

Council Chamber,
Ann Arbor, Mich., Nov. 13, 1905.
Special Session.

Meeting called to order by Pres. Gilmore.

Present, Ald. Gill, Kearns, Markey, St. James, Sherk, Manwaring, Coon, Goodyear, Fischer, Pres. Gilmore—10.
Absent, Ald. Blair, Schlenker, Kurtz, Miller—4.

Mayor's Call.

Ann Arbor, Mich., Nov. 13, 1905.

Ross Granger, City Clerk:

Dear Sir—Please issue the usual call for a special meeting of the council to be held in the council chamber this evening, November 13, 1905, at 7:30 o'clock, to take such action as may be deemed advisable in regard to a storm water sewer on William street, to consider the report of the special water committee; also of the license and bond committee and of the sidewalk committee.

F. M. HAMILTON, Mayor.

Received and placed on file.

Enter Ald. Schlenker.

Communication from special water committee in form of motion received as follows:

Moved by Mr. Davis, supported by Mr. Dean, that the committee recommend to the council the publication of Mr. Russell's report.

Received and following action taken:

Moved by Ald. Coon that Mr. Russell's report be received, referred to water committee of council, published and placed on file. Supported.

Moved by Ald. Fischer as an amendment that report be received, referred to water committee and placed on file. Supported.

Lost as follows:

Yeas—Ald. Schlenker, Kearns, Markey, Fischer—4.

Nays—Ald. Gill, St. James, Sherk, Manwaring, Coon, Goodyear, Pres. Gilmore—7.

Original motion adopted as follows:

Yeas—Ald. Gill, Schlenker, Kearns, Markey, St. James, Sherk, Manwaring, Coon, Goodyear, Fischer, Pres. Gilmore—11.

Nays—None.

PRELIMINARY REPORT ON THE WATER SUPPLY OF THE ANN ARBOR WATER COMPANY.

By Israel C. Russell.

Ann Arbor, Mich., June 24, 1905.

To the Water Works Committee of the Common Council of the City of Ann Arbor:

Gentlemen—In obedience to your instructions, dated Ann Arbor, Mich., May 31, 1905, a copy of which forms accompanying Exhibit No. 1, I have the honor to make the following report concerning the water supply of the Ann Arbor Water Company.

This report is to be considered as a preliminary or partial report, for the reason that it has been impracticable for me to obtain the data necessary in order to furnish detailed and final answers to all the several questions submitted to me for consideration. This short-coming is due, in part, to lack of time, in part because the Water Company states that it is not possible to open their wells for inspection without seriously interfering with their duties in supplying water to the City of Ann Arbor, and in part because existing conditions make it impracticable to obtain measurements of the volume of water supplied from various sources. This report is also incomplete for the reason that observations extending over several years would be necessary in order to determine accurately the seasonal and secular variations in the flow of the wells, springs, etc., referred to in your instructions.

During the investigation which furnished the basis for this report, the officers of the Ann Arbor Water Company have rendered such assistance as they deemed practicable, and I desire to thank them most sincerely for their courtesy and co-operation. I am also indebted to Mr. E. W. Groves, City Engineer, for the plot of Pumping Station No. 1, which forms accompanying Exhibit No. 2.

Your instructions called for a report on the water supply at each of the two pumping stations of the Ann Arbor Water Company, and hence my report is presented in two parts, one dealing with each station.

PART I.

WATER SUPPLY AT PUMPING STATION NO. 1.

Location.

Pumping Station No. 1 is situated in the valley of the Huron River, about one mile north of the City of Ann Arbor.

Land and Water Rights.

The land owned by the Ann Arbor Water Company, at Pumping Station No. 1, consists of about 11¼ acres, purchased by the company in 1885 (deed not seen), and is indicated upon plot marked Exhibit No. 2. On this plot the boundaries of the property are shown, together with the location of the wells, pipe lines, collecting reservoir, etc. This data has been secured by Mr. C. C. Von Volkenberg, from instrumental surveys, supplemented by information concerning pipe lines, etc., furnished by the Water Company. In addition to the 11¼ acres referred to above, the Ann Arbor Water Company has water rights on adjacent or neighboring land, as follows:

(a) Right to enter, etc., and use the water from springs on south side of Michigan Central Railroad track, on land belonging to Walter O'Brien, on s. w. quarter of the s. e. quarter of Section 7, Township of Ann Arbor. Deed by Walter O'Brien to Ann Arbor Water Company, recorded July 16, 1886, Liber 114, Page 474. As I have been informed by the officers of the Water Company, a spring on this property, formerly connected with the city water supply, is not now used, and I have not examined the property referred to.

(b) Right to utilize streams and spring water (but not, I understand, to drill wells), on portion of Tower Farm, on north side of Huron River, opposite Pumping Station No. 1. This right applies to an indefinitely defined tract of land in the gorge of Allen Creek. Deed from Jas. C. Allen to Ann Arbor Water Company, recorded Nov. 4, 1885, Liber 105, Page 482. Water was formerly taken from Allen Spring, situated on this property, but such use has now been abandoned. Two wells, however, are located on the property just designated, and are now tributary to the water supply of the City of Ann Arbor, as will be described below.

(c) Right to drill wells, etc., on Cornwall property adjacent to the lands of the Ann Arbor Water Company on the south and east road lead-

ing to Pumping Station No. 1; this right applies to a strip of land 300 feet wide, measured along said road and extending to Huron River. Deed from Henry Cornwall et al to Ann Arbor Water Company, recorded April 24, 1898, Liber 140, Page 310. One four-inch well was drilled on this property to about the depth of 110 feet by the Ann Arbor Water Company, but at that depth a boulder was encountered and work abandoned without obtaining a serviceable water supply.

Reply to Item No. 1 of Instructions.

(Ascertain the location, number, depth, size, "logs," artesian head, etc., of all the wells that have been put down by the Ann Arbor Water Co. on lands belonging to said company, adjacent to each of its two pumping stations; the method now used for conducting the water from the wells referred to, to pumping wells or tanks, and indicate the location of the wells, water pipes, tanks, etc., on suitable maps, accompanied by sections showing character of strata, penetrated by wells.)

The sources of water supply now utilized at Station No. 1 are as follows:

1st. Four drilled wells in the bottom of a circular surface well 20 feet in diameter, 35 feet deep, gravel bottom, brick lined, with wall extending about 4 feet above the surface of the ground and roofed with wood. This source of supply is designated as "Tank-Well" on plot forming Exhibit No. 2. Opening in the bottom of this tank well are four drilled wells, as I have been informed by the officers of the Ann Arbor Water Company, three of which are 6 inches in diameter respectively; and one, 2 inches in diameter. (Note.—In a report of Messrs. Riggs and Sherman on the value of the property of the Ann Arbor Water Works Company, made in 1901, and now on file in the office of the City Clerk of Ann Arbor, the wells in the bottom of the tank-well are described as follows: "Four eight (8) inch wells one hundred and six (106) feet deep.") These wells, as I have been informed by the officers of the Ann Arbor Water Company, have a depth of about 120 feet, measured from the surface of the ground, are cased, and afford a strong

flow of water, but whether this water comes from more than one well I am unable to state. Thus far it has been impracticable for me to measure the flow of water from this source, but it appears to be the principal supply for Pumping Station No. 1. The water is conducted to a rectangular collecting reservoir near the pumping house by means of an iron pipe, 10 inches in diameter, with leaded joints, which leaves the tank-well about 6 feet below the surface of the ground. The pipe descends into the well within about one foot of the bottom, and is provided with a copper strainer two feet square and 14 to 16 inches long.

Near the lower end of the discharge pipe, just mentioned, there is a gate or valve, which, when closed, permits the water rising from the drilled wells in the bottom of the tank-well to accumulate until it stands within the said tank-well about one foot above the surface of the surrounding ground. If, when the discharge pipe is full of water, and the gate near the lower end of the discharge pipe opened, the said discharge pipe serves as a siphon, and, as reported by Mr. R. Spokes, engineer in charge of Pumping Station No. 1, will flow for about four days. The water in the tank-well can be drawn down by means of this siphon discharge-pipe to within two feet of the bottom. The time required for the tank-well to refill, after being lowered in the manner just stated, when the gate at the lower end of the pipe is closed, has yet to be ascertained.

The above described tank-well, with siphon, etc., was constructed in 1894-1895, and has been in constant use since that date. It is now in good repair and serviceable, but the drilled wells in its bottom should be inspected in order to learn if they require cleaning, etc.

Remarks.

Situated on a bluff about 30 feet high to the southeast of the tank-well, and about 75 feet distant, there is a barn, and at a distance of approximately 170 feet from the well in the same direction, there is a dwelling house, as is indicated on the plot forming Exhibit No. 2. What precautions have been taken to guard against the con-

tamination of the water in the tank-well, from the house and barn referred to, I am not informed. As the tank-well has a gravel bottom, and the water is pumped from it, owing to the action of the siphon described above, it is desirable, in my opinion, that the house and barn just mentioned, should not be used as a dwelling, or for stabling purposes, respectively.

2nd. Situated in the western portion of the land belonging to the Ann Arbor Water Company, and indicated as "The Gallery," on plot forming Exhibit No. 2, is a trench or gallery about 54 feet long (in two parts, one part 15 feet long, at right angles to the other), about 8 feet deep and 2 to 4 feet wide. The gallery is in part bordered by walls of stone and brick, above which there is planking, is roofed with boards, and is entered by means of a door provided with a lock. The bottom of the gallery is of gravel, and situated in it, as reported by the officers of the Water Company, are fourteen drilled wells, ranging in diameter from two to six inches. (Note.—In the report of Riggs and Sherman, referred to above, the wells in the gallery are described as follows: "Five two (2) inch wells and one six (6) inch well, and another well eight (8) inches in diameter and one hundred and forty (140) feet deep, drilled in the year 1900.") A six-inch well at the south end of the gallery is reported to be 95 feet deep; the other wells are said to range in depth from 60 to 120 feet. Of the fourteen wells referred to, only three were flowing at the time of my examination, June 19, 1905. One of the flowing wells, situated at the junction of the two arms of the gallery, is two inches in diameter, and the water coming from it rises $\frac{7}{8}$ of an inch above the top of the casing. This discharge is approximately thirteen gallons per minute. One two-inch well about 10 inches from the one just mentioned and the six-inch well referred to above, in each case barely overflow. The temperature of the water coming from the flowing wells, on the day mentioned above, was 50 degrees F. Surface water, with a temperature of 47 degrees F. enters the gallery near its south end, from beneath its enclosed wall, and is bring-

ing in sand which in part enters the opening of the six-inch well to which reference has been made, and will, no doubt, soon fill it. Water with a temperature of 47 degrees F. also rises from the sand in the bottom of the trench, and, like the inflow from beneath the wall, has a shallow source.

Of the wells in the gallery, which are not flowing, three could be located by means of the projecting ends of their casings, but the remainder were buried from sight by sand and by a reddish deposit (apparently in part a vegetable growth), upon the bottom of the trench.

The volume of water supplied by the gallery and the wells described above was not measured, but, by estimate, is about 30 gallons per minute, fully one-half of which is surface water.

The water on leaving the gallery is conducted through a 12-inch tile-pipe, with cemented joints, to a locality near the Michigan Central railroad track, as indicated on the plot forming Exhibit No. 2, where it is joined by an iron pipe which brings water from two wells situated in the gulch of Allen Creek, to be described below, and from that point is conducted to the gathering reservoir through a 12-inch wooden pipe. At the end of the wooden pipe, next to the collecting reservoir, however, there is one length of iron pipe.

Remarks.

The collecting gallery described above has evidently been repaired at various times, and is now in bad condition. The brick work is crumbling and ready to fall; the casing above the brick and stone side walls is of oak plank, in good condition, which appears to have been placed inside of an older casing of wood, which is badly rotted. The entrance of surface water to the gallery, as described above, is probably not objectionable so long as the field in which the gallery is located is not used for pasturage, or existing conditions are not otherwise changed; but the sand which is being brought in by the surface water will soon entirely close the flowing wells.

3rd. The third source of supply at Pumping Station No. 1, is a well situated south of the pumping house and designated as No. 20 on Exhibit No. 2. This is a six-inch well about 100 feet

deep, from which water is pumped. Another well, two inches in diameter, under the same cover as the six-inch well, is not at present connected with it. The water from the six-inch well, as I have been informed by the officers of the Ann Arbor Water Company, after being used for condensing purposes in connection with the engines of the pumping station, is delivered to a pumping tank connected with the receiving reservoir, and is a part of the Ann Arbor water supply. It is stated in Riggs and Sherman's report, referred to above, that there are six condenser wells at pumping station No. 1, each six inches in diameter and 120 feet deep. The wells referred to, as I understand, are Nos. 20-24, as marked on Exhibit No. 2. Of these, Nos. 20 and 23 are six-inch wells, and Nos. 21 and 22 are two-inch wells; as to No. 24 I am not informed. Of these wells, only No. 20 is now in use.

The location of the receiving tank referred to, and of its connecting pumping-tank, is indicated on plot forming Exhibit No. 2. The collecting reservoir measures 60x102 feet, at the high water line, and is 10 feet deep. The pumping tank is a circular brick well 15 feet in diameter and 35 feet deep, roofed with wood, and in good condition.

4th. A fourth source of supply at Pumping Station No. 1, is a dug well, No. 19, on Exhibit No. 2, 8 feet deep, brick lined, supplied in part with water from a tributary drain-tile about 14 feet long and about 6 feet below the surface. The water in this well is about 10 inches deep, and the discharge, by estimate, approximately six gallons per minute.

Wells on the Tower Farm.

5th. The fifth source of the present water supply at Pumping Station No. 1 is from two wells on the south side of the ravine of Allen Creek, on the Tower Farm, which farm is located on the north side of Huron River, opposite Pumping Station No. 1. These wells are each 4 to 5 feet in diameter and 8 feet deep, with brick linings; one is covered and the other open. The wells have been dug in a swampy tract of land near the base of the south bluff of Allen Creek, and discharge into an iron pipe which crosses beneath Huron River and joins the tile pipe mentioned

above, leading from the gallery on the land of the Ann Arbor Water Company to the receiving reservoir. The wells referred to are not pumped, but discharge by gravity, and may with more justness be termed imperfectly developed springs. The volume of water contributed to the city supply from these wells is, by rough measure, about ten gallons per minute.

The wells just described, as has been stated, are situated in a swampy area, and, in my opinion, are liable to contamination. It is my opinion, also, that this water should at once be excluded from the city water-supply.

6th. A possible sixth source of supply at Pumping Station No. 1, is the Huron River, with which the station is connected by means of a 12-inch wooden pipe, as indicated on the plot forming Exhibit No. 2. (Note. It has been stated that there are two pipes connecting Pumping Station No. 1 with the river, but as to the existence of a second pipe I have no definite information.) As I have been informed by the officers of the Ann Arbor Water Company, water has not been taken from the river for city use for several years.

Unproductive Wells.

The following information has been furnished by the Ann Arbor Water Company, concerning drilled wells on their land at Pumping Station No. 1, which are not utilized. This record is as follows:

First.

The "log" of a well drilled in 1888, and supposed to be located in the gallery described above:

Soil and clay.....	7 ft.
Sand	5
Blue clay	1
Gravel	9
Blue clay	5
Sand	7
Clay	9
Gravel	4
Clay and sand.....	4
Sand	11
Gravel	5
Clay	34
Gravel	6
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Total depth	107 ft.

No other record concerning this well is available.

Second.

Well No. 2, on plot forming Exhibit No. 2, passed through:

Gravel	50 ft.
Hardpan	10
Blue clay	60
Gravel	43
Shale rock	77

Total depth240 ft.

This well was cased with 8-inch iron pipe to a depth of 163 feet from the surface. But little water was obtained and the well did not flow. The casing was not withdrawn, but securely capped and covered with dirt.

Third.

Well No. 13, on plot forming Exhibit No. 1, 2½ inches in diameter, 110 ft. deep, water rose to within 20 feet of surface, not utilized, casing still projects about four feet above the surface of the ground.

Reply to Item No. 2 of Instructions.

(Ascertain the cost of the wells, water pipes, tanks, etc., now used by the Ann Arbor Water Company, to the localities where the water delivered by the said wells is available for pumping into the city water mains, or distributing reservoir.)

The only data I have to present in reference to the cost of the wells, collecting tank, etc., at Pumping Station No. 1, is compiled from the report by Riggs and Sherman, referred to above, and is as follows:

One collecting reservoir, 75x110 feet	\$ 2,160
One well, 18 feet in diameter, 30 feet deep	1,160
Thirty-five wells, 2 inches to 8 inches in diameter.....	7,000
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Total	\$10,320

This information is unsatisfactory, it seems to me, for the use of the present Water Works Committee, inasmuch as it does not specify what portion of the money expended in drilling, resulted in the production of available wells. Whether or not the memorandum includes work done on Allen Creek and now abandoned, and in connection with a former water-supply derived from the O'Brien property referred to above, I am not informed.

In reference to the tank-well, (referred to, as I understand, by Riggs and Sherman as "One well 18 feet in

diameter and 30 feet deep,") it should be noted that this well serves simply as a storage reservoir and that this result could have been much more cheaply secured by enlarging the collecting reservoir. The present arrangement of drilled wells in the bottom of the tank-well is a distinct disadvantage, since it renders the cleaning or repairing of the drilled wells difficult, if not impracticable. The siphoning of water from the drilled wells in as efficient a manner as at present could, in my opinion, have been accomplished without excavating the tank-well.

Reply to Item No. 3 of Instructions.

(Ascertain the location, number, size, etc., of private wells, if any, which have been put down adjacent to the property of the Ann Arbor Water Company, which derive their water supply from the same general source as do the wells of the said Water Company, and also the daily discharge of such private wells.)

So far as I have been able to learn, there are no wells not owned or controlled by the Ann Arbor Water Company, on lands adjacent to the lands of said Company at Pumping Station No. 1, and, so far as I can judge, no decrease in the water supply now available on the lands of the said Company is to be anticipated in the near future from the drilling of wells on adjacent property.

Reply to Item No. 4 of Instructions.

(Ascertain the volume of water now available for city use of the two pumping stations of the Ann Arbor Water Company.)

The only reply I can make at present is that I have been unable to secure direct measurements of the water-supply available at Pumping Station No. 1. A record of the water pumped from this station during the year 1904, as furnished by the Ann Arbor Water Company, is shown on accompanying Exhibit No. 4. The average is 738,356 gallons per day. The degree of reliance, however, to be placed in the records of water pumped, in the absence of direct measurement of the efficiency of the tributary wells, especially during summer months, has not been ascertained.

Reply to Item No. 5 of Instructions.

(Ascertain the variations, if any, which have occurred in the flow of the

wells of the Ann Arbor Water Company, and of private wells adjacent thereto; and also the temperature of the water now flowing from the wells, and, if practicable, any variation in temperature from season to season that may have occurred.)

No information in reference to variations, if any, which have occurred in the discharge of the wells at Pumping Station No. 1, is available, except the general statement that the wells in the gallery, as described above, have decreased in efficiency, owing to their having become clogged with sand, etc., which entered principally, as it seems, from the surface.

Reply to Item No. 6 of Instructions.

(Ascertain if the abandonment of wells or the withdrawal of the casing of one or more wells, on the property of the Ann Arbor Water Company, or adjacent thereto, has affected the flow of neighboring wells, or is likely to detract from the value of either group of wells belonging to said Water Company.)

As reported by the officers of the Ann Arbor Water Company, no casings have been withdrawn from the wells, which have proven failures, in the vicinity of Pumping Station No. 1. There is no reason to think that the value of the wells now in use has in any way been injured in the manner referred to.

Reply to Item No. 7 of Instructions.

(Ascertain if the wells of the Ann Arbor Water Company, now flowing, become clogged from time to time by sand or other material brought up by the water, or by deposits within the casings of said wells, and, if so, how frequently cleaning is necessary, and the cost of the same, together with the delays in pumping caused thereby.)

Information in this connection in reference to the wells in the gallery at Station No. 1, has been given above. As to the wells in the bottom of the tank-well, the evidence seems conclusive that they have never required cleaning. With reference to the entrance of sand, etc., into the well from which water is being pumped, I have no information.

Reply to Item No. 8 of Instructions.

(Collect an average sample of the water that is being pumped into the

water mains of the city, at each of the two pumping stations of the Ann Arbor Water Company, and place them in the hands of a competent chemist, to be selected by yourself, with instructions to furnish this Water Works Committee, through yourself, with reports of complete chemical analyses of the same.)

Samples of the water now being pumped into the city mains, at each of the two pumping stations of the Ann Arbor Water Company have been collected by me and placed in the hands of Professor E. D. Campbell for analysis. Reports on these analyses have been received and are presented in accompanying Exhibit No. 7.

Reply to Item No. 9 of Instructions.

(State your opinion, based on all available evidence, inclusive of the history of artesian wells at other localities where the geographical and other conditions are similar to those pertaining to the region adjacent to Ann Arbor, as to the further changes, if any, to be expected in the discharge of the wells of the Ann Arbor Water Company.)

As to the permanency of the water supply in the wells near Pumping Station No. 1, there seems to be little, if any, doubt that the wells in the bottom of the tank-well will continue to flow essentially as at present for many and, in fact, an indefinite number of years, provided they are properly cared for and no other wells are put down in their vicinity. In reference to well No. 21, from which water is now being pumped, I know of no facts to suggest that a decrease in its present efficiency is to be anticipated. The wells in the gallery, as already described, are badly clogged, but if cleaned and properly connected with the discharge pipe, may reasonably be expected to be of permanent value.

Reply to Item No. 10 of Instructions.

(State your opinion as to the danger, if any, of the contamination of the water discharged by the wells of the Ann Arbor Water Company, owing to the descent and underflow of surface water, sewage, etc.)

With their present surroundings, the only danger of contamination of the wells at Pumping Station No. 1, owing to the descent and underflow of sewage, is from the neighboring house

and barn, as noted above. This danger could easily be removed. It is to be understood, however, that the shallow wells in the gorge at Allen Creek, now utilized by the Ann Arbor Water Company, are not included in the above statement.

In this connection, also, I venture to record my opinion that the danger to the water supply of the city of contamination from surface sources at Pumping Station No. 1, is imminent and should receive serious consideration.

Reply to Item No. 11 of Instructions.

(State your opinion as to the effect of the flow of the wells of the Ann Arbor Water Company which would be likely to occur in case wells are put down in the future on lands adjacent to the lands on which the wells of said Company are located.)

A somewhat careful examination of the property of the Ann Arbor Water Company at Station No. 1 seemed to furnish conclusive evidence that there is no immediate danger of the present water supply at that station being diminished owing to the drilling of wells on adjacent property.

Replies to Items No. 12 and No. 13 of Instructions.

(12: In your opinion is the water supply now being utilized by the Ann Arbor Water Company to be considered as an adequate and reliable supply for the city of Ann Arbor for a period of twenty years to come?)

(13: State your opinion as to the money value of the wells, water pipes, receiving tanks, etc., i. e., the gathering system of the Ann Arbor Water Company, to the City of Ann Arbor, in case the city should desire to purchase the plant of the said Ann Arbor Water Company.)

Replies to these questions will be given later, after considering the existing conditions at Station No. 2.

PART II.

WATER SUPPLY AT PUMPING STATION NO. 2.

Location.

Pumping Station No. 2 and the adjacent lands owned by the Ann Arbor Water Company are located in the western portion of the city of Ann Ar-

bor, between Liberty and Washington Streets.

Lands and Water Rights.

The lands in the vicinity of Pumping Station No. 2, owned by the Ann Arbor Water Company, are indicated by broken lines and the lands adjacent, on which the Water Company has water rights, are indicated in dotted lines on the plot forming Exhibit No. 3. These lands have been purchased in several lots, and water rights acquired at various times, but the deeds relating to them have not been examined by me. The water rights just mentioned, as I have been informed by the officers of the Ann Arbor Water Company, include all water rights on the lands referred to, with two exceptions, namely: First, on the first 150 feet more or less of the Altmendinger property next east of the Pumping Station No. 2, the right to lay a drainage tile only has been secured, on the remainder of the said property, namely two lots abutting on West Washington Street as indicated in Exhibit No. 3, all water rights are owned by the Ann Arbor Water Company; Second, on the White property, situated as shown on Exhibit No. 3, to the west of the west boundary of Ann Arbor, the right to use surface and spring water is owned by the Ann Arbor Water Company, but not the right to drill wells.

In reference to the claim of the Water Company to certain water rights on the White property, it should be noted that the somewhat indefinite information which has been obtained indicates that the claims referred to are not admitted by the owner of the property, and this difference in opinion may lead to litigation.

Well Records, Etc.

The location, diameter and, in some instances, the depth of the wells owned or controlled by the Ann Arbor Water Company adjacent to Pumping Station No. 2, are indicated on Exhibit No. 3; and such data as I have been able to obtain concerning the "logs," etc., of these wells is presented in the accompanying Exhibit No. 6.

Reply to Item No. 2 of Instructions.

(Ascertain the cost of the wells, water pipes, tanks, etc., now used by the Ann Arbor Water Company, to the localities where the water delivered by the said wells is available for pumping

into the city water mains or distributing reservoir.)

All the information I have in reference to the cost of the wells, pipes, etc., of the collecting system at Pumping Station No. 2, has been obtained from a report by Riggs and Sherman, referred to above, viz:

One well, steel cased, 20 feet in diameter	\$3,120
Forty-two wells, 2½ inches to 8 inches in diameter	8,000

Total \$11,520

(The "One well" above referred to is erroneously stated in the report of Riggs and Sherman as being located at Station No. 1.)

Additional wells have been drilled since the date of the above mentioned report (the total number of wells, as I am informed, being 57), and costly developments are now in progress, but concerning these additional expenses I have no information.

Reply to Item No. 3 of Instructions.

(Ascertain the location, number, size, etc., of private wells, if any, which have been put down adjacent to the property of the Ann Arbor Water Company, which derive their water supply from the same general source as do the wells of the said Water Company, and also the daily discharge of such private wells.)

Wells have been put down on property adjacent to the lands owned by the Ann Arbor Water Company as follows:

The Hutzel Well.

The location of this well is indicated on Exhibit No. 3. It is a driven well, 2 inches in diameter, put down in 1889 or 1890, depth about 75 feet, now furnished with a ¾-inch discharge pipe. The well is reported to have flowed continuously since it was put down, and the water will now rise in an open pipe attached to the discharge pipe to a height of 27 inches above the wooden curb of the well, or about 815 feet above sea level. The discharge is small. Water escapes outside the casing of the well, however, and for this reason measurements of the artesian head and of the flow were not satisfactory. The temperature of the water on June 16, 1905, was 52 deg. F. The flow of this well is influenced by the condition of the wells on adjacent

property belonging to the Ann Arbor Water Company, being approximately one-third greater when the pipes leading from the said wells are closed than when they are open and the wells are permitted to flow to the receiving or pumping well, or are drawn on directly by the pumps at Pumping Station No. 2.

Wells on the Allmendinger Property.

Two driven wells, each 2 inches in diameter, and 80 to 83 feet deep, were put down on this property; one in 1890 and the other in 1894 or 1895. The first is reported to have ceased to flow when wells were drilled on the adjacent property belonging to the Ann Arbor Water Company, and was abandoned. The second well at first discharged a jet of water 2 inches in diameter and about 20 feet high, but now barely overflows and does not fill a $\frac{3}{4}$ inch discharge pipe. A variation in the discharge of this well is reported to occur when the pipes leading from the adjacent wells on the property of the Ann Arbor Water Company are opened or closed.

The Lutz Well.

On the Lutz property on the east side of Eighth Street, about 350 feet north of West Washington Street, there is a flowing well, 112 feet deep with a $\frac{3}{4}$ -inch discharge pipe, temperature 51 deg. F. The water discharged by this well is tributary to the Carp pond indicated on Exhibit No. 3.

So far as I have definite information, the three wells just described are the only ones immediately adjacent to the property of the Ann Arbor Water Company at Station No. 2, but other wells are stated to have been put down on property abutting on Huron Street, to the northwest of said Pumping Station, which became useless when the wells of the Ann Arbor Water Company at Pumping Station No. 2, were drilled.

Rep'y to Item No. 4 of Instructions.

(Ascertain the volume of water now available for city use at each of the two pumping stations of the Ann Arbor Water Company.)

The condition of the pipes, well's, etc., at Pumping Station No. 2 is such that it has been impracticable for me to obtain satisfactory measurements of the available water supply. On June 16, 1905, however, the Water Company

kindly closed gate No. 5 on plot forming Exhibit No. 3, thus, as I understand, confining the water furnished by all the wells in the system, excepting wells Nos. 30, 35 and 41, and opened a 5-inch discharge pipe leading to the surface at well No. 38. When the gate of this discharge pipe was opened, a jet of water rose at first to a height of about four feet above the surface of the ground, but soon diminished to a height of about thirteen inches. [The gate holding back the water had been closed, as I was informed by the officers of the Ann Arbor Water Company, for about an hour previous to the exhibition, and the stronger flow first witnessed seemed to have been due to the accumulation of water in the pipes leading from the supply wells. The jet 13 inches in height, referred to, appears to represent the normal outflow, but was irregular owing to the turns in the pipe, etc., and did not afford a means of accurately measuring the discharge. Such measurements as were obtained, however, show that the outflow was at the rate of approximately 500 gallons per minute. This, it is to be understood, was the flow from all the wells at Station No. 2, excepting wells Nos. 30, 35 and 41, which, at the time, were discharging into the receiving well an estimated rate of 15 to 20 gallons per minute, and the four wells in the bottom of the receiving or tank-well, of which no measurements are available. The rough and indefinite data just mentioned indicates that the total capacity of the wells at Pumping Station No. 2, at the present time, with the exception of the four wells in the bottom of the tank-well, is in the neighborhood of 800,000 gallons per day. The record of water pumped at the said station, furnished by the Ann Arbor Water Company, during the year 1904, was on an average 925,000 gallons per day. (See Exhibit No. 4.)

Reply to Item No. 5 of Instructions.

(Ascertain the variations, if any, which have occurred in the flow of the wells of the Ann Arbor Water Company, and of private wells adjacent thereto; and also the temperature of the water now flowing from the wells, and, if practicable, any variation in temperature from season to season that may have occurred.)

As to variations in the flow of the

wells of the Ann Arbor Water Company at Pumping Station No. 2, I have no definite information. The Hutzel and Allmendinger wells, however, immediately adjacent to said property, as already stated, have undergone a decided decrease in flow since the wells on the property of the Ann Arbor Water Company were put down. The artesian head of the Hutzel well, for example, is reported on good authority to have decreased from about 20 feet above the adjacent ground level, at a date soon after the well was constructed, to approximately 27 inches at the present time, and the Allmendinger well has suffered a corresponding depletion. As these two wells are supplied from the same sources as the wells on the adjacent property of the Ann Arbor Water Company, a corresponding decrease in the efficiency of the wells of the Water Company referred to, viz: wells Nos. 1 to 28, as marked on Exhibit No. 3, may be reasonably inferred to have taken place.

Reply to Item No. 6 of Instructions.

(Ascertain if the abandonment of wells or the withdrawal of the casing of one or more wells, on the property of the Ann Arbor Water Company, or adjacent thereto, has affected the flow of neighboring wells, or is likely to detract from the value of either group of wells belonging to said Water Company.)

I have been informed by the officers of the Ann Arbor Water Company that no casings have been withdrawn from any wells drilled in the neighborhood of Pumping Station No. 2, and it does not appear that the artesian head of the wells now in use at that station has been impaired owing to the abandonment of neighboring wells.

Reply to Item No. 7 of Instructions.

(Ascertain if the wells of the Ann Arbor Water Company, now flowing, become clogged from time to time by sand or other material brought up by the water, or by deposits within the casings of said wells, and, if so, how frequently cleaning is necessary, and the cost of the same, together with the delays in pumping caused thereby.)

No information in this connection has been obtained. None of the wells have been opened for my inspection and I am unable to report as to their present condition.

Reply to Item No. 8 of Instructions.

(Collect an average sample of the water that is being pumped into the water mains of the city, at each of the two pumping stations of the Ann Arbor Water Company, and place them in the hands of a competent chemist, to be selected by yourself, with instructions to furnish this Water Committee, through yourself, with reports of complete chemical analyses of the same.)

A sample of the water pumped into the city mains at Pumping Station No. 2 has been collected by me and placed in the hands of Professor E. D. Campbell for analysis. Professor Campbell's report forms Exhibit No. 7, and will be considered later.

Reply to Item No. 9 of Instructions.

(State your opinion, based on all available evidence, inclusive of the history of artesian wells at other localities where the geographical and other conditions are similar to those pertaining to the region adjacent to Ann Arbor, as to the further changes, if any, to be expected in the discharge of the wells of the Ann Arbor Water Company.)

The decrease in the artesian head of the Hutzel and Allmendinger wells, as noted above, together with the history of artesian wells at several localities in Michigan where the geological and other conditions are similar to those at Pumping Station No. 2, favors the conclusion that the surface flow from the wells at that locality, is at the minimum, to be expected so long as the present conditions on which the flow depends remain unchanged. The water delivered by the deeper wells is supplied by rain falling on the uplands to the west, and, for the series of shallow wells, by rain and springs in the immediate vicinity. So long as climatic conditions remain essentially as at present, the wells in each series may reasonably be relied upon to furnish about the same volume of water as at present for an indefinite series of years, providing they are properly cared for. Concerning a possible increase in flow, on account of a possible increase in rainfall, which has been suggested, the data supplied by weather records, as it seems to me, is too meager to admit of framing an opinion. The drilling of additional wells might and probably would in

crease the total outflow somewhat, but the discharge of all the wells in the higher or lower series, according to the depth of the additional wells, would be decreased, and the higher wells in one or the other series would cease to flow. The economic limit in the development of the artesian water supply at this station—within the city limits—has been reached and, in my judgment, much exceeded. This judgment is based on the fact that 57 wells have been put down within a linear distance of about 1,600 feet; the total discharge of these wells, even if the records of the amount of water pumped at Station No. 2 are thoroughly reliable, is 925,000 gallons per day, or at the rate of about 12 gallons per minute for each well. The feebleness of the discharge thus indicated renders it probable that some and possibly a considerable number of the wells are no longer serviceable.

Reply to Item No. 10 of Instructions.

(State your opinion as to the danger, if any, of the contamination of the water discharged by the wells of the Ann Arbor Water Company, owing to the descent and underflow of surface water, sewage, etc.)

In this connection it is to be noted that the wells now utilized by the Ann Arbor Water Company at Pumping Station No. 2 are situated in a ravine in a somewhat thickly inhabited portion of the city, and also that the adjacent streets are without sewers. The wells referred to fall into two groups, in reference to depth. The first group includes wells which are less than 50 feet deep; and the second group includes the wells which are from about 75 to 150 feet deep. The wells less than 50 feet deep penetrate muck, sand, gravel, etc., but do not go through a sufficient thickness of impervious material to exclude seepage from the adjacent uplands; but the wells from 75 to 150 feet deep do penetrate a layer of clay or till from 20 to 50 or more feet thick. In my opinion, the wells deriving their supply from a less depth than that of the surface of the layer of clay or till, penetrated by the deeper wells, are in danger of contamination, owing to descent and underflow of sewage, etc., from the surface in the vicinity. The deeper wells, however, viz: those from 75 to 150 feet in

depth, are to be adjudged safe from contamination so far as cesspools, etc., near at hand are concerned; but it is not certain that they are safe in reference to seepage from cesspools, etc., in the portion of the city farther to the northwest.

My opinion, based upon the above considerations and current knowledge concerning the percolation of water through porous material, etc., is that the water derived from the wells 50 feet or less in depth is in danger of contamination and should be excluded from the water supply of the city of Ann Arbor. How greatly the abandonment of the wells referred to will deplete the present available water supply of the Ann Arbor Water Company I have no means of knowing, as I have been unable to learn the amount of water that is delivered by individual wells. I am in doubt as to the propriety of using the water from the deeper wells, but as no risk should be taken in reference to the sanitary condition of the water supply of a city, I think it would be prudent to abandon these wells also as soon as a more satisfactory source of water supply for the city of Ann Arbor can be made available. While I hesitate in recommending the abandonment of the deeper wells referred to above, so long as they continue to flow, I have no hesitation in saying that water pumped from them on an extensive scale should not be used for domestic purposes. In this connection, account should be taken of the fact that the present arrangement of discharge pipes furnishes a more or less efficient siphon system, which is equivalent to pumping.

The conclusions just presented are essentially in harmony with certain recommendations made to the Common Council of the City of Ann Arbor, by Mr. Frank Leverett, geologist, U. S. Geological Survey, Feb. 6, 1905, a copy of which forms the accompanying Exhibit No. 5.

Reply to Item No. 11 of Instructions.

(State your opinion as to the effect on the flow of the wells of the Ann Arbor Water Company which would be likely to occur in case wells are put down in future on lands adjacent to the lands on which the wells of said company are located.)

The fact that the drilling of wells by

the Ann Arbor Water Company near Pumping Station No. 2 has seriously depleted wells put down on adjacent property is clear evidence that the reverse would be the case. There is no doubt that wells drilled on lands adjacent to the lands of the Ann Arbor Water Company at Pumping Station No. 2, where the surface level is less than about 815 feet above tide, would lessen and, if a number of such wells should be drilled, stop the flow of the 57 wells now controlled by the said Company. The area of the land so situated, however, is small, and the probable danger of loss of water from this source cannot be considered as great.

Reply to Items No. 12 and No. 13 of Instructions.

(No. 12: In your opinion is the water supply now being utilized by the Ann Arbor Water Company to be considered as a reliable and adequate supply for the city of Ann Arbor for a period of twenty years to come?)

(No. 13: State your opinion as to the money value of the wells, water pipes, receiving tanks, etc., i. e., the gathering system, of the Ann Arbor Water Company, to the city of Ann Arbor, in case the city should desire to purchase the plant of the said Ann Arbor Water Company.)

Replies to these two items will be given below, in connection with replies to the same questions with reference to Pumping Station No. 1.

Water Rights.

The lands adjacent to the lands belonging to the Ann Arbor Water Company at Pumping Station No. 2, on which said Company has the right to use water, are indicated on Exhibit No. 3, and part of the wells now in use, viz: Nos. 42 to 46 are situated on such lands. Respecting the value of these water rights I have but little information, excepting in reference to the White property, situated just west of the west boundary of the City of Ann Arbor, where there is a copious spring, which, I am informed, is soon to be connected with the city water supply. The flow of this spring, as measured by A. P. Frapwell and C. E. Wilson, June 24, 1905, was 42.7 gallons per minute. An iron pipe 8 inches in diameter, is now being laid from this spring to Pumping Station

No. 2, and near the spring, as the work that has been done indicates, is to divide into two branches (the branches, I understand, to be tile drains), as shown by dotted lines on the plot forming Exhibit No. 3. But the main water supply is from the southwest branch.

The spring referred to, has a temperature of 52° F., and, as is judged, rises from a source 100 feet or more below the surface. In my opinion the available water supply of this locality could be materially increased by sinking wells. This source of water supply is among the most valuable of the water rights of the Ann Arbor Water Company, but, as already stated, the claims of the Water Company apply only to the surface and spring water and do not include the right to drill wells.

Remarks on the General Plan of the Gathering System of the Ann Arbor Water Company.

The development of the gathering system of the Ann Arbor Water Company appears to have been carried forward without any definite plan in view, and the location of the wells is not, in my judgment, such as to secure the greatest efficiency from the expenditures made. Considering that the work done has been in part exploratory, criticism of the results secured should be conservative, but certain features of what may be termed the "layout" should be understood by a purchaser of the property of the Water Company. The facts referred to are:

1st. The wells are not grouped in reference to the direction of the flow of the water with which they are supplied, so as to secure the greatest efficiency.

2nd. In several instances wells have been drilled within a few feet of each other, sometimes in groups of three or four, within a radius of less than ten feet, and in the case of the gallery at Pumping Station No. 1, fourteen wells are located within a linear distance of fifty-four feet. A wider spreading of the wells would have secured better results at the same cost.

3rd. The wells are in most instances directly connected with a general system of discharge pipes, and if

the statements of the officers of the Ann Arbor Water Company were rightly understood, are without gates by means of which individual wells could be isolated from the general system, and are without caps which could be removed, thus permitting of the opening of an individual well for inspection, repairs, etc.

4th. The wells range in size from 2 to 8 inches in diameter, thus entailing greater cost in maintenance than if a standard size had been chosen.

5th. In the case of the receiving or pumping well at Pumping Station No. 2, four drilled wells are located in the bottom of a dug well thirty-five feet deep, which receives the inflow from all the other wells in the system. This arrangement precludes access to the four drilled wells referred to, and, as the artesian head of these wells, as I have been informed by the Superintendent of the Ann Arbor Water Company, is not known, it is not practicable to ascertain whether they serve to increase the water supply in the receiving well or permit the escape or leakage of the water delivered to it from the other wells. The arrangement referred to also makes it impracticable to clean the drilled wells in the bottom of the receiving well, in case they become clogged. Conditions similar to those to which attention is here directed, exist at the tank-well at Pumping Station No. 1, as already stated, except that the tank-well at that station does not receive water from drilled wells in its vicinity.

6th. A part of the gathering system now in operation consists of tile and wood pipes, as indicated on the accompanying Exhibits Nos. 2 and 3. From a sanitary point of view there seems no objection to such pipes, so far as they are now in use, at Pumping Station No. 1, but at Pumping Station No. 2, a tile pipe, which is a part of the collecting system, and is, in part, as I am informed, without cemented joints, has been laid at a depth of some four or five feet, through a swampy tract of land which receives the seepage from neighboring cesspools, etc., and is an element of danger to the health of this city. In case the plant of the Ann Arbor Water Company is purchased, the

condition of the wooden pipes at Pumping Station No. 1 should be definitely ascertained.

7th. When artesian wells are put down in unconsolidated material like that penetrated by the wells of the Ann Arbor Water Company, it is desirable that they be provided with discharge pipes inside of the larger pipes which form the linings or casings of the wells, and extending from the surface to the bottom of the casing, or, as is the practice under certain conditions, terminate just above where the casing is perforated for the ingress of water. The lower end of a discharge pipe should be provided with a suitable strainer to exclude sand, etc., and just above the strainer the space between the discharge pipe and the casing should be securely closed by means of a seed-bag or other device. By this arrangement, the discharge pipe can be withdrawn for the purpose of cleaning or repairs, without disturbing the casing which encloses the well. So far as I am informed, the wells of the Ann Arbor Water Company are not provided with discharge pipes. I am not positive that I am fully informed in this connection, however, but in case the wells, or a part of them, are not so provided, or the same end is not attained in some other way, account should be taken of this defect in estimating their value.

Summary.

My reply in answer to Item No. 12 of Instructions, including the wells at both pumping stations, is:

1st. About the present average rate of discharge from the wells will probably continue for a great length of time, providing existing conditions are not changed, and the wells are properly cared for.

2nd. The supply, as has been shown by evidence presented before this Committee, is at present inadequate, especially during summer seasons; and the deficiency will most surely increase more and more as Ann Arbor increases in population.

I am unable to make a definite reply in answer to Item No. 13, of Instructions, for the reason that I have been unable to obtain the information necessary for reaching a conclusion. I can say, however, that, in my opin-

ion, it is not desirable for the City of Ann Arbor to purchase the present collecting system of the Ann Arbor Water Company with the expectation of utilizing it permanently for the water supply of Ann Arbor.

Perhaps it will be desirable and practicable to purchase the collecting system, referred to, for temporary use; that is, until a satisfactory water supply can be secured. In case the purchase of the property, referred to, for such temporary use is deemed desirable, I recommend that in order to ascertain its value the entire plant of the Ann Arbor Water Company be placed under the general direction of a competent engineer, to be designated by the Common Council of the City of Ann Arbor, for operating and testing for a period of not less than one month during a summer season.

Recommendation.

As bearing on the several questions submitted to me by your Honorable Body, I desire to state that other water supplies similar to those now utilized by the Ann Arbor Water Company, could be obtained for the use of this City, but the experience gained in this connection by the said Water Company is, in my opinion, sufficient warrant for not expending money in their development.

The only alternative to the use of well water for the water supply of the city of Ann Arbor, which appears to be practicable, is the utilization of the water of the Huron River. In making a choice between these two sources of water supply, three principal considerations present themselves. These are: 1. The volume of water available in each instance. 2. Its sanitary condition. 3. Its chemical composition. The data necessary for a discussion of these questions is not at present available, but I venture to make the following suggestions in reference to the chemistry of the water now supplied to the city.

As shown by the accompanying analyses by Professor E. D. Campbell, the water now used in Ann Arbor contains, approximately, 471 parts in a million by weight, of total solids in solution, consisting principally of calcium, magnesium and silica. That is,

the water is "hard;" and it is not stating this fact too strongly to say that it is excessively hard. Its relation, in this respect, to other waters used for domestic purposes, is indicated by the fact that it contains about three times the percentage of mineral matter, in solution, present in the water of the St. Lawrence, seven eight-tenths times that of the Mississippi near New Orleans, and three times the average for a number of the larger American rivers.

From the analysis referred to, and the records of water pumped during the year 1904, as presented on the accompanying Exhibit No. 4, namely, 607,000,000 gallons, it appears that the total amount of mineral matter in solution supplied to this city during a year is nearly 1,200 tons.

This high content of mineral matter in solution affects the desirability of the water for drinking, and is also a serious matter in reference to what may be termed its commercial use. As to its healthfulness, I am not qualified to express an opinion, but this is obviously a matter that should receive grave consideration. In reference to its commercial use, the expense it entails is well known to every resident of Ann Arbor. In this connection, I need but mention: First, the "scale" formed in boilers, when the water is used in generating steam; second, the clogging of "water-backs" when it is heated for household use; third, the large quantity of soap required to counteract the hardness; fourth, the precipitates formed in water closets, urinals, etc., which lead to unsanitary conditions; and fifth, the deposits made in water meters which, as has been stated by the officers of the Water Company, render their use impracticable.

In comparison with the hardness of the water now supplied to this city, it is reasonable to suppose that the water of the Huron River would be much less objectionable, but in order to accurately determine this question, analyses of the river water are necessary. I therefore suggest that this Committee request the Common Council of the City of Ann Arbor to have two analyses made of the water of Huron River; one sample for an-

alysis to be taken during a high water stage of the river, and the other during the lowest stage in summer. The cost of these analyses will be \$40.

As a tentative plan for supplying the city of Ann Arbor with water, I venture to submit the following scheme for your consideration, viz: Endeavor to secure the co-operation of Dexter and Ypsilanti in placing a dam across the Huron River at Dexter, together with the erection of a suitable filtration plant, and to connect the same with Ann Arbor and Ypsilanti by means of water mains. For the purpose of ascertaining the practicability and cost of such a scheme, and also with a view to learning the feasibility of utilizing the water of Huron River by means of a dam, or otherwise, at some other location than the one named, for the water supply of Ann Arbor only, I respectfully suggest that this Committee recommend the Common Council of the City of Ann Arbor to employ a competent hydraulic engineer, and to instruct him to make such surveys as will enable him to decide upon the best possible plan for utilizing the water of the Huron River for the water supply of Ann Arbor, and also to make detailed plans and specifications for such water works, including filtration plant, etc., as in his judgment should be constructed.

I also respectfully recommend that this Committee request the Common Council of the City of Ann Arbor to require the Ann Arbor Water Company to exclude from the water supply now being furnished this city the water from the wells on the Tower Farm, and the water from all wells less than 50 feet deep now tributary to the water supply at Pumping Station No. 2. Also, that all tile water-pipe now in use for conducting water to Pumping Station No. 2, be replaced by suitably laid iron pipes, or else permanently disconnected from the water supply of the city.

Respectfully submitted,

(Signed) ISRAEL C. RUSSELL.

EXHIBIT No. 1.

To Accompany Preliminary Report by Israel C. Russell, on the Water Supply of the Ann Arbor Water Company. Dated, June 24, 1905.

Water Works Committee.

Meeting held in Council Chamber, Court House, Ann Arbor, May 31, 1905.

Meeting called to order by President Coon. Roll call. Present: Coon, Copeland, Darling, Davis, Dean, Douglas, Fischer, Markley, Ohlinger, Russell, Schlenker, Sherk, Wilgus. Messrs. Darling, Douglas and Sherk entered after the roll was called and during the progress of the meeting. The minutes of the last meeting were not read.

Professor Wilgus, seconded by Mr. Fischer, moved the adoption of the following resolution:

1. Ascertain the location, number, depth, size, 'logs,' artesian head, etc., of all the wells that have been put down by the Ann Arbor Water Company on lands belonging to said Company adjacent to each of its two pumping stations; the method now used for conducting the water from the wells referred to, to pumping wells or tanks, and indicate the location of the wells, water pipes, tanks, etc., on suitable maps, accompanied by sections showing character of strata, penetrated by wells.

2. Ascertain the cost of the wells, water-pipes, tanks, etc., now used by the Ann Arbor Water Company, to the localities where the water delivered by the said wells is available for pumping into the city mains or the distributing reservoir.

3. Ascertain the location, number, size, etc., of private wells, if any, which have been put down adjacent to the property of the Ann Arbor Water Company, which derive their water supply from the same general source as do the wells of the said Water Company, and also the daily discharge of such private wells.

4. Ascertain the volume of water now available for city use at each of the two pumping stations of the Ann Arbor Water Company.

5. Ascertain the variations, if any, which have occurred in the flow of the wells of the Ann Arbor Water Company, and of private wells adjacent thereto; and also the temperature of the water now flowing from the wells, and, if practicable, any variation in temperature from season to season that may have occurred.

6. Ascertain if the abandonment of wells or the withdrawal of the casings of one or more wells, on the property of the Ann Arbor Water Company, or adjacent thereto, has affected the flow of neighboring wells, or is likely to detract from the value of either group of wells belonging to said Water Company.

7. Ascertain if the wells of the Ann Arbor Water Company, now flowing, become clogged from time to time by sand or other material brought up by the water, or by deposits within the casings of said wells, and, if so, how frequently cleaning is necessary, and the cost of the same, together with the delays in pumping caused thereby.

8. Collect an average sample of the water that is being pumped into the water mains of the city, at each of the two pumping stations of the Ann Arbor Water Company, and place them in the hands of a competent chemist, to be selected by yourself, with instructions to furnish this Water Works Committee, through yourself, with reports of complete chemical analyses of the same.

9. State your opinion, based on all available evidence inclusive of the history of artesian wells at other localities where the geographical and other conditions are similar to those pertaining to the region adjacent to Ann Arbor, as to the further changes, if any, to be expected in the discharge of the wells of the Ann Arbor Water Company.

10. State your opinion as to the danger, if any, of the contamination of the water discharged by the wells of the Ann Arbor Water Company, owing to the descent and underflow of surface water, sewage, etc.

11. State your opinion as to the effect on the flow of the wells of the Ann Arbor Water Company, which would be likely to occur in case wells are put down in the future on lands adjacent to the lands on which the wells of said Company are located.

12. In your opinion, is the water supply now being utilized by the Ann Arbor Water Company to be considered as a reliable and adequate supply for the City of Ann Arbor for a period of twenty years to come.

13. State your opinion as to the

money value of the wells, water-pipes, receiving tanks, etc., i. e., the gathering system of the Ann Arbor Water Company, to the City of Ann Arbor, in case the City should desire to purchase the plant of the said Ann Arbor Water Company.

Resolved, That the Common Council be, and hereby is, requested to allot the sum of \$100.00, or so much of that sum as may be necessary, to pay for the hire of laborers, assistants, typewriting, surveying, map-making, etc., in furtherance of the work Mr. Russell has been directed to perform; and also to allot the sum of \$40.00 to pay for two chemical analyses of the water now being furnished the City of Ann Arbor by the Ann Arbor Water Company.

Resolved, That the Common Council be, and hereby is, requested that, in case suitable maps or plats of the lands of the Ann Arbor Water Company are not now available, the City Engineer be directed to make such maps or plats, and to assist in locating the positions of the wells, water-pipes, tanks, etc., thereon, under Mr. Russell's direction.

Adopted by the following vote: Yes—Coon, Copeland, Darling, Davis, Dean, Fischer, Chlinger, Russell, Schlenker, Sherk, Wilgus. No—None.

Respectfully submitted,

(Signed)

ISRAEL C. RUSSELL.

EXHIBITS Nos. 2 AND 3.

To Accompany Preliminary Report by Israel C. Russell, on the Water Supply of the Ann Arbor Water Company. Dated June 24, 1905.

These exhibits consist of two maps, bearing these numbers, which accompany this report.

Respectfully submitted,

(Signed)

ISRAEL C. RUSSELL.

(The maps referred to are on file in the office of the city clerk.)

EXHIBIT No. 4.

To Accompany Preliminary Report by Israel C. Russell, on the Water Supply of the Ann Arbor Water Company. Dated June 24, 1905.

Amount of water supplied to the City of Ann Arbor, by the Ann Arbor Water Company, during the year 1904:

(Information furnished by Dr. A. K. Hale, Manager, Ann Arbor Water Co.)
Pumping Station No. 1.

Volume of water pumped during the month of:

	Gallons.
January	22,000,000
February	23,000,000
March	20,000,000
April	17,000,000
May	23,000,000
June	27,000,000
July	27,500,000
August	24,000,000
September	19,000,000
October	22,000,000
November	22,000,000
December	23,000,000

Total for year.....269,500,000
 Average per day..... 738,356

Pumping Station No. 2.

Volume of water pumped during the month of:

	Gallons.
January	31,000,000
February	33,000,000
March	31,000,000
April	27,000,000
May	28,000,000
June	31,000,000
July	30,500,000
August	27,700,000
September	21,700,000
October	25,000,000
November	24,000,000
December	28,000,000

Total for year.....337,500,000
 Average per day..... 925,000

Total water pumped during the year.....607,000,000

Respectfully submitted,

(Signed)

ISRAEL C. RUSSELL.
EXHIBIT No. 5.

To Accompany Preliminary Report by Israel C. Russell, on the Water Supply of the Ann Arbor Water Company. Dated June 24, 1905.

To the Honorable, The Common Council of the City of Ann Arbor :

Gentlemen:—I beg to submit a brief statement concerning certain conditions in the public water supply of Ann Arbor, based upon an examination made for the United States Geological Survey the past summer. These results are to be embodied in a

Government Report upon the water supplies of the Southern Peninsula of Michigan.

At the time the investigation was begun, there seemed especial need for inquiring into the sanitary conditions, owing to the occurrence of a colon bacillus in the water supply, which indicated that foecal matter was being distributed in the city mains, the knowledge of the occurrence of this bacillus having been obtained from Dr. V. C. Vaughan, who is in charge of the hygienic laboratory of the University. This matter was investigated sufficiently to determine that the contamination had occurred at the upper Station, in Section 17, Ann Arbor Township, and resulted from the access of polluted surface waters to a pipe which conducts the water from the wells to the basin near the Pumping Station. It was merely an incident of the freshets, and the chance for further contamination in that direction has, I believe, been thoroughly guarded against by the Water Company. Aside from this contamination, the supply from the wells at the Pumping Station in Section 17, appears to be satisfactory and safe.

Investigation of the wells at the Washington Street Pumping Station has shown the supply to be from two classes of wells. One class is made up of shallow wells about 30 to 35 feet in depth, which are almost entirely through sand after passing through a surface bed of peat or muck, the supply being from coarse sand or gravel at the depths named. The other class is of deeper wells (80 to 150 feet), which, after penetrating the same deposits encountered in the shallow wells, pass, in most cases, through boulder clay to deeper lying sand or gravel. In each class of well the water has a strong hydrostatic pressure, or upward flow sufficient to bring it to the surface without pumping, and the water flows by gravity from the wells to a large receiving well near the Pumping Station, from which it is pumped to the mains. The wells are all situated in a ravine in the inhabited portion of the City, there being at least sixty cesspools or privy vaults whose natural surface drainage is into the portion of the ravine where these wells are located.

While these surroundings give to the wells an unsavory setting, it cannot be stated that the contamination of the water has yet occurred. It was found that heavy pumping, which occurred at the time the large receiving well was being constructed, drained a number of the wells at residences on the bluffs of the ravine, showing that a part of the supply is from the immediate vicinity, and includes the district in which the sixty or more cesspools and privy vaults occur. A redeeming feature, however, is found in the fact that the wells are all cased clear to the bottom, so that in the shallowest ones the water enters at a depth of about 30 feet from the surface. The chances for surface drainage to penetrate a depth of 30 feet and enter the wells are very remote, especially when the wells are simply allowed to flow. If the wells were subjected to heavy draughts by pumping, as was done when the receiving well was under construction, the chance of pollution would be greatly increased. At present the Water Company is not pumping the individual wells and there seems very little occasion for suspecting contamination. The analyses of these wells made at the hygienic laboratory of the University, have thus far shown no contamination of these waters.

It appears that the present natural flow from wells owned by the Water Company is insufficient to meet the demands of the city in seasons of excessive drouth when large amounts are required for sprinkling streets and lawns and the watering of gardens. If the Water Company meets these demands it must either resort to a heavy draught on the wells, which might bring in water contaminated by cesspools, or must pump water from the Huron River, and this at times when the stage of water in the river is very low and the quality dangerous. Last summer, when a shortage of water arose, the Water Company chose to pump from the Huron River, as admitted by the President of the Water Company at that time, but did not take the precaution to notify the citizens of the introduction of this foul water into the city supply, or make request through the city papers that the water be

thoroughly boiled before drinking. The water was so foul that analyses and cultures made at the hygienic laboratory of the University led to a prompt notice from Dr. Vaughan to stop pumping from the river.

This incident serves to set forth the disadvantage of having the public water supply in the hands of a private company, even though the private company is striving hard to meet the demands of the citizens. It seems important at this time, while attention is being directed to other short-comings of the Water Company, that this matter, so vital to the health of the community, be fully investigated and rectified.

Very respectfully,
 (Signed) FRANK LEVERETT.
 Ann Arbor, Michigan, Feb. 6, 1905.
 Respectfully submitted,
 (Signed) ISRAEL C. RUSSELL.

EXHIBIT NO. 6.
 To Accompany Preliminary Report by Israel C. Russell on the Water Supply of the Ann Arbor Water Company. Dated: June 24, 1905.

Logs of Wells at Pumping Station No. 2.

(Information furnished by Dr. A. K. Hale, Manager Ann Arbor Water Company.)

(The well numbers refer to plot forming Exhibit No. 3.)

Well No. 23—an 8-inch well at the s. w. corner of the pump house:
 Surface soil 12 ft.
 Quicksand 33
 Dry Gravel 3
 Cobblestones and gravel 12
 Clay hardpan 25
 Quicksand 5
 Blue clay 5
 Hard sand 12
 Water gravel (good floor of H₂O) 7
 Clay hardpan and gravel with streaks of water-bearing sand. 9

Total 126 ft.

(Cased to a depth of 107 feet.)

The above section is essentially a duplicate of the section obtained in drilling well No. 22, a 6-inch well put down in 1897, near the s. e. corner of the pump house.

The wells between the pump house

and West Washington Street, namely Nos. 1 to 21, inclusive, are about 80 to 90 feet in depth, are of various diameters, namely 2 inches, 2½ inches, 4 inches and 6 inches, and penetrate material of about the same character as well No. 23.

Well No. 25—a 6-inch well drilled in 1901:

Cobblestones	10 ft.
Sand	12
Clay and gravel	26
Blue clay	36
?	19
?	1
Hardpan	2
Water-bearing gravel	2

Total125 ft.

Surface soil 10 ft.

Well No. 28—a 6-inch well drilled in 1901:

Dry gravel	26
Blue clay	54
Hardpan	38
Water-bearing gravel	2

Total 130 ft.

Well No. 41—

Surface soil, etc.....	8 ft.
Sand and gravel.....	6
Yellow clay	17
Water-bearing sand	7
Blue clay	69
Hardpan	3
Water-bearing gravel	2

Total112 ft.

Well No. 42—a 6-inch well drilled in 1900:

Surface soil	10 ft.
Water-bearing sand	12
Blue clay	25
Quicksand	3
Blue clay	38
Clay and hardpan.....	41
Water-bearing gravel	2

Total131 ft.

Well No. 43—a 6-inch well drilled in 1901:

Cobblestones and clay.....	10 ft.
Water-bearing sand	12
Clay and gravel	25
Quicksand	2
Blue clay	35
Hardpan	43
Water-bearing gravel	2

Total130 ft.

Well No. 44—a 6-inch well:

Cobblestones and dry gravel...	28 ft.
Yellow clay	6
Water-bearing sand	12
Blue clay	26
Gravel-hardpan	20
Clay-hardpan	27
Gravel-hardpan	10
Water-bearing gravel	1

Total 130 ft.

Well No. 45—a 6-inch well drilled in 1901:

Cobblestones and gravel.....	28 ft.
Clay	4
Sand and gravel.....	15
Blue clay	37
Gravel and hardpan.....	23
Water-bearing sand	9
Gravel-hardpan	13
Water-bearing sand and gravel.	4
Gravel-hardpan	16
Slate rock	5

Total154 ft.

(Failed to flow; water stood 23 feet below the surface; abandoned; 147 feet of casing left in place.)

Well No. 46—a 6-inch well drilled in 1900:

Cobblestones and gravel.....	28 ft.
Yellow clay	4
Water-bearing sand	14
Blue clay	25
Gravel-hardpan	24
Water-bearing sand	2

Total 97 ft.

Well No. 47—a 6-inch well:

Surface soil, etc	2 ft.
Sand and gravel.....	19
Dry gravel	4
Blue clay	63
Gravel-hardpan	6
Water-bearing sand	4
Gravel-hardpan	33
Water-bearing gravel	2

Total133 ft.

Well No. 48, west of factory and west of Eighth Street:

Surface soil, etc.....	3 ft.
Sand and gravel.....	13
Water-bearing sand	11
Hardpan	3
Blue clay	9
Gravel-hardpan	8
Quicksand	7
Blue clay	4
Quicksand	5

Blue clay	48
Hardpan	25
Quicksand	4

Surface	3 ft.
Water sand	18
Water gravel	3

Total140 ft.
 (At a depth of 140 feet boulder was encountered, and the well abandoned; casing not withdrawn.)

Total	34 ft.
-------------	--------

V.

Water sand	18 ft.
Water gravel	8

The Shallow Wells.
 Wells Nos. 49 to 57, inclusive, are 6 inches in diameter, cased, and range from 23 to about 45 feet. They were put down in 1904 and penetrate unconsolidated deposits of gravel, sand and muck and then stony clay beneath which the deeper wells obtain water. The "logs" of seven of these wells, supplied by Mr. Frank Leverett, are as follows, but the numbers on the accompanying map, Exhibit No. 3, pertaining to these wells individually, are not known:

Total	26 ft.
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VI.

Pipe driven with screen.....	25 ft.
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VII.

I.

Surface	3 ft.
Gravel	16
Clay	5
Gravel	1
Total	25 ft.

Surface	3 ft.
Water sand	18
Water gravel	2
Total	23 ft.

The shallow wells mentioned above, namely those numbered from 49 to 57, inclusive, on the map forming Exhibit No. 3, are in danger of contamination from cesspools, etc.

II.

Surface	3 ft.
Gravel	5
Water sand	14
Gravel	1
Total	23 ft.

Respectfully submitted,
 (Signed) ISRAEL C. RUSSELL.
EXHIBIT No. 7.

III.

Surface	3 ft.
Water sand	19
Gravel and water.....	4
Total	26

To Accompany Preliminary Report by Israel C. Russell on the Water Supply of the Ann Arbor Water Company. Dated: June 24, 1905.

IV.

Department of Chemical Eng.—Chemical Laboratory of the University of Michigan, Ann Arbor.
 E. D. Campbell, Chem. Engineering and Analytical Chemistry.
 Alfred H. White, Chemical Technology.
 Ann Arbor, Mich., June 30, 1905.
 Prof. I. C. Russell:—

We have completed the analyses of the two samples of water collected and submitted to us by you, and find them to have the following composition:

	Milligrams per liter or parts per million.		Percentage of total solids.	
	No. 1.	No. 2.	No. 1.	No. 2.
Carbonates (CO ₃)	175.2	166.1	38.87	39.97
Sulphates (SO ₄)	96.9	76.8	21.49	18.48
Chlorine (Cl)	3.7	8.5	.82	2.05
Nitrates (NO ₃)4	.12	.08	.02
Calcium (Ca)	115.6	105.3	25.65	25.34
Magnesium (Mg)	27.8	30.8	6.16	7.42
Sodium (Na)	4.7	4.2	1.04	1.01
Potassium (K)	5.6	4.9	1.24	1.18
Silica (SiO ₂)	17.0	16.2	3.77	3.88
Alumina (Al ₂ O ₃)	1.6	.8	.36	.19
Ferric Oxide (Fe ₂ O ₃)	2.3	1.9	.52	.46
Total	450.8	415.6	100.00	100.00
Specific gravity	1.0006	1.0006		

Sample No. 1 marked: ANN ARBOR WATER, PUMPING STATION No. 1, KNOWN AS UPPER STATION; COMPOSITE SAMPLE FROM ALL WELLS AT THIS STATION. Sample No. 2 marked: ANN ARBOR WATER, PUMPING STATION NO. 2, BETWEEN WASHINGTON AND LIBRARY STREETS, KNOWN AS LOWER STATION; COMPOSITE SAMPLE FROM ALL WELLS AT THIS STATION. Each sample collected June 12, 1905.

The spectroscope gave no test for strontium and lithium. No nitrates were found. The difference between the total solids found on evaporation and total solids in columns one and two is water of crystallization, in large part due to the formation of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$).

The water was clear when collected, but upon standing became cloudy, due to the escape of free carbon dioxide (CO_2) and formation of calcium carbonate (CaCO_3).

Almost all of the salts in the water will form scale in boiler, but the water could be much improved by softening with sodium carbonate (soda ash), either alone or in conjunction with calcium hydroxide (milk of lime).

(Signed) E. D. CAMPBELL.

(The original report of Professor Campbell is affixed hereto.)

Respectfully submitted.

(Signed) ISRAEL C. RUSSELL.

SUPPLEMENTARY REPORT ON THE WATER SUPPLY OF THE ANN ARBOR WATER COMPANY.

By Israel C. Russell.

Ann Arbor, Mich., Oct. 28, 1905.

To the Water Works Committee of the Common Council of the City of Ann Arbor.

Gentlemen:—

In compliance with your instructions dated Oct. 20, 1905, calling for information concerning additions to the water supply of the Ann Arbor Water Company made since July 1, 1905, I have the honor to report as follows:

As stated in my preliminary report, dated June 24, 1905, the Ann Arbor Water Company was engaged during the past summer in laying a pipe in

the gulch of Allen Creek, between Washington and Liberty Streets, for the purpose of obtaining water from a spring on the White property, immediately adjacent on the west, to the west boundary of Ann Arbor. The pipe referred to is now in place and connected with a pipe previously laid so as to furnish a continuous conduit from the west boundary of the city to the receiving well or tank at Pumping Station No. 2. The course of the pipe is approximately located on the map forming Exhibit No. 3, which accompanied my preliminary report, but it does not pass west of the city boundary, or branch, as indicated by the dotted lines on the map.

The pipe referred to is of iron, eight inches in diameter, with leaded joints, and, as I have been informed by Dr. A. K. Hale, is provided at intervals with side openings or "T joints," which may be used in the future for connecting additional wells with the source of supply now utilized. The openings referred to, however, are at present closed. The pipe terminates at the west, adjacent to the west boundary of a field belonging to Mr. Buehler, immediately adjacent to land known as a part of the White property, and a few rods down-stream from a locality where a strong spring formerly came to the surface on the said White property. Where the pipe terminates at the west, a well has been dug in gravel to the depth, as I have been informed by Mr. Buehler, of about 18 feet. The well is circular, approximately 36 feet in circumference, and lined with brick. The enclosing brick wall rises about three feet above the surface of the adjacent ground, and resting on it, there is a neat conical roof of wood covered with shingles and provided with a ventilator at the top. In the roof there is a door secured with a lock. The eight-inch iron pipe described above, enters the well about six feet below the surface of the adjacent ground, but whether or not it descends into the well and is arranged so as to form a siphon, I am not informed.

Since the new well, just described, and its connecting pipe, were put in place, the spring which formerly came to the surface on the adjacent White property has ceased to flow. This

spring, as stated in my preliminary report, on June 24, 1905, flowed at the rate of 42.7 gallons per minute. The discharge of the new well is said to be large, but as to the actual volume of water supplied by it I have no information. It is safe to presume, however, that the discharge of the well is considerably greater than the overflow of the former spring, since the water of the spring rose through gravel and there must have been a considerable loss by lateral percolations. The excavation of the well has given the spring a new avenue of escape at a lower horizon than formerly, and the loss due to lateral percolation is probably diminished.

The new well certainly furnishes a valuable addition to the water supply of this city, and the Ann Arbor Water Company is to be congratulated on the success of its recent developments. In view of this new addition to the water supply at Pumping Station No. 2, as it seems to me, there should be no demur on the part of the Water Company to the recommendation suggested to this Committee in my former report, that the shallow wells at the station just mentioned be abandoned.

The new well, like the other wells tributary to Station No. 2, is situated at the bottom of the gulch of Allen Creek, but is up stream from the principal sources of contamination to which the shallow drilled wells, referred to, are exposed. The new well, however, is shallow, and the water it furnishes is supplied in part from the surface. During and immediately following heavy rains, or when snow is melting, the contribution of surface water will be large; but during dry seasons nearly all of the supply will come from a deep source. Surface water during wet seasons is conducted to the locality where the well is located by the upper portion of Allen Creek, and in the region thus drained, there are at least three or four farm houses with barns, stables, etc.; and the land sloping to the creek is, in part, used for pasture. While the chances of the new water supply becoming contaminated from this source are perhaps remote and not great, it is desirable that precautions should be taken to guard against it. In this connection, I wish to state that, in my judgment, the field

immediately adjacent to the new well on the west, should not be used as a pasture at any time of the year. The said field is now a meadow, but is pastured, as I understand, after the hay is harvested. Also, the course of Allen Creek for the distance of about one hundred yards above the new well should be changed so as to pass the well at as great a distance as is practicable. When these precautions are taken, the new source of water supply may be expected to be free from danger of contamination, so long as the region draining to it does not become thickly populated, or existing conditions are not otherwise changed so as to introduce new sources of danger.

Respectfully submitted,

(Signed) ISRAEL C. RUSSELL.

License Committee.

Gentlemen—Your committee on licenses respectfully report that the following application for saloon license complies with the requirements of the ordinance and we recommend that on the filing of the proper bonds a license be issued to Frederick W. Golz.

WM. GOODYEAR.

Moved by Ald. Fischer that report and recommendation be accepted and adopted. Supported and adopted as follows:

Yeas—Ald. Gill, Schlenker, Kearns, Markey, St. James, Sherk, Manwaring, Coon, Goodyear, Fischer, Pres. Gilmore—11.

Nays—None

To the Honorable the Common Council.

Gentlemen—Your committee on bonds have had the following bond under consideration and would recommend its approval:

Saloon bond—Frederick W. Golz, principal; Emil Golz and John Reynolds, sureties.

Liquor dealers' bond—Frederick W. Golz, principal; Emil Golz and John Reynolds, sureties.

B ST. JAMES,

GEO. H. FISCHER,

Committee.

Moved by Ald. Schlenker that report be concurred in. Supported and adopted as follows:

Yeas—Ald. Gill, Schlenker, Kearns, Markey, St. James, Sherk, Manwaring, Coon, Goodyear, Fischer, Pres. Gilmore—11.

Nays—None.

Sidewalk Committee.

The matter of sidewalk along S. A. Moran's property on Ingalls street as it intersects with South University avenue, was presented and the following resolution offered:

By Ald. Fischer:

Resolved, That the street commissioner be and is hereby instructed to repair said walk and all others that need it with cinders in such manner that they will be suitable for public travel during winter.

Adopted as follows:

Yeas—Ald. Gill, Schlenker, Kearns, Markey, St. James, Sherk, Manwaring, Coon, Goodyear, Fischer, Pres. Gilmore—11.

Nays—None.

Enter Ald. Blair and Miller.

William Street Storm Sewer.

By Ald. Gill:

Resolved, That this council reconsider action of the council of 6th inst. relative to storm sewer on William street.

Adopted as follows:

Yeas—Ald. Blair, Gill, Schlenker, Kearns, Miller, Markey, St. James,

Sherk, Manwaring, Coon, Goodyear, Fischer, Pres. Gilmore—13.

Nays—None.

Original recommendation of the board of works was taken up as follows:

By Mr. Nichols:

Inasmuch as Hutzel & Co. are the lowest bidders for the construction of William street storm sewer, this board recommends to the council the acceptance of their bid with the understanding that work be done this fall. Adopted by board of public works Nov. 6, 1905.

Ald. Fischer moved that recommendation of the board of public works relative to William street storm sewer be concurred in. Supported and adopted as follows:

Yeas—Ald. Blair, Gill, Schlenker, Kearns, Miller, Markey, St. James, Sherk, Manwaring, Coon, Goodyear, Fischer, Pres. Gilmore—13.

Nays—None.

There being no further business the council adjourned.

ROSS GRANGER, Clerk.