Map

Report

OF

HE COMMITTEE ON WATER SUPPLY

OF THE

NEW CITY HALL,

PHILADELPHIA;

TOGETHER WITH THE

REPORT OF HOWARD MURPHY, C.E.,

HYDRAULIC ENGINEER TO THE

ommissioners for the Erection of the New Public Buildings,

THEREIN RECOMMENDED FOR ADOPTION,

AND THE

ACTION OF THE COMMISSIONERS THEREON,

FEBRUARY 3, 1885.

ISAAC S. CASSIN, *Chairman,*
WILLIAM BRICE,
WILLIAM S. STOKLEY,
} *Committee on Water Supply.*

PHILADELPHIA:
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1885.

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COMMISSIONERS

For the Erection of the Public Buildings.

FEBRUARY 1, 1883.

WILLIAM BRICE,
ISAAC S. CASSIN,
MAHLON H. DICKINSON,
THOMAS E. GASKILL,
JAMES R. GATES,
JOHN L. HILL,
CHARLES LAWRENCE,
HIRAM MILLER,
RICHARD PELTZ,
SAMUEL C. PERKINS,
WILLIAM B. SMITH,
WILLIAM S. STOKLEY,
WILLIAM H. WRIGHT.

OFFICERS.

President—SAMUEL C. PERKINS.

Secretary—WILLIAM B. LAND.

Treasurer—WILLIAM B. IRVINE.

Solicitor—SAMUEL PELTZ.

Architect—JOHN McARTHUR, Jr.

Assistants—{ JOHN ORD,
THOMAS U. WALTER.

Superintendent—WILLIAM C. McPHERSON.

NEW CITY HALL, PHILADELPHIA.

DIMENSIONS OF BUILDING.

From North to South,	486 feet 6 inches.
From East to West,	470 feet.
Area,	4½ acres.
Height of Main Tower,	537 ft. 4 in. above pavement.
Width at Base,	90 feet.
Centre of Clock Face,	361 feet above pavement.
Diameter of Clock Face,	20 feet.
Height of Upper Balcony,	296 feet above pavement.
Total Number of Rooms in Building,	520.
Total Amount of Floor-room is	14½ acres.
Height of each Centre Pavilion,	202 feet 10½ inches.
" each Corner Tower,	161 feet.
" Basement Story,	18 feet 3½ inches
" Principal Story,	33 feet 6 inches.
" Second Story,	35 feet 7 inches.
" Third Story, Centre Pavilion,	26 feet 6 inches.
" " " Wings,	24 feet 3 inches.
" " " Curtains,	20 feet 5 inches.
" Attic of Centre Pavilions,	15 feet.
" " Corner Towers,	13 feet 6 inches.
" Crowning Statue,	36 feet.
" Figures on Centre Dormers,	17 feet 6 inches.
" " Corner Dormers,	12 feet 10 inches.

COMPARATIVE HEIGHTS
OF THE
PRINCIPAL BUILDINGS OF THE WORLD.

Washington Monument,	550 feet.
City Hall, Philadelphia,	537 " 4 inches.
Cologne Cathedral,	510 "
Great Pyramid,	480 "
Strasburg Cathedral,	468 "
St. Peter's, Rome,	448 "
St. Stephen's Cathedral, Vienna,	441 "
Salisbury Cathedral,	404 "
Toraccio of Cremona,	396 "
Freiburg Cathedral,	385 "
Amiens Cathedral,	383 "
Church of St. Peter, Hamburg,	380 "
The Cathedral, Florence,	376 "
Hotel de Ville, Brussels,	374 "
Torre Asinelli, Bologna,	370 "
St. Paul's, London,	360 "
Church of St. Isaac, St. Petersburg,	336 "
Cathedral, Frankfort-on-the-Main,	326 "
Bell Tower, St. Mark's, Venice,	323 "
Hotel des Invalides, Paris,	310 "
United States Capitol, Washington,	287 "
Masonic Temple, Philadelphia,	230 "

PRELIMINARY ACTION OF COMMISSIONERS.

OFFICE OF THE COMMISSIONERS FOR THE
ERECTION OF THE PUBLIC BUILDINGS.

PHILADELPHIA, *October* 23, 1884.

At a meeting of the Committee on Water Supply held this day: *Present*, Messrs. Brice, Stokley and Cassin, Chairman, with the President of the Commissioners:—

Mr. Howard Murphy, C.E., the Hydraulic Engineer, presented and read his report on the Water Supply of the buildings, and on motion of the President, the Committee received and approved the report and its suggestions, and recommended the same to the Commissioners for adoption.

December 2, 1884.

At a stated meeting of the Commissioners held this day, the minutes of the Committee on Water Supply were read, and the President laid before the meeting the Report of the Hydraulic Engineer, with an oral explanation of its purport, when on motion it was

Resolved, That the Report be printed in pamphlet form in sufficient quantity to supply the Commissioners and the various City Departments.

REPORT

OF

HOWARD MURPHY, C.E.,

HYDRAULIC ENGINEER TO THE

COMMISSIONERS FOR THE ERECTION OF THE PUBLIC BUILDINGS,

ON THE

WATER SUPPLY

FOR THE

NEW CITY HALL.

OFFICE OF THE

Commissioners for the Erection of the Public Buildings.

PHILADELPHIA, OCTOBER, 1884.

THE following report was presented to the Committee on Water Supply :—

MR. ISAAC S. CASSIN, C. E.,

CHAIRMAN OF COMMITTEE ON WATER SUPPLY,
AND GENTLEMEN OF THE COMMITTEE.

In compliance with your request, I respectfully present the following report of my investigations in the matter of supplying the new City Hall with water.

How much water should be available, whence shall it be obtained and how distributed?

QUANTITY.

For a building of this magnitude and importance the writer does not feel called upon to consider the minimum quantity, but that maximum which it may be desirable and convenient to have at hand under all circumstances which comprehensive forethought may reasonably anticipate. This does not imply waste, but safety. A comfortable surplus can be as well protected as empty pipes.

While the City Hall cannot be classed as an establishment requiring water for prospective use in the arts, the only purposes for which it should be available are not included in drinking, sanitary, steam and fire. Electricity, as applied to the purposes of ordinary business, is yet in its infancy, and its laboratory must have a water supply. The familiar "blue process," for the reproduction of drawings, etc., has lately grown into almost universal use in engineering and other offices. It requires, when properly done, a very considerable quantity of water. In short, the whole tendency of the age indicates an increasing application of the resources of nature to every-day life, and the day when one "public pump" was sufficient for a whole block of houses is past.

Liberality in provision is also demanded by the fact that it is desirable to manipulate water at low velocities. The full and free use of the system should not necessitate a high velocity in any part thereof, as the shock incident to a sudden check in the rapid flow of water may be attended by a more or less serious and extended rupture of the appliances and consequent injury to the building and its contents.

And last, but not least, is the fact that, when the total consumption during a given period has been determined, it by no means follows that appliances capable of delivering this quantity, at a safe and uniform rate, during that period, are adequate; for the consumption is not at a uniform rate, and the full use of any portion should not cut off, or inconveniently reduce the discharge of, any other portion of the system. Every one has appreciated this when, under old-fashioned plumbing, the turning on of the water in the kitchen would stop its flow on the second floor.

In this building, as elsewhere, the maximum will be more than double the average rate of consumption.

It may here be stated that the quantity which the following pages show to be possible should not, for these

reasons, be handled in a main less than twelve inches in diameter.

The importance of the most thorough flushing of sanitary appliances is too well recognized by you to need any comment; although it is also to be assumed that where good business management generally prevails, water, which has a positive value per unit, is not intentionally wasted for this purpose.

URINALS.

At the Broad Street Station, Pennsylvania Railroad, where water for the purpose is pumped at the company's expense, the urinals are flushed by means of a pipe extending across the back of the stalls, from which pipe, through a row of small branch nozzles, jets of water are projected against the back of the stall. These unite on its surface, covering the portion used with a thin film of water.

No data as to the quantity of water required for this work could, upon inquiry, be had; a calculation of the discharge, based upon ascertained dimensions in that building, was found to involve much uncertainty, so the writer had an appliance arranged and made actual experiment at the Chamber of Commerce building, where the same kind of flush is used, in stalls 22 inches wide, with 14 or 15 jets to each stall. The quantity required was found to be 2½ gallons per minute, or 150 gallons per hour, for each stall.

Should it, therefore, be found necessary to adopt for the 200 urinals of the City Hall the same flush that is used by the Pennsylvania Railroad and the Chamber of Commerce, the perhaps startling quantity of 30,000 gallons per hour, or 300,000 gallons per ten hours, would be required.

It might be mentioned that the means of supplying this flush at the Chamber of Commerce has been found inadequate to provide therefor during all of their business hours.

WATER-CLOSETS.

At Mr. John Wanamaker's establishment, where water for the purpose is pumped, from wells driven by him, at the proprietor's cost, water-closets are flushed by means of tanks, holding two gallons each, which fill and discharge automatically every three minutes. Each tank flushes two closets. This method, which does not seem to more than accomplish its purpose, would therefore require one gallon per three minutes, or 20 gallons per hour, or 200 gallons per ten hours, for each closet. Used for the 300 closets of the City Hall, it would require 60,000 gallons, per ten hours, of water.

WASHSTANDS.

An ordinary stationary washstand holds about 1¼ gallons up to the overflow. After hand-washing therein with soap, say ¾ gallon more would be used for rinsing, or a total of about 2 gallons per time.

Many persons, however, do not relish a public washbasin, and prefer fastening the valve open (and the writer never saw a contrivance where this could not easily be done) and washing under the flow. A test showed that about 4 gallons per time might be thus consumed.

Averaging these two methods of use we obtain 3 gallons per time.

It is to be hoped that we may estimate upon the occupancy of this building by cleanly persons. Such may be expected to wash hands upon entering, before lunch, before going home and after use of the closets, say four

times per day, and consuming 12 gallons of water per person, or 12,000 gallons for, say, 1000 persons.

In the engineering offices the washstands would also be used considerably for washing cups, brushes, etc., with the waste incident to these operations.

SINKS.

Sinks for the cleansing of spittoons, etc., might run say at 5 gallons per minute. A continuous run of twenty minutes, or 100 gallons per sink, would probably be sufficient. Fifty sinks, at this rate, would require 5000 gallons per day.

BATH-TUBS.

If each bath-tub was used twice per day, at 50 gallons per time, the twenty tubs would require 2000 gallons per day.

SCRUBBING, Etc.

The floor and pavement space which will require cleansing by scrubbing, etc., is, in round numbers, about 400,000 square feet. Asphaltum floors admit of the free use of water thereon, and it is probable, too, that they will require it.

Exactly what average quantity of water is necessary to cleanse a square foot of pavement is difficult to determine. A servant occupying half an hour in cleaning a pavement 12 x 25 feet, = 300 square feet, from a wash pave running 3⅓ gallons per minute, would use 100 gallons of water, or ⅓ gallon per square foot, equal to a covering of water a little over ½ inch deep. This is equivalent in quantity to one-half hour of hard, but not violent, rain. At this rate the 400,000 superficial feet in the City Hall would require 133,000 gallons of water, about 50,000 of which might be used in one day upon the courtyard and lower pavements. The balance of the building would probably be cleaned a portion at a time, and much less per square foot used upon the upper floors.

Comparison might also be made with the experience of our Water Department, as set forth in its "Water Rates and Charges," where washpaves are charged at the same rate as self-acting urinals in public buildings, such as hotels, etc.

STEAM.

For steam purposes 7½ gallons per horse power of boilers per hour should be allowed.

Of the twelve boilers for steam heating, Mr. John F. McCutchen, your engineer, estimates that the use of eight at one time will sufficiently heat the building. Steam will be up on these day and night for probably five months, evaporating 115,200 gallons per twenty-four hours, or 48,000 gallons per ten hours. Water repeatedly evaporated is considered by many to have injurious effect upon iron. Experiments personally conducted by Mr. McCutchen led him to the conclusion that the condensed water should be removed at the rate of about five per cent., or 2400 gallons per ten hours, or 5760 gallons per twenty-four hours, in the case of your boilers.

Should it ever be found necessary to use the twelve boilers at once, the increase would be fifty per cent., or 3600 gallons per ten hours, or 8640 gallons per twenty-four hours.

Of the four boilers for electric lighting and hydraulic elevators, three will be in use day and night, and require 16,875 gallons per ten hours, or 40,500 gallons per twenty-four hours.

Should all four be used at any time, the consumption

would be at the rate of 22,500 gallons per ten hours, or 54,000 gallons per twenty-four hours.

The steam appliances at present in the building, or soon to be in operation, could, therefore, consume about 63,000 gallons per twenty-four hours. In estimating upon a permanent supply it would not be safe to go below this rate, for new uses of steam may arise, quite as unexpectedly as did electric lighting.

FIRE.

Your building is so thoroughly fire-proof that any fire would be confined to the suite of rooms in which it originated. Owing, however, to close furnishing and the storage of large masses of inflammable documents, etc., therein, it might gain considerable headway, and we may assume that the equivalent of the discharge of three fire engines would require twenty minutes to extinguish it. This would consume 12,000 gallons of water.

TOTAL QUANTITY.

The sum total of the above, which include the principal uses of water now foreseen, is 504,000 gallons.

While this estimate does not include new uses to which water ere long may be applied, the writer does not assert that this daily consumption will be positively reached, although the whole tendency of things indicates the entire possibility of such a result. Moreover, while the difference between average and maximum daily consumption would not be so great in this building as in some supplies, a maximum of 504,000 gallons means a much lower average.

Provision for one-half million gallons daily is, therefore, unhesitatingly recommended. Should it be found far in advance of future requirements, it will certainly be the first occurrence of the kind in the history of Philadelphia.

SOURCES OF SUPPLY.

Whence may this supply be obtained? The means at your disposal are—by the collection and storage of the rainfall upon your roof; by driven wells; by Artesian wells; and, from the city works, by pumping from the mains now at hand, or laying a special main to a point at which a gravity supply can be tapped.

RAIN CISTERNS.

Although of superior purity, and although, according to an average of over thirty years in Philadelphia, over 3,500,000 gallons per year, or 11,500 gallons per working day, will fall upon your roof, a large percentage of which could be collected, the utilization of rain-water is not advised, on account of the immense storage capacity required. Moreover, if retained as a flush for your drainage system, this water will by no means be wasted.

DRIVEN WELLS.

Is there reasonable ground to suppose that water from driven wells in this vicinity can be relied upon as potable? The water itself is pure, of course, but whether *uncontaminated* water can be had is a very serious question. All experience, under your conditions, where intelligent investigation has been made, is against it. The contamination of soils by sewage is a most prominent topic among sanitary scientists, and every case that has come under the writer's notice has indicated the uniform dan-

ger of taking drinking water from soils where any possibility of sewage contamination exists.

In country residences and towns where there is no supply but springs and wells, it is now considered ruinous to allow cesspools or drainage wells, even when intended to be water-tight, to be constructed, forms of dry removal and surface disposition having taken the place of the old-fashioned and dangerous methods. What then of this vicinity, where privies and sewers with dry-laid inverts abound? Except where, as is common, the interstices have become clogged and the walls have thus sealed themselves, every such structure is at the apex of a cone or edge of a prism of polluted earth, the depth of which depends upon the character of the soil and the time that the sewage has been flowing downward. It is argued that underlying strata of clay will prevent surface soakage from reaching the water-bearing strata. So it will, if it is *there*, is continuous, and of equal compactness with the well-puddled clay which will retain water in a reservoir. But, if the large proportion of a rainfall that the writer has seen soak away into Philadelphia soil does not reach the water-bearing strata and proceed through them to their outlets, there must be an immense amount of room, somewhere, between the surface and those strata.

It is, moreover, far from likely that, when the soil has been pierced for a distance of from 10 to 30 feet, any impervious strata may intervene between those points and the rock.

That popularly-considered good water is so often found in localities similar to this, is not an argument, as the most dangerous impurities, although they may be accompanied and indicated by large organic particles, are often alone and imperceptible to smell, taste or sight.

A large amount of sewage enters the Delaware and Schuylkill, and the importance of their protection therefrom is great; but the water of rivers is under great self-purifying influences that do not exist in wells. Nature's great agent for the destruction of dangerous organic matter is the oxygen in the atmosphere, to which the waters of a running stream are constantly exposed; and the more the stream is disturbed by falls, rapids, navigation, etc., the more nearly perfect is the oxidizing process. The danger is lessened too by extreme dilution, and the great accumulation of impurities is prevented by the recurring and violent freshets, by which they are flushed and cleansed.

In the chambers of the earth there is but little oxygen, and the old-fashioned farmer belief in purification by filtration through the soil is exploded. Only the coarser and often least dangerous particles may be thus removed, while the others pass through; and it naturally follows that, in course of time, this natural filter itself will become so saturated as to pollute pure water which may pass through it.

Well water is comparatively stagnant. Impurities remain in one place, and the consumers get full effect of a contamination which in a river would become decreasingly dangerous, as stated above.

The writer does not assert that pure water *might* not be found in the gravels beneath this building, or that pure water has not been found in similar localities, but he gravely questions the possibility thereof.

Moreover, if these wells should be adopted, only a small portion of your supply could at best be obtained therefrom. They do not penetrate the rock, and could only collect such water as might rest, in depressions on

its surface, among the interstices of the gravel. The inflow from the storage in the surrounding gravels, or even from the rivers, could not replenish this supply at a rate sufficient to meet your minimum requirements. Driven wells have an acknowledged place in engineering, but it is the writer's opinion that they would be a failure in this locality.

In order, however, that your conclusion may be based upon practical facts, the following data have been collected in this vicinity and compiled for your information.

At the *Philadelphia Record* building, on Chestnut Street above Ninth, I called to learn their experience with driven wells, as I had understood they had obtained good water. The engineer, Mr. Keyser, informed me, to my surprise, that the yield of water had absolutely and entirely failed. He was not the engineer when the wells were driven, and could not give more exact dimensions and dates than the following: the wells, three in number, located, triangularly, about 10 feet apart, are each about 3 inches in diameter, and had been driven about 18 months. He said the wells were only in use for about two weeks, and that frequent efforts had lately been made to get water from them, but that no water at all would come. The building is now supplied from the city mains.

At the Broad Street Station, Pennsylvania Railroad, the engineer informed me that two wells were driven—one 26 or 27 feet, and one 30 feet. About two gallons per minute were obtained from each well separately, for a few minutes, and after standing several hours.

The two driven wells at the Continental Hotel were driven in the spring of 1883, through clay, over gravel, and requiring hard driving. They are 33 feet and 36 feet deep below pavement, and are of 2-inch pipe. The water rises to within about 25 feet of pavement. It is pumped into a tank, whence it returns to the refrigerator, where it is mechanically used in a freezing process; thence it is turned into the laundry or returned to the well. The supply is sufficient for its uses, and constant. For washing purposes it is hard. Soap will not dissolve, but floats on the surface. As affecting the iron with which it comes in contact, it is the most injurious aqueous liquid which the writer ever heard of in this vicinity. It formed no scale, but in six weeks it ate leaks through the boilers. A portion of a section of threaded wrought-iron pipe shown to me had been altered, in appearance, to a spiral spring.

The engineer tried using it alternately with the Artesian well water referred to hereafter, which forms a deposit, in the hope that the accumulative action of the one would balance the erosive action of the other, but without success, each water continuing to independently exercise its injurious proclivities.

This water is extremely clear, will stand for several days in a bottle without forming perceptible deposit, and is not bad, although somewhat acidulous, to the taste; all of which illustrates the fact that such qualities, while belonging to good water, do not in themselves prove it to be good. An analysis of this water was undertaken, and, in reporting thereupon, Dr. Charles M. Cresson, the analyst, says:

> "The results showed that the water was unfit for drinking or domestic purposes, and the investigation was stopped there, and the amount and nature of the inorganic elements was not determined. The following results were obtained:

Free ammonia (parts in 1,000,000),	4.08
Albumenoid ammonia,	0.85
Ammonia from nitrates,	5.09
Sewage may be set down at	8.50

> As over 0.2 parts in the million of albumenoid ammonia with much free ammonia determine the limits of wholesomeness in a water, it is evident that this water is badly contaminated with sewage from some source."

The "some source" to which Dr. Cresson refers may be, partially or entirely, a bilge-water well, about 23 feet deep from pavement, which receives drainage from the basement of the hotel. The water therein deposited now disappears, which was not previously the case.

The above facts were obtained from Mr. Thomas Holland, the engineer of the hotel.

At Mr. John Wanamaker's establishment, opposite the east front of the City Hall, the writer made examination and inquiry. The driven wells are in the basement, which latter is very deep, being 30 feet at ends and 32 feet at centre below the pavement. The wells are three in number and about 8 feet apart, 24 to 32 feet deep below basement, or 54 to 64 feet deep below pavement level, and of 2½-inch pipe. Mr. William Ithell, the engineer, said that he had had water from them for four months, since making some needed repairs to the pump.

The water is not used for drinking or boilers, but only for flushing water-closets, washing, etc. He could not say whether it formed deposits, etc., as the pipe connections had not been examined, but he *thought* it would form hard scale in the boilers.

Mr. Andrew Shearer, the master mechanic, said that when the wells were first driven he worked them steadily for three 12-hour days, and obtained an unfailing stream through a 2-inch pipe. He says, however, that after pumping steadily all day the supply will recede or diminish, but that it will entirely recover by morning, and yield a sufficient quantity to meet its limited uses. Mr. Shearer has had at this place considerable experience with deep foundations, where the water was exposed, and is confident that he observed the effect thereon of tide in the rivers, especially during the spring tides. He is also certain that the direction of flow of the water was always from west to east. He has observed it when it was as perceptible as the flow in an open stream.

The cost of driven wells would probably be about $200 each. The number which would be required to get out of the ground what the writer does not believe to be there, he cannot estimate.

ARTESIAN WELLS.

Artesian wells are as old as the early civilization of China and Egypt. They have stood the test of seven centuries in Europe, and are too well recognized as an important means of supply in Philadelphia and throughout the United States to be neglected in this investigation.

The celebrated Grenelle well of Paris is about 1800 feet deep, 8-inch bore. The Passy well is still deeper, 2 feet in diameter, and has the enormous daily discharge of about 5,500,000 of gallons. The deepest wells noted are at Sperenburg, Prussia, 3900 feet, and at the Insane Asylum, St. Louis, Mo., over 3840 feet deep, the bottom being about 3000 feet below the level of the Atlantic. In Chicago, Ill., a number of wells have been bored, averaging over 1200 feet deep, and yielding as high as about 1,000,000 gallons per day, per well of 5½-inch bore.

All through the East, South and West, Artesian wells of various depths have been bored at great expense and generally with very satisfactory results. Some sections of the country are, and others no doubt will be, almost entirely dependent upon them for a satisfactory water supply.

You are aware that a large number have been bored in Philadelphia, of various depths, and yielding, in the aggregate, a large quantity of water.

The best location for an Artesian well is at the bottom of a geographical basin, underlaid, *inter alia*, by two impervious strata parallel to the surface, and enclosing a water-bearing stratum between them, the inlets of which are at its outcrop on the upper edges of the basin. Through a pipe let into this stratum the water will do its own lifting. The Grenelle well at Paris is so situated, and it is said that its water has been under a head sufficient to raise it, if confined in pipes, over 800 feet above the surface.

Self-flowing wells are very unusual in this vicinity, and are not to be expected in Philadelphia, which is practically located on the southeastern slope of Chestnut Hill —on a hillside rather than in a basin. It is likewise, more generally, located on the eastern slope of the continent.

The underlying rock of the city is gneiss, geologically known as a metamorphic rock, *i. e.*, one which was originally a horizontal stratification of clayey sandstone, but which, through the violent upheaval and buckling of the earth's crust, together with the action, under pressure, of its then escaping heat, was changed in the character of its structure, crystallized, eroded and left beneath us in a mass of distorted crags, the zigzag profile of which is almost indeterminate without actual soundings at frequent intervals. It is, therefore, impossible to predict with any accuracy the depths of the water-bearing strata, or to trace the supply thereof to its outcrop or source.

I have made a study upon a topographical map, which I arranged for the purpose, to discover the relation between the topography of Philadelphia and the depths and yield of its Artesian wells, but with indifferent success. However, although in some cases it seems that a great difference exists in wells located close together, unexaggerated opinion may be formed from the general contour of the surrounding country, and, more particularly, by reference to actual results in this immediate vicinity.

The nearest Artesian well is that at the United States Mint. It was sunk in 1875, and consists of an 8-inch bore, 458 feet deep from surface. The gneiss rock was struck after boring through 53 feet of clay and gravel. The water rises to within 50 feet of the surface. One hundred and forty gallons per minute (or 201,600 gallons per twenty-four hours) are claimed by the contractor as the capacity of this well.

Dr. Thomas H. Garrett reported his test of the water as follows:

> "The water contained 44.829 grains of solid matter in the United States gallon. The solid matter consists chiefly of sulphates and muriates, with smaller quantities of carbonates, of lime, magnesia and soda, and with still less of silica and oxide of iron. Carbonate of lime and iron are held in solution in the freshly-drawn water by an excess of carbonic acid, which escapes during the evaporation of the water and produces a cloudiness in the remaining water. The slightly chalybeate taste of the water is due to the carbonate of iron in solution. The quantity of mineral matter in the Mint water is about twice the amount contained in the Thames water, England. By exposure to the air in tank, or by boiling, the carbonates of lime and iron would be deposited."

Professor James C. Booth, Melter and Refiner of the Mint, in transmitting the report of Dr. Garrett, says:

> "In consequence of the quantity of chlorides in the water I think that in the Refinery and Assay Department it would be better to adhere to the use of Schuylkill water, which has much less of the chlorides. Though the water might be employed, even in the Refinery, for every purpose except that of diluting the silver solutions resting over the fine gold, yet for the present I would not advise bringing it into the Refinery until suitable arrangements can be made for it. Although the water contains the considerable amount of 44 grains solid matter to the gallon, and although there is a considerable amount of sulphate of lime in it, yet I incline to the opinion that it will not form hard-pan stone in the boilers, because of the large content of chlorides and of carbonates of lime, etc., which I think will tend to prevent an adhesive pan-stone from forming, or if a pan-stone form, will tend to render it easily removable. We must further bear in mind that in cases like the Mint well, long-continued pumping usually and progressively improves the quality of the water, because long repose or the slow motion of water through the strata has dissolved a quantity of soluble salts, the removal of which water by pumping will gradually introduce a fresher water.
>
> "In conclusion, then, the quantity of water obtained by the boring is amply sufficient for the Mint; andits quality is such that it may be used for all

purposes, except for the chemical departments, which require, comparatively speaking, a very small part of the whole demand of the Mint.

"I think it very desirable to carry out your (Hon. James Pollock, Superintendent) original suggestion to maintain connection with the city water pipes for a year, so arranging the supply pipes as to cut off either source at our pleasure; and after that period to retain only so much connection with the city works as might be needed to supply the boilers, and perhaps a little beyond."

As a matter of fact, I am informed by Mr. J. L. McGinnis, Chief Engineer of the Mint, that the tanks were filled, the valves in the city pipes closed, and the well water used for one day. They shut down at night, and found, the next morning, that the tanks were empty, the water having escaped into the city mains owing to defective stop-valves, which, however, were not repaired, for after the chemist's analysis, it was feared that the water would be unfit for use in the boilers. Mr. McGinnis says if the Mint had it to do over again they would not sink an Artesian well.

With regard to the water for drinking purposes, Prof. Booth personally considers it palatable.

The original Artesian well at the Continental Hotel was perhaps the first successfully bored in Philadelphia. The boring consisted of—

Sand and gravel to rock,	40 feet.
Blue gneiss,	100 "
Feldspar,	1 "
Light-gray gneiss,	38 "
Pure feldspar,	27 "
Total,	206 "

The diameter was 12 inches to, and 8 inches in, the rock. The comparative analysis of Dr. C. M. Cresson in the spring of 1875 was as follows:

Small amount of sediment—Reaction, neutral.

	Artesian Well.	Schuylkill River.
	Grains in one U. S. gallon.	
Sediment,	——	——
Solid matter upon evaporation to dryness,	13.5800	6.99000
" " after ignition,	——	5.06000
Organic matter (carbonic acid, etc.) by loss on ignition,	——	1.93000
Silicia,	2.11800	0.65000
Alumina,	0.42800	0.05100
Oxide of iron,		0.05900
Lime,	1.47448	0.94640
Magnesia,	0.46908	0.53280
Carbonic acid,	not det.	not. det.
Sulphuric acid, free,	none.	none.
" " in combination,	0.68750	1.18000
Chlorine, free,	none.	none.
" in combination,	0.65000	0.50000
Potash,	chiefly	chiefly
Soda,	potash.	soda.
Ammonia, free,	0.00646	0.00850
" albumenoid,	0.00442	0.02142
Nitrogen from nitrates and nitrites,	0.18360	0.17000
Sewage,	0.04420	0.21420

He therefore pronounced it "a purer and better drinking water than that supplied from the Schuylkill River, and equally good for household purposes." In another copy of his report shown the writer he says it "is harder than the Schuylkill water. In March, 1874 and 1875, water became muddy for four hours and then clear again." Engineer Holland says that this latter condition occurs only at very long intervals.

However, the following analysis by Dr. Cresson, made about two years later (June, 1877), showed a decided deterioration in the water:

Clear—Reaction, neutral.

	Grains in one U. S. gallon.	Fairmount forebay.
Sediment,	none.	none.
Solid matter upon evaporation to dryness,	17.12340	6.40000
Silica,	2.10168	0.62100
Alumina, Oxide of iron,	0.36288	0.05600
Lime,	2.72220	0.89712
Magnesia,	0.30754	0.49176
Carbonic acid,	not estim.	not estim.
Sulphuric acid, free,	none.	none.
" " in combination,	1.27000	1.21000
Chlorine, free,	none.	none.
" in combination,	3.74000	0.32000
Potash,	not estim.	not estim.
Soda,	" "	" "
Ammonia, free,	0.01020	0.08500
" albumenoid,	0.01020	0.01700
Nitrogen from nitrates and nitrites,	0.00680	0.10200
Sewage,	0.10200	0.17000

He says: "This water is very free from organic matter and sewage, and fit for drinking and household purposes. For some reason not apparent the amount of lime and of chlorine has very much increased since the last examination. The lime injures it for washing purposes and the chlorine makes it necessary to carefully exclude sewage. It would be well to make an examination and ascertain if there is any leakage through the piping of the well, which may account for the increase of these two items."

This water, which had for about ten years been acceptably used for all purposes in the house except in the boilers, to which it was only occasionally fed, became decidedly bad—so bad that Mr. Holland says it could be smelled along Sansom Street in the gutter. This deterioration seemed to be entirely due to the well being crooked and the sewage leaking into it. It was drilled 100 feet further, and effort was made to dam the leakage back, but without success; so it was abandoned, and another well drilled about 65 feet westward from it about three years ago. It is about 252 feet deep below the pavement; 12-inch driven pipe to rock and 8-inch diameter in rock. In the boilers its water forms a soft, sandy, irony deposit—so soft that it can be scraped to the iron with the finger-nail. As a large supply of condensed water is available for the boilers, the Artesian water is but little used for that purpose. In the pipes it does not give much trouble, although in time small diameters become stopped up with the deposit alluded to. For laundry use it contains more iron than is desirable, but is better than city water when the latter is muddy. Engineer Holland considers it wholesome, and states that it is palatable to nearly everybody.

The potability of the water is set forth in the following analysis by Dr. Cresson, made in June, 1881:

	Grains in U. S. gallon.
Sediment,	none.
Solid matter upon evaporation to dryness,	16.1800
Silica,	2.4400
Alumina,	0.1013
Oxide of iron,	0.6387
Lime,	5.9800

	Grains in U. S. gallon.
Magnesia,	0.6192
Carbonic acid,	not det.
Sulphuric acid, free,	none.
" " in combination,	0.8200
Chlorine, free,	none.
" in combination,	4.0120
Potash,	not det.
Soda,	not det.
Ammonia, free,	0.0051
" albumenoid,	0.0026
Nitrogen from nitrates and nitrites,	0.0017
Sewage,	0.0260

Dr. Cresson adds: "Fair water for household use. Somewhat harder than Schuylkill water (city supply)."

How long it may remain in this condition, as exhibited in the case of the previous well, remains to be seen.

Estimates for Artesian wells cannot be made with precision. To have available a supply of 500,000 gallons in 10 hours would probably require four wells, located as far apart as possible, say in the four corners of the building. These wells would probably average 500 feet deep, and each consist of 200 feet of 12-inch bore and 300 feet of 8-inch. The 12-inch portion, including tubing, may be estimated at $9 per foot, and the 8-inch portion at $5. Fifty cents per foot might be added to this if the contractor is required to furnish his own steam. The cost of casing, etc., to dam out surface water would probably be $175 for each well. A suction pump, costing about $1500, would be required at each well. A well of these dimensions is supposed to yield something over 200 gallons per minute, or one-fourth of the supply noted above. The total cost of each well, as figured above, would be $5225, or $20,900 for the four wells. Competition among contractors would probably reduce this price; but, as extreme care and the best of workmanship are absolutely necessary to secure *even the probability* of the exclusion of dangerous sewage, low-priced work should not be considered.

Another item of expense is important—the additional lift of water required. It cannot be safely estimated that the water in these wells will rise within less than 50 feet of the surface, and this would increase over 25 per cent. the cost of pumping a like amount from the city mains.

The writer has grave doubts as to the continuous and undiminished yield of four wells located so close together. It is possible, but not probable or in accordance with experience, whether separate strata or a common stratum should be tapped, that these four wells would continue to yield the discharge first obtained. What the diminution would be could only be ascertained by experience.

The pipe connections and other expenses incident to the distance apart of the wells, and the general inconvenience of operating such a system, are also to be noted.

The above is simply given as the best solution the writer could attain of this portion of the problem submitted to him.

In view of all these facts, neither Artesian nor driven wells can be recommended for your supply. The uncertain quantity obtainable from each might serve for a portion of your uses, but the complications resulting from a mixed system are not admissible when a supply suitable for all purposes is available. The writer would reiterate his belief in the great importance of both kinds of wells, but under conditions other than your own.

SUPPLY FROM CITY WORKS.

If the above conclusions meet with your approval, a supply must be obtained from the city works.

The gravity system prevails in Philadelphia and is the best. The water is stored in large elevated reservoirs and allowed to flow thence, by gravity, to consumers. Compared with the direct-pressure system or a gravity system of small storage capacity, it does not depend upon often wayward and failing machinery, it does not require constant attendance and the constant use of fuel, or necessitate the duplication of machinery to provide for accident and for repairs. In some cases, however, the increasing demands are reducing the reservoirs to, relatively, little more than standpipes.

If an adequate gravity supply, under sufficient head, were connected by adequate mains with the streets contiguous to the City Hall, the only problem would be that of its convenient and judicious distribution in the building.

But as Broad and Market Streets, in common with not a few other localities, is far from being provided with the supply and pressure demanded by ordinary modern requirements, how to deliver water at the extraordinary height of 133 feet above the curb becomes a subject of special inquiry.

Not only is the distribution plan of Philadelphia a most complicated study, but conclusions therefrom are greatly modified by the investigations of the Water Department as to the best manipulation of present resources and as to the improvements of the near or remote future, the latter, also, being entirely or largely dependent upon the uncertainties of legislation. The writer will not recount the difficulties he has encountered and the successive re-

visions he has been compelled to make on account of these causes, but submits the following conclusions as the best which the conditions seem to warrant.

Two methods have been investigated, viz., pumping from the mains now surrounding the building to elevated tanks and distributing therefrom by gravity; or laying a special main to a city reservoir, or a point in its distribution, to secure, by the unassisted head of the reservoir, a constant delivery of water to all parts of the building requiring it.

SUPPLY BY PUMPING.

Two mains, of size worthy of consideration, pass the building, as shown on the accompanying plan. The 20-inch main on the west side is from the Fairmount basin; the 30-inch main on the east from the Corinthian basin. A gravity supply for only a portion of the building could be had from either of these, under any conditions, for they are not under sufficient head.

The 30-inch Corinthian main is for the exclusive supply of the city below South Street, and is taxed to its utmost in this service; the reservoir capacity is, also, limited to about one day's supply, thus preventing the subsidence of the impurities suspended in the water as it comes from the river. The Water Department could not be justified in consenting to any draught upon this main except, perhaps, through a reserve attachment to be used only in great emergency.

The 20-inch main from Fairmount is, in a less degree, under the same conditions. It forms a portion of the system supplying the old city. Its relative reservoir capacity is greater, but it is subject to an enormous and fluctuating draught, its pressure being at a minimum during business hours.

The water, of course, is there, and can be taken, but it would seem like questionable public policy for the city to diminish a water supply already inadequate to the wants of the people.

In writing to me of this main, Colonel Ludlow says: "The existing supply, which is chronically less than is demanded for either comfort or safety, with a street pressure of 10 or 15 pounds only, would be reduced in a dangerous degree if the City Hall draught be added."

It would seem, therefore, to be conclusive that a reserve connection with this main is all that can be positively recommended.

Pumping therefrom is, however, better than any reliance upon wells, and should it be adopted by you the special expense involved will be the construction of pump and reserve pump, and operating expenses.

Pumps of full capacity to meet your possible requirements, of the Compound Worthington type, made and finished to correspond with the general style of your building, will cost about $7200, with $1000 additional for foundations and connections, or $8200 in all.

COST OF PUMPING.

The Water Department estimate the total average cost to date of delivering 1000 gallons of water, including plant, at $6\frac{7}{100}$ cents, although very much of this pumpage was by cheap water power. 500,000 gallons at this rate would cost the city $30.35. The average cost of their present steam pumpage is, of course, much higher; so it would seem that this water had cost the city enough already, without the rehandling thereof by means necessarily more expensive.

The actual cost of pumpage, according to "Running

Expenses of the Pumping Stations during 1883" (Report Chief Engineer Philadelphia Water Department for 1883, opp. p. 126), reached the average of $6.51 per million gallons raised 100 feet. This is equivalent to half a million gallons raised 200 feet, which are very nearly your conditions. This includes employes at stations, coal, lubricants and repairs, and a small percentage for packing, lighting, etc. $38\frac{58}{100}$ per cent. of the pumpage in this table was done at Fairmount, where cheap water power prevails, and the cost was but $1.45. At Mt. Airy and Chestnut Hill, where the least pumpage took place, the cost was, for Mt. Airy, $52.07, and Chestnut Hill, $39.08. The average cost of the other steam stations, Spring Garden, Kensington, Belmont, Roxborough, and Frankford, was $8.08. If but $8 may then be taken as the cost of raising your maximum daily requirement, it would amount to $2504 per annum, for 313 working days, and represent the interest, at five per cent., upon $50,000, or $22,000 more than would be required to build the longest of the special connections with the Belmont distribution hereafter noted.

SUPPLY BY GRAVITY.

ROXBOROUGH RESERVOIR.

The best water and the greatest head could be obtained from the Roxborough Reservoir; the best water, because it is taken from the Schuylkill at a point above contamination by Manayunk and other Philadelphia drainage, and sufficiently below the large up-river towns to admit of considerable atmospheric purification in its downward flow.

It has a clear super-elevation of average reservoir surface above the highest fixture in the City Hall of $183\frac{1}{2}$ feet, under which head a 12-inch pipe would discharge 628,000 gallons in 10 hours in the elevated laboratory of the Electrical Department. Unfortunately, however, we find that the present Roxborough distribution is not of a capacity to admit, upon its outskirts, an attachment requiring other than almost exhausted head, and the writer believes that no available increase in that capacity is now contemplated, so it is more than probable that our main would have to be laid to the reservoir itself, a distance, via Broad Street and Ridge Avenue, of about 9 miles, and at a probable cost of $95,000.

BELMONT RESERVOIR.

Belmont Reservoir is next to be considered. It is, in fact, the only resource for a gravity supply, as the elevation of none of the other basins is sufficient to afford it. It has also one feature of especial desirability. Its surface is coincident with the available water surface in your middle pavilions, thus rendering the full head of its distribution always available, and the overflow of the pipe impossible. The City Hall pavement being 40 feet above City Datum, the surface of this reservoir has a super-elevation of 172 feet, and its bottom of 147 feet above your curb. Supposing at least the average super-elevation of $159\frac{1}{2}$ feet to be maintained, a 12-inch pipe would deliver at the elevation of your highest fixture at the rate of 33,000 gallons per hour, at a velocity of about $1\frac{6}{10}$ feet per second.

Tanks in the building, to a point therein $12\frac{1}{2}$ feet above this high fixture, would fill, at that point, at the same rate, when Belmont Reservoir was full.

With but 1 foot of water maintained in Belmont Reservoir, tanks with bottoms at the level of this high fixture would receive about 400,000 gallons of water in 24 hours.

This supposes the extreme of unfavorable conditions; Belmont Reservoir within one foot of being empty, and all the water for the City Hall drawn after being delivered 15 feet above the highest required fixture; whereas the reservoir may be expected to be generally nearly full, and but a comparatively trifling quantity of water will be required at that great elevation in the building. A maximum possible discharge in the sub-basement of from 83,000 to 89,000 gallons per hour might be expected. This maximum discharge is noted simply to show the capacity of a 12-inch main under the existing conditions, for that delivery might never be required, and would necessitate a higher velocity in the structure than is desirable.

Can this supply be obtained by connection with some nearer point on the distribution, or must a main be laid to the reservoir itself?

The accompanying general plan exhibits the principal arteries of the Belmont distribution.

Careful inquiry as to the 30-inch main, now laid along Jefferson Street to Broad and northward on Broad, which is the nearest approach of a large main, has led to the conclusion that the enormous draft upon it, en route, reduces its pressure at Broad Street far below your requirements; and that its combination with the direct pumpage of the Spring Garden system, as now proposed by the Water Department, would only add uncertainty as to what might be daily expected.

The remaining approaches are, therefore, divided generally into, 1st, some connection, near the East Park, with the main now crossing the Schuylkill; and, 2d, some route via West Philadelphia.

The selection of a line for the main involves various considerations. If connection is made with the outskirts of the West Philadelphia distribution there is little choice of lines; but if you should decide to extend to the reservoir itself, a location avoiding the important thoroughfares, as far as possible, is recommended. It is desirable not to disturb travel on such streets; the space therein will be needed for other conduits, the laying of which may disturb your main; and last, but not least, the danger of accidental or intentional connections therewith depends upon its accessibility. In any case, your main should be distinguishable from others by lettering cast upon it.

VIA BELMONT SUBMERGED MAIN.

In the first case, that of tapping the Belmont distributing main on the east side of the Schuylkill, there is but little choice in the general location of the pipe line, as the route via Pennsylvania Avenue and Broad Street seems plainly indicated, unless, on Pennsylvania Avenue, it should interfere with the rights of the Philadelphia and Reading Railroad, in which case there is a choice of lines through the Park and via Spring Garden Street to Broad.

Two important questions, however, are here to be considered: the stability of the Belmont submerged main, and the recent proposition of the Water Department to utilize the Belmont main in question as a cushion for the Spring Garden pumpage.

When the serious leak in the submerged main was first discovered, the immediate necessities of the case and the funds available did not admit of the thorough repair of

even the worst of the failing joints, and dependence thereon could not have been recommended. The whole submerged structure has, however, been recently examined by the Water Department, and the heretofore troublesome portion repaired. The writer made it his business to inspect these repairs while in progress, and could see no reason to conclude that the portion he examined might not be regarded with as much confidence as any of the other structures in the case. The total distance from the City Hall to Belmont reservoir by this route is about 23,500 feet. The 30-inch main extends over about 9500 feet of this distance before any lateral draft is made upon it. Our connection, which would extend over the remaining distance of about 14,000 feet, must therefore be regarded as the first branch in the distribution and subject to its conditions.

X "Head" of water may exert itself entirely in simple pressure, expend itself entirely in velocity and in overcoming the friction incident to velocity, or partially in each at the same time. If a main were built from Belmont Reservoir to the City Hall, the efflux of water from an opening at any point on the main would diminish the pressure at the City Hall. So, while our connection would be generally considered as a draught upon the Belmont main, we must also consider the whole line from the City Hall to the reservoir as the *main* and the balance of the distribution as a draught upon *it;* and the greater this draught the less would be the pressure at the City Hall. X

To obtain the various results under the various conditions which may here arise involves separate and more or less complicated mathematical investigation; but from all calculation and inquiry the writer is satisfied that, with correct detail, an ample supply through a 12-inch pipe could be relied upon, if the submerged main remains in its present condition.

The special main needed in this case would cost, including valves, etc., about $28,000.

VIA WEST PHILADELPHIA TO BELMONT RESERVOIR.

In the case of a special main through West Philadelphia to the reservoir, the route via Market Street, Lancaster Avenue and Belmont Avenue, which would appear at first glance to be the most natural, is open perhaps more than any other to the objections noted, as it would occupy the most important highways in the district.

Any route via West Philadelphia would be along Market Street from Broad Street to beyond the Schuylkill, on account of its directness and because the proposed new bridge will afford the only convenient facilities for crossing the river.

The writer, however, would recommend leaving Market Street at Thirtieth and proceeding along that street to the Fairmount bridge. Thirtieth Street is permanently enclosed by railroad property, may never be largely occupied by conduits, and is not much travelled at present. From Thirtieth and Spring Garden Streets the line could follow the drive through the Park and back of the Zoological Garden to Girard Avenue.

From this point the writer considered several lines through the Park, but concluded that the interference with the grading of new walks and drives and the foundations of future buildings, the probable rock and roots, the disturbance of the lawns, the greater difficulty in tracing location of pipe in case of accident, and the summits and depressions occurring in the line, would more

than balance the advantages of shorter distance, no repaving, isolation of pipe, etc.

A line along the tow-path to the 30-inch main near the Belmont engine-house might be very expensive, on account of rock excavation and flooding of the trench.

It would, therefore, seem better to proceed along Girard and Elm Avenues, under the sidewalk adjoining the Park, to the Belmont Avenue Park entrance, the balance of this line depending upon the future arrangements of the Water Department. A 20-inch main now extends intact to within about 100 feet of Elm Avenue, but its entire service, at a dangerous velocity, is at present demanded by the West Philadelphia distribution, and will be until the proposed new West Philadelphia mains are built; so the line would *now* have to proceed along Belmont Avenue to the 30-inch main now crossing it.

The following lengths were obtained, as closely as the present stage of the subject demands, and are sufficiently accurate for comparative purposes:

	On much travelled streets.	On little travelled streets.	Total streets.	Park.	Total length.	Estimated cost.
Tow-path, .	5,600	3,300	8,900	11,400	20,300	$40,600
Park, . . .	5,600	3,300	8,900	13,100	22,000	44,000
Lancaster Av.	19,000	. . .	19.000	3,600	22,600	45,200
Elm Avenue,	5,600	8,300	13,900	9,400	23,300	46,600

The two latter lines would each be shortened about 3500 feet if connection could be made with the 20-inch main near Belmont entrance to the Park.

WEST PHILADELPHIA ATTACHMENT.

The remaining means of tapping Belmont is by attaching to its distribution at the west end of Market Street bridge, or points beyond hereafter indicated, whence a full supply may be obtained if the West Philadelphia distribution is reinforced as now proposed, and under the latter condition it is certainly a reliable and economical method. It would avoid the possible failure of the submerged main on the first route discussed and the additional expense of an entire line to the basin.

The compounding of your 12-inch main with the 20-inch main now laid would give a much larger discharge than a simple 12-inch main over the same route, neglecting the effect of the lateral draughts thereupon. The exact behavior of your supply under these draughts cannot be determined beforehand; but if the general West Philadelphia distribution is augmented, as proposed, by a 30 or 36-inch main on Fifty-second Street, and if, as is expected, manufacturing establishments and other large consumers will not multiply west of the river to a great extent, a very satisfactory delivery may be expected.

A full discharge at night would be certain, and, if this scheme is adopted, a limited tank-storage capacity only need be provided at first, subject to additions regulated by increase of consumption in the building and reduced pressure during the day from lateral draughts on the main.

There is ample tank space in the building, and additions to the tank capacity need involve no waste as to the structures already in place. In other words, if ten or twenty tanks will be ultimately required, they can be built about as economically one at a time. Reserve storage capacity will be required under any conditions and any means of supply.

It is about 5000 feet to the west end of Market Street bridge. About 1600 feet of 12-inch main are now laid

beyond that point. If this is used as a portion of your main to Thirty-eighth and Market Streets, a total of about 8200 feet will have to be built. A better plan would be to proceed up Lancaster Avenue to meet the 20-inch main at Fortieth Street. Using the 12-inch main on Market Street, as before, this would require about 10,300 feet of pipe. The latter route, omitting the use of the present 12-inch pipe on Market Street, would be better still, requiring a total of about 11,900 feet of pipe. The approximate costs would be respectively $16,400, $20,600 and $23,800, as compared with a minimum of $28,000 by any other route.

The objection to the above is that greater variableness of pressure may be expected than by most of the other routes investigated; but this would not seem to be a material objection, as it is not to be supposed that the city will ever allow its own buildings to be deprived of their supply.

Attachment to this system is just now impossible, as it cannot meet its present requirements; but the probabilities are that the proposed West Philadelphia mains on Fifty-second Street and Lancaster Avenue will be built within one or two years.

In connection with any gravity system limited pumping capacity should be provided as a reserve in view of possible accident.

Attachment to the adjacent Fairmount 20-inch main, and the introduction of a Compound Worthington pump at a cost of $2500, will cover this ground.

TANKS.

As to tanks for storage, each should be as large as circumstances will admit, as the cost per unit of capacity diminishes as the size increases. As the weight, however, upon the supports of a tank is equal to over 62½ pounds per square foot of bottom, per foot of depth, very deep tanks would be inconvenient to support in your building. Separation of the tanks is also essential for purposes of cleaning and repairs and in case of accident. Tanks of about 40,000 gallons capacity would, perhaps, be a convenient and economical size, adapted in shape to their proposed locations. They would probably cost about $1200 each.

RECOMMENDATION.

It is respectfully recommended that a gravity supply from Belmont reservoir, with reserve connection with the Fairmount main and pumping capacity sufficient for use in emergency, be adopted for the supply of the City Hall. The latter will serve your more immediate requirements, and it can be introduced as soon as funds are available for that purpose.

Respectfully submitted.

HOWARD MURPHY,

OCTOBER, 1884. *Civil Engineer.*

REPORT

OF THE

COMMITTEE ON WATER SUPPLY.

February 3, 1885.

At a stated meeting of the Commissioners held this day, the following report was read, when on motion it was

Resolved, That the report of the Committee on Water Supply be accepted and the Resolutions presented by the Committee adopted, subject to the approval of the Chief Engineer of the Water Department.

To the Commissioners for the
Erection of the Public Buildings.

The Committee on Water Supply respectfully

REPORT :—

That at the stated meeting of the Commissioners, held December 2, 1884, they presented the report of Howard Murphy, C.E., of his investigations of the entire subject of providing a sufficient supply for the special use of the buildings.

Your committee preferred to submit that report in such a way that the Commissioners might have ample time fully to consider it in print before the committee should make a definite recommendation. They are now prepared, however, in accordance with what has been their conclusion, after they had themselves considered the report before submitting it to the Commissioners, to recommend that the conclusions and suggestion of the Civil Engineer,—"that a gravity supply from Belmont Reservoir, with reserve connection with the Fairmount main and pumping capacity sufficient for use in emergency, be adopted for supply of the City Hall,"—be adopted; and they further recommend that this gravity supply from the Belmont Reservoir be taken by a special 12-inch main, to be laid for the exclusive use of the buildings, by the route marked on the map which accompanies the report, from the reservoir through Belmont, Elm and Girard Avenues to a point east of the Philadelphia and Reading Railroad, thence through the Park back of the Zoological Gardens, and through Thirtieth Street to Market, and thence directly down

Market Street to the City Hall; and that provision be made to have this route surveyed and the specifications and plans prepared during the present year.

They recommend further, that for the present year the connection with the Fairmount main, through the attachment already made, access to which has been provided for from the northeast corner of the buildings, be made; and that the necessary tankage be put up, with the pipes leading thereto, and the pumping engine to supply the same, together with all necessary connections and appliances for the attachment of the 12-inch main from Belmont Reservoir, when it shall have been completed, being introduced into the buildings, without disturbing the new roadway now being laid down. It is estimated that all of the work recommended for the present year can be done at a cost of from $12,000 to $15,000.

The reasons for these recommendations hardly require elaboration by the committee, in view of the clear, full and detailed report of the Civil Engineer, and the knowledge which the Commissioners possess of the finances of the Commission, and the present condition of the buildings.

The recommendations of the committee are subject, of course, to modifications from time to time, as circumstances may develop necessity for local variations. Your committee submit the resolutions hereto attached, and ask their adoption by the Commissioners.

Respectfully submitted.

ISAAC S. CASSIN, *Chairman*,
WILLIAM BRICE,
WILLIAM S. STOKLEY,
} *Committee on Water Supply.*

RESOLUTIONS.

1. *Resolved*, That a gravity supply from Belmont Reservoir, with the necessary connection with the Fairmount main and pumping capacity sufficient for use in emergency, be adopted for the supply of the City Hall.

2. *Resolved*, That the gravity supply from Belmont Reservoir be by a special 12-inch main, to be laid for the exclusive use of the City Hall, from the Belmont Reservoir by Belmont, Elm and Girard Avenues, to a point east of the Philadelphia and Reading Railroad, thence through the Park back of the Zoological Gardens, and along Thirtieth Street to Market, and thence due east along Market Street to the City Hall.

3. *Resolved*, That the route indicated be surveyed, and the specifications and plans for the construction thereof be prepared during the present year.

4. *Resolved*, That for the present year the necessary connections shall be made with the Fairmount main, through the attachment already made, access to which has been provided for from the northeast corner of the buildings; and that the necessary tankage be provided, with the pipes leading thereto, and the pumping engine for the supply of the same, together with all necessary connections and appliances for the attachment of the 12-inch main from Belmont Reservoir, when it shall have been completed, being introduced into the buildings without disturbing the new roadway now being laid down.

5. *Resolved*, That the construction of the special 12-inch main from the Belmont Reservoir be deferred until next year.

February 6, 1885.

COL. WILLIAM LUDLOW,

Chief Engineer of Water Department, Philadelphia.

DEAR SIR:—In conformity with action taken by the Commissioners for the Erection of the Public Buildings, at their stated meeting held on Tuesday, February 3, 1885, I enclose herewith a certified copy of Resolutions adopted by them on that date, submitted for your consideration and approval.

Very respectfully,

SAMUEL C. PERKINS,

President of Commissioners.

PHILADELPHIA WATER DEPARTMENT.

PHILADELPHIA, *February* 9, 1885.

MR. SAMUEL C. PERKINS,
President Commissioners for the
Erection of the Public Buildings.

SIR:—I have to acknowledge the receipt of your letter of 6th inst., covering copy of the Resolutions adopted by the Commissioners for the Erection of the Public Buildings, relating to the proposed main for the water supply of the New City Hall.

In reply thereto, I beg to say that the securing of either temporary or permanent supply by the means specifically indicated in the resolutions meets with my approval.

Very respectfully,

WILLIAM LUDLOW,
Chief Engineer.