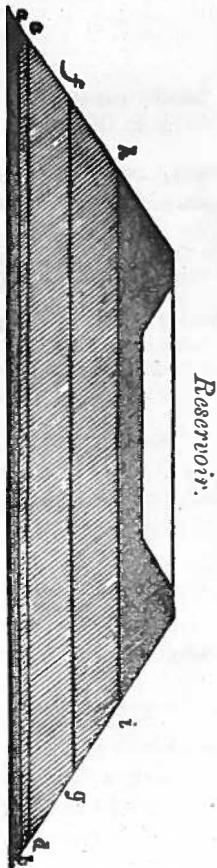


ENGINEER'S REPORT
 TO THE
TRUSTEES OF WATER WORKS,
 OF THE
CITY OF CLEVELAND.



The above cut represents a cross section of the Earth Embankment Reservoir referred to in the Report, with relative levels of the ground upon which the artificial Embankment is to be raised.

- a-b.* Level of ground at Sterling Avenue and St. Clair Street.
 - c-d.* Level of ground at Sterling Avenue and Superior Avenue.
 - f-g.* Level of ground at Sterling Avenue and Euclid Street.
 - h-i.* Level of ground at Prospect and Kentucky Streets, Ohio City.
- The bottom of the Reservoir is 14 ft. above *h-i*, 45 ft. above *f-g*, 73 ft. above *c-d*, and 84 ft. above *a-b*, surface of table land.

It is considered by some of the best informed practical Engineers in the country, that an embankment of loose material could not be constructed to safely support the weight and lateral pressure of 5,000,000 gallons of water at any of the elevations above the natural surface represented in the cut, but at the elevation above *h-i*, Ohio City summit level.

NOTE.—The City Council and Trustees have adopted the third plan to locate in Ohio City, in conformity to the report of the Engineer.

WATER WORKS—ENGINEER'S REPORT.

CLEVELAND, June, 1853.

To the Trustees of Water Works:

GENTLEMEN:—In accordance with your instructions I herewith submit a report, with plans and estimates, giving the character, capacity, and comparative cost of constructing Water Works, on three different plans, for the city of Cleveland.

FIRST PLAN.

It is contemplated in the first plan to construct a Reservoir, Tower and Tank, to contain 1,000,000 gallons of water, (as proposed in a former report,) to which is appended estimates of the additional cost of the same works, growing out of the since advanced prices of iron, including the additional cost which results from changing the locality for Reservoir-Tower and Engine-House, as designated in the former report, to a proposed site at the intersection of Sterling Avenue and Euclid Street, for the Tower, and the foot of the Avenue, on the Lake shore, as a site for Engine House.

I would here state that the estimates of cost in my former report were based upon \$50 per ton for iron pipes. The advance of \$10 per ton for iron has since increased the price to \$60 per ton for water pipes. And the following estimates are based upon the latter price.

So far as iron goes into the construction of water works, as relates to the former report, the cost has been affected in the amount of—

1995 tons of Iron, at \$10 per ton advance,-----	\$19,950 00
Estimated cost of water works in former report,	380,760 60

Total, and additional cost by advance of Iron,	\$400,710 60
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ADDITIONAL COST OF WORKS ON THE SAME PLAN BY EXTENSION.

In the former report on the first plan the estimates are for 4,400 feet of 16-inch supply main, extending from the Public Square to the intersection of Frontier and Euclid Streets. To which 2,500 feet are here added to extend the main to the intersection of Sterling Avenue and Euclid St. Also 1,400 feet additional 24 inch pump main, extending from the Engine House at the lake to the Reservoir Tower.

Supply-main 2,500 feet, 16 inches diameter, weighing 165 lbs. lineal, (206½ tons at \$60 per ton,)-----	\$12,375 00
Lead and labor to lay, per foot \$1 24,-----	3,100 00
Two stop-cocks, 16 inches diameter, at \$200,-----	400 00
Pump-main, 1,400 feet, 24 inches in diameter, weighing 300 lbs. lineal, (210 tons at \$60,)-----	12,600 00
Lead and labor in laying-----	2,150 00
Cost of extension,-----	\$ 30,625 00
To which add cost of works,-----	400,710 60
Total cost of works extended,-----	\$431,335 60

SECOND PLAN.

Cost of constructing an earth embankment Reservoir considered for three different sites, including the site proposed to construct a Reservoir at the intersection of Sterling Avenue and St. Clair Street.

The Reservoir estimates are made for the construction of earth embankments and all appurtenances belonging, to retain 5,000,000 gallons of water. Considering the nature, tenacity, and weight of the material of which the embankments will be formed, together with the form of construction and quantity of earth employed for retaining water, the proportions and form given are strictly due

to the head and lateral pressure of the water to be supported and retained.

The embankment slopes are $1\frac{1}{2}$ to 1 on the outside, and $1\frac{2}{3}$ to 1 on the inside (see drawings.)

When the Reservoir is full, the solid embankment will support a weight of 20,500 tons, and the retaining embankments resist a lateral pressure of 6,500,000 lbs., a force exerted which tends to dis-rupture the work, and to be met by a resistance which consists entirely in sufficiency of earth material and proper form of embankments to oppose the force exerted.

In making these estimates the calculations are based upon one uniform hight for the surface of the water in the reservoir at its maximum depth above the surface of the water in Lake Erie, which hight is 155 feet from surface to surface.

While investigating this subject, it may not be out of place to state—that, in view of economy of construction, some have urged the propriety of placing the reservoir at less altitude than specified, viz: 67 feet for head of water above the summit grounds at the Public Square. But the saving, if any, would be more than lost again by an unavoidable expense for enlargement of the whole system of pipeage, as a consequence of such change to insure an ample supply of water under less head, and the expense so incurred, I am convinced would be greater than the anticipated saving (by the change) would effect. Another serious drawback would result from the loss of head and supply of water to higher districts, tending to destroy the efficacy of the works, especially with reference to the largest population who seek a residence in the high districts, where there may always be found, in any city, the more respectable class of citizens, and better residences. To such a population the benefits of water supply are estimated from its abundance and unrestricted use as a source of personal cleanliness and comfort, as well as an element of health, from the free indulgence in the bath, aside from its manifold applications to the various purposes of domestic life,—the enjoyment of which one-half of the entire population would be deprived by a diminished head of water. By the original plan proposed to you as the best, an ample, uniform head of 67 feet above the high districts will furnish a sufficiency of water for extinguishing fires, and for every other useful purpose whatever, that the wants of the people may require.

RESERVOIR AND GROUNDS.

The reservoir embankments have 20 feet high, to contain 15 feet depth of water when full; terrace 15 feet wide; base of outside slope 30 feet; base of inside slope 35 feet; whole base of retaining embankment ~~70~~⁸⁰ feet; sectional area ~~1,500~~^{1,550} feet; mean length of embankments, 1,150 feet.

Solid yards in embankments, 63,925, at 40 cts.,	\$25,570 00
Brick paving edgewise inside slope, 225,000, \$6 laid,	1,350 00
Brick paving flatwise, bottom reservoir, 175,000, \$6 laid,	1,050 00
Material for puddle, and for labor inside of reservoir previous to paving,	1,500 00
Reservoir appurtenances, consisting of stop-gates, connections, draw-pipes, strainers, etc.,	5,000 00
Grading and graveling terrace walk,	150 00
Terrace iron fence on embankment, 550 feet lineal, \$2 per foot,	1,100 00
Turfing on slopes to prevent embankments from washing by rain, 5,910 superficial yards, 20 cts.,	1,182 00
Flight of stone steps and siding, 31 steps, \$4,	124 00

Total cost, retaining embankments and reservoir appurtenances,

\$37,026 00

SOLID EMBANKMENT.

Supporting embankment, formed of solid earth, for elevating the reservoir, to give 60 feet head at the Sterling lot, on the north-west corner of Sterling Avenue and Euclid street.

Vertical height of solid embankment 45 feet.

Cubic yards, 301,207, at 40 cts.

\$120,482 80

Turfing 15,652 superficial yards at 20 cts.

3,130 40

For 67 stone steps and sides at \$4

268 00

For 2,150 feet lineal paling enclosing fence at \$1 00

2,150 00

Lot for reservoir grounds is estimated to have 20 feet margin all around the embankment slope for setting out shade trees and for a promenade walk, and the enclosing fences to be placed directly on the boundary lines.

\$126,031 20 \$37,026 00

Amount brought over, \$126,031 20 \$37,026 00
 Lot containing $7\frac{1}{100}$ acres at \$4000 00 .. 30,840 00

Total cost of solid embankment and lot..... 156,871 20

NOTICE.—Nothing is allowed for contingencies.

Omitting the Reservoir Tower in the first plan, cost estimated at \$64,425 76, and including the lot required, 4 acres, at \$4,000 00, \$16,000 ; making \$80,425 76 for tower and lot, to be deducted from cost of whole works on the first plan estimated to cost extended \$431,335 60, and the remainder, \$350,909 84, to be added to expense of earth embankment reservoir, solid embankment, and grounds, gives the total cost of works on the second plan, the reservoir situated on Mr. Sterling's lot..... 350,909 84

Total cost of works on the second plan..... 544,807 04

NOTE.—Dr. Ackley's lot at the summit was found to be on a level with Mr. Sterling's ; consequently no estimate was made for Prospect street lot.

CONTINUED.

Estimate of the cost of constructing works on the second plan with reservoir situated at corner of Sterling Avenue and Superior Avenue. Difference in elevation 28 feet less altitude than the Sterling lot.

Additional solid embankment to that estimated for the Sterling lot, 296,388 cubic yards at 40 cents \$118,555 20
 Turf for additional embankment, 11,988 superficial yards at 20 cents 2,397 60
 For 41 additional stone steps and siding at \$4 00 164 00
 For additional ground $1\frac{4}{100}$ acres at \$4,000 4,160 00
 For additional enclosing fence, 336 feet, at \$1 00..... 336 00

Cost of additional embankment, lot, &c..... \$125,612 80

To which add cost of work on second plan..... 544,807 04

Total cost of works..... \$670,419 84

Estimate of the cost of constructing works on the second plan with a 5,000,000 gal. capacity reservoir, situated at the corner of Sterling Avenue and St. Clair street.

Additional solid embankment to that estimated for reservoir on corner of Superior Avenue and Sterling Avenue. Difference of elevation 11 feet.

Solid embankment 141,288 cubic yards at 40 cents	\$ 56,515 20
Turf for additional embankment, 5,007 superficial yards at 20 cents	1,001 40
For 16 additional stone steps and siding at \$4 00	64 00
For 1 acre additional ground at \$4,000 ...	4,000 00
For 264 feet additional enclosing fence at \$1 00	264 00
	<hr/> \$61,844 60

To which add cost of first embankment reservoir in second plan and additional solid embankments to make the altitude and quantity of material for a reservoir as here estimated.

First at Euclid street and Sterling Avenue ; for reservoir retaining embankments, &c., &c.	\$ 37,026 00
Solid embankment for same	156,871 20
Solid embankment for reservoir at Sup'r Avenue and Sterling Avenue	125,612 80
	<hr/> 319,510 00

Cost of reservoir	381,354 60
To which add cost of works, on the first plan, excluding reservoir, tower and grounds	350,869 84
	<hr/> \$732,224 44

THIRD PLAN—OHIO CITY.

Estimate of the cost of constructing works with the Engine House and an earth embankment reservoir, situated in Ohio City. The reservoir to contain 5,000,000 gals. of water, as for the Second Plan, and to be situated on the south-east corner of Kentucky and Prospect streets.

The locality selected for Engine House, is a lot on the south side of old river bed, at the foot of Kentucky street. The water

to be procured from the Lake by Inlet pipe as by the First Plan, and conveyed by Tunnel under the railroad through a brick aqueduct, passing around the west end of old river bed, and extending eastward to the Engine House, at the foot of Kentucky street, where the water will be taken up by the pumps and forced into the Reservoir. By this expedient, crossing under the old river bed would be obviated, and access could at all times be had to the aqueduct, to make any examinations or necessary repairs. In addition to which the expense of preparation and excavation in the construction of foundations for Engine House would be considerably diminished as compared with the expense attending the same work on the First Plan.

During the course of my examination I remarked that the Lake was quite rough from the effects of a high north-west wind, and that at the particular point designated for obtaining the supply of water, the Lake was not discolored at a greater distance than 100 feet from the shore ; while the water for several hundred feet from the shore fronting both Cities, further east, was very much discolored. With reference to source of supply and purity of water, I am more favorably impressed with this point than any I have examined.

I should not perhaps omit to mention that the immediate proximity of old river bed to the Engine House affords excellent facilities for the delivery and storage of Coal from the Canal. And I may note that the reservoir grounds chosen are 31 feet higher than the greatest elevation found on the Cleveland side for a Reservoir.

The reservoir (by this plan) will be so remotely situated from densely populated districts of Cleveland that it will be necessary to lay a 20 inch supply main, taking its rise at the reservoir on the corner of Kentucky and Prospect streets, and extending north on Kentuckystreet to Detroitstreet. Thence on Detroitstreet and River street on the Ohio City side ; crossing under the bed of the Cuyahoga River into Superior street, Cleveland, extending to the east side of the Public Square. Then diminish to a 16 inch pipe to extend to Erie street, to make connections with the various lines of distribution as proposed in the First Plan.

The supply main crossing under the river to be made of very heavy wrought plates, riveted. And the river to be dredged to form a trench to sink the pipe 3 feet below the bottom of the river. The crossing under the river is the most objectional feature in the construction of works on the Third Plan. The supply main may be subject to accident from the continued navigation of the river; the sinking of vessels on the pipe, and from anchorage, &c., which will require great care and permanent work in laying the pipe, to perfectly protect it from accident.

The supply main would have no pipe connection with it, nor be tapped until after passing under the river with a view to use it exclusively for supplying Cleveland with water. And for Ohio City a 20 inch independent branch would be laid (in connection with the reservoir) diminishing to 16 inches diameter for attaching a supply main to furnish the latter place with water. Both cities would be provided with an independent supply main to connect or disconnect at pleasure.

APPENDIX A.

ESTIMATE OF COST OF CONSTRUCTION.

For earth retaining embankment and reservoir appurtenances.....	\$37,026 00
Solid embankment 14 feet high, 73,534 cubic yards at 40 cents.....	29,413 60
Reservoir Ground $4\frac{42}{100}$ acres at \$4,000.....	17,680 00
For 1778 feet of Enclosing Fence \$1.....	1,778 00
<hr/>	
Cost of Reservoir and Grounds.....	\$85,897 60
Lot for Engine House,.....	10,000 00
For 300 feet of Inlet pipe in the Lake, and 1,200 feet Brick Aqueduct, are estimated to cost as much as 1,000 feet of Iron Aqueduct pipe and laying in the Lake on the First Plan.....	\$20,470 00
For Engine House and Foundations.....	18,068 75
For Pumping Engines (Cornish) and stand pipe.....	67,640 00
For furnace and chimney-stack.....	2,951 00
For 2700 feet of 24 inch pumps main 405 tons at \$60.....	24,300 00
<hr/>	
	\$133,429 75 \$95,897 60

Amount brought over,	\$123,429 75	\$95,897 60
For lead and labor for laying at \$1,50 per ft. 4,050 00		
For 8,300 feet of 20 inch supply main 830 tons at \$60.....	49,800 00	
For lead and labor for laying at \$1,40 per foot.....	11,620 00	
Extra expenses in crossing under river....	2,000 00	
For 8-20 inch stop cocks at \$300.....	2,400 00	
For 1,400 feet of 16 inch main 115½ tons at \$60.....	6,930 00	
For labor and lead for laying.....	1,736 00	
For 3 stop cocks 16 inches in diameter at \$200.....	600 00	
For 4,990 feet 10 inch main 170 tons at \$60.....	10,200 00	
For labor and lead for laying at 50 cents per foot.....	2,495 00	
For 4,870 feet 8 inch main 130 tons at \$60	7,800 00	
For labor and lead for laying at 45 cents per foot.....	2,191 50	
For 18,110 feet of 6 inch main 330 tons at \$60.....	19,800 00	
For lead and laying per foot 37 cents.....	6,700 70	
For 25,860 feet of 4 inch pipe 300 tons at \$60.....	18,000 00	
For lead and labor for laying per foot at 30 cents.....	7,758 00	

\$287,510 95

Stop Cocks, Fire Hydrants, &c., &c., for 200 Fire Hydrants at \$30.....	\$6,000 00
For 10 stop cocks 10 inches diameter at \$75.....	750 00
For 10 stop cocks 8 inches diameter at \$65	650 00
For 55 stop cocks 6 inches diameter at \$40	2,200 00
For 104 stop cocks 4 inches diameter at \$30	3,120 00
For boxes and covers for 174 stop cocks at \$5.....	870 00
For handling, draying and labor in construction of works.....	10,000 00
	<u>\$23,590 00</u>

\$396,998 55

For contingencies and superintendence add 10 per cent. 39,699 85

\$436,698 40

APPENDIX B.
COMPARATIVE COST.

The construction of Water Works with Engine House and earth embankment Reservoir of 5,000,000 gallons capacity, situated in Ohio City, according to the foregoing estimates, would cost \$5,362 80 more than Works on the first plan, with Reservoir, Tower and Tank of 1,000,000 gallons capacity, on the Sterling Lot.

And \$108,109 64 less than Works with earth embankment reservoir of 5,000,000 gallons capacity, situated at the corner of Sterling Avenue and Euclid street.

And \$233,721 44 less than Works with reservoir similar in character and capacity to the last mentioned, situated at the corner of Superior Avenue and Sterling Avenue.

And \$295,526 04 less than Works with reservoir the same as last mentioned, situated at the corner of St. Clair street and Sterling Avenue.

APPENDIX C.

Cost of Water Works on first plan, with Reservoir, Tower and Iron Tank, situated on the corner of Sterling Avenue and Euclid street, \$431,335 60.

Cost of Water Works on second plan, with earth embankment Reservoir of 5,000,000 gallons capacity, situated same as Reservoir Tower, \$544,807 04.

Cost of Water Works, same plan, Reservoir situated at the corner of Sterling Avenue and Superior Avenue, \$670,419 84.

Cost of Works on same plan with earth embankment Reservoir of same capacity, situated on the corner of Sterling Avenue and St. Clair street, \$732,224 44.

Cost of Works on the third plan, with Reservoir situated on the corner of Kentucky and Prospect streets, Ohio City, \$436,698 40.

In the event of locating the Engine House and Reservoir in Ohio City, the Reservoir grounds (to be appropriated) as designated in the report on third plan and accompanying plot of town lots, includes all the ground within the following boundaries: Duane street on the east, Kentucky street on the west, Prospect street on the north, and Woodbine street on the south.

Respectfully submitted,

THEO. R. SCOWDEN,
Engineer.