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**UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY**

**Cooperative Ground-Water Investigations in Massachusetts
by the United States Geological Survey
1938-50**

by

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COOPERATIVE GROUND-WATER INVESTIGATIONS IN MASSACHUSETTS

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The United States Geological Survey in cooperation with the Massachusetts Department of Public Works in 1938 began an investigation of the ground-water conditions in Massachusetts. This work is part of a larger cooperative program that includes surface-water investigations, geologic studies, and topographic mapping. The purpose of the ground-water studies is to obtain detailed information concerning the occurrence and availability of ground water throughout the State. The information is used by the Highway Division of the Department of Public Works in connection with design, construction, and maintenance of highways. These studies also provide a basis for the more effective utilization of the ground-water resources of the State. They indicate where additional developments can be made safely or where present use may be excessive. Reports covering the ground-water studies are listed in the appendix.

Because the funds available at the beginning of the cooperative ground-water investigations in 1938 were relatively small, only a part of the State could be covered each year and it was planned to continue the work from year to year until the entire State was covered. During 1939 the appropriation for ground-water studies was reduced and the scope of the work was reduced accordingly until 1944, when the appropriation was increased and the work was expanded again. In 1946 a total of \$19,000 was appropriated for the work by the State and Federal governments. This amount was later increased to the present appropriation of \$20,000.

The work in Massachusetts is under the general supervision of M. L. Brashears, Jr., District Geologist for New York and New England at Mineola, N.Y.

The studies are directed from Boston under the supervision of H. N. Halberg, Engineer in Charge. The personnel of the Boston office consists of the engineer in charge, two geologists, and a clerk. In addition, several part-time employees are employed to make ground-water-level measurements and perform other routine hydrologic tasks.

The subsurface data collected by the Geological Survey, along with interpretative studies, may be used by the Highway Division in many ways, such as in the design of major structures and in the development of public water supplies to replace lost capacity resulting from highway or recreational construction. To date, however, the data have been used chiefly in connection with drainage problems; the records of the position and fluctuation of water levels, the direction and rate of underground flow, and the yield of aquifers are of particular importance to this phase of work.

Although the information collected during the course of the cooperative ground-water studies is of considerable value to highway studies, it is of even more value to those interested in locating and developing water supplies. The ground-water data are utilized extensively by Federal, State, and municipal agencies to regulate and improve public supplies; by engineers, well-drilling contractors, and industrialists to locate well sites and install industrial supplies; and by home owners and farmers to develop supplies for household, stock watering, and supplemental irrigation. Some idea of the importance of ground water as a source of supply is indicated by the following data (for 1948):

Total number of public water supplies in Massachusetts. . . .	260
Total pumpage of public water supplies.	400 mgd
Number of public water supplies using ground water.	150
Total pumpage of public water supplies using ground water . .	75 mgd
Number of people served by public water supplies using ground water	1,156,000
Total industrial pumpage of ground water from private sources.	100 mgd
Estimated rural pumpage of ground water (other than for supplemental irrigation)	23 mgd
Estimated pumpage of ground water for supplemental irrigation	2 mgd
Estimated number of wells in Massachusetts.	30,000
Total estimated ground-water pumpage.	200 mgd

In Massachusetts, as in other glaciated regions of the United States, many of the larger ground-water supplies are obtained from deposits of sand and gravel that lie in preglacial bedrock valleys. In some parts of the United States these buried valleys contain several hundred feet of glacial outwash, but in Massachusetts the valley fill is commonly not as thick. The location and configuration of some of these buried valleys are not readily apparent. The water-bearing characteristics of the fill in the buried valleys change considerably from place to place. In some areas the fill consists of outwash materials, which are very permeable and can supply large quantities of water to wells. In other areas the fill consists of till (hardpan), which is relatively impermeable and will yield very little water. In order to utilize effectively the ground-water resources of such an area, the extent of the buried valleys and physical characteristics of the valley fill must be determined.

In Massachusetts there are a number of buried valleys from which considerable quantities of ground water are withdrawn. Investigations in one of these

areas (the Lowell area) were begun in 1938. Withdrawal of ground water at Lowell is estimated to be slightly less than 7 million gallons a day. Of this more than 5 million gallons a day is used for public supply. In August 1939 the studies were extended to the Aberjona Valley, where about 5 to 6 million gallons a day is used. Of this a little less than 2 million gallons a day is for public supply (see reports ²~~I~~ and ⁴~~II~~).

In 1944 and 1945 quantitative ground-water studies were made in the vicinity of Fresh Pond in Cambridge. These studies were made at the request of the State Health Department to determine the amount of water available in the glacial deposits surrounding Fresh Pond. The City of Cambridge utilizes this water in meeting its legal requirements for water (the chief source is Stony Brook and Hobbs Brook, supplemented by Fresh Pond in extended dry periods). The studies indicated that sufficient water is stored in the glacial deposits adjacent to Fresh Pond (principally those north and northwest of the pond) to meet the legal requirements. The deposits are recharged when the pond level is high, as in the spring, and the water stored underground discharges into the pond when its level is lowered. About 20 test wells were drilled by the Massachusetts Department of Public Health, seismic surveys were made to explore the geologic and ground-water conditions in the buried valley underlying the area, and an intensive program of water-level measurements was instituted. The work in the Fresh Pond area extended the coverage of the field studies in the Aberjona Valley from Winchester to the Charles River (see report ⁶~~III~~).

Since 1945 an intensive study of the ground-water resources of Greater Boston has been made and a progress report (report ⁸~~IV~~) has been issued. A full-scale report is now in preparation. The principal part of the work in this area, as in the areas described previously, has consisted of an inventory of existing wells and the collection of related information pertaining to ground-water conditions. The

well data were collected from the owners, well drillers, consulting engineers, the Boston Society of Civil Engineers, and public agencies, including the Massachusetts Department of Public Health and the Department of Public Works. The results of this study indicate, more fully than has previously been possible, the location and extent of buried valleys in the area and the types and water-bearing properties of the materials filling the buried valleys. This information will enable persons interested in ground-water supply to locate these supplies much more readily than heretofore.

A State-wide reconnaissance of ground-water conditions is in progress and it is expected that preparation of a report will be started during the 1951 fiscal year. This investigation is part of a combined study of the surface- and ground-water resources of the State. A report (report ¹⁰ ~~11~~), "Hydrology of Massachusetts," which presents a summary of all stream-flow and precipitation data for the State, was published recently by the U. S. Geological Survey. That report is part 1 of a report on the water resources of Massachusetts. Part 2 will be an interpretative report and will cover both the surface-water and the ground-water resources of the State. The ground-water section will:

1. Describe ground-water conditions throughout the entire State. It will include a discussion of the quantity, quality, and utilization of ground water. Emphasis will be placed upon the areas that are most densely populated
2. Furnish data on the fluctuation of ground-water levels throughout the State. These data will be discussed in relation to the following: storage of ground water, use of ground water, stream flow, and hydrology of small drainage basins selected for highway design studies where stream flow and precipitation are measured.
3. Present preliminary information for sites where special intensive studies will be needed. The priority of these detailed studies will be indicated.

6.

The reconnaissance study of ground-water resources already has included work in eastern Middlesex County from the New Hampshire State line to the Charles River, including Lowell and Metropolitan Boston. Studies also have been made in Worcester, in the Springfield area, in some parts of northern Worcester County, in parts of Berkshire County, on western Cape Cod, and at scattered localities elsewhere in the State. This work has consisted principally of a collection of existing subsurface information, including data on well and test borings and geologic information, to furnish a representative picture of the availability and occurrence of ground water in these areas.

As part of the studies, observation wells are being established throughout the State to furnish data on water-level fluctuations. At present, periodic measurements are made in approximately 50 wells in the State. Some of these have been established for regional or areal coverage in areas remote from centers of pumping; they show water-level trends related wholly to natural phenomena such as precipitation, evaporation, transpiration, and temperature. Thus, they indicate long-term trends of natural ground-water conditions. On the other hand, some of the wells are in areas of heavy pumping and indicate whether the effects of withdrawal of ground water are resulting in a continuing long-time downward trend of the water levels. Other observation wells are located so as to show the relation between ground-water levels and stream flow, particularly in dry weather. Some of the wells are in very small drainage basins where stream flow and precipitation are measured in connection with the design of highway structures. As the areal work progresses, additional observation wells will be added to the water-level program.

As part of the study it is hoped to determine whether stream flow can be predicted from current ground-water levels. If a sufficiently close relationship can be established, a forecasting system will be set up. Some of the wells to

be installed in 1951 will serve this function. The work on Cape Cod is to be completed as part of the State-wide reconnaissance study during the next year. Information on that area is needed particularly in connection with problems arising from increased use of ground water for supplemental irrigation. Most of the water supplies on the Cape, including those for agricultural purposes, are obtained from wells and springs. Most farmers engaged in cranberry and blueberry production, truck gardening, and dairying need additional water supplies. The U. S. Soil Conservation Service has designated Barnstable County as a key area in which to study water-supply requirements for various agricultural needs. Work has been done on the western part of the Cape in order to set up procedures and to get preliminary information for the rest of the Cape. This work has consisted of the collection of available well data and the examination of the geology of the area to indicate where and in what quantity ground water may be found. During 1951 it is proposed also to make studies in Essex County and in the Connecticut Valley, to extend the work already done in the Springfield areas.

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