REPORT

ON THE

Kansas City Water Works.

Commission of Engineers,

GEO. H. BENZENBERG,
STEPHEN A. MITCHELL,
JOHN DONNELLY.

1902.

Kansas City, Mo. Water Works Engrs

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BOARD OF PUBLIC WORKS AND WATER COMMISSIONERS.

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S. J. HAYDE, Member.
HARRY B. WALKER, Secretary
D. W. LONGWELL, Superintendent Water Dep't.
WM. G. GOODWIN, Chief Engineer Water Dep't

Report of Commission of Water Works Engineers.

Kansas City, Mo.,
February 5th, 1902.

To the Honorable Board of Public Works,
Kansas City, Mo.

GENTLEMEN: In compliance with letters received from your board appointing the undersigned a Commission "for the purpose of making an examination as to the present condition of the water works system of this city, with a view to ascertain what steps are necessary to be taken to place said plant in a thoroughly efficient, adequate and safe condition for the proper supplying of water to this city," we met for the first time for that purpose in this city on the morning of October 29th, 1901. After asking your Board for more definite instructions, we immediately proceeded to a careful and exhaustive examination of the pumping station, intakes and basins at Quindaro, Kansas; the pumping plant and basins at Turkey Creek station in this city, and gathered what information we could regarding the condition of the "flow line" so called between these two stations, and of the distribution system throughout the city.

A brief history and statement of the water works system may be in order that our report, and the reasons and motives for our various recommendations as hereinafter submitted, may be more readily understood.

The original works were built under a franchise granted to the National Water Works Co. of New York, under Ordinance No. 10,524, approved October 27, 1873. The plant was designed and constructed for a population of about 35,000, not over one-fifth of whom became patrons of the Company, and hence, like many other franchise systems, was built upon a scale limited by the immediate demand upon the works and without any attempt to provide for the additional growth of the town or a greater supply of water, the result being that the Company attempted to meet the increased demand by extensions here, additions there, one makeshift, then another, until there was a city of 90,000 people in 1886 dependent upon a village plant for its domestic supply and fire protection. In answer to a clamorous demand from the public for an improved water supply, the National Company built the Quindaro and Kaw Point stations, and transferred the source of supply from the Kansas River to the Missouri River at Quindaro. Under this change the plan of operation was to pump the water from the Missouri River at Quindaro into settling basins, which were supposed to

be at the necessary elevation to permit sufficient water to flow by gravity to the Kaw Point and Turkey Creek Stations, at which points it was pumped direct into the mains for domestic consumption and fire service. It was found, however, that the necessary amount of water would not flow by gravity from Quindaro to Turkey Creek station, and provision had to be made for increasing the flow through the 36-inch conduit by pumps, and this is the method still in use.

These improvements enabled the Company, and has enabled the city since it came into possession of the plant, to send from Quindaro to the city sufficient water to meet all ordinary demands. The policy of the Company had been one of the extension of small mains over a large territory for so many years that the city finds it impossible to force through these an adequate supply to meet the requirements in certain sections of the city.

Such in brief was the character of the plant which came into the possession of the city September 1st, 1895, by a decree of the United States Court, which required the city to pay for the plant, exclusive of Kaw Point station, $3,100,000, an amount which covered a "going value" in additon to the actual valuation of the physical property surrendered to the city.

The plant that became the property of the city, comprised the following: At Quindaro, sixty-three acres of land, including Intake Pier, Pumping Station and Settling Basins, with a single flow line from the Basins to Turkey Creek.

At Turkey Creek ten and nine-tenths acres of land, including Pumping Station and Storage Basins.

At Holly and 21st Streets, two and five-tenths acres of land, including the Storage Reservoir and a Distribution System consisting of 124 miles of water mains, from four to thirty inches in diameter, with hydrants and valves attached.

At Second and Main Streets, one lot 60x142, used for stable and storage purposes.

During city ownership of six and one-half years the plant has furnished all the water for general city use, and has from the revenue of the department made extensive repairs to the walls of the settling basins at Quindaro, and to the storage basins at Turkey Creek and Holly Street Reservoir. Besides necessary repairs to the 9 million gallon Gaskill pumping engine at Turkey Creek, a new 10 million gallon triple expansion pumping engine, and a new 12 million gallon low service pumping engine with necessary boilers, have been added to this station. During this time the first section of a second flow line 6,000 feet in length and about 70 miles of water mains, have also been added to the distribution system.

The works at Quindaro consist of a stone intake pier, erected on the south bank of the Missouri River and connected

with the river bank above high water by an iron foot bridge and by a 42-inch diameter iron pipe of about 750 feet in length connecting the interior well of the intake pier with a suction well located in the center of the basement of the pumping engine house. The river end of this pipe line for about seventy-five feet in length is made of wrought iron, and is flattened into an oval shape where it enters the intake pier, at which point the top of the pipe is more than one foot above lowest stage of water in the river. To overcome the difficulties caused by this condition, an auxiliary 36-inch diameter wrought iron pipe has been connected with the 42-inch pipe near the river, the other end leading to and dropping into the river below the lowest water mark.

The engine house contains two Holly pumping engines, one geared Pearson low service, one Worthington, and one Blake pumping engine. The two Holly pumps have each four single acting plungers operated by a horizontal compound condensing engine. They were designed to pump river water from the suction well direct to the settling basins, with a lift varying from a minimum of 25 to a maximum of 45 feet, and have each a capacity of ten million gallons per twenty-four hours. The suctions of pumps have since been connected with the 42-inch diameter cast iron intake pipe taking water direct from the river, and the suction well has been abandoned and filled.

The Pearson low service pump which has a capacity of six million gallons per day, is used for the same service and is an auxiliary to the Holly pumps.

The Worthington is a double acting pump operated by a compound condensing engine, and is used to pump water from the settling basins to the Turkey Creek pumping station through a cast iron pipe line known as the "Flow Line." The necessary head against which this pump is required to deliver water, depends upon the quantity which is forced through the flow line, and varies from forty-eight to sixty-six feet. The nominal capacity of this pump is nine million gallons, but is reported to have delivered fourteen million gallons per 24 hours.

The Blake pump located in the basement and also used in delivering water into the flow line, has a capacity of two and one-half million gallons per day.

There are six boilers connected with this plant; the first three of 75 H. P. each have been in service over thirteen years; the other three, two of which are 85 H. P., and the other 65 H. P., have been in service fully ten years, and are capable of furnishing not more than eighty-five pounds steam pressure.

The settling basins at Quindaro are four in number grouped together and have a combined capacity of forty-five

million gallons. The water drawn from the river is delivered near the bottom of the North basin, then passes in a thin sheet over a weir 132.9 feet long into the west basin, from this in like manner over a weir 167.8 feet long into the south basin, from here it passes into the central basin, from which it is pumped into the flow line. To facilitate sedimentation during flood periods of the river, provision is made to introduce a fixed quantity of coagulant into the water as it passes over each weir. The flow line through which the water is delivered from Quindaro to Turkey Creek station consists for a length of 18,640 feet to Kaw Point of a light cast iron pipe of 36 inches diameter and of 30 inches diameter from there to Turkey Creek Station, a distance of 12,024 feet. To increase the capacity of this flow line, another 30-inch diameter cast iron pipe was laid for a distance of 6,000 feet from Turkey Creek station towards Kaw Point.

The works at Turkey Creek station consist of a pumping plant and a group of basins. The latter were formerly used for sedimentation purposes, but now receive the water from Quindaro and serve principally as storage basins to meet the variable demand of consumption while the supply through the flow line is being maintained at a uniform rate, or to furnish a supply for a short period while the delivery from Quindaro is interrupted. These basins have at present a total available capacity of only nine million gallons. The water from the point where it enters passes through all the basins to reach the point from whence the pumping engines take their suctions, the highest suction pipe being about five feet above the bottom of the basin. The pumping engines, all of which take their supply direct from these basins, consist of a Gaskill horizontal compound condensing pumping engine of nine million gallons' capacity in 24 hours, erected in 1888, a Holly Quadruplex compound condensing pumping engine of four million gallons capacity, erected in 1881, a Barr vertical triple expansion pumping engine of 10 million gallons capacity, erected in 1897. These pumping engines are used principallly to deliver water into that part of the city east of the so-called "West Bottoms," under a head of about 140 pounds at the pressure gauge or 364 feet above city datum, though a part of the water pumped is delivered by throttling into the Holly Street reservoir at an elevation of 232 feet above city datum, from which elevation the West Bottoms are supplied, losing thereby 132 feet head. The other pumping engines at this station consist of a three million gallons Holly Quadruplex, erected in 1874, and a three million gallons Gaskill, erected in 1884. The former was one of the first pumping engines installed in this station and is located over a suction well 15 feet in diameter and 20 feet deep, which

was originally supplied by a siphon pipe from Kansas river. This pump now, however, takes suction from the basins and is only used to supply water to the Holly Street reservoir or the West Bottoms and in case of fire in this territory, supplies fire protection at 140 pounds pressure at the gauge by drawing its supply under pressure from the reservoir.

The 3-million-gallons Gaskill pump also takes its suction from the basins and is so connected that it can be used to pump to the West Bottoms or to the city east thereof, taking suction from the reservoir, when providing a fire pressure of 160 pounds for the city service. In addition to these pumps, there is a 12 million gallons law service Deane pump located in a pit connected so as to draw water from Kansas river, and deliver the same either to the basins or direct to the suction of the other pumps.

In examining these various parts of the water works system, we noted their condition and also the records of the work performed by them. Meanwhile the following communication containing definite instructions were received from your Board:

"Commission of Expert Hydraulic Engineers,
Geo. H. Benzenberg,
Stephen A. Mitchell,
John Donnelly.

GENTLEMEN: In compliance with Ordinance No. 18207, approved October 1, 1901, you have been selected to act as a Commission of Hydraulic Engineers to ascertain what steps are necessary to be taken to place the Water Works system of Kansas City in a thoroughly efficient, adequate and safe condition, for proper supplying of water to this city.

In investigating this subject, and in reporting thereupon, we wish you to give consideration to the following questions pertaining to this problem:

First—What improvements do you deem necessary should be made in the flow line, and in what direction, in order to obtain the full capacity of the 36-inch pipe line from Quindaro?

Second—Do you deem it advisable for the city to establish a high pressure pumping station at Quindaro?

Third—What changes or additions do you advise at the Quindaro Pumping station for both immediate and future requirements, utilizing the full capacity of the settling basins and the proposed improved condition of the flow line? And in view of the fact that when the demands upon that station are 17,000-000 gallons or more per day, all the engines are in use, what would be your recommendation for immediate relief?

Fourth—What changes or additions do you suggest at the

Turkey Creek Pumping station to meet either immediate or future requirements?

Fifth—What additional mains are necessary and where, to give an adequate pressure and supply of water in the business territory and the elevated districts of the city?

Sixth—State what additions and changes are necessary to the distribution system to provide ample and proper fire protection by direct pressure, in both the business and elevated districts?

Seventh—Do you deem it desirable to provide a separate high level service, dividing the city into two or three level services to meet the future growth? If so, outline your recommendations.

Eighth—Do you recommend the building of any additional elevated storage reservoirs? If so, where, and of what capacity?

Ninth—What do you recommend as the best means of providing ample fire protection in the various districts of the city?

Tenth—Report what else, in your opinion, may be necessary to place the Water Works plant in a more efficient condition, and such additions as in your judgment the future growth will demand.

Eleventh—What changes do you think are necessary in remodeling the Turkey Creek station and its pipe connections, etc., that it may be simplified.

Twelfth—What do you recommend for the improvement of the intake at Quindaro? Is it necessary to make any improvement there for present protection?

Thirteenth—Do you think we will require more ground at Turkey Creek Station for any enlargment or betterment you may recommend?

Fourteenth—Given, that the inflow capacity at Turkey Creek is as stated:

One Holly Quadruplex	4 million gallons
One Holly Gaskill	3 million gallons
One Barr Triple Expansion	10 million gallons
One Holly Quadruplex	5 million gallons
One Holly Gaskill	9 million gallons

or say a total of 31 million gallons, and that the total outflow is as stated:

One 16-inch main	4 million gallons
One 20-inch main	6 million gallons
One 30-inch main	14 million gallons

or say a total of 24 million gallons, which is the outflow for the territory east of the Bluffs, what in your opinion would be the most judicious expenditure of money for additional outflow for fire purposes in the Bottoms? Please give approximate cost

of reservoir, with its capacity, to be builded on city property south of present reservoir at Turkey Creek.

Fifteenth—If one pumping engine with boilers, or, provided one of the pumps at Turkey Creek can be removed to foot of Broadway, please make approximate estimate of cost of station at point named; the cost of 20-inch main south on Broadway to 14th, East on 14th to Grand Avenue, North on Grand Avenue to 3rd, West on 3rd to connection with 20-inch main on Broadway, or any other route as you may suggest. State if ample fire pressure and protection would not then be obtained in district proposed, using these proposed mains and laterals for fire purposes alone.

In considering the above questions on the line of immediate requirements, we wish you to keep in mind the necessity of utilizing existing features as far as practical economy will justify.

We also wish you, in all these questions, to keep in mind the future requirements for a city of 300,000 to 350,000 population within the present territory.

In conclusion we would request you to submit at your earliest convenience an advance report on the first question submitted.

GEO. M. SHELLEY,
Prest., Board of Public Works.

HARRY B. WALKER,
Secretary.

Acting on your last injunction we submitted the following advance report on the *first question*:

"*Kansas City, Mo., Nov. 4th,* 1901.

To the Board of Public Works,
City.

GENTLEMEN: In compliance with your request to report at our earliest convenience upon the first question submitted to us in your letter of instructions, viz: 'What improvements do you deem necessary should be made in the flow line, and in what direction, in order to obtain the full capacity of the 36-inch pipe line from Quindaro,' we have given this subject immediate, earnest and careful consideration.

The experience of your Water Department during the season of hot weather in July last, when it had to resort to pumping water from the Kansas River or subject some parts of the flow line to a pressure which might endanger its safety, in

order to obtain through the present flow line a supply of water from Quindaro settling basins equal to the demand upon the Turkey Creek pumping station, is sufficient evidence of the necessity of increasing the supply capacity from Quindaro at the earliest possible moment, to avoid a possible repetition of this experience.

The flow line, which is the only channel through which the water from the Quindaro settling basins can be delivered to the basins and pumps at the Turkey Creek station, consists of a 36-inch diameter cast iron pipe connected with the clear water basin and various pumps at Quindaro station and running in an easterly and southerly direction along the line of the Missouri Pacific Railway to the Kansas River near its mouth. At this point the pipe crosses the Kansas River on a bridge erected for that purpose and terminates on the south bank in front of the old Kaw Point pumping station.

From this point the flow line consists of a 30-inch diameter cast iron pipe, running through the ground of the Metropolitan Water Company to James Street, from whence it runs through Wood and Bell Streets to the Turkey Creek Station.

In order to reinforce the capacity of this flow, an additional 30-inch cast iron pipe was laid in 1899 from Turkey Creek Station northward on Genesee Street connecting with the old 30-inch pipe at the intersection of 12th and Bell Streets.

The 36-inch pipe is 18,640 ft. in length and the 30-inch from it to Turkey Creek Station is 12,024 ft. in length. The second 30-inch line is 6,000 feet long, or nearly 6,000 feet short of a connection with the south end of the 36-inch line.

As there is but about 11 feet difference between the surface of the water in the clear water basin at Quindaro and that in the reservoirs in Turkey Creek, pumping must be resorted to at Quindaro to elevate the water sufficiently to deliver the same in required quantities to Turkey Creek Station.

As the pipe of the original line, especially the 36-inch, is very light and possibly somewhat uneven in thickness, there is a low limit to the pressure to which this pipe can be subjected, above which it is hazardous to go, in that a break in this line means interruption in the delivery of water to the city. The only means therefore, by which to increase supply capacities lies in providing additional pipe lines.

The cheapest and most speedy manner in which this can be accomplished at present, is to extend the 30-inch pipe line laid two years ago, from its terminus near 12th and Bell Streets, to the lower end of the 36-inch pipe near the old Kaw Point pumping station.

Several routes have been suggested along which this pipe could be laid.

One line along the line of Genesee Street from 12th Street northward to just beyond the right of way of the Union Terminal Railway Company; thence along the said right of way on the accretions of the Missouri River recently formed, to the Kansas River; and thence south along the bank of said river to the 36-inch pipe where it leaves the bridge.

Another route suggested is the same as the above with the exception that the pipe is to leave the line of the Union Terminal Railway Company at Ohio Street, follow this Street to James Street, thence along the latter to the City's ten-foot right of way through the Metropolitan Company's property, thence along this right of way to the end of the 36-inch line.

This latter route, though 600 feet longer than the former, is suggested in case any difficulty should arise in securing the right of way for the former line near its northerly end.

These routes are suggested with the view of making either a part of a force main to be laid down from Quindaro, should a high pressure pumping plant be hereafter installed at the latter place, and are to consist of heavy pipe.

A third route proposed was from the present end of the new 30-inch line at the crossing of 12th and Bell Streets, in a direct line to and along James Street to the City's right of way across the Metropolitan Water Company's property and along this to the end of the 36-inch pipe.

We have personally gone over these routes and other routes to examine the condition and difficulties which each line presents.

The first route mentioned is about 6,096 feet long and extends for a distance of 3,307 feet along side the Union Terminal Railway Company's right of way. Along nearly 2,000 feet of this distance the pipe line would rest on an unsettled embankment, unfit for support of pipe line without a special foundation which would materially increase the cost of this line. Unless there were no other alternative route, it would not be advisable or desirable to follow this line, especially when the question of right of way and the right of following the river bank is taken into consideration.

The second route is about 6,740 feet long, has no special advantages, and is simply a makeshift in case the first route is selected and the legal difficulties which might present themselves could not be removed.

The third route is the most direct that could be selected, being nearly a straight line between the points to be connected, and about 5,410 feet in length. It is therefore the shortest line and the one which will best serve the particular purpose for which it is needed. The estimated cost of this line is $31,633, which is $12,500 less than the estimated cost of the first route,

and $17,232 less than the cost of the second route. This third route presents no question as to the right of way along its entire length, nor does it present any special difficulties of construction which are greater than those of either of the other two lines.

We therefore recommend that the present flow line be reinforced by a 30-inch diameter cast iron pipe line along the third or last route above described. We are emphatically of the opinion that this line should not become a part of any force main, and therefore recommend that this pipe weigh not less than 250 pounds per foot and be tested to not less than 60 pounds pressure at the foundry. We also recommend that at the lowest points in the 36-inch main immediately north of the Kansas River bridge, and also north of the Jersey Creek bridge, suitable blow-off connections be inserted for the purpose of draining said mains rapidly when necessary, and to free the pipe line from any deposits that may have collected at these points and interfere with the full flow of said line.

(Signed) GEO. H. BENZENBERG,
STEPHEN A. MITCHELL,
JOHN DONNELLY.

Your commission has had extended conferences with the Chief of the Fire Department, Mr. G. C. Hale, the Superintendent of the Water Department, Mr. D. W. Longwell, its Chief Engineer, Mr. W. G. Goodwin, the Engineer in charge of the Turkey Creek and Quindaro Pumping Stations, and many others, and personally familiarized themselves with the topography of the city and especially with the requirements of the business district.

After requesting that copies of records at the pumping stations be prepared and certain data be obtained and furnished us, we adjourned on Nov. 4th. Since then we have met a number of times in Kansas City to study and confer upon the various questions submitted to us and to advise with your Board upon other matters incidentally submitted.

Surveys, plans, pressure readings, borings, and estimates were meanwhile being made and prepared, and these were carefully examined and studied during the interim.

On January 22nd, 1902, we met in Milwaukee to witness a test of some special fire pipe lines and to note the operation of some centrifugal, rotary, and other pumping machinery in Milwaukee and Racine, Wis., and in Chicago, South Chicago and Rockford, Ill., returning thence to Kansas City on January 26th. After a further study of the whole subject and the plans and data previously collected and prepared, we have arrived at the following report and conclusions upon the various questions submitted, acting on your suggestion that in considering

the questions on the line of immediate requirements, we are to keep in mind the necessity of utilizing existing features as far as practical economy will justify.

The first question having been answered, we will take up the other questions in the order in which they were submitted by you, viz:

"Second—Do you deem it advisable for the city to establish a high pressure pumping station at Quindaro?"

This question contemplates one of two propositions for providing a supply of water direct from Quindaro, first at a pressure sufficient to accommodate every section of the city with an additional pressure, whenever necessary for fire protection in the business and elevated districts, or, second, at a pressure sufficient to meet the requirements of the lower districts only, such as the West and North Bottom lands, and possibly part of the O. K. Creek valley. The first proposition would mean abandoning Turkey Creek Station with nearly all of its machinery and the storage basins, the Holly Street Reservoir and the flow line, without practically any other benefit than to centralize the entire pumping machinery at one station, to materially reduce the number of pumps and the cost of operation. The offset to this advantage is the loss of the flow line, the Holly Street Reservoir, and practically of the investment at Turkey Creek Station, the necessity of constructing two high pressure pipe lines between the Quindaro station and the city to guarantee the same means of safety which the present works possess under high pressure, and lastly, the fact that the entire pumping plant would be located in the State of Kansas, and subject to taxation by it.

The second proposition presents the same objections as the last two mentioned. Two pipe line systems would have to be maintained between Quindaro and the city. One consisting of a high pressure line and the other of the present and an additional flow line to meet the future requirements of the city. The second proposition possesses no advantageous features at all, excepting that so much of the water as would be supplied to the low lying districts would require one less pumping, i. e., from the settling basins at Quindaro to Turkey Creek Station. The cost of fuel being the same at each station, this would only represent a saving equal to the difference in duty developed by the high service pumping, which would have to be installed at Quindaro, and the low service pumps now or hereafter engaged in delivering water to Turkey Creek Station. As the volume of water required in the entire low level territory will never exceed two-fifths of the total consumption the saving in fuel capitalized will not amount to one-fourth of the cost of the

high pressure pipe line. and as this is the only principal advantage against the many objectionable features of this proposition, we do not deem it at all advisable or desirable to establish a high service station at Quindaro.

"Third—What changes or additions do you advise at the Quindaro pumping station for both immediate and future requirements? Utilizing the full capacity of the settling basins and the proposed improved condition of the flow line? And in view of the fact that when the demands upon that station are 17,000,000 gallons, or more, per day, all the engines are in use, what would be your recommendation for immediate relief?"

The present conditions at the Quindaro pumping station are as follows: The two 10,000,000 gallons Holly and the 6,000,000 gallons Pearson pumps, having a total daily capacity of 26,000,000 gallons, were installed for the purpose of pumping water from the river to the settling basins, while the Worthington and Blake, with a maximum capacity of 16,500,000 gallons are used to pump from the settling basins to Turkey Creek station. As the total daily consumption frequently exceeds this latter amount, the west Holly pump has been so connected that it can be used in delivering water from the basins into the flow line, thus assisting the Worthington pump in furnishing the required volume to the city. This service, however, subjects the pump chambers of the Holly engine to 26 pounds pressure or more than twice as much as when used to pump into the basins, and as a result two of the pump chambers are cracked. These pump chambers were originally of weak design and construction so that even the lower pressure beyond which the other Holly pump was never subjected, was sufficient to crack one of its pump chambers. These pump chambers have been partly repaired and banded, but they are no better than they were originally. Neither of these pumps, therefore, should be subjected to any heavier strain than that for which they were originally designed, for should either one give out, the total available daily capacity of either service at Quindaro would be immediately reduced to 16 million gallons without any available reserve for either service. These conditions, therefore, should be remedied at the earliest possible moment by properly increasing the pumping capacity from the settling basins to the flow line. This increase should be fully equal to the capacity of the flow line when reinforced as suggested in answer to the first question, so that the Worthington pump, now the principal factor in this service, and which has been in practically continuous service, can be shut down for repair or other purposes, and the Holly pump permanently relieved from the overstrain

MISSOURI RIVER →

INTAKE

Auxiliary Suction 36"

Platform

Boiler House

Coal Track

2" Suction to River

HOLLY ENGINE NO.2.

HOLLY ENGINE NO.1.

Holly No.2

36" Suction from Settling Basin

36" Discharge from Holly No.2 to Settling Basin

WORTHINGTON ENGINE

Blake Pump

Fire Pump

To City

36" Discharge to City

From Settling Basin

To Settling Basin

Settling Basins

PLAN OF

QUINDARO STATION

Showing Pumping Station, Intake and Pipe connections.

WATER WORKS COMMISSION

G.H. Benzenberg
John Donnelly
S.A. Mitchell

SCALE -

PLAN NO. 5

of this service, and be returned to the exclusive service for which it was installed. The new pump or pumps, therefore, should have a capacity of delivering 20 to 25 million gallons daily into the flow line.

The 36-inch pipe, which for the upper 18,640 feet constitutes the flow line, is, as already stated, very light and possibly somewhat uneven in thickness; it is therefore very liable to rupture under even a low pressure. This is evidenced by the fact that it has already cracked and broken a number of times, especially during the past year, causing interruptions in the supply from Quindaro and producing serious conditions at Turkey Creek Station, where the storage supply was several times nearly exhausted before the repairs were completed. The fact that the pumps engaged in sending water to Turkey Creek station are pumping directly into this main and thereby subject it to a pulsating pressure, especially when their strokes are in unison, greatly increases the danger of this main yielding. This can and should be somewhat remedied by connecting a large air chamber to the main immediately beyond the pump connections.

These conditions, as well as the necessity of securing this increased capacity immediately and within a low limit of cost has determined us to recommend a centrifugal pump, because we believe that this style of pump is peculiarly adapted for this special service, giving steady flow at a uniform pressure and at a much greater economy of fuel than is being obtained at this station now. Such a pump of 25 million gallons capacity can be constructed and erected within nine or ten months after date of contract and at a price of less than one-half the cost of a reciprocal pump of equal capacity and efficiency. This pump should be contracted for at the earliest possible moment to relieve the exigency existing at this end of the Water Works system. This, however, will not be in time to meet a possible demand liable to arise with the approach of warm weather. We would therefore recommend that you proceed without delay to secure a temporary rotary or centrifiugal pump and engine of from 8 to 10 million gallons capacity, capable of re-inforcing the Worthington pump. Such a second-hand pump and engine in good order can be obtained and installed west of the building in a temporary shed within three months at a cost not to exceed $3,000, and will answer until the 25 million gallons pump is ready for service.

In the consideration of future requirements under this and other questions, you have requested us to keep in mind the needs of a city of 300,000 to 350,000 population within the present territory. In arriving at the amount of water necessary to meet the demands of a city of that size, we have as-

sumed that this city and its citizens will have recognized the merit and have largely followed the example of other cities in the introduction of the meter system to check not the proper use, but the absolutely useless waste of water, and that therefore the average daily requirements will by that time not exceed 85 gallons per capita or 30 million gallons per day. The maximum daily consumption, however, during long dry periods in the summer or even long cold spells in winter, is likely to exceed the average daily consumption by 33 per cent and as it is impracticable to provide storage to meet this maximum requirement for more than a few days, this maximum must be provided for by ample reserve in the pumping capacity at both pumping stations, and in the capacity of the intake, the flow line and the settling basins. With the two Holly pumps and the Pearson pump all in good repair and condition, and limited to the service for which they were intended, the combined capacity for delivering water into the settling basins at Quindaro is 26 million gallons per day. With one of the Holly pumps out of service, however, the capacity would be only about 16 million gallons daily. Such a condition is a possibility and should be guarded against by the installation of an additional pump of not less than 20 million gallons capacity. For the reason heretofore given, we believe that the centrifugal style of pump is best adapted for this service, also especially when the river water carries a large amount of sediment.

We would therefore recommend, that as soon as funds for future extensions are available, a 20-million-gallon centrifugal pumping engine be added to the initial pumping service, which, as soon as the consumption has reached 26 million gallons daily, is to be supplemented by a second pumping engine of like style and capacity. This would provide a pumping capacity to the settling basins equal to the estimated maximum daily consumption with 50 per cent of such capacity in reserve so long as the Holly pumps remain serviceable.

The total boiler capacity at this station at the time of our inspection consisted of 460 horse power, furnished by six boilers capable of furnishing steam at 85 pounds. Your Board has ordered the 65-horse power boiler replaced with one of 200 horse power capable of furnishing steam with 150 pounds pressure at the guage, and have contracted for its erection. Its installation will meet the immediate demands for boiler capacity, but the other boilers at this station having been in service for many years, we would recommend that at the time the new pumping engines as above described are installed, that the present boilers be replaced with larger units, capable of furnishing steam at 150 pounds pressure; by so doing, the necessary boiler capacity can be provided without any extension or enlargment

MISSOURI RIVER

INTAKE

Auxiliary Suction 36"

Brick Coal Shed

Boiler House

River

Coal Track

42" Suction to

Proposed 20,000,000 Gallons Centrifugal Pump

Proposed 20,000,000 Gallons Centrifugal Pump

30"

42"

36"

Proposed Temporary Pump

HOLLY ENGINE NO.2

HOLLY ENGINE NO.1

From Settling Basin

36" Suction from Settling Basin

36" Discharge from Worthington

Holly No 2 Discharge from

Proposed 25,000,000 Gallons Centrifugal Pump

WORTHINGTON ENGINE

Pearson Gaffney PUMP

Discharge from Holly No 1

BLAKE PUMP

36" Discharge from Holly No 2 to Settling Basin

To Settling Basin

To City

36" Discharge to City

PLAN OF

QUINDARO STATION

Showing proposed location of new pumps and new pipe connections

WATER WORKS COMMISSION

G. H. Benzenberg
John Donnelly
S. A. Mitchell

PLAN NO. 6

SCALE

BASIN EMBANKMENT

TOP OF

ROOT OF INSIDE SLOPE

of the present boiler house. In this connection we would recommend that brick coal sheds be provided of ample capacity to operate the station during such time as the delivery of coal may be interrupted by strikes or unforseen causes.

Regarding the alterations contemplated in the pipe connections at this station, we would recommend that a more direct and simpler system of connection be made with a view of clearing the space immediately west of the Worthington pump to make room for the centrifugal pump above suggested, as a reinforcement for the city service, and to be erected at the earliest date possible. Under this plan the pit now constructed between the engine house and boiler room will be available for the location of the new pumps above recommended for the initial service, and the construction of the building over this pit and the coal sheds will thus be the only additions to the buildings at Quindaro to provide for the proper housing of the necessary machinery to meet the contemplated demand, provided the new flow line to Turkey Creek be made a gravity conduit.

A second centrifugal pumping engine of 20 or 25 million gallons capacity would have to be added to the service engaged in pumping water from the settling basins to Turkey Creek station, unless the second flow line between these points be of such ample capacity that with the present flow line it can supply the required quantity without the aid of pumps, in which case the first centrifugal pump can be transferred to the initial service.

The 36 and 30-inch cast iron flow line was originally designed to convey the water from Quindaro by gravity, and was therefore made of very light weight pipe. Pumping, however, had to be resorted to very soon to deliver the required quantity of water, and as this quantity has steadily increased, it became necessary to gradually increase the head, and thereby subject this pipe to an increased pressure for which it was not intended, hence the continuous danger of this pipe bursting as it has, and shutting off the supply from Quindaro.

Another element of danger to this pipe line consists in the probability of a water hammer or sudden increase of pressure being produced by the rapid or sudden shutting off of one or the other of the large connections through which several consumers are taking water directly from the flow line. Such water hammer is capable of producing a shock sufficient to burst the light weight pipe and these consumers ought to be required to take their supply through a small pipe continuously into a tank from which they may draw in quantity as required without affecting the flow in the pipe line. There is very little doubt that the capacity of this pipe has also been somewhat reduced by interior tuberculation and possibly by the collection of sediment

during the past fourteen years, especially at low points, no provision having ever been made for blowing off the pipe line.

Careful tests as to the capacity of this flow line made several years ago indicate that the same is materially below that of a new pipe line. It is not safe, therefore, to estimate that the capacity of the flow line when reinforced by a second 30-inch line from Kaw Point to Turkey Creek Station, now being laid, will, with a head at Quindaro of 65 feet above the water level of the full basins at Turkey Creek, exceed 20½ or 21 million gallons per 24 hours. This limited capacity, less about 1½ million gallons drawn off daily by consumers connected direct with the flow line, is likely to be exhausted within two or three years, during periods of maximum daily consumption, without taking into account the possibility of a break in the flow line, especially during such periods when the pipe is likely to be subjected to excessive pressure in the effort to meet the demands of maximum consumption. These conditions and facts are brought to your attention to show the necessity of making provisions as soon as possible for the construction of another flow line, which will take not less than two years to complete and which if commenced within the next year, its completion will be none too soon to meet the conditions of maximum consumption, even should no serious accident happen to the flow line which possibility should not be lost sight of.

In considering this question in connection with the requirements of a city of 300,000 to 350,000 population as indicated by your Board, we are of the firm opinion, that, all things being considered, it is desirable to construct this second flow line of such diameter that the maximum daily consumption can be supplied by it and the present flow line by gravity from the settling basins at Quindaro to the Turkey Creek storage basins, providing the cost of such line can be kept within reasonable limits and its durability be assured.

The difference in the water level of the basins between these two stations is but nine feet and the distance between them along the new flow line about 28,000 feet.

With a head of nine feet the capacity of the present reinforced flow line will be about 7½ million gallons per day. This requires that the capacity of the new flow line with the same head be 32½ million gallons to meet the demands of maximum consumption, which will necessitate it to be five feet four inches in diameter, and should be of such construction as to successfully withstand an interior pressure due to a head of about 60 feet. After having carefully considered the merits and cost of various material, we are of the opinion that a concrete or cement conduit constructed according to the Ransome system, or the Monier, or other like construction, will fully

KANSAS CITY, MO. WATER WORKS

PLAN NO 4.

Map of Quindaro Settling Basins and proposed Extensions.

SCALE -

WATER WORKS COMMISSION

G. H. Benzenberg
John Donnelly
S. A. Mitchell

MISSOURI RIVER

Siphon Line

24" Outlet Sewer

Manhole

BOILER HOUSE

ENGINE HOUSE

Outer Slope of Embankment

Inner Slope of Embk.

NORTH BASIN

WEST BASIN

CENTER BASIN

SOUTH BASIN

EXTENSION

PROPOSED CAPACITY

Valve in Outlet Pipe to River

Mo. Pac. R'y.

answer all purposes required of this conduit, including durability. Conduits of either of the above style construction have been in successful operation long enough to satisfy us that it is perfectly safe to employ such construction for a conduit subjected to an interior pressure of 60 feet or less; and that such conduit will resist all necessary exterior pressure, except where the same may pass under steam railway tracks, at which points the same should be reinforced by an eight-inch thick exterior ring of brick work.

The cost of such a conduit in place is less than that of light steel pipe, 40 per cent less than that of a light weight cast iron pipe of like diameter, and less than half what the cost of a four feet diameter light weight cast iron pipe and necessary pumping machinery to deliver this same quantity of water, in addition to the cost of operating such machinery capitalized would amount to.

The proposed construction possesses, therefore, great economical advantages, while it meets the requirements of strength and durability and is not subject to deterioration due to tuberculation like iron pipe. A survey for a suitable line for this conduit has been made. It follows the location of the present flow line from Quindaro to the Kansas River, where we recommend that it be carried in a tunnel under the river to a shaft near the east end of James Street bridge and thence in a straight line through Wood street across the Railway Yard at its narrowest point, continuing in a straight line if possible to the intersection of 16th and Genessee Streets and thence to the Turkey Creek Station. This route is along the shortest and most direct line, being less than 28,000 feet in length, and presents no greater obstacles than any other line. The right of way wherever necessary along this line, should be secured as soon as possible. We recommend crossing under the Kansas River in a tunnel because its construction is practicable and feasible and because it is permanent, removed from disturbance and is in every way preferable to a line crossing in an exposed position on a perishable bridge. We have carefully examined the location and had a boring made on the east side, the rock being on the surface on the west side, and found shale that is very suitable for tunnelling at a depth of 47 feet below datum. The tunnel and shafts should be of shale brick construction, the shaft at the east end preferably carried to an elevation on a level with the coping of the settling basins at Quindaro. The tunnel should be not less than 7 feet in diameter and at an elevation of not less than 75 feet below city datum line. Suitable air vents on the high and blow-offs at the low points of this conduit should be introduced.

This flow line and tunnel can, when its capacity as a grav-

ity conduit has been exhausted, be used as a pressure conduit to twice its capacity as a gravity line.

The settling basins at Quindaro, with about 7.2 acres of water surface, were constructed at the same time as the pumping plant and flow line from that station to Turkey Creek in 1886, and no detailed plans of it have been preserved or turned over to Kansas City at the time of transferring the property.

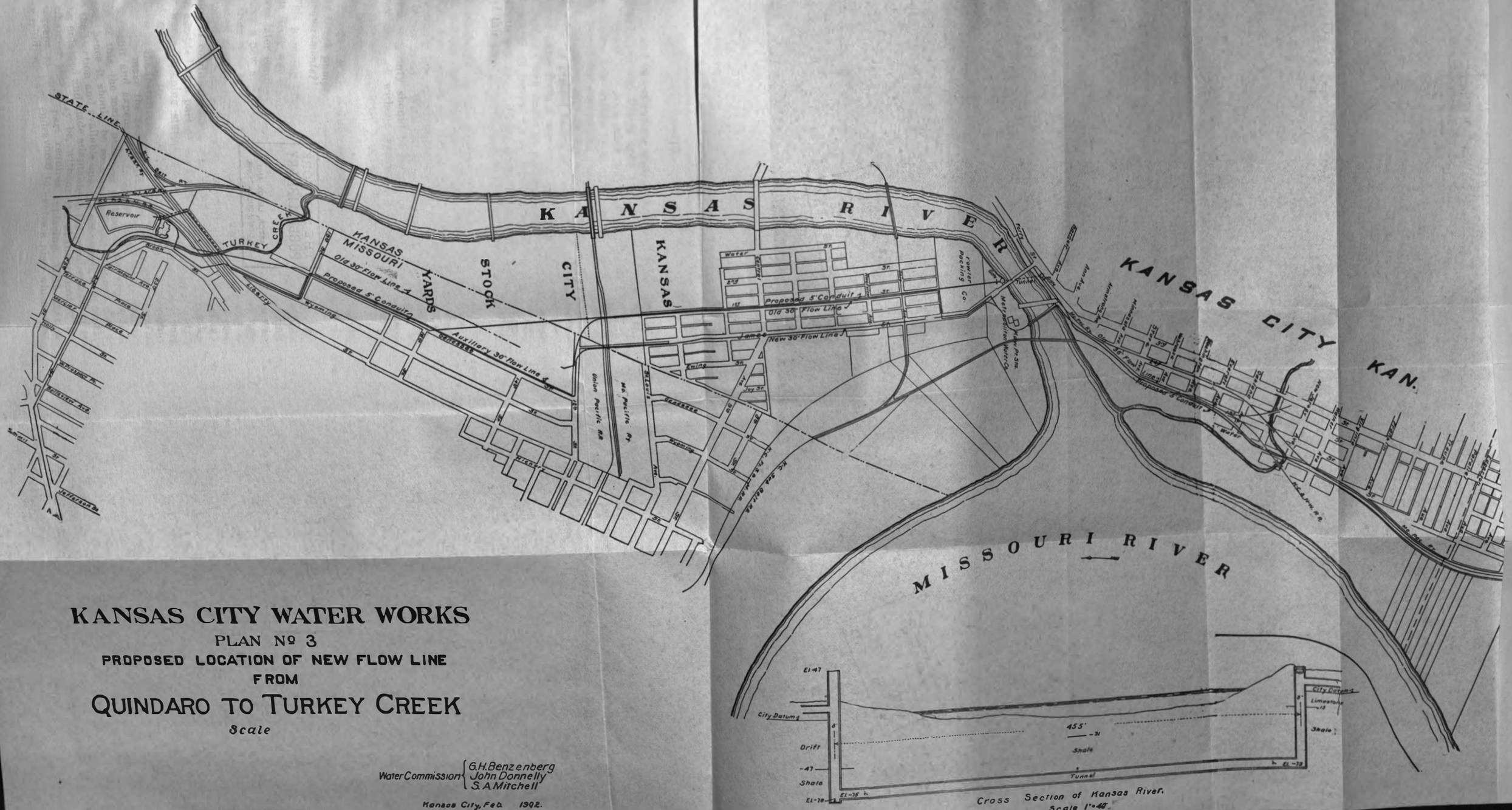
From surveys made and such information as we have obtained from the Superintendent and officers in charge, we find the following conditions:

The basins, four in number, have a depth of about 20 feet and when free from deposit of sand and sediment, a storage capacity of 45,000,000 gallons, with water surface in clear well, when full, 9 feet above water surface in Turkey Creek basin and a difference of 11 feet between the tops of outer walls of these basins.

The operation of these basins under the management of the National Water Works Company was for the purpose of sedimentation, by pumping into the small central basin and passing the flow through the other basins slowly to permit of sedimentation throughout its course to the clear well, or southeast basin, where it was intended to enter the 36-inch flow line to Turkey Creek. The failure of this flow line to deliver sufficient water at Turkey Creek necessitated the re-pumping of the water and the delivery of same to the flow line under a head of about 55 feet by pumps installed for that purpose. Under city management, large sums have been expended in the reconstruction of the embankments and partition walls of this reservoir, made necessary by their slipping or failure to withstand the pressure of water in the adjacent basins while any one of these was being drained and cleaned. Therefore the Department in charge changed the system of flow and sedimentation to a method heretofore described and now in use.

Since the installation of this method the quality of the water delivered at Turkey Creek has been satisfactory except during extreme high water. It is very probable that with the present method of sedimentation these basins will be of sufficient capacity for some years to come. At some time after the inauguration of a new flow line it may become necessary to increase the capacity of these basins by additional basins as shown on Plan No. 4, which will have a capacity of 42,000,000 gallons, giving a combined total capacity of 87,000,000 gallons.

If it should be found desirable to operate the new basins in connection with the present basins in a continuous series, the water should be delivered high enough in the new initial basin to maintain the water surface in the clear well at not less than 44 feet above city datum.



KANSAS CITY WATER WORKS

PLAN Nº 3

PROPOSED LOCATION OF NEW FLOW LINE

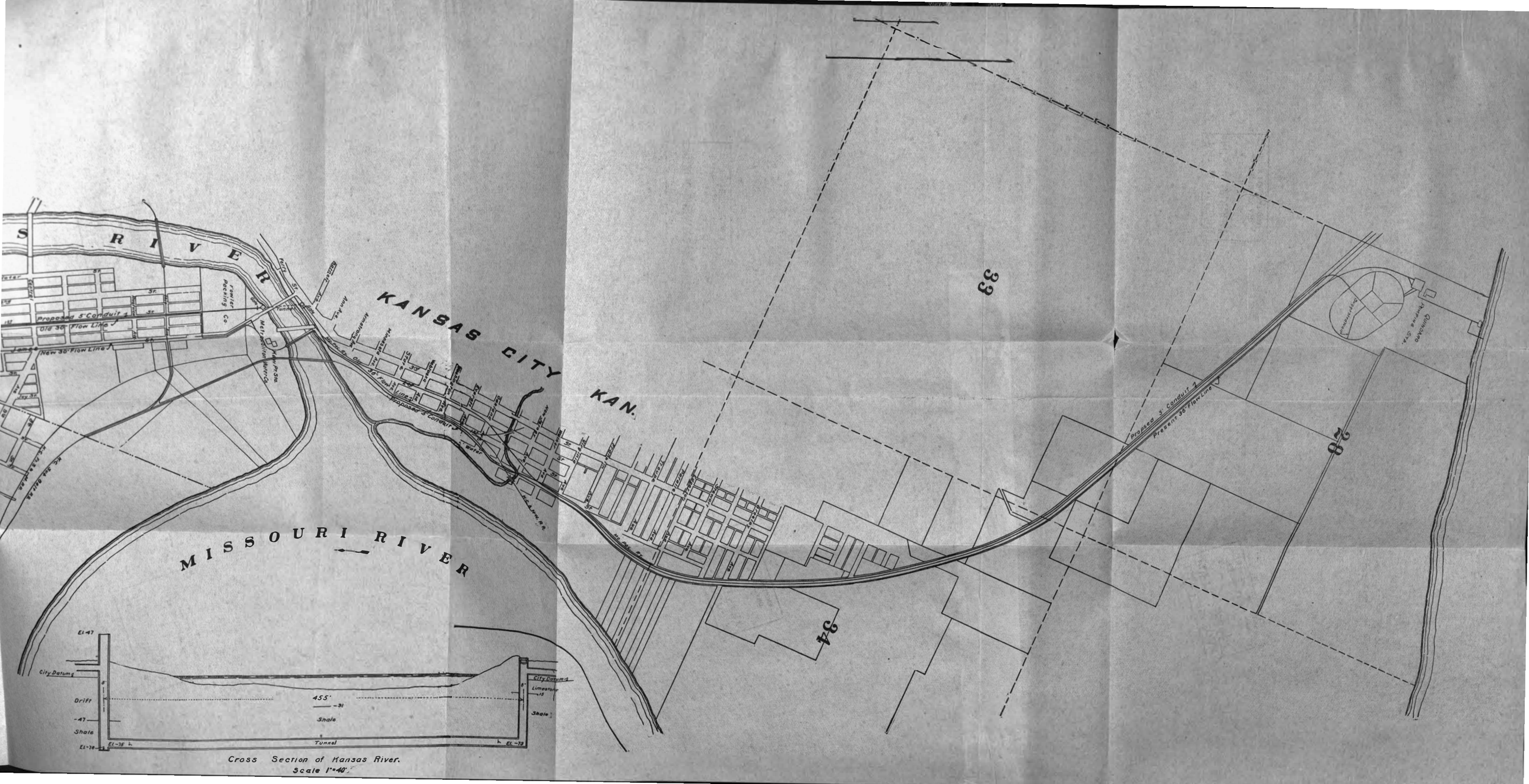
FROM

QUINDARO TO TURKEY CREEK

Scale

Water Commission { G.H. Benzenberg, John Donnelly, S.A. Mitchell

Kansas City, Feb. 1902.



Cross Section of Kansas River.
Scale 1"=40'.

Surveys and investigations with a view to a future location of settling basins and filters upon higher ground south of the present location have been made with a view that the city may at some future time decide upon filtering its water supply. Suitable ground for economical construction at an elevation of about 90 feet above city datum was found, which will permit of the use of the present basins as a clear well, or by delivering the filtered water from a new clear well direct to the new conduit to Turkey Creek under an additional head of 27 feet, which will permit of its increasing its flow capacity to about 60 million gallons per day. Under such arrangement, the pumping plant at this station would have to undergo an entire modification.

In conclusion to this question we wish to state that the general average duty developed at this station does not exceed 26 million foot pounds per 100 pounds of coal consumed, which is exceedingly low, notwithstanding the lift of the pumps engaged is not great. With the new machinery and boilers as proposed, this duty should be doubled at least, enabling it to do twice the work without increasing the amount of fuel now used, which will represent a saving equal to the interest on its cost of installation.

"Fourth—What changes or additions do you suggest at the Turkey Creek pumping station to meet either immediate or future requirements?"

This pumping station was located and erected when the Kansas River was deemed a suitable source for a water supply, and was later continued and modified to meet the conditions following a new and remote source of supply. Additions were made from time to time without following any apparent well-established plan or system, or without considering economy of the limited space, or in operating the works, resulting in a complication of conditions which should not be continued, and cannot be accepted as a part of a proper, modern, and economical water works pumping station for a city of Kansas City's present, much less future requirements. A continuation of such conditions in the installation of any additional pumping machinery will only make the reconstruction of the station hereafter more difficult and expensive. It is not at all likely that the location of this, the main pumping station of the city, will be changed, hence it should be so arranged and planned that so far as the location and available space is concerned, it is capable of being enlarged and made adaptable to the requirements of the city, whatever they may be, without the abandonment of any part, except as such part requires replacing. With that object in mind, we have endeavored to evolve a plan which would

carry out this idea without, as far as it is possible, abandoning any of the present machinery or relocating the same, excepting as it can be done with safety or as the demand for increased pumping capacity will make it necessary.

Plan No. 8 submitted with the report, shows the present system, while Plan No. 9, shows the proposed re-arrangement of the station with the location of the present machinery and boilers, when moved, and of the proposed new pumping engines when installed. This arrangement groups the machinery for the low service at the north end and for the high service at the south, with room for extension in both directions for new machinery and boilers when needed in either service. It also provides for coal storage in the rear of the boilers, not now available, with track facilities along side upon city property, which storage can be increased as the works require it.

The plan also shows the re-arrangement of the suction and the discharge mains which now consist of a complicated and intricate system of pipes and specials occupying practically all the available ground around the building and radiating therefrom in every direction. The new system is simple and comprehensive and capable of being extended without change of plan, and we recommend that the work to be done under the re-arrangement consist first in the gradual relocation of these mains as indicated on the plan. This plan can possibly be carried out to meet the requirements of the estimated maximum consumption, within the limits of the land now owned by the City at this station, but it would be most desirable to secure the vacant land for a distance of two hundred and fifty feet north of the water works ground and lying between Brooks Street or Allen Avenue, and the right of way of the St. Louis and San Francisco Railway Company, permitting the new station to be located further north, thus affording more room for extensions hereafter to the south without encroaching upon the basins. This strip of land covers about 1½ acres, is not used, and is the only ground which can be secured and utilized for extending the works. It is therefore necessary and should be purchased before other use of it is made. The plan prepared contemplates its purchase by the city.

As heretofore stated, the pumping machinery at this station consists of a nine million Gaskill, a ten million gallon Barr, and a four million gallon Holly Quadruplex pumping engine, which are used to supply the city east of the West Bottoms, and also, by throttling the delivery into Holly Street reservoir, to supply the West Bottoms, thereby wasting the energy and work developed by the pumps in lifting this water 132 feet above the Holly Street reservoir. Two levels are being supplied with water from this station, one consisting of the West Bot-

WATER WORKS SYSTEM

KANSAS CITY MO.

Plan showing Turkey Creek Station and Proposed Extensions

Scale

PLAN NO. 7.

WATER WORKS COMMISSION

G H Benzenberg
John Donnelly
S A Mitchell

N.

Kansas
Missouri

State Line

TURKEY CREEK

GENESEE ST.

19TH ST.

WYOMING ST.

LIBERTY ST.

60 ST.

APPROACH

VIADUCT

Old 30" Line from Quindaro

Map 30"

15" Discharge

A.T. & S.F. R.R.

St.L. & S.F. R.R.

Area 138 Acres

APPROACH

ALLEN AV.

BROOK

23RD ST.

BENTON PL.

AV.

FAIRMOUNT

ST.

16" Discharge

30" Discharge

24TH ST.

El 27.5

El 27.2

Proposed Extension—
Capacity 7.000000 Gal.

El 26.2

El 26.3

El 27.00

25TH ST.

tons, using about 2½ million gallons per day, supplied at an elevation of 232 feet above city datum, and the other consisting of the balance of the city, using on the average of about 12½ million gallons daily, and supplied at an elevation of 364 feet above datum. These two services should be kept separate and each supplied by its own set of engines, which should be capable of promptly furnishing the required quantity and fire pressure when needed in their respective districts. Connections between the high and low level service should be maintained, but only used in case of emergency, as in case of breaking down of pumps or mains.

The total daily capacity of the engines supplying the high level is 23 million gallons; with either the Gaskill or Barr engine disabled the capacity is only 13 or 14 million gallons, nearly equal to the present average daily consumption. With only one of the other two small pumps available for this service, it will be seen that within the next year provision should be made to secure a new pumping engine to be ready for service by the summer of 1904. This engine should be of the best construction, of the triple expansion type, and have a capacity of not less than 12 million gallons per 24 hours, delivered against a pressure of 160 pounds at the gauge, with steam pressure of 150 pounds to be supplied by a new battery of boilers installed with this engine.

This new machinery should be located in keeping with the proposed re-arrangement and in a section of the new buildings, as shown on plan No. 9. Thereafter new foundations of proper depth and ample strength should be constructed in the new building for the Barr pumping engine as indicated, and this engine overhauled and erected thereon. Like disposition should be gradually made of the four million Holly and the three million Gaskill engines, placing both on the low level service, and also of the high pressure boilers then in service at this station. The 12 million low service Deane pump we suggest to remain where it is until the new conduit is completed and in service.

Following this, an additional triple expansion pumping engine of not less than 15 million gallons capacity should be provided, preceding which, however, the Gaskill 9 million gallons pump should be removed into the new station and made available for the high level service, until the new 15 million pump is in service, when the 9 million Gaskill pump should be placed permanently in the low level service, which will by that time require increased pumping capacity. In this way a gradual change from an unsightly, expensive, complicated and unsatisfactory pumping station, to one of modern, simple, economic and systematic design and service can be brought about. Each installation of a new pump of modern construction will,

in its operation, produce sufficient saving in fuel at $1.40 per ton, when compared with the present cost of pumping at this station, to pay at least 5 per cent interest on its cost, or it will pump twice as much water against the same head and with the same amount of fuel as is now on the average being pumped at this station.

The new station should be equipped with a thirty tons electric traveling crane, to facilitate the handling of heavy parts of the machinery when necessary. The design of the station should be simple and substantial, and capable of extension without marring its appearance, ample in room, and space for tools, oil, and repair rooms, and suitable conveniences for the employees.

The basins at Turkey Creek station have a surface of about 3.25 acres, and a storage capacity of about 9 million gallons above the 30-inch suction pipe of the Barr pump. By lowering the present suction pipe in these basins about two feet, an additional storage of 2 million gallons can be secured, or a total of about 11 million gallons. the greatest available depth in this reservoir being about 8.5 feet.

A proposed addition to this basin shown on Plan No. 7 and constructed similar to present basins, would give an additional storage capacity of 8 millon gallons, making a total of 18 million. No greater quantity can be secured without an entire reconstruction of these basins. the cost of which would not justify the outlay. Any raising of the reservoir walls will diminish the head under which water is delivered from Quindaro. and therefore diminish such delivery. It might be advisable to construct this addition at some time in the future, but its present undertaking is hardly justifiable, in view of other pressing demands, and the fact that it adds but one-half day's supply at our present rate of consumption, especially when the construction of a new flow line from Quindaro, with its ample capacity, will obviate the necessity of additional storage at Turkey Creek.

The location of these basins in the vicinity of the greatest railroad yards in the south and west, is the cause of a constant depositing of soot. dirt, and cinders upon their water surface, which is very unsightly and no benefit to the water. There is no remedy against this except covering the basins, pending which, this and other floating matter should be removed several times daily.

It is the practice at Turkey Creek pumping station to discharge the condensation water back into the basins. This water, excepting that coming from surface condensers, is objectionable and should be wasted until the same can be thoroughly filtered and all the oil removed before returning same to the basins.

PLAN OF

TURKEY CREEK STATION

Showing present arrangements of Pumping Engines & pipe connections

WATER WORKS COMMISSION

G. H. Benzenberg
John Donnelly
S.A. Mitchell

PLAN NO. 8

center line 23rd St.

Turkey Creek

28" High Pressure Branch from Engine No. 1

Hydrant

20" Suction from Upper Reservoir to Engine No. 1

16" High Pressure Line via 24th St. from Engine No. 2

Drain

12" Main to West Kansas

24" Siphon from Kaw River

Discharge

Suction

ENGINE NO. 4

ENGINE NO. 3

ENGINE NO. 2

ENGINE NO. 1

30" Discharge

30" Suction

Deep Well

Sickels Pressure Regulating Valve

Discharge from Engine No. 5

Suction to Engine No. 4

Suction from Quindaro or Lower Basin

Air Chamber

ENGINE NO. 5

Stand Pipe

30" Suction to Engine No. 3

Suction to Engine No. 2

16" Discharge from Engine No. 5

Suction to Engine No. 5

16" Discharge from Engine No. 4

Suction to Engine No. 4

New 24" Pipe

Suction from Quindaro

30" Suction to Engine No. 1

New 30" Pipe

16" Discharge from Air Pumps of Engine No. 1

30" Suction

30" High Pressure Line via 24th St.

Hydrant

"Fifth—What additional mains are necessary, and where, to give an adequate pressure and supply of water in the business territory and the elevated districts of the city?"

We assume that this question refers only to providing an adequate pressure and supply for domestic consumption and the uses of water for business, manufacturing and municipal purposes, but not including fire protection by direct pressure, and has therefore been answered in accordance with that view.

A study of the distribution system of the city and the history of its development, so far as obtainable, clearly shows that after the first lot of water pipe had been laid to meet the requirements of the franchise granted in 1873, all subsequent extensions and occasional reinforcements of the system were made without any well developed plan or in keeping with the increased requirements of business and populated districts, nor in a manner which would indicate that advantage was being taken of the topographical conditions to aid in the distribution of water.

Since the city has come into possession of the works, nothing has been done to improve the unsatisfactory conditions in the business and the north elevated districts, especially in the former where the requirements have rapidly increased.

Of the 17 miles of water mains located in the territory (principally business) lying between Jefferson and McGee Streets, and from 15th Street north to the river, containing about 400 acres, 32 per cent consists of 4 inch or less, 29 per cent of 6 inch, while only 39 per cent consists of 8-inch or larger pipes. A large part of this territory lies above an elevation of 150 feet above datum and is covered with business blocks, hotels and apartment houses from four to ten stories high, many of them on ground, 200 feet and more above datum. The main feed pipes into this territory consist of one 15-inch, one 12-inch, and one 10 inch pipe, or equal to the capacity of one 20 inch pipe. In an attempt to better the conditions, a 30-inch main was laid some 14 years ago, on the Southwest Boulevard paralleling a 16-inch main to Baltimore Ave., thence on Baltimore Ave. to 17th street, and thence east on 17th Street for a mile, following low ground to Lydia Avenue. No benefit is being derived in the business section from this main as no connection is made to it with any main leading to that territory. Very much the same conditions exist all over the city, except in the West Bottoms, the O. K. Creek Valley traversed by the 30-inch main, and in the immediate vicinity of the above mentioned main, where it passes with diminished diameters along Lydia Avenue, 13th Street and Euclid Avenue.

An examination of the automatic pressure gauge charts, and

pressure gauge readings taken at various times at different points of the city by the Water Department, supplemented by a large number of like records taken by us, show where the principal depressions of water pressure is caused by inadequate capacity of mains to supply the demand of that locality.

These conditions in the business and north high districts can be greatly improved by laying a large main from the 30-inch main through this territory north and eastward to a connection with the same main near its eastern terminus, connecting all old supply mains where crossed, and new ones wherever needed.

The most economic method of reinforcing the supply and pressure of any district, consists in laying one large main into such territory capable of supplying a large volume of water with a minimum loss of pressure, rather than in an attempt to supply such volume through a number of smaller pipes located on different streets, and more especially so if such streets are paved.

We, therefore, recommend to relieve the conditions in the above outlined business and elevated districts, that a 24-inch heavy cast iron main be laid at once, from the 30-inch main at 17th Street along Baltimore Avenue, replacing the present 4 and 6-inch pipe, to 9th Street, and on Wall Street to 7th, branching the main at this point to a 12-inch main west on 7th Street to May Street; thence north on May Street with an 8-inch pipe to 6th Street, replacing the 4-inch pipe in the last named block, and a 20-inch main east on 7th Street, from Wall Street to Grand Avenue; thence on Grand Avenue to 6th Street; thence east on 6th Street to Oak Street, branching here into a 12-inch main north on Oak to 3rd Street for the present, and later to be extended by a 16-inch main east on 6th Street to a connection with the 16-inch main at the corner of 7th Street and Euclid Avenue. This large feeder should be connected with the 12-inch main where it crosses on 13th Street, with a new 10-inch main to be laid on 12th Street from Main west to Penn Street, replacing the 4-inch pipe, and with all existing mains where they are crossed by it. In addition thereto a 10-inch pipe should be laid on Wabash Avenue from Lexington to Pendleton in lieu of the 8-inch and a 10-inch pipe from the end of the pipe on Wabash Avenue be laid down the slope to a connection with the 8-inch pipe on Guinotte Avenue.

The south high territory is sparsely settled as yet, but covers somewhat higher ground than the north side, and has but three 10-inch feeders from the north, which are not capable of supplying a very great amount of water without a large loss of pressure, and hence the insufficient service in this district. To remedy this immediate deficiency, as well as meet future requirements, we would recommend laying a separate 24-

PROPOSED

NEW PUMPING STATION

AT

TURKEY CREEK

Showing rearrangement of Machinery and Piping

PLAN NO. 9

SCALE-

WATER WORKS COMMISSION

G.H. Benzenberg
John Donnelly
S.A. Mitchell

TURKEY CREEK

HOUSE

GASKELL Compound 3,000,000

HOLLY Quadruple 4,000,000

GASKELL Compound 8,000,000

Proposed 12,000,000 Triple

BARR Triple 10,000,000 Gallons

Proposed 15,000,000 Triple

Proposed 15,000,000 Triple

Stack

Stack

BOILER

PROPOSED COAL SHED

Coal Track

Center line of 23rd St.

Line of Right of way of Erie R.R.

Proposed 42" Suction

Proposed Extension 30" Discharge

30"

16" Discharge

Proposed 42" Suction

Proposed 64"

64"

Conduit

Flow Line

30"

Auxiliary

Old 30" Flow Line

Old 30" Flow Line

inch main from Turkey Creek station by way of 25th Street and Terrace Street to 27th Street; thence east on 27th Street to Summit; south on Summit to 29th; then southeasterly to 30th; thence to Penn and 31st, branching here for the present with a 20-inch main east on 31st to a connection with the 10-inch pipes on both Main and 31st Streets at their intersection, with the view of hereafter extending the 20-inch feeder eastward and of laying a 16-inch feeder southward from 31st Street on Penn. These and the proposed location of the principal mains required to meet future requirements are shown on plan No. 2.

"Sixth—State what additions and changes are necessary to the distribution system to provide ample and proper fire protection by direct pressure, in both the business and elevated districts."

Ample and proper fire protection demands immediate accessibility to a large volume of water with power to discharge same in a sufficient number of solid streams to reach and extinguish the burning material.

In this city a fire pressure of 160 pounds at the pumps is supplied, generally sufficient for protection of property in the business district, and of residence property in the elevated districts, providing no undue amount of pressure is consumed in forcing the volume of water required for fire protection, in addition to that of ordinary consumption, through the mains or through long lines of hose. A 1⅛-inch stream, with a pressure of 80 to 100 pounds at the hydrant, will generally discharge from 270 to 300 gallons per minute. Such a stream consumes from 18 to 20 pounds of pressure in passing through every 100 feet of 2½-inch best rubber lined hose, and about 8 pounds in passing through 300 feet of clean 4-inch cast iron pipe, while two such streams will consume about 30 pounds in passing through 1,000 feet of six-inch pipe. It is very important, therefore, that the size of the mains be ample, that the pressure developed be not consumed in transit to the hydrant or in long lines of hose, imperatively so, where fire protection is required at high elevations by direct pressure.

Of the 194 miles of main in the distribution system, 14½ per cent consist of 4-inch, practically all of which was laid by the National Water Works Company, and 53 per cent of 6-inch pipe, while in the business district heretofore mentioned, 32 per cent of the pipes consist of 4-inch.

The condition in the business district, where a larger number of streams are required for adequate protection than in the residence sections, if direct fire protection service is to be continued, should be remedied at once by replacing the present

pipe lines with the following, in addition to the recommendations contained in answer to Question 5, viz:

An 8-inch main on Third Street from Grand Avenue to Broadway.

A 10-inch main on Broadway from 3rd Street to 7th Street.

An 8-inch main on 6th Street from Delaware to May Street.

A 12-inch main on 7th Street from May to Broadway.

A 10-inch main on 7th Street from Broadway to Washington Street.

An 8-inch main on Central Street from 5th Street to 10th Street, and a 12-inch main on 9th Street from Wyandotte to Broadway, for the present, and thereafter as the requirements may demand.

A 12-inch main on Broadway from 7th Street to 10th Street.

A 10-inch main on Broadway from 10th Street to 16th Street.

An 8-inch main on Missouri Avenue from Oak to Troost Avenue.

A 10-inch main on 12th Street from Locust Street to Holmes.

An 8-inch main on 9th Street from Broadway to Washington.

An 8-inch main on 14th Street from Broadway to Madison.

An 8-inch main on Walnut Street from 11th Street to 15th Street.

An 8-inch main on 8th Street from Penn to Jefferson Streets.

In addition hereto the replacing of all four-inch pipes on north and south streets not mentioned in the above list by a 6 or 8-inch or larger pipe, according to the locality and elevation of the streets, not less than an 8-inch being used on those streets above elevation 200.

We also recommend discontinuing all hydrants from 4-inch pipe lines and connecting them to the larger mains crossing the 4-inch pipe at location of hydrants. If there are no such cross mains, then provide them. If that is impossible, then replace the four-inch pipe with a six or eight-inch pipe in streets above elevation 100. Also remove all four inch hydrants and four-inch hydrant branches, where connected to mains of larger size above elevation 125, and substitute six-inch double nozzle combination hydrants and branches, using the four-inch hydrants on mains below elevation 125. In especially hazardous localities, place six-inch double nozzle hydrants not more than 150 feet apart on the larger mains, excepting on feeders above 24 inches in diameter. No such fire protection as can be ob-

WATER WORKS SYSTEM

KANSAS CITY MO.

SCALE

FEB'Y. 1901

PROPOSED REINFORCEMENT AND EXTENSION OF DISTRIBUTION SYSTEM

PLAN Nº 2

Water Works Commission
G.H. Benzenberg
John Donnelly
S.A. Mitchell.

Note

Black —— Present pipe System 10" and above
Red —— Reinforcements for immediate requirements
. ------- . . future .
. ---o--o-- . to be made if special fire
System is not built ——

N.

HARLEM

RIVER

MISSOURI

KANSAS

City Limits

Heim's Brewery

Scarriff Training School

NORTH TERRACE PARK

BURGE PARK

BUDD PARK

INDEPENDENCE AVE.

BOULEVARD

UNION DEPOT

Reservoir

Turkey Cr Sta

DEPOT

UNION CEMETERY

ELMWOOD CEMETERY

ST MARY'S CEMETERY

CENTROPOLIS

ROSEDALE

WESTPORT

LEEDS

BLUE RIVER

ARMOUR BVD.

LINWOOD

PROSPECT

MADISON

MAIN

WALNUT

GRAND

BROADWAY

JEFFERSON

PENN

WASHINGTON

BROADWAY

CENTRAL

WYANDOTTE

BALTIMORE

MAGEE

OAK

LOCUST

CHERRY

HOLMES

CAMPBELL

HARRISON

TROOST

FOREST

TRACY

LYDIA

GROVE

FLORA

VINE

HIGHLAND

WOODLAND

MICHIGAN

LUDLOW

GARFIELD

TERRACE

MERCIER

HOLLY

ELMWOOD

HARDESTY

OAK

BRUSH CREEK

tained in the business sections can be expected in the remote and higher elevated districts, nor is such pressure or number of streams necessary, because the buildings are not as large nor generally more than 40 to 45 feet in height. In districts not above elevation 225 a pressure of 50 pounds at the hydrants can be secured by a liberal system of large mains which will conserve the pressure for fire protection purposes. We, therefore, recommend that in the extension of the distribution system the size of the mains as indicated on Plan No. 2 be followed to provide the best protection possible by direct pressure.

"Seventh—Do you deem it desirable to provide a separate high level service, dividing the city into two or three level services to meet the future growth? If so, outline your recommendations."

This question has no doubt been prompted by the suggestion which we understand has been repeatedly urged that for topographical and economical reasons there should be a subdivision of the system into high and low level districts to avoid pumping all the water consumed to an elevation of 364 feet above city datum, when such a large percentage of it is taken off at or below the 125 foot level.

We find that the territory within the city limits shows a range of elevations from 25 to 290 feet above city datum, the area lying below an elevation of 35 to 55 feet is what they may be strictly called the low level district, comprising what may be defined as West Bottoms, North Bottoms, Blue Valley, and a portion of O. K. and Turkey Creek Valleys. The remainder of the territory is of such varied topography that there is no line of elevation that clearly defines any intermediate territory between the low or bottom level, and the elevated district.

This district may be described as being of crescent or horse shoe shape, the two arms of which extend along the north and south slopes of O. K. Creek Valley and the crest enclosing the upper end of the Valley, on about the line of Prospect Avenue.

If all of the territory of either a high or low level were confined to a compact area, it would manifestly be the proper thing to provide each level with an independent supply at different pressures, but the low level territory being as widely separated as it is, would require, in order to supply it as an independent service, main supply lines of 20 or 24-inch pipe, each at least five miles in length. The interest on the cost of such lines would far exceed the annual cost of fuel required in pumping the water to an additional elevation of the high level as is now done, and hence we are of the opinion that it would not be wise

or economical to attempt to supply all the low level territory as an independent service, and the remainder of the city through another system.

It is desirable, however, that the extension of mains in the high level territory, both to the north and the south of O. K. Creek valley should be of such sizes and along such lines that should the increased consumption in either district demand different pressure to serve them economically, they could then be readily separated along some east and west line in O. K. Creek Valley.

The West Bottoms being a compact district and in close proximity to the pumping station, a saving in operating expenses can be made by mantaining this as a separate system in connection with the Holly Street Reservoir.

We would therefore recommend that this territory be supplied direct by pumping engines engaged exclusively in supplying this district, instead of the indirect manner in which the supply is now furnished through the high service pumps.

"Eighth—Do you recommend the building of any additional elevated storage reservoirs? If so, where, and of what capacity?"

As the Holly Street reservoir already provides sufficient storage for the West Bottoms, and as there is no reservoir location at sufficient elevation to furnish storage capacity available for the elevated districts, we do not recommend the building of any additional elevated storage reservoirs.

It would be advisable, however, to provide some storage which could be used to meet sudden heavy demands for water in various parts of the city, other than for fire service, so as to relieve the pumps as much as possible from that dangerous speeding which they are subjected to in their attempt to maintain the supply and pressure.

Stand pipes of about 20 feet diameter, reaching to a height of 370 feet above city datum, located at suitable elevations upon both the north and south high levels, not too remote from the pumping station, would provide such a remedy. Suitable means for promptly shutting off these stand pipes during time of fire pressure, must be provided. Fluctuation of engine speed due to direct fire pressure service cannot however be reduced by such stand pipes.

"Ninth—What do you recommend as the best means of providing ample fire protection in the various districts of the city?"

For the West Bottoms we recommend a direct fire pressure through the reinforced system of 140 pounds maintained

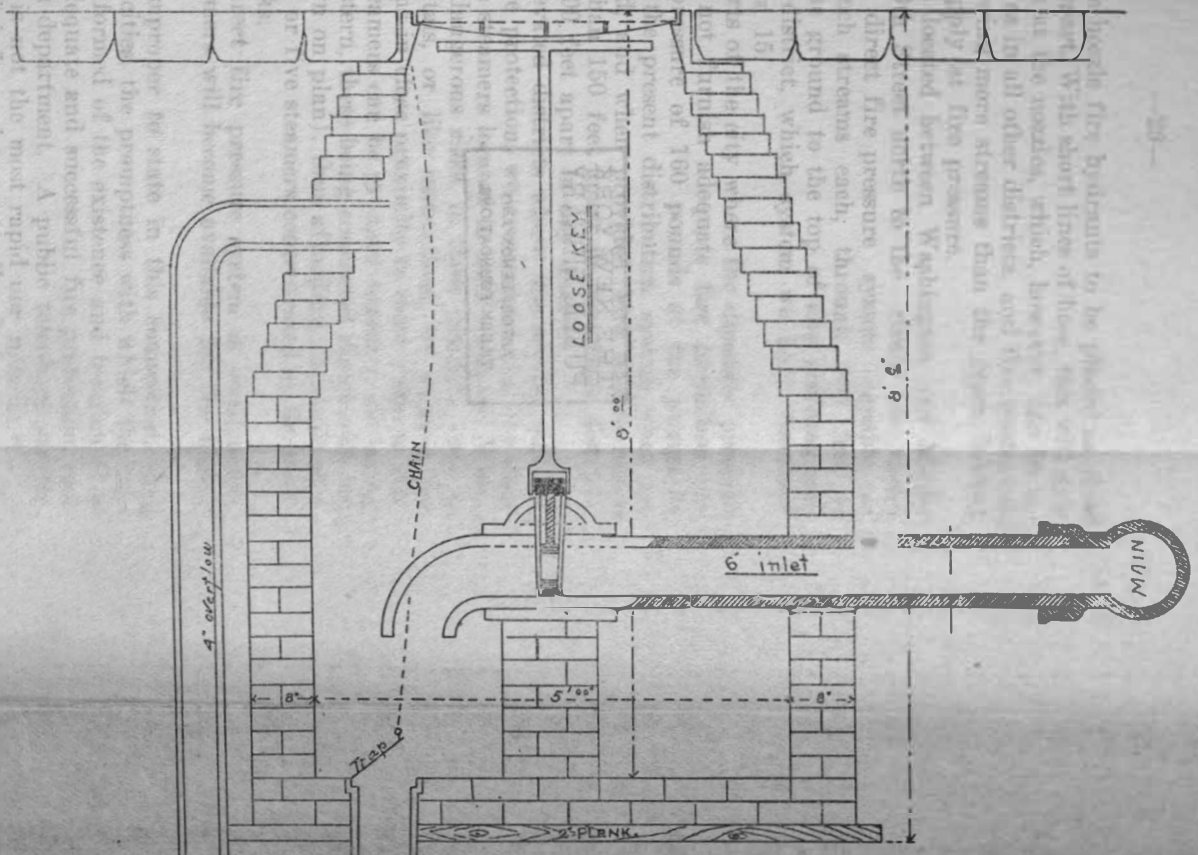
—Water Works Comm.—
S. A Mitchell
John Donnelly
G H Benzenberg

Engineers

—Kansas City Water Works—

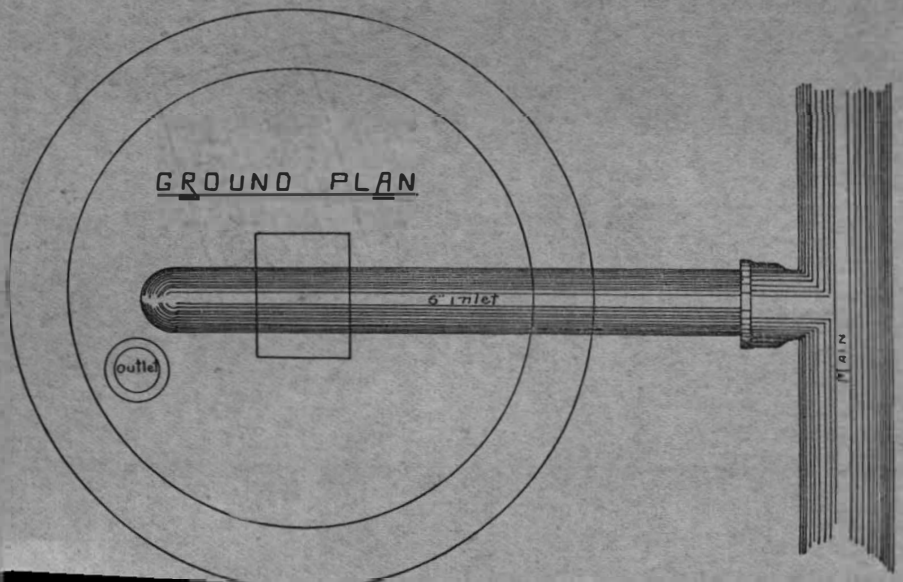
PLAN NO. 11

—PROPOSED FIRE CISTERN.—



PLAN of FIRE CISTERN.

SCALE



at the pumps, double nozzle fire hydrants to be placed as close as 150 and 125 feet apart. With short lines of hose, this will give an excellent pressure at the nozzles, which, however, can be exhausted here as well as in all other districts, and fire protection be defeated, by throwing more streams than the pipes feeding the hydrants can supply at fire pressure.

For the district located between Washington and McGee Streets and from 13th Street north to the river, we would recommend a special direct fire pressure system capable of [illegible] five two-inch streams each, through 100 feet of [illegible] hose, from the ground to the top of any building now located within said district, which system we have described in answer to question 15.

For all other parts of the city where the domestic pressure of 140 pounds will not furnish adequate fire protection, we recommend that a pressure of 160 pounds at the pumps be maintained through the present distribution system when reinforced as suggested, and when provided with double nozzle hydrants not more than 150 feet apart in hazardous districts, and no more than 300 feet apart in any district.

In the higher elevated districts where this service will not provide an ample fire protection, we recommend that the same be augmented by fire steamers located in such territory. Where there are especially dangerous risks, in these districts, such as public schools, hospitals, or like institutions, we suggest the placing of fire cisterns in close proximity to those risks, so that quite a number of steamers can be grouped together, all taking suction from such cistern, these being connected direct with the water main, (as shown on plan), thus affording an ample supply of water for four or five steamers concentrated at the nearest point to such risks.

If the special direct fire pressure system is constructed, then several fire steamers will become available for the higher elevated districts.

It may not be improper to state in this connection, that particularly in large cities, the promptness with which the fire department can be informed of the existence and location of a fire, adds much to adequate and successful fire protection, and the efficiency of such department. A public telephone service as the only medium, is not the most rapid nor reliable [illegible] of communicating such information to the fire depa[illegible] to the water works pumping station, which [illegible] always be promptly notified when the [illegible] ing fire pressure has ceased.

"Tenth—Report what else in your opinion, may be necessary to place the Water Works Plant in a more efficient condition, and such additions as in your judgment the future growth will demand."

In order to further perfect the efficiency of the plant, careful and complete records should be kept of all the items of cost in connection with its operation. Hence we deem it desirable that an improved system of records be maintained so that the work of each station and of each engine can be definitely determined.

The providing of an ample supply of water is not the only essential in the economic management of a waterworks system. Preventing an unnecessary waste of water is as great a factor in the successful management as the providing of an ample supply. This can best be obtained by the general use of meters and we urge that their use be required by every consumer.

We would also recommend that as soon as it is practical, where the force mains leading from Turkey Creek station cross the creek, that auxiliary lines be laid under the bed of the creek so as to be available for use in case of accident to the present pipe bridges. In this connection, in view of the fact that the location and plans for the Allen Avenue Viaduct have been agreed upon and that this location covers a portion of the 30-inch flow line, we would advise the removal of a portion of this line from a point near the station to the intersection of Liberty and Wyoming Streets, and relaying it south along Liberty Street parallel to the other flow line under the bed of Turkey Creek to a point near the station.

As a matter of safety to the public and of protection to the supply stored in the Holly Street reservoir, we would advise that a watchman be placed at this property.

"Eleventh—What changes do you think are necessary in remodeling the Turkey Creek station and its pipe connections, etc., that it may be simplified?"

This question has been answered in our reply to the fourth question and by plans No. 8 and No. 9,to which we refer you.

"Twelfth—What do you recommend for the improvement of the intake at Quindaro? Is it necessary to make any improvement there for present protection?"

The present intake consists of a timber and masonry pier which is not constructed at sufficient depth to afford the full capacity of water to the 42-inch suction at low water and has been supplemented by an auxiliary suction 36 inches in diam-

N

West Line of Street

East Line

Holly St.

Top of wall

Bottom Line of Brickwork

33.46'

174.1'

31.4'

62.6'

20

217.1'

320.28'

Top of wall

West Prospect Pl.

20" Pipe

Cliff St.

47'

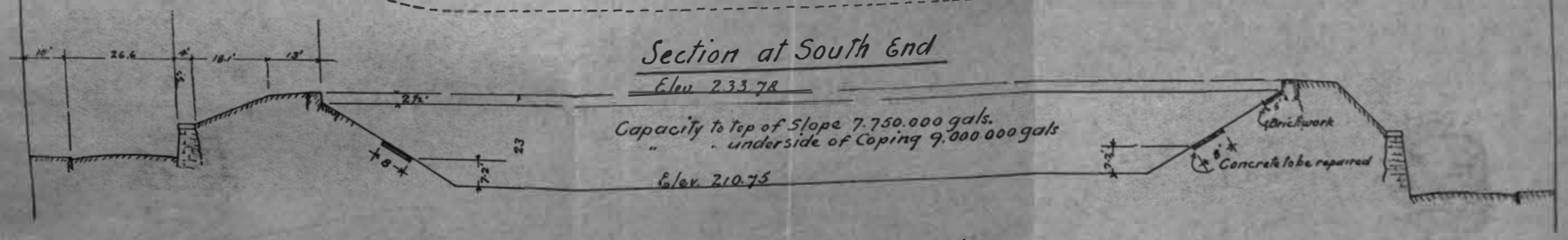
32.17'

172.7'

33.3'

33.3'

Strip of Concrete to be repaired about 850' long by 8' wide



Kansas City Water Works

Diagram of Holly St. Reservoir

PLAN NO. 12

S. A. Mitchell
John Donnelly ..... Engineers
G.H. Benzenberg

eter, which has to be relied upon to furnish water to the pumps during short periods of low water, which do not extend over a few weeks, during any year. As it is found to be troublesome to secure the necessary amount of water through this suction during such periods, and as the present connection between the 42-inch pipe and intake pier seems to be defective, we would recommend, that, whenever the stage of the river will permit, the end of this suction pipe be dropped to the lowest point possible, and its connection with the back of the intake pier made safe and tight. In order to increase the inflow capacity at low stage of the river, we would recommend that the timbers in front of each screen chamber of the pier, below the cap timber be removed and a screen of heavy round vertical iron rods set in an iron frame, be substituted therefor. If it is found such changes do not secure a condition that is safe to rely upon during extreme low water, we would then suggest the use of a second auxiliary suction until such time as the conditions warrant the construction of a new intake, which, when built, should be farther out in the channel and admit of taking water at different levels, and also below lowest stage of river level.

We do not deem it necessary to provide a special improvement for the protection of the intake aside from maintaining the present protection, but we are of the opinion that special care should be taken to prevent drift material from lodging in front of the intake pier..

"Thirteenth—Do you think we will require more ground at Turkey Creek station for any enlargment or betterment you may recommend?"

We are of the opinion that additional ground should be secured for the enlargement and reconstruction of the pumping station as indicated in our answer to question No. 4, and as shown on Plan No. 7, and as there is but this limited piece of ground which is at all available, and as it is necessary to the bringing in of new and rearranging of the old lines of pipe around this pumping station, we would recommend that the city secure this strip of land as soon as possible.

"Fourteenth--Given that the inflow, capacity at Turkey Creek is as stated:

One Holly Quadruplex ..... 4 million gallons
One Holly Gaskill ..... 3 million gallons
One Barr Triple Expansion .....10 million gallons
One Holly Quadruplex ....5 million gallons
One Holly Gaskill ..... 9 million gallons
or say a total of 31 *million gallons, and that the total outflow is as stated:*

One 16-inch main ..... 4 million gallons
One 20-inch main ..... 6 million gallons
One 30-inch main ..... 14 million gallons

or say a total of 24 million gallons, which is the outflow for the territory east of the Bluffs, what in your opinion would be most judicious expenditure of money for additional outflow for fire purposes in the Bottoms? Please give approximate cost of reservoir, with its capacity, to be builded on city property south of present reservoir at Turkey Creek."

In reply to this question, we would state that it is our opinion that an additional supply for fire purposes could be best secured by the laying of an additional main to the West Bottoms. The size and location of this additional main is shown on Plan No. 2.

The available capacity of a new reservoir or storage basin southeast of the present reservoir or storage basin at Turkey Creek, covering about 2 1-2 acres would be seven million gallons and its approximate cost is estimated to be $30,875.00.

As the new conduit from Quindaro and the present flow line will have a capacity of about 40 million gallons per 24 hours by gravity flow, it is not so essential that the storage capacity at this station be increased, especially when the total available storage capacity to be gained will not exceed ten hours supply for the city.

"Fifteenth—If one pumping engine with boilers, or, provided one of the pumps at Turkey Creek can be removed to foot of Broadway, please make approximate estimate of cost of stations at point named; the cost of 20-inch main south on Broadway to 14th, east on 14th to Grand, north on Grand Avenue to Third, west on Third in connection with 20-inch main on Broadway, or any other loop, as you may suggest. State if ample fire pressure and protection would not then be obtained in district proposed, using these proposed mains and laterals for fire purposes alone."

This question contemplates a special direct fire pressure service for the territory outlined with special pumps, water mains, and hydrants exclusively devoted to fire protection.

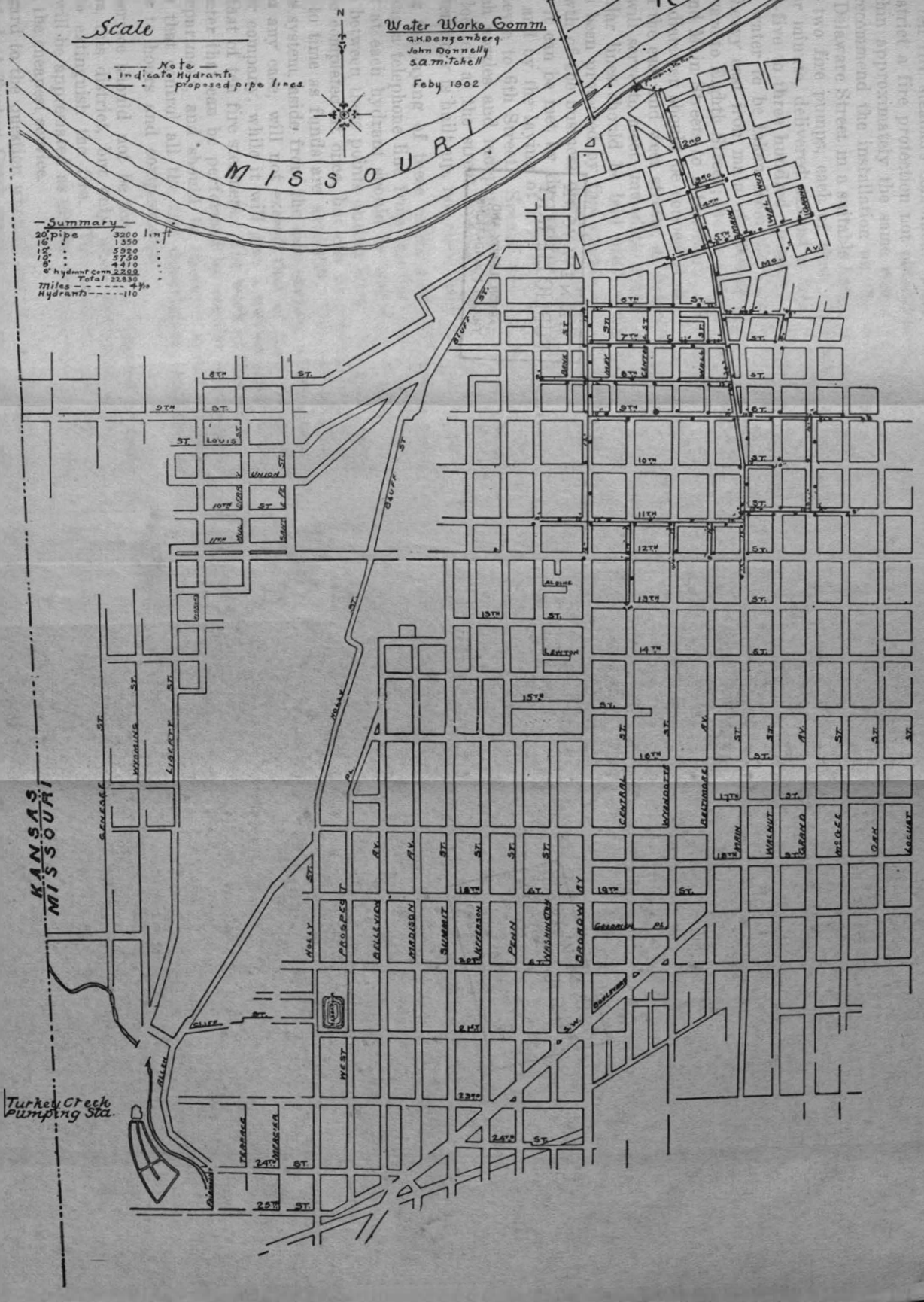
Such special fire protection systems are in use in many of the larger eastern cities where they are considered of extraordinary value in protecting high buildings or fighting large fires as compared with fire protection by either fire steamer or direct pressure service.

The special value consists of the ability of such a system delivering either several 2-inch, 2½, or even a 3-inch stream with a pressure and a volume which would equal the energy and

PLAN No 10

Kansas City Mo. Water Works

Plan showing Proposed Special Fire Service System



capacity of ten fire steamers combined. Such a system would give this district a fire protection not obtainable by any other method within approximately the same cost. To obtain such, we would recommend the installation on the river front near the foot of Delaware Street in a suitable house, of the necessary boilers and two fire pumps, each of three thousand gallons capacity per minute, delivered against a head of two hundred and seventy-five to three hundred pounds pressure at the pumps, the water to be taken from the river and discharged through a heavy cast iron main of 20-inch diameter, running along Delaware to Eighth Street; thence as a 16-inch main along Delaware and Main Streets to 11th Street. Cross mains 10 and 8 inches in diameter should be connected with this main line and laid on the east and west streets, as indicated on Plan No. 10, which will serve to meet immediate requirements, but ultimately similar lines should be laid until every block in said district has been protected by this special service. Should the future growth of the business district require the extension of the system, it can be met by the addition of another pump at the station and by the laying of a 16-inch main on Broadway from the Levee to 6th Street. Special fire hydrants with two 3½ or 4-inch nozzles and independent valves at each nozzle, should be located at the street crossings and intermediately where the territory is built up, not more than 200 feet apart.

During the laying of these mains and hydrants, a small pipe carrying a telephone line from the fire pump station to a transmitter at each hydrant should be laid to facilitate communication between these points during fires. The pipe system need not be completed at once, but can be gradually extended from time to time as funds are available. The cost of operation of this system, aside from the hose service, which must be supplied in any case, will not exceed that of maintaining one fire steamer company, while it will give a service equal to and exceeding that of ten fire steamers. The work of this station is of a character that can be performed by regular employees of the fire department, and should be operated under the same regulations that control all the fire department stations at present, as to hours and compensation.

This service should not be expected to respond to every alarm from this district, but only when additional service is required to extinguish the fire. This system when once in operation will be appreciated as giving the very best and at the same time, the cheapest service.

In regard to the question whether any of the pumps or boilers located at Turkey Creek station could be used in connection with this system when removed to the foot of Broadway

(or to any other point), we would state that none of the pumps or boilers at that station put in first-class condition, could supply the pressure required for this service.

SUMMARY.

Having fully considered the subject matter of the improvement of the Water Works system of this city under the various and comprehensive inquiries submitted by your Board, and having answered them with our reasons therefor, in the order in which they were presented, we herewith submit a summary of our recommendations regarding the betterment of the Water Works system necessary to place the same "in a thoroughly efficient, adequate and safe condition for the proper supply of water to this city," keeping in mind its requirements when the population within its present limits shall have reached 300,000 to 350,000; taking up the various parts in the following order, Quindaro, Flow Line, Turkey Creek Station, Distribution system and Fire Protection.

QUINDARO.

At this station we recommend that the river end of the main suction pipe be lowered as far as the floor in the screening chamber will permit; closing the opening through which this pipe enters the intake pier so as to prevent sand from entering the chamber during the low stages of water; by substituting iron rods for the timbers which now obstruct the flow. Should this change not provide a sufficient flow, we suggest that a second auxiliary suction pipe be provided, until conditions warrant the construction of a new intake to be built in deep water.

Within the pumping station, we recommend a re-arrangement of the round-about system of suction and discharge mains, simplifying the same, adding to their efficiency, gaining thereby valuable space required for additional pumping machinery; the installation of a 25 million gallons centrifugal pump and boilers, this pump to deliver water from settling basins through the present flow line to Turkey Creek Station, until the new proposed conduit between these stations is completed, when it may be transferred to the service of pumping from the river to the settling basins.

To meet the urgent necessity of providing additional pumping capacity from the settling basins to Turkey Creek Station during the coming summer, we recommend the immediate purchase of a second-hand rotary or centrifugal pumping engine of 8 to 10 million gallons capacity as a temporary expedient until the 25 million gallons pump has been erected ready for service, when the Holly pump should be discontinued in this service.

We also recommend the providing of an additional 20 million gallons centrifugal pumping engine for delivering river water to the settling basins, and the replacing of the old boilers with new ones with larger units and higher steam pressure, as such become necessary from time to time. Aside from providing a brick coal shed for storing a supply of coal and the housing in of the new pump pit between the engine and boiler house, no additional buildings will be required at this station to meet the requirements for a supply of 350,000 population.

The settling basins with the present method of sedimentation will, with careful operation, continue to furnish a satisfactory water supply for a number of years. Whenever the consumption approaches their capacity, additional basins of equal size should be constructed adjacent to the present basins and so arranged as to permit of their being operated in connection with each other.

FLOW LINE.

To meet the maximum requirements for water during the coming heated season, we have recommended the immediate extension of the auxiliary 30-inch pipe from the intersection of 12th and Bell Streets to a connection with the 36-inch line at Kaw Point, and your Board, following this advice, promptly contracted for its construction and the work on the same has been commenced. As the maximum daily consumption will have reached the capacity of the reinforced flow lines in a few years, and as it is dangerous for a large city to be dependent for its supply upon a single pipe line that has proven itself weak and unsafe, we recommend the construction of a concrete steel gravity conduit of 64 inches diameter, capable of delivering with the present flow line, 40 million gallons daily by gravity, thereby obviating the necessity of pumping this water a second time at Quindaro. This conduit is to cross the Kansas river in tunnel, the only permanent way of passing this stream.

In connection with the present flow line, we recommend that consumers taking their supply direct be required to draw from tanks supplied continuously, so as to remove the possibility of any water hammer in the flow line.

We also recommend the re-location of the original 30-inch flow line near Turkey Creek station to reduce its circuitous length and remove it from possible injury and interference by the construction of the Allen Avenue viaduct.

TURKEY CREEK STATION.

At this station we recommend the purchase of additional ground necessary for future enlargement and the general rear-

rangement and modernizing of this plant; the gradual abolishing of the present unnecessary net work of pipe lines around this station and substituting therefor a systematic, comprehensive and efficient line of piping; also the removal of the pumping machinery and boilers, without any interference with the service, into a new engine and boiler house which, when built as proposed, will permit of its extension from time to time as required. This arrangement also provides for a sidetrack and ample coal storage sheds.

We also recommend the early purchase of a 12 million gallons triple expansion pumping engine with necessary boilers and thereafter as needed an additional 15 million gallons engine of the same type.

We also urge the filtering and purifying of the water from the jet condensers before being returned to the basins, and the daily removal of floating soot and cinders from the water surface until the basins can be covered.

DISTRIBUTION.

For the purpose of improving the pressure and capacity of the water supply in certain sections of the city where the same is now deficient, we recommend the immediate laying of a 24-inch main on Baltimore Avenue from the 30-inch main at 17th Street to the center of the business district, then continuing this large feeder as a 20 and 16-inch pipe eastward to the elevated ground in the northeast part of the city. We also recommend the laying of a 24-inch main from the pumping station southeastward to the high ground in the south side of the city.

In the business section we recommend that the flow of the large new feeder be distributed by numerous connections and some new branch mains, definitely outlined in our answer to the Fourth question.

We also recommend that in the extension of the distributing system, the general plan outlined providing for the proper supplying of water to various parts of the city with the view of meeting future requirements, be followed.

FIRE PROTECTION.

For the business district of the city located between Washington and McGee Streets north of 13th Street, we recommend a special direct high pressure fire system particularly applicable to this elevated business territory, as it is capable of furnishing the best modern district fire protection now known.

In case this special system should not be installed, we recommend further specific reinforcement of the distribution

system in this business district so as to afford the best protection with this system and 160 pounds pressure at the pumps. We also specify for certain conditions existing outside of this business section, the substituting of larger pipe for the four-inch lines and of disconnecting all hydrants from four-inch pipe and reconnecting them to larger mains.

In the higher elevated districts, we recommend the use of liberal sized mains and the use of fire steamers. To afford the best possible protection to large school, hospital and other buildings in these districts, we recommend the construction of small cisterns in close proximity to them directly connected with the water mains, so that a number of fire engines can be concentrated near such institutions.

For the west bottoms we recommend the laying of an additional large main from the pumping station, and the location of additional hydrants in hazardous districts to enable the fire department to concentrate their streams with shortest lines of hose upon any fire.

CONCLUSIONS.

It is not contemplated that the betterments herein recommended should all be made at once, but rather that they be carried out from time to time as the necessity for them may arise. There are certain improvements, however, which in our opinion, should be made immediately to improve the condition of the water works system, and for the better protection of property, which we will undertake to outline in the order in which we believe they should be made, together with an estimate of cost of such improvements as will have to be done by contracts.

The contracts for the extension of the auxiliary 30-inch flow line, for one 200 H. P. boiler for Quindaro, and for two 300 H. P. boilers for Turkey Creek station have been let since the beginning of our investigations.

We deem it of the utmost importance that the distribution system in the business district be reinforced by the laying of the 24-inch main on Baltimore Avenue as far as 7th and Wall Streets, and a 20-inch main from there on 7th Street, Grand Avenue and 6th to Oak Street, a 12-inch main from there on Oak Street to 3rd Street, a 12-inch main on 7th from Wall to May Street, and an 8-inch main on May from 7th to 6th Street.

We estimate the cost of these mains in place at $40,500. We also deem it of equal importance that a temporary second hand rotary or centrifugal pumping engine be purchased and installed at Quindaro, for the purpose of delivering water into

the flow line, and also that a 25 million gallons centrifugal pumping engine for the same service, be contracted for.

The first pumping engine can be secured and installed within 90 days of date of purchase, at an estimated cost of $3,000.

The second pumping engine will require ten, and possibly 12 months for its construction and erection, and we estimate the cost of this engine erected and connected up on suitable foundations, at $23,000.

The re-arranging and simplifying of the piping system at Quindaro to make the same safe, and also to provide room for this pumping engine, the lowering of the river end of the suction pipe and changes at the inlet to the screening chamber cannot be let by contract, but must be made gradually by your water department and when conditions will permit. The same is to be said regarding the rearranging of the pipe system around and at Turkey Creek station, which work should be commenced soon and carried on with skill.

We also deem the providing of a special direct high pressure fire protection system for the business district of great importance, or if such system is not approved of, then the immediate further reinforcement of the present system throughout such district.

We estimate the cost of the special system, as follows:

Two fire pumps of 3,000 gallons per minute capacity each and necessary boilers	$18,000.00
Engine house, foundations and river connection	2,500.00
Pipe line as shown on Plan No. 10	52,000.00
110 Special hydrants with their connections	7,025.00
1,500 Feet of 3½-inch hose and nozzles	2,500.00
Telephone line and boxes	3,000.00
Total	$85,025.00

This system is not a part of the water works and hence, in our opinion, should not be paid for by that department.

The cost of the further reinforcement, as itemized on page 26 of this report, necessary in case the special fire protection system should not be built we estimate as $14,800.

The above improvements, it is our opinion, should be made during the present year, to be followed in 1903 by the contracting for a section of the new conduit, so as to insure its entire completion in 1905.

We estimate the total cost of this conduit complete including the tunnel crossing at Kansas river at $266,600.00.

During 1903 certain further reinforcements to the distribu-

tion system must be made, and we recommend that the 24-inch main from Turkey Creek station to Penn and 31st Streets, and the 20-inch main from there to Main and 31st Streets, be laid.

We estimate the cost of this line at $35,500.00.

In addition to this, we recommend the laying of the following: A 10-inch main on Wabash Avenue from Lexington Avenue to Guinotte Avenue; a 10-inch main on 12th Street from Main to Penn Street; an 8-inch main on 14th Street from Broadway to Madison Avenue; an 8-inch main on 8th from Penn to Jefferson Street, and a 10-inch main on 12th from Locust to Holmes.

We estimate the cost of these lines at $11,250.00.

We also recommend that during 1903 an additional 12 million gallon triple expansion pumping engine and boilers for Turkey Creek Station be contracted for, pending the construction of which the middle section of the proposed new station be erected.

We estimate the cost of the engine and boilers erected on their foundations at $104,000.00.

This section of the building, including a 30-ton electric traveling crane, and a steel stack, we estimate at $36,500.00.

With these improvements completed, and the further extensions made, when necessary in conformity with our recommendations, we believe the water works system will prove to be ample and safe for the future requirements as they may arise.

Respectfully submitted.

GEO. H. BENZENBERG.
S. A. MITCHELL,
JOHN DONNELLY,
Commission of Water Works Engineers.

List of Plans Submitted With the Report of the Commission of Water Works Engineers.

Plan No. 1. General Distribution System.

Plan No. 2. Proposed reinforcement and extension of distributing system.

Plan No. 3. Proposed location of new flow line from Quindaro to Turkey Creek.

Plan No. 4. Map of Quindaro settling basins and proposed extension.

Plan No. 5. Quindaro station showing pumping station, intake and pipe connections.

Plan No. 6. Quindaro station, showing proposed location of new pumps and new pipe connections.

Plan No. 7. Plan showing Turkey Creek station and proposed extensions.

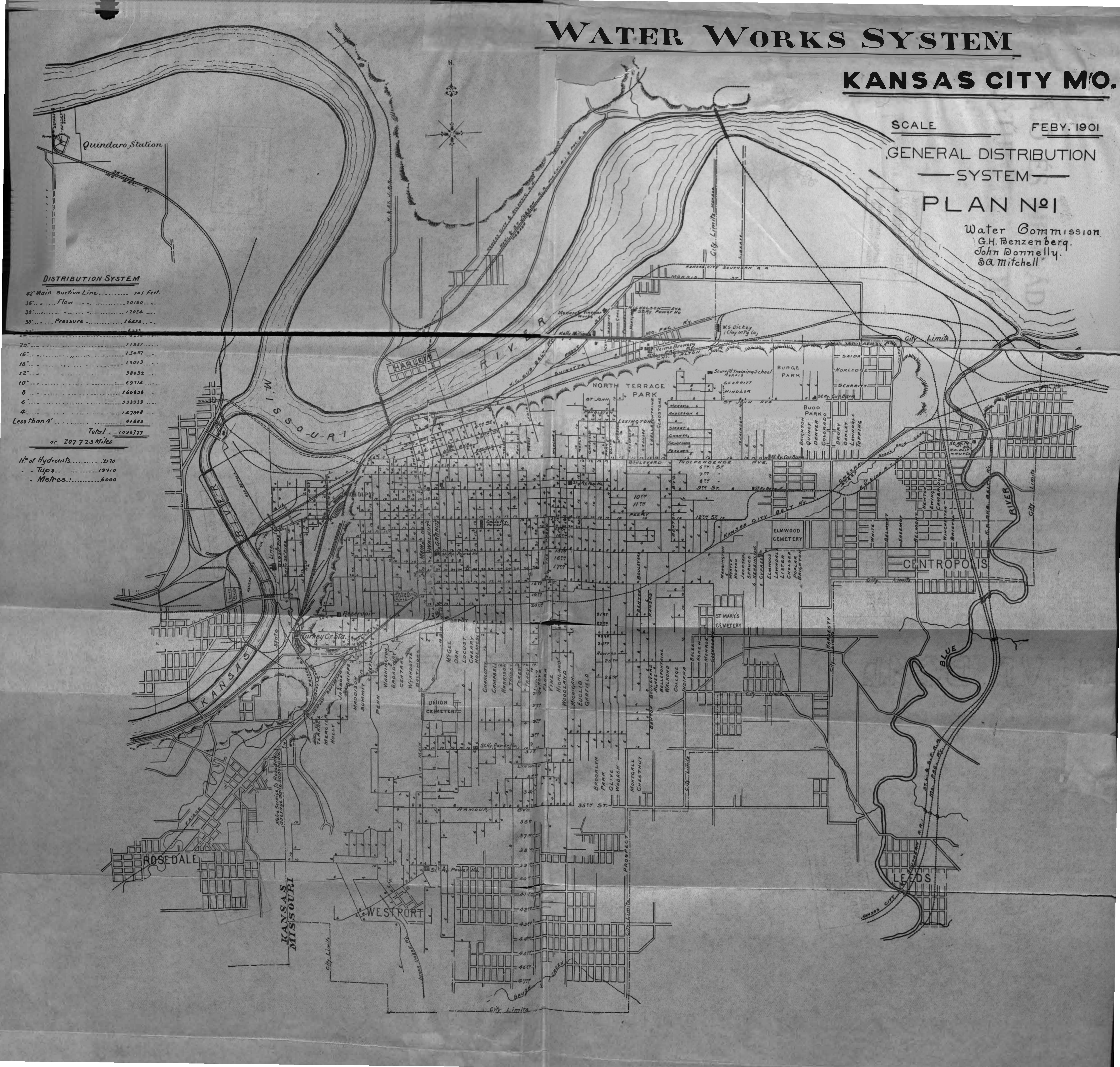
Plan No. 8. Plan of Turkey Creek station showing present arrangement of pumping engines and pump connections.

Plan No. 9. Proposed new pumping station at Turkey Creek showing re-arrangement of machinery and piping.

Plan No. 10. Plan showing proposed special fire service system.

Plan No. 11. Proposed fire cisterns.

Plan No. 12. Diagram of Holly Street Reservoir.


WATER WORKS SYSTEM
KANSAS CITY MO.
SCALE
FEBY. 1901
GENERAL DISTRIBUTION
SYSTEM
PLAN No 1
Water Commission
G.H. Benzenberg.
John Donnelly.
S.A. Mitchell
Quindaro Station
DISTRIBUTION SYSTEM
42" Main Suction Line 745 Feet.
36" Flow 20160
30" 12026
30" Pressure 16485
20" 11851
16" 15437
15" 13013
12" 38432
10" 69314
8 169656
6" 333939
4 147848
Less than 4" 41640
Total 1096777
or 207 723 Miles
No of Hydrants 2170
Taps 19710
Metres 6000
MISSOURI RIVER
KANSAS RIVER
BLUE RIVER
NORTH TERRACE PARK
BURGE PARK
BUDD PARK
ELMWOOD CEMETERY
ST MARY'S CEMETERY
UNION CEMETERY
CENTROPOLIS
ROSEDALE
WESTPORT
LEEDS
HARLEM
KANSAS
MISSOURI
City Limits
Reservoir
Turkey Cr. Sta.
Kansas City Belt Ry.
INDEPENDENCE AVE.
ARMOUR BVD.
35TH ST.
PROSPECT