NEW WATER--WORKS.

(Continued from Fifth Page.)

of the next higher level, and is apparently a feasible device, and very ingenious.

The Reservoir—

The location of the reservoir site, which has been selected for the terminus of the conduit, at an elevation of 282.5 feet, appears to be an excellent one, and the soil, as shown by the borings made on the site, is of a character easily excavated, and readily packed and consolidated by rolling into a secure and solid embankment around the reservoir. Its location on a knoll with low ground on three sides apparently insures it against the appearance of springs in the reservoir excavation. The borings show no rock nearer than five feet below the bottom of the reservoir The reservoir as designed by Mr. Adams appears to fit the ground as well as it could be made, and is about the right capacity, without being excessively large or costly. I suggest that it be made as nearly rectangular in form as possible, because of the greater ease and certainty with which the slopes can be dressed to true surface and line. I have also recommended to your engineer a modification of the plan of gate house, and connections which will enable the water to be handled independently of the reservoir proper, allowing the reservoir to be cleaned without interrupting the flow in the conduit and distributing pipes, and admitting the possibility of omitting the reservoir entirely for a year or two, if for any reason it was deemed desirable to do so. The character of lining planned consists of a layer of concrete, 6 inches thick, covered with a course of brick laid flat ways in cement mortar, and coated with California asphalt, over the entire surface. This will make a water tight and satisfactory lining, I am sure, if properly applied. I think I should prefer, however, to use asphaltum for the cementing material for the bricks, applying a coat of asphalt to the concrete, then dipping the bricks into hot asphalt and laying them together on the asphalt surface thus made, and afterwards coating the whole of the surface of the bricks with asphalt of such consistency as will resist the ordinary heat of the sun without drooping down the slope. Bricks can be made from asphaltum and sand which will be superior to any other for this purpose, and cost no more. I suggest that the specifications be so modified as to admit of asphalt bricks, and their laying in the method described.

Water Power—

One of the most interesting and valuable features of the proposed conduit is the possibility which it affords of developing a considerable water power at the gate house of the reservoir. From the summit of the ridge at the lower end of the wood-pipe, to the reservoir, a distance of 5,450 feet, the total fall is 144.4 feet; of which 54.4 feet is necessarily consumed in friction, and 90 feet is available for power. This fall with 4,000,000 gallons per day would yield 62 1-2 horse power, theoretical, or allowing for an efficiency of 80 per cent in the power wheels, a net 50 horse power, available for electric lighting, or for pumping to higher levels, say to a reservoir on Coxcomb Hill, or both. This power may be readily utilized and can doubtless be put to better service in lighting the city than if devoted to any other purpose. The best dynamos now made have an efficiency of over 90 per cent, which would give us 45 horse power net in electrical energy, or 33 1-2 Kilowatts, which is sufficient for 66 arc lights of 2,000 candle power each. A sixty-light machine will be the most convenient one to use, for which the power will be ample. The cost of the plant for utilizing this power would be approximately as follows:

1 Pelton Water Wheel, complete and erected	$ 2,000
1 60-light D. C. Dynamo, with lamps, complete	2,500
10,000 feet of line wire, No. 4,	
10,000 lbs, at 12 cents	1,200
300 60-ft. poles erected, at $10	2,000
60 brackets for lamps, at $6	360
Pins, insulators, etc.	100
Linework	300
Frame power house and foundations	1,540
Total cost	$10,000

The cost of maintenance of such a system would be about as follows:

1 chief electrician at $100 per month	$ 100
1 assistant	60
2 trimmers	100
Carbons, 3 cents each per night	54
Interest on cost of plant at 6 per cent	50
Depreciation on cost, 5 per cent	34.50
Total cost per month	$ 398.50

This is an average of $6.65 per month.

The city council could afford to pay the water commission a rental of $50.00 per annum per horse power, which is a fair price for power elsewhere, and still keep the cost of illumination down below $10.00 per month per light, which is two thirds of what I understand she is now paying. The rental thus received would pay one-fifth of the interest charges for the entire cost of the water works. Considered entirely apart from its normal function of supplying an abundance of water to the entire city, now so meagerly supplied, the proposed water works seem to me to be a most desirable investment for the advantages to be derived from the cheap illumination of the city, and the superior protection afforded from fire. The present water works are of no service whatever for extinguishing fires because of the scanty water supply, and the utter lack of fire hydrants. The fire department depend entirely on drawing water for fire purposes directly from the river with their engines, and if a fire should occur at such a distance back from the river as to be beyond the reach of the firemen's hose at any considerable elevation, it would have free and uncontrolled sway. With an excellent and well drilled fire department, consisting of three engine companies and a hook and ladder company, the expense of which averages nearly $13,000 per annum, the city is really handicapped for lack of abundant water supply available for hydrants, placed so generally over the city as to be convenient to be tapped at a moment's notice. With the new water works constructed as planned, it would be possible to substitute hose companies for engine companies, and reduce the expenses of the fire department a very considerable amount, possibly 50 per cent; at the same time enjoying highly increased security and enlarged efficiency in the fire department. For this service the city council should pay a stipulated amount to the water commission, as much at least as the saving thus effected, in the form of hydrant rental. As much as $100 per annum per hydrant is not infrequently paid by cities to water companies for hydrant rental, while $50 is considered a very moderate figure. The latter would in this case pay the interest on one-third of the proposed bonded indebtedness for water works, on the basis of 91 hydrants erected. This is not an unreasonable per centage of the cost of water works to pay for first-class fire pressure.

With these two sources of revenue--hydrant and power rentals--bearing half the burden of the interest charges on the cost of the water works, without increase in general expense of the city, but rather effecting economy by reason of assuming these charges, the available water rates from present consumers, counting no increase, should readily take care of the remaining interest, and operating expenses and accumulate a sinkping fund for the early retirement of the bonds.

Pumping to Coxcomb Hill—

In connection with the development of electric power for lighting purposes it would be well to consider the question of utilizing the same power during the day time for pumping to a future reservoir to be located on Coxcomb Hill, from the end of the wood pipe at Station 54. The height to be pumped is about 100 feet above the pipe at Station 54—or Elev. 525. It would be perfectly feasible to establish a pump at the power house, connect it with the Pelton wheel, and pump direct to Coxcomb Hill, but the pressure on the pump would be about 240 feet, and considering the cost of pipe, etc., it would be cheaper to transmit the power electrically to station 54, and there operate a motor to pump from the proposed cistern a the end of the wood pipe. The cost of transmitting 20 horse power, including dynamo, motor, line wire, poles, insulators, switchboard, and apparatus would be about $2,650. The entire cost of the power-pump and pump house to deliver say 300,000 gallons per 24 hours to the top of Coxcomb Hill would be under $5,000, if the power wheel at the main reservoir be used for that purpose when not occupied in driving the lighting plant. As this pumping system is probably uncalled for at present it is only necessary to so arrange the connections of the Pelton wheel and arc light dynamo in the power house that it could be attached at any time without a general alteration of the machinery.

Tunnel.—

To reach the city distributive system from the reservoir, a tunnel 800 feet long, with 320 feet of deep approach on the south end is required. Borings made near either end of the tunnel location indicate that at the tunnel level a stratum of black shale, peculiar in thos region, passes through the hill,. This appears to be a formation favorable for tunneling, and may not require timbering, unless water is encountered. I have added $3,456 to the estimate for th cost of this tunnel, to provide for temporary timbering and other incidental costs that frequently accompany tunnel work. I should advise the use of cast iron pipe in the approaches where the depts of covering is over ten feet. For lining I should prefer to use concrete throughout, although there is no objection to brick. Either will make a satisfactory lining it properly put in. With concrete lining all space between the forms and the roof and sides of the tunnel are sure to be filled with a homogenous material uniting with the walls.

Distribution.—

I have carefully examined the map of the proposed revision of the city distribution system, and consider the general arrangement of the pipes and their sizes to be well adjusted. The only change I would care to suggest would be to make the Jerome avenue pipe 12 inches in diameter instead of 10, because the 18 inch main has a greater capacity than the 14 and 10 inch pipes which receive the supply. The dead ends on Franklin avenue and Astor street should be avoided if possible, by small pipes to form a circuit and keep up a circulation. The arrangement and location of fire hydrants appear to be adequate to the present needs of the city.

Estimate of Cost—

I have carefully gone over the detailed estimate of cost prepared by Mr. Adams, of which I present here the following summary:

Head works		$ 1,700.00
Clearing, grubbing, bridging, and grading road		21,427.00
Telephone line on conduit		500.00
Trenching and backfilling, 25,000 cu. yds. at 25 cents		12,250.00
Wooden-stave pipe—		
Lumber	$8,700	
Steel	16,706	
Hauling	3,684	
Construction	7,910	
		37,000.00
Steel pipe, 16 in. No. 12		25,944.00
Steel Pipe, 14 in. No. 14		6,098.00
Air valves		896.00
Flushes		289.00
Tees		884.00
Special castings		875.00
Manholes		2,983.00
Reservoir—		
Excavation	$9,800	
Concrete lining	9,298	
Brick work	2,926	
Stone masonry	1,812	
Plaster	510	
Asphalt	1,637	
Gate fixtures	2,000	
		28,981.00
Tunnel and lining		7,204.00
Distribution		28,545.00
Pipe laying		11,843.00
Hydrants		3,276.00
Gates and boxes		2,306.00
Taking up, dipping and testing old pipe		3,233.00
Making connections with present reservoir		500.00
Superintendence		10,000.00
Electric plant		7,500.00
Total		$214,732.00

The prices used in the estimate are generally quite liberal, and the allowance made for cost of lumber, steel bands and shoes, hauling, steel pipe, etc., is certainly ample to cover all probable cost, and contractors' profits. I have added, however, the following items which seem to me to be reasonable:

Headworks for shed over settling tank, etc	$ 800
Telephone line, rental of instruments during construction	300
Conduit—construction of wood pipe, sundry items	1,133
Air valves	540
Reservoir—additional cost of asphalt lining	655
Gate well figtures	3,000
Electric lighting and power plant additional	2,500
Tunnel, sundries	2,546
Distributing system, wood pipe in in same	1,650
Taking up old pipe, add for scraping, cartage, etc	1,500
Brick relief tank, at Station 54	500
	$15,124

The addition of these amounts would bring the total cost up to $230,856, of which $10,000 would be for the lighting plant, and not strictly chargeable to the water works. With these supplementary items included I consider the estimate a safe and reasonable one.

In closing my report and completing my computations I feel like congratulating you upon the fact that the plans and estimates of your engineer bear so well the rigid test and scrutiny to which I have subjected them in the search for flaws and errors. If he carries out the construction with corresponding care and good judgment your works will be highly satisfactory and efficient.

I have spent a good deal of time over the specifications prepared by your engineer, and have noted upon them a number of suggestions which occur to me as important, in the way of changes and additions, to make them more complete. Some of them may be mentioned briefly as follows:

1. The best steel piece is known as "Open Hearth." This should be specified in preference to Bessemer.

2. The steel plate being specified as fully up to required gauge, it needs to be specified that this shall be on the sheared edges, where the weakest part of the pipe is, on account of the seams, and rivet holes. I have added a clause which I think will clarify this point.

3. The steel pipe is to be laid with lead joints, and a cast iron sleeve is mentioned, to carry the lead and form the junction. I suggest a wrought iron or steel band 6 inches wide, to be welded into one solid ring, as preferable, and probably cheaper. I would also suggest the insertion of two inches of hemp packing to be driven into the center of this band after it is in place, the lead to be poured on each side, and thoroughly caulked. This saves lead and makes a better joint. As the caulking does not reach any further than 1 1-2 inches from the edge of the ring, in any event, the packing will be of more service by swelling and closing possible leaks than an equal bulk of pecous lead.

4. The method of estimating and paying for the steel pipe is not specified. Knowing the outer diameter of pipe and inner diameter of ring and its width, the contractor should be required to form his own estimate of the weight of ring, and amount of lead required, and make his bid by the lineal foot for the pipe, completed, including steel plates, rivets, manufacturing and dipping, freight and cartage, storage, laying, making and furnishing sleeves, lead, hemp packing, and all other tools and materials required. The average price per foot should also include all surved pipe, whether vertical or horizontal—the total amount of deflections of this sort being estimated from the profile and notes of survey, by the engineer. If allowed to go in as extras, the curves are apt to run into high figures.

5. In the specification for the rolling of the reservoir embankment I suggest a roller of 3,000 to 4,000 lbs. per foot of roller width, rather than 1,000 lbs. A heavy roller does vastly better and safer work than a light one.

6. If concrete is used for the lining it is important that the finish coat should go on within two hours after the concrete is laid, in order to have them homogeneous. I am inclined to think, however, after my experience with all these materials in the Portland reservoirs, that two courses of brick laid in asphalt with all joints thoroughly filled and each layer separately coated, will make a cheaper reservoir than the proposed combination of cement, concrete and common brick, and one equally satisfactory in every respect. The brick, however, should be of best quality, uniform in size, and better if vitrified—and still better if made of asphaltum and sand, seven percent of the former and ninety-three of the latter, moulded and pressed under 80 tons pressure. They can be made at the reservoir and used as made. The brick should be dipped into hot asphalt with tongs and laid at once, dripping from the kettle, which stands by each brick-layer. I suggest that the specifications be so modified as to admit of the use of either vitrified brick, common brick, or asphalt brick, laid in asphaltum and coated over with the same, in the manner specified for coating the brick layer over the concrete described in the specifications.

If the work of constructing the new plant is to be completed the coming season, I think you should lose no time in printing your specifications and advertising the work. It is not essential that this step should wait for the sale of your bonds, for all contracts should be made subject to such financial arrangements, and it is highly desirable that contractors have ample time to prepare, so that all the work can be finished by September 1st, 1895. The first contracts to be let are for the clearing of the right of way, the construction of the wagon road along the conduit line, and the erection of a telephone line. This should be in progress all through the winter and finished by March first. The others should follow as quickly as possible, especially the excavation of the reservoir, which should be finished in April, or early in May.

Reviewing the forgoing report in a nutshell, I may say that I find the water supply sufficient for the proposed conduit, the conduit sufficient for the water supply, and both ample for the immediate future of the city; the works are an imperative necessity, and the plans entirely feasible, devised with good judgment, and worthy of all confidence.

Faithfully yours,
JAS. D. SCHUYLER,
Consulting engineer.