC. 2. This act shall take effect immediately.

PHILLIP A. STANTON,
Speaker of the Assembly.

WARREN R. PORTER,
President of the Senate.

Approved April 22, A. D. 1909.
JAMES N. GILLETT,
Governor.

COOPERATION IN GEOLOGIC SURVEYS.

Cooperation in geologic work has been of less extent than in topographic work. However, cooperation in geologic surveys under a variety of forms has been arranged with a number of States.

In 1890 an arrangement was made between the Director of the Federal Survey and the State Geological Board of New Jersey, to the effect 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 their 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 was made with the state geologist whereby the State Survey furnished the results of detailed areal mapping for folio publication, while the Federal Survey carried on the necessary paleontologic investigations for the discrimination and correlation of stratigraphic horizons.

In the case of Pennsylvania, already referred to (see p. 12), 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 \$40,000, \$2,000 was allotted for geology. Since then from \$4,500 to \$5,000 of the annual appropriation of \$20,000 has been allotted for the geologic work up to the close of the fiscal year 1908-9. Cooperative geologic work ceased June 30, 1909, owing to a reduction of the state appropriation by the legislature of 1909. As a result of this cooperative geologic work since 1899, portions of 21 counties have been covered and the results will be included in 23 geologic folios. The area so mapped covers more than 5,000 square miles. The cost to the State has been close to \$2 per square mile. Of these folios, 12 have already been published, 3 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 investigations were 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 of \$1,100 from the State. Preliminary and final reports on both of these investigations have been published.

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 allotted by this Survey. Owing to the loss of \$480 of state funds in a bank failure and to certain exceptional expenses connected with the work an added allotment was granted 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 and a final report on the results of the investigation have been published.

Since 1903 a cooperative agreement including geologic work has been in force with the 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 in the investigation of special economic problems in which the people of the State were particularly interested.

Cooperative work has been in progress in Illinois since 1905. The Federal Survey has contributed toward this work \$2,000 annually, usually in the form of the services of one of its members and whatever balance there might remain, within the \$2,000, toward his expenses. To meet this the Illinois Survey has contributed a similar amount, or generally \$1,000 more. The work done is of such a character as to yield economic results for publication by the State Survey and results suitable for publication in folios by the Federal Survey.

For several years the Federal Survey has been engaged in a systematic geologic investigation of the Atlantic-Gulf coastal plain with special reference to its underground water supply. This work, which is still in progress, has been done in cooperation with the States which border the coast from New Jersey to Louisiana, the exact form of the agreement being adapted to the needs of the several States.

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

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.