# FINAL REPORT

TO THE

# Trustees of the Covington Reservoir,

WITH AN

# APPENDIX.

BY

G. BOUSCAREN,

CHIEF ENGINEER.

August 1st, 1891.

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# INDEX.

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— OF THE —

## CHIEF ENGINEER

— TO —

# The Trustees of the Covington Reservoir.

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*To the Trustees of the Covington Reservoir :*

GENTLEMEN:—The works undertaken under your management for supplying the City of Covington with water from the Ohio river, are now completed and in successful operation. As the Chief Engineer for these works, I have the honor to submit for your information and consideration, the following report :

## GENERAL REMARKS.

Leaving out of consideration the Licking river, which is a comparatively small stream draining a thickly populated country, the Ohio river is the only available source of water supply for the City of Covington.

The old works, built in 1870, being located below the mouth of the Licking, at a point where the Ohio river water is contaminated by the sewerage and surface drainage of the greater part of the Cities of Cincinnati, Covington and Newport and of adjoining villages, furnished a quality of water entirely unfit for domestic usage. The capacity of the pumping plant was inadequate to the present demand. Being of old design and very much worn, the machinery was expensive to operate and subject to frequent stoppages for repairs, during which the city was entirely deprived of water. The direct system being applied without stand pipe or a reservoir of any kind, the distribution of water was very imperfect, and the effective pressure very low and irregular,

owing to the presence of a very large quantity of mud and sand in the pipes.

Such was the condition of affairs when the construction of a new plant was decided upon.

The essential features of the new plant were to be:

1st.—An intake above all local source of contamination in the Ohio river.

2nd.—Clarification of the river water by subsidence in a reservoir of about one hundred million gallons capacity.

3d.—Capacity of plant for a daily supply of twenty million gallons by subsequent additions to the machinery *only*.

The new plant is composed mainly, of a pumping station on the Kentucky shore of the Ohio river above the city, of a system of reservoirs on the highlands dividing the valleys of the Licking and the Ohio, and of pipe lines connecting the pumping station with the reservoir and the reservoir with the distributing mains of the city.

The entire plant has been constructed substantially in accordance with the description given in the progress report addressed to your Board, dated February 8th, 1888. No material departure has been made from the plans and specifications of the contracts for the different parts of the work.

## RESERVOIR.

### DESCRIPTION—BASINS.

The Reservoir is located on the Licking side of the divide between the Ohio and Licking rivers, and between the Alexandria and Highland pikes, at a distance of about 3,800 feet from the pumping station.

It is composed of three basins formed by the construction of an earth dam below the fork of a ravine and of two partition dams, also built of earth, across each prong of the ravine. The curbs of the two upper basins are on the same level and are 25 feet above the curb of the lower basin.

The two upper basins, known as the North and South basins, act as settling basins; they receive the water from

the pumping station through inlets at their upper ends, and feed the lower basin alternately through floating tubes, taking the clarified water a few feet below the surface, near the partition dams.

The water supply for the city is taken from the lower basin, also by a floating tube near the lower dam. In this manner the water delivered to the city undergoes two processes of clarification by subsidence.

The arrangement of the pipes and valves is such as to allow the lower basin to be filled directly from the pumping station, and the city to be supplied directly from either of the upper basins, and either of the three basins to be cleaned without interrupting the service of the others.

The general dimensions and the capacities of the three basins are as follows :

| | NORTH BASIN. | SOUTH BASIN. | LOWER BASIN. |
|---|---|---|---|
| Elevation of curb above high water of 1884 in Covington,... | 304.83 feet. | 304.83 feet. | 279.83 feet. |
| Elevation of curb above floor of new pumping station,..... | 300.61 feet. | 300.61 feet. | 275.61 feet. |
| Elevation of "low water" in basin below curb..... | 35 feet. | 35 feet. | 40 feet. |
| Length of Floating Tube ..... | 29 feet. | 29 feet. | 35 feet. |
| Maximum depth of basin below curb..... | 46 feet. | 46 feet. | 47 feet. |
| Minimum depth of basin below curb ..... | $16\frac{4}{10}$ feet. | $21\frac{3}{10}$ feet. | 35 feet. |
| Surface inside curb line..... | 245.093 sq. ft. | 270.305 sq. ft. | 212.575 sq. ft. |
| Capacity in gallons from curb level ..... | 35.299.200. | 41.448.700. | 34.783.700. |
| Capacity in gallons from a plane 5 feet below curb level..... | 26.622 200. | 31.970.100. | 27.368.800 |

Total capacity below curb for the three basins, 111.531.600 gals.
Total capacity 5 feet below curb for the three basins, 85.959.100 gals

The basins are graded to a uniform side slope of 1 vertical to 3 horizontal and a bottom slope of nearly 4 ft. in a 100 feet.

Their figure in plan is a combination of circles and straight lines, such as would fit most closely in each case, the natural contours of the ground.

### BERME ROAD AND SURFACE DRAINAGE.

Each basin is entirely surrounded by a MacAdamized drive-way or berme road 12 feet wide, on the outside of which a paved ditch collects all the drainage water from the grounds and roads and conducts it below the lower dam to a culvert under the Alexandria pike, which empties into Three Mile Creek.

The berme roads of the upper and lower basins are connected by ramps of about 9 feet in 100 feet gradient, they also connect with the Alexandria and Highland pikes by McAdamized roads of about the same gradient.

With the clarification of the water and the exclusion of the surface drainage, two other conditions of great importance were to be realized in the construction of the reservoir, viz:

That the basins should be as nearly as practicable, water-tight.

And that adequate means should be provided to clean them promptly and with little expense.

The first condition could be realized in two ways:

*a* By revetting the entire surface of the excavated basin with a puddle covering and protecting the same with dry paving.

*b* By dispensing with the puddle covering and making the paving revetment of a superior grade of masonry laid in cement.

The estimated costs of the two plans were about the same. The objections to the first method were:

1st—Scarcity of good puddling material on the reservoir grounds.

2nd—The large increase in the quantity of material to be excavated for the grading of the basins if their capacity was to be preserved, or otherwise a sacrifice of about fifteen per cent of their capacity, for the space occupied by the puddle. For these reasons the second plan was adopted.

REVETMENT.

The side slopes are revetted with sand stone blocks, 12 inches thick, laid in cement on a foundation of broken stones 12 inches deep. This paving extends from the curb line to the low water level 35 feet below the curb for the two upper basins, and to an elevation of 15 feet below the curb for the lower basin. The side slopes below these levels, as well as the entire surface of the bottoms of the three basins, are revetted with concrete plastered over with a covering of Portland cement mortar.

This method of construction has been entirely successful, the leakage from the basins is imperceptible, no sign of back pressure from water behind the revetment when the basins are emptied rapidly, has been observed, and the spring hydrants which had been designed for the relief of this back pressure were dispensed with as unnecessary.

The sand stones used for the paving revetment was procured from quarries on the Ohio river near Portsmouth, Ohio; it is mostly of the light buff colored variety, and has so far, without a sign of failure withstood the severe ordeal of exposure to which it is subjected from the fluctuation of the water level in the basins during winter.

All the limestone used for the ditch paving, the concrete, the road metal and the broken rock foundation of the paving revetment, has been supplied from the excavation for the basins.

All the domestic cement used, was furnished by the Louisville Cement Association, it was all tested before shipment.

The Portland cement, used exclusively for pointing and

plastering, was mostly of the Shifferdecker German brand, it was not tested as a rule, but was found to be of uniform good quality.

CLEANING.

The means adopted for the rapid cleaning of the basins without interruption to the service, and with a small outlay, consist in a pressure pump, supplied either from the lower basin, or from the influent pipe from the pumping engines ; it delivers water under a pressure of 150 pounds per square inch into a line of six inch pipe laid in the center of the berme roads, around the three basins. Four-inch branches connect this pipe with hydrants located inside the curb of the basins at a distance of about 400 feet apart. With an ordinary fire hose 200 feet long, 1¼ inch nozzle, screwed on to these hydrants, eight men will clean a basin in two days, or the operation can be done in *one day* with a double crew.

INLETS.

The influ nt pipe delivers the water into the two upper basins through a 30 inch elbow 2 feet below the curb level, in a masonry chamber from whence it flows in cascade into the basin.

A groove in the side walls of the inlet chamber allows the attachment of a weir trough. A weir trough built of iron has been connected to the inlet chamber of the north basin, for the purpose of measuring the quantity of water delivered by the pumping engines during the duty tests, and has been left in position for future use in testing the performance of the engines from time to time.

The direct inlet into the lower basin, which is only intended to be used exceptionally, is also through a 30 inch elbow near the bottom of the basin.

OUT-LETS.

The outlet for each basin is formed of two openings, one 18 inches in diameter flush with the lowest part of the bottom, is covered with a bell valve which is raised by a hand

crane from the top of the outlet pier to let out the mud when the basin is being cleaned.

Another opening on top of the outlet pier is formed by the flanged end of a 30 inch pipe, over which is bolted the fixed elbow of the floating tube.

### FLOATING TUBES.

The floating tubes are riveted sheet iron pipes ¼ inch thick, 30 inches in diameter, each tube is bolted at its lower end to a cast iron elbow revolving around a horizontal axis, and fitting into the fixed elbow of the outlet pipe through a cup-leather ring, which forms a water-tight joint. The upper end of the pipe is capped with a screen drum, built of "1 x 1" angles ¼ inch apart. A cylindrical float of riveted sheet iron 5 feet in diameter, is securely fastened to the under side of the floating tube, and has sufficient buoyancy to keep the screen drum always out of water unless it is purposely submerged by drawing on the chain fastened to the end of the tube, which passes around a sheave anchored to the masonry revetment of the basin. The chain is operated by a hand crab located on top of the dam.

The lengths of the floating tubes are

| | |
|---|---|
| For the upper basins - - - | 29 feet. |
| For the lower basin - - - | 35 feet. |

### OVERFLOW.

In addition to these outlets, the lower basin has an overflow weir 6 feet wide and three feet deep from the curb, the object of which is to guard against the possibility of overflowing the crest of the dam, in case of the inflow from the upper basins becoming unmanageable by reason of the floating tube and stop valve being both out of order at the same time.

### DAMS.

The dams are built of selected material from the excavation of the basins.

They have a front slope, next to the water, of 3 horizon-

tal to 1 vertical, and a back slope of 1¾ to 1, they are 15 feet wide on top and the partition dams have an offset or berme 30 feet wide on a level with the curb of the lower basin. They are built without a core wall of masonry or puddle, but with a puddle fronting increasing in thickness from 3 feet at the top to about 20 feet at the base, penetrating through the clay formation of the bottom and sides to the blue shale.

The general dimensions of the dams are as follows:

| | H'ght. | Length. | Width bet. Foot of Slope. |
|---|---|---|---|
| North Dam, | about 53 | 355 ft. | 335 ft. |
| South Dam, | | 345 ft. | 335 ft. |
| Lower Dam, | | 325 ft. | 285 ft. Increased to about 400 ft. by the waste bank. |

ARCH CULVERTS

The arch culverts under the dams, containing the pipes and valves for the distribution of the water, are built in trenches excavated into the solid blue shale and lime stone.

Their general dimensions are as follows:

| | Width. | H'ght. | Length. | Material of Arch. | Side Walls. |
|---|---|---|---|---|---|
| North Culvert, | 6 feet. | 6 feet. | 182 feet. | Limestone. | Limestone. |
| South Culvert, | 6 feet. | 6 feet. | 182 feet. | Brick. | Limestone. |
| Lower Culvert, | 12 feet. | 8 feet. | 207 feet. | Sandstone. | Limestone. |

They are all paved with an invert of concrete finished with a plastering of Portland cement mortar.

The shafts giving access to the lower ends of these culverts are of brick masonry for the upper culverts, and of sandstone masonry for the lower culvert. The upper shafts are 12 feet in diameter and 35½ feet deep, from the floor of the shaft house to the invert of the culvert. The lower shaft is 16 feet in diameter and 34 feet deep. The valves are operated from the floor of the shaft houses.

Both upper culverts drain into the lower culvert, through 8 inch cast iron pipes laid in the bottom of the lower basin under the concrete revetment. The lower culvert drains

through a pipe of the same size into a catch basin below the lower dam, which collects also the discharge from the 18 inch flush pipe, and from the spill ways carrying the surface drainage.

No sign of slips or seapage is observable in the dams, a slight depression in the revetment on the slope of the north dam, is the only indication of any settling in the material of the dams. The small leaks through the head walls of the culverts where they are traversed by the 30 inch pipes, which appeared when the basins were first filled with water, are steadily decreasing and will probably disappear entirely when the pores of the concrete are filled by silting.

### SODDING.

The back slopes of the dams as well as the front slopes of the side fills adjoining the basins, have been revetted with blue grass sod laid on a 3 inch bed of the black soil saved for that purpose from the stripping of the dam and basin sites. Such of the excavation slopes as needed immediate protection, have been treated in a like manner.

The flat surfaces of the side fills, with a few exceptions, have been covered with black soil and sowed in grass last winter, the grass has taken a good stand everywhere and could only be injured now by a protracted drouth, but this can be averted by sprinkling, making use for that purpose of the pump and hydrants designed for flushing the basins.

The excavation slopes which are not sodded are all in the hard stratified material, their inclination being less than 1 to 1 sodding would not stand on them, they should be protected eventually by revetments of dry paving, as the frost will gradually disintegrate the stratified material.

The platforms of the side fills which could not be sowed in grass by reason of being occupied with the limestone waste remaining from the excavation of the basins, should receive the same treatment as the others as soon as the stone has been disposed of.

PIPE SYSTEM.

The influent pipe is a continuation of the force main, from the stand pipe in the west end of the tunnel under the Highland pike, where from an elevation of 7 2-10 feet above the curb level of the upper basins, it follows the contour of the point between the two basins with a continuous descending grade, ending at the cascade inlet to the south basin 6 feet below the curb level. It is supported across the side fills by rubble walls carried down to the original surface of the ground. The length of the influent pipe from the stand pipe to the inlet of the south basin is 2,258½ feet, the influent branch to the north basin is 53½ feet long, the influent branch to the lower basin is 333½ feet long.

The pipes connecting the upper basin with the lower basin and with the supply pipe for the city, are supported on concrete blocks on the inverts of the culverts. Outside of the culverts, under the dams and through the lower basin, they are laid in trenches excavated into the solid shale and limestone, and packed with concrete.

The entire system was tested after being laid with a hydrostatic pressure varying from 75 pounds to 100 pounds per square inch, no leaks have been discovered since the beginning of operations.

The floors of the shaft houses have been so constructed as to be removable in sections and allow valves and pipes to be taken in and out of the culverts.

The lengths of pipes entering into the construction of the reservoir are as follows:

30 inch pipe including the influent pipe 4895 l. ft.
18 inch pipe used for flushing basins 457.7 l. ft.
8 inch pipe used for draining culverts 1099.3 l. ft.
6 inch pipe used to supply the flushing hydrants and the U. S. barracks 6791.8 l. ft.

SUPPLY OF THE U. S. BARRACKS.

On July 10, 1890, an agreement was entered into with the U. S. authorities in Washington to supply the Fort

Thomas Regimental Post with water. This agreement appears as exhibit "*I*" in the Appendix to this report.

The auxiliary pump erected for flushing and cleaning the basins is also used for this service.

A stand pipe 12 feet in diameter and 96 feet high, was constructed by the Government on its grounds on the east side of the Highland Pike directly opposite the reservoir grounds, the 6 inch pipe supplying the flushing hydrants of the north basin was connected with this stand pipe and a 4 inch Worthington meter inserted on that line of pipe near the stand pipe.

The top of the stand pipe is at an elevation of 165 7-10 feet above the pump house floor.

CONSTRUCTION.

The construction of the reservoir and of works adjunct thereto was done under the following contracts.

| No. of Con. | Date of Execution. | Names of Contractors. | Kind of Work. | Date of Final Estimate. |
|---|---|---|---|---|
| 1 | May 10, 1887. | Newp't Iron & Pipe Foundry. | Making of pipes and Castings | Mch. 5, 1889. and |
| 2 | May 10, 1887. | Newp't Iron & Pipe Foundry. | Delivery of Pipes and Castings. | Sep. 26, 1890. |
| 4 | July 15, 1887. | Peter, Scully & Crane, transferred to Casparis & Co., Dec. 8th, 1887. | Grading, Masonry, Valve Houses, erection of floating tubes pipe laying, etc. | May 2, 1890. |
| 12 | Sep. 8, 1889. | D. Shanahan & Co. | Grading, Masonry, Valve houses erection of floating tubes, Pipe laying. | Jun. 25, 1891. |
| 7 | July 13, 1888. | Lane & Bodley Co. | Floating tubes and Flushing valves. | Dec. 26, 1890. |
| 8 | July 16, 1889. | Peter Keefer Jr. & Brothers. | Auxiliary pump house. | Nov. 29, 1889. |
| 9 | May 31, 1889. | Laidlaw & Dunn Co. | Auxiliary pump and boiler. | July 25, 1890. |

The general form of contracts as well as the specifications for the different parts of the work embraced in these contracts, are given in the Appendix to this report as exhibits A, B, C, D, E, F, G and H.

### PIPES AND CASTINGS.

The first contracts awarded for construction, were for the making and delivery of pipes and castings required for the reservoir and pipe lines.

Owing to delays in the completion of their new plant in Newport, the Newport Iron and Pipe Foundry, now the "Addyston Pipe and Steel Co.," did not begin to cast and deliver the pipes until September, 1887. The quantities and cost of pipes and special castings furnished by them for the reservoir are as follows:

| | | |
|---|---|---|
| 30 inch pipe, | 1,509,970 lbs. | |
| 18 " | 67,080 " | |
| 8 " | 56,212 " | |
| 6 " | 303,785 " | |
| Total staight pipe, 1,937,047 lbs.=968.5235 tons, @ $28.40= | | $27,506.07 |
| Special castings, 164,772 lbs.=82.3860 tons, @ $50.00= | | 4,119.30 |
| Delivery of 968.5235+82.3860—1.1735=1049.736 tons, @ $2.25= | | 2,361.90 |
| Total amount, | | $33,987.27 |
| Deduct amount allowed pipe layers for extra lead and labor in joints, on account of sockets being larger than standard, | | 257.14 |
| Total net cost of pipes and castings, | | $33,730.13 |

1.1735 tons of special castings were delivered by the trustees.

GRADING, MASONRY, PIPE LAYING, ETC.

The date specified for the completion of the work under the contract with Peter, Scully & Crane was August 1st, 1888. One year was a very short time for the execution of the work, considering the amount and character of the same.

To avoid the delays attendant to the procurement of suitable limestone in sufficient quantity for the masonry, and to facilitate the work of the contractors, permissions were granted to them at an early date for the substitution of sandstone in place of limestone for the masonry of the paving revetment, and for the substitution of sandstone and brick in place of limestone for the culvert masonry. The contractors did not avail themselves of these permissions until the end of the working season, and the progress of work at that date was otherwise so unsatisfactory that a proposition for the transfer of the contract to Messrs. Casparis & Co. was readily accepted, and the transfer made December 8th, 1887.

The progress made under the new management did not meet your expectations, the leniency shown and the favors granted to the new contractors, as an encouragement to proceed with the work and avoid the delays attendant upon a reletting, failed to have the desired effect, and the work was abandoned by Messrs. Casparis & Co. on July 30th, 1889 in a half finished condition.

A contract was executed with D. Shanahan & Co., September 8th, 1889, for the completion of the work, these gentlemen offering the lowest bid obtainable at the time from responsible parties.

Their prices were, nevertheless, much higher than those of Casparis & Co., but you have under the terms of the contract, a legal recourse on Casparis & Co. and their bondsmen to recover the additional cost arising from their failure to complete the work.

The following statement shows the quantities of work done under both contracts and the cost of the same.

## Statement Showing the Quantities of Work Done Under Both Contracts.

| Kind of Work. | CASPARIS & CO. | | | D. SHANAHAN & CO. | | | TOTALS. | |
|---|---|---|---|---|---|---|---|---|
| | Quantities. | Prices. | Amounts. | Quantities. | Prices. | Amounts. | Quantities. | Amounts. |
| Embankment, c. yds | 97,206.7 | $ .39 | $ 37,910.38 | 12,079.5 | $ .75 | $ 9,059.63 | 109,286.2 | $ 46,970.01 |
| Puddle, c. yds | 49,666.2 | .75 | 35,001.90 | 5,148.7 | .80 | 4,118.96 | 51,814.9 | 39,120.86 |
| Waste, c. yds | 46,490.0 | .40 | 18,596.00 | 21,265.5 | .60 | 12,759.30 | 67,755.5 | 31,355.30 |
| Broken Range Masonry, c. yds | 1,414.5 | 10.00 | 14,145.00 | 250.4 | 10.00 | 2,504.00 | 1,664.9 | 16,649.00 |
| Stone Arch Masonry, c. yds | 568.7 | 9.00 | 5,118.30 | ..... | ..... | ..... | 568.7 | 5,118.30 |
| Brick Arch Masonry, c. yds | 12.8 | 11.00 | 140.80 | ..... | ..... | ..... | 12.8 | 140.80 |
| Brick Masonry, c. yds | 33.9 | 10.00 | 339.00 | ..... | ..... | ..... | 33.9 | 339.00 |
| Concrete in Foundations, c. yds | 2,150.9 | 6.00 | 12,905.40 | 692.0 | 6.50 | 4,498.00 | 2,842.9 | 17,403.40 |
| Coping, c. yds | 6.2 | 7.00 | 43.40 | ..... | ..... | ..... | 6.2 | 43.40 |
| Dry Masonry, c. yds | 11.6 | 3.00 | 34.80 | ..... | ..... | ..... | 11.6 | 34.80 |
| Metal in Roads, c. yds | ..... | ..... | ..... | 3,707.6 | 1.75 | 6,488.30 | 3,707.6 | 6,488.30 |
| Metal in Revetment of Basins | 6,872.8 | 1.75 | 12,027.40 | 9,925.3 | 1.75 | 17,369.28 | 16,798.1 | 29,396.68 |
| Flagging in Revetment, c yds | 32.7 | 10.00 | 327.00 | 24.2 | 10.00 | 242.00 | 56.8 | 569.00 |
| Stone Paving Revetment, c. yds | 5,991.9 | 5.00 | 29,959.50 | 11,456.9 | 8.75 | 100,247.88 | 17,448.8 | 130,207.38 |
| Stone Paving in Bands, in Revetment, c. yds | 338.7 | 8.00 | 2,709.60 | 1,256.7 | 9.00 | 11,310.30 | 1,595.4 | 14,019.90 |
| Concrete in Revetment, c. yds | 3,143.5 | 6.00 | 18,861.00 | 9,482.3 | 6.50 | 61,634.95 | 12,625.8 | 80,495 95 |
| Concrete below Grade, c. yds | ..... | ..... | ..... | 696.80 | 6.50 | 4,529.20 | 696.8 | 4,529.20 |
| Replastering Concrete Revetment, sqrs | ..... | ..... | ..... | 400.34 | 10.00 | 4,003.40 | 400.34 | 4,003.40 |
| Plastering Unfin'd Concrete Revet., sqrs | ..... | ..... | ..... | 21.78 | 10.00 | 217.80 | 21.78 | 217.80 |
| Pointing Unfin'd Paving Revetment, sqrs | ..... | ..... | ..... | 1,495.5 | 5.00 | 7,477.50 | 1,495.5 | 7,477.50 |
| Sodding of Dams, sqrs | ..... | ..... | ..... | 453.36 | 4.00 | 1,813.44 | 453.36 | 1,813.44 |
| Sodding Berme Slopes, sqrs | ..... | ..... | ..... | 837.68 | 4.00 | 3,350.72 | 837.68 | 3,350.72 |
| Valve Houses | ..... | ..... | ..... | 3. | 175.00 | 525.00 | 3. | 525.00 |
| Stone Paving in Cement, c. yds | ..... | ..... | ..... | 100.5 | 5.50 | 552.75 | 100.5 | 552.75 |

## Statement Showing the Quantities of Work Done Under Both Contracts.—Continued.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Stone Paving, Dry | ..... | ..... | ..... | 2,178.7 | 4.50 | 9,804.15 | 2,178.7 | 9,804.15 |
| Pipe Laying, l. ft — 30 inches. | 4,880.1 | 1.95 | 9,516.20 | ..... | ..... | ..... | 4,880.1 | 9,516.20 |
| Pipe Laying, l. ft — 18 inches. | 457.7 | 1.60 | 732.32 | ..... | ..... | ..... | 457.7 | 732.32 |
| Pipe Laying, l. ft — 8 inches. | 1,099.3 | .50 | 549.65 | ..... | ..... | ..... | 1,099.3 | 549.65 |
| Pipe Laying, l. ft — 6 inches. | ..... | ..... | ..... | 6,791.8 | .40 | 2,716.72 | 6,791.8 | 2,716.72 |
| Setting Hydrants | ..... | ..... | ..... | 14. | 7.00 | 98.00 | 14. | 98.00 |
| Setting Valves — 30 inches. | 11. | 7.00 | 77.00 | ..... | ..... | ..... | 11. | 77.00 |
| Setting Valves — 6 inches. | ..... | ..... | ..... | 9. | 3.00 | 27.00 | 9. | 27.00 |
| Erecting Floating Tubes | ..... | ..... | ..... | 3. | 100.00 | 300.00 | 3. | 300.00 |
| Erecting Sluice Gates | ..... | ..... | ..... | 3. | 50.00 | 150.00 | 3. | 150.00 |
| 4 inch Drain Pipe, l. ft. | 70.5 | .50 | 35.25 | ..... | ..... | ..... | 70.5 | 35.25 |
| Iron in Ladders. Weir, Guards, &c. lbs. | 372. | .10 | 37.20 | 3,375.4 | .06 | 202.52 | 3,747.4 | 239.72 |
| Timber in Bridges, Weir, &c. ft. b. m | 2.350 | 30.00 | 70.50 | 7.316 | 40.00 | 292.64 | 9,666. | 363.14 |
| Totals | ..... | ..... | $199,137.60 | ..... | ..... | $266,293.44 | ..... | $465,431.04 |
| Added Work | | | 1,709.59 | | | 16,999.30 | | 18,708.89 |
| Material Delivered | | | 17,872.05 | | | ..... | | 17,872.05 |
| Grand Totals | | | $218,719.24 | | | $283,292.74 | | $502,011.98 |
| DEDUCTIONS. | | | | | | | | |
| Cost of Completing unfinished work estimated as complete, and replacing defective work | | | 20,472.02 | | | ..... | | 20,472.02 |
| For Materials and tools furnished by trustees | | | ..... | | | 39,229.43 | | 39,229.43 |
| Total Net Amounts | | | $198,247.22 | | | $244,063.31 | | $442,310.53 |

The amounts under the head of "Added work" are for a variety of work done by force account, with an allowance of ten per cent. to the contractors for the use of their tools, this item in the case of D. Shanahan & Co. is unusually large for the following reasons:

1st.—The grading of the lower basin and of the berme roads around the north and lower basins, left by Casparis & Co. in an unfinished condition, could only be finished, in justice to the contractor, by force account, owing to the small quantities of material to be removed.

2nd.—The lines of 30 inch pipe laid by Casparis & Co. in the bottom of the lower basin, had to be taken up and relaid by force account owing to the defective character of the concrete packing around them, other defective works done by Casparis & Co. were rebuilt in the same manner.

3rd.—The spill-ways carrying the drainage of the reservoir grounds from the lower dam to the creek, the reconstruction of the culvert under the Alexandria pike, and the construction of the MacAdamized road connecting the reservoir with the Highland and Alexandria pikes, were also done by force account.

4th.—During the progress of the work several springs were developed in the bottom and on the slopes of the basins, which were disposed of by conducting the water through drains, built under the masonry revetment, to small hydrants which by the automatic action of a ball valve, allow the spring water to enter the reservoir but do not allow the escape of the reservoir water. This work was done also by force account.

5th.—A considerable amount of labor was furnished by D. Shanahan & Co. for work not properly chargeable to the construction of the reservoir, but which was paid for as parts of their estimates as shown by the following:

CLASSIFICATION OF ADDED WORK.

| | |
|---|---|
| On account of replacing defective work and completing unfinished work of Casparis & Co. | $ 4.837.20 |
| On ac't of Pipe Laying by McRae & Lalley | 323.63 |
| On ac't of construction of Pump house by C. J. Limerick | 30.03 |

| | |
|---|---|
| On ac't of construction of Pumphouse | 135.19 |
| On ac't of repairs of Pipe line, | 1,550.90 |
| On ac't of repairs of Pipe line for Water Works department | 472.03 |
| On ac't of Legal expenses | 35.10 |
| On ac't of Floating Tubes by The Lane & Bodley Co. | 13.21 |
| On ac't of construction of Reservoir | 9,602.01 |
| Total amount, | $16,999.30 |

The amount paid Casparis & Co. is $181,589.48, leaving a balance unpaid of $16,657.74. This balance is not sufficient to cover the additional cost of the work due to the larger prices of D. Shanahan & Co.

This additional cost is estimated at $50,567.55. You have therefore a legal claim against Casparis & Co. for $50,567.55 minus $16,657.74 equal to $33,909.81.

In addition to the amount of $244,063.31 paid to D. Shanahan & Co. on their estimates, they were paid $1,542.20 as a compromise settlement of claims which I could not allow under their contract.

The total amount paid under both contracts is:

| | |
|---|---|
| To Casparis & Co. | $181,589.48 |
| To D. Shanahan & Co. | 245,605.51 |
| Total, | $427,194.99 |

FLOATING TUBES AND FLUSHING GATES.

The floating tubes forming the intake in each basin, the flushing gates for cleaning the basins, and the hand crabs for the operation of the floating tubes and gates, were made and delivered by The Lane & Bodley Co. under their contract of July 13th, 1888.

The cost of this work was as follows:

| | |
|---|---|
| Three floating tubes, floats, cast stands, chains, sheaves, chain-ways, elbows, 39,321 lbs. @ 7⅝c. | $2,998.23 |
| Three flushing gates and appendages and one lifting crane, 4,013lbs. @ 11c. | 441.43 |
| Three hand crabs, 3,372 lbs. @ 7 ⅞c. | 265.55 |
| Extra work on floats, | 121.61 |
| Total amount, | $3,826.82 |
| Deduction for labor and material furnished by Trustees, | 470.64 |
| Amount paid The Lane & Bodley Co. | $3,356.18 |

AUXILIARY PUMP AND BOILER.

The auxiliary pumping plant designed for the supply of the United States barracks and for cleaning the basins by flushing, was built and erected by The Laidlaw & Dunn Co. under their contract of May 31st, 1889.

The cost of this plant was as follows:

| | |
|---|---|
| One Duplex pump, 10x12 in. steam cylinders, 10x7 in. water cylinders, with boiler and all necessary appendages | $1,685.00 |
| One automatic pressure regulating valve, | 51.00 |
| One national filter, 16x54 in. | 100.00 |
| Total cost, | $1,836.00 |

AUXILIARY PUMP HOUSE.

The brick house and coal shed for the auxiliary pump was built by Peter Keefer Jr. & Bros. under their contract of July 16th, 1889. The price paid for the same, not including the foundation walls nor the ballast filling under the floor was $1,200.00

Less labor and material furnished by trustees ..... 27.60

Amount paid Peter Keefer Jr. & Co. $1,172.40.

SUMMARY OF COST OF CONTRACT WORK FOR THE CONSTRUCTION OF RESERVOIR.

| | |
|---|---|
| Grading, masonry, pipe laying, etc., by Casparis & Co. and D. Shanahan & Co. | $427,194.99 |
| Pipes and castings by the Newport Iron & Pipe Foundry, | 33,730.13 |
| Floating tubes, flushing gates and appendages by the Lane & Bodley Co. | 3,356.18 |
| Auxiliary pumping plant by The Laidlaw & Dunn Co | 1,836.00 |
| Auxiliary pump house by Peter Keefer Jr. & Bros | 1,172.40 |
| Total amount of contract work, | $467,289.70 |

In addition to the contract work, the following items of expense are chargeable to the cost of construction:

| | |
|---|---|
| Real estate, 43 69-100 acres, | $28,655.00 |
| Cement and stone, bought by trustees | 2,137.54 |
| Inspection of cement—being the total amount paid for inspection, part of which is chargeable to the construction of the Pumping Station and a small part to the pipe lines, | 2,726.10 |
| 30 in. sleeve bought after the termination of contract with The Newport Pipe & Iron Co. | 24,50 |
| Foundation, floor ballast, and miscellaneous additions to auxiliary pump house, | 402.74 |
| Labor and material for floating tubes, and flushing valves | 195.42 |
| Labor and material for auxiliary pump, | 13.99 |
| Labor and material for Spring Hydrants, | 91.68 |
| 14 Flushing Hydrants by The Laidlaw & Dunn Co. | 263.80 |
| Stop valves, valve stands and valve boxes by The Eddy Valve Co. and The Laidlaw & Dunn Co. | 4.253.30 |
| Rubber Hose and fixtures for flushing basins, | 286.00 |
| 4 in. Worthington meter for U. S. barracks supply, | 276.00 |
| Labor and material for meter chamber and meter | 104.05 |
| Miscellaneous labor and material, | 116.40 |
| Iron weir trough from The Walton Architectural Co. | 744.35 |
| Additional labor and material for weir | 8.75 |
| Hook gauge for weir measurement, | 50.60 |
| Grass Seed, | 19.60 |
| 25 corner stones for boundary lines of Reservoir grounds, | 45.00 |
| Appraisement of Casparis & Co.'s plant, insurance of same and removal of plant from Reservoir grounds, | 523.22 |
| Total amount, | $40,938.04 |

RECAPITULATION OF COST.

| | |
|---|---|
| Cost of contract work, | $467,289.70 |
| Cost outside of contract work | 40,938.04 |
| Total cost of Reservoir and appurtenances | $508,227.74 |
| Deduct cost of United States pipe line, paid by the city | 2,303.20 |
| Net total cost of Reservoir | $505,924.54 |

OPERATION.

Owing to the failure of the first contractors and the delays attendant upon the reletting of the work, the city was kept dependent upon the operation of the old works much longer than was anticipated.

When it became apparent in the fall of 1887, that the

reservoir would not be completed within the contract time, the contractors were made to concentrate their work principally upon the north and lower basins and later on, chiefly upon the north basin.

This basin was only completed in the fall of 1889, just in time to save the city from a disastrous water famine, the condition of the old works being at that time such as to render them almost entirely unserviceable.

Water was first pumped into the north basin on November 21st, 1889, and the basin put in regular service for the supply of the city on January 23rd, 1890.

Water was first let into the lower basin on July 31st, 1890, and the basin put in service on August 4th, 1890.

The south basin was partly filled with water on December 13th, 1890, when it was yet unfinished, to protect the freshly built concrete revetment from the effect of the frost during winter, it was put in service in the latter part of May, 1891.

The north basin has been cleaned twice to test the efficiency of the plant provided for the flushing process of cleaning.

The result has been all that could be desired. The total cost of cleaning with inexperienced men, was a little over $200, for both operations.

In the regular course of operations, I would recommend that each of the upper basins be cleaned once every year, and the lower basin every two years. The cleaning should be done in the summer time, and on each occasion the floating tube, flushing valve, chain and other iron work which are ordinarily submerged, should be thoroughly cleaned and painted with a good coat of black varnish to preserve them from rusting.

A light boat should be kept on the premises to enable the reservoir keeper to recover the floating tube in case of accidental breakage of the chain, and to remove any floating substance which might accidentally find its way in the basins.

I would further recommend that the level of water in each basin be not allowed, as a rule to rise above a plane 5 feet below the curb line, measured vertically, this precaution is considered necessary to avoid the splashing of water over the curb line in very high wind.

To relieve the floating tubes from the effect of surface agitation, and of ice in winter, the screen heads should be kept submerged about 5 feet below the surface. The paved ditches should be kept clean to avoid overflow on the berme roads in time of heavy rains.

The berme roads should be easily maintained if heavy wagons are kept off of them. They should be repaired with limestone screenings or gravel, the practice of mixing clay with the stone should be carefully avoided. You now have on the reservoir grounds a sufficient quantity of limestone and screenings to maintain these roads for a period of several years.

Water was first delivered into the stand pipe of the United States barracks on July 15th, 1890.

From January 1st to July 1st, 1891, 2,827,800 gallons by meter measurement have been pumped into it, which gives an average daily rate of consumption of about 15,500 gallons.

The present rate of consumption, as shown by the pumpage in June, is about 18,000 gallons.

The connection with the barracks pipe, issuing from the stand pipe was made in the center of the Highland Pike, by a 6 inch cross, which will allow a 6 inch pipe to be laid each way on the Highland Pike, to supply the wants of the locality which is settling very rapidly.

The Ohio River water during the greater part of the year is charged with a considerable quantity of clay and fine sand in suspension.

In the process of settling, the clay carries with it to the bottom a large proportion of the organic matter and living or-

ganisms which are always present and constitute the most unhealthful class of impurities.

Sedimentation, therefore, purifies as well as it clarifies the turbid river water.

The water thus purified, will remain a long time in the reservoir without acquiring any perceptible taste or odor.

During the short period of low water stage in the river, when the water is clear, it is charged with a larger proportion of the organic elements, and purification by sedimentation does not take place.

This water will corrupt rapidly and it is essential to use it almost immediately after pumping. At such times, the use of the upper settling basins should be discontinued and the water pumped directly into the lower basin.

## PUMPING STATION.

The pumping station is located between the river and the C. & O. R. R., at a distance of about 4,000 feet above the Newport pumping station, and about seven miles by the river above the mouth of the Licking. The location is especially favorable for an intake, the channel of the river being permanent at that point, and the deepest water occuring within 60 feet of the low water shore line, and 160 feet from the engine house.

The water at that point is free from local contamination, and its quality as good as can be procured from the Ohio river in this vicinity.

The pumping station consists of an engine house, smoke stack, well, intake aqueduct, and the pumping machinery.

### ENGINE HOUSE.

The engine house is a rectangular brick building, 94 feet 7 inches long, in the direction of the river by 83 feet 6 inches wide, out to out, built on stone wall foundations, 3 feet thick at the top, and 4 feet thick at the base, resting on the solid

stratification of blue shale and limestone, and extending one foot 3 inches above the high water of 1884.

Being built on the declivity of the river bank, these walls vary in height from 40 feet 1 inch to 52 feet 6 inches, they are constructed of sand stone from quarries on the Ohio river near Quincy, Ky., laid in Louisville cement. The outside brick walls of the building are 17 inches thick, with outside pilasters projecting 4 inches, and inside pilasters projecting 18 inches, for the support of the roof trusses.

A 13 inch partition wall, divides the building into two rooms, one for the engines, 50x80 feet, the other for the boiler 40x80 feet in the clear.

The floor is constructed of iron beams and brick arches supported by iron plate girders, and finished with 1½ inch flooring for the engine room, and a Portland cement covering for the boiler room, it stands 15 inches above extreme high water.

The roof is supported by wooden trusses 80 feet span in the clear, and is covered with iron.

### SMOKE STACK.

The smoke stack is built on a foundation block of sand stone masonry 12 feet square, 30 feet 10½ inches deep, resting on the solid shale, it is 101 feet high from the floor of the house, and 6 feet diameter inside. The base is octagonal in shape for a height of 12 feet, above this base the shape is circular, the walls varying in thickness from 22 inches at the base to 13 inches at the top. An inside iron ladder extends to the top of the stack.

Connection with the boilers is made by a horizontal brick conduit back of the boilers.

### WELL.

The well for the pumping engines is formed of two cross walls 4 feet thick, extending from the front to the back foundation walls of the house, it is rectangular in shape, 77 feet

6 inches by 12 feet on top, and 75 feet 6 inches by 8 feet at the bottom, its depth is 79-.29 feet from the floor of the engine room, which gives a depth of 9 feet of water below extreme low water mark.

The walls are built of sandstone and capped under the engine beds with large blocks of Indiana limestone.

The side walls are braced by three tiers of iron beams, serving also for the support of the machinery inside the well and of the three floors which give access to the same.

The bottom of the well is revetted with concrete 15 inches thick, plastered with Portland cement. A sump 4 x 4 feet deep provides for the complete drainage of the well when it is pumped out for cleaning. An iron stair-way gives access to the three floors, and to the bottom of the well.

### INTAKE AQUEDUCT.

The intake aqueduct is formed by a tunnel excavated in the solid shale, and lined with brick laid in cement with a covering of Portland cement, it is 4 feet in diameter inside and 158 14 feet long from the inside face of well to the outside face of inlet pier in the river, it falls from the well to the river with a gradient of 1.03 feet in 100 feet, the river end being 1 ft. 7½ in. lower than the well end. At low water the water in the well stands 2 ft. above the top of the arch at the well end of the aqueduct, the bottom of the arch at the river end stands 4 ft. above the rock bottom of the river, which secures to a great extent the exclusion of the drifting sand and gravel which are always in motion with the current on the bottom of the river.

The river end of the aqueduct is protected by a casing of masonry, built of sandstone faced and capped with large blocks of Indiana limestone. The projections of the side walls of the pier beyond the face, are grooved for a strong iron grating which prevents the entrance of large drift. A timber bulkhead can be substituted in place of the iron grating, for closing entirely the opening, in case that it should be-

come necessary to get in the aqueduct to repair or clean it.

The well end can also be closed at will, by means of a 4 ft. gate operated from the floor of the engine room.

An 8 inch pipe connecting with the force main of the pumping engines, opens inside of the aqueduct, and serves to wash out the deposits which will form from time to time, by the force of the jet issuing from the pipe when the 4 ft. gate is closed and the valve connection with the force main is opened. The hight of the column of water in the force main, from the opening of the 8 inch pipe to the apex in the tunnel under the Highland pike is 383-77 ft.

### HEATING AND LIGHTING.

The engine room is heated by coils of steam pipe against the walls, supplied directly from the boilers through a pressure regulator, and driaining through a steam trap to the hot well of the feed pumps.

The entire building, including the well, is lighted by an Edison electric light plant operated by a Beck automatic cut-off engine of 8 horse power, the guarranteed capacity of the plant is of 45 lamps of 16 candle power.

### PUMPING MACHINERY.

The pumping machinery consists of two compound, condensing vertical Gaskill engines and six tubular boilers.

Each engine has two high pressure and two low pressure steam cylinders 24 in. diam. x36 in. stroke and 48 in. diam. x 36 in. stroke respectively, all steam jacketed, and operate 4 single acting plunger pumps 19 in. diam. x 36 in. stroke. There are two fly wheels to each engine 12 ft. in. diameter.

Each engine has a surface condenser through which passes the water on its way from the pumps to the force main.

The steam distribution gear is of the Corliss type.

The pumps, and valve chambers stand on the first floor in the well, 24 ft. 3 in. above the bottom and 15 ft. 3 in. above extreme low water, the valves are of 1¼ in. opening with

¼ in. lift. Besides the air feeders attached to each engine to maintain the supply in the air chambers, an independent Westinghouse air pump is provided to charge the air chambers before starting the pumps after a period of inoperation.

The open end of each suction pipe takes water through a cylindrical wire screen 4 ft. diameter by 8 ft. high, which serves to keep out small drift from the pumps. These iron screens are cleaned without stopping the pumps, by inside water jets derived from the force main and operated from the floor of the engine room.

The 30 inch force main is located outside of the well and receives the water from each engine through a 20 in. branch. It is supported by cast iron brackets anchored to the well walls, and is itself anchored endwise to the front foundation wall of the building by means of iron rods which take the thrust due to the pressure of the water against the closed end of the pipe, and relieve the joints from all longitudinal stress.

The engines are duplicates of each other and built to deliver, each, 5 million gallons of water per 24 hours in the reservoir, with a consumption of coal not exceeding 18,000 lbs. at the lowest stage of water in the river.

Sufficient space is left in the engine room and well for an additional engine of 10 million gallons capacity in 24 hours, which would bring the total pumping capacity to 20 million gallons per 24 hours.

The boilers are also duplicates of each other. They are 5 ft. 6 in. diam. by 18 ft. long and contain each, 80, 3½ in. lap-welded tubes, the grate surface for each is 30 square feet. They are mounted in pairs, one pair being sufficient to supply one pumping engine, one pair remains in reserve when both engines are working. Sufficient space is left in the boiler room for two more pairs of boilers, which would still leave two boilers in reserve when the pumping capacity of the station is increased to 20 million gallons per 24 hours.

The feed water derived partially from the condensers, is heated through a live steam heater to 212° and passed

through a national filter on its way to the boilers. Most of the impurities remain in the filter which is cleaned every two or three hours by a simple reversion of the flow. This device prevents to a great extent the formation of scales and the accumulation of mud in the boilers, it reduces to a considerable extent the labor of cleaning, keeps the boilers at all times in a better working condition and increases their effective capacity for producing steam.

An independent duplex pump has been provided as boiler feeder in case of accident to the feeders operated by the pumping engines, but is not used, as the boiler can be supplied directly from the force main.

### BILGE PUMP.

A duplex Worthington pump of the admiralty type—steam cylinders 12 in. diam. by 10 in. stroke, water cylinders 8½ in. diam. by 10 in. stroke, is suspended to the roof truss by a Weston differential chain-block of 3 tons capacity, by means of which it can be raised or lowered in the well between iron guides, it serves to pump out the well at all stages of the water to give access to any submerged part of the machinery needing repairs.

A Nye pump No. 5 placed permanently in the bottom of the well, pumps out the mud and sand when the well is being cleaned. By means of this pump and of an ordinary fire hose connected to the force main, the well can be cleaned very rapidly and with very little labor.

### WORKING TOOLS.

The floor space in the engine room is ample to receive all the machine tools required for ordinary repairs. These tools have not been procured, the equipment of the station in this respect not being considered a proper item of expenditure out of your construction fund, they should be provided as soon as possible by the operating department.

### COALING FACILITIES.

The coal supply is now received through the C. & O. Railway, a spur track about 300 feet long having been built for the accommodation of this service in front of the engine house. The entire space between the railroad and the pump house is filled to the grade of the railroad track, and affords room for the storage of about 500 tons of coal.

The spur track should be made a siding, connected at both ends, and a track scale should be put in at the upper end of this track to verify the weight of coal received.

Coal can also be received by river. The river front of your property is 600 feet in length, and affords excellent landing for boats at all stages of the water.

### CONSTRUCTION.

### CONTRACT WORK.

The construction of the pumping station was done under the following contracts:

| No. of Con. | Date of Execution. | Names of Contractors. | Kind of Work. | Date of final Estimate. |
|---|---|---|---|---|
| No. 5. | Aug. 12,1887. | C. J. Limerick. | Engine house,smoke stack and acqueduct | Mar. 2, 1891. |
| " 6. | Sep. 2. 1887. | Holly Manufacturing Co. | Pumping engines & boilers, stairs, and 4 ft. gate. | Feb. 25, 1891. |
| " 10. | June 11,1889. | J. K. Rugg, agent for H. Worthington. | Bilge pump and hoisting block. | Jul. 10, 1890. |
| " 11. | Aug. 17,1889. | Walton Architectural Co. | Guides for Bilge pump. | Nov. 8, 1889. |

The general form of contract is the same as for the reservoir work, given as exhibit *A* in the Appendix to this report, the specifications for the different contracts are given as exhibits *K*, *L*, *M* and *N*.

PUMP HOUSE AND AQUEDUCT.

The contract for the construction of the Pump House was executed by C. J. Limerick, August 12th, 1887, the time specified for the completion of the work being June 1st, 1888.

The work done by Mr. Limerick in 1887, was confined to the excavation for the foundation walls and well, and the building of the river end of the aqueduct by means of a coffer-dam.

Very soon after the signature of his contract, permission was asked by Mr. Limerick, and granted, for the substitution of sandstone in place of limestone for the masonry of the foundations.

Very little masonry was laid in 1887. The work on the masonry was continued during the winter, using Portland instead of Louisville cement. Very slow progress was made during the year 1888, owing to the insufficiency of the force employed, and delays occasioned by high water. The aqueduct was only completed in January, 1889, it was built by tunnelling from the well end to a junction with the inlet pier in the river.

The foundation walls and the well were completed the succeeding month, and the pumping engines being then delivered, a wooden shed was built over the well, to allow the work of erection of the machinery to proceed.

The construction of the house and smoke stack above the foundations, consumed eight months, extending from April to October 1889.

The temporary bulk head which closed the river end of the aqueduct during the construction of the tunnel was only removed in November, 1889. A feeble and unsuccessful effort was then made by the contractor to remove the coffer-dam, the continued presence of which was subsequently a cause of much annoyance and expense. The contractor ultimately failed to remove this coffer-dam which was a part of his contract, until it threatened to stop entirely the flow

of water into the well and cut off the city supply. It was then removed by a dredge employed by your board, and the cost of the work was charged to Mr. Limerick.

The following statement shows the quantities and cost of all work done under this contract, including the "Added work," which was paid for at cost with ten per cent. added.

Mr. Limerick has declined to accept this final estimate, and has entered suit against you for the recovery of $26,000 which he claims as additional compensation for the "Added work" done by him, above the amount allowed him by your Chief Engineer.

C. J. LIMERICK.

| | | |
|---|---|---|
| Aqueduct in coffer-dam, | 85.62 c. yds. Masonry, @ $10.00 | $ 856.20 |
| | 13.09 " Brick Arch, @ $9.00 | 117.81 |
| | 59.27 " Concrete, @ $7.00 | 414.89 |
| | 1780 lbs. iron in grating and clamps, @ 10 cts. | 178.00 |
| Aqueduct in tunnel, 122.24 l. ft., @ $35.00, | | 4,278.40 |
| 5434.1 c. yds. Masonry in house, foundations and well, @ $9.75, | | 52,982.48 |
| 298.28 c. yds. Concrete, @ $6.60, | | 1,968.65 |
| 19182.5 lbs. Iron in floor and well, @ 5 cts., | | 9,591.25 |
| 118.84 c. yds. Brick arch in floor, @ $7.00, | | 831.88 |
| 93.71 c. yds. Concrete in floor, @ 6.50, | | 609.12 |
| 6.850 ft. b. m. timber in floor, @ $27.00, | | 184.95 |
| 5394.20 c. yds. Embankment, @ 45 cts., | | 2,427.39 |
| 102.5 l. ft. 6 inch Drain pipe, @ 50 cts. | | 51.25 |
| Setting sluice gate, | | 150.00 |
| House above foundations and floor, complete | | 13,771.00 |
| Smoke stack, 100 ft. high, complete, | | 3,950.00 |
| Total, | | $92,363.27 |
| Added work, | | 6,505.55 |
| Total amount, | | $98,868.82 |
| Deductions for material and labor furnished by trustees, | | 1,455.84 |
| Total net amount of contract work, | | $97,412.98 |
| Mr. Limerick has been paid, | | 91,344.86 |
| Leaving a balance in his favor of | | $ 6,068.12 |

Which he has declined to accept in full settlement of his contract.

PUMPING ENGINES.

The contract for the construction and erection of the pumping machinery was executed September 2nd, 1887, the date specified for the completion of the work being August 1st, 1888.

Owing to the delays in the construction of the pump house, the condition of the contract as to time of completion of the machinery could not be carried out. All that could be required of the Holly Manufacturing Company, was that it should have the machinery in readiness for erection when the foundations were completed by Mr. Limerick.

The boilers and the first pumping engine were delivered in December, 1888, but had to wait until February, 1889, for the completion of the foundations and well, and the temporary shed required for the erection of the engine during winter.

The work of erection progressed slowly owing to inferior castings which had to be replaced, and the omission of the air chambers and other parts which, by an oversight of the contractors, were not included in the first shipment of the machinery. The untimely death of Mr. Gaskill, the able Engineer and Manager of the Holly Company, a short time after the execution of the contract, was the principal cause of these discrepencies and delays. The progress of work was also hampered by the fact that the house was being built at the same time that the engines were being erected, which crowded the premises uncomfortably with men and materials, and interfered with the best disposition of both.

The first engine was tried in November, 1889, bursting a defective 16 inch elbow in the well.

Under the emergency created by the failure of the old works in Covington, and with the consent of the Holly Company, the engines were put into service on January 13th, 1890, although they had not as yet been properly adjusted. The men employed by you to operate the engines, were

placed under the immediate direction of the Holly Company's agent.

The engines did not work satisfactorily under these conditions.

On February 23rd, the cross head of engine No 1 broke. On March 13th, the cross head of engine No. 2 broke. On March 14th, two joints on the line of the 30 inch force main, about half way up the hill broke simultaneously with a 20 inch elbow in the well.

These accidents were probably caused by the water hammer effect produced by the want of air in the air chambers, and the irregular motion of the engines. The independent Westinghouse air pump had not yet been provided, the air chambers had not yet been made air tight, and it was found impossible at the time to maintain properly the air supply.

On April 3rd, 1890, the service was resumed with men employed directly by the Holly Company, but it was soon discovered that the outside jacket of the four high pressure steam cylinders were cracked, which made it necessary to replace these cylinders. This was done without interrupting the service, by the dismantling and repair of one engine at a time.

Both engines ran very satisfactorily during the summer and fall, and everything being in readiness for the duty test specified in the contract, the test was made with the assistance of Mr. Ch. Hermany, C. E., beginning November 25th, at noon, and ending December 5th, at noon. The separate reports addressed to your board by Mr. Hermany and myself on the results of this test, appear as exhibits *O* and *P* in the Appendix to this report. The conclusions were, that the performance of the pumping machinery during the test, with regard to the consumption of coal for a certain quantity of water delivered in the reservoir, was within the limits specified in the contract.

On March 13th, 1891, the engines being then in good

working condition, were finally received from the hands of the Holly Company and a final estimate returned in favor of that Company.

The engines have since that time continued to work satisfactorily, and should continue to do so for many years, provided the necessary care and attention are given to them.

The following statement shows the cost of the work done under the contract with the Holly Manufacturing Co.

THE HOLLY MANUFACTURING CO.

| | |
|---|---|
| Two pumping engines and six boilers complete with all appurtenances | $110,000.00 |
| One 4-foot gate for intake aqueduct, | 996.00 |
| Iron stairs in well, erected, 11,427 lbs. @ 7c | 799.89 |
| One 8-inch T connecting with steam main, | 15.21 |
| Two 8-inch pipes and two 8-inch elbows, | 24.64 |
| Total | $111,835.74 |
| Deductions for material and labor furnished by Trustees, | 178.33 |
| Total net amount of contract work paid to the Holly Manufacturing Company | $111,657.41 |

BILGE PUMP AND HOISTING BLOCK.

On June 11th, 1889, a contract was executed with Mr. J. K. Rugg, agent for Henry Worthington, for the delivery and erection of a bilge pump of the admiralty type and a three ton Weston chain block for raising and lowering the pump in the well. This plant was duly delivered and erected. It was tested by pumping out the well on several occasions, and a final estimate returned in favor of Mr. Rugg on July 10th, 1890, for the amount named in the contract, viz: $1,250.00.

IRON GUIDES FOR BILGE PUMP.

On August 17th, 1889, a contract was executed with the Walton Architectural Co. for making and erecting the iron guides in the well for the bilge pump. The same was paid for Nov. 8th, 1889, $301.02.

PIPES AND CASTINGS.

The following work done by the Newport Pipe and Iron Foundry, under their contract of May 10th, 1887, is chargeable to the construction of the Pumping Station:

| | |
|---|---|
| Straight pipe furnished, 0.3050 tons, @ $28.40, | $ 8.66 |
| Special castings furnished, 1.2675 tons, @ $50.00 | 63.38 |
| Tarring castings, gates and beams | 45.00 |
| Bolts for valves | .32 |
| Hauling 1.5725 tons @ $2.25 | 3.54 |
| Total amount | $120.90 |

TOTAL AMOUNT OF CONTRACT WORK.

| | |
|---|---|
| C. J. Limerick, pump house and aqueduct | $ 97,412.98 |
| Holly Manufacturing Company, pumping machinery | 111,657.41 |
| J. K. Rugg, bilge pump and hoisting block, | 1,250.00 |
| Newport Pipe and Iron Foundry, pipes and castings | 120.90 |
| Walton Architectural Company, iron guides | 301.02 |
| Total amount | $210 742.31 |

In addition to the contract work, the following items of expenditure, incurred to complete and equip the pumping station, are chargeable to the construction of the same:

| | |
|---|---|
| Grounds (5 49-100 acres) | $ 8,523.20 |
| Heating apparatus for engine house | 325.00 |
| Electric light plant, | 643.10 |
| Removing coffer dam and other work connected with construction of aqueduct, | 1,461.95 |
| Nye pump and connections, | 483.78 |
| Water closet | 42.90 |
| Plumbing | 58.00 |
| Water gauge, | 103.81 |
| Lumber and carpenter work, | 123.62 |
| Painting and varnishing, | 102.10 |
| Valves and pipes, | 23.78 |
| Miscellaneous hauling and freight, | 223 23 |
| Miscellaneous labor and material, | 301.28 |
| Miscellaneous supplies, | 69.17 |
| Testing engines | 987.95 |
| To C. & O. R. R. for side track, | 200.00 |
| Steps up river bluff, | 285 75 |
| Total amount, | $13,958.62 |

RECAPITULATION OF COST.

| | |
|---|---|
| Cost of contract work, | $210,742.31 |
| Cost outside of contract work, | 13,958.62 |
| Total cost of pumping station, | $224,700.93 |
| Deduct amount paid by the city as cost of pumping water, | 72.77 |
| Total net cost of pumping station, | $224,628.16 |

OPERATION.

After the coffer dam was removed from the river end of the aqueduct last fall, it was intended to close the opening by a temporary bulkhead, and to remove by hand the large quantity of clay and loose rock which had found its way in the tunnel while the dredging was being done. Owing to a sudden rise in the river as work was about to be started, and to a continued high stage of water since that time, the operation was postponed until this summer.

I am glad to report that the diver recently employed to make a preliminary examination of the intake, states that the greater part of the material in the tunnel has been washed away by the action of the flushing device provided to prevent the accumulation of sediment in the aqueduct, rendering the cleaning of the same by hand unnecessary.

Since January 23d, 1890, when operation began for the supply of the city from the new works, the wages of the employees at the pumping station and that of the reservoir keeper have been paid by your Board, but refunded by the Water Department of the city.

As the Water Department furnished directly the coal and the greater part of the supplies used in operating the machinery, I am unable to give correctly the cost of operation.

The quantity of water pumped into the reservoir from July 1st, 1890, to July 1st, 1891, computed from the number of revolutions of the engines during that time, and allowing a slip of 3 per cent for the pumps, was 861,458,580 gallons,

which shows an average daily consumption by the city of 2,360,000 gallons.

The total quantity of coal burnt during that time was 3,411,168 lbs., or nearly 39,600 lbs. for every ten million gallons delivered into the reservoir. The average height of lift for the year was 359.05 feet. The quantity of coal allowable under the specifications for this lift is:

$$36000 \times \frac{359.05}{378.10} = 34190 \text{ lbs.}$$

Showing an excess of coal burnt for every ten million gallon, of 5,410 lbs. $= 15\frac{8}{10}$ per cent. The greater part of this excess is due to the coal consumed for keeping up steam in the boilers when the engines are not working, the machinery being idle more than one-half of the time.

When it is further considered that steam is also used for the operation of the electric plant, for heating the building during winter, and for pumping out the well occasionally, it would appear that the performance of the engines in the conditions of ordinary running, is not far from the stipulations of the contract.

The performance will be further improved and the cost of pumping per million gallons reduced, both as to fuel and wages, as soon as an increased rate of consumption allows the machinery to be operated continuously.

## PIPE LINES.

### FORCE PIPE LINE.

The force or discharge pipe of the engines issues from the front foundation wall of the pump house, nearly at right angles therewith, at a depth of 11 feet 9 inches below the floor. It is securely anchored to the wall by iron rods and cross beams calculated to transmit the longitudinal stress due to the pressure of water against the closed end of the pipe.

The pipe crosses under the C. & O. R. R. track, and ascends the steep declivity of the river bluff, rising 268 feet in a distance of 554 feet, thence, follows the side slope of a ravine

with a continuous ascending grade to the apex of the line at the west end of the tunnel under the Highland pike, where the force main proper ends, and the influent pipe to the reservoir begins, being a continuation of the force main on a descending grade.

Distance from pump house to apex, ..... 3,149 feet.
Elevation of apex above floor of pump house, ..... 307.8 feet.
Elevation of apex above extreme low water at pump house... .. 378.10 feet.

The force pipe is 30 inches inside diameter throughout. The pipes vary in thickness according to their position on the line, there being three grades of thickness, viz: 1 inch, 1⅛ inches, and 1¼ inches.

There is only one stop valve on the line, located inside the pump house. It is provided with an 8 inch by pass.

At the apex point, is an open stand pipe 18 inch diameter, which prevents the accumulation of air at that point, and serves as a safe-guard in case that all the stop valves on the influent pipe line should be accidentally closed, when the pumping engines are being operated.

On the steep grade of the bluff, one joint of pipe every 100 feet is laid in a wedge shaped block of concrete, which relieves the pipes from a part of the stress due to their own weight.

The tunnel under the Highland pike was constructed to avoid the extra cost of elevating all the water pumped into the reservoir 33 feet higher, which is the difference of elevation between the line as built, and a surface line under the pike. The tunnel is 300 feet long, 8 feet wide and 8 feet high in the clear of the brick arching. A shaft 8x8 feet gives access to it at the west end. It is drained by an 18 inch drain pipe at the east end. The pipe is supported by concrete blocks on the floor of the tunnel. Outside of the tunnel it conforms generally with the undulations of the surface, with a minimum depth of 3 feet of earth covering.

SUPPLY MAIN.

The supply main which takes the water from the reservoir to the city, issues from the culvert under the lower dam

on the Alexandria pike, and follows the same for a distance of about 3,800 feet.

On leaving the pike, it crosses under a branch of Three Mile Creek, and follows the side slopes of the valley to Budde's road for a distance of about 3,900 feet, thence Budde's road for a distance of about 4,100 feet to the Licking pike, thence the Licking pike for a distance of about 4,300 feet to a point near Dana's coal yard, where it crosses under the Louisville Short Line R. R., crosses the coal yard, and reaches the C. & O. R. R., bridge over the Licking. The pipe crosses the Licking on that bridge and lands in Covington near the foot of Byrd street.

The location of the pipe line in Covington, is on Byrd street westward to Stevens street, on Stevens northward to 13th street, on 13th westward to Madison, on Madison northward to 12th, on 12th westward to Russell, on Russell northward to 3rd street, where it connects with the 20 inch main from the old works. A 20 inch branch on Greenup street from 13th to 3rd street, connects also the main line with the 16 inch line on 3rd street.

The grades and elevations of the line are as follows:

| Location. | Continuous ascending or descending gr. | Distance from outlet lower basin (approx.) | Elevation above L. W. lower basin. | Summit or depression. |
|---|---|---|---|---|
| Outlet lower basin to Branch crossing near Budde's dairy ..... .... | Descend'g. | 0<br>7,750 feet. | 0<br>209 feet. | Depression. |
| Branch crossing near Budde's dairy to top of hill in Budde's road. | Ascending. | 10,900 " | 76 " | Summit. |
| Top of hill in Budde's road to east End C. & O.R.R.bridge, (below.) | Descend'g. | 16,750 " | 255 " | Depression. |
| East end C. & O. R. R. bridge (below) to East end C.& O.R.R. bridge (above.)..... | Ascending. | 16,750 " | 221 " | |
| East end C. & O. R. R. bridge (above) to West end C. & R. R. bridge (above)..... | Level. | 17,400 " | 221 " | Summit. |

(GRADES AND ELEVATIONS CONTINUED.)

| Location. | Continuous ascending or descending gr. | Distance from outlet lower basin (approx.) | Elevation above L. W. lower basin. | Summit or Depression. |
|---|---|---|---|---|
| West end C. & O. R. R. bridge, (above) to West end C. & O. R. R. bridge, (below.)..... | Descend'g. | 17,400 feet. | 255 feet. | Depression. |
| West end of C. & O. R. bridge (below) to crossing Byrd & Stevens Streets..... | Ascending. | 18,700 " | 238 " | Summit. |
| Crossing Byrd & Stevens Streets to crossing Stevens & Pleasant Sts | Descending. | 19,200 " | 244 " | Depression. |
| Crossing Stevens and Pleasant Sts. to crossing 12th & Madison... | Ascending. | 21,200 " | 209 " | Summit. |
| Crossing 12th & Madison to crossing 12th & K. C. R. R. tracks..... | Descending. | 21,700 " | 219 " | Depression. |
| Crossing 12th and K. C. R.R.tracks to crossing 11th and Russell..... | Ascending. | 22,600 " | 195 " | Summit. |
| Crossing 11th & Russell to crossing 3d and Russell ..... | Descending. | 26,100 " | 250 " | Depression. |
| **GREENUP STREET LINE.** | | | | |
| 13th and Greenup ..... | | 19,850 feet. | 254 feet. | On Grade. |
| Crossing 13th & Greenup to Greenup bet. 11th & Bush..... | Ascending. | 20,650 " | 216 " | Summit. |
| Greenup bet. Eleventh and Bush to Greenup between Seventh and Eighth..... | Descending. | 22,250 " | 239 " | Depression. |
| Greenup bet. Seventh & Eighth to crossing 6th and Greenup..... | Ascending. | 22,850 " | 225 " | Summit. |
| Crossing 6th & Greenup to crossing 3d and Greenup ..... | Descending. | 24,200 " | 230 " | On Grade. |

From the reservoir to the corner of Greenup and 13th, the pipes are 30 inches in diameter, and vary in thickness from 1 inch to 1¼ inches according to their position on the line with regard to elevation. From Greenup and 13th to 12th and Russell, the pipes are 24 inches in diameter and 1⅛ inches thick. From 12th and Russell to 3rd street, and from Greenup and 13th to 3rd street, the pipes are 20 inches in diameter and 1 inch thick.

At all points of depression, blow-off branches have been provided. At all summit points air valves have been put in.

Stop valves have been put in at the following points:

| Location. | Approx distance from outlet of L.B | Size of Valve. |
|---|---|---|
| Where line leaves Alexandria pike. | 4,000 feet. | One 30 inches. |
| Budde's dairy | 7,750 " | " " " |
| Where line leaves Licking pike | 16,150 " | " " " |
| Crossing of Byrd and Rickey | 17,850 " | " " " |
| " " Greenup and 13th | 19,850 " | " 24 " one 20 in. |
| " " 12th and Russell | 22,150 " | " " " " " " |
| " " Russell and Pike | 24,200 " | " 20 " |
| " " Russell and 3rd | 26,100 " | Two " " |
| " " 8th and Greenup | 22,000 " | One " " |
| " " 3rd and Greenup | 24,200 " | " " " one 16 in. |

Every 30 inch valve has a 6 inch by-pass. All the valves are enclosed in substantial brick vaults properly drained, and built with openings large enough to allow the removal of the valves for repairs without interference with the brick work.

Branches for connections with the city mains, have been put in at all street intersections in the city, but the connections have not been made, this should properly be done by the men in charge of the water department of the city.

All the valves required for the pipe line and the connections with the city mains, were furnished by the Eddy Valve Co., of Waterford, N. Y.

The pipes are generally laid to a depth of 5 feet below the surface of the ground, measuring from the center of the pipe, the minimum depth of earth covering allowed is 3 feet. In fills across abrupt depression of the ground, where the

pipe is above the original surface, it is supported by walls of dry masonry.

The pipe line crosses four branches of Three Mile Creek. The first one near the reservoir, is over an 8 feet arch built for that purpose. The second one is near the point where the line leaves the Alexandria pike. The bed of the stream at that point is in blue shale, the pipe crosses in a trench excavated into the blue shale and packed with concrete, the concrete is protected by a covering of limestone paving laid in cement. The third crossing is near Budde's dairy, under an open culvert paved with limestone laid in cement. The fourth crossing is on Budde's road over an 8 feet arch built for that purpose.

The line crosses the Licking on the C. & O. R. R. bridge by virtue of an agreement concluded with the Railroad Company on January 23rd, 1889, which appears as exhibit *Q* in the appendix to this report.

The cost of an inverted syphon under the river at that point, would have been less perhaps than the prices paid to the Railroad Company for the privilege of using its bridge, but the advantage of greater security and of accessibility to the pipe for repairs, were of such importance as to overbalance any saving which could have been made by the adoption of the syphon plan. The banks of the Licking at that point are subject to frequent and extensive slides. The sand and boulder deposit overlaying the bed rock in the bottom of the river is about 30 feet deep, and the freshets in the stream are occasionally of such violence as to preclude any dependence on this loose material for a permanent foundation.

The pipe rises vertically from the ground at each end of the bridge about 35 feet, and runs horizontally under the floor between the two tracks for a distance of 623 ft. It is suspended to the inside iron stringers by wrought iron yokes 1¼ in. square, spaced about 10 ft. apart, it is braced sideways by 1⅛ in. rods spaced about 20 ft. and attached to the outside stringers.

A stuffing box at each end, provides for the expansion and contraction of the pipe and the end elbows are securely anchored to the masonry of the piers, by iron rods proportioned to resist the thrust due to the hydrostatic pressure against these elbows.

An air valve is placed on the horizontal stretch half way between the ends.

The length of the exposed part of the pipe is about 683 feet. Owing to the size of the pipe no covering protection against frost is considered to be necessary as long as the pipe is in service, and none has been put in. If it should happen from any cause that the circulation of water in the pipe be stopped during very cold weather, the pipe should be emptied.

The supply which the pipe line is able to furnish is limited to the quantity of water which can flow at the summit point in Budde's road 10,900 ft. from the outlet of the reservoir and 76 ft. below the low water line in the lower basin, this quantity is over 20 million gallons in 24 hours, which is the ultimate capacity of the works as planned. Should the daily consumption of the city ever exceed this amount, the capacity of the pipe could be increased by tunneling under the summit. A tunnel 900 ft. long, costing about $25,000 would allow the pipe to be lowered about 40 ft. at that point and increase its capacity about 5 million gallons in 24 hours, but owing to the great loss of pressure by friction in a 30 in. pipe at that rate of delivery, it will probably be found advisable to replace the 30 in. pipe by a larger one, or to duplicate the line of 30 in. pipe, before the daily consumption has reached 20 million gallons.

### RIGHT OF WAY.

A right of way 15 ft. wide was secured from the land owners whose property is traversed by the force and supply pipe lines, the pipe is generally laid in the center of this 15 ft. strip. Indemnities were paid to the Alexandria and Licking Pike Companies for the privilege of laying and maintain-

ing the pipe on these highways. The pipe is generally laid on the side of the pike next to the hill side, to secure a firmer foundation. The amounts paid for right of way are as follows:

| | |
|---|---|
| To land owners for a 15 ft. strip, | $ 7,214 30 |
| To the Maysville & Big Sandy R. R. for the privilege of crossing on the Licking bridge | 20,000.00 |
| To the Newport & Licking Turnpike Co | 3,640.00 |
| To the Campbell Turnpike Co. (Alexandria pike) | 3,000.00 |
| Total amount paid for right of way | $33,854.30 |

In view of the fact that the cities of Covington and Newport are each dependent for their water supply on a single line of conduit from their respective reservoirs, the danger of a water famine to both cities, arising from a possible break of these conduits, could be averted to a great extent by the construction of a branch line starting from the stop valves on the Licking pike near Finchtown, running down to the Newport and Covington bridge on Brighton street in Newport, thence across the bridge to a connection with the 20 in. main on 4th and Greenup in Covington. The length of this branch line would be about 6,900 ft., it should be laid with 16 in. pipes and connected with the 16 in. main on York street in Newport, which is 2,300 ft. east of Brighton street.

Provision has been made in the construction of the Newport and Covington bridge for carrying a 16 in main under the floor of the wagon way.

CONSTRUCTION.

The construction of the pipe line was done under the following contracts:

| No. of Con. | Date of Execution. | Name of Contractors. | Kind of Work. | Date of final Estimate. |
|---|---|---|---|---|
| 1 | May 10, 1887. | Newport Iron and Pipe Foundry. | Making of pipes and castings. | Mar. 5, 1889. and Sep. 26, 1890. |
| 2 | May 10, 1887. | Newport Iron and Pipe Foundry. | Delivery of pipes and castings. | |
| 3 | July 1, 1887. | McRae & Lally. | Pipe laying. | Jun. 14, 1889. and Feb. 24, 1891. |

The specifications for these contracts appear as exhibits *C*, *D* and *R* in the appendix to this report, the general form of contract is the same as given in exhibit *A*.

MANUFACTURE AND DELIVERY OF PIPES AND CASTINGS.

All the pipes and castings for the pipe line as well as for the reservoir were made in the foundry of the Newport Pipe and Iron Foundry (now the Addyston Pipe and Steel Company) in Newport, Ky. Owing to delays in the completion of their new foundry, the contractors did not begin to make and deliver the pipes until the month of September, 1887.

The pipes were inspected at the foundry by an inspector employed by your board, and tested under a hydrostatic pressure of 300 lbs. per square inch. They were again inspected in the field after delivery by the inspector for the pipe laying.

The iron used for the manufacture of the pipe was tested every day for tensile strength at the foundry, and showed generally a resistance of more than 20,000 lbs. per square inch.

Only 6 joints of pipe were rejected in the field for defect in manufacturing or damages received in delivery.

All the pipes and castings were coated by dipping in coal tar while hot.

With the exception of the two joints of 30 inch pipe broken on the force main during the first trial of the pumping engines, no break has occured to the present time on the pipe line.

The following statement shows the quantities and cost of all pipes and castings made and delivered by the Newport Pipe and Iron Foundry for the pipe lines.

| | | |
|---|---|---|
| Straight pipes, | 5,626.8955 tons @ $28.40 | $159,803.83 |
| Special castings | 117.5685 tons @ 50.00 | 5,878.43 |
| Delivery | 5,744.4640 tons @ 2.25 | 12,925.04 |
| Added work | | 114.42 |
| Total | | $178,721.72 |
| Deduct 8,235 lbs. of scrap @ ½c | $ 41.18 | |
| Deduct labor and material furnished by Trustees | 242.53 | |
| | | 283.71 |
| Total net amount | | $178,438.01 |

PIPE LAYING.

The work of pipe laying was begun by McRae & Lally in September, 1887, on the supply main line in Finchtown, and was practically completed in 1888, with the exception of the pipe laying on the Licking bridge and the connections with the city main on 3rd street and with the pumping engines at the pumping station. The connection with the city main on 3rd street were only mad : by McRae & Lally in February, 1889, and the connection at the pump house was made by a force of men employed by your board in the absence of McRae & Lally.

The force pipe was filled with water for the first time on November 21st, 1889, and stood the test well, there has not been a leak on the line to the present date.

On March 14th, 1890, two adjoining pipes on the line about half the way up the river bluff, broke suddenly, no apparent defect could be discovered in the broken pipes, the accident was probably due to the effect of a water hammer, produced by the irregular working of the pumping engines which had not at the time been properly adjusted.

The line of the supply main was filled with water from the reservoir to the Licking bridge on December 5th, 1889. The water was let into the pipe over the bridge and partly into the line in Covington, on December 13th, 1889, when the anchorage securing the elbow at the Newport end of the bridge yielded to the pressure owing to the inferior character of the masonry of the bridge pier; investigation showed that this masonry notwithstanding its first-class appearance on the face, had been laid practically with dry hearting and without any bond between the stones, allowing the anchor beam and the face stones against which it rested to plow their way through the pier bodily, without disturbing the adjoining stones.

The anchorage at the Covington end of the bridge showed no sign of yielding, the masonry at that point being evidently of better quality.

It was thought more prudent however, to place no reliance whatever on the good quality of the masonry, and both anchorages were remodeled to satisfy this condition.

Water was let into the remainder of the supply main and into the city mains on January 21st, 1890.

It was found that the material of the fills at the corner of 13th and Stevens and of 13th and Madison was so loose as to afford insufficient backing support for the elbows at these points. This led to the insertion of timber platform backings at all the elbows in the city. These platforms being built of white oak will last several years. They should be replaced with a solid concrete backing before the timbers become seriously affected by decay.

Quite a number of leaky joints on the line had to be recaulked, but no break of pipe has yet occurred. The entire line is now in perfect condition, it should be carefully watched and all leaks stopped promptly, especially on that part of the line between the Alexandria pike and Budde's dairy, and between the Licking pike and the bridge, on account of the great danger of slides at those points.

The following is an itemized statement of the quantities and cost of all work done by McRae & Lally.

| | | | | | |
|---|---|---|---|---|---|
| 22,711.4 | l. ft. | 30 in. | Pipe laid | @ $ 1.75 | $ 39,744.95 |
| 2,286.5 | " | 24 " | " | " 1.39 | 3,178.24 |
| 8,297.9 | " | 20 " | " | " 1.15 | 9,542.58 |
| 15. | " | 18 " | " | " .80 | 12.00 |
| 18.2 | " | 16 " | " | " .72 | 13.10 |
| 12.2 | " | 12 " | " | " .50 | 6.10 |
| 51.8 | " | 10 " | " | " .43 | 22.27 |
| 952.4 | " | 8 " | " | " .35 | 333.34 |
| 231.4 | " | 6 " | " | " .30 | 69·42 |
| 5 | | 30 in. | Valves set | " 3.50 | 17.50 |
| 2 | | 24 " | " | " 3.50 | 7.00 |
| 7 | | 20 " | " | " 3.50 | 24.50 |
| 1 | | 15 " | " | " 3.00 | 3.00 |
| 10 | | 10 " | " | " 1 75 | 17.50 |
| 8 | | 8 " | " | " 1.50 | 12.00 |
| 39 | | 6 " | " | " 1.00 | 39.00 |
| 7 | | 4 " | " | " 1.00 | 7.00 |

| | | | | |
|---|---|---|---|---|
| 16 | Air valves, | @ | 4.00 | 64.00 |
| 10 | l. ft. 24 in. Drain pipe laid | " | 3.50 | 35.00 |
| 4 | " 21 " " | " | 2.75 | 11.00 |
| 238.8 | " 18 " " | " | 2.00 | 476.60 |
| 35. | " 15 " " | " | 1.62½ | 56.87 |
| 29. | " 12 " " | " | 1.25 | 36.25 |
| 379. | " 6 " " | " | .50 | 189.50 |
| 1,396. | " 4 " " | " | .35 | 488.60 |
| 37.04 | cu. yds. Stone Arch Masonry | " | 9.00 | 333.60 |
| 249.05 | " Broken Range Masonry, | " | 6.09 | 1,494.30 |
| 38.38 | " Brick Arch " | " | 9.00 | 345.42 |
| 96.19 | " Brick " | " | 7.00 | 673.33 |
| 27.46 | " Rubble " | " | 4.00 | 109.84 |
| 145.31 | " Dry " | " | 5.00 | 726.55 |
| 188.38 | " Concrete " | " | 5.00 | 941.90 |
| 35.91 | " Stone Paving in Cement | " | 4.00 | 143.64 |
| 55.15 | " Stone Paving Dry | " | 3.00 | 165.45 |
| 11.11 | " Broken Stone in founda'n, | " | 2.50 | 27.78 |
| 316. | ft. b. m. Timber in foundation, | " | 40.00 | 12.64 |
| 295.5 | l. ft. Tunnel, complete, | " | 28.00 | 8,274.00 |
| 22. | " Shaft, " | " | 15.00 | 330.00 |
| 1. | Entrance House | " | 100.00 | 100.00 |
| Added work, | | | | 1,436.78 |
| | Total amount of Work | | | $ 69,522.55 |
| Deductions for labor and material furnished, | | | | 1,009.96 |
| | Net amount of work paid to McRae & Lally | | | $ 68,512.59 |

TOTAL AMOUNT OF CONTRACT WORK.

| | |
|---|---|
| To the Newport Pipe and Iron Foundry for making and delivering pipes and castings | $178,438.01 |
| To McRae & Lally for pipe laying | 68,512.59 |
| Total amount | $246,950.60 |

The following items of expenditure and of work not done under contract, are also chargeable to the cost of construction of the pipe line.

| | |
|---|---|
| Valves and valve fixtures and repair of same, | $ 4,559.59 |
| Inspection of pipes and castings at foundry, | 1,015.31 |
| Anchorage of pipe on Licking bridge and suspenders, | 1,535.87 |
| Remodeling of anchorage | 521.78 |
| Bracing of pipe on Licking bridge | 487.68 |
| Revision and repair of pipe line, Material, | 264.16 |

| | |
|---|---|
| Revision and repair of pipe line, Labor | 1,092.10 |
| Miscellaneous labor and material | 134.44 |
| Miscellaneous hauling and freight | 52.95 |
| Damage paid land owners | 40.00 |
| Right of way | 33,854.30 |
| Total, | $ 43,558.18 |

RECAPITULATION OF COST.

| | |
|---|---|
| Cost of contract work | $246,950.60 |
| Cost outside of contract work | 43,558.18 |
| Total cost of pipe lines, | $290,508.78 |

## ENGINEERING.

The surveys for the location of the different parts of the work were all done by Mr. Alfred Petry, who was appointed Resident Engineer when construction began in 1888, and remained in charge of the work until its completion.

In addition to Mr. Petry the following assistants were employed at various times during the progress of the work.

*In the Office—*

K. E. HILGARD, Draughtsman.
W. H. SCHUERMAN, Draughtsman.
C. N. MILLER, Draughtsman.

*In the Field—*

J. D. DARLINGTON, Assistant Engineer.
PAUL FORWERG, Assistant Engineer.
EUGENE CARROLL, Assistant Engineer.
C. P. YEATMAN, Assistant Engineer.
WILLIS KENNEDY, Rodman and Ass't Eng'r.
J. B. DELANEY, Rodman.
THOMAS RYAN, Inspector of Masonry.
WM. THOMPSON, Inspector of Pipe Laying.
LEE WHITTAKER, Inspector of Machinery.

I desire to acknowledge my personal obligation to all the members of the Engineer Corps for their able co-operation. The good quality of the work done is due in the

largest measure to the vigilance and good judgment displayed in the performance of their duty.

The following statement gives the cost of engineering:

| | | |
|---|---|---|
| Salaries. | 1887 | $ 8,855.10 |
| | 1888 | 12,801.31 |
| | 1889 | 12,640.21 |
| | 1890 | 11,043.88 |
| | 1891 | 4,061.33 |
| Supplies | | 1,506.61 |
| | Total cost of Engineering | $50,908.44 |

RECAPITULATION OF COST OF CONSTRUCTION.

| | | |
|---|---|---|
| Reservoir | | $ 505,924.54 |
| Pumping Station | | 224,628.16 |
| Pipe Line | | 290,508.78 |
| Engineering | | 50,908.44 |
| General Expenses. | Current expenses, including salaries of trustees, auditor, janitor, rents, hire of livery &c. | 30,848.78 |
| | Legal expenses | 5,263.40 |
| | Incidental expenses, including postage, tolls, traveling expenses, &c | 1,329.48 |
| | Contingent expenses | 189.32 |
| | Advertising and printing | 2,071.49 |
| | Stationery | 421.02 |
| | Office furniture | 437.37 |
| | Horse and wagon | 304.50 |
| | Borings in Licking River | 177.00 |
| | Total cost of plant to August 1st, 1891 | $1,113,012.28 |

ADDITIONAL REQUIREMENTS.

Temporary gates have been erected across the three roads leading to the reservoir from the Highland and Alexandria pikes, to regulate the admission of vehicles on the grounds, but the grounds will be exposed to the incursion of cattle from the adjoining fields until a substantial fence is built on the boundary lines and connected with the gates.

A dwelling house for the reservoir keeper is a necessity, it is important that the man in charge of the reservoir should always remain on the ground.

Dwelling houses for the engineers and other employees at the pumping station should also be provided as soon as possible, there are no convenient boarding places in the neighborhood and the men are working under conditions of great personal discomfort, which is detrimental to the good of the service.

For convenience and prompt action in case of accidents telephonic communication should be completed between the pump house, the reservoir and the office of the superintendent of the water department in the city.

Very respectfully,

G. BOUSCAREN,
Chief Engineer.

# APPENDIX.

## EXHIBIT "A."

## COVINGTON NEW WATER WORKS.

### GENERAL FORM OF CONTRACT.

This agreement made and concluded this ——— day of ——, 1887, by and between ——— of the first part and the Trustees of the Covington Reservoir of the second part: Witnesseth, that in consideration of the undertakings, agreements and promises of the said Trustees hereinafter contained, the said ——— hereby covenant and agree and bind themselves, their successors and assigns, strictly in accordance with the terms and stipulations of this agreement and the proposition of the said party of the first part, hereunto attached, and with the specifications forming a part of this agreement and under the direction of the chief engineer of the said Trustees and under his supervision and control, to furnish all the material and tools and do the works opposite which prices are affixed in their proposal, pertaining to ——— called for by this agreement, the same to be done in all particulars in accordance with the specifications that are a part thereof and the plans and drawings that may be from time to time furnished by the chief engineer of said Trustees and all of which are made a part hereof.

It is further expressly agreed and understood that the prices affixed to their proposal by the said party of the first part, shall be and are hereby accepted as full and entire consideration for labor, materials and tools required to complete and put in permanent working order, to the satisfaction of the engineer, each and all the works required to be done under the provisions of this contract and these specifications, and to maintain the same in a good, perfect, and wa-

ter tight condition for a period of six months after the acceptance of the entire completed work by said engineer.

That the said Trustees shall be and are hereby authorized to appoint, under their engineer, such inspectors and assistant engineers as they may deem proper to inspect the materials to be furnished and the work to be done and to see that the same strictly correspond with the specifications and plans. That all works herein referred to, necessary to fully complete and put in working order ————————————————shall be executed in the best, most thorough and workmanlike manner with the best of materials of their several kinds to the full satisfaction of and under the direction of the engineer for the Trustees and in conformity with the drawings prepared to illustrate said works, and with the instructions explanatory thereof.

That the ——— shall commence on or before the ———, and shall be fully completed and delivered to the Trustees on ———. That to insure prompt and speedy action, and save the party of the second part from loss from any cause whatsoever, the party of the second part reserves the right to order and direct the work to be prosecuted at such points as the engineer may designate and to order such force worked at such points as he may deem necessary to complete the work to be done within the time specified, and should the party of the first part fail to comply with said order by neglecting or refusing to employ such force or fail at any time or in any wise to prosecute the work and every part of it in such manner as in the opinion of the engineer is necessary to give reasonable assurance of the completion of the same within the time specified, or should the party of the first part persist in any of said work, in an improper manner, or in employing improper persons or in neglecting or evading the performance of their obligation under this contract, in any manner, then the party of the second part or their engineer, after giving ten days written notice to the person in charge, without the evil complained of being corrected to the entire satisfaction of said engineer, under the advice of the Trustees may declare this contract forfeited, and in such case all the rights of the party of the first part under this contract shall from thenceforth cease and be determined and the party of the second part may thereupon proceed to take possession of and use in completing the work or any part of it, such tools, machinery, tenements and other buildings and materials as may be on the work or

prepared for it and belonging to the party of the first part, to employ such number of workmen, laborers, teams and foremen as may in the opinion of the engineer, be necessary to insure the completion of the work within the time hereinbefore limited or as soon thereafter as may be practicable at such prices and wages as may be found necessary or expedient to give, and charge over the amount so paid, to the party of the first part as so much money paid to said party of the first part on this contract, and if for failure in any manner for non compliance with the Engineer's direction or for any omission or neglect of the requirements of this agreement by the party of the first part, this contract shall be declared forfeited, the party of the second part may at their option take possession of and re-let the work to other parties, the same as if this contract had never existed and such declaration of forfeiture shall exonerate the said party of the second part from any and all obligations and liabilities arising under this contract and the reserved percentage upon work done shall be forfeited absolutely to the party of the second part and by them retained for ever as liquidated damages, and the party of the first part agrees to give peaceable and immediate possession of all said work to the party of the second part or its authorized agents and contractors.

That the said party of the first part shall indemnify and save the said Trustees harmless from all claims against said Trustees for labor done and materials furnished under this contract, and shall furnish the said Trustees with satisfactory evidences, when called for by them, that all persons who have done work or furnished materials under this contract for which the said Trustees or the city of Covington may become liable under any law of the State of Kentucky, have been fully paid or satisfactorily secured; and in case such evidence is not furnished, an amount necessary or sufficient to meet the claims of the persons aforesaid, shall be retained from the money due the said party of the first part under this contract, until the liabilities atoresaid shall be fully discharged or satisfactorily secured.

That the said party of the first part shall execute a bond in such sum and with such securities as shall be approved by the said Trustees for the faithful performance of this contract, conditioned to indemnify and save harmless the said Trustees and the said City of Covington from all suits and actions of every name and description brought against the said Trustees or the said City of Covington for

or on account of any injuries or damages received or sustained by any person or persons by or from said party of the first part, their servants or agents, in the fulfillment of this contract or by or on account of any act or omission of the said party of the first part or their agents or by reason of failure by the said party of the first part to ——— in the manner and at the time hereinbefore agreed upon and for the faithful performance of this contract by the party of the first part; and that so much of the money due the said party of the first part under this contract, as shall be considered necessary by the said Trustees may be retained by the said Trustees until all such suits for claims or damages as aforesaid shall have been settled and evidence to that effect furnished to the satisfaction of the Trustees.

PAYMENTS.

On or about the first day of each month during the progress of the work, an estimate shall be made of the relative value of the work done, to be judged of by the engineer and upon his certificate of the amount being presented to the Board of Trustees at a regular meeting, eighty-five per cent. of the amount of said estimate shall be paid to the said party of the first part. When all work embraced in the contract is completed agreeably to the specifications and in accordance with the directions and to the satisfaction and acceptance of the engineer for the Trustees, there shall be made a final estimate of the quantity, quality, character and value of said work agreeably to the terms of this agreement, by and under the direction of the chief engineer; when the balance appearing due to the said party of the first part, less ten per cent. of the entire amount, shall be paid to them upon their furnishing the engineer of said Trustees with a sworn statement that all their obligations due for materials and labor have been paid and the engineer's certificate presented to the Trustees by them.

The remaining ten per cent. shall be paid at the expiration of six months after the completion of the work on presentation by the party of the first part of a certificate from the Engineer for the Trustees to the effect that the entire work is then in a perfect and water-tight condition.

The monthly estimates are to be paid on or about the fifteenth of each month.

The parties to this contract hereby mutually agree that the

Chief Engineer of the party of the second part shall be the sole judge and arbiter in all cases of disagreement, difficulty or dispute as to the quality or amount of work performed under this contract and also in relation to all other matters of differences that may arise between the parties hereto in relation to or touching the proper performance of any or all the conditions thereof, and his decisions given in writing shall be in the nature of an award, and the same shall be conclusive upon and between the parties as a final judgment in a court having jurisdiction of the parties and subject.

In witness whereof, the said ——— and the said Trustees of the Covington Reservoir, by their President, have signed this agreement in triplicate.

———————
———————
———————

## EXHIBIT "B."

# SPECIFICATIONS.

FOR THE

# CONSTRUCTION OF RESERVOIR FOR THE CITY OF COVINGTON, KY.

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### DESCRIPTION OF WORK AND EXTENT OF CONTRACT.

The work shall include all excavation, filling, puddling, concreting, paving, masonry, pipe laying and other works necessary to construct and maintain for a period of six months after completion, in good working order, three reservoir basins, as now located or to be located on the Moreland place, in Campbell county, Ky., with dams, culverts, shafts, ditches, pipes, valves and appendages and other structures, as shown on the plans or described in the specifications, or which may be ordered from time to time by the Chief Engineer for the Trustees of the Covington Reservoir.

### CLEARING.

All trees, bushes, stumps, grass and rubbish, as well as other surface obstructions, and all muck or other materials deemed objectionable by the Engineer, shall be removed from the entire surface covered by the dams, basins and fills adjoining thereto.

## DAMS AND FILLS.

### MATERIALS.

The dams and fills on the sides of the reservoir basins, shall be formed with the materials excavated from said basins and from the ditches, as far as the same are suitable for that purpose, excepting a part of the fill at the easterly end of the northerly basin which shall be made by the contractor for pipe laying, with the waste excava-

tion from the tunnel under the Highland pike, the materials excavated shall be selected for their respective positions. The best and most retentive clay for the puddle walls, the finer material next to the puddle walls and the coarser material for the back part of the dam or fills. The stone suitable for concreting, paving, or any other class of masonry shall be used by the contractor for that purpose.

FORM AND DIMENSIONS.

The dams shall be 15 feet wide on top and carried to the same heighth and level as their respective basins; the slopes on the basins sides of all dams and fills shall have an inclination of three horizontal to one vertical, the back slopes of dams shall be inclined 1¾ to 1. At the elevation of the top of the lower basin, the intermediate dams shall have a berm or horizontal offset 30 feet wide or such other width as the Engineer may determine, extending to the foot of the back slope.

All dams and fills shall be built on the basin sides with a puddle wall 5 feet wide on top and sloping 3 to 1 in front and 1¾ to 1 in the rear.

METHOD OF CONSTRUCTION.

The entire width between foots of slopes of puddle walls shall be excavated to the solid and water tight strata, the remaining width of seats of embankments shall be stepped or benched as directed by the Engineer.

The puddle shall be of carefully selected clay, free of stones measuring more than two inches in any direction, chopped up with spades and ground dry if necessary in the opinion of the Engineer, spread in horizontal layers of not more than six inches thick and rolled with approved grooved rollers weighing not less than two tons, with a sufficient sprinkling of water to weld thoroughly together all parts into a solid, homogeneous, compact, and water tight mass. Where the roller cannot reach, the puddle shall be rammed by hand. When a layer of puddle has been lying exposed for any length of time, the surface shall be cleansed and reworked before a further layer is added to it.

The remainder of the embankment shall be formed in horizontal layers of not more than 12 inches thick, rolled with two ton rollers and sprinkled with water as above. No stone shall be put into

the embankment measuring more than six inches, and there must be a sufficient quantity of clay with the stones to completely fill all void spaces.

The puddle walls and the remainder of the embankments shall be carried up simultaneously and kept always on the same level.

No perishable material of any kind or frozen earth shall be allowed in the embankments.

All slopes shall be carefully trimmed to the proper shape and inclination. The slopes on the basins sides shall be reveted as specified for the basins. The top, berm and back slopes shall be finished with a layer of loam six inches thick and sodded or sown with grass seed at the proper season, the kind and quantity of seed to be determined by the Engineer.

### CULVERTS, SHAFTS AND VALVE HOUSES.

Arch culverts to contain the pipes and valves shall be built in the dams as shown in the plans. They shall be of such size and length and shall be built of such class of masonry as the Engineer may determine.

A shaft shall be built at the lower end of each culvert over the valves, and shall be finished one foot above the berm level with a coping course of stone which shall serve as foundation for a valve house, or a platform cover of timber as may be determined by the Engineer. Each shaft shall be provided with a strong iron ladder well secured to the masonry and with iron supports and guides for the valve spindles well secured also to the masonry. The culverts shall be drained at their lower end through the waste pipes as shown. The masonry of the culverts and shafts above foundation shall be entirely wrapped in puddle 2 feet thick.

The valve houses shall be of brick with asphalt roof, doors and windows as shown; joists and flooring 2 inches thick of yellow pine; the door shall be of two thicknesses of one inch plank, tongue and grooved; it shall be hung with strong wrought iron hinges and provided with strong and approved lock.

The platform covers shall be built of 2x12 inch joists strongly bridged, and 2x6 inch planks spiked thereunto. Over the ladders they shall have trap doors hung with strong wrought iron hinges and provided with strong and approved locks.

BERM DITCH AND WALK.

The berm of the southerly intermediate dam shall have a paved ditch of the required size and shape at the foot of the back slope of the dam to convey the drainage water from the grounds between the two upper basins to the southerly ditch.

The berm of the northerly intermediate dam shall have a walk in place of a ditch to connect the inside and outside walks of the lower basin.

OVERFLOW.

An overflow 3 feet deep, 4 feet wide at the bottom and lined with paving on a concrete foundation shall be built as located for each dam by the Engineer, with a by wash also paved and connecting with the ditch.

## RESERVOIR BASINS, AND DITCHES.

GRADING.

The aera of each basin, including the side ditches and walks, shall be graded, sloped and finished as shown on the plans and laid out by the Engineer.

All side depressions below grade shall be filled level with the top of the basin for their entire length, with a front slope wall of puddle built as specified.

The bottom of each basin shall have a uniform grade as shown on the plans, and the sides slope shall have a uniform inclination all around of 3 to 1.

SIDEWALKS.

A berm 10 feet wide or more, shall be graded level with the top of the basins, between the berm and the side ditches. It shall be covered with a six inch layer of road metal.

SIDE DITCHES.

The side ditches shall be excavated to such grades and of such widths as the Engineer may direct; they shall be paved where necessary in the opinion of the Engineer.

The side ditches of the upper and lower basins shall connect with paved falls or shutes as located by the Engineer.

The inside drainage shall be conveyed to the outside ditches of the lower basin through a paved ditch on the berm of the southerly intermediate dam. The outside slope of the excavation for side ditches shall have an inclination of 1 to 1, or such other as may be found more suitable to the character of the material.

BORROWED MATERIAL.

If materials suitable for the dams and side fills are not found in sufficient quantity in the regular excavations for the reservoir basins and ditches, the deficiency shall be supplied from outside of the ditches, but the excavations for the same must be carried in regular form and must be shaped, sloped and finished as directed by the Engineer.

WASTE MATERIAL.

Materials excavated not suitable for embankments and masonry shall be deposited in regular shape on the Trustee's grounds at the foot of the back slope of the lower dam, or at such other place as the engineer may select.

REVETMENT.

The bottom and sides of each basin shall be reveted with concrete or paving, or both as each case may require in the opinion of the Engineer.

The bottom and sides must first be carefully trimmed to the proper shape and cleaned. Where the excavation has been carried down below the proper grade, it shall be filled to the proper grade by the contractor at his own expense with metaling or concrete as the case may require. From the top to the low water line of each basin the paving or concrete shall be laid on a foundation of broken rock mixed with a sufficient quantity of gravel and sand to fill all the interstices between the stones.

The concrete shall be mixed by machinery and well rammed in place in layers not more than 12 inches thick. It shall be finished with a coating of rich Portland cement mortar of sufficient thickness to cover all the stones and make a smooth finish. The paving shall be such as described under the head of paving for Reservoir Basins.

The fresh concrete shall be protected by suitable covering until it has sufficiently hardened to stand the weather.

MASONRY FOR INLET AND OUTLET.

Curbs of masonry shall be built around the inlet pipes in the upper basins as shown in the plan. This masonry shall be of even range or broken range work capped with a 12 inch course of dimension stones well clamped together.

Masonry piers for the inlets in lower basin and for the outlets in the three basins as well as rest piers for the floating tubes, shall be built as shown on the plans. These piers shall be built of even range or broken range work with heartings of concrete capped with 12-inch courses of dimension stone well clamped together.

The bottom, inside the inlet curbs and for a space three feet wide all around them, shall be paved with flag-stones hammer dressed and laid in cement, the tail walls of the inlet curb in the northerly upper basin shall have vertical grooves on their inside faces 8 inches deep and 10 inches wide, the grooves and the inside faces of the tail walls from the grooves to the end of the walls shall be dressed with the bush hammer

Stone steps 2 feet long, 8 inches high and 2 feet 4 inches wide, overlapping 4 inches, shall be laid from the top of each dam to the level of the top of outlet piers as shown on plans, these stones shall be hammer dressed and laid in cement on a foundation of concrete. The joints between the steps and revetment shall be thoroughly filled and pointed with rich cement mortar.

FOOT BRIDGES.

A foot bridge to be supplied by the Trustee's shall be erected and placed in position in each basin, resting at one end on the outlet pier and at the other end on the first stone step on the dam. These foot bridges shall be anchored at both ends on to their seats as shown on the drawings.

WEIR.

A timber weir shall be built by the contractor in accordance with plans furnished, and instructions from the Engineer for the purpose of measuring the water delivered into the reservoirs by the pumping engine. This weir shall be erected as a continuation of the tail walls of the inlet in the northerly reservoir, and shall form a water tight connection therewith.

When the measurements are completed the contractor shall dis-

connect the weir and deliver it on the reservoir grounds at such point as the engineer may direct.

## PIPES, CASTINGS, VALVES AND FLOATING TUBES.

### PIPE LAYING.

All the pipes, valves, special castings, floating tubes, pedestals and other appendages, required in and out of reservoir from a point near the westerly end of the tunnel under the Highland pike to a point near the foot of the westerly slope of the lower dam, shall be laid and erected by the contractor.

All pipes inside of the reservoir shall be laid in concrete as shown on plans. All flanged pipes and castings shall be jointed with sheet lead gasket properly lapped and of the full diameter and width of the flanges.

### TESTING OF PIPES LAID.

All pipes laid inside of the basins and dams shall be tested to 300 pounds hydraulic pressure after they are laid, and all joints must be made water tight under that pressure before they are covered up. The contractor shall supply the water, pumps, gauges, plugs and all other appliances, materials and tools, as well as all labor necessary for these tests, without extra charge, the cost of same being included in his prices for pipe laying.

All the pipes and special pipe castings shall be delivered to the contractors on the reservoir grounds. All valves, sluice gates, floating tubes, foot bridges and their appendages shall be delivered by the Trustees to the contractors at the railroad depot in Covington or Newport; from the time of delivery the contractor shall be responsible to the Trustees for all breakages or injury to the same. The contractor shall furnish all labor, tools and materials necessary for the work, excepting the materials to be furnished by the Trustees as named above.

### GRADE AND ALIGNMENT.

The grade and alignment of the pipe shall conform with the grade and alignment shown on the profile and plan furnished to the contractor and with any modification or change thereof that may be considered necessary or advisable by the Engineer during the progress of the work.

CLEARING.

All trees, stumps, bushes and rubbish, as well as other surface obstructions within six feet of the center line of the trench, and any additional width that may be required for the work, shall be removed.

TRENCHES.

The width of trenches shall be sufficient at all points to allow the pipes and their appendages to be laid, set and caulked in the best and the most thorough and workmanlike manner.

The depth of the trenches shall be such as may be required to conform with the grade given by the Engineer for the pipe, there shall be at least three feet of earth covering on top of the pipe.

Wherever the bottom of the trench has been carried down below the proper grade, it shall be brought up to grade with selected material well rammed in.

FOUNDATION.

Where the bottom of the trench is soft and liable to yield, it shall be excavated to such additional depth as the Engineer may require and a foundation of broken rock covered with a six-inch layer of selected material well rammed or such other foundation as the Engineer may prescribe shall be put in.

ROCKY BOTTOM.

Where the bottom of the trench is rocky it shall be excavated six inches below grade and brought up to proper grade with selected material well rammed in.

PRECAUTIONS.

In excavating the trench, the contractor shall carefully remove all loam, pavement and road metal at the surface and separate the same from the other material excavated, to be used in restoring the grounds, roads and streets to their original condition.

All blastings near houses and public thoroughfares shall be done with the most diligent care and precaution to prevent injury to persons and property. All trenches shall be properly shored up. Trenches through public and private roads and through pasture lands shall be properly fenced and guarded. The contractors shall place and maintain in public highways proper painted notices of warning by day and red lights of warning by night.

REPAIR OF SEWERS, PIPES, FENCES, ETC.

The contractor shall at his own expense divert, repair and restore to the satisfaction of the Engineer, all sewers, culverts, drains, pipes, ditches, roads, fences and other works and properties which he may disturb or injure during the progress of his work.

TRAVEL NOT TO BE INTERRUPTED

The contractor shall so conduct and manage his work as not to interrupt travel in streets and public highways, and shall provide safe and convenient temporary crossings for the same when necessary.

BACK FILLING.

After the pipe is laid the trench shall be filled with selected material, free from rock, measuring more than two inches, carefully rammed on the side and top of the pipe to a level of six inches above the top of the pipe. The remainder of the fill shall be made with the material excavated, excluding all stones measuring more than six inches in any direction, rammed in layers of six inches in depth until sufficient room is left to receive the loam or the road metal or pavement which must be carefully replaced with such additional quantity as may be required for the restoration of the original surface. In streets and roads, the contractor shall finish the same to the satisfaction of the City Engineer or Superintendent of road or others having the same in charge. The surface shall generally be left higher than originally, making such allowance for the settling of the fill as the Engineer may direct. Frozen earth, roots, grass, and other perishable materials shall be carefully excluded from the fills. Where the trench is so shallow as to leave less than 3 feet depth of covering on top of the pipe, sufficient material shall be added on to obtain the requisite depth of three feet. Where the bottom of the pipe is above ground, a foundation shall be built for its support after carefully removing for the entire width of its base, all grass, vegetable mold and other materials deemed objectionable by the Engineer and a fill shall be made and carried to a height of not less than 3 feet above the top of the pipe, making always proper allowance for shrinkage. The fill shall be made with approved material, using the same care and method as prescribed for the back filling in trenches.

All fills above ground shall have side slopes of not greater inclination than 1½ to 1. On sloping ground the fills shall be protected with approved surface ditches, and drains of approved size and construction shall be put in when required.

WASTE MATERIAL.

All waste material from the trenches shall be used for the construction of dams and fills as far as they may be suitable therefor.

BORROWED MATERIAL.

When the material excavated is insufficient or unfit to complete the back filling or fill, the contractor shall supply approved earth for the purpose from the side excavations of the basins as provided under the head of grading.

CLEANING.

Before being laid the pipes shall be brushed through to remove adhering earth and all foreign matters which may have been left therein.

MANNER OF LAYING.

They shall be placed singly in the trench and bedded so as to rest firmly and uniformly throughout their entire length on the solid earth.

JOINTS.

The joints shall be made with the best quality of tarred hempen yarn, closely twisted in one piece for each joint, well caulked into the socket with a special tool, and soft lead poured in at one running and set up thoroughly and entirely around the pipe. The depth of lead after caulking shall not be less than 2½ inches. The joints must be well and faithfully caulked by an experienced and competent man in the best manner.

PRECAUTIONS.

Care shall be taken to prevent any earth, stone or other material from entering the pipes as they are being laid, and every open end of a pipe laid shall be plugged before leaving the work for any length of time.

The pipes and appendages shall be handled with the greatest care and with proper tools so as to avoid injury to the coating. No injured or imperfect pipe shall be laid.

No vertical and horizontal curve or bend shall be laid with straight pipes of less radius than 478 feet, without special provision and permission of the Engineer.

### CROSSING OF WATER COURSES.

At the crossing of water courses, arch culverts and pipe drains shall be built in accordance with plans furnished by the Engineer, and the pipe laid thereon and covered to such a depth as may be required.

Where the pipe crosses under the bed of the stream it shall be laid in concrete and protected with paving and slope walls, when required by the Engineer.

Where the pipe crosses existing culverts and drains so as to require the reconstruction of any part thereof, the same shall be done in accordance with plans furnished or approved by the Engineer.

### VALVE CURBS.

Valve curbs, where required, shall be of stone or brick laid in cement with approved cast iron neck and cover. They shall be built on a foundation of stone or brick laid in cement and shall be drained with a stone-ware pipe of suitable size.

## MASONRY.

### STONE.

The stone shall be generally blue lime stone of best quality found in the hills surrounding Newport and Covington, or other stone of good quality approved by the Engineer. It shall be of the size prescribed for each class of work, free from clay and dry seams, and sound in every particular.

### BRICK.

The brick shall all be hard burnt paving brick, well tempered, of good form, free of lime and cracks and capable of standing a pressure of four thousand pounds per square inch without crushing. They shall be soaked in water immediately before using.

### CEMENT.

The cement shall be equal to the best quality of Louisville hydraulic cement and shall stand, without breaking, a tensile stress of

one hundred pounds per square inch in briquettes seven days old; it shall not swell or crack in the process of hardening. The Portland cement shall stand, without breaking, a tensile strain of 300 pounds per square inch in briquettes seven days old. All cement shall be properly cooled and air slacked before used.

SAND.

The sand shall be clean, sharp river sand.

MORTAR.

The cement mortar shall generally be composed of one measure of cement and two measures of sand, well mixed with clear water in clean mortar beds and used immediately after mixing.

Different proportions of sand and cement shall be used, if required by the Engineer.

BRICK ARCHING.

Brick arching shall consist of the required number of rings of brick laid flush in cement mortar, each line of brick breaking joints with the adjoining lines in the same ring and in the ring below it. No headers shall be used in the arch. No bats shall be allowed in the work except for closures.

The thickness of joints shall not exceed one-half inch between bricks in the same ring nor five-eight inch between rings. The arch shall be covered over with a coating of cement mortar not less than three-quarters inches thick.

BRICK WALLS.

The same specifications shall apply to brick walls as for brick arching, excepting that the brick shall be laid in wall with the ordinary bond, every seventh course being of headers.

BRICK PAVING.

The bottom or floor shall be first carefully trimmed to the proper form and covered with a thick bed of cement mortar, the brick shall be floated thereon and laid close with full joints to the required template. The brick shall be laid on edge and shall break joints as for brick arching.

The paving shall also be grouted after being laid if the same be considered necessary by the Engineer.

### STONE ARCH MASONRY.

The arch proper shall be built of selected stone of uniform thickness in each course, laid flush, in cement mortar, each stone extending through the entire thickness of arch. The stones shall not be less than six inches thick; they shall be hammer dressed on the intrados, bed and joints; the joints shall be square with the face and not less than nine inches deep; each course shall break joints not less than eight inches with the courses adjoining; the thickness of joints shall not exceed three-quarter inches.

The arches shall be backed from the haunches with rubble work, laid flush, in cement mortar. The ring stones at the ends shall be rock faced.

The abutment walls, wing walls, parapet and sunk walls shall be built of even or broken range work, such as described under that head; the parapets and wings shall be capped with selected stones, projecting four inches beyond face of walls, not less than six inches thick and eighteen inches long, and extending through the entire width of the coping course with parallel joints. The joints and beds of the coping course shall be hammer dressed.

### EVEN AND BROKEN RANGE WORK.

Even and broken range masonry shall be built of stones not less than 6 inches thick, well bonded and laid flush in cement mortar. No stone shall measure less than 1½ square foot on the bed and ⅓ at least must be headers extending through the entire thickness of wall when the same does not exceed 18 inches. All stones must be square-faced and break joints not less than 8 inches with those adjoining. The face-joints shall not be less than 6 inches deep—joints and beds shall not exceed ¾ inches in thickness. No spalls shall be allowed in the beds and face joints.

The masonry shall be capped with selected stones of the entire width of coping course, of uniform thickness, not less than 6 inches. They shall have hammer dressed beds and joints.

### STONE PAVING.

Stone paving shall be built with selected stones from 8 to 12 inches deep and not less than 4 inches thick roughly squared at the ends and laid on edge dry or flush in good cement mortar, as the Engineer may direct.

CONCRETE.

Concrete shall be composed by actual measurement of four measures of broken stone of uniform size, measuring not more than two inches in any direction, free from clay and well screened, two measures of sand and one measure of cement, all well mixed on a plank bed and well rammed in place in layers as directed by the Engineer.

DRAIN PIPE.

None but double strength, vitrified stone pipe of the best quality and manufacture shall be used. The pipes shall be laid on a solid foundation carefully shaped to fit the pipe and covered with a good bed of cement mortar. The joints shall be completely filled with cement mortar. The ends of the pipe must be carefully set in a wall of brick or stone of approved shape and size and protected with a covering of earth not less than 2 feet thick.

PAVING FOR REVETMENT OF RESERVOIR BASINS.

The stones shall be of uniform thickness in each course, not less than 6 inches, 12 inches deep and not less than 12 inches long; they shall be square faced with good beds and joints, the joints extending not less than 8 inches from the face; they shall be laid square with the face of revetment and shall break joints not less than 6 inches. For dry paving they shall be laid and rammed firmly on a good bed of coarse sand spread uniformly on top of the metal foundation, and all joints shall be thoroughly filled with coarse sand, gravel and chippings. For paving in cement they shall be laid flush in cement mortar, on a good bed of mortar spread uniformly on top of the metal or natural foundation. All joints and beds shall be thoroughly filled and pointed with rich cement mortar; no spalls shall be allowed in the beds and joints. The thickness of joints shall not exceed ¾ inches.

FLAGGING.

The flag-stones for pavement inside and around the curbs and piers shall be of compact limestone, free of seams, and of quality approved by the Engineer. They shall measure not less than 8 square feet on the face, and not less than one foot in thickness. They shall have hammer dressed joints and face, and the joints

shall extend through the full thickness of the stones. They shall be laid flat on their natural quarry bed, in good cement mortar. All joints shall be well filled and pointed with rich cement mortar.

COPINGS.

The coping stones for the curbs and the piers shall be in all respects similar to the flag-stones for pavement. They shall be thoroughly bound together with approved iron clamps set in lead.

GENERAL.

All showing joints of all classes of masonry shall be neatly pointed with rich Portland cement mortar.

No masonry shall be laid in freezing weather without permission from the Engineer.

The foundations for all masonry shall be carried to such depths as the Engineer may direct; they shall be properly prepared with a bed of concrete or a timber platform if required. The timber shall be white oak free of sap and of all defects affecting its strength or durability.

## PRICES AND MEASUREMENTS.

Bidders must put in a price for every item of work named in the form of proposals furnished to them.

All grading shall be measured in the embankments and paid for as "embankment," "puddle" and "waste." There shall be no classification of materials excavated; the price to be paid shall include clearing, trimming, hauling, and all other items of expense connected with grading.

All classes of masonry, excepting drain pipes, shall be paid for by the cubic yard; measuring the actual quantity of each class of work in each structure; in arch culverts, only the masonry of arch proper above the spring line with the backing at the haunches shall be paid as arch masonry.

The prices to be paid shall include all items of expense necessary or incidental to the work.

The measurement of pipes for payment shall be the actual lineal measurement along the center line of pipes after they are laid and without any extra allowance for laps. The prices to be paid shall be for the pipes laid and covered including all curved and

other special pipe castings, other than valves, with all the works incidental thereto, complete, excepting masonry.

The prices to be paid for erecting and setting stop and waste valves, sluice gates, floating tubes and foot bridges shall include their cartage from the railroad depot in Covington or Newport and the carting and setting of their foundation, curbs, covers, pedestals, supports, anchorage and other fittings with all the works incidental thereto, complete, excepting masonry.

The prices to be paid for each valve-house shall be for the house complete, with floor, roof, doors, windows and all other works incidental thereto.

The prices to be paid for timber and wrought iron shall be for the actual quantities of these materials furnished by the contractors and left by him in the completed structures, and shall include all items of expense incidental to the placing of said materials in said completed structures.

The said prices shall also cover and include all the costs of excavations, trenching, blasting, hauling, bailing, pumping, shoring, centering, filling, and back filling, soiling, sodding, fencing, lighting, notices, guards, watchmen, repairs and restorations and all the materials, tools and labor necessary for or incidental to the construction and maintenance of the work until it is completed and accepted under the provisions of this contract and these specifications.

## GENERAL CONDITIONS.

The grading, masonry, pipe-laying and other works shall be proceeded with at such time as the Engineer shall direct.

### OBSERVANCE OF LAWS AND REGULATIONS.

In all operations connected with the work, all laws, ordinances and regulations controling or limiting in any way the action of those engaged on the work shall be respected and observed.

### SUB LETTING AND TRANSFERS.

The contractor shall not sub-let, assign or transfer this contract or any part thereof to any person or persons without the consent of the Trustees.

### COMPETENT WORKMEN.

He shall give his personal supervision to the work and shall employ competent workmen and experienced mechanics, skilled in

the several works assigned to them. He shall immediately discharge on request of the Engineer any of his employes considered by said Engineer as incompetent or disorderly, and shall not again employ him upon the works.

ORDERS CONCERNING THE WORK.

In the absence of the contractor from any part of the work, the engineer shall give his orders respecting that work to whomsoever may be in charge of or executing said work, and said orders shall be respected and obeyed.

CHANGES.

The Trustees shall have the right to make without vitiating this contract any changes in location, grade, alignment, form, dimensions and numbers at the several structures, and to increase or diminish the quantities of the work to be done as the interests of the city of Covington may in their judgment require, if the character of the work is also changed thereby and rendered more costly, the Engineer shall estimate and determine the amount which should fairly and equitably be allowed to the contractor, and the same shall be accepted by the contractor without any claims for anticipated profits on the work that may be dispensed with.

EXTRA WORK.

The value of any extra work shall be likewise estimated and determined by the Engineer.

No claim for extra work shall be made or allowed unless the work shall have been done in compliance with a written order from the Trustees or the Engineer. All claims for extra work shall be made in writing before the payment of the succeeding estimate after the work is performed, failing to make such claim the same shall be considered as abandoned by the contractor.

REJECTED MATERIAL.

The contractor shall promptly remove all rejected material to such distance as may in the judgment of the Engineer be sufficient to prevent its being used in the work.

DEFECTIVE WORK.

All defective work shall be promptly taken down by the con-

tractor on orders from the Engineer to that effect, and rebuilt properly at his own expense.

RATE OF PROGRESS.

The rate of progress of the work at all times must be such as to insure its completion within the limit of time specified. Should the same appear insufficient in the opinion of the Engineer, he shall have the right to order such increase in the working forces as he may think necessary.

SUSPENSION OF WORK.

The contractor shall without any claim for damages or extra compensation suspend the work when he shall be ordered to do so by the Engineer by reason of inclement weather or for other causes.

EXTENSION OF CONTRACT. TIME

But if his work be delayed by reason of non-delivery of pipes, valves or other appliances to be furnished by the Trustees, failure to procure the right of way, or other acts of the Trustees, he shall be entitled to a reasonable extension of time for the completion of his work and the Engineer shall estimate and determine the length of such extension, but the contractor shall have no claim for damages on account of such delays.

LIABILITIES AND RISKS.

The contractor assumes all risks arising from the weather, accidents and casualties of all kinds. He shall pay all damages to persons and properties and repair at his own cost all damages that may occur to the work until it is completed entirely and accepted by the Engineer. He shall further maintain at his own cost in a good, perfect and water tight condition, all parts of the work for a period of six months after its acceptance by the Engineer.

SPECIFICATIONS DEFINED.

The meaning and intent of these specifications shall be defined by the Engineer and his decision thereon shall be final and binding upon the parties thereto.

CONVICT LABOR.

No convict labor shall be employed on the work.

ENGINEER DEFINED.

Wherever the word Engineer is mentioned in this contract it shall be taken to mean the chief Engineer for the Trustees.

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# FORM OF PROPOSAL

FOR THE

## CONSTRUCTION OF RESERVOIRS.—1st CONTRACT.

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The undersigned hereby certif that ha personally and carefully examined the grounds and site of the proposed reservoir for the city of Covington, Ky., on the Moreland place, in Campbell county, Ky.: also, that ha carefulıy examined the plans and profile for the same, and carefully read the annexed specifications and form of contract.

Having made such examination, the undersigned hereby propose to the Trustees of the Covington Reservoir to construct and complete said reservoir, to do all the works specified according to the conditions and specifications aforesaid and on the acceptance of this proposal hereby binds to enter into and execute the contract for the work at the following prices.

These prices are to be in full compensation for performing the said work and for guaranteeing their permanency and durability as provided in the contract and specifications.

PRICES.

| | Dollars. | Cts. |
|---|---|---|
| Embankment (excepting puddle) per cubic yard | | |
| Puddle, per cubic yard | | |
| Waste excavations, per cubic yard | | |
| Stone arch culvert masonry, per cubic yard | | |
| Broken Range Masonry, per cubic yard | | |
| Brick arch culvert masonry, per cubic yard | | |
| Brick masonry, per cubic yard | | |
| Brick paving, per cubic yard | | |
| Stone paving in cement, per cubic yard | | |

| | | Dollars. | Cts. |
|---|---|---|---|
| Stone paving, dry, per cubic yard | | | |
| Concrete, per cubic yard | | | |
| Revetment of Basins. | Stone paving in cement, per cubic yd. | | |
| | Stone paving, dry, per cubic yard | | |
| | Flagging in cement, per cubic yard | | |
| | Metal in foundations, per cubic yard | | |
| | Concrete, per cubic yard | | |
| Copings of piers and curbs basins, per cubic yard | | | |
| Drain Pipes | 12 inches diameter, per lineal foot | | |
| | 6 inches diameter, per lineal foot | | |
| | 4 inches diameter, per lineal foot | | |
| Pipe laying Complete. | 30 inches diameter, per lineal foot | | |
| | 18 inches diameter, per lineal foot | | |
| | 8 inches diameter, per lineal foot | | |
| | 6 inches diameter, per lineal foot | | |
| | 4 inches diameter, per lineal foot | | |
| Setting stop Valves Complete, each. | 30 inches diameter, each | | |
| | 18 inches diameter, each | | |
| | 8 inches diameter, each | | |
| | 6 inches diameter, each | | |
| | 4 inches diameter, each | | |
| Setting flushing hydrants, each | | | |
| Erecting floating tubes and supports——, each set | | | |
| Erect foot bridges——, each | | | |
| Erecting and setting sluice gates——, each | | | |
| Valve houses——, each | | | |
| Timber in platform covers and weir————per 1,000 feet B. M | | | |
| Wrought iron in weir, clamps, spindles, ladders, bolts, &c.,————, per pound | | | |

Signature_____

_____

_____

Address_____

_____

_____

_____

Dated_____

# FORM OF PROPOSAL

FOR THE

## COMPLETION OF RESERVOIR.—2nd CONTRACT.

The undersigned hereby certif that personally and carefully examined the grounds, site and unfinished work of the proposed Reservoirs for the City of Covington, Ky., in Campbell County, Kentucky, as also the materials delivered for the same, the plans and profiles for the same, and carefully read the annex specifications and form of contract. Having made such examination, the undersigned hereby propose to the Trustees of the Covington Reservoirs to construct and complete said Reservoirs, and to do all the works specified according to the conditions and specifications aforsaid, using the materials delivered as far as they are suitable for the same; and on the acceptance of this proposal hereby bind to enter into and execute the contract for the work at the following prices. These prices are to be in full compensation for performing the said work and for guaranteeing their permanency and durability as provided in the contract and specifications.

| | Dollars. | Cts. |
|---|---|---|
| Embankment excepting puddle, per cubic yard | | |
| Puddle, per cubic yard | | |
| Waste excavation, per cubic yard | | |
| Broken or even range masonry, per cubic yard | | |
| Brick masonry, per cubic yard | | |
| Brick paving, per cubic yard | | |
| Stone paving in cement, per cubic yard | | |
| Stone paving dry, per cubic yard | | |
| Concrete, per cubic yard | | |
| Revetment of Basins — Stone paving in cement, per cubic yard | | |
| Revetment of Basins — Flagging in cement, per cubic yard | | |
| Revetment of Basins — Metal in foundations, per cubic yard | | |
| Revetment of Basins — Concrete, per cubic yard | | |
| Pipe laying—6 inches diameter—per lineal foot | | |

| | Dollars. | Cts. |
|---|---|---|
| Setting hydrants, including 4 inch pipe, branch and valves—each | | |
| Setting 6-inch valves—each | | |
| Erecting and setting floating tubes and supports—each set | | |
| Erecting and setting sluice gates and appendages, each | | |
| Valve houses, upper dams, each | | |
| Valve house, lower dam | | |
| Timber in platform covers and weir per 1,000 feet—B. M | | |
| Wrought iron in weir, clamps, guards, ladders, bolts, &c., per lb | | |
| Sodding slopes per square (10ft. square) | | |
| Pointing unfinished paving revetment north basin per square (10ft. square) | | |
| Plastering unfinished concrete north basin per square (10ft. square) | | |
| Additional concrete in depressions below grade in lower basin—per cubic yard | | |
| Prices allowed to the Trustees for material delivered on the ground | | |
| Sand stone for broken or even range masonry { Dressed, per cubic yard | | |
| Undressed, per cubic yard | | |
| Sand stone for paving Revetment of basins { Dressed, per cubic yard | | |
| Undressed, per cubic yard | | |
| Limestone { For broken or even range masonry, per cubic yard | | |
| For paving revetment of basins, per cubic yard | | |
| Undressed { For paving, outsides of basins, per cubic yard | | |
| For concrete and metal, per cubic yard | | |
| For sand, per cubic yard | | |
| For cement, per barrel { Portland | | |
| Louisville | | |

## EXHIBIT "C."

# COVINGTON NEW WATER WORKS.

## SPECIFICATIONS FOR CAST IRON PIPES.

### QUALITY AND STRENGTH OF METAL.

The iron shall be of pig metal, it shall be tough, close-grained, of homogeneous texture and uniform in quality, it shall stand without breaking a tensile stress of 20,000 lbs. per square inch.

### METHOD OF CASTING.

The pipes shall be cast vertically and without the use of core nails, they shall be cooled gradually to avoid chilling in any part.

### PERFECT PIPES.

The pipes shall be straight, square at the ends and at the inner edge of socket, truly cylindrical and of the exact internal diameter specified, their sections shall be truly concentric and their thickness uniform throughout their length between socket and spigot. They shall have a smooth surface inside and out, free from air bubbles, scoria and core nails, all spigot ends shall fit well into sockets to the bottom.

The sockets and spigots shall conform in shape and size to the adopted standard which shall be subject to the approval of the Engineer for the Trustees.

### SPECIAL CASTINGS.

Curved pipes and other special castings shall be made in conformity with drawings furnished and approved by the engineer, they shall joint properly with straight pipes of the same diameter and with other castings with which they may be intended to connect.

### PROTECTION.

All pipes and special castings shall be coated inside and out with Dr. Augus Smith's preparation of soft pitch, linseed oil and

rosin at a temperature of about 300° Fahrenheit. Before dipping, the pipes must be free of rust and shall be carefully cleansed with hard brushes to remove adhering clay and sand. They shall remain in the bath not less than 30 minutes, the dipping pan shall be emptied and the mixture renewed after every day of continuous use.

TEST.

Every pipe shall be tested at the expense of the contractor under a hydraulic pressure of 250 lbs. per square inch for the pipes one inch thick, 300 lbs. per square inch for the pipes one and one-eighth inches thick, and 350 lbs. per square inch for the pipes one and one-quarter inches thick, and struck sharply with a hammer while being tested, to detect hidden flaws and cracks.

The weight and thickness of every length of pipe and casting must be marked thereon in plain legible letters and figures, in white paint.

DISCREPENCIES IN WEIGHTS.

Pipes weighing less than two per cent. of the calculated weight from the thickness specified, shall be rejected, any excess of weight over two per cent. of the calculated weight shall not be paid for.

INSPECTION.

An expert inspector appointed by the Trustees shall inspect and supervise the work and material and see that all the stipulations o these specifications are faithfully carried out, he shall have free access to the foundry and all tests and weighing shall be made under his personal supervision. The contractor shall furnish him with necessary facilities and all tools, specimens, appliances and labor required for his work, without extra charge.

REJECTED PIPES.

Pipes and special castings found defective after acceptance by the inspector and after delivery, shall be rejected and the contractor shall replace them with good pipes and castings acceptable to the engineer, free of cost to the Trustees.

QUANTITIES AND THICKNESS OF PIPES REQUIRED.

The quantities of pipes to be furnished under this contract are estimated to be approximately:

35,000 lineal feet of 30 inch internal diam. varying from one

inch to one and one-quarter inches in thickness and 2,000 lineal feet of 18 inches internal diam. one inch thick. These quantities include special castings. The exact quantity of each kind shall be determined hereafter when the location of the pipe line shall have been finally decided upon, but the aggregate is not expected to vary from the foregoing approximate figures more than 20 per cent.

RATE OF DELIVERY.

The pipes shall be delivered at the rate of 1/8 of the entire quantity required for each of the months of June, July, August, September and October, 1887, each delivery shall consist of pipes of such size and thickness as the Engineer shall direct and all special castings shall be made and delivered within thirty days of the orders therefor, the remainder of the pipes and castings shall be delivered within ninety days of the receipt of the order therefor.

FAILURE TO DELIVER.

The progress of the pipe laying and other work of the trustees must not be delayed by the failure of the contractor to deliver the pipes and castings in accordance with the conditions herein specified, and in case that the contractor should fail to comply with these conditions or any other stipulation of his contract, it shall be in the discretion of the Trustees to order and purchase their pipes and castings elsewhere and to deduct any extra charges thereby incurred from any money which may then be or afterwards become due to the said contractors.

TERMS OF PAYMENT.

The contractor shall be paid on or about the 15th of every month 90 per cent. of the monthly estimate returned by the Engineer for pipes delivered during the preceding month and the balance at the termination of the contract, on presentation of the final certificate of the Engineer.

PROPOSALS.

Proposals shall be received for the pipes delivered on board cars in Covington and Newport, and also for the pipes delivered and distributed on the located line for the pipe, each length to be deposited within 30 feet of the position it is to occupy in the trench. For delivery on board cars the Trustees reserve the right to determine the quantities that shall be delivered in Newport and Covington, re-

spectively. Information as to the probable location of the pipe line can be had at the Engineer's office—contractors bidding for the delivery of the pipe on the line, are requested to go over the ground and acquaint themselves with the difficulties of delivery.

## FORM FOR PROPOSAL.

The undersigned having carefully read the specifications hereunto annexed for the pipes and castings of the Covington New Water Works, and having personally examined the ground on the location of the pipe line, hereby propose to furnish and deliver said pipes and castings, and upon acceptance of this proposal by the Trustees of the Covington Reservoir, hereby agree and bind themselves to enter into and execute a contract for the delivery of said pipes and castings in accordance with said specifications at the following prices:

Straight pipe delivered o, b, c, in Covington per ton of 2,000 lbs. ———.

Straight pipe delivered o, b, c, in Newport per ton of 2,000 lbs. ——— .

Straight pipe delivered and distributed on the located line of pipe—per ton of 2,000 lbs. ——— .

Special castings delivered on board cars in Covington—per ton of 2,000 lbs. ———.

Special castings delivered o, b, c, in Newport—per ton of 2,000 lbs ——— .

Special castings delivered and distributed on the located line of pipe—per ton of 2,000 lbs. ———.

Signature ———————.

Address ———————.

## EXHIBIT "D."

# SPECIFICATIONS

FOR THE

## DELIVERY OF PIPES AND CASTINGS FOR THE NEW COVINGTON WATER WORS.

### EXTENT OF CONTRACT.

The contract for the delivery of the pipes and castings shall include the unloading from the cars at the railroad yard in Covington and Newport and the hauling of the same to the place they are intended to occupy on the pipe line and at the reservoir site. The pipes intended to be laid on the west side of the Licking shall be delivered by the foundry on board of cars in Covington, those intended to be laid on the east side of the Licking shall be delivered by the foundry on board of cars in Newport.

### UNLOADING.

The cars must be unloaded promptly within the time allowed by railroad company for the same. Any charge for demurrage of cars beyond said time shall be paid by the contractors. In unloading the cars the pipe shall not be allowed to drop therefrom, but shall be handled with a derrick, or rolled off gently by means of skids and ropes. The same care shall be used in unloading from the wagons and trucks at the place of delivery on the line.

### HAULING AND DELIVERY.

The pipes shall be hauled on suitable trucks and wagons and delivered on the ground, in a sound condition, within thirty feet of the place they are intended to occupy in the trench, or at such place as shall be satisfactory to the engineer for the Trustees. They shall

not be dragged or rolled over stony ground, but shall be handled with proper care and judgment to avoid injury to the iron and the rubbing off of the coating. The engineer shall designate the exact location on the line of each class of pipe.

FAILURE TO DELIVER.

The progress of the pipe laying and other work of the Trustees must not be delayed by the failure of the contractor to deliver the pipe and castings as specified; and in case he should fail to deliver the same promptly as they arrive from the foundry, or cause any injury or damage to the pipes in handling or hauling the same, or fail to comply with any other condition of his contract, it shall be in the discretion of the Trustees to employ any other person or persons by contract or day's work, or otherwise, to do the work, and to purchase other pipes and castings to replace those that may have been damaged or injured, and to deduct all expenses thereby incurred from any money which may then or may afterwards become due to the said contractors.

PRICES.

The prices must cover all labor, tools, appliances, working tools, and other expenses necesary or incidental to the prompt and safe delivery of the pipes and castings as specified.

LIABILITIES.

The contractor shall be liable for all damages done to persons and properties, caused by them or their agents.

PAYMENTS.

The contractors shall be paid on or about the 15th of every month ninety per cent. of the monthly estimates returned by the Engineer for pipe delivered during the preceding month, and the balance at the termination of the contract on the presentation of the final certificate of the Engineer.

INFORMATION.

Information as to the location of the pipe line and reservoirs can be had at the Engineer's office. Contractors are required to go over the ground and acquaint themselves with the difficulties of delivery and the length of the haul before bidding.

The Trustees guarrantee to the Cincinnati and Newport Iron and Pipe Company free right of ingress and egress on the entire line of the pipe, to be exercised with due care on their part in doing said hauling.

## FORM FOR PROPOSALS FOR THE DELIVERY OF PIPES.

The undersigned having carefully read the specifications hereto annexed for the delivery on the line of pipe, of the pipes and castings required for the new Covington Water Works, and having personally examined the ground on the location of the pipe line, hereby proposes to deliver said pipes and castings from the railroad cars in Newport and Covington, and on acceptance of this proposal by the Trustees of the Covington Reservoir, hereby agree to enter into and execute a contract with said Trustees for the delivery of said pipes and castings in accordance with said specifications at the following price :—

1. For pipes and castings delivered on the west side of the Licking—per ton of 2,000 lbs.—$ ———

2. For pipes and castings delivered on the east side of the Licking—per ton of 2,000 lbs.—$ ———

Signature.
Address.

## EXHIBIT "E."

# SPECIFICATIONS

— FOR —

## FLOATING TUBES, WASHOUTS, GATES AND APPENDAGES OF THE COVINGTON RESERVOIR.

## GENERAL DESCRIPTION.

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### FLOATING TUBES AND APPENDAGES—BODIES.

There shall be three floating tubes, 30 inches inside diameter, and 29 feet, 29 feet and 35 feet long respectively from center of rotation to upper end of strainer.

The body of each tube shall be built of sheet iron ¼ inch thick, riveted with butt joints, batten rings and plates; the batten rings on the outside and the batten plates on the inside.

The tube bodies shall be stiffened with 2 in. x 2 in. x 3.1 lb. angle rings, space as shown on plan.

### CAST ELBOWS.

The lower end of tube shall be fastened to a flanged cast iron elbow by a 3 in. x 3½ in. x9 lb. angle, and 24 bolts, ⅝ in., with a lead gasket between them. To a cast bracket on the elbow is fitted a wrought iron journal, fastened thereto with four ⅞ inch bolts, and turning on brass bearings on a cast iron chair, as shown on plan.

A circular frame of wrought iron pressed into the opposite end of the elbow is fastened thereto with four [4] ⅝ set screws. Into the center of the frame is fitted a 2 in. pin, fastened with nut and washer, and fixed with a ⅝ set screw.

The journal end of the pin, turns in a brass bushing, fitted into the center of a similar frame at the end of a 30-in. cast elbow bolted to the upper end of the effluent pipe which projects above the masonry, as shown. The joint between the two elbows is made water tight by a cup leather packing, as shown.

STRAINERS.

The strainer at the upper end of the tube is formed of 71 parallel angle bars, 1 in. x 1 in. x 1 lb. x 2 ft. 11 1/8 in. long, spaced 3/8 of an inch in the clear, and fastened by two [2] 1/4-in. rivets at each end, to iron angle rings 3 in. x 3 in. x5. 9 lbs. The strainer head is a 1/4-in. plate, perforated with 1/2-in. holes, 2 in. center to center, staggered, riveted to the upper angle iron ring. All the rivets in the tube, excepting when otherwise specified, are 1/2 in., spaced 2 in. center to center.

To facilitate repairs, three of the parallel angle bars on each side of the strainer are fastened together but are not riveted to the angle rings, as shown on plan, and can be removed when the plates are taken off.

Immediately below the strainer, a yoke made of two bars 3/4 in. x 2 in. riveted to the body of the tube, serves for the attachment of the float on the upper side, and of the hauling down chain on the under side.

FLOAT.[1]

The floats are cylinders, 4 ft.—6 in. diameter, with curved top and bottom, as shown; the length of the cylindrical part being 4 ft. —3 in. for the lower basin, and 3 ft.—9 in. for the upper basins.

They are built of 1/4-in. iron plates and 2 1/2 x 2 1/2 angles, riveted with 1/2 in. rivets 2 in. pitch. On the top is riveted a wrought iron flange collar 2 inches inside diameter, closed with a brass screw plug to admit the suction end of a hand pump for the purpose of pumping out water that may leak into the float.

The top and bottom are connected with a 3/4 inch rod upset and threaded at the upper end, with an eye-head and shoulder at the lower end. The rod goes through two wrought iron flanged collars

[1]The construction and sizes of floats were modified, they are riveted under the tubes and made all of the same size, viz, 6 ft. 4 in. in diameter, and 5 ft. long in the body.

riveted to the top and bottom of float; these collars project 1 inch inside of float through the ends of a two inch gas pipe strut.

The nut of the ¾ inch rod is forged with a ¾ inch round holder, through which a check nut is screwed home. The lower end of the ¾ inch rod is attached to the hinge frame through a double-forked forging, forming two knuckle joints at right angles. Lead washers are interposed between bearings at each end of the ¾ inch rod to form water-tight joints.

The hinge frame is forged in one piece, "A" shaped, with 1 in. x 1 in. iron, and turns on a 1 inch rod through the upper end of the yoke attachment.

### CAST STAND FOR FLOAT.[2]

A $\frac{7}{16}$ inch check chain, 5 feet long, fastened at one end to the lower pin of the knuckle joint, and to the strainer head at the other, forces the float to settle on a cast iron stand in front of the strainer when the tube is at rest in a horizontal position. This stand is flanged at both ends, one opened in front at the top and in the rear at the bottom, to allow for the free motion of the hinge frame and of the hauling down chain. It is anchored to a stone pedestal with four anchor bolts, ¾ inch diameter, as shown.

### CAST SUPPORT FOR FLOATING TUBE.

Another cast iron stand, also anchored to a stone pedestal with 4¾ inch bolts, serves to support the floating tube when it is at rest in a horizontal position. This stand supports also an 8 inch pully, with brass bushing, for hauling down chain.

### HAULING DOWN CHAIN AND CAST IRON WAYS.

This is a $\frac{7}{16}$ inch chain, fastened at one end to the lower part of the yoke back of the strainer, and at the other end to the drum of a crab anchored on top of the dam, in a direct line with the floating tube.

The chain rests on cast iron ways, made of ribbed slabs, laid on the stone pavement of the dam, as shown. The length of chain, which must be sufficient to allow the tubes to stand in a vertical position, is 179 feet for the lower basin, and 156 feet for each of the two upper basins.

[2]This stand was dispensed with.

### HAND CRABS.

The three hand crabs are alike. They shall be built with strong cast iron frames, anchored on a masonry foundation, and shall be geared with sufficient power and strength for a pull of 6,000 pounds with two men at the cranks; they shall have a hand-brake and ratchet wheel, and all journal bearing shall be of Babbitt metal.

## FLUSHING GATES AND APPENDAGES.

There shall be three flushing gates, one for each basin of the Reservoir. They shall be alike, excepting the length of the chains, which shall be thirteen feet for the lower basin, and 17 feet 6 inches for each of the other two upper basins.

### GATE BELL.

The gate bell is a cylinder 21½ inches inside of diameter, 4 feet 3 inches high, out to out, made of ¼ inch iron riveted with butt joint and outside batten plates on the seam. It shall be closed on top with a riveted flanged plate ⅜ inch thick. An annular cast footing riveted at the bottom forms the seat of the gate. All the rivets shall be ½ inch with 2 inch pitch, unless otherwise specified.

Underneath the inside flange of the cast footing a rubber ring ¾ inch thick, 13¾ inches, inside diameter, is bolted with 12 half inch bolts, and a wrought iron washer ring 2 in. x ¼ in. All bearing surfaces of the cast footing shall be dressed; the inside surface of same below the flange shall be dressed to a conical shape, as shown.

### GUIDE RODS.

Two guide rods, 1⅛ inch diameter, have T heads at the lower ends fitting into notched lugs cast on the flushing elbow set in the concrete revetment of the basin. The top ends of the guide rods are threaded, and screw on two cast bearings, bolted on a wrought iron bracket frame, set in the masonry, as shown.

Two wrought iron guides, riveted to the body of the gate bell, fit on the guide rods through bored holes 1½ inches in diameter, lined with brass bushings ⅛ inch thick.

BRACKET FRAME.

The bracket frame is formed of a horizontal bar, ¾ in. by 3 in., forged into a U shape, and bent downwards at the ends, which are laid 18 inches into masonry. Two inclined braces of the same size support this bar underneath; they bear squarely against the masonry at the bottom through a forked end, and connect with the horizontal bar at the top by riveted butting pieces, and 4 three-quarter inch bolts, which serve also to fasten the bearings for the guide rods.

The gate bell is suspended to a ⅝ inch chain by a V shaped stirrup, made of ⅞-inch round iron, riveted to the body of the bell, as shown.

ANCHOR BOLTS.

Provide four anchor bolts for each gate with 6 in. x 6 in. x ½ in. wrought washers to set the lifting crane on top of the masonry pier. These bolts shall be of 1¼ inches in diameter, and 22 inches long, from center of eye. They shall be forged with flat eye heads, as shown.

LIFTING CRANES.

Provide one lifting crane with folding legs as shown on drawing, to serve for the three basins. The hinge on top is formed by 1¼-inch pin through eye forgings bolted to the ends of frame and leg timbers, and supports the chain pulley 9 inches in diameter, with brass bushing.

Forgings with forked eyes are also bolted to the bottom ends of frame and leg timbers, and fastened by pins to the four anchor bolts on the pier. On the frame is mounted a hand crab geared with sufficient power and strength for a pull of 6,000 pounds on the chain with two men at the crank wheels. The crab shall have a hand brake and ratchet wheel, and all journal bearings shall be of Babbitt metal or brass.

The crank wheels shall be three feet in diameter; they shall be built to act as common wheels rolling on the ground when the legs are folded and the crane is being moved from place to place. When acting in this manner they shall be disconnected from the gearings.

## WORKMANSHIP AND DETAILS OF CONSTRUCTION.

All workmanship shall be first class in every particular.

### RIVETING.

Rivet holes shall be accurately spaced, and shall fit exactly opposite to each other, without drifting. No crack shall be allowed between the rivet holes and edge of piece. Rivets, when driven, shall completely fill the holes. Rivet heads shall be full size, well formed, and concentric to the holes. No loose rivets shall be allowed. All joints in the floating tube, float and gate bell, must be thoroughly caulked and water-tight.

### BEARING SURFACES.

All bearing surfaces except between riveted plates, must be machine dressed, and must fit with close contact throughout.

### PIN HOLES.

All pin holes shall be bored at right angles with the plane of rotation.

### PINS.

All pins shall be turned true to size and straight.

### NUTS, THREADS AND WASHERS.

There shall be wrought iron washers under all nuts of pins, and under nut and head of all bolts through wood; and the bearing of all nuts and heads must be uniform and true.

All threads must be well and uniformly cut and full. Nuts shall generally be hexagonal in shape; they must fit well and without play.

### GEARING.

All gearings shall fit well without lost motion, and shall be proportioned with a factor of safety of 5 for wrought iron, and 10 for cast iron.

## QUALITY OF MATERIAL

### WROUGHT IRON.

All wrought iron shall be tough, ductile, and of fibrous texture. Specimens of ½ square inch in sectional area cut out of bars and angles shall stand without breaking, not less than 50,000 pounds tensile stress, with elongation of 18 per cent., and shall bend cold 180° without sign of fracture, around a circle whose radius is equal to the thickness of the iron. Specimens, cut out of plates, shall stand without breaking, a tensile stress of not less than 48,000 pounds with elongation of 10 per cent., and shall bend cold without sign of fracture, 90° around a circle whose radius is equal to the thickness of the iron. Cold rivets shall bend flat on themselves without sign of fracture.

### CAST IRON.

Cast iron shall be of the best quality of tough gray metal, and shall stand without breaking, 20,000 pounds tensile stress, in specimens ¾ inches in diameter. Castings shall be smooth, well-shaped, free from air holes, cracks, cinders, core nails, and other imperfections.

All the wrought and cast iron must be thoroughly protected with a coating of coal tar and oil by Dr. Angus Smith's process.

## PRICES.

The price bid must cover all the material and work for the entire outfit, delivered in a finished condition, ready for erection at the Reservoir. All parts being distributed and left as near as practicable to the places which they are designed to occupy. The prices must also cover the guarantee that the entire plant, as well as each part thereof, shall work satisfactorily. All injuries or imperfections which may occur, or be discovered during the first six months of continuous use of plant, and which may be attributed to inferior material or workmanship, shall be made good by the contractor at his own cost.

## EXHIBIT "F."

# SPECIFICATION

FOR

# ENGINE HOUSE AND COAL SHED FOR AUXILIARY PUMP AT RESERVOIR.

### GENERAL DESCRIPTION.

The engine house and coal shed shall be located on the side of the driveway around the lower basin at the Reservoir, about 20 feet from the center line of the influent pipe branch to the lower basin, on a site specially graded for the same. The work shall include the foundation and valve pit, the walls, roof, floor, doors, windows, drains, and all the materials and labor necessary and sufficient to complete the house and shed in accordance with plans and specifications, ready to receive the machinery and coal supply.

### FOUNDATION AND VALVE PIT.

The excavation for the foundation and valve pit shall be carried down to a solid stratum to such depth as the Engineer may direct. The bottom of the trench and pit shall be properly trimmed and stepped to the proper level.

The first course of masonry shall be laid on a good bed of cement mortar. The walls, 18 in. thick, shall be of rubble masonry built of large, selected, flat limestone of the best quality excavated out of the basin, free of clay and laid flush in good Louisville cement mortar, composed of one part cement and two parts of clean, sharp sand mixed on a plank bed, and used immediately after mixing. The stones shall be thoroughly bedded in mortar, and joints thoroughly filled—there shall be no void spaces in the masonry. All showing parts of the walls shall be smooth and pointed with Portland cement. The bottom of the pit shall be covered with six

(6) inches of good concrete, made of 4 parts of broken rock, two parts sand and one part Louisville cement, thoroughly mixed on a plank bed, and well rammed in place. This concrete shall be plastered with Portland cement mortar so as to cover all projections and leave a smooth surface. The foundation walls for the brick walls shall be capped with a 10 in. course of sandstone, 14 in. wide. The pit walls shall be capped with 3 x 12 in. wooden plates. The space between the masonry and the sides of the excavation shall be filled with clay well rammed in.

Where pipes go through the walls, a small arch opening shall be made for the same, and the space between the pipe and opening filled with concrete after the pipe is laid.

The pit shall be drained with a 6 inch, vitrified, stoneware pipe laid in cement, and leading to the lower basin.

BRICK WALLS.

The brick walls shall be 13 in. thick; they shall be built of sound, hard burned, well tempered brick, free from cracks, well shapped, soaked in water before being laid, and laid flush in good lime mortar; all the joints to be well filled and not to exceed 3/8 in. thick.

The walls shall be well bonded, every seventh course being of headers; no bats shall be used except for closures.

The walls shall be neatly pointed and cleaned inside and out.

PLANK WALLS.

The front of the coal shed shall be boarded and battened from the roof down, leaving an opening of 6 ft. high from the floor. The boards shall be 8 in. x 1 in., and the battens 3 in. x 1 in. chamfered.

All outside wood work shall be dressed.

FLOORS.

The floors shall be constructed of 2 inch matched, white oak boards 6 in. wide, nailed to 4 in. x 6 in. sills, 3 feet centre to centre, laid flush on a bed of broken stone and sand 10 in. thick. The pit shall be covered with movable boards 3 in. thick.

ROOF.

The rafters shall rest on 2 in. x 12 in. wall plates, and shall be spiked thereon at both ends.

The sheathing shall be one-inch matched boards, free of holes and loose knots.

The roof covering shall consist of 3 plies of best quality of roofing felt, weighing not less than 50 lbs. to the square, each ply to be securely fastened to roof sheathing every 3 ft. with 6 penny nails with tin washers ¾ in. diameter.

There shall be a coating of roofing pitch between each ply, evenly spread, using not less than 40 lbs. of pitch to the square. The felt shall be covered with two coats of semi-liquid asphalt evenly spread, using in both coats not less than 60 lbs. of asphalt to the square, and embedding in the last coat, fine crushed granite free from dust and sand, that shall completely cover the roof. The felt shall be closely nailed to the edge of the sheathing all around, and shall be worked over the flange of the drum on the upper side, under the same on the lower side and over the tin of gutters, so as to make a water tight finish.

DRUM.

A flanged drum of No. 12, galvanized iron, 26 in. diameter and 30 in. high, shall be provided and placed as shown on plans, for the passage of the smoke stack through the roof.

GUTTERS AND DOWN-SPOUTS.

The gutters shall be made with raised strips on sheathings, slanting with proper fall, and lined with best quality of roofing tin soldered and painted on both sides.

The down-spouts shall be of No. 22, galvanized iron secured to walls with approved wrought iron fastenings; they shall make water tight connection with gutter, and discharge in a 4 inch vitrified stoneware pipe laid in cement, and leading to the road ditch.

WINDOWS AND DOORS.

The windows shall have freestone sills and caps, strong box frames and sashes for 10 in. x 16 in. lights. The sashes shall be well balanced, shall slide easily, and shall be fitted with spring locks and brass hook lifts.

The front door shall have sandstone cap and steps. There shall be a transom above the door. The door shall be 1⅞ inches thick, and shall be fitted with strong lock.

The sliding door between the engine room and coal shed shall

be of dressed white pine, hung on approved rollers to wrought iron bar well secured to wall. It shall be fitted with approved bolt and handle.

PAINT.

Doors, windows, cornices, and all outside wood work, shall be painted with three (3) coats of white lead mixed with boiled linseed oil and a pigment of approved color. All inside painting shall be finished with two coats of varnish. Gutters, down spouts, drums, and all metal about the building shall be painted with three (3) coats of best iron clad paint.

TIMBERS.

All timbers shall be full size, sound, true and straight, of the sound heart wood of living trees; they shall be free of sap, worm holes, wind shakes, decayed or loose knots and all other defects impairing their strength or durability.

The kind of timber for each part of the work shall be subject to the approval of the Engineer.

GENERAL CONDITIONS.

All materials and workmanship must be of the best class and subject to the inspection and acceptance of the Engineer.

The contractor shall promptly remove all rejected material from the premises.

He shall promptly take down on orders from the Engineer, all defective work and rebuild the same at his own expense. The contractor assumes all risks from the weather and casualities of all kinds, and agrees to make good and repair at his own expense all damage or defect arising from imperfect materials or workmanship within twelve months after the acceptance of the building by the Engineer.

## EXHIBIT "G."

# GENERAL SPECIFICATIONS

FOR

# AUXILIARY PUMP FOR THE NEW COVINGTON WATER WORKS.

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## PUMP AT THE COVINGTON RESERVOIR.

### GENERAL DESCRIPTION.

This plant is to be located at the Covington Reservoir, at a point marked P, on sheet No. 1, showing the general plan of the reservoir and location of pipes, hydrants and stand-pipe. It shall consist of a pump and boiler with all necessary appendages and connections intended for two services; namely:

1st. The delivery of water in the stand-pipe S, for the supply of the U. S. Barracks.

2nd. The direct supply of flushing hydrants Nos. 1 to 14, inclusive, designed for cleaning the three basins, A, B and C, by means of water jets.

The source of supply shall be from the force main F, F, when the pumping engines are working; when they are not working the supply shall be from the lower basin, A. The floor of the pump house shall be about six (6) feet above the highest water level and 21 feet above the lowest water level in basin A, and about twenty (20) feet below the force main F, F, and about 170 feet below high water in stand-pipe S.

The length of the suction pipe from the pump to the strainer in basin A, shall be about 90 feet.

The distance from the pump to the stand-pipe shall be about 1,800 feet.

The water delivered to the stand-pipe shall be measured through a meter, M, on the branch leading to the stand-pipe.

The diameter of the suction pipe and of the several discharge pipes throughout their entire lengths shall be six (6) in. inches.

The general arrangement shall be such as shown by diagram on sheet No. 2. There shall be a connection between the boiler and the supply pipe leading to the force main F, F, in order to fill the boiler when cold and empty.

The suction and discharge pipes shall be connected as shown, in order to drain the entire system of discharge pipes through the suction pipe; point L, being the lowest point of said system.

CONDITIONS OF WORK AND DETAILS OF CONSTRUCTION.

When running at a piston speed of not more than 100 feet per minute, with a pressure of steam in the boiler of not more than 75 lbs. per square inch, the pumps shall deliver through a 1 ¼ in. nozzle at the end of a hose two hundred feet (200) long attached to any of the hydrants, not less than three hundred and fifty (350) gallons of water per minute, by actual measurement, under a hydraulic pressure head of about 85 lbs. per square inch.

Under these conditions, the boiler shall evaporate not less than nine (9) lbs. of water per pound of ordinary Pittsburgh coal, run of the mine (unscreened).

There shall be no foot valve to the suction pipe. The pump shall work with a water piston instead of a plunger. The pump cylinder shall be lined with brass; the piston rod shall be of brass; the valve seats shall also be of brass, and shall be easily accessible for cleaning and repair. The air chamber shall be of sufficient capacity to insure a uniform flow of jet.

The pump shall be provided with a water pressure gauge, with a boiler feeder, heater, check valve, oil cups, and other accessories.

The boiler shall be proved under hydraulic test to one hundred and eighty (180) lbs. per square inch; it must be provided with an iron stack of suitable size, properly secured with guys, and capped; it shall have a damper and a drip collar over drum through roof of engine house. The boiler shall have a safety valve, gauge cock, a water gauge, a steam pressure gauge, man holes and hand holes sufficient to render all parts of the interior easily accessible for cleaning; discharge cock, check valve, water-tight ash pan, and all other necessary accessories.

The boiler, pipes, and all unfinished parts of the machinery shall be protected with (3) coats of black Japan varnish.

All materials used in the construction of the pump, boiler and appendages, must be of the best quality, and all workmanship must be of the first-class in every particular.

PRICE.

The price shall include, besides the pump and boilers as described above, the pipes and valves connecting the boiler with the pump, the four valves and the pipes necessary to connect the pump with the discharge and suction pipes, as shown in diagram on sheet No. 2, all tools necessary to take apart or put together the different parts of the machinery, and all other materials and labor necessary or incidental to the construction, delivery and erection of the plant in good working order, and to the acceptance of the Engineer, for the Trustees of the Covington Reservoir.

## SPECIFICATION AND PROPOSAL

FOR

## PUMPING OUTFIT AT NEW RESERVOIR OF COVINGTON WATER WORKS SUBMITTED BY THE LAIDLAW & DUNN CO.

PUMP.

The pump will be of our standard "Duplex" pumps, having 12 in. steam cylinders, 7 in. water cylinders and 10 in. stroke. The pump will be fitted with cast brass removable and interchangeable water cylinders, brass valve seats brass studs and springs, composition valves and bronze piston rods, copper air vessel, steel adjustable valve, motion to take up tear and wear on same. Pump fitted for 6 in. suction pipe and 6 in. discharge pipe, 2½ in. steam pipe and 3 in. exhaust pipe.

BOILER.

The boiler will be of the well known Tubular type, 41 H. P., 48 in. diameter x 14 ft. long, having 26 tubes 4 in. diameter x 14 ft. long. Shell 3-10 in. thickness. Heads 7-16 in. All made of

60,000 T. S. steel. Dome 24 in. x 24 in. Two cast lugs on each side of boiler to suspend same. Man-hole front and back and boiler tested to 180 lbs. Water pressure and certificate furnished. Boiler set with one full fire front, 15 in. door liners, bearing bars, 4 ft. x 4 in. Tupper grate bars, ash pit doors, flue plate, soot frame and door, smoke plate and damper, six (6) buck bars and bolts; setting to be brick, with fire brick where it comes in contact with flame, set in best system for economy.

CHIMNEY.

Chimney will be 22 in. diameter x 50 ft., made of No. 12 iron, painted and thoroughly stayed with guy ropes.

BOILER FEEDER.

The boiler feeder will be one of our standard "Duplex" steam pumps, having 3 in. steam cylinders and 2 in. water cylinders x 3 in. stroke, guaranteed to feed boiler, fitted with brass valves and valve seats, and copper air vessel.

FOUNDATIONS FOR PUMPS.

The foundations for pumps will be built of brick with a free-stone on top of brick work; large pump having a 6 in. stone of proper size, and the small pump having a 4 in. stone of proper size.

PIPE WORK.

The pump will be fitted with 2 suctions and 2 discharges, with a 6 in. gate valve on each suction and discharge. We will also make a connection between discharge pipe and suction pipe, with a 6 in. gate valve in the same, to drain both discharges into suction leading to basin A, making in all, five (5) 6 in. gate valves with pipe, nipples, elbows and tees necessary to make these various connections. We will also fit piping from boiler to both steam pumps, and fit exhaust pipe from both steam pumps up through the roof of building. Blow-off from boiler to be carried to the outside of building. A separate feed pipe shall be run from suction pipe to feed boiler when cold and empty.

Boiler to be fitted with standard steam gauge, and all suitable gauge cocks, water column, safety valve and trimmings. All pipes to be painted as specified.

Water gauge to register pressure in pounds and feet, to be attached to pump. We will also furnish and attach to exhaust pipe

at large pump, a coil heater to pass the feed water through from small boiler feeder to the filter and hence into boiler. Said heater to heat the water to 212 degrees F.

We propose to furnish you a 2 ½ in., automatic pressure, regulating valve, fully guarranteed to work satisfactorily, put on for the sum of fifty-one dollars ($51.00) net.

We further propose to furnish a National Filter, 16 in. diameter x 4 ft. 6 in., guarranteed of sufficient capacity to filter all the feed water between the heater and the boiler for one hundred dollars ($100.00) net, set up and connected.

The whole plant to be erected in running order and made satisfactory to all concerned.

Yours respectfully,
THE LAIDLAW & DUNN CO.
Robt. Laidlaw, Pres.

| | |
|---|---|
| Prices accepted as follows with Duplex pump 10 in. x 12 in. steam cylinders, | $1,685.00 |
| Automatic pressure regulating valve, | 51.00 |
| One national filter 16 in. x 4 ft. 6 in. | 100-00 |
| Total, | $1,836.00 |

## EXHIBIT "H."

# SPECIFICATIONS

FOR

## WEIR FOR COVINGTON RESERVOIR.

### DESCRIPTION.

The Weir shall consist of a rectangular iron trough, 25 ft. long, 8 ft. 6¼ in. wide and 4 ft. 6¼ in. deep, inside measurement, resting on a timber frame work prepared for the purpose, as shown on plans.

The trough shall be built of ¼ in. plates, riveted with but joints and outside batten plates, stiffened and tied with 2 x 2 in. x 3.2 lbs. angles, as shown.

The open end of the trough next to the influent well shall be lined with a rim angle, 2 x 2½ in. x 3.5 lbs., forged to fit the inside section of the trough; this angle shall be bolted to an iron rim on a timber bulkhead, made of three (3) iron plates, one horizontal, 7x¼ in. x 9 ft. 3¼ in., and two (2) vertical, 7x¼ in. x 4 ft. 1½ in., screwed on the inside face of the bulkhead: there shall be 101 half inch bolts, and a suitable gasket shall be used to form a water-tight joint.

There shall be three (3) guide frames, 1 ft. 10½ in. apart, next to the open end of the trough, built of 2 x 2 in. x 3.2 lbs., and 2 x 2½ in. x 2.7 lbs., angles, and properly braced and tied together, as shown on plans, for the support of moveable screen partitions. Each partition to consist of four (4) plates, 2 ft. ¾ in. x 4 ft. $\frac{3}{16}$ in.; one set of these plates shall be plain, the plates of the other two sets shall be perforated, as shown. Each plate shall have riveted handles, as shown, and holding-up pins ½ inch in diameter, chained to each guide, shall serve to fasten the plate at any desired elevation through holes in the guide angles and the sides of the plate.

There shall be two (2) observation boxes, built of $\frac{3}{16}$ in. bent plates resting on a 2 x 2 in. angle footing, at distance of 3 ft. 6 in. and 9 ft. 6 in. respectively from the weir end to centers of boxes. The boxes shall be connected with the inside of trough by perforated pipes, 1½ in. diameter, as shown.

The weir end of the trough shall be closed with a ¼ in. plate, stiffened with 2 x 2 in. x 3.2 lbs. angles, as shown, and notched with a rectangular opening on top, 5 ft. 8 in. x 2 ft. 4 in.; this opening shall be rimmed with three (3) plates, one horizontal, 4 in. x ¼ in. x 6 ft., and two (2) vertical, 4 in. x ¼ in. x 2 ft., riveted on the outside with fillers 2 x ¼ in., so as to form an inside shoulder on bottom and sides of opening, ½ in. deep, upon which the brass plates of the weir shall fit.

These plates shall be of hard brass, 4 x $\frac{7}{16}$ in. x 5 ft. 8 in. for the bottom plate or sill, and 4 x $\frac{7}{16}$ in. x 1 ft 11 in. for the side plates; they shall be chamfered on the edges next to the weir opening; the chamfered edges shall be sharp cornered, mitre jointed and dressed perfectly true. The brass plates shall be bolted to the rim plates with fifty-six (56) half inch bolts, using a suitable gasket to make a water-tight joint. The bolt heads shall be counter-sunk in the brass plates so as to leave no projections inside the weir.

BOLTS.

All bolts must have well formed threads, heads and nuts, and must completely fill the nuts; gum washers shall be used under the heads and nuts, if necessary to make water-tight joints; bolt holes must be drilled.

RIVETING.

All rivets shall be ½ in. diameter; the pitch on joints designed to hold water shall not exceed two inches.

Rivet holes shall be accurately punched and fit exactly opposite to each other without drifting.

Rivets must completely fill their holes, and must have well shaped heads.

CAULKING.

All joints designed to hold water shall be thoroughly caulked and made water-tight.

The end joints between rim plates on bulkhead and between the rim plates of the weir opening and between the brass plates of

the weir shall, if necessary, be neatly filled with sodder to make them water-tight and smooth.

DRAIN-COCK.

A brass drain-cock, one inch in diameter, shall be fitted to the bottom of trough near the weir end to drain the trough.

PAINTING.

The entire iron work shall be protected with two (2) good coats of approved black varnish.

ERECTION.

The weir trough shall be erected on the timber frame work prepared for it, and shall be bolted to the bulkhead; it must be built square, straight and level. In particular, the sill of the weir must be exactly level and the sides exactly plumb.

QUALITY OF IRON.

The iron must be tough, ductile, of fibrous fracture and uniform in quality. It shall stand, without breaking, 46,000 lbs. tensile stress per square inch in specimens $\frac{1}{4}$ x 1 inch, with eight (8) per cent. elongation in 12 inches; it shall bend cold 90 degrees without sign of fracture around a circle of $\frac{1}{2}$ inch radius.

The rivets and bolts shall bend cold flat on themselves without sign of fracture.

All the iron shall be well shaped, smooth, free from injurious seams or flaws, blisters, buckles and imperfect edges.

PRICE.

The price bid must include the construction and erection at the influent well of the north basin of the Covington reservoir of the entire structure, (excluding timbers, but including the iron rim on bulkhead) ready for use.

INSPECTION AND SUPERINTENDING.

All material and workmanship shall be subject to the inspection of the Chief Engineer for the Trustees, or his authorized assistant; all material condemned by him shall be replaced and defective workwanship corrected; the work must be done to his satisfaction and acceptance.

# FORM OF PROPOSAL.

Having examined the plans and specifications for the Iron Weir for the Covington Reservoir, the undersigned hereby propose to the Trustees of the Covington Reservoir to construct and erect said Weir in accordance with said plans and specifications, for the sum of Seven Hundred and Thirteen Dollars, ($713.00) and to have the structure completed and ready for use on or before the Eighteenth day of October, 1890.

(Signed). THE WALTON ARCHITECTURAL IRON CO.
Per J. F. WALTON, Pres.

The foregoing is accepted as and for the contract for the performance of said work, September 12th, 1890.

{SEAL.} TRUSTEES OF COVINGTON RESERVOIR.
By A. SHINKLE, Pres.

Attest:
JAMES SPILLMAN, Sec'y.

## EXHIBIT "I."

# ARTICLES OF AGREEMENT

Entered into this Tenth day of July, Eighteen Hundred and Ninety, between R. B. TURNER, 1st Lieut. 6th Infantry A. A., Quartermaster United States Army, of the first part, and THE TRUSTEES OF THE COVINGTON RESERVOIR for and on behalf of the City of Covington, Kentucky, of the County of Kenton, State of Kentucky, of the second part

THIS AGREEMENT WITNESSETH, that the said R. B. Turner, 1st Lieut. 6th Infantry A. A. Q. M. U. S. A., for and in behalf of the United States of America, and the said Trustees of Covington Reservoir for and on behalf of the said City of Covington and its legally ordained Successor or Successors, have mutually agreed, and by these presents do mutually covenant and agree, to and with each other, as follows, viz :

ARTICLE I. That the said United States Government, for supplying Water to the New Military Post and Barracks now being established and erected by the Government in the Highlands, Newport, Campbell County, Kentucky, from the Reservoir now being constructed by said Trustees : Agrees to construct a Stand-pipe about twelve feet in diameter and one hundred feet high, on the Government ground near the influent tunnel under the Highland pike, furnish and lay all the necessary pipe in the Goverment grounds and buildings, and a six inch Supply Pipe from the Stand-pipe to the center of said Highland pike, in the direction of said Reservoir. The said City will furnish a necessary pumping plant for re-pumping water from the Reservoir to the Stand-pipe, furnish and lay a six inch pipe from said pumping plant to the connection with the Government supply pipe, to be laid as aforesaid, and will furnish all the water required for said Military Post, at the following rates per thousand gallons : To-wit,

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| For a daily consumption of | | | | 10 000 | to | 15 000 | galls., | | 20c. |
| " | " | " | " | 15 000 | " | 20 000 | " | | 19c. |
| " | " | " | " | 20 000 | " | 25 000 | " | | 18c. |
| " | " | " | " | 25 000 | " | 30 000 | " | | 17c. |
| " | " | " | " | 30 000 | " | 35 000 | " | | 16c. |
| " | " | " | " | 35 000 | " | 40 000 | & above, | | 15c. |

The quantity of water supplied to the Government to be determined by Meter Measurement on the Supply Pipe from the pumps to the Stand pipe, the Meter to be furnished and put in place by the said City on its own ground.

ART. II. That deliveries on this contract shall, if required, commence on the first day of August, Eighteen Hundred and Ninety, provided that the agreement is approved by the Quartermaster General, U. S. Army; otherwise, not until such approval is obtained.

ART. III. That for and in consideration of the faithful performance of the stipulations of this agreement, the party of the second part shall be paid at the office of the Post Quartermaster, at the said new Post near Newport, Ky., as follows: Quarterly at the end of each quarter beginning at the first delivery of water, upon the presentation to said Quartermaster, at his Office, by the Secretary of the Water Works Commissioners of said City, of an account of water delivered, verified by the Meter register.

ART. IV. That in case of failure of the said party of the second part to comply with the stipulations of this contract according to the true intent and meaning thereof, except in case of unavoidable accidents to its pumping plant or force main for supplying its said Reservoir, or to the pumping plant or supply pipe for delivering water into said stand pipe, the party of the second part shall be liable to pay such damages as the said United States Government may sustain thereby, to be recovered by appropriate action, unless otherwise adjusted.

ART. V. Neither this contract nor any interest therein shall be transfered by the said party of the second part, (except to its legally constituted Successors) to any other party or parties, and any such transfer shall cause the annulment of the contract so far as the United States is concerned; all rights of action, however, for any breach of this contract by the said party of the second part, are reserved to the United States.

ART. VI. No member or delegate to Congress, nor any person belonging to or employed in the Military service of the United States, is or shall be admitted to any share or part of this contract, or to any benefit which may arise here from.

ART. VII. This contract shall be subject to approval of The Quartermaster General, U. S. Army.

IN WITNESS WHEREOF, the undersigned have hereunto placed their hands and seals the date first hereinbefore written.

Witnesses:
H. P. YOUNG,
J. O'HARA,

R. B. TURNER,
1st Lieut. 6th Infantry A. A. (Seal.)
Quartermaster, U. S. A.

Trustees of Covington Reservoir, by
A. SHINKLE, President. (Seal.)
JAMES SPILMAN, (Seal.)
Secretary Board of Trustees.

Approved:-------- 189--

## EXHIBIT "K."

# COVINGTON NEW WATERWORKS.

## SPECIFICATIONS FOR ENGINE HOUSE AND AQUEDUCT.

### GENERAL DESCRIPTION AND EXTENT OF CONTRACT.

The engine house shall be located on the south bank of the Ohio River, on the land purchased by the Trustees of the Covington Reservoir from C. and J. Wilmer, at the end of the pipe line, leading from the reservoir site on the Moreland place in Campbell County, Ky., to the Ohio River.

The contract shall embrace the construction of the house proper, designed to contain the pumping engines and boilers, of the embankment approach to the same, of a smoke stack for the boilers, of a well for the pumps, and of an aqueduct leading from the pump well to deep water in the Ohio River. Said house, embankment, smoke stack, well and aqueduct, to be completed in every particular in accordance with plans and specifications and the direction of the Engineer and to his satisfaction, and to be delivered to the Trustees, ready for the erection and operation of the pumping machinery.

### GRADING.

#### CLEARING.

All trees, bushes, driftwood, and other rubbish, as well as all muck, or other materials deemed objectionable by the Engineer, shall be removed from the entire surface covered by the fill. The embankment shall be made in horizontal layers one foot thick, enough earth being used with the rock to fill completely all void spaces.

No perishable material of any kind or frozen earth shall be allowed in the embankment.

EXCAVATION FOR FOUNDATION.

The excavation for the foundation of the house, smoke stack, well and aqueduct, shall be carried down into the solid strata of soapstone and limestone to such depths as the Engineer may direct, and the bottom of the trenches or pits shall be properly trimmed and stepped, or shall be leveled with concrete, as may be directed by the Engineer, to receive the first course of masonry.

EMBANKMENT APPROACH.

The space between the engine house and the track of the Elizabethtown and Big Sandy Railroad shall be filled to the level of the railroad grade with the material excavated for the foundation, well and aqueduct; if these excavations are not sufficient to make the fill, the deficiency shall be supplied with material borrowed from the Trustees' grounds below the engine house.

## ENGINE HOUSE.

FOUNDATION WALLS.

The foundation walls shall be of the sizes and shapes shown on the drawings, or otherwise determined by the Engineer; they shall be built of even coursed stone masonry laid flush in hydraulic cement mortar, the face stones shall be rock faced with hammer-dressed beds and joints; they shall not be less than six inches thick, and shall measure not less than four square feet on their beds. The joints shall be square with the face and beds and shall extend not less than eight inches from the face. They shall break joints not less than eight inches, the masonry shall be thoroughly bonded, not less than one-third of the face stones being headers.

All joints and beds must be thoroughly filled with mortar, there shall be no void spaces in the masonry. No spalls shall be allowed in the joints and beds, and the same must not exceed $\frac{5}{8}$ inches in thickness.

The stones for the capping course shall be twelve inches thick, and shall be of the entire width of course. They shall have hammer-dressed joints throughout.

The space between the masonry and the sides of the excavation for foundations shall be filled with the material excavated, well rammed in, or with concrete, where the same is required by the Engineer.

The foundation walls shall have openings left through them at such places and of such sizes as the Engineer shall direct, to allow for the ingress and egress of the river water at high stages.

All face work shall be neatly pointed with rich cement mortar.

### BRICK WALLS.

The outside walls shall be 17 inches thick in the body, with inside and outside pilasters spaced, as shown on plans.

The partition wall between the engine and the boiler rooms shall be 13 inches thick.

All walls shall be built with sound, hard burnt brick, soaked in water immediately before being used, and laid flush in good lime mortar. All the joints to be full of mortar and not to exceed ½ inch in thickness. The walls shall be thoroughly bonded, every seventh course being of headers.

No bat, except for closures, or salmon brick, shall be allowed in any part of the walls. Every course shall be level throughout. All the walls shall be carried up together on the same level, and shall be straight and plumb. All centers needed shall be made and the arches turned perfectly true. All flues shall be neatly and smoothly pargeted with good mortar and thoroughly cleaned. Windows and door sills and coin blocks for the door hinges, of the best quality of limestone or freestone and of the sizes and shapes shown on the drawings, shall be provided and properly set in place by the contractor.

All brick walls shall be neatly pointed inside and out.

### FLOOR.

The floor shall be constructed of 9 inch I beams, spaced 3 feet from centers and supported at intervals by plate girders or stone walls, as the Engineer may deem best. The spaces between the I beams shall be filled with brick arches, built as shown on drawings, with hard paving bricks laid flush and close in good lime mortar, centers to be carefully made and set. The I beams shall be thoroughly tied together and to the side walls with iron rods one inch in diameter, six feet from centers, imbedded in the brick arching and anchored to the side walls with approved wrought iron washers. On each brick arch, parallel with the I beam, lay two strips of yellow pine, 4 inches wide, fitting the extrados of arch and

high enough to reach level of top of I beams; then fill and back up arch with concrete well rammed in. In engine room lay 1½ inch matched flooring of yellow pine, not more than 4 inches wide, breaking joints, and blind-nailed to the under strip, swith smooth finish.

In boiler room lay paving bricks in good hydraulic cement mortar with close joints and smooth finish. (1)

ROOF.

The roof shall be framed as shown in drawings, each truss to have 1½ inch camber and to rest on wall plates, 14 feet x 18 feet x 30 feet, of white oak.

Purlins to be lap-jointed over trusses and held by shoulder blocks well secured to the same with lag-screws of approved length.

Rafters shall be spiked to each purlin. Sheathing shall be of sound matched boards, one inch thick, surfaced, free of loose knots and holes and blind-nailed to every rafter.

Make gutters perfect with proper falls. The roofing shall be of the best quality of Vermont or Virginia slate, 10x20 inches, ¼ inch thick, carefully gauged and machine punched, each slate nailed with two composition nails, heads countersunk in slate and slate to lay 8 inches to the weather. (2) The crest and hips of roof shall be neatly finished with No. 20 galvanized iron of best quality, painted on under side with two coats of best ironclad paint, and well secured to the sheathing.

Flashings of the best leaded roofing tin X. I. M. F. brand, secured in the most approved manner, shall make a perfect and water-tight protection.

GUTTERS AND DOWN SPOUTS.

The gutter shall be lined with the same quality of tin as above. The tin shall reach beyond the first lap of slate, and shall run over and turn down over edge of gutter. All tin must be soldered on both sides and painted on the under side with two coats of best iron-clad paint.

The down spouts shall be of No. 22 galvanized iron of best quality, and shall make a perfect and water-tight connection with

[1] Changed to concrete, with cement covering.

[2] Iron roofing was substituted for slate.

gutters. They shall be well secured to the walls with approved wrought iron fastenings. The down spout in front of the building shall discharge into a six-inch vitrified stoneware pipe, laid in cement, 2 feet below the top surface of fill and leading the drain water to the foot of the down stream slope of fill.

WINDOWS.

All windows shall be box-framed; the frame shall be 2½ inches and the sash 2 inches thick; use best axle pullies and chords, and approved weights for all sashes. All sashes to be framed, finished and hung in the best manner. The lower half of sash must be well balanced, made to slide easily and fitted with approved spring lock and strong brass hook lifts. All glazing must be done in the best manner, bedded, sprigged and back puttied. All window sashes and transoms shall be glazed with the best Pittsburg glass, free from color, bubbles, waves and other defects.

DOORS.

The doors and transoms shall be made in accordance with detail drawings, and provided with required fastenings. Frames to be of clear white pine, ceiled with the best seasoned common ceiling. Provide wicket door with good lock. All doors shall fit well and work easily. The hinges of the large doors shall be set in lead in the coin blocks.

FRAMING.

All framing must be done to a close fit and in a thorough and workmanlike manner. No open joints or filling shims will be allowed.

PAINT.

Doors, windows, cornices, and all outside wood-work shall be painted with three coats of best white lead mixed with boiled linseed oil and approved colored pigment. All inside painting shall be finished with two coats of best varnish. Flashing, gutters, crestings, down spouts, and all metal work about the building shall be painted with three coats of the best ironclad paint mixed in boiled linseed oil.

## SMOKE STACK.

The smoke stack shall be built in accordance with plans furnished. The foundation below the floor level of the building

shall be of stone masonry and concrete of the same character as specified for the foundation walls of the house, capped with a belting course, as shown. Above the floor level the stack shall be built of hard-burned brick, laid in good lime mortar, the same as specified for the brick walls of the house,—the thickness of wall shall decrease from bottom to top of shaft, by steps, as shown. The shaft shall be built plum, with uniform batter and true circular sections, as shown. It shall connect through an arch way, as shown, with the interior of the boiler room, to receive the end of the smoke box. A wrought iron door, as per detail drawing, shall give access to the ash pit for the purpose of cleaning the same. The stack shall be capped with an approved cast iron top, and shall be provided with an outside iron ladder, as shown. ([3]) It shall be cleaned, when finished, and thoroughly pointed inside and out.

## WELL.

The excavation for the well shall be of the size laid out by the Engineer; it shall be carried down vertically, and to the depth required:—it is intended that the bottom of well, when finished, shall be 9 feet below extreme low-water mark in the river. The walls shall be of the thickness and shape required for the support of the engines and pumps. The character of the masonry shall be the same generally, as specified for the foundation walls of the house, but the capping courses for the seats of the engines and pumps shall be 2 feet thick, and the stones for the same of such lengths and widths as may be required.

All anchor rods for the engines and pumps shall be furnished by the engine builder, but shall be put in the masonry by the contractor according to template and directions of the Engineer.

The space between the sides of the rock excavation and the back side of walls shall be made as small as practicable and thoroughly packed with concrete. The bottom of the well shall be concreted and finished with a coating of rich Portland cement mortar of sufficient thickness to cover all the stones and make a smooth finish.

The down stream wall of well shall have a 6 inch cast iron pipe built through it, extending to the outside of the house, and pro-

[3] The ladder was built inside the stack.

vided with a stop valve, to serve as a discharge when the well is being pumped out.

Wooden stairways with hand rails, leading from the engine room floor to the bottom of well, shall be built as directed, and strongly secured to the well walls. (4)

AQUEDUCT.

The aqueduct, connecting the pump well with the river, shall have a circular section 4 feet in diameter in the clear, the bottom of the aqueduct, where it enters the well shall be 3 feet above the bottom of well, and is intended to be 6 feet below extreme low water mark in the river. The aqueduct shall be straight, and shall have a uniform descending grade from the well towards the river, of 6 inches in 100 feet; it shall be built in tunnel for a distance of about 120 feet, and in open cut, protected by a cofferdam, for the remainder of its length.

The circular arch of the aqueduct shall be made of two concentric rings of hard paving brick, laid flush in hydraulic cement mortar, each line of brick breaking joints with the line adjoining it. All joints shall be close, not exceeding ½ inch in thickness, and thoroughly filled with mortar, the arch shall be a true circle, straight, and finished with a smooth inside coating of rich Portland cement mortar ¾ inches thick, applied after a thorough cleaning of the intrados.

The arch shall be finished at both ends with ring stones of approved sizes, hammer dressed on all faces and joints, and well bonded with the brick arch.

The tunnel part of the aqueduct shall be excavated as closely as practicable to the extrados of the brick arch, and the space between the rock and the masonry shall be thoroughly filled with concrete or cement mortar. The exact point where "aqueduct in tunnel" shall end, and "aqudeduct in open cut" shall begin, shall be determined by the Engineer. The part of the aqueduct built in open cut, into the river, shall be protected with side walls and a capping course of ashlars in cement, as shown in drawings.

The stones in the side walls shall not be less than 12 inches thick, and average not less than 30 inches in width. They shall have hammer-dressed beds and joints—the joints extending not less

[4] The stairways were built of iron.

than 12 inches from the face; they shall break joints not less than 12 inches. The capping course shall be 24 inches thick, the stones shall have hammer dressed beds and joints throughout, and shall be thoroughly clamped together with approved iron clamps countersunk in stones and set in lead. The end face wall shall be shaped as shown in drawings; the face of capping and footing courses and the vertical grooves in the side walls shall be dressed with the bush hammer.

The space between the brick arch and the side walls and capping course shall be filled with concrete, well rammed in. All spaces between the rock excavation and the masonry shall also be filled with concrete.

### IRON GRATING AND SLUICE GATE.

An iron screen, built in accordance with detail drawings, shall be provided and put in place by the contractor at the river end of the aqueduct.

The well end of the aqueduct shall be provided with a sluice-gate, to be worked from the engine floor. This gate and its appendages shall be furnished by the Trustees, but shall be properly set in position, ready for operation by the contractor. The coffer-dam and all temporary work used for the construction of "aqueduct in open cut" shall be removed by the contractors at such time as the Engineer shall direct.

## MATERIALS.

### STONE.

The stone shall be compact limestone or hard sandstone of the best quality, and approved by the Engineer.

### BRICK.

The brick shall be hard burnt, well tempered, of good form, free of lime and cracks, and acceptable to the Engineer; they shall be soaked in water immediately before using.

### CEMENT.

The cement shall be equal to the best quality of Louisville hydraulic cement, and shall stand without breaking a tensile stress of 100 pounds per square inch in briquettes, seven days old. It shall not swell nor crack in the process of hardening.

The Portland cement shall stand without breaking a tensile stress of 300 pounds per square inch in briquettes, seven days old. All cement shall be properly cooled and air-slacked before used.

LIME.

The lime shall be of the best quality of fresh fat lime; it shall be free of silica, magnesia and allumina, in sufficient quantity to injure its qualities as a fat lime; it shall slack freely in water; it shall be allowed to stand at least two days in a slacked form, and shall be screened before used.

SAND.

The sand shall be clean, sharp river sand, of the degree of coarseness suitable to each kind of work.

MORTAR.

Cement and lime mortar shall generally be composed of one measure of cement or lime and two measures of sand, well mixed with clean water in clean mortar boxes.

The cement mortar shall be used immediately after mixing. Different proportions of sand and cement, or lime, shall be used when required by the Engineer.

CONCRETE.

Concrete shall be composed, by actual measurement, of four measures of broken stone, of uniform size, measuring not more than two inches in any direction, free of clay, and well screened—two measures of sand and one measure of cement, all well mixed in a concrete mixer or on a clean plank bed, and well rammed in place in layers as directed by the Engineer.

TIMBER.

All timber must be of the best quality of the kind specified, sawed true and out of wind, full size, free of wind shakes, large or loose knots, worm holes, sap, or any defect impairing its strength or durability.

IRON.

All wrought iron shall be tough, ductile, uniform in quality, and shall have a tensile strength of not less than 50,000 pounds per square inch with elongation of 15 per cent. for rods and rolled

shapes, and a tensile strength of not less than 48,000 pounds per square inch, with elongation of 10 per cent. for plates over 24 inches wide. Cast iron shall be of the best quality of tough, gray metal; it shall have a tensile strength of not less than 20,000 pounds per square inch. Castings shall be smooth, well shaped, free from air holes, cracks, cinders, and other imperfections.

## GENERAL CONDITIONS.

### PROGRESS OF WORK.

All work shall be proceeded with in such order as the Engineer shall direct. The rate of progress at all times must be such as to insure its completion within the limit of time specified. Should the same appear insufficient in the opinion of the Engineer, he shall have the right to order such increase in the working force as he may think necessary.

### SUBLETTING AND TRANSFERS.

The contractor shall not sublet, assign or transfer this contract or any part thereof to any person or persons without the consent of the Trustees.

### COMPETENT WORKMEN.

He shall give his personal supervision to the work and shall employ competent workmen and experienced mechanics skilled in the several works assigned to them. He shall immediately discharge on request of the Engineer any of his employes considered by said Engineer as incompetent or disorderly, and shall not again employ him upon the works.

### ORDERS CONCERNING THE WORK.

In the absence of the contractor from the work, the Engineer shall give his orders respecting the work to whomsoever may be in charge of, or executing the same, and said orders shall be respected and obeyed.

### CHANGES.

The Trustees shall have the right to make, without violating this contract, any changes in location, form, dimensions and quantities of the work as the interest of the city of Covington may in their judgment require, and the Engineer shall estimate and determine the amounts which should fairly and equitably, on account of such changes, be deducted from or added to the amounts which

would otherwise be due to the contractor, had such changes never been made, and the amounts so determined by the Engineer shall be accepted by the contractor without any claim for anticipated profits on the work that may be dispensed with.

EXTRA WORK.

The value of any extra work shall be likewise estimated and determined by the Engineer. No claim for extra work shall be made or allowed unless the work shall have been done in compliance with a written order from the Trustees or the Engineer.

All claims for extra work shall be made in writing before the payment of the succeeding estimate after the work is performed. Failing to make such claim, the same shall be considered as abandoned by the contractor.

REJECTED MATERIAL.

The contractor shall promptly remove all rejected material to such distance as may in the judgment of the Engineer be sufficient to prevent it being used in the work.

DEFECTIVE WORK.

All defective work shall be promptly taken down by the contractor on orders from the Engineer to that effect, and rebuilt properly at his own expense.

SUSPENSION OF WORK.

The contractor shall, without any claim for damage or extra compensation, suspend the work when he shall be ordered to do so by the Engineer, by reason of inclement weather or for other causes.

EXTENSION OF CONTRACT TIME.

But if the work be delayed by any act of the Trustees contrary to the true intent and meaning of this contract, he shall be entitled to a reasonable extension of time for the completion of his work, and the Engineer shall estimate and determine the length of such extension, but the contractor shall have no claim for damages on account of such delays.

MASONRY IN FREEZING WEATHER.

No masonry shall be laid in freezing weather.

LIABILITIES AND RISKS.

The contractor assumes all risks, arising from the weather, floods, and casualities of all kinds. He shall pay all damages to

persons and properties and repair at his own cost all damages that may occur to the work until it is completed entirely and accepted by the Engineer.

He shall further mantain at his own cost all parts of the work in a good perfect condition for a period of six months after its acceptance by the Engineer.

ERECTION OF ENGINES AND BOILERS.

The Trustees shall have the right to commence and proceed with the erection of the pumping engines and boilers from_____ 1888, regardless of the unfinished condition of the work at that date, and the contractor shall have no claim for damages on that account.

SPECIFICATIONS DEFINED.

The meaning and intent of these specifications and contract shall be defined by the Engineer and his decision thereon shall be final and binding upon both parties thereto.

ENGINEER DEFINED

Wherever the word "Engineer" is mentioned in this contract it shall be taken to mean the Chief Engineer for the Trustees.

CONVICT LABOR.

No convict labor shall be employed on the work.

## PRICES AND MEASUREMENTS.

Bidders must put in a price for every item of work named in the form of proposals furnished to them.

There shall be no classification of material in the embankment. The price to be paid shall include clearing, trimming, hauling and all other items of expenses connected with the construction of the embankment.

All classes of masonry, except the brick work in the house and stack above foundation walls, shall be paid for by the cubic yard, measuring the actual quantity of each class of work.

The prices to be paid shall include all excavation, bailing, pumping, centering, shoring, scaffolding, stairways, cofferdams and all other items of expense necessary or incidental to the work.

The measurement of "aqueduct in tunnel" for payment shall be the actual length of tunnel from the inside face of masonry in the well to the face of excavation for "aqueduct in open cut."

The price to be paid shall include all excavation in tunnel, concrete packing, Portland cement coating, temporary supports, centering, bailing, pumping and all other items of expense necessary or incidental to the work.

The price to be paid for the smoke stack above the foundation walls shall be for the stack complete, including the ash pit door, cap and iron ladder and all other items of expense necessary or incidental to the work.

The prices to be paid for the house above foundation walls shall be for the house complete, including all stone, brick, wood and iron work, as well as doors, windows, roofing, guttering, glazing, painting and other work necessary or incidental to the construction of the house in a complete state and ready for use.

The prices to be paid for timber, iron and masonry in the floor of the building and for iron in the screen and clamps for the aqueduct shall be for the actual quantity of these several materials used and left in a finished state in the completed structures, including scaffolding, centering, painting, countersinking, lead setting and all other items of expense necessary or incidental to the work.

The price to be paid for the setting of the sluice gate at the well end of the aqueduct shall be for the setting of the gate and all its appendages in a complete and good working condition, including all items of expense necessary or incidental thereto.

The prices to be paid for stoneware drain pipe shall be for the actual measured length of pipe laid and shall include excavation, laying with cement, back-filling and all other items of expense necessary or incidental to the work.

## FORM OF PROPOSAL FOR THE CONSTRUCTION OF ENGINE HOUSE AND AQUEDUCT.

THE UNDERSIGNED HEREBY CERTIF____THAT _____ personally and carefully examined the grounds and site for the proposed engine house and aqueduct for the city of Covington, Ky., on the Ohio river, in Campbell Co., Ky., also that _____ carefully examined the plans and sections for the same, and carefully read the annexed specifications and form of contract. Having

made such examinations, the undersigned hereby proposes to the Trustees of the Covington reservoir to construct and complete said engine house and aqueduct, as the also embankment approach, and a smoke stack for the same, and to do all work specified according to the conditions and specifications aforesaid, and on the acceptance of this proposal hereby bind_____ _____ to enter into and execute the contract for the work at the following prices.

These prices are to be in full compensation for performing the said work and for guaranteeing their permanency and durability as provided in the contract and specifications.

PRICES.

(1.) Embankment in approach, _____ per cubic yard - - - - $

(2.) Stone masonry in well and foundation walls of building and stack, _____ per cubic yard, - - - - -

(3.) Concrete in well and foundation walls of building and stack, _____ per cubic yard, - - - - - -

(4.) Aqueduct in tunnel, ____per lineal foot -

Aqueduct in open cut.

(5.) Stone masonry per cubic yard, ____ -

(6.) Brick arch, " " " ____ -

(7.) Concrete, " " " ____ -

(8.) Iron in screens and clamps, per lb____

Floor.

(9) Smoke-stack above foundation walls, complete, - - - - -

(10.) Iron in Plate girders, I beams, rods etc., per lb., - - - - -

(11.) Brick arches, ____ per cubic yard,

(12.) Concrete filling, ____ " " " .

(13.) Timber, ____per 1000. ft b.m.

(14.) House above foundation walls, complete, - - - - - -

(15.) Setting of sluice-gate and appendages at well end of aqueduct, - -

(16.) Six-inch vertified stoneware pipe, laid complete,____per lineal ft. - -

SIGNATURE: _____

ADDRESS: _____

## EXHIBIT "L."

# GENERAL SPECIFICATIONS

## FOR PUMPING ENGINES AND BOILERS FOR THE NEW COVINGTON WATER WORKS.

### GENERAL DATA.

The pump house will be located on the South bank of the Ohio River and the water forced over the top of the Highland ridge, is to be delivered into reservoirs built on the South slope of the ridge.

| | |
|---|---|
| Elevation of Engine and boiler floor of engine house above low water | $70\frac{29}{100}$ ft. |
| Horizontal distance of engine house to apex of force pipe | 31411 ft. |
| Horizontal distance from apex of force pipe to outlet of reservoir | 670 ft. |
| Vertical lift from low water to apex of force pipe | $378\frac{1}{10}$ ft. |
| Vertical fall from apex of force pipe to highest water level in reservoir | $12\frac{2}{10}$ ft. |
| Diameter of force pipe from engine house to apex of pipe | 30 inches |
| Diameter of delivery pipe from apex of pipe to outlet in reservoir | 30 inches |

### GENERAL DESCRIPTION AND CHARACTER OF PLANS REQUIRED.

The plant shall consist generally of two pumping engines of the capacity of five million U. S. standard gallons per 24 hours each, and of the necessary boilers to operate both together at a normal working pressure of 100 lbs. of steam in the boilers.

The arrangement of the machinery shall be such as to allow the engines to be worked singly or jointly. The character of the plant shall be first-class in every particular, both as to workmanship and as to the kind and quality of material used. Special regard shall be had in providing all possible facilities for the convenient inspection and repair of all parts subject to wear. The engines and pumps shall be duplicates of each other, all parts being made interchangeable as far as practicable.

All other things being equal preference will be given to simplicity of design.

CAPACITY AND DUTY.

Each pumping engine working either singly or jointly with the normal pressure of 100 lbs. of steam in the boilers shall deliver water in the reservoir at the rate of 5,000,000 U. S. standard gallons in 24 hours with a consumption of coal not exceeding 18,000 lbs. in 24 hours when the level of water in the river is 385 feet below the center of force pipe at the apex on the hill. The consumption shall be proportionally less as the water in the river rises above the datum referred to.

FACTOR OF SAFETY.

The machinery shall be strongly and substantially built. All parts subject to strain from the water pressure shall be proportioned with a factor of safety not less than 10 and all provisions shall be made that is possible to reduce vibration in all the working parts.

The boilers shall be tested with a hydraulic pressure of not less than 300 lbs. per square inch.

PRICE.

The price bid must include all the necessary pipes, valves and connections inside of the pump house as well as feed pumps, air pumps, revolution counters, steam pressure and vacuum gauges, lubricators, cranes, wrenches and other tools necessary for the handling of parts in repairing, and all other expenses necessary or incidental to the construction, erection and maintainance of the plant in complete working order until its acceptance by the engineer for the Trustees, after its final test, as hereinafter described, have proved satisfactory.

PLANS AND SPECIFICATIONS.

Contractors must submit with their proposal general plans of the machinery and boilers, drawn to the scale of one-half inch to the foot with a complete description specific as to the kind of material used and the size of all working parts, and all detail drawings necessary for a clear understanding of the strength and operation of the machinery.

The plans and specifications, after they have been approved by the engineer for the Trustees, shall be incorporated to and become

a part of the contract and no change or modification shall be made thereto without the formal consent of the Trustees and approval of the engineer.

INSPECTION.

The entire work of construction and erection shall be subject to the inspection of the engineer for the Trustees, or a special inspector appointed by him and shall be done to his satisfaction. All necessary facilities for the inspection of the work and for the tests of the materials to be used shall be furnished by the contractor free of charge.

TESTS.

After a period of ninety days operation the final tests for duty shall be made in the following manner:

1st. Both pumping engines shall be worked simultaneously in normal condition with a steam pressure of 100 lbs. to the square inch in the boiler, and a rate of delivery into the reservoir not less than ten million gallons in 24 hours for a period of not less than 48 hours.

The coal consumed shall be carefully weighed. The quantity of water shall be carefully measured over a weir at the reservoir and an accurate record shall be kept of the elevation of the water in the river during the test.

2nd. A similar test shall be made with each engine working singly in normal condition with 100 lbs. steam pressure in the boilers.

The coal used shall be the run of the mine, ordinary quality Pittsburgh coal.

PAYMENT.

During the progress of the work (on the contractors executing bond to the Trustees, with two good sureties, to their satisfaction, in the sum equal to twenty per cent. of the value of the work to be done) quarterly payments shall be made on the engineer's estimate of the relative value of the work done, retaining 15 per cent.

The remaining 15 per cent. shall be due at the expiration of three months after the final test on presentation by the contractors of the final certificate of the engineer for the Trustees to the effect that the plant has worked in a satisfactory manner during that time.

All costs of repairs to the plant due to defective construction, accidents, ordinary wear and tear and other causes which shall have been incurred to date of final payment, shall be charged to the con-

tractors and deducted from the amount which would otherwise have been due to him on that day.

DATE OF COMPLETION.

The entire plant must be completed and ready for service by August 1st, 1888.

Covington, Ky.

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# SPECIFICATIONS

— FOR A —

## GASKILL VERTICAL COMPOUND PUMPING ENGINE, FOR THE COVINGTON, KY., WATER WORKS,

— BY THE —

## HOLLY MANUFACTURING CO., OF LOCKPORT, N. Y.

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GENERAL ARRANGEMENT.

This engine will be the kind known as the Gaskill Vertical Compound Pumping Engine. There will be four steam cylinders, two high pressure 24 inches in diameter and 36 inches stroke of piston, and two low pressure steam cylinders 48 inches in diameter and 36 inches stroke of piston. These steam cylinders will be firmly bolted to a heavy cast iron bed plate extending across the well. This bed plate to have cast on its sides, pillow blocks forming bearings for each end and center of the crank shaft, the outer ends of which will carry the two fly-wheels. On the lower side of the bed plate, and located on the under side of the same, will be the beam pillow blocks, four in number, between which the beams will oscillate. The beams will be connected to the piston rods of the cylinders by suitable links, also to the cranks by suitable main connecting rods. The piston rods of both high and low pressure steam cylinders will connect directly with the pump piston rods. The pumps will be four in number, of the kind known as single acting plunger pumps, and will be placed on a suitable base, and firmly bolted thereto, and will be connected with the valve boxes which

are in turn to be connected to the base and firmly bolted thereto. On each pump cylinder will be two ears placed to receive two $4\frac{1}{2}$ inch wrought iron stretchers, the other end of which will be bolted into the bed plate. The pumps will rest on the foundations — feet below the bed plate of the engine, being tied to the engine as shown, by these stretchers, the whole forming a machine of great compactness and strength, as shown on the "blue points" of H. F. Gaskill's Vertical Compound Pumping Engine accompanying these specifications, and intended to be a part thereof.

STEAM CYLINDERS.

The steam cylinders will be four in number, two high pressure and two low pressure. The high pressure steam cylinders to be 24 inches in diameter, and 36 inch stroke of piston, and the low pressure steam cylinders to be 48 inches in diameter and 36 inches stroke of piston. The steam cylinders to have steam jacketed heads, also to be surrounded by a steam jacket. The steam cylinders to be made in dry sand moulds and cast on end, and to be of first quality both in workmanship and material.

BED PLATE.

The bed plate will be cast iron, and will be in two pieces, bolted together. On each part of the bed plate will be lugs for $4\frac{1}{2}$ inch wrought iron stretchers. To the upper surface of the bed plate will be bolted the steam cylinders; also there will be cast on the upper surface of the bed plate, the main pillow blocks, in which will revolve the crank shaft.

MAIN CRANK SHAFT.

The crank shaft, containing two cranks, will be 13 inches in diameter, and will be of the best fagoted iron.

FLY-WHEELS.

The fly-wheels will each be 12 feet 4 inches in diameter.

MAIN PILLOW BLOCKS.

The main pillow blocks will be three in number; which will be cast in the upper surface of the bed plate. The journal bearings to be lined with first quality anti-friction metal, and to have adjustable nuts to compensate for wear.

BEAM PILLOW BLOCKS.

The beam pillow blocks will by four in number, and will be cast in the lower side of the engine bed plates. The journal bearings to be lined with first quality anti-friction metal and to have adjustable nuts to compensate for wear.

BEAM SHAFT AND BEAM.

The beam shaft will be 9 inches in diameter, to which will be keyed the beams, and will by supported be the beam pillow blocks. The beams will each consist of two plates of wrought iron $1\frac{1}{4}$ inches thick, placed at a suitable distance from each other, and to have pins firmly bolted and riveted in for the attachment of the main connecting rods, and links for the engine piston rods, as shown in the drawing.

GUIDE BARS.

The guide bars, two in number for each cylinder, will be of cast iron, in which will run the cross heads. They will be bolted to the inside of the bed plate castings.

VALVE MOTION.

The valve motion will be the kind known as the "Corliss" valve motion.

CONNECTION RODS.

The connection rods and links will be of the best fagoted iron, rectangular in section, straps of the best "American" iron, and boxes on the bearings, of bronze, with adjustable gibs and keys of the usual pattern.

ENGINE & PUMP PISTON RODS.

The piston rods for both engines and pumps will be of hammered steel. The piston rods for each high pressure steam cylinder will be $3\frac{1}{2}$ inches in diameter. The piston rods for each low pressure cylinder will be two in number, and will be 4 inches in diameter. The pump piston rods will be two to each pump, each $3\frac{1}{2}$ inches in diameter.

ENGINE PISTONS.

The engine pistons, four in number, will be of the variety known as the "ring" type of piston. There will be two pistons for the high pressure steam cylinders, 24 inches in diameter; and

two pistons for the low pressure steam cylinders 48 inches in diameter.

PUMP PLUNGERS.

The pump plungers will be four in number, one for each pump, of cast iron, and will be 19 inches in diameter, and packed by means of an external gland.

ARRANGEMENT OF CONNECTIONS.

The arrangement of connections between the steam piston rods and the beams will be as follows:

The single piston rod will be connected to a double rod by a cross head; and also by means of another cross head lower down united into the pump plunger rod. On the high pressure side of each beam will be placed a pin of hammered steel securely fastened to the beam, which will be in turn connected to a pin on a cross head placed below the upper cross head and separated therefrom by a spool. The two side rods to pass from a shoulder below the second cross head, through it, the spool and upper cross head, and to be secured by nuts upon their upper ends.

WROUGHT IRON STRETCHERS.

From the engine bed plate extending downward will be two wrought iron stretchers, $4\frac{1}{2}$ inches in diameter, to each pump. At the upper end they will pass through lugs left for that purpose, on the engine bed plate; they being provided with a shoulder and fastened at the top by a nut. At their lower end they will be provided with a shoulder and set into ears on the pumps of suitable strength, and will be secured by a nut on their lower end.

PUMP CYLINDERS.

The pump cylinders shall be four in number, of cast iron, and of the variety known as the single acting plunger pumps, the plungers of which will be 19 inches in diameter, and will be packed with external glands, the glands to be bushed with bronze. The pump cylinders will be bolted firmly to the base, also to the valve boxes. On each pump will be cast two lugs, into which the stretchers will be placed and properly secured by nuts.

VALVE BOXES.

The valve boxes will be of cast iron and circular in form. Each valve box will consist of three pieces,—the lower valve plate,

upper valve plate and cover. In each valve box will be placed man holes 15 inches in diameter, allowing easy access to the valves The pump valves will be of the kind known as the "Troy valve' (Gaskill's Patent) with a lift not to exceed ¼ of an inch.

BASE.

There will be a base for the four pumps, which will be firmly bolted to the foundation below, also to the pump cylinders above. There will be an opening in the base to take suction from. The upper and lower surfaces of the base will be connected by webs.

AIR AND SUCTION CHAMBERS.

There will be suitable air and suction chambers on the suction and discharge pipes. The discharge air chambers will be provided with suitable air charging device. The suction pipes to pumps will be provided with screens having openings at least 4 times the area of the suction pipe.

WATER GAUGE, STEAM GAUGE, ETC.

The engine will be fitted with a water pressure gauge, steam gauge, vacuum gauge, revolution counter, put up in a group of tasteful design with a nickel plated finish.

AIR PUMP AND CONDENSER.

The air pumps will be two in number, single acting, of proper form and sufficient capacity. The condenser will be of the form known as a surface condenser, and will be of ample size to perform the work of condensation.

OIL CUPS.

All journals and bearings are to have oil cups wherever necessary.

WOODEN LAGGING.

The steam cylinders will be covered with black walnut lagging, which will be secured by $\frac{5}{16}$ inch round head machine screws. The steam cylinders will be furnished with automatic lubricators.

CAPACITY.

The above described machinery will be guaranteed to be capable of pumping 5,000,000 U. S. gallons of water per 24 hours against a static head of $378\frac{1}{10}$ feet, at a piston speed of 120 feet per minute with 90 lbs. steam, and to develop a duty equivalent to raising 2,500,000 gallons $378\frac{1}{10}$ feet high, in 24 hours, with a con-

sumption of 9,000 pounds of coal and to raising 5,000,000 gallons $378\frac{1}{10}$ feet high, in 24 hours, with a consumption of 18,000 pounds of coal, test to be conducted as per your specification.

WORKMANSHIP AND MATERIAL.

It is the intent of these specifications that all material and workmanship shall be first quality in every respect.

THE HOLLY MANUFACTURING CO.

H. F. GASKILL,

*Vice Pres. Eng. and Supt.*

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# SPECIFICATIONS

—FOR—

## SIX HORIZONTAL TUBULAR STEAM BOILERS

—FOR—

THE NEW COVINGTON WATER WORKS.

TYPE.

The boilers to be of the horizontal tubular type with full cast iron fronts and double doors complete, together with such other castings as may be called for in these specifications.

DIMENSIONS.

Boilers to be 5 feet 6 inches in diameter by 18 feet in length. Each boiler to have a steam dome 2 feet 9 inches in diameter and 3 feet 6 inches in height.

TUBING.

Each boiler to contain eighty 3½ inch lap welded tubes 17 feet 10½ inches long, set in vertical rows. All tubes to be spaced 1⅛ inch vertically and 1⅛ inch horizontally. No tubes to be nearer the shell than 3 inches, or nearer the bottom of the shell than 8 inches. Tubes to be expanded with a "dudgeon expander." The ends of the tubes to be beaded over with a hand tool.

MATERIAL.

The shells and heads of the boiler to be of best quality Homogeneous steel. The shell to be in three courses, each course in one

sheet. Shell of boiler to be 3/8 inch thick, shell of dome $\frac{5}{16}$ inch thick; main and dome heads 1/2 inch thick. The steel composing the boiler to have a tensile strength of between 58,000 and 62,000 pounds per square inch, and to show an elongation of 25 per cent., of specimens 8 inches in length, and a reduction of area of 50 per cent., and strips cut from the plates indiscriminately, heated to a low cherry red heat, quenched in water 82° Fahrenheit, must stand bending 180° in a circle the radius of which is not greater than one and one-half times the thickness of the plates, tested without sign of fracture, and specimens of steel must bend on themselves cold.

FLANGING.

All flanges to be turned in a neat manner to a radius of 2 inches. To be clear of flaws, checks and hammer marks.

RIVETING.

To be riveted with 5/8 inch iron rivets throughout. (Rivets to be Bendan's best.) Rivets to have sufficient length to form heads equal in strength to the pressed heads of same. All girt seams to be single riveted, horizontal seams and flange seams of dome at junction with shell of boiler, also vertical seam of dome, to be "stagger riveted." All riveting to be done by hand.

CHIPPING AND CAULKING.

Seams to be chipped and caulked thoroughly. All caulking to be done with the Connery Patent System. No drift pins to be used in the construction of the boiler. A reamer to be used to "fair up" holes where required. Dome to be placed on the center course of boiler.

BRACING HEADS.

The main heads of boiler to be braced to the shell with twelve 1 1/8 inch round iron braces on each head, four to reach from five inches above center of upper row of tubes on head to second course of shell, and the remainder on first course of shell near second sheet. All to be equally distributed on the heads of boilers. All to be solid "crow-foot" braces, with flattened end against shell, and to be riveted with two 5/8 inch rivets in each end, care being taken in setting braces that they do not come in the way of entering the boiler.

BRACING DOME.

Dome to be braced as follows: Heads to be braced to shell of

dome with ten 1 inch braces, same description as above, and to reach at least 20 inches down on shell of dome. Also to have twelve ¾ inch by 2½ inch by 12 inch long braces reaching from shell of dome to shell of boiler to reinforce the flange seam, and to be "crow-foot" braces, each riveted with two ⅝ inch rivets.

MAN AND HAND HOLES.

To have a suitable man hole mouth piece, 12 x 15 inches, extra heavily secured to head of boiler dome, to be furnished with plate and fastening, and to have suitable hand holes in each end of the boiler heads below the tube line, furnished with proper plates and fastenings.

OPENING.

Opening into dome from boiler to be cut girtwise, and not to exceed 10 x 12 inches, and to be provided with a stiffening ring 2½ inches wide by ⅝ inches thick, riveted around the same.

DRIP HOLES.

Drip holes to be punched at or near the junction of the shell of dome, to properly drain the same.

SIDE LUGS.

Boiler to have four cast iron side lugs, to support the same, securely riveted to each side, one on each course.

CASTINGS.

Each boiler to be furnished with full cast iron front of neat design, with all necessary doors and fastenings for facility of access to the tubes, furnace and ash-pit. Each boiler to be also furnished with rear doors exposing the rear end of tubes. To be also furnished with all suitable buckstays and buck-stay rods for securing and holding fronts and brick work in position, and with all necessary nuts and washers.

GRATES.

Each boiler to be provided with not less than 30 feet of grate surface.

FITTINGS.

Each boiler to be furnished with one 8 inch brass case, nickel-plated steam gauge with stop cocks and siphon; three ¾ inch gauge cocks, one ¾ inch glass gauge, and with all suitable feed, blow-off and check valves, also with one 4 inch pop safety valve of approved make, with brass stems, seats and valves.

MATERIAL AND WORKMANSHIP.

The whole to be put together in a first class workmanlike manner, materials used to be the best of their several kinds, all subject to the approval of the Chief Engineer of the Covington Water-Works, who shall have authority to reject any or all parts of said materials or workmanship that are not in full conformity with these specifications.

PRESSURE AND TEST.

These boilers are to carry safely a working pressure of 100 pounds per square inch, and must be tested, and made thoroughly tight at a cold water pressure of 200 pounds before shipment from the place of manufacture.

FEED PUMPS.

The boilers to be furnished with independent feed pumps having capacity to supply the water evaporated by the six boilers.

MUD DRUM.

Each boiler to be supplied with a suitable mud drum arranged o as to be accessible from the outside of brick setting.

FEED WATER PURIFIER.

The boilers to be furnished with a suitable feed water heater and purifier, one that will satisfactorily perform its office. ([5])

SHIELD PLATES.

Shield plates to be attached to the doors in front of flues of boiler to prevent excessive radiation of heat.

SETTING.

The six boilers to be furnished, set up complete at the Covington City pumping station, including all brick work, which is to be put in, in a thorough and workmanlike manner to the satisfaction of the Chief Engineer of the Covington City Water-Works. Brick work to include the necessary brick flue extending back of the boilers, as shown by plans herewith submitted, sheet No. 3.

THE HOLLY MANUFACTURING CO.

H. F. GASKILL,

*Vice Pres. Eng. and Supt.*

[5] The mud drums were dispensed with, and a "National Filter" placed between the heater and the boilers.

## EXHIBIT "M."

# GENERAL SPECIFICATIONS

FOR

# BILGE PUMP AT THE PUMPING STATION.

### GENERAL DESCRIPTION.

This pump is intended to be used for pumping out and cleaning the well at the pumping station. A boiler is not required, the necessary supply of steam being obtainable from the boilers of the pumping engines.

The general arrangement shall be such as shown in diagrams on sheet No. 3.

The pump, which shall be of the direct acting, duplex type, shall be movable vertically between iron guides of sufficient strength and stiffness, fastened to the iron beams of the floors. These guides shall have holes or brackets every five (5) feet, supporting a moveable cross bar upon which the pump shall rest when working. The pump shall be raised and lowered by means of a Weston differential block, suspended from a cross-beam supported by the roof trusses.

### CONDITIONS OF WORKING AND DETAILS OF CONSTRUCTION.

The pump shall work vertically, the water cylinders down and the steam cylinders up. The steam cylinders shall be connected with the steam pipes of the pumping engines with a steam hose of sufficient length to allow the lowering of the pump to a distance of 14 feet from the bottom of the well.

The stationary discharge pipe, *D. D.*, with outlet sixty (60) feet above the bottom of well, is six (6) inches in diameter and has four branch valves about 14½ feet apart for connection with the pump by a 5 inch, flexible hose. This hose must be long enough

to connect the discharge pipe at the lowest branch valve with the pump at its lowest position in the well.

The suction pipe permanently attached to the pump, shall be 15 feet long, and shall have a strainer at the end, reaching to the bottom of the sump *S.*, when the pump occupies its lowest position.

When running at a piston speed of not more than 100 feet per minute, with a steam pressure in the boiler of 75 lbs. per square inch, and the water at its lowest level in the well, the pump shall discharge not less than 500 gallons per minute, actual measurement.

The pump must be constructed with the view of pumping muddy and sandy water, such as must be expected in cleaning out the well.

The plungers and piston rods shall be of brass. If the pump is made with water pistons instead of plungers, the water cylinders shall be lined with brass. The valve seats shall be of brass and easily accessible for inspection and repair.

All materials used in the construction of the pump and appendages must be of the best quality, and the workmanship first class in every particular. All unfinished parts of the pump must be painted with three coats of black Japan varnish.

PRICE.

The price bid must include, besides the pump, the necessary length of steam hose with couplings at ends, the necessary length of discharge hose with couplings at ends, the necessary length of suction pipe with strainer the necessary steam exhaust pipe in place, with valves, the necessary steam exhaust hose, with couplings to connect with pump and exhaust pipe, the differential block for raising and lowering the pump, with chains of sufficient length to be operated conveniently from the floor of the engine room, the chain for suspending the pump to the block, and all the tools necessary to put together or take apart the different parts of the machinery.

All of which must be delivered in good working order, ready for use, and to the acceptance of the Engineer, at the new Covington Pumping Station, situated on the Ohio river, and on the line of the C. & O. R. R., about eight (8) miles from Covington, Kentucky.

## PROPOSALS.

CINCINNATI, OHIO, June, —, 1889.

*To the Trustees Covington Reservoir:*

GENTLEMEN:—We have the honor to herewith submit proposal for Pump and accessories for use at pumping station, as set forth in specifications.

We would offer one 9 in. x 8½ in. x 10 in. Worthington Duplex (brass mounted) Plunger Pumping Engine, so constructed and arranged as to be operated vertically, and so arranged as to be raised and lowered by a chain block, and secured at various stages within the well, to cross-bars or a platform that are made movable on guides to be provided by you.

This pump will have brass plungers, brass piston rods, brass valve seats, and will have a permanent 6 inch suction pipe fifteen (15) feet long, projecting downwardly from the pump, which suction pipe will be provided with substantial strainer, 18x24 inches, filled with $\frac{5}{16}$ inch perforations, and the same rigidly secured to lower end of suction pipe. All needed 2 inch steam hose with necessary brass couplings to conduct the steam from the steam pipe to steam cylinders of the pump; the necessary 2½ inch steam hose for the exhaust of the steam cylinders to connect with the out-port exhaust, including the needed brass couplings; also the necessary 5 in. x 4 ply hose with brass couplings for the water discharge of the pump, and to connect to your discharge pipe connections. All iron pipe valves and fittings needed for the out-port exhaust, to which the exhaust hose will attach, and one Weston differential chain block of 3 ton capacity, with necessary length of chain to lower pump to lowest point in well, and all needed attachments for the same, except as to the over head or roof attachment, which you are to provide.

All needed lubricators, oil cups, wrenches and other appurtenances necessary for caring for or operating the pump are included, as contemplated by the specifications.

All of which we will guarantee to be first class in every particular, and to have the power with 75 lbs of steam pressure to deliver

the quantity of water you stipulate, and to satisfactorily perform your service, for the sum of eleven hundred eighty-seven dollars, ($1,187.00).

We would recommend, however, as better adapted to this service, the Admiralty Pump, as illustrated on page 36 of our illustrated catalogue.

The 12 in. x 8½ in. x 10 in. of this type, brass fitted, with the other appurtenances for pumping out well hole, would cost you twelve hundred and fifty dollars (1,250.00), same terms as above.

The above prices contemplate painting, as stipulated.

Yours truly,

J. K. RUGG & CO.,

Agent for Henry R. Worthington.

## EXHIBIT "N."

# SPECIFICATIONS

FOR

## GUIDES OF BILGE PUMP AT THE COVINGTON, KY., PUMP HOUSE.

### GENERAL.

The work shall be done in accordance with the plans and specifications furnished by the chief Engineer for the Trustees of the Covington Reservoir.

The work shall include all iron, shop work, coating, labor, transportation and other work necessary or incidental to the construction and erection of the guides in the pump well at the new pumping station on the line of the C. & O. R. R., about eight miles from Covington, Ky., including the attachments and stays for the same and the hinges for the trap door over the well.

### QUALITY OF THE IRON.

The iron shall be tough, ductile, uniform in quality and shall stand without breaking, not less than 50,000 pounds per square inch tensile stress with 15 per cent. elongation in eight inches, in specimens ½ square inch of sectional area. All pieces shall be smooth, free from injurious seams or flaws, blisters, buckles, cinder spots and imperfect edges.

### WORKMANSHIP.

All workmanship shall be first-class in every particular.

All parts shall be free from twists and bends. Abutting ends shall be planed or turned in a plane perpendicular to their axis and shall be in contact throughout.

Rivet holes shall be accurately spaced and shall fit exactly opposite to each other without drifting.

Rivets when driven shall completely fill the holes.

Rivet heads shall be full size, well formed and concentric to the holes.

No loose rivets shall be allowed.

All bolts shall have perfect threads.

COATING.

All the iron work shall be coated with approved black varnish or other water proof coating approved by the Engineer.

ANCHORING.

The intermediate stays between floors shall be leaded into the masonry of the well as shown on plans.

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## PROPOSAL FOR THE GUIDES OF AUXILIARY PUMP AT THE NEW PUMPING STATION FOR COVINGTON, KENTUCKY.

The undersigned, having carefully examined the plans and specifications for the guides of auxiliary pump at the new pumping station for Covington, Ky., hereby propose to the Trustees of Covington Reservoir to construct and erect the same, ready for use, in accordance with said plans and specifications and under the direction and to the satisfaction of the chief Engineer for said Trustees, for the sum of ——— cts. per pound, and complete the work on or before the 15th day of September, 1889.

## EXHIBIT "O."

CINCINNATI, December, 11, 1890.

*Trustees Covington Reservoir, Covington, Ky.:*

GENTLEMEN :—I beg to submit the following report on the duty tests recently made of the Covington pumping engines built by the Holly Manufacturing Co. under contract with your Board.

The general specifications under which proposals were received for these pumping engines stipulate that "each pumping engine working either singly or jointly with the normal pressure of 100 lbs. of steam in the boilers shall deliver water in the Reservoir at the rate of 5 million U. S. standard gallons in 24 hours with a consumption of coal not exceeding 18,000 lbs. in 24 hours when the level of the water in the river is 385 feet below the center of force pipe at the apex on the hill. The consumption shall be proportionally less as the water in the river rises above the datum referred to.

"After a period of ninety days operation the final tests for duty shall be made in the following manner: 1st. Both pumping engines shall be worked simultaneously in normal condition with a steam pressure of 100 lbs. to the square inch in the boilers, and a rate of delivery into the Reservoir, not less than 10 million gallons in 24 hours for a period of not less than 48 hours. 2nd. A similar test shall be made with each engine working singly in normal condition with 100 lbs. steam pressure in the boilers. The coal consumed shall be carefully weighed. The quantity of water shall be carefully measured over a weir at the Reservoir and an accurate record shall be kept of the elevation of water in the river during the test."

In the contract as executed by the Holly Manufacturing Co. these conditions were slightly modified by the following clause: "The above described machinery will be guarranteed to be capable of pumping 5 million U. S. gallons of water per 24 hours against a static head of 378 1-10 feet at a piston speed of 120 feet per minute with 90 lbs. steam and to develop a duty equivalent to raising

2½ million gallons 378 1-10 ft. high in 24 hours with a consumption of 9,000 lbs. of coal and to raising 5 million gallons 378 1-10 feet high in 24 hours with a consumption of 18,000 lbs. of coal, test to be conducted as per your specifications."

The changes made from the general specifications by this clause of the contract are :

1st. That a maximum static head of 378 1-10 feet is substituted for 385 feet, the former being the difference in elevation between extreme low water in the river and the highest point on the force pipe line at the open stand pipe in tunnel.

2nd. That a pressure of 90 lbs. of steam (inferred to apply to the working pressure at the engines, but not expressly defined) is substituted in place of 100 lbs. pressure at the boilers.

3rd. That the piston speed of the engines is limited to 120 ft. per minute, whereas no limit is stipulated in the general specifications.

The weir used for gauging the quantities of water delivered was erected at the inlet of the north basin of the Reservoir.

The tests were made in the following order :

1st. Engine No. 1 running alone from November 25th, 12:30 P. M. to November 27th, 12:30 P. M.

2nd. Engine No. 2 running alone from November 27th, 6 P. M. to November 29th, 6 P. M.

3rd. Engines No. 1 and No. 2 running together from December 3rd, noon, to December 5th, noon.

The interval of time between test No. 2 and test No. 3 was rendered unavoidable by the necessity of waiting for the necessary room in the two basins of the Reservoir to receive the water pumped during the 3rd test and by the absence of Mr. Hermany who was compelled to attend to urgent business in Louisville.

The water delivered during test No. 1 for the 46 hours beginning at 1:50 P. M. November 25th, and ending at 11:50 A. M. November 27th, was carefully measured in the basin to serve as a check to the gauging at the weir. The same was done during test No. 3 for the first 24 hours run from noon December 3rd, to noon December 4th. As a further check to show the changes in the condition of the engines which might have taken place during the tests, short runs were made at the end of test No. 3 with each engine working alone.

For Engine No. 1 from 12:15 P. M. to 1:45 P. M.

For Engine No. 2 from 2:15 P. M. to 3:45 P. M.

The results of my calculations from all the observations taken are tabulated in the accompanying exhibit.

The notes have been handed by me to Mr. Hermany who will make his own computation and submit his report to your Board next week.

The weir and basin measurements in the first test were found to agree within about one per cent. which is as close as could be expected.

## EXHIBIT SHOWING RESULTS OF DUTY TESTS OF COVINGTON PUMPING ENGINES.

| | Engine No.1 | Engine No. 2 | Engines Nos. 1 & 2 Combined. | Engine No. 1 short run. | Engine No. 2 short run. |
|---|---|---|---|---|---|
| Water delivered (Weir measurement.) | gals. 10,909,269 | gals. 10,937,261 | gals. 21,546,323 | c. f. 50,245 | c. f. 47,306 |
| Water delivered (Basin measurement.) | *gal. for 46 hrs. 10,570,610 | not taken. | ** gal. for 1st 24 hrs. 11,153,805 | not taken. | not taken. |
| Discrepency between basin and weir (basin in excess of weir.) | 0.01092 | —— —— | 0.03507 | —— —— | —— —— |
| Number of revolutions of engine. | 63,795 | 64,299 | No. 1 64,899 No. 2 65,295 | 2,230 | 2,106 |
| Displacement of pumps. | gals. 11,275,432 | gals. 11,364,510 | gal. 23,011,103 | c. f. 52,689 | c. f. 49,759 |
| Slip of pumps by weir measurement. | 0.0325 | 0.0376 | 0.0637 | 0.0464 | 0.0493 |
| Slip of pumps by basin measurement. | 0.0217 | not taken. | 0.0308 | | |

EXHIBIT SHOWING RESULTS OF DUTY TESTS OF COVINGTON PUMPING ENGINES.—CONTINUED.

| | Engine No. 1. | Engine No. 2. | Engines Nos. 1 & 2 Combined. | Engine No. 1. short run. | Engine No. 2, short run. |
|---|---|---|---|---|---|
| Average depth of water in well below floor engine house. | ft. 49,279 | ft. 54,136 | ft. 60,330 | | |
| Depth of water below center of force main at stand pipe. | ft. below 0.125 | ft. below 0.125 | ft. above 0.375 | | |
| Total average lift | 356.964 ft. | 361.821 ft. | 368.515 ft. | | |
| Quantity of water assumed in computation of allowable coal. | gals. 10,909,269 | gals. 10,937,261 | gals. 22,061,091 | | |
| Allowable coal. | 37,078 lbs. | 37,679 lbs. | 77,406 lbs. | | |
| Coal burnt. | 35,041 lbs. | 36,675 lbs. | 76,725 lbs. | | |
| Marginof allowable coal over coal burnt. | 2,037 lbs. | 1,004 lbs. | 681 lbs. | | |
| Margin in per cent | 5.5 per ct. | 2.66 per ct. | .88 per ct. | | |
| Actual piston speed. | 132.9 ft. | 134 ft. | No. 1 134.9 ft. No. 2 135.6 ft. | | |
| Piston speed on basis of 5 million gallons for each engine. | 121.8 ft. | 122.5 ft. | Average 122.9 ft. | | |
| Excess of piston speed in per cent. | 1.5 per ct. | 2.04 per ct. | 2.4 per ct. | | |

*For the same 46 hours weir measurement, 10,456,400 gals.

**For the same 24 hours weir measurement, 10,775,952gals.

In the 3rd test the basin measurement exceeded the weir measurement by more than 6 per cent. which can only be explained by the fact that the current in the weir trough was disturbed to such an

extent by the large quantity of air carried by the water from the stand pipe as to impair the accuracy of the gauging. The quantity of water given by the basin measurement less 1.092 per cent. was taken as a basis for the computation of the allowable coal in that test.

My conclusion with regard to the tests is that the engines have complied with the conditions of the contract except in the following particulars:

1st. That the pressure of steam corresponding to the specified duty is 100 lbs. instead of 90 lbs. 2nd. That the piston speed necessary for the delivery of the specified quantity of water in the 24 hours, exceeds the specified speed by $1\frac{1}{2}$ to $2\frac{1}{2}$ per cent.

These discrepancies being of a purely technical nature, I recommend the acceptance of the engines from the contractor's hands.

Very respectfully,

G. BOUSCAREN.
Chief Engineer.

NOTE.—The weight of coal allowable is given by the following formulas in which H=total average lift, Q=quantity of water delivered in million gallons.

For tests Nos. 1 and 2, $W = 18{,}000 \times \frac{H \times Q}{378.1 \times 5}$

For test No. 3, $W = 36{,}000 \times \frac{H \times Q}{378.1 \times 10}$

The gauge readings at the weir were taken every 5 minutes and the discharge for every hour calculated from Mr. Francis' tables computed for this formula:

$Q = 3.33\ (L - 0.1 \times n \times H)\ H^{\frac{3}{2}}$ in which L=length of weir, u=number of end contractions and H=depth of water on weir.

In applying the tables, corrections were made for the increased discharge due to the velocity of approach equal to $\frac{1}{8}^{0}$ of the mean velocity.

## EXHIBIT "P."

LOUISVILLE, KY., Dec. 18th, 1890.

*To the Trustees of the Covington Reservoir, Covington, Ky.*

GENTLEMEN.—Below please find my report upon the fuel and capacity tests made with two pairs of compound steam pumping engines, built by the Holly Mfg. Co., for the Covington, Ky., Reservoir Trustees.

### ENGINE No. 1.

1. Duration of test from 12:30 p. m., Nov. 25th, to 12:30 p. m., Nov. 27th, 1890—48 hours.

2. Two boilers fired during test, Nos. 3 and 4.

3. Coal burnt in 48 hours, 34 990 pounds.

4. Quality of fuel used was good Pittsburgh lump coal forked and free from slack. The contract says: "The coal used shall be the run of the mine, ordinary quality Pittsburg coal."

5. The average pressure of steam in boilers during test was 104 18 pounds per square inch. Pressure stipulated in contract was 90 pounds per square inch.

6. Engine No. 1 operates four single-acting plunger pumps, each 19 inches in diameter and 36 inches stroke.

7. Plunger displacement per revolution, equals $(19)^2 \times 0.7854 \times 36 \times 4 \times (\frac{1}{231}) = 176.7456$ U. S. Gallons.

8. Number of revolutions during test 63,795.

9 Piston Speed 120 feet per minute as named in contract for 10,000 000 gallons in 48 hours.

10. Average piston speed during test was:

$$\frac{63{,}795 \times 6}{48 \times 60} \times \frac{10{,}000{,}000}{11{,}030{,}201} = 120.49 \text{ feet per minute.}$$

11. Volume of water pumped during 48 hours, estimated by plunger displacement was 63,795 x 176.7456=11,275,436 gallons.

12. Static head against pumps from low water in the river to

water surface at apex at force main at stand-pipe, 378.1 feet as specified.

13. Average vertical distance during test from Engine Room Floor to water in well 49.342 feet.

14. Average height during test from Engine Room Floor to water surface at apex in force main at stand-pipe 307.81 feet by Engineer's levels. Same by pressure gauge 314.61 feet.

15. Total static head against pumps during test 357.152 feet by Engineer's level.

16. The mean head on the weir during test from 576 readings of hook-gauge, was 0.64495 feet, head due velocity of approach 0.0024 feet, and total head on weir 0.64735 feet. Length of weir 4 995 feet.

17. Volume of water delivered into reservoir in 48 hours by weir measurement (computed by Francis' well known formula) $Q.=3.33(L-0.1 \times n \times H) H^{\frac{3}{2}}$ was—

$3.33(4\ 995-0.\ 1 \times 2 \times 0.64735)\ 0.64735^{\frac{3}{2}} \times 7.4805 \times 60 \times 60 \times 48=10{,}908{,}310$ gallons.

18. Volume of water delivered into reservoir in 46 hours by basin measurement. Water in n. basin Nov. 25th at 1.50 p. m. by table of reservoir capacity.....12,689,340 gallons.

Water in same Nov. 27th, at 11:50 a m. 23,259,950 "

In 46 hours.....10,570,610 gallons.

Equivalent to..... 48/46

In 48 hours.....11,030,201 gallons.

19. These three different methods of determining the volume of water delivered into the reservoir, as shown in sections 7—11 16—17 and 18 of this report, give the following as delivery in 48 hours, viz,

By pump plunger displacement.....11,275,486 galls.
" Weir gauging.....10,908,310 "
" Basin measurement.....11,030,201 "

The lost action (slip) of the pumps was therefore 0 03366 when estimated by weir gauging and 0.02223 compared with basin measurement.

The volume of water delivered into reservoir, as determined by basin measurement, is taken as the closest approximation to ac-

curacy, and therefore Engine No. 1 is given credit for having delivered 11,030,201 gallons of water into the reservoir in 48 hours.

20. The contract stipulates that the Engine shall pump 10,000,000 gallons of water in 48 hours from low water level in the river to the height of the center of the force pipe at the stand pipe (a height of 378.1 feet) with 36,000 pounds of coal, or the same volume of water with a proportionately less weight of coal as the water in the river rises above the low water level. Which alternative means, that if the conditions named in the contract do not exist at the time of making the test, then the result of the test made under changed conditions, shall be the *mechanical equivalent* of the work stipulated in the contract.

Instead of pumping the stipulated volume as above stated this engine pumped 11,030,201 gallons of water in 48 hours 357,152 feet high with 34,990 pounds of coal, which is the mechanical equivalent of the work stipulated to be performed, with 2,519 pounds of coal less than the weight allowed in the contract—a reduction of $7\frac{2}{10}$ per cent., expressed as follows, viz:

$$\frac{11{,}030{,}201 \text{ gal. x } 357\ 152 \text{ feet head}}{10\ 000{,}000 \text{ gal. x } 378.1 \text{ feet head}} \text{ x } 36{,}000\text{—lbs. coal.}$$

—34,990 pounds of coal=2,519 pounds of coal less than the contract allowance.

## ENGINE No. 2.

1. Duration of test 6:00 p. m., Nov. 27th, to 6:00 p. m., Nov. 29th, 1890—48 hours.

2. Two boilers fired during test, Nos. 3 and 4.

3. Coal burnt in 48 hours 36,777 pounds.

4. Quality of fuel used was good Pittsburg coal, containing a large percentage of slack. The contract says: "The coal used shall be the run of the mine, ordinary quality Pittsburg coal."

5. The average pressure of steam in boiler during the test was 103.81 pounds per square inch. Pressure stipulated in contract is 90 pounds per square inch.

6. Engine No. 2 is a duplicate of No. 1, and operates four single-acting plunger pumps, each 19 inches in diameter and 36 inches stroke.

7. Plunger displacement per revolution, equals

$(19)^{\frac{2}{}}$ x. 7854x 36 x 4 x $(\frac{1}{231})$=176.7456 U. S. gallons.

8. Number of revolutions during test 64,299.

9. Piston speed 120 feet per minute as named in contract for 10,000,000 gallons.

10. Average piston speed during test was

$$\frac{64{,}299 \times 6}{48 \times 60} \times \frac{10\,000\,000}{10{,}936{,}128} = 122.49 \text{ feet per minute.}$$

11. Volume of water pumped during 48 hours, estimated by plunger displacement, was

64,299 rev. x 176 7456 galls. = 11,364,565 gallons.

12. Static head against pumps from low water in the river to water surface at apex in force main at stand-pipe, 378.1 feet as specified in contract.

13. Average vertical distance during test from engine room floor to water in well 54.115 feet.

14. Average height during test from engine room floor to water surface at apex in force main at stand-pipe, 307.81 feet by Engineer's levels—same by pressure gauge 314.61 feet.

15. Total static head against pumps during test was 361.925 feet by Engineer's levels.

16. The mean head on the weir during the test from hook-gauge readings taken at regular intervals of five minutes apart was 0.64607 feet, head due velocity of approach 0.0024 feet, and total head on weir 0.64847 feet—length of weir 4.995 feet.

17. Volume of water delivered into Reservoir in 48 hours by weir mersurement, computed by Francis' formula, was

$3.33(4.995-0.1 \times 2 \times 0.64847) \times 0.64847^{\frac{3}{2}} \times 7.4305 \times 60 \times 60 \times 48$=10,936,128 gallons.

18. Volume of water delivered into reservoir in the test of this Engine was not measured in the basin.

19. The two different methods of determining the volume of water delivered into the reservoir give the following as the delivery in 48 hours, viz :

By pump plunger displacement----------11,364,565 gallons.
" weir gauging----------10,936,128 "

The result of the test made with Engine No. 1, gave the volume of water delivered, by basin measurement, as 1.01117 times that determined by weir gauging. For the reason assigned in the

report on the test with Engine No. 1, the weir volume of the delivery by Engine No. 2, is multiplied by 1.01117, and the engine given credit for delivering 11,058,328 gallons of water into the reservoir in 48 hours.

The lost action (or slip) of the pumps was therefore 0.03917 estimated by weir gauging, and 0.02769 compared with *estimated* basin measurement.

20. The contract requires Engine No. 2 to perform the same work with the same consumption of coal as stipulated for Engine No. 1. Engine No. 2, pumped 11,058,328 gallons of water 361.-925 feet high in 48 hours with 36,777 pounds of coal, which is the mechanical equivalent of the work stipulated to be performed with 1330 pounds of coal less than the weight allowed in the contract, a reduction of $3\frac{61}{100}$ per cent., expressed as follows, viz:

$$\frac{11{,}058{,}328 \text{ galls. water} \times 361{,}925 \text{ feet head}}{10{,}000{,}000 \text{ galls water} \times 378.1 \text{ feet head}} \times 36{,}000 \text{ lbs. coal}$$

—36,777 pounds of coal = 1330 pounds of coal less than the contract allowance.

The difference in the coal consumption by the two engines is 1139 pounds, and is evidently due to the difference in the condition of the coal.

## ENGINES Nos. 1 & 2, WORKING SIMULTANEOUSLY.

1. Duration of test from 12 noon, Dec. 3rd, to 12 noon, Dec. 5th, 1890—48 hours.

2. Four boilers fired during test, Nos. 1, 2, 3, and 4.

3. Coal burnt in 48 hours 76,460 pounds.

4. Quality of fuel used was good Pittsburgh coal containing a large percentage of slack. The contract says "the coal used shall be the run of the mine, ordinary quality Pittsburgh coal."

5. The average pressure of steam in the boilers during the test was 103.78 pounds per square inch. Pressure stipulated in contract is 90 pounds per square inch.

6. The two engines working simultaneously operate eight single acting plunger pumps, each 19 inches in diameter and 36 inches stroke.

7. Combined plunger displacement by the two engines per joint revolution, equals

$$19^2 \times .7854 \times 36 \times 4 \times 2 \times \tfrac{1}{231} = 353.4912 \text{ U. S. gallons.}$$

8. Number of revolutions during test for both engines was, (64,899 for No. 1 x 65,295 for No. 2) = 130,194.

9. Piston speed 120 feet per minute as named in contract for 20,000,000 gallons in 48 hours.

10. Average piston speed during test was,

$$\frac{130.194 \times 6 \times 20{,}000{,}000 \times 1}{48 \times 60 \times 22{,}307{,}610 \times 2} = 121.5^{8} \text{ feet per minute.}$$

11. Volume of water pumped during 48 hours estimated by plunger displacement, was,

$$65{,}097 \times 353.4912 = 23{,}011{,}217 \text{ gallons.}$$

12. Static head against pumps from low water in the river to water surface at apex in force main at stand-pipe, is 378.1 feet as specified in contract.

13. Average vertical distance during test from engine room floor to water in well was 60.333 feet.

14. Average height from engine room floor to water surface at apex in force main at stand-pipe 307.81 feet by Engineer's levels. Same by pressure gauge 314.61 feet.

15. Total static head against pumps during test 368,143 feet by Engineer's levels.

16. The mean head on the weir during the test, from hook-gauge readings taken at regular intervals of five minutes apart, was 1.02124 feet, head due velocity of approach 0.0087 feet, and total head in weir 1.02994 feet. Length of weir 4,995 feet.

17. Volume of water delivered into reservoir in 48 hours by weir measurement, computed by Francis' formula, was

$$3.33(4.995 - 0.1 \times 2 \times 1.02994) \times 1.0299^{\frac{3}{2}} \times 7.4805 \times 60 \times 60 \times 48 = 21{,}546{,}782 \text{ gallons.}$$

18. Volume of water delivered into reservoir in 24 hours by basin measurement:

| | |
|---|---|
| Water in n. basin Dec. 3rd, at 11:50 a. m. | 14,616,590 galls. |
| Water in same at 11:50 a. m Dec. 4th, | 25.770 395 " |
| In 24 hours | 11 153,805 " |
| Equivalent to | $\frac{48}{24}$ |
| In 48 hours | 22,307,610 galls. |

19. The volume of water delivered into the reservoir in 48 hours by the two engines when worked simultaneously, is therefore as follows, viz:

By plunger displacement ..... 23,011,217 galls.
" weir gauging ..... 21,546,782 "
" basin measurement ..... 22,307,610 "

The lost action (slip) of the pumps was therefore 0.06796 when estimated by weir gauging, and 0.03154 when compared with the basin measurement.

The basin measurement, for reasons heretofore stated, is taken as the closest approximation to the correct volume of water delivered into the reservoir, and the two engines running jointly are therefore credited with having delivered 22,307,610 gallons of water in 48 hours.

20. The contract stipulates that the two engines running jointly shall pump 20,000,000 gallons of water in 48 hours 378.1 feet high with 36,000 pounds of coal.

The two engines running jointly did pump 22,307,610 gallons of water in 48 hours 368.143 feet high with 76,460 pounds of coal, which is the mechanical equivalent of the work stipulated to be performed with 1732 pounds of coal less than the weight allowed in the contract—a reduction of $2\frac{27}{100}$ per cent, expressed as follows, viz :

$$\frac{22,307,610 \text{ galls. water} \times 368.143 \text{ feet head}}{20,000,000 \text{ galls. water} \times 378.1 \text{ feet head}} \times 72,000 \text{ pounds coal}$$

—76,460 pounds coal = 1732 pounds less than the contract allowance.

The results from these several tests, show that the Pumping Engines meet the contract requirements fully (exceed them in some respects), with two exceptions, viz : Steam pressure in boilers and piston speed per minute.

These exceptions are technical when considered in connection with the entire plant and of too little importance to be made a subject for discussion.

From the tests made and a careful inspection of the whole plant, I am justified in saying that it is first-class in every respect and fulfills the contract.

Very Respectfully,

CHAS. HERMANY,
*Civil Engineer.*

## EXHIBIT "Q."

### THE MAYSVILLE AND BIG SANDY RAILROAD CO.,

A corporation created and existing under the laws of Kentucky, now engaged in the erection of a railroad bridge across Licking River from a point at or near Byrd street, in the City of Covington, in Kenton County, Ky., to a point near the corporation line of the City of Newport, in Campbell County, Kentucky, agrees with the Trustees of Covington Reservoir, a corporation also created and existing under the laws of Kentucky, now engaged in the construction of a Water Reservoir for supplying the city of Covington with water, to be connected with the present water pipe system of said city by a thirty inch main, in consideration of the sum of $20,000, to be paid to the said railroad company by said Trustees, as hereinafter provided; that the said railroad company will permit said water main over the said river, to be laid under the right of way of said railroad company in approaching said bridge from either side of said river, and be supported underneath the floor of said bridge, in the manner shown by the diagrams hereto attached and made a part of this agreement, in such manner as to in nowise to interfere with the use thereof by said railroad company, nor to run into or through any portion of the embankments of said railroad company, nor so as to interfere with said railroad company in the conduct of their business.

Those parts of said water main connecting the main in the ground on either side of the river with that extending under the bridge across the river, to be attached to the piers of the bridge in the manner represented in said diagrams. The said railroad company to furnish the necessary appliances for the attaching and supporting said main under the superstructure of the bridge, but are not to furnish the attachments for the pipes on the piers; but the said Trustees are to furnish the necessary labor and material for making said attachments to the floor and pier of said bridge, but all work to be done under the supervision of said railroad company.

The main to be placed in position as soon as the bridge is in condition to receive the pipe, and the Trustees have been officially notified of the fact; and they, the said Trustees, will, within ten days from such notification, pay said railroad company the said sum of twenty thousand dollars.

The said Trustees and said city of Covington shall have access to said water main, attached to said bridge, and said right of way, for the purpose of inspecting or repairing the same, or readjusting said main to said bridge or piers should it in any manner become detached, in whole or in part, from said bridge or piers; such right to be exercised in all cases with the least possible interference, for the time being, with the operations of said railroad, and under the supervision of said railroad company.

IN WITNESS WHEREOF, The corporate name of said railroad company and of said Trustees of Covington Reservoir have been hereto affixed by their respective Presidents, I. E. GATES, and A. SHINKLE, with the seal of said corporations, and attested by their respective Secretaries.

Maysville and Big Sandy Railroad Company,
BY I. E. GATES, President.

Attest: F. H. DAVIS, Secretary.

Trustees of Covington Reservoir,
BY A. SHINKLE, President.

Attest: JAMES SPILMAN, Secretary.

January 23d, 1889.

## EXHIBIT "R."

# SPECIFICATIONS

— FOR LAYING —

## THE WATER PIPES OF THE NEW WATER WORKS

— FOR THE —

## CITY OF COVINGTON, IN KENTON AND CAMPBELL COUNTIES, KY.

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### DESCRIPTION OF WORK AND EXTENT OF CONTRACT.

The work shall include all the excavation and back-filling, filling, tunneling, masonry, paving, metalling, and other works necessary to construct and complete the line of water main pipes as now located or to be located by the Engineer of the Trustees, with all valves, special castings and other appendages from the corner of Russell and Third streets, in the city of Covington to the proposed Reservoir at the Moreland place, in Campbell County Kentucky, and from the said Reservoir to the proposed pumping station on the south bank of the Ohio River above the Newport pump-house, excepting the pipes and castings within the Reservoir site, extending from a point near the west end of the proposed tunnel under the Highland pike to a point near the foot of the westerly slope of the dam of lower basin of said Reservoir.

### GRADE AND ALIGNMENT.

The grade and alignment of the pipe shall conform with the grade and alignment shown on the profile and plan furnished to the contractor, and with any modification or change thereof that may be considered necessary or advisable by the Engineer during the progress of the work.

CLEARING.

All trees, stumps, bushes and rubbish, as well as other surface obstructions within six feet of the center of the line of the trench, and any additional width that may be required for the work, shall be removed.

TRENCHES.

The width of trenches shall be sufficient at all points to allow the pipes and their appendages to be laid, set and caulked in the best and the most thorough and workmanlike manner.

The depth of the trenches shall be such as may be required to conform with the grade given by the Engineer for the pipe, there shall be at least three feet of earth covering on top of the pipe.

Wherever the bottom of the trench has been carried down below the proper grade, it shall be brought up to grade with selected material well rammed in.

FOUNDATIONS.

Where the bottom of the trench is soft and liable to yield, it shall be excavated to such additional depth as the Engineer may require, and a foundation of broken rocks covered with a six-inch layer of selected material well rammed or such other foundation as the Engineer may prescribe shall be put in.

ROCKY BOTTOM.

Where the bottom of the trench is rocky it shall be excavated six inches below grade and brought up to a proper grade with selected materials well rammed in.

PRECAUTIONS.

In excavating the trench, the contractor shall carefully remove all loam, pavement and road metal at the surface and separate the same from the other material excavated, to be used in restoring the grounds, roads and streets to their original condition.

Trenches are not to be opened in advance of the laying of the pipe for any greater length than shall be necessary for the expeditious performance of the work, and the back-filling shall be completed as far as the pipe laying shall be done and approved by the inspector.

All blastings near houses and public thoroughfares shall be

done with the most diligent care and precaution to prevent injury to persons and property. All trenches shall be properly shored up. Trenches through public and private roads and through pasture lands shall be properly fenced and guarded. The contractor shall place and maintain in public highways proper painted notices of warning by day and red lights of warning by night.

REPAIR OF SEWERS, PIPES, FENCES, ETC.

The contractor shall at his own expense divert, repair and restore to the satisfaction of the Engineer, all sewers, culverts, drains, pipes, ditches, roads, fences, and other works and properties which he may disturb or injure during the progress of the work.

TRAVEL NOT TO BE INTERRUPTED.

The contractor shall so conduct and manage his work as not to interrupt travel in streets and public highways, and shall provide safe and convenient temporary crossings for the same when necessary.

BACK FILLING.

After the pipe is laid the trench shall be filled with selected material, free from rock, measuring more than two inches, carefully rammed on the side and top of the pipe to a level of six inches above the top of the pipe. The remainder of the fill shall be made with the material excavated, excluding all stones measuring more than six inches in any direction, rammed in layers of six inches in depth until sufficient room is left to receive the loam or the road metal or pavement, which must be carefully replaced with such additional quantity as may be required for the restoration of the original surface. In streets and roads, the contractor shall finish the same to the satisfaction of the City Engineer or Superintendent of roads, or others having the same in charge. The surface shall generally be left higher than originally, making such allowance for the settling of the fill as the Engineer may direct. Frozen earth, roots, grass, and other perishable materials shall be carefully excluded from the fills. Where the trench is so shallow as to leave less than 3 feet depth of covering on top of the pipe, sufficient material shall be added on to obtain the requisite depth of three feet. Where the bottom of the pipe is above ground, a foundation shall be built for its support after carefully removing for the entire width

of its base, all grass, vegetable mold and other materials deemed objectionable by the Engineer, and a fill shall be made and carried to a height of not less than 3 feet above the top of the pipe, making always a proper allowance for shrinkage. The fill shall be made with approved material, using the same care and method as prescribed for the back filling in trenches.

All fills above ground shall have side slopes of not greater inclination than 1½ to 1. On sloping ground the fills shall be protected with approved surface ditches, and drains of approved size and construction shall be put in when required.

WASTE MATERIAL.

All waste material shall be promptly removed and deposited at such places as the Engineer may direct.

BORROWED MATERIAL.

Where the material excavated is insufficient or unfit to complete the back filling or fill, the contractor shall supply approved earth for the purpose.

## PIPE LAYING.

All the pipes and castings shall be delivered to the contractor on the ground along the line and as near as practicable to the position they are to occupy in the trench, generally within thirty feet of the same, excepting the pipes to be laid on the bridge over the Licking, which shall be delivered on the ground at or near either end thereof, and the pipes for the force main from the pump house to the top of the bluff, which shall all be delivered at a convenient place near the line on the top of the bluff. All valves, air-cocks and their appendages, shall be delivered by the Trustees to the contractors at the railroad depots in Covington or Newport. From the time of delivery the contractors shall be responsible to the Trustees for all breakage or injury to the pipe and appendages.

The contractor shall furnish all labor, tools and materials necessary for the completion of the work, excepting pipes, special castings and valves.

The pipes shall be laid on true grade and alignment as shown on the map and profile, and laid out by the Engineer.

CLEARING.

Before being laid the pipes shall be brushed through to remove adhering earth and all foreign matters which may have been left therein.

MANNER OF LAYING.

They shall be placed singly in the trench and bedded so as to rest firmly and uniformly throughout their entire length on the solid earth.

JOINTS.

The joints shall be made with the best quality of tarred hempen yarn, closely twisted in one piece for each joint, well caulked into the socket with a special tool, and soft lead poured in at one running, and set up thoroughly and entirely around the pipe. The depth of lead after caulking shall not be less than 2½ inches. The joints must be well and faithfully caulked by an experienced and competent man in the best manner. All flanged pipes and castings shall be jointed with a sheet lead gasket, properly laped, and of the full diameter and width of the flange.

Such waste and blow-off pipes, valves and air cocks as may be furnished by the Trustees shall be laid and set where and as directed by the Engineer.

PRECAUTIONS.

Care shall be taken to prevent any earth, stone or other material from entering the pipes as they are being laid, and every open end of a pipe laid shall be plugged before leaving the work for any length of time.

The pipes and appendages shall be handled with the greatest care and with proper tools, so as to avoid injury to the coating. No injured or imperfect pipe shall be laid.

No vertical and horizontal curve or bend shall be laid with straight pipes of less radius than 478 feet, without special provision and the permission of the Engineer.

CROSSING OF WATER COURSES.

At the crossing of water courses, arch culvert and pipe drains shall be built in accordance with plans furnished by the Engineer, and the pipe laid thereon and covered to such a depth as may be required.

Where the pipe crosses under the bed of a stream it shall be laid in concrete and protected with paving and slope walls, when required by the Engineer.

Where the pipe crosses existing culverts and drains so as to require the reconstruction of any part thereof, the same shall be done in accordance with plans furnished or approved by the Engineer.

### VALVE CURBS.

Valve curbs, where required, shall be of stone or brick laid in cement with improved cast iron neck and cover. They shall be built on a foundation of stone or brick laid in cement and shall be drained with a stoneware pipe of suitable size.

### TUNNEL.

The tunnel under the Highland pike shall be built in accordance with plans and detail drawings furnished, and directions given by the Engineer.

It shall be arched throughout and closed at the east end with masonry. It shall have an entrance shaft at the west end, also curbed with Masonry, enclosing the air pipe, and covered with an entrance house. The tunnel shall be drained at the east end with an eighteen-inch pipe culvert. The exact length of the tunnel and shaft shall be determined by the Engineer.

### EXCAVATION OF TUNNEL.

The excavation shall be made to conform as closely as practicable with the outline of masonry, particular care being used in blasting and in the temporary shoring of the sides and roof, to avoid falls.

The waste material shall all be deposited between the tunnel and the reservoir at such place as the Engineer may direct.

### LINING AND CURBING.

The masonry arching of the tunnel proper shall be of brick laid in cement mortar with the exception of the closing walls at the east end, which shall be of broken range stone-work, as well as the curbing of the shaft. This curbing shall be capped one foot above the ground with a belting course of selected stone, upon which shall be built the entrance house. Blind arches of six foot span shall be built in the walls at both ends of the tunnel to provide for facility

of repair and replacement of pipe in the future. The floor of the tunnel shall be paved with brick laid in cement.(6)

PACKING.

The space between the masonry and the side and roof of the excavation shall be packed with selected material, carefully and firmly rammed in, a sufficient amount of clay being used to fill completely all void spaces.

DRAINAGE.

Should springs be encountered in excavating the tunnel, the water shall be carefully confined by walling, and led by pipe drains of suitable size, discharging inside of tunnel at the foot of the side walls.

REFILLING.

After the completion of the masonry and of the pipe laying in the tunnel, the excavated approaches at both ends shall be refilled, using the same method and care as prescribed for the back filling of trenches, so as to restore the surface to its original condition.

ENTRANCE HOUSE.

The entrance house shall be built in accordance with plans furnished, with nine-inch walls of brick and asphalt roofing; the door shall be of two thicknesses of one-inch plank, tongue and grooved; it shall be hung with strong wrought-iron hinges and provided with a strong and approved lock. A strong iron ladder, well secured to the masonry, shall lead from the floor to the bottom of the shaft.

## MASONRY.

STONE.

The stone shall be of blue limestone of best quality found in the hills surrounding Newport and Covington, or other stones of good quality approved by the engineer. It shall be of the size prescribed for each class of work, free from clay and dry seams, and sound in every particular.

BRICK.

The brick shall all be hard burnt paving brick, well tempered,

(6) Changed to concrete with cement covering.

of good form, free of lime and cracks, and capable of standing a pressure of four thousand pounds per square inch without crushing. They shall be soaked in water immediately before using.

CEMENT.

The cement shall be equal to the best quality of Louisville hydraulic cement, and shall stand, without breaking, a tensile stress of one hundred pounds per square inch in briquettes seven days old; it shall not swell or crack in the process of hardening.

SAND.

The sand shall be clean, sharp, river sand.

MORTAR.

The cement mortar shall generally be composed of one measure of cement and two measures of sand, well mixed with clear water in clean mortar beds and used immediately after mixing.

Different proportions of sand and cement shall be used, if required by the engineer.

BRICK ARCHING.

Brick arching shall consist of the required number of rings of brick laid flush in cement mortar, each line of brick breaking joints with the adjoining lines in the same ring and in the ring below it. No headers shall be used in the arch. No bats shall be allowed in the work except for closures.

The thickness of joints shall not exceed one-half inch between bricks in the same rings, nor five-eight inch between rings. The arch shall be covered over with a coating of cement mortar, not less than three-quarter inches thick.

BRICK WALLS.

The same specifications shall apply to brick walls as for brick arching, excepting that the brick shall be laid in the wall with the ordinary bond, every seventh course being of headers.

BRICK PAVING.

The bottom or floor shall be first carefully trimmed to the proper form and covered with a thick bed of cement mortar, the brick shall be floated thereon and laid close with full joints to the required template. The brick shall be laid on edge, and shall break joints as for brick arching.

The paving shall also be grouted after being laid, if the same be considered necessary by the engineer.

STONE ARCH MASONRY.

The arch proper shall be built of selected stone of uniform thickness in each course, laid flush, in cement mortar, each stone extending through the entire thickness of arch. The stones shall not be less than four inches thick; they shall be hammer dressed on the intradoes, beds and joints; the joints shall be square with the face and not less than nine inches deep; each course shall break joints not less than six inches with the courses adjoining; the thickness of joints shall not exceed three-quarter inches.

The arches shall be backed from the haunches with rubble work, laid flush, in cement mortar. The ring stone at the ends shall be rock faced.

The abutment walls, wing walls, parapet and sunk walls shall be built of broken range work, such as described under that head; the parapets and wings shall be capped with selected stones, projecting four inches beyond face of walls, not less than six inches thick and eighteen inches long, and extending through the entire width of the coping course with paralled joints. The joints and beds of the coping course shall be hammer dressed.

BROKEN RANGE WORK.

Broken range masonry shall be built of stones not less than 4 inches thick, well bonded and laid flush in cement mortar. No stone shall measure less than 1½ square foot on the bed and ⅓ at least must be headers extending through the entire thickness of wall when the same does not exceed 18 inches. All stones must be square-faced and break joints not less than 6 inches with those adjoining. The face-joints shall not be less than 6 inches deep—joints and beds shall not exceed ¾ inches in thickness. No spalls shall be allowed in the beds and face-joints.

The masonry shall be capped with selected stones of the entire width of coping course, of uniform thickness, not less than 6 inches. They shall have dressed beds and joints.

STONE PAVING.

Stone paving shall be built with selected stones from 8 to 12 inches deep and not less than 3 inches thick, roughly squared at the

ends and laid dry or flush in good cement mortar as the engineer may direct.

CONCRETE.

Concrete shall be composed by actual measurement of four measures of broken stone of uniform size measuring not more than two inches in any direction, free from clay and well screened, two measures of sand and one measure of cement, all well mixed on a plank bed and well rammed in place in layers as directed by the engineer.

DRAIN PIPE.

None but double strength, vitrified stone pipe of the best quality and manufacture shall be used. The pipes shall be laid on a solid foundation carefully shaped to fit the pipe and covered with a good bed of cement mortar. The joints shall be completely filled with cement mortar. The ends of the pipe must be carefully set in a wall of brick or stone of approved shape and size and protected with a covering of earth not less than 2 feet thick.

GENERAL.

All showing joints of all classes of masonry shall be neatly pointed with rich cement mortar.

No masonry shall be laid in freezing weather without permission from the engineer.

The foundations for all masonry shall be carried to such depths as the engineer may direct, and prepared with a bed of concrete or a timber platform if required. The timber used shall be white oak free from sap and of all defects affecting its strength or durability.

## PRICES AND MEASUREMENTS.

In bidding contractors must put in a price for every item of work named in the form of proposals furnished to them.

The measurement of pipes for payment will be the actual lineal measurement along the centre line of pipes after they are laid and without any allowance for extras for laps.

The measurement of tunnel for payment shall be the actual length of tunnel from easterly face of east wall of shaft to outside face of closing wall at west end of tunnel.

The measurement of shaft for payment shall be the actual depth

of shaft curbing from top of belting course to the bottom of foundation of wall.

The prices to be paid per foot for laying pipes shall be for the pipes laid and covered, including all the special castings other than valves, with all the work incidental thereto complete, excepting masonry, tunnel and shaft.

The prices to be paid for setting valves shall include their cartage from the railroad depot in Covington or Newport, and the cartage and setting of their foundations, curbs, covers and fittings, with all the work incidental thereto complete, excepting masonry.

The prices to be paid per cubic yard for all classes of masonry and per thousand feet b. m. of timber in foundations shall be for the material furnished and set in position with all the work incidental thereto.

In the classification of arch and culvert masonry, only the masonry of arch proper above the spring line, of arch with the the rubble backing at the haunches shall be paid as arch masonry, the parapet, abutments, wing and sunk walls shall be paid as broken range work and the concrete and paving as concrete and paving.

The price to be paid per lineal foot of tunnel shall be for the tunnel complete, including masonry and all other work incidental thereto.

The price to be paid per lineal foot of shaft shall be for the shaft complete, including masonry, ladder and all other work incidental thereto.

The price to be paid for the entrance house shall be for the house complete, with roof, doors, windows and all other work incidental thereto.

The said several prices shall also cover and include all the costs of trenching, blasting, excavation, bailing, pumping, shoring, centering, filling, and back filling, sodding, fencing, lighting, notices, guards, watchmen, repairs and restoration and all the materials, tools and labor necessary for, or incidental to, the construction and maintenance of the work until it is completed and accepted under the provisions of this contract and these specifications.

GENERAL CONDITIONS.

The opening of the trenches, the laying of the pipes, and the setting and connecting of their appendages shall be proceeded with at such time and at such places as the Engineer shall direct.

OBSERVANCE OF LAWS AND REGULATIONS.

In all operations connected with the work all laws, ordinances and regulations controlling or limiting in any way the action of those engaged on the work shall be respected and observed.

SUB-LETTING AND TRANSFERS.

The contractor shall not sub-let, assign, or transfer this contract, or any part thereof, to any person or persons without the consent of the Trustees.

COMPETENT WORKMEN.

He shall give his personal supervision to the work, and shall employ competent workmen and experienced mechanics, skilled in the several works assigned to them. He shall immediately discharge on request of the Engineer any of his employes considered by said Engineer as incompetent or disorderly, and shall not again employ him upon the works.

ORDERS CONCERNING THE WORK.

In the absence of the contractor from any part of the work the Engineer shall give his orders respecting that work to whomsoever may be in charge of or executing said work, and said order shall be respected and obeyed.

CHANGES.

The Trustees shall have the right to make without violating this contract any change in location, grade, alignment, form and dimension of the trenches, tunnels, shafts, pipes, and appendages, and to increase or diminish the quantities of the work to be done as the interest of the city of Covington may in their judgment require, if the character of the work is also changed thereby and rendered more costly, the Engineer shall estimate and determine the amount which should fairly and equitably be allowed to the contractor, and the same shall be accepted by the contractor without any claim for anticipated profits on the work that may be dispensed with.

EXTRA WORK.

The value of any extra work shall be likewise estimated and determined by the Engineer.

No claim for extra work shall be made or allowed unless the work shall have been done in compliance with a written order from the Trustees or the Engineer. All claims for extra work shall be made in writing before the payment of the succeeding estimate after the work is performed, failing to make such claim the same shall be considered as abandoned by the contractor.

### REJECTED MATERIAL.

The contractor shall promptly remove all rejected material to such distance as may in the judgment of the Engineer be sufficient to prevent its being used in the work.

### DEFECTIVE WORK.

All defective work shall be promptly taken down by the contractor on the order from the Engineer to that effect, and rebuilt properly at his own expense.

### RATES OF PROGRESS.

The rate of progress of the work at all times must be such as to insure its completion within the limit of time specified. Should the same appear insufficient in the opinion of the Engineer, he shall have the right to order such increase in the working forces as he may think necessary.

### SUSPENSION OF WORK.

The contractor shall without any claim for damages or extra compensation, suspend the work when he shall be ordered to do so by the Engineer, by reason of inclement weather, or for other causes.

### EXTENSION OF CONTRACT TIME.

But if his work be delayed by reason of non-delivery of pipes or valves, failure to procure right of way, or other acts of the Trustees, he shall be entitled to a reasonable extension of time for the completion of his work, and the Engineer shall estimate and determine the length of such extension, but the contractor shall have no claim for damages on account of such delays.

LIABILITIES AND RISKS.

The contractor assumes all risks arising from the weather, accidents and causualities of all kinds. He shall pay all damages to persons and properties and repair at his own cost all damages that may occur to the work until it is completed entirely and accepted by the Engineer. He shall further maintain at his own cost in a good perfect and water tight condition, all parts of the work for a period of six months after its acceptance by the Engineer.

SPECIFICATIONS DEFINED.

The meaning and intent of these specifications shall be defined by the Engineer and his decision thereon shall be final and binding upon the parties thereto.

CONVICT LABOR.

No convict labor shall be employed on the work.

ENGINEER DEFINED.

Wherever the word Engineer is mentioned in this contract it shall be taken to mean the chief Engineer for the Trustees.

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## FORM OF PROPOSAL.

The undersigned hereby certify that they have personally and carefully examined the grounds on the located line of pipe for the Covington New Water works, also that they have carefully examined the map, profile and plans and carefully read the annexed specifications and form of contract.

Having made such examination, the undersigned hereby propose to the Trustees of the Covington Reservoir to do all the works specified according to the conditions and specifications aforesaid, and on the acceptance of this proposal hereby bind themselves to enter into and execute a contract for the work at the following prices.

These prices are to be in full compensation for performing said work and for guaranteeing their permanancy and durability as provided in the contract and specifications.

PRICES.

| | | |
|---|---|---|
| Pipe laying per lineal foot complete | 30 inches diameter | $ 1 75 |
| | 18 inches diameter | 80 |
| | 12 inches diameter | 50 |
| | 8 inches diameter | 35 |
| | 6 inches diameter | 30 |
| Setting stop and blow off valves, each, complete. | 30 inches in diameter | 3 50 |
| | 12 inches in diameter | 2 00 |
| | 8 inches in diameter | 1 50 |
| | 6 inches in diameter | 1 00 |
| Setting air valves, each, complete | | 4 00 |
| Tunnel per lineal foot, complete. | | 28 00 |
| Shaft per lineal foot, complete | | 15 00 |
| Stone arch culvert masonry, per cubic yard | | 9 00 |
| Broken range masonry, per cubic yard | | 6 00 |
| Brick arch culvert masonry, per cubic yard | | 9 00 |
| Brick masonry, per cubic yard | | 7 00 |
| Brick paving, per cubic yard. | | 6 00 |
| Stone paving in cement, per cubic yard | | 4 00 |
| Stone paving dry, per cubic yard | | 3 00 |
| Concrete, per cubic yard | | 5 00 |
| Dry masonry, per cubic yard | | 5 00 |
| Drain pipes, per lineal foot complete | 24 inches diameter | 3 50 |
| | 18 inches diameter | 2 00 |
| | 12 inches diameter | 1 25 |
| | 6 inches diameter | 50 |
| | 4 inches diameter | 35 |
| Broken stone in foundation, per cubic yard | | 2 50 |
| Timber in foundation, per 1,000 feet, B. M. | | 40 00 |
| Building entrance house complete | | 100 00 |
| Setting 18 valves, each | | 3 00 |

Signature, McRAY & LALLEY,
by JOHN M. LALLEY.
Address, Detroit, Mich.,
or Lockport, N. Y.

Date, July 17, 1887.