

Henry E. Conant,* 1892. Resigned Jan. 8, 1895.
 Parsons B. Cogswell,* *ex-officio*,
 1893-1895.
 Solon A. Carter, 1893. Now in office.
 Frank D. Abbot, 1893-1901.
 William M. Mason, 1893-1899.
 William E. Hood, 1894-1902.
 Henry Robinson, *ex-officio*, 1895-1897.
 Ebenezer B. Hutchinson,* 1895. Resigned Jan. 10, 1899.
 Edson J. Hill, 1895. Now in office.
 Albert B. Woodworth,* *ex-officio*,
 1897-1899.
 Nathaniel E. Martin, *ex-officio*,
 1899-1901.
 Henry E. Conant,* 1899. Died in 1911.
 Timothy P. Sullivan, 1899. Resigned May 14, 1901.
 Harry G. Sargent,* *ex-officio*, 1901-1903.
 Obadiah Morrill, 1901-1905.
 George D. B. Prescott, 1901. Now in office.
 Harry H. Dudley, 1902. Now in office.
 Nathaniel E. Martin, 1902. Now in office.
 Charles R. Corning, *ex-officio*, 1903-1909.
 Henry C. Holbrook, 1903. Now in office.
 Harley B. Roby, 1905. Resigned Jan. 24, 1911.
 Charles J. French, *ex-officio*, 1909. Now in office.
 Burns P. Hodgman, 1911. Now in office.
 Frank P. Quimby, 1911. Now in office.

PRESIDENTS OF THE BOARD.

Josiah Minot,* 1872. Resigned Jan. 10, 1874.
 Benjamin A. Kimball, 1874-1875.
 Edward L. Knowlton,* 1875. Resigned Sept. 25, 1875.
 John Kimball,* 1875-1876.
 Benjamin A. Kimball, 1876-1878.
 John Kimball,* 1878. Resigned July 1, 1891.
 William P. Fiske,* 1891-1902.
 Solon A. Carter, 1902. Now in office.

*Deceased.

SUPERINTENDENTS.

V. C. Hastings,*
P. R. Sanders,

1873. Died March 14, 1907.
1907. Now in office.

* Deceased.

CONSTRUCTION.

Cost of land damages, flowage and water rights:

| | |
|--|-------------|
| Paid B. F. & D. Holden, for water rights, | \$60,000.00 |
| Concord Manufacturing Co., for water rights, | 83,000.00 |
| W. P. Cooledge, for mill privilege and land, | 5,500.00 |
| Humphrey & Farnum, for kit-shop privilege, | 4,900.00* |
| Flowage rights around Penacook Lake, | 4,375.61 |
| W. P. Cooledge, Hutchins lot, | 1,050.00† |
| Mary C. Rowell, for land, | 1,500.00 |
| Moses H. Bradley, for land, | 5,000.00 |
| Harry Phillips, for land, | 100.00 |
| Joseph B. Walker, for land, | 2,214.00 |
| John G. Hook, for land, | 370.00 |
| A. S. Ranney, for land, | 1,350.00 |
| Alfred Roberts, for land, | 1,275.00 |
| Charles E. Ballard, for land, | 2,500.00 |
| Mary G. Carter, for land, | 1,250.00 |
| Elizabeth Widmer, for land, | 1,564.50 |
| A. L. Proctor, for land, | 450.00 |
| Robert Crowley, for land, | 3,000.00 |
| Miles Hodgdon, for land, | 2,200.00 |
| heirs of Lowell Brown, for land, | 1,032.55 |
| Coffin & Little, for land, | 800.00 |
| O. F. Richardson, for land, | 100.00 |
| M. H. & C. R. Farnum, for land, | 4,500.00 |

* Original cost, \$5,000; land sold for \$100.

† Original cost house and lot, \$2,250; portion of lot sold for \$1,200.

| | |
|---|------------|
| Paid Cook & Hood, for land, | \$1,750.00 |
| Charles H. Farnum, for land, | 1,410.36 |
| Fred N. Ladd, for land, | 300.00 |
| A. W. Hill, for land, | 6,500.00 |
| Helen G. Evans and others, for land, | 2,000.00 |
| Frank B. Kilburn, for land, | 2,500.00 |
| Joseph A. and Mary E. Hal- loran, for land, | 600.00 |
| Wheelock Club, for land, | 1,400.00* |
| Dr. I. A. Watson, for land, | 2,490.00† |
| Frank E. Horner, for land, | 1,900.00 |
| Frank E. and William H. Horner, for land, | 100.00 |
| Alva A. Young, for land, | 2,700.00 |
| Henry J. Putnam, for land, | 2,600.00 |
| Alert Boat Club, for land, | 2,160.00‡ |
| C. F. Moseley, for land, | 1,500.00 |
| C. H. Amsden, water and flowage rights, | 5,000.00 |
| Cost of property and rights of Tor- rent Aqueduct Association, | 20,000.00 |
| dam, gate-house and appur- tenances, | 32,756.17 |
| conduit and gate-houses, | 29,818.94 |
| mains (low service main and pump main from the dam to Penacook Street, force main from the pump to the reservoir, fire main through North and South Main Streets, and high service main from Pena- cook Street to Stark Street, Penacook), | 182,241.70 |

* Original cost, \$1,500; house sold for \$100.

† Original cost, \$2,700; house sold for \$210.

‡ Original cost, \$2,250; buildings sold for \$90.

WATER DEPARTMENT.

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| | |
|--|--------------|
| Cost of distribution pipe, | \$395,911.56 |
| service pipe, | 63,639.57 |
| reservoir, | 42,460.09 |
| pumping station, shop, sta- ble and storehouse, | 24,165.35 |
| pumping machinery, | 17,000.42 |
| engineering and superintend- ence, | 14,913.12 |
| incidentals, | 6,531.19 |

Cost of works, January 1, 1915, \$1,052,380.13

Bonds of the city have been issued to pay a part of said cost, of which the following are still outstanding:

| When due. | Rate. | Amount. |
|----------------|-------|---------------------|
| Jan. 1, 1915, | 4, | 5,000.00 |
| Jan. 1, 1916, | 4, | 9,000.00 |
| Jan. 1, 1917, | 4, | 10,000.00 |
| Jan. 1, 1918, | 4, | 10,000.00 |
| Jan. 1, 1919, | 4, | 10,000.00 |
| Nov. 1, 1920, | 3, | 7,000.00 |
| Nov. 1, 1921, | 3, | 4,000.00 |
| April 1, 1921, | 3½, | 5,000.00 |
| Jan. 1, 1922, | 4, | 337,000.00 |
| March 1, 1922, | 3½, | 20,000.00 |
| April 1, 1922, | 3½, | 30,000.00 |
| Jan. 1, 1923, | 3½, | 15,000.00 |
| Jan. 1, 1924, | 3½, | 15,000.00 |
| | | <u>\$477,000.00</u> |

REPORT OF BOARD OF WATER COMMISSIONERS.

To His Honor the Mayor and the Board of Aldermen:

The Board of Water Commissioners transmits herewith the reports of the superintendent and the engineer of the pumping station, exhibiting in detail the operations of this department for the year ending December 31, 1914, which are made a part of this report.

The past year has been an unusually busy one for the employees of the department.

The 8-inch cement-lined pipe installed in 1887 to supply St. Paul's School and adjacent territory has been replaced with 12-inch cast-iron pipe involving an expenditure of \$16,778.00.

On the night of August 21, the six-way hydrant in front of Central Block on No. Main Street was forced by the pressure from its connection with the high service main. The flow of water from a 10-inch pipe under 88 lbs. pressure quickly undermined the concrete sidewalk, a portion of the foundation of the block, flooded the basements and damaged a considerable quantity of merchandise stored therein. Only the prompt response of the department employees in shutting off the water prevented much more serious consequences. The Board has adjusted all the claims for damages to the satisfaction of the claimants.

The accident was unprecedented; the superintendent has adopted measures to prevent a recurrence by tying each six-way hydrant with $\frac{3}{4}$ -inch iron rods to a yoke attached to the nearest bell joint.

The unusual amount of extension work has made it impracticable to carry out the policy of tree planting on the land acquired by the city, but it is hoped that that work will be resumed the coming year.

In addition to the redemption of the annual instalment of \$10,000, 49 water loan bonds due January 1, 1914, it has been possible to anticipate the payment of an equal amount

due at later dates, thus materially reducing the annual interest charge.

During the summer of 1914, the Board authorized an inspection of our system by a sanitary engineer.

Under date of July 13, 1914, Mr. George C. Whipple, the engineer selected to make the inspection, submitted his report. This report with preliminary comments by the Board under date of July 22, 1914, was printed in pamphlet form and distributed to the public.

In view of the importance of the subject treated by Professor Whipple, the value of the statistics embodied in the comments of the Board and the desirability of preserving them in permanent form, we reproduce the pamphlet referred to.

At the suggestion and on the recommendation of Professor Whipple, a subsequent investigation was made by Prof. John W. M. Bunker, covering certain features which were not considered in the examination conducted by Professor Whipple.

Professor Bunker submitted a report of his investigation which the Board considers should be preserved in permanent form supplementing as it does the very satisfactory report of Professor Whipple.

While Professor Bunker's report contains many technical terms which may not be intelligible to the public generally, his conclusions cannot fail to be understood and appreciated by all.

Respectfully submitted,

HARRY H. DUDLEY,
NATHANIEL E. MARTIN,
SOLON A. CARTER,
BURNS P. HODGMAN,
HENRY C. HOLBROOK,
FRANK P. QUIMBY,
EDSON J. HILL,
GEORGE D. B. PRESCOTT,
CHARLES J. FRENCH, *ex-officio*,
Board of Water Commissioners.

REPORT ON THE WATER SUPPLY OF CONCORD.

BY GEORGE C. WHIPPLE, CONSULTING ENGINEER, NEW YORK CITY.

OFFICE OF THE BOARD OF WATER COMMISSIONERS,
CONCORD, N. H., July 22, 1914.

To the Patrons of the Concord Water-Works and the Citizens of Concord:

It has been the aim of the Board of Water Commissioners to supply the patrons of the system with an abundance of pure water and to make the service satisfactory.

In our efforts we have had the assistance, coöperation and approval of our local and state boards of health (especially the latter), and to them the board desires to express its appreciation.

From time to time the board has discussed the desirability of employing some sanitary engineer of more than local reputation whose experience in the matter of public water supplies would entitle his views to respectful consideration, to carefully inspect our system and report his conclusions.

At a recent meeting of the board the employment of such an expert was authorized, and the president and superintendent were instructed to secure the services of a competent sanitary engineer to make such inspection.

Under these instructions, Mr. George C. Whipple, Gordon McKay Professor of Sanitary Engineering of Harvard University and the Massachusetts Institute of Technology, was employed. Professor Whipple is a member of the firm of Hazen & Whipple, sanitary engineers of New York City. Each member of the firm has published several volumes on water supplies and allied subjects. Each member has a national reputation and is recognized as an authority on the subject.

Professor Whipple was requested to make a thorough, systematic and comprehensive investigation of our sys-

tem and report to the board his conclusions and to make such suggestions for its improvement as he deemed advisable.

Most, if not all of his suggestions under the latter clause had received the careful consideration of the board, and steps have been taken to correct the conditions referred to.

Since 1893, the board has acquired twenty-six parcels of real estate on the shores of the lake at an aggregate cost of \$47,872.41.

The city now owns 365.47 acres, comprising more than 80 per cent. of the shore line.

The state (State Hospital) owns about 10 per cent., leaving a little less than 10 per cent. of shore line controlled by nine individual owners. No part of the city's holdings is used for pasturage, and all will eventually be covered by forest growth.

In addition to the natural growth of hard and soft woods, the board, during the past five years, has set out 150,000 seedling pines.

The report of Professor Whipple is presented herewith for the information of our citizens, with the recommendation that it be studied carefully.

It is our confident belief that a critical perusal of the report will convince all fair-minded people that Mr. Whipple is justified in his general conclusions, that the water of Penacook Lake can be used for all domestic purposes with perfect safety.

Respectfully submitted,

SOLON A. CARTER,
BURNS P. HODGMAN,
HENRY C. HOLBROOK,
FRANK P. QUIMBY,
EDSON J. HILL,
GEORGE D. B. PRESCOTT,
HARRY H. DUDLEY,
NATHANIEL E. MARTIN,
CHARLES J. FRENCH, *ex-officio*,
Board of Water Commissioners.

REPORT ON THE WATER SUPPLY OF CONCORD.

BY GEORGE C. WHIPPLE.

July 13, 1914.

*Mr. Percy R. Sanders, Superintendent of the Water-Works,
Concord, N. H.,*

DEAR SIR: In accordance with the request of the President of the Water Commissioners, I have made a careful sanitary inspection of the water supply of your city, and I hereby present my report.

In preparation for the investigation I have examined the Annual Reports of the Water Department, the reports of the Concord Health Department, and the analyses that have been made from time to time in the laboratory of the State Board of Health. I have also read certain reports on the quality of the water made by Dr. Charles D. Howard, the chemist of the State Board of Health.

In the forenoon of Friday, June 26, I made an inspection of the catchment area in company with you and Doctor Howard. On this trip samples of water were collected and tested for the presence of algæ, etc. I also visited the high service reservoir and the pumping station. In the afternoon of the same day an inspection of the reservoir was made, using a launch.

As a result of these investigations it is my opinion that the city of Concord has an excellent water supply. It is safe and sanitary and there is no reason why it should not be used for drinking and for all domestic purposes. It is unnecessary to boil it, and it is unnecessary for the citizens of Concord to purchase spring water from fear that the water drawn from the taps is not safe.

The Board of Health records of the city show no indication that the water has been the cause of typhoid fever or diseases which may be spread through the agency of a public water supply. The water is attractive in appearance, almost odorless, clear and nearly colorless. It is soft and palatable.

The odor of the water is the only physical quality which seems likely to be occasionally at fault. All New England lakes and reservoirs are affected occasionally with growths of microscopic organisms. Some of these produce unpleasant tastes and odors. There is no question but that such growths of organisms occur in Penacook Lake and they will doubtless occur in the future. Unpleasant as they may be, there is no reason to believe that the odors or the microscopic plants which cause them are deleterious to health. They should not occasion alarm as they do not indicate infection of the water. At the present time the water has no odor due to this cause.

Having made this general statement, I will now discuss some of the conditions in detail and call attention to certain matters which, in my judgment, should be attended to.

THE CLEANLINESS OF THE CATCHMENT AREA.

When surface waters are used without purification, they should be collected from a catchment area that is reasonably clean and free from pollution by fecal matter. The records of the Water Department state that the catchment area of Penacook Lake is about three square miles. The area of the lake is about 338 acres, and to this should be added about 30 acres which represents the area of Forge Pond, now practically a part of the lake. Forge Pond has a catchment area of about 200 acres. The lake has a total length of approximately two miles. The catchment area comprises woodland and farmland. On the west side of the lake a highway extends from the lower end of Forge Pond to the extreme upper end of the lake. Its distance from the lake shore varies from 500 to 2,000 feet except at the two ends of the lake where it approaches closely to the shore. A part of the catchment area of the east side of the lake is also traversed by a highway, but this is at a considerable distance from the lake.

There are on the catchment area somewhat over a dozen

dwelling houses occupied permanently throughout the year. All of these were visited by us. The premises were examined and information obtained as to the number of persons and farm animals at each place. As a result of this hastily made census it was found that the permanent population of the catchment area is about 75 persons, or something less than 25 persons per square mile. During the summer this population is increased by an indefinite number of persons who temporarily occupy the cottages along the shore of the lake. It seems probable that during short periods of the summer season the population of the catchment area may be considered as about 50 per square mile. There are about 100 cows and between 30 and 40 horses kept at the various farms. At Sunnyside there is a poultry yard where about 700 hens are said to be kept. There seems to be nothing abnormal for a farming region on this catchment area, if we except the cottages which are located near the lake shore.

There are no artificial sewerage disposal systems on the watershed. The sanitary conveniences at the different houses include privies and cesspools. Most of these are satisfactorily located with respect to the lake. The soil of the watershed is generally porous and well adapted to the reception and natural purification of the liquids from the cesspools. The largest cesspools are those at the State Farm, but they are located several hundred feet from the lake in sandy soil and there is not the slightest reason to believe that any of the contents reach the waters of the lake by percolation. There are one or two cases where there is an opportunity for surface water to carry household wastes into the lake at times of rain, but these are matters that can easily be corrected and have all been brought to your attention. The chief danger from cesspools, however, is not while they are in use but at the time when they are being cleaned. In some cases we were informed that it was the practice to dispose of the contents on the surface of the ground, but in a number of instances the practice is to bury the fecal matter in the ground, cover-

ing it with earth. This is the proper method and should be insisted upon, whether the privy be located near the lake or at a considerable distance from the lake. The object of this is to avoid accidental contamination of the water.

While it is true that animal manure does not cause typhoid fever, yet this substance should be kept out of public water supplies. Obviously, it is impossible to eliminate all animal manure from catchment areas which include farms and farm lands. Cows, sheep, and other animals require water and it is but natural that they seek it in streams and ponds. In this way all surface waters become more or less contaminated. Even streams which drain nothing but forest lands may become contaminated from the manure of birds, squirrels and other warm-blooded animals. These sources of contamination are relatively unimportant from a hygienic point of view when compared with pollution by human fecal matter. In the case of the water supply of Concord, the water is subjected to long storage before it flows to the city, which causes the danger of even the animal contamination to be reduced to a minimum. The use of manure on plowed fields is a natural use of the land. The washings of fields thus manured are bound to enter the lake at certain times of the year. While this is a source of contamination that cannot be wholly eliminated, it should be reduced when possible. Often this may be accomplished by friendly arrangements with the landowners. Some of the fields of the State Farm are located near the lake and it is said that during the past season this land was heavily manured with the result that the washings entered the lake. This condition might and should be prevented. When manure is applied to land on watersheds ridges at the bottoms of the hills should be constructed to retard the surface flow, and cause more of the water to soak into the ground before reaching the lake. This would benefit the farmer as well as the water supply. The poultry farm maintained by the state is another possible source of contamination by animal

manure. While these are matters that should be attended to, I do not regard them in the present instance as being serious. The analyses of the Concord water made by the State Board of Health do not indicate any marked contamination from this source.

For the most part, swamps are conspicuously absent on the catchment area and accordingly the color of the water is very low. There is, however, a small swamp at the upper end of the lake which, in my judgment, should be drained. At the present time it forms a breeding place for microscopic organisms.

The summer cottages along the shore deserve special consideration. Here, if anywhere, the waters of the lake are in danger of contamination by human fecal matter. Many of the cottages have been already purchased by the city. This general policy of the Concord Water Board is one which I approve. The city should control the entire shore line of the lake in order to prevent the sources of contamination from being located too near the water. This does not necessarily mean that it is necessary for the city to actually own all of the land along the shore. Doubtless arrangements can be made by which the owners of land will take adequate precautions against contamination. The wisdom of purchasing any given piece of property must depend largely upon the price for which it can be purchased. The present situation does not warrant the paying of excessive prices for the mere sake of holding title to the shore line.

I have inspected the premises at the St. Paul's School boat-houses, and find the sanitary arrangements to be satisfactory. The water used in the shower baths does not enter the lake, but is discharged into the ground. It is my judgment that the use of the lake for boating carried on under proper restrictions is not deleterious to the hygienic quality of the water supply of Concord.

SUMMER VERSUS WINTER CONDITIONS.

It is a well-known fact that the typhoid fever bacillus does not multiply in water. If the germs of this disease get into the water they do not live many weeks, and very few of them live more than a few days. They are able to survive much longer in cold water than in warm water, and it is a fact that most typhoid fever epidemics which have been traced to water have occurred during the colder months of the year, and that water-borne typhoid fever is more common in northern than in southern latitudes. Surface waters are less likely to transmit intestinal diseases during the summer than during the winter. This tends to minimize the effect of temporary summer pollution on the watershed, the effect of summer cottages, and the effect of accidental contamination from persons who boat or fish on the lake or along the shores. Furthermore, sedimentation, the disinfecting influence of sunlight, and other destructive agencies combine to minimize the effect of contamination during warm weather.

THE TYPHOID FEVER RECORD OF CONCORD.

The typhoid fever record of Concord for many years has been exceptionally good. Data received from the local Board of Health and hereto appended have indicated that during the twelve years from 1902 to 1913, the largest number of deaths from this disease in any one year was four, while during two of these years there were no deaths from typhoid fever. The maximum typhoid fever deaths per 100,000 was 18.3, the average, 10.3, and the minimum 0. These records compare very favorably with those of cities supplied with filtered water or with well water. Even more significant than this low typhoid fever death-rate is the distribution of the typhoid fever cases during the year. The records show that most of the cases have occurred during the late summer and autumn, and that the number of cases of this disease occurring during the winter has been very small. Since water-borne typhoid fever occurs

chiefly in cold weather this distribution would not have occurred if any considerable amount of this disease had been caused by the public water supply. To me, the figures mentioned are significant and indicate unmistakably that the water supply of the city has been safe.

OBJECTIONS TO SURFACE WATER.

It must be admitted that there are certain inherent objections to a water supply taken from the surface of the ground. One of these is the possibility of accidental contamination by the fecal matter of some person who happens to be sick with typhoid fever, or who is one of those unfortunate individuals, who, having had this disease, retain the germs of it in their system for long periods of time. Such persons are termed "typhoid fever carriers." It is said that in round numbers about one person out of every 40 or 50 who have had this disease remain carriers for a considerable period of time. Fortunately the number of typhoid fever carriers in the country at large is decreasing, for the reason that this disease is being gradually stamped out. It is partly because of the danger of this accidental contamination that sanitary engineers favor the filtration of surface waters. It is recognized, however, that storage is an important agency in protecting a water supply against accidental infection, and the long storage provided by Penacook Lake is in itself an important factor in the local problem.

Another objection to the use of surface waters is from the growth of microscopic organisms which takes place in waters stored in reservoirs and lakes. In respect to these growths great differences are noticed between different parts of the country, and sometimes between different lakes and reservoirs quite near together. The effect of these microscopic organisms, most of which belong to the vegetable kingdom, is to make the water slightly turbid and produce unpleasant tastes and odors of water at certain times of the year, chiefly in summer. Penacook Lake is not en-

tirely free from such growths, and the water occasionally acquires a vegetable and woody, or it may be a fishy odor. At the time of my inspection the water contained only a few of these organisms and the odor which they produced was practically negligible. Algæ have been observed in the waters of the lake for many years. They were mentioned by Dr. T. M. Drown in the report which he made to the city in the year 1891. Apparently, they have been no more numerous in recent years than they were then. The growth of these organisms depends upon many different conditions which cannot be discussed at length in this brief report. One of the important factors, however, is the food supply which they demand. Manure is used to fertilize the land and contribute to the growth of the crops. When it is allowed to wash into the lake it tends to fertilize the lake and contribute to the growth of microscopic plants. This is one of the reasons why care should be taken to exclude surface wash from Penacook Lake.

STAGNATION.

In this latitude all lakes which are as deep as Penacook Lake undergo two periods of what is called "stagnation," one during the summer and one during the winter. At these times the water at the bottom does not mix with the waters above, and it usually becomes foul through the decomposition of organic matter. Following these periods of stagnation the foul water becomes mixed with the waters above and may give rise to noticeable odors. At such times also microscopic organisms are likely to develop and add to the odor. In all probability this condition occurs in Penacook Lake, but thus far it has not been studied.

Nothing can be done to prevent this, and it is mentioned here merely to explain why it is that during the spring and fall there is a slightly noticeable odor to the water.

CLEANLINESS OF THE DISTRIBUTION SYSTEM.

The water supply of Concord is taken from the lake at a point several hundred feet from the gate-house. It first passes through a brick conduit laid along the bottom of Forge Pond. It then passes through two sets of screens in the gate-house and flows to the city through cast-iron pipes. An inspection of the screens showed an accumulation of organisms of various kinds. On the screens were found leaves, small fish, frog spawn, fragments of water plants, fresh water sponge, and more or less miscellaneous debris. It is probable that the conduit at the bottom of the lake is not entirely clean and that growths of fresh water sponge are there present. This pipe moss, as it is sometimes called, is almost always present in conduits through which surface waters are flowing. The algæ, above mentioned, serve as food for these pipe organisms. Practically the only harm they do in the pipes is to occasionally make the water slightly dirty and turbid in some parts of the city where by reason of excessive draughts they become dislodged.

Samples taken by us from certain of the taps of the city showed that in most cases the water was exceptionally free from turbidity. A sample from the tap in the State Laboratory, however, contained a considerable amount of sediment, which was evidently derived from the pipes.

I have suggested to you that the screens of the gate-houses be cleaned daily during the summer season and that the pipes of the city be thoroughly flushed by taking certain streets, one at a time, and increasing the velocity of the water through the pipe so as to thoroughly clean out any accumulated dirt. A velocity of about 8 feet per second is needed for efficient flushing. To do the work properly will require several weeks. It should be done at night.

HIGH SERVICE RESERVOIR.

The water in the high service reservoir appeared to be free of algæ growth at the time of our inspection.

WATER ANALYSES.

I have examined with care the analyses of the Concord water which have been made by Doctor Howard in the laboratory of the State Department of Health. The methods used have conformed to standard methods.

The chemical analyses have been more complete than is necessary. It would be useful, however, to have microscopical examinations of the water made regularly by the Sedgwick-Rafter method and by the use of the cotton filter. It would also be useful to maintain records of the number of bacteria in the water and the approximate number of *B. coli*. At present these tests are made, but infrequently.

QUANTITY OF WATER AVAILABLE.

At the present time there are no records which adequately show the quantity of water that is being used by the city. It is thought, however, that this quantity is not far from 3,000,000 gallons per day. If this figure is correct, it seems probable that the limit of the capacity of the catchment area of Penacook Lake has been nearly reached, and that the most important problem of the near future will be to secure an additional supply of water. The level has been below high-water mark for a number of years. The chief reason for this probably has been the recent lack of rainfall, but doubtless an increased water consumption has been another reason.

In anticipation of the need of additional water, it seems to me that immediate steps should be taken to secure accurate records of the water now being used, and I recommend the installation of Venturi meters on the pipe lines leading to the city. The expense of these meters would not be large and the definite results obtained would be of great value to the city.

CONCLUSION.

In conclusion, I wish to express my thanks to the Mayor, and the members of the Water Board, the Secretary and Chemist of the State Board of Health, and yourself for affording me the ample opportunities for conducting the present inspection. And I wish to congratulate the citizens of Concord on having at hand such an excellent water supply as that of Penacook Lake.

Attached to this report will be found certain data in regard to the typhoid fever records of the city and some of the cotton discs which were used in the examination of samples of the sediment found in the water in different parts of the system.

Yours respectfully,

(Signed) GEORGE C. WHIPPLE,
Consulting Engineer.

CONCORD, NEW HAMPSHIRE.

TYPHOID FEVER DEATH-RATES, 1902-1913.

| Year. | Population. | Typhoid Fever Deaths. | Typhoid Fever Death Rate per 100,000. |
|---------------------|-------------|--------------------------|---|
| 1900 | 19,632 | .. | |
| 1901 | 19,819 | .. | |
| 1902 | 20,006 | 3 | 14.9 |
| 1903 | 20,193 | 3 | 14.8 |
| 1904 | 20,380 | 1 | 4.9 |
| 1905 | 20,566 | 3 | 14.6 |
| 1906 | 20,753 | 3 | 14.4 |
| 1907 | 20,940 | 0 | 0.0 |
| 1908 | 21,127 | 1 | 4.7 |
| 1909 | 21,314 | 4 | 18.8 |
| 1910 | 21,497 | 0 | 0.0 |
| 1911 | 21,684 | 3 | 13.8 |
| 1912 | 21,871 | 4 | 18.3 |
| 1913 | 22,058 | 1 | 4.5 |
| Average, 1902-1913, | | | 10.3 |

NUMBER OF CASES OF TYPHOID FEVER REPORTED TO THE
CONCORD BOARD OF HEALTH DURING THE MONTHS FROM
JANUARY, 1902, TO DECEMBER, 1913.

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|-------|------|------|------|------|------|-------|-------|------|-------|------|------|------|-------|
| 1902 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 0 | 13 | 4 | 0 | 1 | 23 |
| 1903 | 0 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 6 | 3 | 2 | 17 |
| 1904 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 2 | 3 | 1 | 0 | 12 |
| 1905 | 3 | 1 | 1 | 0 | 1 | 3 | 0 | 1 | 0 | 8 | 4 | 1 | 23 |
| 1906 | 3 | 0 | 0 | 1 | 0 | 0 | 5 | 8 | 5 | 5 | 2 | 3 | 32 |
| 1907 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 11 |
| 1908 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 0 | 6 |
| 1909 | 2 | 0 | 2 | 0 | 0 | 1 | 2 | 2 | 3 | 11 | 3 | 2 | 28 |
| 1910 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 6 | 1 | 2 | 1 | 2 | 16 |
| 1911 | 1 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 2 | 2 | 0 | 10 |
| 1912 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 9 | 2 | 0 | 0 | 15 |
| 1913 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 1 | 2 | 1 | 2 | 1 | 10 |
| Total | 12 | 6 | 7 | 5 | 4 | 10 | 18 | 21 | 40 | 47 | 21 | 12 | 203 |

NOTES:

1903. "Large number of cases traced to sources outside of city."
1904. "Source of most of these cases was located beyond the limits of the city."
1905. "Several of hospital cases were brought here for treatment from other places."
1906. "Largest number of cases ever reported to this office in one year . . . widely scattered over the city. Several trace their origin outside."
1909. "Eight of these cases were brought to the hospitals from out of town."
1910. "Origin of several of these cases was traced to sources outside of the city."

MEMORANDUM CONCERNING RESEARCH AT
PENACOOK LAKE.

CONCORD, N. H., SEPTEMBER 21, 22, 1914.

On September 21, 1914, I went to Concord, N. H., with Mr. Mackenzie and Mr. Barker, students in Sanitary Engineering at Harvard to make limnological investigations of the water in Penacook Lake.

We were met by Mr. Sanders, superintendent of the water-works, who was with us during most of the investigation.

The following determinations were made throughout the vertical at the deepest portion of the lake on two successive days.

- (1) Temperature.
- (2) Dissolved oxygen.
- (3) Carbon dioxide.
- (4) Quantitative test for microorganisms.
- (5) Cotton disc records at top, middle and bottom.

The work was greatly expedited by the use of the water-works launch operated by Mr. Richardson.

The apparatus used was as follows:

- From Harvard Sanitary Laboratory,
 - Thermophone and coil for temperature work.
 - Dissolved oxygen sampler.
 - Field laboratory.
 - Microscope and field outfit for algæ work.
 - Sounding line and lead.

- From city engineer, Concord,
 - Transit and rod.

SOUNDINGS.

The wide part of the lake just west of the gate house was selected as being that portion of the body of water on which to concentrate our efforts. On the afternoon of September 21 a hydrographic survey of this portion of the lake was run, soundings being taken along selected lines. The

position of each reading was determined by the time between soundings and checked by transit angles from a shore station. These soundings were plotted on a map furnished by the city engineer, and ten-foot contours of the lake bottom run out. Five-foot contours were plotted by interpolation. The stage of the water was 180.3 and the contours are corrected to the same base and so designated on the blue prints. These contours are probably accurate in the main to .5 foot. The deepest sounding was 73 feet at this stage of the water and there is a small area of this depth at the region indicated. This reading was obtained several times and rechecked by cross line soundings. All determinations were made at a point over this deep hole.

TEMPERATURE.

The temperature of the water in Penacook Lake showed little decrease during the first twenty feet, with the exception of the warming of the surface layers from the sun's rays. The air temperature on September 21 was 89° in the shade. There was no wind on this or the succeeding day, the surface of the water being flat and glassy. Between twenty and twenty-five feet there was a drop in water temperature of 3° F. This drop increased greatly up to twenty-nine feet where the temperature was 15° lower than the surface. Between twenty-nine and thirty-one feet there was a region of more uniform temperature, and from this depth the water became gradually cooler until sixty feet was reached where the minimum reading was obtained of 43.1° F. This temperature was maintained to the bottom. These results are plotted on a blue print diagram.

The interpretation of these results shows that at some time of heavy wind the water of the lake was stirred to circulation to a depth of thirty feet. The average wind action however stirs it to a depth of only twenty or at most twenty-five feet. In this upper layer there is considerable circulation most of the time and the water contained in this layer is frequently brought in contact with the air. In this manner it acquires an even temperature throughout.

Below twenty-five feet is a period of non-circulation. Here the water remains more or less quietly and will so remain until the fall overturn.

MICROSCOPIC ORGANISMS.

Samples were examined for the presence of microorganisms at the surface, twenty, thirty, forty and seventy foot depth. A surprisingly small number of organisms was found. At the surface there was a growth of *anabæna* which from inspection seemed to have increased by the end of the second hot day. On September 21 there were however only 72 standard units of this form per cubic centimeter. It was visible as minute specks at the surface of the water, and under the microscope was shown to be tangled in clumps. This organism is subject to rapid increase and sudden death and decay. In the latter stage it sometimes imparts to the water a disagreeable odor, but probably never in such small quantities as this.

In addition to this form there was a sprinkling of protozoan forms and a few rotifers. The protozoa were in no case members of that class which thrive in polluted waters but rather of the group which I have come to regard as clean water organisms.

DISSOLVED OXYGEN.

The first twenty feet of water showed a dissolved oxygen content of between 90 and 100 per cent. saturation. From this point the per cent. of saturation gradually fell off until at a depth of sixty feet there was only 11 per cent. of the saturation amount for that temperature. This depletion of oxygen in the non-circulating depths is due to the oxidation of organic matter in decay. At no point was there any complete depletion of oxygen.

CARBON DIOXIDE.

Carbon dioxide is a product of oxidation either in respiration or in decay. As dissolved oxygen in water is used up it is expected that carbon dioxide will increase.

The carbon dioxide in Penacook lake is distributed in the normal manner. From 2 to 2.5 parts per million are found in the circulating surface waters of the first twenty feet, below which depth there is an increase corresponding to the decrease of dissolved oxygen. The maximum normal content at seventy feet was about 9 parts per million.

Certain determinations made at a slightly different point showed a peculiar variation in the CO₂. For instance at the forty-foot depth a content of 10 parts per million was noted and checked, while at the sixty-foot depth at this point only 7.7 parts could be found. Minor fluctuations were noted also in the upper levels. Inasmuch as there were no concentrations of microorganisms at the layers indicated, it would seem that some other explanation for this phenomenon must be obtained. A possible explanation might be that ground water enters the lake at various points in so-called springs, and with its high CO₂ content seeks its proper temperature level, before spreading.

ODOR.

The water at the surface had a very faint vegetable odor that would hardly be detected by the ordinary observer.

Below the surface no odor was detected until the 70' level was reached. Inasmuch as the intake is at a depth of between fifteen and twenty feet the present city supply is odorless.

At the seventy-foot level a distinct odor of H₂S is present, the product of decomposing organic matter in all probability.

COTTON DISC RECORDS.

The cotton disc records had no apparent value in this case as the water is too clean to make any stain beyond a very slight darkening of the cotton. This record was therefore discarded as time was pressing.

CONCLUSIONS.

The physical and biological qualities of the water of Penacook lake were excellent at the time of examination, there being very little color, turbidity or odor.

At the time of this examination the condition of the water is practically the same for the first thirty feet, and is not likely to undergo any natural change until the time of the fall overturn.

The small number of organisms present would seem to indicate that the pond is at present not heavily seeded with their spores or that there is a deficiency of those substances which form their food supply.

The swampy pool west of the lake, across the road from St. Paul's School boathouses is richly populated with various microorganisms, some of which are ciliate, protozoa. These latter forms indicate possible unclean water.

The lower layers are "stagnant" in that they are non-circulating at this season but cannot be regarded as "stagnant" as the word is popularly used, *i. e.* foul, unsightly or ill-smelling.

Penacook Lake is unusually free from organic matter. The condition of the sounding lead indicated a clean bottom. Samples of water from various depths down to 65 feet were generally clear and sparkling.

J. W. M. BUNKER, PH.D.,
Laboratory of Sanitary Engineering, Harvard University.

REPORT OF THE SUPERINTENDENT.

To the Board of Water Commissioners:

I herewith present to you the forty-third annual report of the operations of this department, showing the receipts, expenditures and abatements, together with a statement of the extensions and improvements made during the year ending December 31, 1914.

RECEIPTS.

| | |
|---|-------------|
| For water, from consumers by fixed rates, | \$12,985.65 |
| For water, from consumers by meter rates, | 60,791.64 |
| From delinquents, | 85.01 |
| For water for building purposes, | 27.58 |
| pipe and stock sold and labor, | 449.31 |
| old brass and iron sold, | 46.58 |
| buildings, | 90.00 |
| freight refunded, | .57 |
| | \$74,476.34 |
| Deduct abatements, | 54.19 |
| | \$74,422.15 |
| Net receipts for 1914, | \$74,422.15 |

There has also been furnished the city free of charge the following use of water:

| | |
|---|----------|
| Fire department, | \$111.50 |
| Police department, | 43.00 |
| Public Library, | 11.00 |
| Ward 7, ward house, | 7.00 |
| Ward 9, ward house, | 7.00 |
| S. P. School Sewer Precinct, flush tanks, | 45.00 |
| City playground, | 6.00 |

| | | |
|---------------------------------|-----------|-------------|
| Parks, city, | \$38.00 | |
| Park, Washington Square, | 10.00 | |
| Cemeteries, | 108.00 | |
| Drinking fountains, | 20.00 | |
| Watering troughs, | 260.00 | |
| Street department, stable, | 18.00 | |
| Stone crusher, | 6.00 | |
| Stand pipes, city and Penacook, | 750.00 | |
| 436 fire hydrants, at \$25.00, | 10,900.00 | |
| | | \$12,340.50 |

EXPENDITURES.

GENERAL EXPENSES.

| | |
|---|-------------|
| Paid pay-rolls, salaries and labor, | \$13,961.60 |
| S. G. Sanborn, rent of shop in Penacook, | 24.00 |
| Ira C. Evans Co., printing and postage, | 292.50 |
| Rumford Printing Co., books, | 87.75 |
| Geo. B. Graff Co., office supplies, | 5.25 |
| Library Bureau, office supplies, | 4.45 |
| W. C. Gibson, office supplies, | 2.50 |
| Geo. H. Richardson & Co., office supplies, | 1.50 |
| A. R. Andrews, office supplies, | 1.00 |
| The Old Corner Book Store, book, | 4.00 |
| Brown & Saltmarsh, repairing frames, | 1.25 |
| Granite State Mfg. Co., repairing chairs, | 2.35 |
| W. L. Fickett & Co., repairing clock, | 2.00 |
| <i>Concord Evening Monitor</i> , advertising, | 8.00 |

WATER DEPARTMENT.

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| | |
|--|--------|
| Paid N. H. Patriot Co., advertising, | \$3.30 |
| N. E. Telephone & Telegraph Co., telephones, | 96.52 |
| Concord Electric Co., lighting and thawing pipes, | 50.42 |
| Hazen & Whipple, report on water supply, | 153.36 |
| J. W. M. Bunker, survey of Penacook Lake, | 25.70 |
| Will D. Hutchinson, distribut- ing report, | 9.30 |
| J. M. Stewart & Sons Co., sup- plies, | 15.50 |
| W. A. Thompson, rubber boots, | 18.75 |
| Thorne Shoe Store, rubber boots, | 4.00 |
| Hardy & McSwiney, oil coats, | 3.00 |
| J. G. McQuilkin, oil coat, | 1.25 |
| Globe Stamp Works, pay checks, | 3.20 |
| Thompson & Hoague Co., hard- ware, | 226.88 |
| A. H. Britton & Co., hardware, | 69.63 |
| Dickerman & Co., lanterns, | 10.80 |
| John Swenson Co., dynamite, | 8.13 |
| Joseph T. Walker, hay, | 138.80 |
| Walter S. Dole, grain and straw, | 64.08 |
| G. N. Bartemus & Co., grain, | 44.84 |
| W. S. Darley & Co., pipe locator, | 65.00 |
| Niagara Searchlight Co., lamp, | 3.75 |
| Wm. P. Ballard, chestnut posts, | 30.00 |
| Tragle Cordage Co., packing, | 30.72 |
| Frank E. Fitts Mfg. Co., waste, | 25.14 |
| Concord Lumber Co., lumber, | 21.71 |
| Standard Oil Co., gasoline, | 143.70 |
| Eagle Garage, supplies and re- pairs, | 219.77 |

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| Paid Carl A. Hall, supplies, | \$126.09 |
| Hall Bros., supplies, | 4.00 |
| Ward's Vulcanizing Works, supplies, | 9.00 |
| Fred A. Eastman, supplies, | 3.00 |
| P. H. Larkin Co., supplies, | 29.00 |
| Batchelder & Co., supplies, | 8.80 |
| C. H. Martin & Co., supplies, | 11.41 |
| W. Carpenter, supplies, | 4.10 |
| C. W. Dadmun, electrical sup- plies, | 11.10 |
| Woodworth & Co., cement, | 31.50 |
| Donaldson Iron Co., cast-iron pipe, | 9,301.88 |
| Standard Cast Iron Pipe & Foundry Co., cast-iron pipe, | 312.80 |
| Builders Iron Foundry, castings, | 449.47 |
| Rensselaer Mfg. Co., valves and hydrants, | 840.32 |
| Ludlow Valve Mfg. Co., valves and hydrants, | 691.21 |
| Water Works Equipmet Co., Water Works Equipment Co., valve and sleeve, | 44.70 |
| City of Boston, valve and sleeve, | 40.15 |
| Bingham & Taylor, gate boxes, | 88.81 |
| Chadwick-Taylor Lead Co., pig lead and lead pipe, | 698.02 |
| Richards & Co., pig lead, | 168.34 |
| Boston Pipe & Fittings Co., wrought-iron pipe, | 225.13 |
| Geo. E. Gilchrist Co., service boxes, | 144.50 |
| H. Mueller Mfg. Co., service boxes and tools, | 119.04 |
| Glauber Brass Mfg. Co., brass goods, | 6.05 |

| | |
|--|---------|
| Paid Concord Foundry & Machine Co., machine work and castings, | \$84.47 |
| Ford & Kimball, castings, | 2.43 |
| Walworth Mfg. Co., tools and fittings, | 164.19 |
| Harold L. Bond Co., tools, | 82.55 |
| Chandler & Farquhar Co., tools, | 11.76 |
| The Borden Co., tool, | 1.90 |
| Page Belting Co., pipe, fittings and supplies, | 214.74 |
| Crane Co., fittings, | 30.94 |
| Orr & Rolfe Co., fittings, | 11.25 |
| Concord Pipe Co., fittings, | 8.19 |
| National Meter Co., meters and repairs, | 519.22 |
| Thomson Meter Co., meters and repairs, | 386.97 |
| Neptune Meter Co., meters and repairs, | 370.70 |
| Henry R. Worthington, meters and repairs, | 155.14 |
| Union Water Meter Co., meters and repairs, | 69.72 |
| Pittsburgh Meter Co., repairs, | 2.96 |
| Hersey Mfg. Co., meter repairs, | 1.50 |
| Globe Horseshoeing Shop, smith work, | 241.66 |
| A. L. Dickerman & Co., repairs, | 78.72 |
| Manchester Welding Co., repairs, | 27.50 |
| Cushman Electric Co., repairs, | 24.77 |
| George D. Huntley, repairs, | 18.65 |
| E. P. Cornish, repairs, | 10.00 |
| Holt Bros. Mfg. Co., repairs, | 7.00 |
| Abbot & Downing Co., repairs, | 6.83 |
| Wm. T. Bailey & Co., repairs, | 5.82 |
| George G. Fogg, repairs, | 5.80 |

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|---|--------|
| Paid A. Henry, repairs, | \$4.00 |
| C. Pelissier & Co., repairs and supplies, | 17.75 |
| George L. Theobald, team work, | 439.50 |
| Henry M. Richardson, team work, | 52.21 |
| E. L. Davis, team work, | 8.75 |
| E. H. Runnells, labor, | 12.25 |
| C. H. Carter, auto hire, | 52.00 |
| John F. Waters, auto hire, | 11.00 |
| E. S. King, auto hire, | 11.00 |
| William S. Kaime, livery, | 29.00 |
| H. T. Corser, livery, | 4.00 |
| C. E. Bartlett, carrying men, | 192.11 |
| George F. Tandy, repairing concrete, | 294.89 |
| Hutchinson Bldg. Co., lumber and labor, | 15.08 |
| Horne & Hall, lumber and labor, | 1.90 |
| Rowell & Plummer, mason work, | 173.21 |
| B. Bilborough & Sons, painting, | 99.06 |
| Morrill & Danforth, insurance, | 436.52 |
| Eastman & Merrill, insurance, | 45.00 |
| Boston & Maine R. R. freight and repairing siding, | 159.28 |
| Town of Webster, taxes, | 40.00 |
| State of New Hampshire, auto registration and license, | 11.00 |
| A. G. Cochran, clerk, cash paid out, car fares, express and sundries, | 170.27 |
| P. R. Sanders, expenses to Water-Works convention, | 20.00 |
| <i>Engineering News,</i> | 5.00 |

| | |
|--|--------------------|
| Paid Hardy & McSwiney, damages on account leak at Central Block, | \$2,000.00 |
| Carl A. Hall, damages on ac- count leak at Central Block, | 385.00 |
| N. C. Nelson & Co., damages on account leak at Central Block, | 66.71 |
| Lee Bros. Co., repairs on ac- count leak at Central Block, | 230.24 |
| Fred E. French, repairs on ac- count leak at Central Block, | 26.85 |
| James S. Mansur, repairs on ac- count leak at Central Block, | 14.64 |
| Frank Morrill, repairs on ac- count leak at Central Block, | 9.50 |
| Parisian Dry Cleaning Co., cleansing on account leak at Central Block, | 111.03 |
| Warren W. Lee, washing, on account leak at Central Block, | 37.65 |
| Alva A. Young, land, | 2,700.00 |
| Henry J. Putnam, land and buildings, | 2,600.00 |
| The Alert Boat Club, land and buildings, | 2,250.00 |
| C. F. Moseley, land and build- ings, | 1,500.00 |
| E. H. Brown, recording deeds, | 3.80 |
| John H. Walker, damages, | 25.00 |
| Florence B. Walker, damages, | 25.00 |
| Margaret R. Eastman, damages, | 80.00 |
| Silas S. Wiggin, appraising damages, | 10.00 |
| incidentals, | 11.70 |
| | <hr/> \$ 46,191.10 |

PUMPING STATION EXPENSES.

| | |
|--|------------|
| Paid pay-rolls, salaries and labor, | \$1,947.36 |
| labor on fuel, | 90.68 |
| Tenney Coal Co., coal, | 973.76 |
| Bader Coal Co., coal, | 43.96 |
| Boston & Maine Railroad, freight on coal, | 162.65 |
| H. M. Richardson, drawing slabs, | 1.87 |
| W. C. Robinson & Sons Co., oil, | 59.38 |
| Eagle Oil & Supply Co., pack- ing, etc., | 109.99 |
| Thompson & Hoague Co., sup- plies, | 12.56 |
| C. H. Martin & Co., supplies, | 8.20 |
| Batchelder & Co., supplies, | 4.30 |
| F. A. Eastman, polish, | .50 |
| J. A. & W. Bird & Co., soda ash, | 2.50 |
| The Borden Co., tools, | 15.00 |
| Walworth Mfg. Co., tools, | 11.15 |
| Chandler & Farquhar Co., tools, | 4.23 |
| M. E. Clifford & Co., fittings, | 1.45 |
| Orr & Rolfe Co., fittings, | 1.20 |
| Page Belting Co., fittings, | 2.09 |
| Rowell & Plummer, mason work, | 26.95 |
| Globe Horseshoeing Shop, smith work, | 2.00 |
| George E. Winslow, indicator supplies, | 20.28 |
| Wm. H. Reed, Jr., loam, | 9.00 |
| F. W. Kelsey Nursery Co., shrubs, | 7.50 |
| C. W. Dadmun, wiring for elec- tric lights, | 172.72 |
| Concord Electric Co., lighting, | 2.28 |

| | | |
|---------------------------------|--------|-------------|
| Paid Concord Light & Power Co., | | |
| lighting, | \$8.56 | |
| N. E. Telephone & Telegraph | | |
| Co., telephone, | 34.60 | |
| Boston & Maine Railroad, re- | | |
| pairing siding and freight, | 62.42 | |
| A. G. Cochran, clerk, cash | | |
| paid out, | 1.15 | |
| Morrill & Danforth, insurance, | 28.00 | |
| | <hr/> | \$3,828.29 |
| | | <hr/> |
| | | \$50,019.39 |

The expenditures are divided as follows:

GENERAL EXPENSES.

| | |
|--------------------------------|-------------|
| For office expenses, | \$1,278.73 |
| maintenance, | 7,814.86 |
| inspection, | 840.00 |
| care and repair of hydrants, | 346.81 |
| new service pipes, | 1,884.85 |
| new distribution pipes, | 17,932.34 |
| new hydrants, | 741.16 |
| new meters, | 1,519.91 |
| work at lake, | 344.61 |
| care of wood-lots, | 41.49 |
| erecting fence at pumping sta- | |
| tion, | 147.75 |
| leak at Central Block, | 3,329.71 |
| land at Penacook Lake, | 9,050.00 |
| insurance, | 476.52 |
| incidentals, | 442.36 |
| | <hr/> |
| | \$46,191.10 |

PUMPING STATION EXPENSES.

| | |
|-------------------------|------------|
| For salaries and labor, | \$1,947.36 |
| fuel, | 1,272.92 |
| oil and packing, | 170.69 |

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CITY OF CONCORD.

| | | |
|-------------------------------|---------|------------|
| For supplies, | \$83.76 | |
| repairs and repairing siding, | 90.05 | |
| care of grounds, | 17.35 | |
| wiring for electricity, | 172.72 | |
| lighting and telephone, | 45.44 | |
| insurance, | 28.00 | |
| | <hr/> | \$3,828.29 |

EXTENSIONS AND IMPROVEMENTS.

Cast-iron distribution pipes have been laid and hydrants set during the year as follows:

In Pleasant Street,

west from Liberty Street to New Upper School, St. Paul's School 10,191 feet 12-inch pipe in place of 8-inch cement-lined and cast-iron pipe and 6-inch cement-lined and cast-iron pipe discontinued.

In Mill Road, so called, St. Paul's School,

south from Pleasant Street, 750 feet 8-inch pipe in place of 6-inch pipe discontinued.

In Kensington Road,

north from Pleasant Street, 207 feet 8-inch pipe.

In Stevens Avenue,

north from Pleasant Street, 53 feet 8-inch pipe.

In Hopkinton Road.

extended west from Gray's, 692 feet 2-inch pipe.

In Merrimack Street, Penacook.

at Washington Square, 70 feet 10-inch pipe in place of 8-inch cement-lined pipe discontinued.

In Summer Street, Penacook,

at Washington Square, 54 feet 10-inch pipe in place of 8-inch cement-lined pipe discontinued.

On hydrant branches,

27 feet 8-inch and 177 feet 6-inch pipe; 116 feet 6-inch cement-lined pipe discontinued.

On blow-offs,

22 feet 6-inch pipe; 50 feet 4-inch cement-lined pipe discontinued.

Also 1,291 feet 1-inch and $\frac{3}{4}$ -inch pipe.

We have also lowered 100 feet of 6-inch pipe on Pillsbury Street and 576 feet of 1-inch and 2-inch pipe on Stevens Avenue and Kent Street.

Seven new hydrants have been set as follows:

On Kensington Road at Pleasant Street.

On Stevens Avenue at Pleasant Street.

On Pleasant Street, at No. 251.

On Pleasant Street, opposite No. 270.

On Pleasant Street, opposite No. 291.

On Washington Street, Penacook, near South Main Street.

On South Main Street, Penacook, opposite Exchange Block.

One hydrant has been removed:

In Washington Square, Penacook, opposite Washington Street.

There have been set 29 gates; discontinued, 22.

SUMMARY OF THE FOREGOING.

NEW PIPES, HYDRANTS AND STOP-GATES.

| <i>Pipes.</i> | | <i>Hydrants.</i> | | <i>Stop-Gates.</i> | |
|-----------------------|--------------|------------------|-------|--------------------|-------|
| $\frac{3}{4}$ -inch, | 153 feet. | In city, | 5 | 4-inch, | 1 |
| 1-inch, | 1,138 feet. | In Penacook, | 2 | 6-inch, | 16 |
| 2-inch, | 692 feet. | | | 8-inch, | 4 |
| 6-inch, | 199 feet. | | | 10-inch, | 1 |
| 8-inch, | 1,037 feet. | | | 12-inch, | 7 |
| 10-inch, | 124 feet. | | | | |
| 12-inch, | 10,191 feet. | | | | |
| | <hr/> | | <hr/> | | <hr/> |
| | 13,534 feet. | | 7 | | 29 |
| equal to 2.563 miles. | | | | | |

DISCONTINUED.

| <i>Pipes.</i> | | <i>Hydrants.</i> | <i>Stop-Gates.</i> | | |
|-----------------------|--------------|------------------|--------------------|---------|-------|
| 1-inch, | 96 feet. | In Penacook, | 1 | 4-inch, | 5 |
| 4-inch, | 76 feet. | | | 6-inch, | 14 |
| 6-inch, | 3,461 feet. | | | 8-inch, | 3 |
| 8-inch, | 7,661 feet. | | | | |
| <hr/> | | | <hr/> | | <hr/> |
| | 11,294 feet. | | 1 | | 22 |
| equal to 2.139 miles. | | | | | |

Total length of main and distribution pipes now in use, 372,293 feet, equal to 70.51 miles.

Total number of gates now in use, 1,028.

Total number of hydrants now in use, 442.

SERVICE PIPES.

There have been laid during the year and connected with the main pipes, 51 service pipes, consisting of

| | |
|-------------------------|-------------|
| 41 $\frac{3}{4}$ -inch, | 1,015 feet. |
| 1 1-inch, | 21 feet. |
| 3 4-inch, | 56 feet. |
| 2 6-inch, | 43 feet. |
| 2 8-inch, | 66 feet. |
| 2 10-inch, | 51 feet. |
| <hr/> | <hr/> |
| 51 | 1,252 feet. |

There have been discontinued, 6; total number of service pipes at the present time, 3,837; total length of service pipes, 89,579 feet, or 16.96 miles.

There have been relaid 20 services and 60 curbs have been placed on old services.

We have set 76 meters during the year; removed 1; total number now in use, 2,393.

The following table shows the height of water in Penacook Lake on the first day of the month:

| | | | |
|-----------|--------|------------|--------|
| January, | 176.85 | July, | 181.10 |
| February, | 176.80 | August, | 180.65 |
| March, | 177.20 | September, | 180.80 |
| April, | 179.20 | October, | 179.90 |
| May, | 181.60 | November, | 179.40 |
| June, | 181.65 | December, | 178.95 |

The lowest point reached during the year was on February 28, being 176.65; the highest was on May 14 and was 181.95; mean height for the year was 179.55 which was .35 foot higher than the mean height for the year 1913.

All of the buildings under the control of this department are in good condition. The iron fence for the pumping station grounds which arrived too late in 1913 to erect that season has been set up and adds greatly to the appearance of the grounds. The pumping machinery is giving good service and shows evidence of the care bestowed upon it by the engineer.

All hydrants, public and private, have received the customary thorough inspection and care. Beginning with freezing weather in the fall and continuing through the winter until all danger of freezing is over the hydrants are inspected once a week and oftener if necessary.

The meter system continues to meet the approval of consumers; there are now nearly 2,400 meters in service and their care and maintenance occupy nearly the entire time of two men and a team.

The 8-inch cement-lined main laid in 1887 supplying Pleasant street west from Liberty and St. Paul's School has been replaced by a 12-inch cast-iron main. In Mill Road, so called, 750 feet of 8-inch pipe was laid in place of 6-inch; as this highway was discontinued several years ago, this expense was borne by St. Paul's School.

Five new hydrants were set on the Pleasant street line in locations determined by the Board of Hydrant Com-

missioners, and the St. Paul's School Corporation has been given four sprinkler connections and has set eleven private hydrants around the school buildings.

On August 21 occurred one of the worst leaks in the history of the department. At 10.15 p. m. notice was received of a bad leak on North Main street near Central Block. Upon arrival at the block the large six-way hydrant in front of the Postal Telegraph office was nowhere to be seen. As soon as we were able to shut off the water and pump out the cellars of the block, we found that the hydrant had been moved completely off from the 10-inch lateral connecting it to the 20-inch high service main. The pressure at this section is 88 lbs. per square inch and from the indicator record at the pumping station it is estimated that in the short time that the water was running over 500,000 gallons ran to waste. All damages to the blocks and the occupants arising from this break were satisfactorily settled.

There have been but two breaks on the cement-lined pipes in Penacook this season and with no greater signs of deterioration than this, the mains ought to give good service for a number of years yet.

Following is the report of Mr. Rowell, the engineer, giving the operations of the pumping engines in detail.

Respectfully submitted,

PERCY R. SANDERS,
Superintendent.

**REPORT OF THE ENGINEER AT PUMPING
STATION.**

PUMPING STATION, CONCORD WATER WORKS.

P. R. Sanders, Superintendent:

SIR: I would report that the pumping machinery at the pumping station is in good working condition.

The boilers are in as good condition as can be expected for the years they have been in service, and will need but few repairs the coming year. The fire box will need building over on boiler No. 2.

Following is a statement of coal and other supplies, used at the pumping station during the year, with a table showing the work for each month.

STATEMENT.

126 tons 809 pounds of Pocahontas coal.
107 tons 1,427 pounds of New River coal.
18 tons 1,695 pounds of Bader coal.
129 gallons of valve oil.
9 gallons of engine oil.
42 pounds of waste.
12 pounds of grease.
6 cords of wood.

ENGINE RECORDS.

| MONTHS. | No. days pumping engine No. 1. | | No. days pumping engine No. 2. | | Total days pumping. | Total hours pumping. | Average time pumping. | | Total water pumped. | Daily average pumped. | Total coal consumed.* | Daily average coal consumed. | Total pounds of wood consumed. | Gallons pumped per pound of coal. |
|-----------------|--------------------------------|--------|--------------------------------|--------|---------------------|----------------------|-----------------------|--|---------------------|-----------------------|-----------------------|------------------------------|--------------------------------|-----------------------------------|
| | No. 1. | No. 2. | H. M. | H. M. | | | | | | | | | | |
| January..... | 18 | 22 | 30 | 309: | 9:58 | | | | 25,676,816 | 828,284 | 49,088 | 1,583 | 1,440 | 523 |
| February..... | 13 | 22 | 28 | 287: | 10:15 | | | | 23,817,373 | 850,620 | 48,452 | 1,730 | 389 | 491 |
| March..... | 12 | 20 | 30 | 273:30 | 8:43 | | | | 23,575,240 | 760,491 | 46,230 | 1,491 | 2,048 | 509 |
| April..... | 15 | 15 | 27 | 246: | 8:12 | | | | 20,388,242 | 679,608 | 39,958 | 1,331 | 2,236 | 510 |
| May..... | 13 | 17 | 26 | 256: | 8:15 | | | | 21,578,129 | 696,068 | 41,842 | 1,349 | 1,629 | 515 |
| June..... | 14 | 18 | 30 | 295: | 9:50 | | | | 26,062,982 | 868,766 | 49,165 | 1,638 | 1,303 | 530 |
| July..... | 14 | 18 | 31 | 269: | 8:40 | | | | 22,401,943 | 722,643 | 42,358 | 1,366 | 672 | 528 |
| August..... | 16 | 16 | 31 | 277:30 | 8:57 | | | | 23,639,591 | 762,567 | 45,353 | 1,463 | 620 | 521 |
| September..... | 15 | 18 | 30 | 293: | 9:46 | | | | 25,794,491 | 859,816 | 49,972 | 1,665 | | 516 |
| October..... | 13 | 20 | 31 | 310: | 10: | | | | 27,798,877 | 896,737 | 53,332 | 1,720 | 426 | 521 |
| November..... | 18 | 23 | 30 | 302: | 10: 4 | | | | 26,501,353 | 883,378 | 52,160 | 1,738 | | 481 |
| December..... | 18 | 16 | 30 | 285: | 9:11 | | | | 24,597,643 | 793,472 | 48,261 | 1,556 | 1,217 | 509 |
| Total..... | 179 | 225 | 354 | 3412: | | | | | 291,832,680 | 799,541 | 566,171 | 1,551 | 11,980 | 515 |
| Daily average.. | | | | | 9:20 | | | | 799,541 | | 1,551 | | | |

* Amount of coal consumed includes that used for starting fires, banking fires and heating buildings.

Amount of coal consumed per thousand gallons pumped, 1.94.

HENRY A. ROWELL,
Engineer.

**CITY TREASURER'S CONDENSED STATEMENT OF
WATER-WORKS ACCOUNT.**

W. F. Thayer, treasurer, in account with Concord
Water-Works.

RECEIPTS.

| | | |
|-----------------------------------|--------------|--|
| Balance on hand, January 1, 1914, | \$32,582.46 | |
| P. R. Sanders, superintendent, | 74,422.15 | |
| | \$107,004.61 | |

EXPENDITURES.

| | | |
|--------------------|--------------|--|
| Interest on bonds, | \$18,758.32 | |
| Bonds paid, | 20,000.00 | |
| Orders paid, | 50,006.01 | |
| Cash on hand, | 18,240.28 | |
| | \$107,004.61 | |

AUDITOR'S STATEMENT.

I hereby certify that I have examined the books showing the receipts of the Concord Water-Works from January 1, 1914, to December 31, 1914, and find the same correct; and that the total amounts given therein correspond with the amount of receipts given by Percy R. Sanders, superintendent, in his report for the year and also with the receipts reported by William F. Thayer, city treasurer.

HENRY E. CHAMBERLIN.

APPENDIX.

A.

RECEIPTS FOR EACH YEAR SINCE THE CONSTRUCTION OF
THE WORKS.

| | | |
|-------------------------------------|-------|------------|
| For the year ending January 31, | 1874, | \$4,431.10 |
| For fifteen months ending April 1, | 1875, | 17,535.00 |
| For the year ending April 1, | 1876, | 16,921.24 |
| “ “ “ | 1877, | 19,001.07 |
| “ “ “ | 1878, | 20,763.03 |
| “ “ “ | 1879, | 21,869.86 |
| “ “ “ | 1880, | 22,451.53 |
| “ “ “ | 1881, | 26,744.58 |
| For nine months ending December 31, | 1881, | 25,534.01 |
| For the year ending December 31, | 1882, | 27,243.06 |
| “ “ “ | 1883, | 28,255.48 |
| “ “ “ | 1884, | 28,915.65 |
| “ “ “ | 1885, | 30,222.54 |
| “ “ “ | 1886, | 30,862.64 |
| “ “ “ | 1887, | 34,047.52 |
| “ “ “ | 1888, | 38,441.32 |
| “ “ “ | 1889, | 40,237.53 |
| “ “ “ | 1890, | 42,133.41 |
| “ “ “ | 1891, | 46,075.16 |
| “ “ “ | 1892, | 48,351.52 |
| “ “ “ | 1893, | 52,299.66 |
| “ “ “ | 1894, | 53,230.10 |
| “ “ “ | 1895, | 55,343.19 |
| “ “ “ | 1896, | 56,557.81 |
| “ “ “ | 1897, | 55,156.42 |
| “ “ “ | 1898, | 59,147.54 |
| “ “ “ | 1899, | *53,953.13 |
| “ “ “ | 1900, | *57,003.71 |
| “ “ “ | 1901, | 62,253.61 |
| “ “ “ | 1902, | 63,430.85 |
| “ “ “ | 1903, | 65,088.45 |
| “ “ “ | 1904, | 68,570.48 |

* No hydrant rental this year.

WATER DEPARTMENT.

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| | |
|--|----------------|
| For the year ending December 31, 1905, | \$71,076.44 |
| “ “ “ 1906, | 73,063.45 |
| “ “ “ 1907, | 73,782.64 |
| “ “ “ 1908, | 71,362.67 |
| “ “ “ 1909, | *67,307.84 |
| “ “ “ 1910, | 68,673.71 |
| “ “ “ 1911, | 71,881.34 |
| “ “ “ 1912, | 76,145.13 |
| “ “ “ 1913, | 76,154.45 |
| “ “ “ 1914, | 74,422.15 |
| Total receipts for 42 years, | \$1,995,942.02 |

B.

MEAN HEIGHT OF WATER EACH YEAR.

| | | | |
|-------|--------|-------|--------|
| 1873, | 175.86 | 1894, | 172.81 |
| 1874, | 179.50 | 1895, | 171.15 |
| 1875, | 180.00 | 1896, | 178.96 |
| 1876, | 180.28 | 1897, | 183.33 |
| 1877, | 176.46 | 1898, | 184.31 |
| 1878, | 179.50 | 1899, | 183.49 |
| 1879, | 179.74 | 1900, | 183.09 |
| 1880, | 175.30 | 1901, | 183.86 |
| 1881, | 174.70 | 1902, | 184.98 |
| 1882, | 179.15 | 1903, | 184.75 |
| 1883, | 176.40 | 1904, | 184.40 |
| 1884, | 178.18 | 1905, | 183.37 |
| 1885, | 176.80 | 1906, | 183.94 |
| 1886, | 178.10 | 1907, | 183.59 |
| 1887, | 179.04 | 1908, | 183.41 |
| 1888, | 181.96 | 1909, | 181.40 |
| 1889, | 180.91 | 1910, | 180.22 |
| 1890, | 181.90 | 1911, | 177.60 |
| 1891, | 180.00 | 1912, | 178.86 |
| 1892, | 174.32 | 1913, | 179.20 |
| 1893, | 173.38 | 1914, | 179.55 |

* No hydrant rental after 1908.

