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REPORT

OF

COUNCIL COMMITTEE

ON

WATER WORKS,

FOR

CITY OF SANDUSKY,

WITH ESTIMATE AND REPORT OF

J. D. COOK, C. E.,

ALSO,

MESSAGE OF MAYOR—REPLY OF TRUSTEES, AND REPORT OF CITIZENS' COMMITTEE OF TOLEDO.

SANDUSKY:
STEAM PRINTING HOUSE OF KINNEY BROTHERS.
1875.

Resolved, That the Report of J. D. Cook, Civil Engineer, and the Committee on Water Works be accepted, and the recommendations adopted, so far as the Council are now advised, but all questions relating to the plan of Water Works and their mode of construction, and the place of obtaining water, are reserved for our future determination, and we hereby order the publication of the several reports of the Committee on Water Works, that the electors of the city may be advised on the subject submitted by Ordinance at this meeting.

The above Resolution was adopted January 11th, 1875, and is published by order of Council.

CHAS. CROSS, City Clerk.

REPORT OF COUNCIL COMMITTEE.

To the Hon. President and Council:

In pursuance of the duties imposed upon your special committee, to whom was referred the petition for the construction of Water Works, they invited J. D. Cook, Esq., Chief Engineer of the Toledo Water Works, to visit our city, overlook the situation, and report at his earliest convenience upon the best and most economical plan of carrying into effect the wishes of numerous citizens representing a very considerable share of the wealth and respectability of the city. His report and estimate has been received, and is hereunto appended and submitted for your consideration.

With perhaps a few changes on locating water mains and possible modification in regard to the *settling basins*, your Committee recommend the adoption of his plan for constructing the Works. They believe the estimated cost is a liberal one and that the entire work, covering contingencies, can be completed within the estimate of $365,000. Should the stone taken from the trenches in laying mains, be made available for McAdamizing streets, sold for lime or filling docks, the Engineer's estimate can be reduced, for that portion of the work, fifty per cent. This alone (and we believe it possible) would reduce the total cost to say $325,000, or even less. Your Committee are of the opinion that the settling basins may be dispensed with, or constructed at considerable less than the sum estimated. If to these possible savings in expense be added that on iron, as intimated by Mr. Cook, after his estimate for that material, the gross cost for substantial Water Works may be brought down to $300,000.

The advantages of such expenditure, or even if necessary the full sum estimated, must be apparent if the object be attained. In addition to the local benefits to be gained from a complete system of Water Works, mentioned in the report of Mr. Cook, such as extended facilities for manufacturing in all parts of the city and consequent enhancement of value in real estate, there is yet to be considered the sanitary advantages, alike important and, in fact, of the greatest importance to every citizen. Our city is literally, and in truth, built upon a rock, and although we have high authority for wisdom in so doing, yet in our case its disadvantages are manifest. As a rule, our citizens use water from wells for drinking and culinary purposes. This water comes from the surface exclusively, reaching the wells through fissures in the rocks, and bringing with it the poisonous remains of decayed vegetable and animal matter.

During and immediately subsequent to the cholera season of 1849, it was the favorite theory of some of our citizens, and no doubt a true one, that its extraordinary fatality in this locality was due to the lime stone immediately underlying (at a depth of from one to four feet) our entire city. But your Committee suggest that the lime stone would then have proven harmless had there been sufficient soil overlying it to purify the surface water perculating through it before reaching the conduits to our wells immediately underneath. It is well known that in cities, however deep the soil, the unavoidable accumulation of fecal matter permeates and fills it beyond its capacity of purification. This is easily discoverable by the crystal clearness, sparkling quality and sweetness of taste.

That bad or impure water from well or cistern generates typhoid and other malarial fevers, with a long list of other diseases, is at this day unquestioned.

There are other considerations yet important, and among them the saving of fire insurance. In Ogdensburg and some other cities insurance companies reduced their rates one-third on the completion of Water Works. In other cities where underwriters refused to make suitable deductions on premium rates, citizens reduced their amounts insured, choosing to take the risk themselves where facilities for extinguishing fires were so greatly increased. As a rule, companies will insure no more than two-thirds the valuation of building and contents. The other one-third is at the risk of the owner, but with one hundred and twelve hydrants, each equal to two of our best engines, and one such within 200 feet of nearly every building in the city, the fire risk is greatly lessened. It is more difficult to estimate a hypothetical saving of money than to ascertain an amount actually expended in insurance. It is said there is the sum of $75,000 paid annually by our citizens for insurance. If this is the premium on two-thirds the property insured, then the other one-third, which the owner himself must risk, is $37,500, one-half of which is gained to him by the increased facilities for extinguishing fires.

One-third deduction on $75,000,	$25,000
One-half saved on estimated owner's risk,	18,500
Total saving on insurance by Water Works,	$43,500

A sum greatly exceeding the interests on their entire cost.

The city has eight cisterns located at various points beyond the reach of water supply from our water fronts. These cisterns cost about $1,000 each. There were petitions for five additional ones the last Spring, and it is safe to say that to equalize their benefits to all our citizens by any scale of justice, there should be at least fifteen additional cisterns within that portion of our city beyond water supply from the bay. Any one of these cisterns can be drained in from forty to sixty minutes by either of our rotary engines, while the sediment unavoidably settling on their bottoms, cuts away their valves and necessitates immediate and expensive repairs. With the Water Works completed, two volunteer hose companies may be organized in each ward, and made effective at merely trifling expense to the city. This would save a large sum to the city in the fire department. In addition, for further security against fire, each person may keep ready for use a section of small hose, to be used in an emergency for extinguishing fire in his own or adjoining premises.

Your Committee suggest that a system of sewerage should be provided for in laying the Water mains. The expense of sewers would be materially reduced if constructed conjointly with Water Works. By dividing the expense between the two improvements in some equitable way, either would cost less than if done singly, and should the manner of assessments for Whisky Run Sewer District be adopted it would not be oppressive on our tax payers.

The means of payment for the heavy expense to be incurred in constructing a valuable system of Water Works does not necessarily come within range of duty expected of your Committee. They, therefore, make no suggestions on that subject, further than to say that the present is a most favorable time for selling the bonds of the city on long time, say twenty or thirty years. And further, that labor and material needed in accomplishing the work is now cheaper than for the last twelve years.

With the view of giving general and perfect understanding as to the various systems of Water Works, we append hereto the report of the Trustees of Toledo Water Works with their reasons for preferring the Stand-Pipe to the Holly system of supply. The various opinions of hydraulic engineers and experts embodied in their reports, justify our choice of the two systems in accord with theirs. This, however, your Committee can only recommend, nor would they if they could determine a question so important until the last opportunity had closed for avoiding the mistakes of others, or making available the latest possible improvement in works of this kind.

In submitting their report, your Committee feel that their duties have carried with them great responsibilities. Some of its members were opposed to any improvement which involved the beginning of a bonded indebtedness; but, on a careful investigation of the subject, their opinions were unanimous that the advantages to be derived from Water Works greatly overbalance any conceivable objection.

WM. ZIMMERMANN,
A. H. BARBER,
B. F. FERRIS, } Committee.

January 11th, 1875.

REPORT AND ESTIMATE OF J. D. COOK, C. E.

To William Zimmerman, Chairman, and the Committee on Water Works, Sandusky, Ohio:

Gentlemen:—Having been requested by your Committee to present, or suggest a general plan or system of Water Works that would, in my judgment, be best adapted to the present and prospective requirements of your people, I respectfully report that I have made such examinations and investigations as were deemed necessary to a reasonably correct understanding of the local characteristics of your city, its topographical features, natural obstacles to be encountered, &c.

In contemplating a subject so replete with interest to every citizen, and so inseparably connected with the present and future health, safety, and general welfare of an entire city, many questions of varying importance and magnitude are necessarily presented for candid consideration. Among the more prominent of which may be named the source of supply, the purity of the water to be supplied, the most eligible means in point of durability, economy and safety by which to obtain the desired force or pressure necessary to secure an adequate supply for domestic, manufacturing and fire purposes;—the kind of pumping machinery best adapted to the performance of the service required, at least comparative current cost, with greatest immunity from delays and the frequent recurrence of expensive repairs, consequent upon imperfections in mechanism or design;—a judicious pipe distribution, covering a territorial area commensurate with public and private requirements—a liberal distribution of fire hydrants of large capacity, located in such proximity as to guarantee the greatest attainable safety during times of conflagration, &c.

The primeval construction of Water Works in most or all the cities of the country, has been characterized by misconception of future necessities engendered partly by misjudgment as to the unparalleled subsequent growth which has almost uniformly marked the history of American cities, and largely by a tendency on the part of municipal authorities to remain unmindful of future wants, in their efforts at financial economy in first or original cost.

In the general design of a system to be recommended for your city, it has been my purpose to offer that which would best subserve your present and future interests, by the adoption of a pipe distribution both liberal in extent and capacity, with the most approved and reliable pumping machinery, substantial buildings, and everything necessarily incident to utility rather than ornament.

SOURCE OF SUPPLY.

The source of supply is a question fraught with an importance second, perhaps, to no other consideration. Situated as you are, however, on the southern verge of Sandusky Bay, and so nearly adjacent to the waters of Lake Erie, there would certainly seem to be little or at least inconsiderable ground for solicitude as to the general purity of your water supply. In the absence of adverse winds, the natural current caused by the outflow of Sandusky river, must tend to carry impurities held in suspension, such as local drainage, sewerage, &c., into the Lake, to be carried off by waves or precipitated into quiet water, deeper than the bay contiguous to the city, and below the influence of surface waves or river current.

Some of your citizens have suggested the propriety or necessity of taking water from the Lake on the easterly side of Cedar Point—others from a large well, constructed or excavated to proper depth into the sand, of which the Point is composed, —and others from a point nearly abreast of the foot of Sycamore Street, and some 300 feet east of the old Lake Shore Railroad track.

Referring to the first proposition, I fail to see the feasibility of the project, excepting at a cost beyond your probable present desire or ability to meet—necessitating as it would the laying of some two miles of submerged conduit pipe—the excavation or dredging of a channel through Cedar Point, in order to reach a point sufficiently distant into the Lake from the Cedar Point shore to secure the necessary depth of water and to avoid impurities, consequent upon the back flow caused by easterly and north-easterly winds acting upon and disturbing the shoal waters near shore.

I am also compelled to express more or less distrust, as to the feasibility and permanent utility of sinking an influent well in the Cedar Point sand—fearing that the history of other cities where similar experiments have been tried, might be repeated in your case. The constant convergence of so large a volume of water to one comparatively small point—ever depositing impurities held in suspension, during incessant percolation, would naturally tend to estop or retard the inflow, and ultimately prove inadequate and unreliable. Another fruitful cause of objection to this project may be found in the fact that the quantity and the cost of submerged pipe necessary to reach the Point would very nearly equal the amount requisite for taking water from the Lake as above set forth. Without going into the more minute or practical details to be observed in constructing the Cedar Point well, it may be proper to suggest, that in case the face of the excavation extending from top to bottom, should be left nearer perpendicular, than say 2½ to 3 feet horizontal, to 1 foot perpendicular, a rip rap wall or other protection would be found necessary to hold it in place. Or should it be decided to have the sides perpendicular, walls of masonry or sheet piling would be brought in requisition—the major part, or all the water in that case being delivered into the well through the bottom—the constantly inflowing water might tend to reduce the depth of well by a gradual, though unceasing sand deposit.

In view of the immense (and as I think unnecessary) expenditure which either of the foregoing projects, when permanently consummated, must ultimately entail, I would respectfully suggest, and recommend for the consideration of your Committee and the Honorable City Council the construction of two settling reservoirs between the Railroad track and main shore at a point near the foot of Sycamore Street. Accompanying map and hydrographical chart of your city and bay, will correctly represent the location and general plan of these proposed reservoirs. The earth, overlying the rock, to be removed by dredging and used as far as practicable in the formation of reservoir banks, with a thorough rip rap, or lining of broken stone to prevent impregnation of the water by contact with the earth. Each reservoir to have separate influent and effluent chambers, constructed with sluice gates,—the former for receiving water from the Bay Crib, and the latter for discharging by natural flow, into pumping well; —each to have a storage capacity of six million gallons, and a consequent subsidence of four to six days before passing into distribution.

Considering the benefits, almost universally derivable from settling reservoirs, as evinced by a wide range of experience elsewhere, it would seem fair to conclude, and I have no hesitancy in predicting, that with such an arrangement the water from your bay could be favorably brought into analytical comparison with the supply of any or all the other cities of the country.

PUMPING ENGINES.

Without deeming it prudent or promotive of your interests to recommend any particular system of machinery, it is proper to suggest that your pumping service will for all time, be the governing element in your entire system, in point of current financial economy, reliability and safety,—constituting a question, the importance and magnitude of which cannot be too fully appreciated, and to which all others will be daily and hourly tributary. It should be characterized by simplicity in mechanical design, and directness in the transmission of power. I would recommend for your service two pumping engines, each with a capacity of raising two million gallons of water in twenty-four hours, from pumping well to top of stand pipe, (as hereinafter described and recommended). They should be so constructed as to properly facilitate expansion of steam—with condensing apparatus of such size and proportion as to ensure a working vacuum of not less than twenty-six inches, together witl steam jackets and all other appliances for securing a high duty, and consequent saving in cost of fuel.

Steam should be furnished by two sets of boilers of proper metal and most approved construction, with twenty-two square feet of heating surface per actual horse power of 33,000 pounds raised one foot high per minute.

STAND-PIPE.

There being no natural elevation of ground, reasonably contiguous to your city to render practicable the construction of a reservoir, with an altitude sufficient to furnish the requisite pressure for fire or even for domestic and manufacturing purposes, I would recommend the construction of a wrought iron stand pipe five feet internal diameter and 200 feet high—resting on a stone foundation ten feet above city base, giving a total altitude or water head of 210 feet above high water line in the bay. The tower or stand pipe enclosure to be of brick or stone as may be desired.

The benefits derivable from the use of a stand pipe, in contradistinction to the several other projects, and advocated systems of direct supply, urgently seeking public favor, have been often and thoroughly canvassed. I therefore deem it needless to encumber this report or weary your patience with anything like an extended discussion—further than to remark that it subserves all the purposes for which reservoirs of equal altitude are constructed, excepting in storage capacity, and the consequent necessity for running the pumping machinery in continuity. It is an ever-present medium of relief and safety to the engines by concentrating and reducing the applied power to the simple service of controlling a column of water extending from the pumps to the top of the pipe—the force or pressure meeting with an elastic resistance by the water in the pipe being in constant contact with the atmosphere—the distributing pipes throughout the city receiving gravity pressure directly from, and in proportion to the altitude of water in the pipe.

PIPE DISTRIBUTION.

In deciding upon and recommending a pipe distribution which may be adequate to your present and probable future wants, I am admonished by the almost countless calamities which have befallen other cities, as a general resultant of small and insufficient water pipes and fire hydrants ;—and the further fact that most or all the leading cities of the country are annually taking up small pipes and replacing them with others of greater capacity.

When we consider that the comparative weight and cost of pipes of different diameters, are widely different from their comparative capacity, the policy which dictates an inefficient distribution for the purpose of subserving present financial economy becomes at once an erroneous and demonstrably dangerous one. The weight of a 12 inch pipe, as estimated for your works, is approximately 88 lbs. per lineal foot, and a 6 inch pipe 35 lbs. per lineal foot—weight of 12 inch $2\frac{51}{100}$ times that of 6 inch. The practical capacity or comparative discharge of pipes is directly as the 2.5 power of their diameters. Hence the capacity of a 6 inch pipe is to the capacity of a 12 inch pipe as 88.2 is to 498.8, the 12 inch being $5\frac{65}{100}$ times greater than the 6 inch—leaving out of view the immense excess in loss of head by friction due to increased velocity for an equal discharge through the smaller pipe.

The location of the main and distributing pipes so as to best promote free and perfect circulation, and afford ample and prompt supply at most remote points in the distribution, is a desideratum of permanent importance. Every system of water works dependent upon the constant running of the pumping engines, should be indemnified against the ever-present danger of accidents by which the main may become disabled, and the general distribution momentarily liable to become inoperative and temporarily worthless. In view of, and to avoid such possible contingency in your case, I have included in the general design an auxiliary main, connecting with the pumps and extending independently of force main into the general distribution—this main to be so connected and arranged with valves, that it can be worked independently of, or through the stand pipe as may be desired.

The following tabular statements will correctly represent the general plan of pipe distribution, sizes of pipes together with approximate lengths ;—also, fire hydrants and water gates, which are respectfully presented for your consideration :

PROPOSED LOCATION OF PIPES.

Diam. of Pipe.	Name of Street.	From	To	Length Lineal feet
20 inch...	Madison,.	Engine House...	Columbus Av..	3400
16 inch...	Madison,.	Columbus Av...	Miami Av..	1430
	Columbus Av....	Madison,.	Park Place.	1300
				2730
12 inch...	Madison,.	Engine House...	Meigs	430
	Meigs.	Madison,.	Washington	1450
	Washington	Meigs.	Wayne	2340
	Wayne,	Washington	Huron	115
	Park Place,	Wayne,	Jackson	980
	Jackson,	Park Place,	Water	1050
	Washington	Jackson,	Lawrence	1400
	Poplar.	Madison..	Jefferson	700
	Jefferson.	Lawrence	Camp	1300
				9800
8 inch...	Water,.	Shelby.	Perry	5200
	Washington	Lawrence	Camp	1000
	Jefferson.	Lawrence	Meigs	4740
	Monroe	Lawrence	Columbus Av...	1900
	Tiffin Av.	Harrison.	Shelby	1700
	Camp.	Monroe	Washington	2050
	Shelby.	Market	Water	530
	Lawrence	Monroe	Water	2900
	Decatur.	Madison..	Water	2350
	Hancock.	Scott..	Water	4230
	Perry.	Monroe..	Water	2930
				29530
6 inch...	Market	Shelby.	Perry	5200
	N. side Park	Jackson,	Wayne	980
	Adams,	Camp,	Meigs	5950
	Madison,.	Camp,	Lawrence	1580
	Monroe	Camp,	Lawrence	1750
	Monroe	Columbus	Meigs	2850
	Scott,.	Columbus	Hancock	980
	Harrison.	Monroe	Tiffin	
	R. R. Av.	Monroe	Tiffin	1460
	Monroe	Harrison.	Camp	1200
	R. R. Av,	Tiffin	Shelby	1000
	Shelby.	Washington	Market	489
	McDonough	Adams	Water	1510
	Fulton.	Madison..	Water	2400
	Decatur.	Madison..	Columbus Pike	2000
	Wayne.	Scott..	Water	4060
	Franklin	Madison..	Water	2390
	Meigs.	Monroe	Madison	1770
	Columbus Pike..	Decatur.	Wayne	2100
	Huron Av	Park Place.	Franklin	1460
	Hydrant,.	Connection,		1283
	Extra.			10560
				52960

LOCATION OF HYDRANTS.

One at Engine House.
One at the northwest corner of Washington and Meigs streets.
One at the northwest corner of Meigs and Adams streets.
One at the northwest corner of Meigs and Jefferson streets.
One at the northwest corner of Meigs and Madison streets.
One at the northwest corner of Meigs and Monroe streets.
One at the northwest corner of Perry and Monroe streets.
One at the northwest corner of Perry and Madison streets.
One at the northwest corner of Perry and Jefferson streets.
One at the northwest corner of Perry and Adams streets.
One at the northwest corner of Perry and Washington streets
One at the northwest corner of Perry and Market streets.
One at the southwest corner of Perry and Water streets.
One at the southwest corner of Water and Warren streets.
One at the northeast corner of Market and Warren streets.
One at the northeast corner of Washington and Warren streets.
One at the northeast corner of Adams and Warren streets.
One at the northeast corner of Jefferson and Warren streets.
One at the northeast corner of Madison and Warren streets.
One at the northeast corner of Monroe and Warren streets.
One at the northwest corner of Franklin and Madison streets.
One at the northwest corner of Franklin and Jefferson streets.
One at the northwest corner of Franklin and Adams streets.
One at the northwest corner of Franklin and Washington streets.
One at the northwest corner of Franklin and Market streets.
One at the southwest corner of Franklin and Water streets.
One at the southwest corner of Hancock and Water streets.
One at the northwest corner of Hancock and Market streets.
One at the northwest corner of Hancock and Washington streets.
One at the northwest corner of Hancock and Adams streets.
One at the northwest corner of Hancock and Jefferson streets.
One at the northwest corner of Hancock and Madison streets.
One at the northwest corner of Hancock and Monroe streets.
One at the northwest corner of Hancock and Reese streets.
One at the northwest corner of Hancock and Neil streets.
One at the northwest corner of Hancock and Scott streets.
One at the northwest corner of Wayne and Scott streets.
One at the northwest corner of Wayne and Neil streets.

One at the northwest corner of Wayne and Reese streets.
One at the northwest corner of Wayne and Monroe streets.
One at the northwest corner of Wayne and Madison streets.
One at the northwest corner of Wayne and Jefferson streets.
One at the northwest corner of Wayne and Adams streets.
One at the northeast corner of Washington and Wayne streets.
One at the northwest corner of Wayne and Market streets.
One at the southwest corner of Wayne and Water.
One at the southwest corner of Columbus Av. and Water streets.
One at the northwest corner of Columbus Av. and Market streets.
One at the northwest corner of Park Place and Columbus Av.
One at the southwest corner of Park Place and Columbus Av.
One at the northwest corner of Adams street and Columbus Av.
One at the northwest corner of Jefferson st. and Columbus Av.
One at the southwest corner of Columbus Av. and Madison st.
One at the northwest corner of Monroe street and Columbus Av.
One at the northeast corner of Columbus Pike and Columbus Av.
One at the west side of Columbus Pike, opposite Neil street.
One at the northeast corner of Scott street and Columbus Av.
One at the northwest corner of Jackson and Monroe streets.
One at the northwest corner of Jackson and Madison streets.
One at the northwest corner of Jackson and Jefferson streets.
One at the northwest corner of Jackson and Adams streets.
One at the northwest corner of Jackson and Washington streets.
One at the northwest corner of Jackson and Market streets.
One at the southwest corner of Jackson and Water streets.
One at the southwest corner of Decatur and Water streets.
One at the northwest corner of Decatur and Market streets.
One at the northwest corner of Decatur and Washington streets.
One at the northwest corner of Decatur and Adams streets.
One at the northwest corner of Decatur and Jefferson streets.
One at the northwest corner of Decatur and Madison streets.
One at the northwest corner of Decatur and Monroe streets.
One at the west side of Decatur street, south of Monroe street.
One at the northeast corner of Columbus Pike and Decatur st.
One at the east side of Columbus Pike at Townsend street.
One at the northwest corner of Fulton and Miami streets.
One at the northwest corner of Fulton and Jefferson streets.
One at the northwest corner of Fulton and Adams streets.

One at the northwest corner of Fulton and Washington streets.
One at the northwest corner of Fulton and Market streets.
One at the southwest corner of Fulton and Water streets.
One at the southwest corner of Lawrence and Water streets.
One at the northwest corner of Lawrence and Market streets.
One at the northwest corner of Lawrence and Washington sts.
One at the northwest corner of Lawrence and Adams streets.
One at the northwest corner of Lawrence and Jefferson streets.
One at the northwest corner of Lawrence and Madison streets.
One at the northwest corner of Lawrence and Monroe streets.
One at the northwest corner of Monroe and McDonough streets.
One at the northwest corner of Madison and McDonough sts.
One at the northwest corner of Jefferson and McDonough sts.
One at the northwest corner of Adams and McDonough streets.
One at the northwest corner of Washington and McDonough sts.
One at the northwest corner of Market and McDonough streets.
One at the southwest corner of Water and McDonough streets.
One at the southeast corner of Water and Shelby streets.
One at the northwest corner of Market and Shelby streets.
One at the northwest corner of Madison and Shelby streets.
One at the northwest corner of Monroe and Shelby streets.
One at the northeast corner of Monroe and Camp streets.
One at the west side of Camp street, opposite Madison street.
One at the west side of Camp street, opposite Jefferson street.
One at the west side of Camp street, opposite Adams street.
One at the southwest corner of Tiffin Av. and Washington st.
One at the west side of Railroad st., bet. Tiffin Av. and Market st.
One at the southeast corner of Tiffin Av. and Railroad street.
One at the northwest corner of Railroad and Jefferson streets.
One at the northwest corner of Railroad and Madison streets.
One at the northwest corner of Railroad and Monroe streets.
One at Tiffin Av., near Jefferson street.
One at Tiffin Av., southwest corner of Harrison street.
One at the northeast corner of Monroe and Harrison streets.
One at the northwest corner of Monroe and Clinton streets.

Total number—112.

VALVES.

20-inch at stand-pipe, Madison street.
20-inch northwest corner of Madison street and Huron Av.
16-inch at the northwest cor. of Madison st. and Columbus Av.
16-inch at the southwest cor. of Columbus Av. and Adams st.
12-inch at Madison street, near engine house.
12-inch at the northwest cor. of Meigs and Madison streets.
12-inch at the northwest cor. of Washington and Meigs streets.
12-inch at the northwest cor. of Washington and Warren sts.
12-inch at the northeast cor. of Washington and Wayne sts.
12-inch at Park Place, southeast cor. of Columbus Av.
12-inch at Park Place, southwest cor. of Columbus Av.
12-inch at Washington street, northwest cor. of Jackson street.
12-inch at Jefferson street, northeast cor. of Camp street.
8-inch at Washington street, southwest cor. of Lawrence st.
8-inch at Water street, southwest cor. of Decatur street.
8-inch at Water street, southwest cor. of Jackson street.
8-inch at Water street, southeast cor. of Jackson street.
8-inch at Water street, southwest cor. of Wayne street.
8-inch at Water street, southwest cor. of Franklin street.
8-inch at Water street, southwest cor. of Perry street.
8-inch at Washington street, northeast cor. of Shelby street.
8-inch at Washington street, northwest cor. of Lawrence st.
8 inch at Jefferson street, northeast cor. of Lawrence street.
8-inch at Jeflerson street, northeast cor. of Decatur street.
8-inch at Jefferson street, northwest cor. of Columbus Av.
8-inch at Jefferson street, northeast cor. of Columbus Av.
8-inch at Jefferson street, northeast cor. of Hancock street.
8-inch at Jefferson street, northwest cor. of Warren street.
8-inch at Jefferson street, northwest cor. of Meigs street.
8-inch at Monroe street, northwest cor. of Columbus Av.
8-inch at Tiffin Av., northwest cor. of Harrison street.
8-inch at Camp street, northwest cor. of Monroe streets.
8-inch at Camp street, southwest cor. of Jefferson street.
8-inch at Camp street, southwest cor. of Washington street.
8-inch at Shelby street, southwest cor. of Water street.
8-inch at Lawrence street, northwest cor. of Monroe street.
8-inch at Lawrence street, northwest cor. of Jefferson street.

8-inch at Lawrence street, southwest cor. of Washington st.
8-inch at Lawrence street, northwest cor. of Washington st.
8-inch at Lawrence street, southwest cor. of Water street.
8-inch at Decatur street, southwest cor. of Jefferson street.
8-inch at Decatur street, southwest cor. of Washington street.
8-inch at Hancock street, northwest cor. of Scott street.
8-inch at Hancock street, northwest cor. of Reese street.
8-inch at Hancoek street, southwest cor. of Madison street.
8-inch at Hancock street, northwest cor. of Washington st.
8-inch at Hancock street, southwest cor. of Huron Av.
8-inch at Hancock street, southwest cor. of Adams street.
8 inch at Hancock street, southwest cor. of Washington st.
8-inch at Hancock street, northwest cor. of Washington st.
8-inch at Hancock street, southwest cor. of Water street.
8-inch at Perry street, southwest cor. of Madison street.
8-inch at Perry street, northwest cor. of Madison street.
8-inch at Perry street, southwest cor. of Adams.
6-inch at Market street, northeast cor. of Shelby street.
6-inch at Market street, northwest cor. of Lawrence street.
6-inch at Market street, northwest cor. of Decatur street.
6-inch at Market street, northwest cor. of Jackson street.
6-inch at Market street, northeast cor. of Jackson street.
6-inch at Market street, northwest cor. of Wayne street.
6-inch at Market street, northwest cor. of Franklin street.
6-inch at Market street, northwest cor. of Perry street.
6-inch at Park Place, northeast cor. of Jackson street.
6-inch at Park Place, northwest cor. of Wayne street.
6-inch at Adams street, northeast cor. of Camp street.
6-inch at Adams street, northwest cor. of Lawrence street.
6-inch at Adams street, southwest cor. of Decatur street.
6-inch at Adams street, northwest corner of Columbus Av.
6-inch at Adams street northeast cor. of Columbus Av.
6 inch at Adams street, northwest cor. of Huron Av.
6-inch at Adams street, northwest cor. of Warren street.
6-inch at Adams street, northwest cor of Meigs street.
6-inch at Madison street, northwest corner of Camp street.
6-inch at Madison street, northwest cor. of Lawrence street.
6-inch at Monroe street, northwest cor. of Lawrence street.
6-inch at Monroe street, northwest cor. of Wayne street.

6-inch at Monroe street, northwest cor. of B. & O. R. R.
6-inch at Monroe street, northwest cor. of Meigs street.
6-inch at Scott street, northeast cor. of Columbus Av.
6-inch at Railroad street, northwest cor. of Monroe street.
6-inch at Railroad street, southwest cor. of Tiffin Av.
6-inch at Railroad street, northwest cor. of Tiffin Av.
6-inch at Monroe street, northeast cor. of Harrison street.
6-inch at Monroe street, northwest cor. of Camp street.
6-inch at Shelby street, northwest cor. of Washington street.
6-inch at Shelby street, southwest cor. of Water street.
6-inch at McDonough street, northwest cor. of Adams street.
6-inch at McDonough street, southwest cor. of Water street.
6-inch at Fulton street, northwest cor. of Madison street.
6-inch at Fulton street, southwest cor. of Washington street.
6-inch at Fulton street, northwest cor. of Washington street.
6-inch at Fulton street, southwest cor. of Water street.
6-inch at Decatur street, northwest cor. of ——— street.
6-inch at Decatur street, northwest cor. of Monroe street.
6-inch at Decatur street, northwest cor. of Jefferson street.
6-inch at Wayne street, northwest cor. of Scott street.
6-inch at Wayne street, southwest cor. of Monroe street.
6-inch at Wayne street, southwest cor. of Madison street.
6-inch at Wayne street, northwest cor. of Madison street.
6-inch at Wayne street, southwest cor. of Park Place.
6-inch at Wayne street, northeast cor. of Park Place.
6-inch at Wayne street, southwest cor. of Water street.
6-inch at Franklin street, northwest cor. of Madison street.
6-inch at Franklin street, southwest cor. of Washington.
6-inch at Franklin street, northwest cor. of Washington st.
6-inch at Franklin street, southwest cor. of Water street.
6-inch at Wayne street, southwest cor. of Madison street.
6-inch at Columbus Pike, cor. of Townsend street.
6-inch at Columbus Pike, southwest cor. of Monroe street.
6-inch at Huron Av., southeast cor. of Park Place.
6-inch at Huron Av., northwest cor. of Franklin street.

RECAPITULATION.

Total length	20 inch	pipe,	3,400	lineal feet.
"	"	16 "	"	2,730	"	"
"	"	12 "	"	9,800	"	"
"	"	8 "	"	29,530	"	"
"	"	6 "	"	52,960	"	"
				98,420	"	"

Or, 18.64 miles.

Total number of Fire Hydrants, 112.

Number of 20 inch Valves,	2
" " 16 " "	3
" " 12 " "	9
" " 8 " "	41
" " 6 " "	57
	112

Discharge in 24 *hours, due to pipes of different diameters—under* 200 *feet head—for a length of one half mile.*

DIAMETER OF PIPES IN INCHES.				
20	16	12	8	6
DISCHARGE—GALLONS IN 24 HOURS.				
22,944,000	13,150,080	6,405,120	1,321,280	1,131,840

Loss of head by friction for a general discharge of 2,000,000 *gallons in* 24 *hours—length of pipes* 3,000 *lineal feet.*

DISCHARGE—GALLONS IN 24 HOURS.				
2,000,000	1,600,000	1,200,000	800,000	600,000
LOSS OF HEAD IN FEET BY FRICTION.				
1 72-100	3 36-100	11 34-100	38 82-100	92 50-100

Height of jets or fire streams due to 200 feet head.

SIZE OF NOZZLES IN INCHES.						
½	¾	1	1¼	1½	1¾	2
HEIGHT OF JETS IN FEET.						
90	116	137	150	158	166	169

It will be seen that the above tabular statement is based upon a delivery of 100,000 gallons per inch diameter of pipes, which, of course, is disproportionate to their respective capacities, being but little over 10 per cent. of capacity for 20 inch main, while it is more than 50 per cent. of the capacity of 6 inch pipe. It must be borne in mind, however, that while the main is called upon for the entire supply, the small pipes are intersected and frequently supplied by other and larger ones—hence the loss of head by friction for 6 and 8 inch pipes, as shown above, is greater than will be found in practice. The actual loss of head cannot be considered more than one-half the loss as shown by above statement. With the ample distribution herein contemplated’ your remotest hydrants will give a jet or fire stream of 140 to 150 feet in height.

Estimated cost of entire work is as follows:

20 inch pipe, 325 tons,		
16 " " 181 "		
12 " " 424 " 930 tons at $45,		$ 41,850
8 " " 741 "		
6 " " 930 " 1670 " $46,		76,820
6 " " 2 miles extra 155 tons at $46,		7,130
Special Castings, 50 tons, $70,		3,500
Pipe laying,	$98,500	
Per centage of excess over schedule weights of pipes,		
55 tons at $45,	2,475	230,275
112 Fire Hydrants, $60,	6,720	
Setting " 10,	1,120	7,840
2 Check Valves, $400	800	
2 Foot Valves, 300	600	

3 20 inch Stop Valves,	500	1,500		
4 16 " " "	175	700		
12 12 " " "	80	960		
45 8 " " "	45	1,980		
70 6 " " "	30	2,100		
Setting and enclosing valves,		2,500	11,140	
Suction and force main and other pipe connections at pumping works,		4,500		
Influent pipe and screen,		3,750		
Conduit to pumping well,		1,750		
Pumping well,		2,550		
2 settling reservoirs,		21,300		
Engine and Boiler Houses,		11,000		
Stand Pipe,		20,500		
2 Pumping Engines, including Boilers and settings,		25,000	90,350	
Officers' salaries, engineering, inspection, and superintendence—office and all other contingent expenses from commencement to completion,			25,000	
Estimated cost of entire works complete,			$364,605	

It is usually found to be practically impossible in making preliminary estimates to correctly foresee all the contingent elements of cost, occurring during the progress of a work so miscellaneous in its nature. In making the foregoing computations, I have therefore endeavored, as far as possible to compass the entire range of uncertainties, accidents and omissions that could by any reasonably imaginary probability be considered as liable to occur.

All of which is respectfully submitted.

J. D. COOK.

DECEMRER 26, 1874.

AN ORDINANCE

To submit to the electors of the City of Sandusky the question whether Water Works shall or shall not be established by said City, at a cost not exceeding Three Hundred and Seventy-five Thousand Dollars.

SECTION 1. Be it ordained by the City Council of the City of Sandusky, That Water Works shall be established and constructed by said City, for the purpose of supplying the citizens thereof with water, to increase its manufacturing facilities, to aid in the extinguishment of fires and prevent the destruction of property.

SECTION 2. In order to defray the necessary expenses of making surveys, purchasing real estate, and constructing said Water Works, the bonds of the City of Sandusky shall be issued to an amount not exceeding Three Hundred and Seventy-five Thousand Dollars, to bear interest, at the rate of eight per cent. per annum, with interest coupons attached, and in every other respect to conform to the municipal code of Ohio, and its amendments thereto, to be issued in such denominations and payable at such times and places, as may hereafter be determined by the City Council of said City.

SECTION 3. For the purpose of determining the question as to the construction of said Water Works, and the issue of bonds to the amount specified in the foregoing section of this ordinance, the Mayor of the City is hereby directed to issue his proclamation for a special election, in conformity to law, at least ten days before holding the same, which election is to take place on the fifteenth day of February, A. D. 1875, at such places as the City Council may determine, and the same is to be conducted by the same officers, under the same regulations, and the returns to be made in the same time, place and manner as the annual municipal elections of the City of Sandusky, and in all respects to conform to the laws of the State of Ohio on that subject.

SECTION 4. All electors of the City of Sandusky who favor the establishment of Water Works, and the issue of the bonds of said City, not exceeding the amount specified in this ordinance, shall place upon their ballots, the words "For Water Works," and all opposed to the establishment of said Water Works, and the issue of bonds as aforesaid, shall place upon their ballots the words, "Against Water Works," and it shall be the duty of the Clerk of said City to report the result of said election to said Council, at its next meeting after the holding of said election, and if a majority of the electors, voting at said election, shall vote "For Water Works," it shall be the duty of the City Council of said City, immediately to provide by ordinance for making the necessary surveys, the purchase or condemnation of all real estate requisite for the purpose, the election of all officers, at the ensuing municipal election, and in every practicable way, by legislation and by instruction to the executive officers of said City, to give full effect and operation to the vote of the electors, as declared at said special election.

Passed January 11, 1875.
Attest: CHAS. CROSS,
City Clerk.

W. H. WILSON,
Prest. of the Council.

APPENDIX.

MESSAGE FROM THE MAYOR.

MAYOR'S OFFICE,
TOLEDO, O., March 31, 1873.

Gentlemen of the City Council:

At the suggestion of a number of citizens interested in the establishment of Water Works at the earliest practicable moment, I addressed a communication to the Trustees of Water Works, asking them to state to me more specifically the facts and reasons by which they were induced to report adverse to the Holly System of Water Works, and in favor of the Stand-pipe plan, recommended in their report of Dec. 28, 1872. The enclosed communication has been received in reply, and is transmitted to your honorable body as containing information which may contribute light upon a subject which has been given a patient and faithful investigation by them, and which it is hoped may conduce to relieve the embarrassments of the situation.

I can do no less than express the opinion that their conclusions are based upon sound facts and views. We have a large extent of territorial area, which must be supplied with water at no distant day, for the experience of municipalities proves that clamors for the wants and comforts of man will not cease until they finally consummate them by their political power. As showing the extent to be supplied with water in our City, the areas of some of the principal cities of the country are submitted, viz:

New York, 22 7-10 square miles.
Brooklyn, 21 8-10 " "
Chicago, 35 " "
St. Louis, 19 9-10 " "
Louisville, 12 3-10 " "
Toledo, 21 5-10 " "
Milwaukee, 14½ " "

It will be seen that the territory to be supplied with water nearly equals that of Brooklyn or New York, and a prudent foresight would dictate that the supply mains and pumping machinery should be of large size, if we would not too soon outgrow them. We may reasonably expect our manufacturing interests to vastly increase upon the advent of cheap coal, and a liberal supply of water will be indispensable to their welfare.

I cannot too strongly urge upon your consideration the propriety of granting authority to the Trustees to advertise for water pipes, such as they have recommended, in order that the work may progress as much as possible during the coming season. The question of machinery is no less important, but at the moment, perhaps, less urgent.

Feeling the urgent need of Water Works to promote our material progress, our people have regretted that unfortunate differences of opinion should have arisen between the Council and the Board of Water Works, by which these delays have been brought about. But now, as it is understood that the Committee of citizens appointed by the Council, have concluded their investigations and will to-day submit their report, it is hoped that no future differences will retard the completion of our much needed Water Works.

Very respectfully,
Your obt. servant,
W. W. JONES, Mayor.

REPLY BY THE TRUSTEES.

TOLEDO, March 29th, 1873.

Hon. W. W. JONES, Mayor of the City of Toledo.

DEAR SIR:—Your communication, asking the Trustees of Water Works to state to you more specifically the facts and reasons by which they are induced to report adverse to the Holly System of Water Works, and in favor of the plan recommended in their report of December 28, 1872, has been received, and we avail ourselves of the earliest opportunity to reply. We have at all times been ready and willing to impart to any of the City authorities of citizens any and all information of which we are posessed, touching upon the question of different systems of Water Works, and also make known the facts and reasons controlling our action.

Before entering upon a statement of the facts and reasons influencing our action, we desire to state the understanding we have had as to the duties required of us, as agents of the citizens and tax-payers of the City, as well as the object to be attained in the establishment of Water Works.

Upon our election and qualification as Trusteess of the Water Works, we deemed it obligatory upon us to make such investigations as would enable us to ascertain what system of water supply would best subserve the true interests of our City; and being novices in the matter, we spent considerable time in the examination of various systems of Water Works in operation in the principal cities of the country, and gleaning information from those in charge of such Works, as to the original cost, efficiency, durability and expense of maintaining the same, and in procuring suggestions and advice from Hydraulic Engineers, not immediately connected with the Water Works, in different places visited by us.

Whatever motives may have influenced the votes of those who elected us as Trustees, we are free to say that we entered upon the discharge of our duties, as understood by us, unprejudiced and uncommitted to the success or defeat of any particular plan or system of Water Works, the paramount consideration with us being that of deciding upon such a system as, in our opinion, would best promote the public interests.

A difference of opinion seems to prevail as to the real object to be attained in the establishment and maintenance of Water Works, it being urged by some that the principal object to be secured is that of furnishing protection against fire; and, indeed, this has been claimed with such a degree of pertinacity by the adherents of the so-called "Holly System," that the question of furnishing a supply of water for domestic and all ordinary purposes, has been almost entirely lost sight of and ignored.

While we have not overlooked the great importance of securing a protection against the ravages of fire in the establishment of a system of water supply, we must confess that we have greatly mistaken the real object to be obtained in the erection and maintenance of Water Works in our City, if it should be chiefly for fire purposes. If the question of domestic supply was and is so important in the solution of the problem as to the best system to be adopted, why did the City Council incur the trouble and expense of procuring an analysis of water taken from artesian wells and from the River, for the purpose of ascertaining the relative freedom from organic matter and other impurities? Or, why did the Council, in the ordinance providing for the construction of Water Works, provide for their location at a point above the outlet of all the sewerage of the City, and also provide for the construction of filtering beds? We think no one will claim that there is any necessity for having water pure and free from organic matter or sedimentary deposit, in extinguishing fires, and a very great saving of expense could be secured by dispensing with the process of filtration, locating the pumping works near the center of population, and taking water direct from the River, and at the same time answer every purpose as a fire protection.

In the Spring of 1869, the proposition was submitted to the voters of the City to authorize the levy of $100,000 for a water supply from the Miami and Erie Canal, and intended solely as a fire protection, and it was overwhelmingly defeated. We cannot believe that so great a change has been brought about in public sentiment, as to authorize, by a very large majority of the votes cast at an election held three years later, the levy of $500,000 for the same purpose.

If our Water Works are designed for fire purposes only, the expense of maintaining them, as well as the first cost, must be met by the general tax, regardless of the benefits that may accrue to particular portions of the City, as section 344 of the Municipal Code clearly provides that the Trustees of Water Works shall make no charge for supplying water for extinguishing fires, or cleaning fire apparatus, &c. No revenue can be derived from the operation of Water Works for their maintenance, except for the supplying of water for household and all other ordinary purposes.

Numerous other facts might be cited, and arguments given to sustain us in the belief acted upon, that Water Works for our City would be expected to meet the requirements for protection against fire, and *domestic supply;* but the clearly understood wishes of the people are of such an unmistakable character that further comment on this point is unnecessary.

The motive power by which our City is to be supplied with water, involves the real question in controversy, as the quality of pipe recommended has not been questioned, a difference of opinion existing merely as to the size of the main and some of the distribution pipes, and upon which we shall have more to say when we come to the reasons by which we were induced to recommend the use of nothing smaller than six-inch pipe and a thirty-inch main.

The question as to the first cost of pumping engines is not so important as that relating to the expense of future maintenance; although from the prices charged in other cities by the Holly Company, and the estimate made by Mr. Ketchum for pumping engines on the Holly plan for this City, the first cost of the Holly engines greatly exceeds that of most other kinds of equal pumping capacity. The cost of the Holly machinery in Columbus, exclusive of foundations, was $55,000, and the greatest capacity claimed for it by the President of the Holly Company is three million gallons per day. The estimated cost of the same kind of machinery for this place, with a capacity of four million gallons per day, was $60,000; while our estimate of the cost of a different kind of machinery, including foundations, with a capacity of six millions per day, is only $65,000.

The real utility and duty of engines, and the cost of keeping them in operation and proper repair, are the main questions to be considered in determining the merits of pumping engines, and that system or kind of machinery which combines in the largest degree all of these qualities, is certainly entitled to the preference, and the one possessing the least should be discarded.

In our investigations as to the real merits of Water Works machinery, we have been forced to the conclusion, by proof too palpable for successful contradiction, that the Holly machinery stands very low in point of efficiency, duty and durability, when compared with the Worthington, Henderson and Cornish engines, as well as many others that might be mentioned; but on the other hand experience shows that the Holly machinery is a fruitful source of expense to maintain in anything like good working order.

No weightier or more conclusive testimony is needed to verify the above statements, than the official reports of the authorities in charge of Works in cities where such machinery is in use. In Buffalo, where the Holly machinery has been used for two or three years, we found that the authorities were taking steps to rebuild their works on a much enlarged scale—not by duplicating or supplementing the Holly engines, but by introducing into the pumping service there a Worthington engine, with a capacity of supplying ten million gallons of water per diem. If the practical workings of the Holly machinery in that city had given satisfactory evidence of its efficiency, economy or durability, it is rather remarkable that a different kind of machinery should be introduced for their new Works, is an evidence of the lack of confidence the authorities had in such machinery, as ample time had been given to test it, besides the fact that Buffalo is near the home office of the Holly Manufacturing Company, and this would be strong reason to use such machinery if it were adapted to the wants of that city in furnishing an adequate water supply.

In Columbus the official reports of the Trustees and other officers of the Water Works, show most conclusively that the operation of the Holly Works has not yet proven their adaptability to the wants of that place, while they have been a continual source of expense to keep in proper repair and working condition, as breakages and other disarrangements have been of frequent occurence. The Superintendent of the Works in that city, in his official report for the year ending March 31, 1872, after specifying the various repairs in machinery, concludes with the following words: "Making a total for repairs to machinery and boilers, more than was anticipated or reasonable to expect, from the amount of labor performed. To guard against possibilities and to insure an abundance of reliable power for the future use, a comparatively short time will elapse, ere it will be absolutely necessary to duplicate the pumping machinery." From this language we are to infer that double the amount of machinery will be absolutely necessary to insure an abundance of reliable power "for an adequate water supply" in that city, which would make the first cost of the machinery $110,000, exclusive of foundations for the same. Since the date of said report, measures have been taken for the substitution of other pumping machinery in place of the Holly, which is another evidence of the inefficiency of the latter.

The workings of the Holly system in Dayton, as shown by the official reports of the officers in charge of the Works, have not been of such character as to recommend that system, in point of economy or efficiency, for other cities of an equal size; as the reports show that the repairs on machinery have been both numerous and expensive, the amount paid during the last year being $1,072.86, besides the fact that their machinery has not the capacity to meet the requirements for supplying water, as anticipated for the ensuing year, although the average daily supply for the last year was less than three quarters of a million gallons. The reports contain language as follows: "The necessity for an additional set of machinery cannot be safely or economically postponed." Although the duty performed by the Holly engines in Columbus and Dayton, is not given in the reports, from the data showing the average pressure pumped against, the number of gallons supplied, and pounds of coal consumed, it is ascertained that the maximum duty performed during any of the years, in which they have been in operation, does not exceed thirteen millions; that is, the raising of thirteen million pounds one foot high, by the consumption of one hundred pounds of coal, or *less than one-fourth the duty* required under our specifications for the machinery recommended by us.

The Holly pumps were introduced in the Water Works at Minneapolis, Minn., in the fall of 1867, and a different kind was put in last season to supersede them. Many other places might be named, in which the Holly works have proven unsatisfactory in practical operation, but it is not deemed necessary to multiply facts upon this point. This machinery is so complicated in its construction as to render it liable to become frequently disarranged, besides being inefficient and expensive in its use.

Our reasons for reporting against the Holly system are, that we do not consider it adapted to the present and prospective wants of the City in furnishing a water supply, and that it is too expensive, inefficient and unreliable in its operation to justify its introduction. The amount authorized for the construction of Water Works is too limited to warrant the making of experiments in machinery, when that which has proven to be durable, reliable and efficient can so readily be obtained. We are told that Clapp & Jones, of Hudson, N. Y., have improved on the system known as the Holly, but the agent of that firm, Mr. Richardson, says that "the only thing experimental about their machinery for Water Works is the pump." Shall we, then, invest in this "experiment?"

We have recommended the kind of pumping machinery described in our report to the Council December 28, 1872, for the reason that a thorough test in many cities of the country has demonstrated its superiority as regards simplicity of construction, economy, reliability and efficiency in operation, as well as in point of its durability. Pumping engines of this kind have been in use for supplying water during a period running back about twenty years, in the following cities, viz: Savannah, Ga.; Cambridge, Charlestown and Salem, Mass.; Newark, Jersey City and Rahway, N. J.; Harrisburg, Philadelphia and Norristown, Pa.; Providence, R. I.; Poughkeepsie and Brooklyn, N. Y.; Burlington, Vt.; Portland, Oregon; and Annapolis, Md.; and they are being built for the Water Works in Baltimore, Md., Buffalo, N. Y.; New Bedford, Wobum and Waltham, Mass.; Phœnixville, Pa.; Zanesville, O.; and Bowling Green, Ky. This machinery is highly recommended by those familiar with its workings in the cities named, and it has been subjected to the close scrutiny of professional men in the leading cities of the country, and its merits have become so widely known as to produce a rapid increase in its introduction, during the past few years, into the pumping service for water supply in different cities.

Of this kind of engines, T. R. Scowden, Esq., in his report on Water Works for Newport, Ky., uses the following language: "This much may be said, and is conceded by competent and impartial judges of the performance and merits of machinery, that the Duplex engine for simplicity, cheapness of foundations, reliability, economy of working, and required attendance, is doubtless unsurpassed by any other pumping engine in use." In his annual report for the year 1871, Frederic Graff, Esq., Chief Engineer of the Philadelphia Water Works, in speaking of the workings in that city of this kind of machinery says: "Engine No. 1 has run almost daily since September 19, 1870, giving entire satisfaction; it has not cost one dollar in repairs or additions." In a later report he says the Duplex has given him no trouble, the cost for repairs have been so trifling as scarcely to deserve mention, and that their immunity from accidents, due to their mechanical construction, is such that he is relieved from the anxiety and care inseparably connected with the working of Cornish Engines.

Edward Lawrence, Esq., President of the Works at Charlestown, Mass., says "that the Duplex was adopted after a full and careful examination of the claims of the Cornish and other forms of pumping engines, and after using the Duplex for six years he is so well satisfied concerning its superiority, that he has recently ordered a third engine of the same pattern, but of larger dimensions for the Mystic Works, and that the cost of repairs for the six years had been less than one hundred dollars."

In his annual report for the year 1872, John P. Culver, Esq., Chief Engineer of the Jersey City Water Works, quotes from a previous report made by the Consulting Mechanical Engineer of said Works and himself, as follows: "The Worthington Duplex appears to be the engine destined to supplant the Cornish, and from the date of its introduction its reputation has grown and increased, until now its superiority is generally acknowledged by those most competent to decide. Seventeen years ago three Worthington Engines were put up at Savannah; others of the same kind were erected at Cambridge, in the year 1856, which, under careful trial, excelled every other engine in the country. The Charlestown engines were erected in the year 1864, and their performance is asserted to be the best on record. One has been running at Harrisburg, Pa., almost constantly for ten years with almost no repairs. A noticeable feature and valuable characteristic of the Duplex Engine, is the noiseless way in which it performs its work. There is no concussion, nor even an appreciable jar, in the engine or its attachments. So that from motives of economy, believing that a great saving can be effected, and the work done as well, if not better, than in any other manner, we would give our most emphatic preference to the Worthington Duplex Engines."

Additional testimony could be given to show the superiority of the Duplex engines in furnishing a water supply for cities, but we do not consider it necessary to add anything further on this point, as the practical workings of this kind of machinery in the various cities named, furnish the most potent reasons for their use in preference to any other.

We have recommended the use of a Stand-pipe, because our investigations led us to believe that it would serve as a great safeguard to the pipes, besides serving as a measure of relief to the engines, and to illustrate the correctness of our views on this point we beg leave to refer you to opinions of hydraulic engineers, embodied in this communication.

COMPARISON OF COST.

We have been charged through the press, time and again, with attempting to force upon the City a system of Water Works that would cost $200,000 more in their construction than the Holly, and we desire to notice these statements by comparing the estimate of the two systems, and then leave you to judge whether the figures justify such charges. The estimated cost on the Holly plan, with pumping machinery of four million gallons daily capacity was $500,000; and the estimated cost on the Stand-pipe system with pumping machinery of six million gallons daily capacity is $595,987; which makes the cost, as per approximate estimates of the Stand-pipe system $95,987 in excess of that for the Holly.

Now let us examine the items of said estimates and see if we can account for this difference in cost.

Estimate of Trustees.

Filtering Beds, ...$		60,000 00
Engine House,...		20,000 00
Cost of 5,245 tons of pipe, at $75,......		393,375 00
Engines six millions capacity		65,000 00
For superintendence, &c., ...		20,161 25
By Mr. Ketcham,		Excess of Trustees' Estimate.
Filtering Beds,......	26,000	34,000 00
Engine House, ...	16,000	4,000 00
Cost of 4,816 tons of pipe, at $75,.....	361,200	32,175 00
Engines, 4 millions capacity,.....	*60,000	*10,000 00
Superintendence, &c., ...	*Nothing.*	20,761 25
Total of excess,......		$100,936 25

*In comparing the cost of pumping machinery, an allowance of twenty-five per centum has been added to the cost of the Holly engines to increase their daily capacity from four to six million gallons.

Adding this amount of the cost of excess of materials, labor and increased pumping power of machinery to the estimated cost of the Holly system would make $600,936.25, as the real cost of said system, with machinery of equal capacity and an equal amount of materials with that of the Stand-pipe system, making the cost of the latter $4,949.25 less than the former.

Six-inch supply pipe is the smallest we have recommended, and our reason for so doing is the fact that sizes anything smaller have proven to be of little practical utility in the water supply of cities scattered over a large scope of territory. In many of the large cities where smaller sizes have been used, they have been taken up and discarded, and the advice uniformly given us by men of large experience in such matters, has been to use nothing smaller than six-inch pipe, which is the minimum size now adopted in cities of equal or larger population than Toledo.

The report of our Engineer, Mr. Lane, heretofore submitted to the Council, is so elaborate on the question of pipes, and the relative value in regard to capacity of the various sizes, so clearly defined that we would respectfully refer you to it for further reasons for our action on this question.

PIPES.

The proposed location of the pumping works being so remote from the center of population of the City, suggested to us the importance of providing a principal main of ample size to afford a sufficient amount of water for the distribution pipes in different portions of the City for several years to come, and thereby obviate the necessity for duplicating the mains. The first cost of the thirty inch main, is only seventy per cent. in excess of that of twenty-inch main, while it has a capacity of nearly three times that of the latter; and the cost of the thirty-inch main is only 28 per cent. more than of a twenty-four-inch main, while it has a capacity for supplying water nearly two-fold that of the latter, from which it must appear evident in considering the quantity of water that will be required to meet the varied demand that it would be a matter of economy to use the thirty-inch main in preference to anything smaller.

OPINIONS OF EXPERTS.

As previously stated by us, we were greatly aided in our investigations by the advice given us by our own Engineer, and other eminent Hydraulic Engineers in different places, as to the relative merits of various systems of Water Works in operation, and in arriving at our conclusions as to the system of water supply to be adopted in this City, we relied in great measure upon the information conveyed to us by professional men, and others of large experience, because we believe the opinions and advice of such men entitled to far greater weight in the determination of the question under consideration, than the statements of contractors and others interested in the introduction of particular kinds of machinery. We therefore append copies of the opinions of few Engineers, whose reputations in point of skill and integrity cannot reasonably be questioned, and who are so widely known as to need no other introduction than the mere mention of their names.

HENRY EARNSHAW, ESQ.,

Chief Engineer of the Cincinnati Water Works, says: "My own opinion is, your City is entirely too large for the Holly system."

T. R. SCOWDEN, ESQ.,

Engineer for the new Water Works in Cincinnati, says:

"They (Trustees of Columbus Water Works) employed me as Engineer to investigate and make plans for improvements for additional supply. I made the necessary investigations, surveys, plans and esti mates for Filter Basin, and recommended Stand-pipe and Worthington Duplex Engine as a substitute for Holly machinery now in use. As an Engineer, I estimate the value of any motor for its efficiency, reliability and economy of working. I think if any pumping engine combines the advantages desired, it is the Worthington Engine. I send you my report on Newport Water Works, to which I beg leave to refer you on the subject of Pumping Engine. The other fact bearing upon the question of economy is established by referring to the records of the different Water Works in practicable operation in this country, which will show, by comparison, that the Worthington Engine does the very highest duty, and the Holly the least or lowest."

JAMES P. KIRKWOOD, ESQ.,

Hydraulic Engineer, Brooklyn, N Y., gives his opinion as to the advantages to be derived by the use of a Stand-pipe, in the following language, viz:

"The Stand-pipe is a great relief to an engine of any size, as compared with the dull resistance it would have to encounter in pumping into a column of water two or three thousand feet long or more, whose requirements of delivery might besides be varying every hour. Under such circumstances, you cannot cut off short, you can get little benefit of expansion, but the application of the Stand-pipe changes all that, and the load being transferred to a short column, the engine controls it with comparative ease and can venture on a high, or at least a profitable expansion, with freedom. This tells on the economy of coal, but it tells in a more palpable way on the economy of capital. For instance, at Belleville, (the pumping station of the Jersey City Water Works,) before the Stand-pipe was built, the Cornish Engine there, (see trials by Copeland & Worthen,) made in the first trial 4.8 strokes per minute, and in the second trial 4.5 strokes per minute. After the erection of the Stand-pipe the same engine made 7 strokes per minute; they are now making 8 easily. The Stand-pipe increased the pumping capacity of the engine, besides enabling it to do its work more economically. In this case two engines with a Stand-pipe would do more work than three engines of the same size without the Stand-pipe. Undoubtedly, at Belleville, the Stand-pipe in this sense has more than paid for itself—I mean that two engines and Stand-pipe would cost less than three engines without the Stand-pipe, and do more work. This will be more or less the effect of a Stand-pipe anywhere; but we have generally dwelt upon it more as a measure of relief and safety to the engine, than as besides an economizer of capital."

The following is the opinion of

JOHN BIRKINBINE, ESQ.,

Hydraulic Engineer, Philadelphia, as to the advantages to be derived by the use of a Stand-pipe, instead of pumping directly into and through the mains and distribution pipes:

"The first Stand-pipe erected in this country was a part of a water supply constructed by my father, H. P. M. Birkinbine, for Germantown, (then a suburb of Philadelphia.) This Stand-pipe, erected in 1852, is still in use. Since that time we have erected three in Philadelphia, one at Camden, N. J., one at Erie, Penn., and expect to have one form a part of the new Works now being constructed for Harrisburg, Penn. I have, therefore, had considerable opportunity to examine into the advantage, utility and economy of using Stand-pipes.

"Water-towers or Stand-pipes are used in connection with the water supplies of London, and other large European cities, and in this country may be mentioned, New York, Boston, Chicago, Jersey City, Charlestown, Mass., Erie, Pa. Camden, N. J., and Philadelphia, the latter city having in use six (6) of them. Among the advantages arising from the use of Stand-pipe in connection with a water supply, are the following:

"*First.* In pumping water each stroke of the pumping apparatus produces a wave, which is carried along the pipes until it finds an outlet. Each wave is distinct, although they may follow each other very rapidly, and each wave produces a distinct shock upon the pipes conveying the water from the pumps. (It has been claimed that pumping apparatus moving rapidly, overcomes these shocks by making them a continuous strain. I can best illustrate this fallacy by calling your attention to the jar experienced by a Railroad car crossing slowly a joint in the tracks, as the speed increases the shock is less perceptable, but none the less severe.) By placing a Stand-pipe upon the forcing main the waves created by the pumps exhaust into it, and in it all the oscillations take place, the water flowing from it in a steady and continuous stream at a uniform pressure. The introduction of a Stand-pipe, therefore, relieves the mains from the continuous shocks, and reduces the risk of breakage. It allows the pumping machinery to work freer, and thus saves fuel; and the pipes leading from it will convey a greater quantity of water with less strain.

"*Second.* A reservoir, where it is possible, is a valuable adjunct to any system of water supply—keeping in store surplus water in cases of emergency, and delivering the water at a uniform pressure. Stand-pipes are often used as substitutes for reservoirs, where the latter are impracticable, either for the want of the necessary elevated ground, or the requisite funds for their construction. The Stand-pipes at Erie, West Philadelphia and Germantown, were constructed as substitutes for reservoirs, until the corporations felt at liberty to incur the additional expense. The City of Erie proposes to construct a large reservoir during the coming season, and retain the Stand-pipe for the advantages above mentioned. Of course, the quantity of water contained in a Stand-pipe will not allow of the stoppage of the machinery for any length of time; but it has a great advantage over *direct supply* works, (so called,) in permitting the engine to be stopped long enough to attend to any trifling repairs and packing.

"*Third*. Where the reservoir is connected with the pumping machinery by a long line of pipes, or where the distributing pipes connect directly with the forcing main, a Stand-pipe is a valuable auxiliary. At Camden, N. J., and Kensington, Pa., the pumping machinery discharges into reservoirs by a long line of pipe, and Stand-pipes are placed immediately at the works, in both cases having amply repaid all outlay by the reduction of the risk of breakage and freedom of working the machinery.

"*Fourth*. In pumping water, it is always advantageous to run the machinery at a uniform speed, and have as few sudden fluctuations as possible. There are several patented regulators, of complicated construction, designed to compensate for variable demand; but a Stand-pipe in a more simple manner fully answers the purpose. The most simple forms of pumping machinery can be used in connection with a Stand-pipe, and be made self-regulating. When the Germantown Works were built, in 1852, an alarm bell gave notice of a decrease of pressure from the Stand-pipe. We consider there is not a Stand-pipe in use in this country which is not amply repaying all interest upon its cost, and have so strong faith in the advantages gained, that they are always recommended for pumping works, unless the reservoir is very close to the pumps.

"Being fully aware of the energy and pertinacity used in giving publicity to forms of patented machinery for direct supply works, I am convinced Toledo has been favored with all its claimed advantages. I, however, am free to say that your City will certainly find a Stand-pipe a valuable addition to any system of direct supply it adopts, and by its use will secure the advantage of—

"Free working of machinery and saving of fuel;

"Exhaustion of waves and decrease of risk; and

"A reserve supply sufficient for any ordinary purpose and uniformity of pressure secured by simple arrangements.

"An accident to a Stand-pipe at Jersey City, several years ago, which was owing to defective construction, has been magnified to the damage of what is termed the Stand-pipe system; but you will find a large majority of Hydraulic Engineers unite in considering the Stand-pipe as a great advantage to a water supply."

JOHN B. JERVIS, ESQ.,

Rome, N. Y., who has given the subject of water supply for cities a great deal of attention, and whose opinion as a professional man is entitled to great respect and consideration, defines the advantages of a Stand-pipe as follows:

"As to Stand-pipe in pumping water for the supply of a city, the object is, first, to keep a uniform action on the pumps; and, second, to maintain a uniform pressure on the supply pipes. A Stand-pipe is provided with a waste pipe, to carry off the water at a certain height or pressure. If you pump directly into the supply pipes, you should have a proper waste-cock in some convenient point in your main, that will open and waste when an excess of pressure is on. Water will be used in a city very irregularly, and without some provision to let off above the pressure you want, there would often be such over-pressure as to endanger, and sometimes burst the pipe. This regulating valve should be as near your pump-house as you can have it, so that the man in charge of the pump may see when he is pumping to waste. In the night much less water will be used. If you desire to give your pump extra power at any time as in a fire, you have only to add to the weight on your valve the addition you want, or what you think your pipe will bear. Unless you have some provision of this sort, you will be likely to burst your pipe, especially the service-pipe in buildings.

"The Holly plan profess to regulate by a contrivance which opens or shuts off as the occasion may require, and it is called 'self-acting, or automaton.' This is a very ingenious contrivance of machinery, and I do not like to speak against it. It is very plausible to most men, but I do not regard it as of any practical value. I greatly prefer a good waste-cock that will let off surplus when necessary, and not depend on any apparatus that may disappoint. A Stand-pipe will be an expense, and for moderate size pumps you might get along without it; but if you have large pumps, they will work more steadily, be less liable to get out of order, and give you a regular pressure on your pipes. If you desire a large head or pressure, as in case of fire, then, I would make a connection between the rising and falling main, at such height as would give proper pressure for your ordinary wants. In this cross-pipe put a stop-cock that may be shut when you want the high pressure, and the water will rise to the top and give the pressure you want. Keep in mind this extra pressure should not be allowed to rise beyond the strength of your pipe, either supply pipes or service pipes in dwellings. A Stand-pipe can be arranged as not to have a falling main, by uniting your supply main near the bottom of Stand-pipe.

"For a City like Toledo—present and prospective—I should recommend a Stand-pipe, as the best method I have known, when you cannot have a reservoir of sufficient height. You can work by pumping directly into your supply pipes, being careful to have a good waste-cock that will lift when the pressure is too high. To your City, the cost of a Stand-pipe, with all the provision you need for extra pressure and waste-pipe, is small, compared to the advantage of regularity in pumping and saving in current repairs. Don't fail to have your *pumps made to move slow—large and slow, is much better than small and quick.*"

It may be added, in this connection, that Mr. Jervis was the Engineer who built the Croton Water Works for supplying the City of New York, and he is generally acknowledged to be one of the first Hydraulic Engineers in the country.

E. S. CHESBROUGH, ESQ.,

City Engineer of Chicago, says, in relation to the system recommended by us:

"I think you have devised a very judicious plan. On such a site, it is better to spend the large sums required for satisfactory reservoirs, in duplicating the pumping power, whenever found necessary, such was the conclusion arrived at here fifteen years or more. Our supply has been practically a direct one for a long time, our reservoirs being too small to hold two hours' consumption at present. The Worthington Pumping Engine has now been so thoroughly tested in different cities, that there can be no doubt of its satisfactory performance. With regard to fire purposes—if you make your Stand-pipe 175 ft. high and have distributing pipes of suitable size, (which I am glad to see you recommend,) there can be no doubt of your ability to throw water from hydrants over all ordinary buildings. As to extraordinary ones, they require in other cities extraordinary measures. So far as I can learn, buildings nearly or quite one hundred feet high, when once ablaze, are not extinguished readily, either by hydrants under high pressure, or the most powerful fire steamers, unless the hose be carried to near the top of the buildings on fire or to an adjoining one."

"In this connection, I send you a copy of Mr. Shedd's report on the fire hydrants of Providence. I think it will interest you. The great point in the extinguishment of fires, is to have an abundant supply, under a high pressure, at the hydrants. Whether this pressure should be obtained by means of reservoirs or pumping directly into the mains and distributing pipes, must depend upon local circumstances. The duty of the Engine is to secure the object aimed at, with the least expense, having reference, not merely to first cost, but to future maintenance."

FREDERIC GRAFF, ESQ.,

For several years the Chief Engineer of Water Works in Philadelphia, gave us some very valuable suggestions when we were in that City last fall examining into the question of Water Works, and in acknowledging the receipt of a copy of our report, embodying the report of Mr. LANE, on the question of water supply for our City, Mr. Graff makes use of the following language, viz:

"The printed report sent is before me, and I have looked over it carefully and can fully endorse Mr. Lane in the matter. I am free to say that his views in regard to the rejection of the so-called "Holly System," and the adoption of the Stand-pipe plan with an economical and efficient pair of pumping engines, are sound in every particular, and is the plan I certainly would adopt under similar circumstances."

JOHN P. FREEMAN,
EDWARD MALONE,
CARL SCHON,
Trustees.

J. T. GREER, Secretary.

REPORT OF THE CITIZENS' COMMITTEE.

Gentlemen of the City Council:

At a meeting of your honorable body, held at the Council Chamber, on the 15th day of February last, you adopted a series of preamble and resolutions reciting the wants and necessities of the City in relation to an "economical and efficient supply of pure water, not only for the present, but for the future demands of the City," And in view of the large expense of your Fire Department, and the urgent necessity of its increase within a few years to double its present expense, a system should be adopted for efficient fire protection, as well as for domestic and manufacturing purposes. And in order to gain such information as would enable the Council to adopt such plan as in their judgment will serve the best interests of the City, all things considered, in your last resolution, you declare "that for the purpose of such investigation a committee be appointed, who shall be authorized to visit the principal points where these various systems are in operation, thoroughly investigate the same and report to this Council such facts and information as will enable it intelligently to decide which system will be the best adapted to the present and future wants of our City.

With these objects in view, and fully appreciating the responsibility of the undertaking, your Committee left Toledo on the evening of the 5th inst., and in the course of twenty-three days traveled over three thousand miles, visited twenty-five principal cities and thirteen States.

At most of the points visited, a careful and even critical examination was made of the systems, machinery, size and cost of pipes, capacity of engines, quantity of water pumped daily, expense of raising a given quantity a given height, amount and cost of fuel, and all the other expenses necessary for the performance of a given duty. Also the length of time each had been in operation, the expense of keeping them in repair, their durability and liability to breakage, and consequent expense and danger from failure of supply. At all points we were courteously received, and every facility placed at our disposal for obtaining the information desired. In this connection it gives us pleasure to acknowledge our obligations to Mr. Frederick Graff, of Philadelphia, Mr. J. Herbert Shedd, of Providence, R. I., and others. And while availing ourselves of the information tendered by those having supervision of the works, we also examined the mechanism of the engines, and consulted the operative engineers in charge.

From a careful examination of exhibits, reports, etc., received from financial officers at the various points visited, as also the verbal and detailed statement of engineers and others in actual charge of works, we have arrived at what we deem at least a near approximation as to actual duty of engines, to wit: amount of water pumped, together with actual cost of same. In order to secure a correct comparison between the different systems and kinds of machinery, we have made all our calculations upon a common initial basis, the cost of raising one million gallons of water one foot high. Such a comparison may militate against some of the systems named, owing to difference in quality of coal used, and cost of same, together with other local causes to which we hereinafter refer.

While we have examined several different kinds of pumping engines, we deem it needless to include in this report more than three representative systems. We accordingly give below the cost of raising one million gallons one foot high, at the several points named, by what is known as "Cornish," "Holly," and "Worthington Duplex" Engines.

CORNISH ENGINES.

Erie, Penn., one million gallons one foot high, 10½ cents.
Roxboro, Phil., one million gallons one foot high, 12 7-10 cents.
Schuykill, Penn., one million gallons one foot high, 11 2-10 cents.

HOLLY ENGINES.

Dunkirk, N. Y.,	1,000,000	gallons	one	foot	high,	61	cts.
Columbus, O.,	"	"	"	"	"	22 2-10	"
Dayton, O.,	"	"	"	"	"	47 1-2	"
Covington, Ky.,	"	"	"	"	"	36 1-2	"
Indianapolis, Ind, partly run by water, ...						18 1-10	"

WORTHINGTON DUPLEX ENGINE.

Poughkeepsie, N. Y.,	1,000,000	gallons	one	foot	high,	10 3-10	cts.
Belleville, N. J.,	"	"	"	"	"	8	"
Newark, N. J.,	"	"	"	"	"	8	"
Roxborro, Phil.,	"	"	"	"	"	9 9-10	"
Bellmont, Phil.,	"	"	"	"	"	7	"

RECAPITULATION.

Average cost one million gallons one foot high:
Cornish Engines,......................................11 35-100 cts.
Holly Engines,........ .... 36 8-100 "
Worthington Duplex Engines,..................... 8 64-100 "

In view of the immense excess in comparative cost of operating the Holly Works as shown above, and as these figures, unexplained, would tend to mislead, we deem it just and proper to remark that this system is intended to subserve the double purpose of furnishing water for domestic supply, and also supplant the steam fire engines, and that in thus saving, or mitigating expenses of the Fire Department, it is equitably entitled to corresponding credit, when brought into financial comparison with machinery intended for domestic supply only. Another fruitful cause of the above excess must be found in the fact that most or all of the Holly Works referred to are located at points requiring an amount of water vastly below the capacity of the engines to furnish, while the expense necessarily required in operating the works cannot be correspondingly diminished. For instance, the engines at all points named above, are claimed to be capable of pumping two million gallons per diem, the amount actually required and pumped is but little, if any, in excess of one million; and the first named, (Dunkirk,) is only required to pump 300,000 gallons. With an addition of perhaps not more than fifty per cent. in current expenses, the daily average could be increased to two million gallons.

We are satisfied from knowledge obtained, and the comparison of statistics given above, that for the use intended in our case, there can be little question which engine should be selected. The efficiency of the pumping service of a city, underlies the prosperity, comfort, safety and health of its inhabitants, and such efficiency is dependant to a great extent upon the durability of the engines, and their freedom from accidents; and on these points, in the judgment of your Committee, the Worthington Duplex is the most desirable. In fact, its superiority is generally acknowledged by those most competent to decide; the capacity of pumping machinery for the prospective wants of the City, has also received careful attention. All things considered, it is the unanimous opinion of the Committee, that two Duplex Engines, of the capacity of five million of gallons each, will be the safest, and in the end prove most economical. Should these figures seem large, it should be borne in mind, that the universal experience in this country and elsewhere, is that Water Works for City supply have always been constructed on too small a scale. The demand for water usually very largely exceeds the most sanguine expectation of the projectors and this has been especially true since steam has been so largely used as a motive power for manufacturing establishments; the tendency being to concentrate these establishments in cities, principally on account of the much greater facility of obtaining skilled labor, and receiving and shipping conveniences, and such influences must continue to operate to a still greater extent than heretofore. The desire of your Committee has been, and is, that works of a substantial and permanent character, with a supply of water ample beyond contingency, should be provided for; and nothing expended for ornament.

The question of constructing a small Reservoir, with capacity o about three million gallons, has also been the subject of careful inquiry All engineers, and others who have given attention to the question of water supply for cities, unhesitatingly recommend the reservoir system over all others, where, from the nature of the location, it can be adopted. Toledo is not favored with ground of sufficient elevation on which to construct reservoirs of large capacity, and hence whatever is constructed on that plan, must necessarily be on a limited scale. Wrought-iron tanks are in use in New York, Boston and Cincinnati. In the latter city, two tanks of this description, located on Mt. Auburn, of capacity of 750,000 gallons each, are in use, and we were informed, while there, another one of similar, or greater capacity, is to be erected this year. They serve a good purpose there, and at all other points where used, hence your Committee unhesitatingly recommend the construction of a wrought-iron reservoir tank, to hold not less than 3,000,000 gallons of water, on ground now owned by the City, and convenient to the spot where, in all probability, the pumping works will be erected. This ground is twenty-five feet above the surface of the street at the Post Office, and a reservoir of this description, located there, of, say, seventy feet in heighth, and ninety feet in diameter, will more than contain the quantity mentioned above, and furnish an ample supply for domestic and manufacturing purposes, as well as a reserve for fire and other contingencies. Water from this reservoir, making all needful deductions for loss by friction, depletion through lateral means, &c., will be forced by gravity pressure to any altitude in the City, required for domestic use. An estimate of the cost of construction will be given elsewhere in this report.

The subject of protection from fire through other means than an extensive fire department, has also received the careful and patient consideration of your Committee. The system of pumping directly through the mains on what is known as the Holly plan, for fire purposes, is in use in several of the cities visited by us. At these points we were unremitting in our efforts to become acquainted with actual workings of that system, and after weighing all the available evidence, we are clearly of the opinion that it is not what Toledo wants. There remains but the Stand-pipe system for consideration. With the plan and recommendations submitted to your honorable body herewith, your Committee are of the opinion that the Stand-pipe can be made available in connection with the reservoir for efficient fire protection. A pipe five feet in diameter and 225 to 250 feet in heighth, according to approved authority, will furnish fire pressure in any part of the City, equal to an altitude of 140 to 150 feet above City base line.

On the score of economy, the Stand-pipe, in connection with the reservoir will effect a great saving, by reason of having a receptacle sufficiently large to hold what will be pumped by a slow, regular motion of engine, during the entire twenty-four hours, raising the water to a maximum head of about ninety-five feet for domestic distributions, instead of forcing all the water used for all purposes through a Stand pipe alone of much greater altitude. We therefore recommend the construction of a Stand-pipe of the dimensions given above, an estimate of the cost of which will be found elsewhere in this reply.

While nothing is said in your preamble or resolutions in reference to the filtering process, through which the water taken from the Maumee River must pass before it will be fit for culinary uses, yet this branch of the subject is of such vital importance to the whole system of water supply, your Committee deem it within the province of their duty to examine carefully the processes in use at the several points where filteration is resorted to. The conclusion to which we have arrived is herewith submitted. Since our return, we have examined the ravine easterly from the House of Correction, and find it well adapted to the construction of a subsiding reservoir and filtering beds. This depression or ravine is but little above the ordinary level of the Maumee River, and with comparatively light earth work can be cheaply prepared for the natural flow of water from the river into and through the filtering beds. This plan avoids the necessity of constructing such beds in the River, where they would be more expensive and very much less secure; and also the necessity and expense of raising water by steam into filter beds located above the surface of the River, where, after filteration, would again have to be pumped into the reservoir. In this connection, we also recommend that the pumping engines be located on the northerly side of the River Road, on land belonging to the City, and connected with the filtering well by a conduit or suction main.

Without deeming it necessary to enter into a detailed estimate of cost of construction, we give you herewith what we consider a sufficiently near approximation, as follows:

One wrought iron reservoir, complete,	$ 60,000
One Stand Pipe,	10,000
Two Worthington Duplex Engines, in place,	95,000
Engine House,	20,000
Pipes, Hydrants, Superintendence, &c.,	440,000
Total,	$685,000

These estimates, we regret to say, materially exceed the appropriation set apart for this purpose, yet we are unanimous in the belief that the interests of our City, present and prospective will be better subserved by what may seem a burthensome outlay, than by the adoption of a policy, engendered by a mistaken financial economy and a misconception of the rapidly growing requirements of our people.

In recommending the construction of a Stand-pipe in connection with a reservoir for fire protection, the design is to use the pressure through the pipe only in case of fire. At all other times the pipe will be kept full of water, so that when the alarm of fire is given the pumping machinery may be turned into the Stand-pipe and the extreme pressure kept up during the continuance of the fire; or, in other words, to use the Stand-pipe for fire-pressure only. It can, however, be used for domestic or other purposes if necessary.

All of which is respectfully submitted for the consideration of your Honorable Body, trusting that commensurate good may grow out of the protracted investigation of the undersigned.

J. S. NORTON,
J. D. COOK,
H. A. BOYD,
JOHN T. MAHER.

TOLEDO, March 31, 1873.