GOVERNMENT OF MADRAS.

LOCAL AND MUNICIPAL DEPARTMENT.

READ—again the following paper :—

G.O., dated 30th March 1894, Mis. No. 414 M., Local and Municipal.

Read—the following papers :—

From J. A. JONES, Esq., MEM., INST. C.E., F.R.S.E., Sanitary Engineer to Government, to the Chief Secretary to Government, dated Fort St. George, 6th November 1893, No. 2415.

Referring to my letter No. 2570, dated 23rd November 1892, embodied in G.O., dated 12th December 1892, No. 2035 M., Local and Municipal, I have the honour to forward a report, estimate and plans of a scheme for a supply of water to Conjeeveram.

ENCLOSURES.

Report on a scheme for the water-supply to the town of Conjeeveram.

In November 1890, at the request of the Collector of Chingleput, the Assistant Sanitary Engineer to Government was deputed to inspect Conjeeveram, and report on the subject of the improvement to the water-supply of the town.

2. In that report the objections taken to the scheme proposed by Mr. W. F. Donaghue, the Local Fund Engineer, were set forth and discussed ; and as the scheme was not considered a satisfactory one, the Assistant Sanitary Engineer suggested two alternative schemes for the water-supply of the town from the Végavati river, which passes close to Conjeeveram. As the result of this report which was forwarded to the Collector, an allotment of Rs. 400 was made by the council for the investigation of the schemes referred to.

3. The scheme hereinafter described is practically the same as one of the two schemes suggested in the above-mentioned report.

4. The Végavati river passes to the south of, and close to, Conjeeveram. The river is dry for most part of the year, but below its bed there is as usual a large substratum of water in the sand, and this no doubt extends to a width much greater than the actual surface width of the river itself.

5. It is proposed to draw the supply for the town from this water by means of infiltration works.

6. The population of Conjeeveram in 1881 was 37,275 and in 1891 it was 46,362. A large concourse of pilgrims come to the town on festivals and their number has been stated to amount to as much as 40,000. In view of this it was considered desirable to provide for a supply in excess of the requirements of the permanent population. The scheme, so far as the pipes and infiltration works are concerned, is designed to meet the requirements of a population of 56,000 at 15 gallons per head per diem. This is equal to an average supply of 583 gallons per minute. The supply required at certain hours of the day being double the average supply, the above-mentioned portions of the works are designed so as to be capable of delivering 2×583, or 1,166 gallons per minute or 186 cubic feet per minute.

7. The point selected for the location of the head works is on the left bank of the river opposite the famous Jain temple in the village of Tiruparattikundram on the right bank. The reasons for the location of the head works here have been given in the Assistant Sanitary Engineer's report mentioned above.

8. The water taken from temporary wells in the bed of the river and on the bank at the proposed site of the head works has been analysed and pronounced to be "usable." A copy of the analysis is subjoined :—

—		Water from river well.	Water from garden well.
Total solids	Grms. per litre.	0·160	0·110
Volatile solids	Do.	0·070	0·040
Chlorine	Do.	0·011	0·014
Total hardness	Clark's scale.	1°·050	1°·400
Permanent hardness ..	Do.	1°·050	1°·050
Free ammonia	Ml. grms. per litre.	0·080	0·140
Albuminoid ammonia	Do.	0·060	0 100
Nitric acid	Do. (As ammonia).	3·000	0·600
Apparent quantity of the water as inferred from the results on examination.		Usable.	Usable.

Remarks.—Both these waters would be better of filtration after boiling. Microscopically they contain sand, vegetable matter and ova of animals of low formation.

9. At the point selected for the site of the head works the river-bed is 1,000 feet wide, and its sandy bed, as ascertained by trial pits, is some fifteen feet deep. The summer water level falls as low as eight feet below the surface of the sandy bed and this, it is believed, is the lowest known summer water-level. It was taken when the river was at its lowest in the year 1891. From the subjoined table of rainfall at Conjeeveram it will be seen that the year 1891 had the smallest rainfall of any since 1877 :—

Year.	Yearly rainfall in inches.	Year.	Yearly rainfall in inches.
1877	38·54	1886	43·81
1878	37·76	1887	62·47
1879	41·33	1888	60·35
1880	40·87	1889	37·82
1881	33·80	1890	37 23
1882	40·60	1891	27·10
1883	39·16	1892	39·29
1884	61·48		
1885	43·16	Average ..	42·79

It may therefore be accepted that the water-level is not likely to be lower than when it was at its lowest in 1891, which is seven feet above the hard bed—*vide* plan No. 2.

10. Some observations on the sufficiency of water in the Végavati to meet the town supply have been made in the Assistant Sanitary Engineer's report above mentioned. It is not possible to gather any more particulars on this point without expensive experiments as to the yield of water from a trench similar to the one proposed and hereafter to be described. But when it is considered that thousands of acres of land both above and below Conjeeveram are irrigated by spring channels cut from the bed of the river, there is not much doubt but that a sufficient supply of water for the town can be obtained at all times.

11. After careful consideration as to the most suitable plan for collecting the water from the sub-soil, it is proposed to do so by laying four lines of open jointed 9″ stoneware pipes in a trench at right angles to the axis of the river and at a depth of seven feet below lowest known water-level—this trench commencing from the river

bank where the engine-house will be located will extend a distance of 550 feet. The trench will be re-filled up with gravel up to the summer water-level and above that with river sand.

12. More than one method was designed and actually estimated for, but it was finally decided upon to adopt the above method as being the most economical and best suited to the circumstances of the case. This method of drawing water has been successfully adopted at Cuddapah. It is not suited to any river with a sandy bed which is liable to scouring by high floods. The highest floods in the Végavati have not been found to exceed three feet. Though the river is 1,000 feet wide at the site of the head works, and has all the appearance of a river draining a very large area of country, it takes its rise only 9 miles from Conjeeveram. The river is of the nature of a broad sandy belt traversing the valley into which the drainage of the adjoining country flows, but the actual area it has not been possible to ascertain.

13. It has been said in the previous paragraph that infiltration works can be worked up to a head of three feet. The head is limited solely by consideration of the velocity of the inflow generated by the head. This velocity should be such that the inflowing water should be incapable of carrying sand with it through the openings in the infiltration works.

14. The area of the openings in the proposed gallery at Conjeeveram is calculated to be 46 square feet. The maximum inflow per minute is to be 1,166 gallons or 186 cubic feet which will require a velocity ·8 of a foot per second. In some experiments made by Mr. Anderson in connection with his revolving purifiers—*vide* Vol. LXXXI, Minutes of Proceedings of the Institute, C.E., he found that a velocity of four inches per second was incompetent to move any but the finest particles of iron in a verticle tube. In the light of Mr. Anderson's experiments a velocity of ·8 of a foot per second is too low to cause the finest particles of sand to enter the pipes.

15. The infiltration pipes will terminate in a manhole near the bank of the river. From the manhole a 18″ cast iron pipe will convey the water to the suction well. The opening of the inlet pipe into the suction well will be fitted with a sluice gate.

16. The arrangements for pumping direct into the pipe and distribution will be similar to other schemes already sanctioned by Government, and it is therefore unnecessary to describe them at length in this report.

17. The total lift of water at the pumping station will be 55 feet. There will be three engines of 10 pump horse-power each, any two of which will deliver the maximum quantity of 1,166 gallons per minute, the third engine being in reserve. The distribution will be effected by 60,140 feet of cast iron pipes varying from 16 to 3 inches in diameter. There will be 46 two-tap and 16 one-tap fountains and the necessary valves, stop-cocks, hydrants, &c.

18. The scheme is estimated to cost Rs. 2,70,000 distributed under the major heads of work as follows :—

	Rs.
Infiltration works with manhole	14,267
Engine and boiler house with suction well	13,405
Store shed	2,000
Engine driver's quarters	5,000
Engines, pumps and boilers	33,600
Compensation, &c.	1,050
Pipes, valves, fountains, hydrants	1,40,157
Laying and jointing pipes	25,171
Total ..	2,34,650
Contingencies ..	35,350
Grand Total ..	2,70,000

The cost of pumping the whole supply for which the scheme is designed would be at 10 annas per million gallons lifted one foot high—

$$\frac{56{,}000 \times 15}{1{,}000{,}000} \times \frac{10}{16} \times 55 = \text{Rs. } 29 \text{ per day or Rs. } 10{,}585 \text{ per annum.}$$

But for some years after the construction of the works it will be sufficient if the town is supplied with half the above quantity of water which will give ten gallons per head per diem on the entire present population, and this will probably be sufficient except in festival times, and at any rate as much as the town can afford for the present.

If the supply is restricted to ten gallons per head on the present population, the annual pumping charges will be about Rs. 5,000, and one engine will be sufficient to pump all the water required, so that it would be necessary at first to arrange for only two engines—one of which will be always in reserve. All other works will, however, have to be constructed as designed for the full supply of fifteen gallons per head. The omission of one engine will reduce the estimate to Rs. 2,57,000.

19. The annual charges for a supply of ten gallons per head and assuming that Government will contribute half the initial cost will be —

	RS.
Interest and sinking fund at 5·96 per cent. on Rs. 1,28,500	7,659
Pumping charges	5,000
Maintenance charges	2,341
Total ..	15,000

20. The assessment on buildings amounts to Rs. 10,000 per annum at 5 per cent. on the rental value. By raising the tax to the maximum rate of 7½ per cent., an extra revenue of about Rs. 5,000 will be derived. The water-tax should bring in a revenue of Rs. 8,000. There should therefore be no difficulty on the part of the municipality in raising sufficient extra revenue to meet the cost of the scheme.

21. Conjeeveram has already been referred to as a town which is frequented by a large number of pilgrims. It is stated that no less than 40,000 pilgrims visit the town yearly and there is no doubt but that these people must spend a very large income in the town—supposing that each person stays four days and spends 2 annas per day the amount spent in the town by pilgrims alone would be about Rs. 20,000 yearly from which there must be a considerable profit. This is mentioned because on a meeting with the Chairman he was inclined to urge the poverty of the town—no doubt the inhabitants to some extent live on what is derived from the pilgrims, but in any case Conjeeveram cannot be a poor town, and as a town from which any epidemic disease would be rapidly spread it is all the more necessary that the sanitary necessities of the town, of which a water-supply is one of the most important, should be supplied as soon as possible.

No. 828.

Referred to the Public Works Department for remarks.

FORT ST. GEORGE,
14*th November* 1893. (Signed) A. T. PRINGLE,
Assistant Secretary.

To the Public Works Department (with plans).

Note by the Chief Engineer, Public Works Department.

The scheme appears sound in its general features, but paragraph 13 of the Assistant Sanitary Engineer's report is not intelligible; nothing whatever is said in the preceding paragraph as to the head up to which infiltration works can be worked.

Paragraph 14 as written involves the extraordinary argument that, because a velocity of four inches per second will just move the lightest particles of iron, a velocity of ·8 of a foot, or 9·6 inches per second, will not move sand, a much lighter material.

It is, however, clear that ·8 of a foot is a clerical error for ·8 of an inch, the real velocity being $\frac{186}{60 \times 46} = ·067$ of a foot or ·8 of an inch, and it is probable that this velocity will not be enough to draw sand into the pipes.

It is not quite clear why the "manhole" between the infiltration pipes and the inlet pipe to the suction well is not taken up to the ground level; as drawn, it is not a "manhole" at all being completely inaccessible; this is probably only a mistake in the drawing.

(Signed) J. PENNYCUICK, Col., R.E.,
Chief Engineer, P.W.D.
22*nd December* 1893.

No. 4498 C.

Transferred to the Local and Municipal Department.

CHEPAUK,
28*th December* 1893. (Signed) J. PENNYCUICK, Col., R.E.,
Secretary to Government, P.W.D.

No. 12.

Referred to the Sanitary Engineer for remarks.

FORT ST. GEORGE,
13*th January* 1894. (Signed) A. T. PRINGLE,
Assistant Secretary.

From HORMUSJI NOWROJI, Esq., B.C.E., A.M.I.C.E., Assistant Sanitary Engineer to Government, in charge of office of Sanitary Engineer to Government, to the Chief Secretary to Government, dated Fort St. George, 15th January 1894, No. 100.

With reference to your endorsement No. 12, dated 13th January 1894, on note by the Chief Engineer, Public Works Department, on the Conjeeveram water-supply scheme, I have the honour to state that paragraph 13 of the report on that scheme should read, "In infiltration works the velocity of inflow during the maximum demand should be such that the inflowing water should be incapable of carrying sand with it through the openings in the infiltration works."

2. In the original draft of the report a paragraph preceding paragraph 13 of the present report was struck out, and I regret that by an oversight the consequential alteration in paragraph 13 was not made.

3. In paragraph 14, ·8 of a foot is, as stated by the Chief Engineer, a clerical error for ·8 of an inch.

4. The plan has now been altered with reference to the Chief Engineer's remarks on the manhole between the infiltration pipes and the inlet to the suction well. The manhole has been carried well above the ground level to prevent surface water getting into the manhole. It is, however, not necessary to alter the estimate as the increase is very inappreciable.

No. 54.

The Sanitary Engineer is requested to forward a copy of the Assistant Sanitary Engineer's report on the water-supply of the town of Conjeeveram, which is referred to in his letter, dated 6th November 1893, No. 2415.

(Signed) L. DAVIDSON,
Ag. Assistant Secretary.
1*st February* 1894.

To the Sanitary Engineer.

From R. E. ELLIS, Esq., A.M.I.C.E., Acting Sanitary Engineer to Government to the Chief Secretary to Government, dated Fort St. George, 6th February 1894, No. 281.

With reference to your official memorandum No. 54, dated the 1st instant, I have the honour to forward a copy of the Assistant Sanitary Engineer's report on the water-supply of Conjeeveram, as also my letter to the Collector of Chingleput, forwarding the same to him.

Enclosures.

Report on the water-supply of the town of Conjeeveram, inspected 25th to 28th November 1890.

The town of Conjeeveram lies in the valley of the Palar. It is situated on the north bank of the Végavati river which joins the Palar a few miles below the town. From the former river the town rises gradually but considerably towards the north and west. The general lie of the country around Conjeeveram is in the same direction. The town occupies an area of about 4 square miles. Along the river bank the length of the town is $3\frac{1}{2}$ miles and its width varies from $1\frac{1}{2}$ miles at the north end to $\frac{1}{2}$ a mile at the south end. The streets are very broad and every house has attached to it a small garden or backyard; the town, therefore, is not densely packed with houses. It is well to remember this fact in comparing the cost of the water-supply of Conjeeveram with other cities as the density of a town very much influences the cost. The number of houses in the town is 7,179 and the population according to the census of 1881 was 37,275. It is supposed that the population now exceeds 40,000.

The town lies on the bank of the Végavati river.

Area, 4 square miles.

Population, 40,000.

2. The soil under and around the town consists of a sandy loam of some considerable depth below the surface. The purity of the sand and the depth of the stratum increases as the land approaches the river.

Soil near the river is sandy.

3. As one of the water-supply schemes proposed and the only one that has been completely worked out (by Mr. Donaghue, the Local Fund Engineer) is based on the lines of the ancient water-supply of Conjeeveram, it is well to concisely describe that supply.

The ancient water-supply of Conjeeveram.

4. The source of the water-supply is some four miles above and to the west of the western extremity of the town on the north bank of the Végavati river. At this place on the bank of the river there is a spring head or basin excavated about a 100 feet from the river bank. The bed of this basin is some 20 feet below the bed of the river. The basin is replenished by springs percolating from under the bed of the river as well as land springs from the shore side. The soil down to the bed of the basin is pure sand. From the basin the water flows down an open cut, called the Lâlâkâl, until it reaches the north-western extremity of the town. This is the highest point of the town. Here the Lâlâkâl bifurcates. The larger branch feeds the Konérikuppam irrigation tank, and the smaller branch fills, or is supposed to fill, the masonry tanks in the town. After the point of bifurcation the smaller channel, or what may be called the town-

The source of water is a spring head or basin excavated in the bank of the river some four miles above the town.

Water from the basin is led to the town by an open channel called Lâlâkâl.

Just outside the town the channel bifurcates.

The larger branch feeds the Konérikuppam irrigation tank. The smaller branch supplies the town with water.

supply channel runs in an open cut for some distance and then enters a masonry cistern, and the water is distributed to the various tanks in the town by means of underground masonry conduits. The conduits are out of repair and some of them are so choked up with earth that they cannot pass any water. All traces of some of these conduits are lost, and many of the tanks that were at one time replenished by the Lâlâkâl water are not so now. Owing to the scarcity of rain, none of the tanks in the town except Sarvatírtam, which forms the first of the chain of tanks replenished by the Lâlâkâl, received any supply of water during this or last year. The town-supply channel, though called so and apparently vested in the municipality, is also used for irrigation. According to the chairman's statement some fields belonging to the Krishna temple and lying on the line of the town-supply channel have the right to draw water from this channel for irrigation purposes. So that in years of drought, like this year and the last, whatever share of water the town-supply channel receives from the Lâlâkâl is drawn off to irrigate the fields mentioned above. This was so during my inspection, the water being prevented from going into the town by a block in the channel.

Distributary conduits within the town are out of repair.

During years of insufficient rainfall the tanks in the town are not replenished by the Lâlâkâl water.

Certain fields have the right to draw water from the town supply channel.

5. Of the proposals for the water-supply of Conjeeveram, the one first demanding consideration is the proposal to improve this ancient water-supply scheme. The first question is the quantity of water available. From information collected it would appear that the Lâlâkâl flows for only eight months in the year during a year of ordinary rainfall and for shorter periods during years of drought. It is possible that improvements in the gradients and section of the channel would permit the spring-head or basin being deepened a little. But it is doubtful whether this deepening to the permissible extent will secure a perennial supply to the town, though it may increase the yield to some extent. The original idea of the scheme was not to secure a perennial supply, but merely to fill up the tanks in the town with fresh water during the wet months, so that sufficient water for the hot weather might be stored in the tanks.

Suggested improvement of the Lâlâkâl.

First objection.—The Lâlâkâl does not flow perennially, and would not be so even after improvement.

6. The next point to be considered is how far would the improvement of the Lâlâkâl benefit the town supply? The shrotriems under the Konérikuppam tank have a right to the water of the Lâlâkâl. The portion to which they have a right is variously stated at three-fourths, two-thirds and three-fifths and the portion of water coming down the town-supply branch would therefore be from one-fourth to two-fifths of the yield from the Lâlâkâl. I gauged the flow of water in the Lâlâkâl near its head and found that to equal 360 cubic feet per minute. If the quantity available for the town-supply channel be taken at one-third the amount is 120 cubic feet per minute. This is the time of year during which the flow is at its maximum. It may therefere be assumed that the average yield to the town supply during the months when the Lâlâkâl flows, which is from six to eight, would not exceed 60 cubic feet per minute. The town-supply channel would therefore yield in a year like the present one about 15,000,000 cubic feet of water. The aggregate capacity of the various stone-built tanks in the town is, I calculate, not less than 30,000,000 cubic feet, so that in the present condition of the Lâlâkâl and provided that the water in the town-supply channel is not otherwise used, the tanks would receive not more than half of the quantity of water required. I have already said that the tanks in the town except one did not receive any supply during this year nor last; so that the greater portion of the 15,000,000 cubic feet of water brought down by the town-supply channel was used for irrigating the lands belonging to

Second objection.—The difficulty and cost of purchasing the right of the shrotriemdars to the Lâlâkâl water.

the Krishna temple which lie along the course of the channel. A proper supply of water to the tanks in the town can only be secured if the Krishna temple authorities and the shrotriemdars under the Konérikuppam tanks could be induced to surrender their rights for a consideration. I believe this is an impossibility from a financial point of view. If to this we add the cost of the improvement of the channel with the necessary masonry works which are now wanting, and look, moreover, to the fact that the town supply would still be a very primitive and defective one for other reasons also, it is thought that the results of improving the ancient water-supply would not warrant the probable cost.

Third objection.—Large cost of improvements.

7. The difficulty of inducing the shrotriemdars to surrender their right to the water of the Lâlâkâl, the necessary compensation and the cost of the improvements to the channel were evidently apparent to Mr. Donaghue, who therefore drew up a scheme to construct an independent channel; the lines of his scheme are, however, precisely the same as the ancient water-supply of Conjeeveram.

Mr. Donaghue's scheme on the lines of the ancient water-supply.

8. Mr. Donaghue's scheme is briefly as follows:—To construct a spring-head or basin on the north bank of the Végavati river, 1,520 yards below the old Lâlâkâl spring-head; to conduct the water in an open channel about 3¼ miles long to a cistern at the north western extremity of the town; to construct a masonry conduit 8,273 feet long from the cistern along the main street of Big Conjeeveram with six minor branches having an aggregate length of 3,917 feet for supplying various tanks. Twenty-one wells to be provided at convenient places over the conduit for drawing water from and it was supposed that in about nine wells the water would rise so high above ground level as to allow the water being drawn by taps; water from the remaining wells to be drawn by dipping buckets or pots into them as with ordinary wells.

Description of Mr. Donaghue's scheme.

Defects in the scheme.

9. The main points of the scheme that fail to recommend themselves for approval are as follow:—

(1) Uncertainty of a perennial yield.

(1) The uncertainty of a perennial flow in the proposed channel.

(2) The proposed channel traverses irrigated land especially in its lower course where the channel is in cutting, and the water is therefore liable to contamination.

(2) Channel traverses irrigated lands.

(3) The inefficiency and insufficiency of the distributing portion of the scheme as the water let into the tanks will be as liable to pollution as at present.

(3) Channel not properly protected.

10. There is some uncertainty as to whether the new spring-head would yield a constant and unfailing supply of water even during the driest months, especially during a year of deficient rainfall like the present one. The Lâlâkâl flows only for about eight to six months in the year. The new channel, however, has its bed considerably below the bed of the old channel, but there is no certainty that the new channel is sufficiently low to secure a perennial supply. There is no doubt, however, that from the character of the soil and the conditions under which water is available at the site of the proposed spring-head that the question of the sufficiency of water resolves itself merely into a question of sufficient depth of the spring-head. But unfortunately the levels of the town do not permit of the spring-head and the

Uncertainty of the proposed spring-head yielding a constant and unfailing supply of water during summer months.

Ample water is available underground, but the levels of the town do not permit a greater depth to the spring-head.

channel being placed at a much lower level than as designed in the scheme. Mr. Donaghue is evidently not insensible to the uncertainty of a sufficiency of water, as in his report he suggests that the spring-head should be first constructed as an experiment before all other works so as to ascertain the quantity of water available before any expenditure is incurred on the other works connected with the scheme.

11. Mr. Donaghue anticipates a flow of water three inch deep even during the driest months. This flow will yield 792,000 gallons per day. This quantity, if available as anticipated, would be just sufficient to meet the wants of the permanent population *plus* the large number of pilgrims who resort to the town during the grand festival in May. But even if this quantity of water is available, the distribution part of the project is so defective and inefficient that only a very small portion of the population will benefit by it. The people living in the main street through which the conduit passes, and in its immediate vicinity would resort to it. But some parts of the town are fully 1½ miles distant from the nearest point on the line of the conduit; persons in these portions would naturally prefer to draw their water as they do now from the nearer source, *i.e.*, the tanks. It is no doubt proposed to fill these tanks with water from the channel. But the advantages of such a course are problematical. In the first place it is doubtful whether the people will not object to these tanks being reserved entirely for drinking purposes. In reserving these tanks there is the difficulty of combating with the religious or superstitious beliefs of the people about the sacred character of the water of some of these tanks and their power to absolve the sins of those that bathe in them. This self-same religious prejudice which makes the people and especially the pilgrims bathe in these tanks, also causes the various tanks to form the source from which the water is drawn for domestic consumption. Many of these tanks are vested in the temple authorities and there is little possibility of reserving a sufficiently large number of tanks solely for drinking purposes and preventing people from bathing in them. People who live at a distance from the conduit—and their number is a large one—will have to use the water they do now—water from tanks in which people bathe and wash their dirty clothes.

The minimum quantity of water anticipated by Mr. Donaghue, if available, sufficient for the town.

The distributary part of the scheme insufficient; only a small portion of the population will benefit by it.

The proposal to fill the tanks in the town cannot be recommended.

12. How small a portion of the town will be benefited by the conduit water will be more evident by comparing the length of the conduit and the length of streets in the town. The total length of conduit, all branches included, will be two miles, while the length of streets considerably exceeds 35 miles. This distributary conduit affecting, as it will do, only a small portion of the population is far from satisfactory in itself. Where the level of the hydraulic pressure rises sufficiently above ground level, Mr. Donaghue proposes to build up the wells to certain height above the surface of the ground and draw the water by taps as from fountains. Mr. Donaghue has drawn a level line in the longitudinal section of the conduit to show the hydraulic level of water pressure. This would be correct if there was no drought on the conduit. But the moment the people began to draw the water a hydraulic gradient will be produced and will fall as the drought increases, then the hydraulic level there would be as shown by me by a dotted blue line. The loss of head with the full drought is calculated to be 3·1 feet, so that out of the 21 wells over the conduit only two wells will admit of being treated as fountains, and this on the supposition that the yield from the channel does not fall below the minimum anticipated quantity which is a matter involved in doubt. So that from almost all, if not all, the wells over the conduit water will have to be drawn in the ordinary way by dipping buckets or pots during the hot months, a

The distributary part of the project inefficient.

The system of conduit wells necessitates water being drawn by dipping pots into them.

part of the year when the necessity for water is the greatest. The plan appears to be objectionable. Dr. C. J. H. Warden, Chemical Examiner to the Government of Bengal, in his report on tube-wells embodied in G.O., No. 2708 L., of the 21st October 1890, says "what I believe to be a frequent source of contamination of well and tank waters is the introduction of dirty "lotahs" (small brass vessels). Believing as I do that the cholera bacillus is something more than a harmless comma-shaped micro-organism, and knowing from experiments which I have witnessed the rapid way in which it multiplies when placed in suitable media, there is nothing surprising to me from a "lotah" which has been placed on the ground, and taken up some minute particles of a cholera patient's dejecta, when subsequently introduced into a well or tank, contaminating the whole supply." If this is so with large bodies of water in tanks, the chances of contamination are greater when water is confined within the narrow limits of a conduit. During May, one of the driest months in the year, and when the water level in the conduit will be at its minimum, there is a large influx of people into the town who flock to attend the grand festival. The danger of contamination is augmented when a vast concourse of people of all sorts and conditions are allowed to touch the water-supply with their chatties and pots. It is also a serious matter for consideration whether the caste principles of the people will permit the use of conduit wells at the same time by the high caste and low caste people. How deeply rooted this caste prejudice is, is evident from the necessity of reserving separate tanks and wells for separate classes of people.

This plan of drawing water is liable to contaminate water.

The chances of contamination are greater during the grand festival.

13. The system of conduit wells is such as cannot be approved of from a sanitary point of view and such as will not find favour with the people on account of the caste principles. The modern system of distribution by pipes and fountains is the proper one and it would be a retrograde step to go back to an antiquated and obsolete method of distribution.

On grounds of sanitation and caste principles, pipes and fountains are preferable to conduit wells.

14. In discussing this question of conduit wells *versus* fountains and pipes, I have entered into particulars which perhaps do not strictly pertain to a professional report, but I have thought it necessary to do so, because I have been told that in a place that has been regarded with such religious veneration as Conjeeveram the modern abominations like pipes and fountains will not be viewed with complacency by the higher class of Hindus. Conjeeveram is the most sacred city in the south of India and has long been the head-quarters of Brahmins. The question of water-supply for such sacred cities like Conjeeveram is not purely an engineering one, but is closely associated with such circumstances as caste prejudice and habits of the people. There need, however, be no apprehensions about the ultimate universal use of pipe water, if introduced into Conjeeveram by all classes. In the beginning the higher class of Hindus, especially the Brahmins, may hold off, but as has been the experience in other towns where pipe water has been introduced, they are ultimately reconciled to it. This is naturally so owing to the facility of procuring water in a pipe system and its comparative purity. These two circumstances are sufficient to overcome the most deep-rooted prejudices.

Objections to a pipe system for Conjeeveram answered.

15. I will now describe what, with the information now before me, appears to be the best mode of supplying the town with water.

The mode of supplying water to the town now proposed.

16. All circumstances point to the river as the proper source from whence to derive the water-supply of the town. The sandy bed of the Végavati river extends to a considerable depth. During

The river Végavati is the proper source of the water-supply.

the driest summer months water is always procurable within a few feet from the surface of the bed. There being no uncertainty as regards the source and quantity of water, the only questions to be considered are from what point in the river the supply is to be taken and how conveyed to the town and distributed. Seeing that water obtained from the bed of a river by any arrangement has been naturally filtered through a long expanse of sand, the necessity for avoiding surface exposure and contamination subsequently is apparent. From the point of off-take in the river the water ought to enter a closed pipe and not see daylight until it is drawn at the taps. It is thus evident that the longer the distance of the off-take from the town the greater will be the cost of the scheme. At the same time the site of the off-take should be sufficiently far from the town as to be free from such contaminations as every river is liable to from towns lying on its banks. The site that appears to answer these requirements is nearly opposite the Jain temple situated in the hamlet of Tiruparattikundram. This point is just outside the western end of the town and above the place where the dhobies wash their clothes and the Hindu dead are cremated.

Position of the off-take.

17. Several ancient irrigation canals start from a spring head or basin excavated in the banks of the river. The water for the town of Conjeeveram can also be obtained from the banks of the river. This peculiarity of the bank soil is favourable because it does not necessitate the construction of works for the collection of water in the bed of the river which would be more costly and more liable to damage during floods than such works in the bank of the river. An open excavation in the bank would be the simplest method of collecting the water; but for the water-supply of a town, the collected water should be protected from exposure to air, and either the plan of collecting wells or a gallery will have to be adopted. This will however, for reasons already stated, be a simple and inexpensive work. The water thus collected could be pumped up into a compensating reservoir at the north-western extremity of the town, which is the highest point of the town, and from thence distributed into the town by gravitation by means of pipes and fountains.

18. The total lift from the river to the maximum level of water in the reservoir would be about 60 feet, and, making a provision for 40,000 people at 15 gallons per head, and assuming that the whole quantity of water required is to be lifted in eighteen hours at a uniform rate, the horse-power of engines required would be —

Probable lift of water and horse-power of engines required.

$$\frac{40{,}000 \times 15 \times 60}{18 \times 60 \times 3{,}300} = 10 \text{ horse-power}$$

Add 80 per cent. for friction &c.	8	do.
Total horse-power required ..	18	

or, say, three engines of 10 horse-power each so that one engine may always be in reserve for use during a break-down in one of the working engines.

19. A rate of Rs. 1,500 per horse-power would probably cover the cost of engines, pumps, boilers and house complete.

Cost of pumping machinery and buildings.

20. I have said that the area of the town in proportion to its population as compared with other towns in Southern India is very great owing to the wide streets and the gardens and spacious backyards attached to each house. I calculate that if the water-supply is to reach all parts of the town not less than twelve miles of piping will be required including the pumping main which will be about one and a half miles. At a very low estimate a mile of piping on an average will cost not less than Rs. 12,500.

Length of piping required and cost.

Probable cost of the scheme.

21. The probable cost of the scheme would be as below. The figures are, of course, very approximate—

	Rs.
Arrangements for collection of water	10,000
Engines, pumps, boilers and house, &c., complete, 30 horse-power at Rs. 1,500 per horse-power	45,000
Twelve miles of piping including main at Rs. 12,500 per mile	1,50,000
Compensating reservoir	20,000
Total ..	2,25,000
Contingencies including establishment	25,000
Grand Total ..	2,50,000

Possible reduction in the estimate.

Some reduction in the cost of the works may be effected by omitting one engine for the present and also some lengths of piping, leaving them for a future time; but even with these omissions the cost cannot be reduced to much below Rs. 2,00,000.

Annual working and maintenance charges.

22. One important consideration in the scheme here proposed and in all pumping schemes is the annual working charges. At the recognized rate of 10 annas per million gallons pumped one foot high, the annual cost of pumping would be about Rs. 8,500, and, adding Rs. 1,500 for maintenance of pipes and fountains, the total cost of working and maintaining the scheme would be Rs. 10,000 per annum. Probably the maximum quantity of water would not be used for some years until after the completion of the works and until then the working and maintenance charges would probably not exceed Rs. 7,500 a year.

23. I would also mention here an alternative scheme which, if the levels are favourable, possess some advantages as compared with the one above described. The idea is to pump the water from the river somewhere near the place selected by Mr. Donaghue for his spring head or even a little lower down if possible and convey the water thence by stoneware pipes under pressure to a reservoir outside the town as in No. 1 scheme and distribute water from thence by pipes. Stoneware pipes are usually tested to a head of 30 feet of water and the working head must therefore be limited to 15 feet. If, therefore, the ground between the proposed site of the pumping station and the north-west extremity of the town admits of a line of pipes being laid so that the pressure nowhere exceeds more than 15 feet, this scheme will be feasible. Of this, however, I cannot speak very definitely in the absence of the necessary information as to levels, &c. The cost of this scheme, if anything, will be slightly in excess of No. 1; but it has one great advantage to recommend it, namely, a considerable reduction in the annual cost of pumping as the water will not have as great a lift as in No. 1 scheme. The river Végavati falls considerably between the points proposed as sites for pumping in Nos. 1 and 2, and the incline of underground water-line usually follows the incline of the river. Therefore, by placing the off-take higher up the river, a higher level of water will be met with; but at the same time the length of main pipe through which water has to be forced increases with the distance of the off-take from the town. Increased length of piping means an increased head lost in friction, and therefore the second point that requires investigation in this scheme is to what extent the difference in the water level at the points of off-take in the two schemes will exceed the head lost in friction by the increased length of piping in No. 2. This scheme, however, deserves to be considered side by side with No. 1.

Financial aspect of the scheme.

24. The financial aspect of the scheme can best be considered and argued by the Collector, but I would here point out that a water-tax at the rate of 3 per cent. would probably yield Rs. 6,000 per annum. The house and land tax could also be enhanced to the maximum rate of 7 per cent., the rate now levied being 5 per cent. This would increase the revenue by Rs. 4,000.

25. Notwithstanding that circumstances tend to make the scheme costly, the anticipated cost of the scheme will compare favourably with other pumping schemes.

26. If further investigation of the schemes here proposed appears desirable to the council, it would be advisable to sanction at an early date the requisite staff for taking the necessary levels of the town and for conducting experiments so as to ascertain the lowest summer water level and the probable yield of water from the sandy stratum, &c. This year there was insufficient rainfall, and therefore the time is well suited for experimenting as the minimum available water can be ascertained. I would therefore suggest that the staff be sanctioned early enough to enable the experiments being carried out not later than May 1891.

27. The staff required for taking the necessary levels and preparing the plans for the schemes would be as below :—

	Rs.
One surveyor and draftsman at Rs. 60 for four months	240
Four lascars for two months at Rs. 7	56
Contingencies including drawing instruments, paper, &c.	104
Total ..	400

28. The cost of the experimental wells and pumping will probably not exceed Rs. 500.

29. I cannot conclude this report without tendering my thanks to the Chairman of the council and to Mr. C. N. R. Appana Aiyangar, municipal councillor, for having assisted me by accompanying me during all my inspections to long distances beyond the town. Without their aid I should have been unable within so short a time to see the various places or gather the information that was necessary.

(Signed) HORMUSJI NOWROJI,
Asst. to the Sanitary Engineer.

19*th December* 1890.

From J. A. JONES, Esq., mem. inst. c.e., f.r.s.e., Sanitary Engineer to Government, to the Acting Collector of Chingleput, dated Fort St. George, 19th December 1890, No. 706.

I have the honour to send herewith a report from my Assistant Mr. Hormusji Nowroji, b.c.e., regarding the water-supply of Conjeeveram.

2. I regret that other duties have rendered it impossible for me to visit Conjeeveram, nor would I be able to do so for at least two months more. The report obviates any necessity for a visit by me at present.

3. The general result of the inquiry is that to obtain a pure and sufficient supply and to distribute it by pipes in Conjeeveram requires that the water be pumped from the Végavati river. The question yet to be decided is where is the most economical site for that operation. As provision for the cost of pumping will have to be made annually, I am in favour of investigating the alternative scheme; the more the cost of pumping can be reduced the better even though the original cost of the works may be in consequence increased.

4. You will see that it is estimated that it will cost Rs. 400 to investigate the schemes; if the council will sanction that amount, the work can be soon put in hand.

5. The other questions raised in the report, such as the use of the water from the pipes, the possibility of the municipality being able to afford the scheme, &c., can be better dealt with by you than by me, but I may say that my experience leads me to believe that whatever opposition may at first be raised against the use of a pipe supply that opposition will gradually die away when it is found that comfort and convenience are factors in the question.

6. I cannot recommend the acceptance of Mr. Donaghue's scheme and agree with the reasons urged in the report against its adoption.

Order—dated 30th March 1894, Mis. No. 414 M., Local and Municipal.

The papers will be referred to the municipal council for remarks. The council should state whether the Sanitary Engineer's scheme meets its wants and report in detail how it proposes to finance it.

(True Extract.)

(Signed) J. F. PRICE,
Chief Secretary.

To the Chairman, Municipal Council, Conjeeveram,
with connected papers and plan.

READ—also the following papers:—

From M.R.Ry. E. SUBRAHMANYA AIYAR Avargal, Chairman, Municipal Council, Conjeeveram, to the Chief Secretary to Government (through the Sub-Collector and Collector of Chingleput), dated Conjeeveram, 6th March 1895, No. 42-Index.

With reference to G.O., Mis. No. 1183 M., dated 1st September 1894, calling for a detailed report in connection with the water-supply scheme as to what additional income the municipality would be able to realize from house, &c., taxes, I have the honour to submit, herewith, a statement in detail, together with a copy of resolution of the council, dated 26th February 1895, on the subject.

2. It will be seen from the above that the settled demand of the house-tax as revised recently amounts to Rs. 10,969, showing an increase of Rs. 1,662 over that of 1893–94 or Rs. 5,484, the increased amount at $7\frac{1}{2}$ per cent. over the revised final demand, while that of the tax on arts as per recent revision gives Rs. 1,987 more than the actuals of 1893–94. Thus the increase under the two taxes amounts to Rs. 7,471. This being added to the water-tax of Rs. 9,416, calculated at the maximum rate of 4 per cent. on the tax on buildings and lands, gives an additional income of Rs. 16,887.

3. The amount of loan required from the Provincial funds will be Rs. 1,28,500. This will be drawn in two years by four half-yearly instalments each amounting to Rs. 32,125 and will be liquidated in thirty years. The interest for the said period will amount to Rs. 80,553–7–0, which, together with the loan of Rs. 1,28,500, makes up a total of Rs. 2,09,053–7–0. The average of this sum payable annually will be Rs. 6,968–7–2 or Rs. 6,970 in round number.

4. Deducting the said average amount from the additional income of Rs. 16,887 referred to in paragraph 1 *supra*, there will be a balance of Rs. 9,917 available to meet the maintenance charge on account of water-supply.

5. The loan application, revised, together with the detailed account of the revenue and expenditure for the past three years, is herewith submitted.

Forwarded.

PERIYAPÁLAIYAM,
14*th March* 1895.

(Signed) N. S. BRODIE,
Sub-Collector.

Ref. on No. 42-Mupl.

Forwarded.

2. The figure, Rs. 16,887, calculated as the total additional income to the Conjeeveram municipality is incorrect, the correct figure being Rs. 18,548 as shown below:—

	Rs.
Increase under house-tax over the figure of 1893–94	1,662
Increase under arts tax over the figure of 1893–94	1,986
Increase of house-tax from 5 to $7\frac{1}{2}$ per cent.	5,484
Water-tax	9,416
Total ..	18,548

Taking 90 per cent. of the increased demand to be realizable, Rs. 16,693 may be taken to represent the probable additional income.

A sum of Rs. 15,000 is estimated by the Sanitary Engineer as the annual charge for the water-supply scheme as below:—

	Rs.
Repayment of capital with interest at $4\frac{1}{4}$ per cent.	7,659
Pumping charges	5,000
Maintenance charges	2,341
Total ..	15,000

The estimated additional income of Rs. 18,548 does not include the increase of tax on lands which does not appear to have been revised yet.

SATYAVÉDU,
28*th March* 1895.

(Signed) N. S. BRODIE,
Acting Sub-Collector in charge.

To the Chief Secretary to Government,
Local and Municipal Department.

No. 559.

The Chairman is requested to return without delay the papers and plans connected with the water-supply scheme which were forwarded to him with G.O., dated 30th March 1894, No. 414 M.

26*th April* 1895.

(Signed) C. G. TODHUNTER,
Ag. Assistant Secretary.

To the Chairman, Municipal Council, Conjeeveram.

From M.R.Ry. E. SUBRAHMANYA AIYAR Avargal, Chairman, Municipal Council, Conjeeveram, to the Chief Secretary to Government (through the Sub-Collector and Collector of Chingleput), dated Conjeeveram, 27th April 1895, Ref. on memo. No. 34-Eng.

With reference to the official memo. No. 559, dated 26th April 1895, I have the honour to return the papers and plan in connection with the water-supply scheme of this town, together with a list of them, as directed therein.

ENCLOSURE.

LIST of papers in connection with the water-supply scheme of the Conjeeveram municipality.

1. Report by the Assistant Sanitary Engineer to Government on the Conjeeveram water-supply scheme, dated 19th December 1890.

2. Sanitary Engineer's letter to the Collector of Chingleput, No. 706, dated 19th December 1890.

3. Sanitary Engineer's letter to Government No. 28, dated 6th February 1894.

4. Report of the Sanitary Engineer on the Conjeeveram water-supply scheme.

5. Estimate No. 14 of 1893–94 for the water-supply scheme.

6. Sanitary Engineer's letter to Government No. 2415, dated 6th November 1893.

7. Note by the Chief Engineer, Public Works Department, dated 22nd December 1893.

8. Endorsement of the Secretary to Government, Public Works Department, No. 4498 C., dated 28th December 1893.

9. Sanitary Engineer's letter to Government No. 100 of 15th January 1894.

Forwarded.

(Signed) L. E. BUCKLEY,
Sub-Collector.

30*th April* 1895.

Forwarded.

(Signed) C. H. MOUNSEY,
Acting Collector.

MADURÁNTAKAM,
3*rd May* 1895.

To the Chief Secretary to Government,
Local and Municipal Department.

From the Sanitary Engineer to Government, dated 3rd May 1895, No. 1248.

ABSTRACT.—Submitting copies of correspondence between him and the Chairman, Municipal Council, Conjeeveram, and requesting that early orders may be passed on the scheme for the water-supply of the town.

ORDER—dated 7th June 1895, No. 951 M., Local and Municipal.

The proposed scheme for the water-supply of the town of Conjeeveram, which is estimated to cost Rs. 2,57,000, is sanctioned.

2. The Government will be prepared to make a grant of half the initial cost of the scheme and to lend the balance at $4\frac{1}{4}$ per cent. interest repayable in thirty years.

3. The instalments in which this loan is to be taken should be fixed in consultation with the Sanitary Engineer. The amount of those in which it is to be repaid should be given as Rs. 7,659 instead of Rs. 6,968–7–2 in the loan application, and the statement of receipts and charges of the municipality should be for the years 1892–93, 1893–94 and 1894–95. A revised application should be submitted without delay with reference to these remarks. As soon as the loan is sanctioned, the grant will be made from Provincial funds.

4. The Sanitary Engineer will take the necessary steps for carrying out the work and report what funds will be required in the current year.

(True Extract.)

J. F. PRICE,
Chief Secretary.

To the Chairman, Municipal Council, Conjeeveram.
" Collector of Chingleput.
" Sanitary Engineer (with plans and estimates).
" Public Works Department.
" Financial Department.
Editors' Table.

Exd. S. J. Pereira.

Govt. of {1895} Madras.

LOCAL AND MUNICIPAL.

No. 1872 W. 26 July 18

Recorded.
(21) J. P.
W

Issued

Recd. *Encl.*

G.O., 7th June 1895, No. 951 M.

JUNE.

Water-supply.

Sanctioning, with remarks, the proposed scheme for the — of Conjeeveram estimated to cost Rs. 2,57,000, and requesting the municipal council to submit a revised application for a loan of Rs. 1,28,500 and the Sanitary Engineer to report what funds will be required in the current year.

S.E. V circle
for information.

GOVERNMENT OF MADRAS.

LOCAL AND MUNICIPAL DEPARTMENT.

READ—again the following paper :—

G.O., dated 30th March 1894, Mis. No. 414 M., Local and Municipal.

Read—the following papers :—

From J. A. JONES, Esq., MEM., INST. C.E., F.R.S.E., Sanitary Engineer to Government, to the Chief Secretary to Government, dated Fort St. George, 6th November 1893, No. 2415.

Referring to my letter No. 2570, dated 23rd November 1892, embodied in G.O., dated 12th December 1892, No. 2035 M., Local and Municipal, I have the honour to forward a report, estimate and plans of a scheme for a supply of water to Conjeeveram.

ENCLOSURES.

Report on a scheme for the water-supply to the town of Conjeeveram.

In November 1890, at the request of the Collector of Chingleput, the Assistant Sanitary Engineer to Government was deputed to inspect Conjeeveram, and report on the subject of the improvement to the water-supply of the town.

2. In that report the objections taken to the scheme proposed by Mr. W. F. Donaghue, the Local Fund Engineer, were set forth and discussed ; and as the scheme was not considered a satisfactory one, the Assistant Sanitary Engineer suggested two alternative schemes for the water-supply of the town from the Végavati river, which passes close to Conjeeveram. As the result of this report which was forwarded to the Collector, an allotment of Rs. 400 was made by the council for the investigation of the schemes referred to.

3. The scheme hereinafter described is practically the same as one of the two schemes suggested in the above-mentioned report.

4. The Végavati river passes to the south of, and close to, Conjeeveram. The river is dry for most part of the year, but below its bed there is as usual a large substratum of water in the sand, and this no doubt extends to a width much greater than the actual surface width of the river itself.

5. It is proposed to draw the supply for the town from this water by means of infiltration works.

6. The population of Conjeeveram in 1881 was 37,275 and in 1891 it was 46,362. A large concourse of pilgrims come to the town on festivals and their number has been stated to amount to as much as 40,000. In view of this it was considered desirable to provide for a supply in excess of the requirements of the permanent population. The scheme, so far as the pipes and infiltration works are concerned, is designed to meet the requirements of a population of 56,000 at 15 gallons per head per diem. This is equal to an average supply of 583 gallons per minute. The supply required at certain hours of the day being double the average supply, the above-mentioned portions of the works are designed so as to be capable of delivering 2×583, or 1,166 gallons per minute or 186 cubic feet per minute.

7. The point selected for the location of the head works is on the left bank of the river opposite the famous Jain temple in the village of Tiruparattikundram on the right bank. The reasons for the location of the head works here have been given in the Assistant Sanitary Engineer's report mentioned above.

8. The water taken from temporary wells in the bed of the river and on the bank at the proposed site of the head works has been analysed and pronounced to be "usable." A copy of the analysis is subjoined :—

—		Water from river well.	Water from garden well.
Total solids	Grms. per litre.	0·160	0·110
Volatile solids	Do.	0·070	0·040
Chlorine	Do.	0·011	0·014
Total hardness	Clark's scale.	1°·050	1°·400
Permanent hardness ..	Do.	1°·050	1°·050
Free ammonia	Ml. grms. per litre.	0·080	0·140
Albuminoid ammonia	Do.	0·060	0 100
Nitric acid	Do. (As ammonia).	3·000	0·600
Apparent quantity of the water as inferred from the results on examination.		Usable.	Usable.

Remarks.—Both these waters would be better of filtration after boiling. Microscopically they contain sand, vegetable matter and ova of animals of low formation.

9. At the point selected for the site of the head works the river-bed is 1,000 feet wide, and its sandy bed, as ascertained by trial pits, is some fifteen feet deep. The summer water level falls as low as eight feet below the surface of the sandy bed and this, it is believed, is the lowest known summer water-level. It was taken when the river was at its lowest in the year 1891. From the subjoined table of rainfall at Conjeeveram it will be seen that the year 1891 had the smallest rainfall of any since 1877 :—

Year.	Yearly rainfall in inches.	Year.	Yearly rainfall in inches.
1877	38·54	1886	43·81
1878	37·76	1887	62·47
1879	41·33	1888	60·35
1880	40·87	1889	37·82
1881	33·80	1890	37 23
1882	40·60	1891	27·10
1883	39·16	1892	39·29
1884	61·48		
1885	43·16	Average ..	42·79

It may therefore be accepted that the water-level is not likely to be lower than when it was at its lowest in 1891, which is seven feet above the hard bed—*vide* plan No. 2.

10. Some observations on the sufficiency of water in the Végavati to meet the town supply have been made in the Assistant Sanitary Engineer's report above mentioned. It is not possible to gather any more particulars on this point without expensive experiments as to the yield of water from a trench similar to the one proposed and hereafter to be described. But when it is considered that thousands of acres of land both above and below Conjeeveram are irrigated by spring channels cut from the bed of the river, there is not much doubt but that a sufficient supply of water for the town can be obtained at all times.

11. After careful consideration as to the most suitable plan for collecting the water from the sub-soil, it is proposed to do so by laying four lines of open jointed 9″ stoneware pipes in a trench at right angles to the axis of the river and at a depth of seven feet below lowest known water-level—this trench commencing from the river

bank where the engine-house will be located will extend a distance of 550 feet. The trench will be re-filled up with gravel up to the summer water-level and above that with river sand.

12. More than one method was designed and actually estimated for, but it was finally decided upon to adopt the above method as being the most economical and best suited to the circumstances of the case. This method of drawing water has been successfully adopted at Cuddapah. It is not suited to any river with a sandy bed which is liable to scouring by high floods. The highest floods in the Végavati have not been found to exceed three feet. Though the river is 1,000 feet wide at the site of the head works, and has all the appearance of a river draining a very large area of country, it takes its rise only 9 miles from Conjeeveram. The river is of the nature of a broad sandy belt traversing the valley into which the drainage of the adjoining country flows, but the actual area it has not been possible to ascertain.

13. It has been said in the previous paragraph that infiltration works can be worked up to a head of three feet. The head is limited solely by consideration of the velocity of the inflow generated by the head. This velocity should be such that the inflowing water should be incapable of carrying sand with it through the openings in the infiltration works.

14. The area of the openings in the proposed gallery at Conjeeveram is calculated to be 46 square feet. The maximum inflow per minute is to be 1,166 gallons or 186 cubic feet which will require a velocity ·8 of a foot per second. In some experiments made by Mr. Anderson in connection with his revolving purifiers—*vide* Vol. LXXXI, Minutes of Proceedings of the Institute, C.E., he found that a velocity of four inches per second was incompetent to move any but the finest particles of iron in a verticle tube. In the light of Mr. Anderson's experiments a velocity of ·8 of a foot per second is too low to cause the finest particles of sand to enter the pipes.

15. The infiltration pipes will terminate in a manhole near the bank of the river. From the manhole a 18″ cast iron pipe will convey the water to the suction well. The opening of the inlet pipe into the suction well will be fitted with a sluice gate.

16. The arrangements for pumping direct into the pipe and distribution will be similar to other schemes already sanctioned by Government, and it is therefore unnecessary to describe them at length in this report.

17. The total lift of water at the pumping station will be 55 feet. There will be three engines of 10 pump horse-power each, any two of which will deliver the maximum quantity of 1,166 gallons per minute, the third engine being in reserve. The distribution will be effected by 60,140 feet of cast iron pipes varying from 16 to 3 inches in diameter. There will be 46 two-tap and 16 one-tap fountains and the necessary valves, stop-cocks, hydrants, &c.

18. The scheme is estimated to cost Rs. 2,70,000 distributed under the major heads of work as follows :—

	Rs.
Infiltration works with manhole	14,267
Engine and boiler house with suction well	13,405
Store shed	2,000
Engine driver's quarters	5,000
Engines, pumps and boilers	33,600
Compensation, &c.	1,050
Pipes, valves, fountains, hydrants	1,40,157
Laying and jointing pipes	25,171
Total ..	2,34,650
Contingencies ..	35,350
Grand Total ..	2,70,000

The cost of pumping the whole supply for which the scheme is designed would be at 10 annas per million gallons lifted one foot high—

$$\frac{56{,}000 \times 15}{1{,}000{,}000} \times \frac{10}{16} \times 55 = \text{Rs. } 29 \text{ per day or Rs. } 10{,}585 \text{ per annum.}$$

But for some years after the construction of the works it will be sufficient if the town is supplied with half the above quantity of water which will give ten gallons per head per diem on the entire present population, and this will probably be sufficient except in festival times, and at any rate as much as the town can afford for the present.

If the supply is restricted to ten gallons per head on the present population, the annual pumping charges will be about Rs. 5,000, and one engine will be sufficient to pump all the water required, so that it would be necessary at first to arrange for only two engines—one of which will be always in reserve. All other works will, however, have to be constructed as designed for the full supply of fifteen gallons per head. The omission of one engine will reduce the estimate to Rs. 2,57,000.

19. The annual charges for a supply of ten gallons per head and assuming that Government will contribute half the initial cost will be —

	RS.
Interest and sinking fund at 5·96 per cent. on Rs. 1,28,500	7,659
Pumping charges	5,000
Maintenance charges	2,341
Total ..	15,000

20. The assessment on buildings amounts to Rs. 10,000 per annum at 5 per cent. on the rental value. By raising the tax to the maximum rate of 7½ per cent., an extra revenue of about Rs. 5,000 will be derived. The water-tax should bring in a revenue of Rs. 8,000. There should therefore be no difficulty on the part of the municipality in raising sufficient extra revenue to meet the cost of the scheme.

21. Conjeeveram has already been referred to as a town which is frequented by a large number of pilgrims. It is stated that no less than 40,000 pilgrims visit the town yearly and there is no doubt but that these people must spend a very large income in the town—supposing that each person stays four days and spends 2 annas per day the amount spent in the town by pilgrims alone would be about Rs. 20,000 yearly from which there must be a considerable profit. This is mentioned because on a meeting with the Chairman he was inclined to urge the poverty of the town—no doubt the inhabitants to some extent live on what is derived from the pilgrims, but in any case Conjeeveram cannot be a poor town, and as a town from which any epidemic disease would be rapidly spread it is all the more necessary that the sanitary necessities of the town, of which a water-supply is one of the most important, should be supplied as soon as possible.

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No. 828.

Referred to the Public Works Department for remarks.

FORT ST. GEORGE,
14*th November* 1893.

(Signed) A. T. PRINGLE,
Assistant Secretary.

To the Public Works Department (with plans).

—

Note by the Chief Engineer, Public Works Department.

The scheme appears sound in its general features, but paragraph 13 of the Assistant Sanitary Engineer's report is not intelligible; nothing whatever is said in the preceding paragraph as to the head up to which infiltration works can be worked.

Paragraph 14 as written involves the extraordinary argument that, because a velocity of four inches per second will just move the lightest particles of iron, a velocity of ·8 of a foot, or 9·6 inches per second, will not move sand, a much lighter material.

It is, however, clear that ·8 of a foot is a clerical error for ·8 of an inch, the real velocity being $\frac{186}{60 \times 46} = ·067$ of a foot or ·8 of an inch, and it is probable that this velocity will not be enough to draw sand into the pipes.

It is not quite clear why the "manhole" between the infiltration pipes and the inlet pipe to the suction well is not taken up to the ground level; as drawn, it is not a "manhole" at all being completely inaccessible; this is probably only a mistake in the drawing.

(Signed) J. PENNYCUICK, Col., R.E.,
22*nd December* 1893. *Chief Engineer, P.W.D.*

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No. 4498 C.

Transferred to the Local and Municipal Department.

CHEPAUK,
28*th December* 1893.

(Signed) J. PENNYCUICK, Col., R.E.,
Secretary to Government, P.W.D.

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No. 12.

Referred to the Sanitary Engineer for remarks.

FORT ST. GEORGE,
13*th January* 1894.

(Signed) A. T. PRINGLE,
Assistant Secretary.

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From HORMUSJI NOWROJI, Esq., B.C.E., A.M.I.C.E., Assistant Sanitary Engineer to Government, in charge of office of Sanitary Engineer to Government, to the Chief Secretary to Government, dated Fort St. George, 15th January 1894, No. 100.

With reference to your endorsement No. 12, dated 13th January 1894, on note by the Chief Engineer, Public Works Department, on the Conjeeveram water-supply scheme, I have the honour to state that paragraph 13 of the report on that scheme should read, "In infiltration works the velocity of inflow during the maximum demand should be such that the inflowing water should be incapable of carrying sand with it through the openings in the infiltration works."

2. In the original draft of the report a paragraph preceding paragraph 13 of the present report was struck out, and I regret that by an oversight the consequential alteration in paragraph 13 was not made.

3. In paragraph 14, ·8 of a foot is, as stated by the Chief Engineer, a clerical error for ·8 of an inch.

4. The plan has now been altered with reference to the Chief Engineer's remarks on the manhole between the infiltration pipes and the inlet to the suction well. The manhole has been carried well above the ground level to prevent surface water getting into the manhole. It is, however, not necessary to alter the estimate as the increase is very inappreciable.

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No. 54.

The Sanitary Engineer is requested to forward a copy of the Assistant Sanitary Engineer's report on the water-supply of the town of Conjeeveram, which is referred to in his letter, dated 6th November 1893, No. 2415.

(Signed) L. DAVIDSON,
1*st February* 1894. *Ag. Assistant Secretary.*

To the Sanitary Engineer.

From R. E. ELLIS, Esq., A.M.I.C.E., Acting Sanitary Engineer to Government to the Chief Secretary to Government, dated Fort St. George, 6th February 1894, No. 281.

With reference to your official memorandum No. 54, dated the 1st instant, I have the honour to forward a copy of the Assistant Sanitary Engineer's report on the water-supply of Conjeeveram, as also my letter to the Collector of Chingleput, forwarding the same to him.

Enclosures.

Report on the water-supply of the town of Conjeeveram, inspected 25th to 28th November 1890.

The town of Conjeeveram lies in the valley of the Palar. It is situated on the north bank of the Végavati river which joins the Palar a few miles below the town. From the former river the town rises gradually but considerably towards the north and west. The general lie of the country around Conjeeveram is in the same direction. The town occupies an area of about 4 square miles. Along the river bank the length of the town is $3\frac{1}{2}$ miles and its width varies from $1\frac{1}{2}$ miles at the north end to $\frac{1}{2}$ a mile at the south end. The streets are very broad and every house has attached to it a small garden or backyard; the town, therefore, is not densely packed with houses. It is well to remember this fact in comparing the cost of the water-supply of Conjeeveram with other cities as the density of a town very much influences the cost. The number of houses in the town is 7,179 and the population according to the census of 1881 was 37,275. It is supposed that the population now exceeds 40,000.

The town lies on the bank of the Végavati river.

Area, 4 square miles.

Population, 40,000.

2. The soil under and around the town consists of a sandy loam of some considerable depth below the surface. The purity of the sand and the depth of the stratum increases as the land approaches the river.

Soil near the river is sandy.

3. As one of the water-supply schemes proposed and the only one that has been completely worked out (by Mr. Donaghue, the Local Fund Engineer) is based on the lines of the ancient water-supply of Conjeeveram, it is well to concisely describe that supply.

The ancient water-supply of Conjeeveram.

4. The source of the water-supply is some four miles above and to the west of the western extremity of the town on the north bank of the Végavati river. At this place on the bank of the river there is a spring head or basin excavated about a 100 feet from the river bank. The bed of this basin is some 20 feet below the bed of the river. The basin is replenished by springs percolating from under the bed of the river as well as land springs from the shore side. The soil down to the bed of the basin is pure sand. From the basin the water flows down an open cut, called the Lâlâkâl, until it reaches the north-western extremity of the town. This is the highest point of the town. Here the Lâlâkâl bifurcates. The larger branch feeds the Konérikuppam irrigation tank, and the smaller branch fills, or is supposed to fill, the masonry tanks in the town. After the point of bifurcation the smaller channel, or what may be called the town-

The source of water is a spring head or basin excavated in the bank of the river some four miles above the town.

Water from the basin is led to the town by an open channel called Lâlâkâl.

Just outside the town the channel bifurcates.

The larger branch feeds the Konérikuppam irrigation tank. The smaller branch supplies the town with water.

supply channel runs in an open cut for some distance and then enters a masonry cistern, and the water is distributed to the various tanks in the town by means of underground masonry conduits. The conduits are out of repair and some of them are so choked up with earth that they cannot pass any water. All traces of some of these conduits are lost, and many of the tanks that were at one time replenished by the Lâlâkâl water are not so now. Owing to the scarcity of rain, none of the tanks in the town except Sarvatírtam, which forms the first of the chain of tanks replenished by the Lâlâkâl, received any supply of water during this or last year. The town-supply channel, though called so and apparently vested in the municipality, is also used for irrigation. According to the chairman's statement some fields belonging to the Krishna temple and lying on the line of the town-supply channel have the right to draw water from this channel for irrigation purposes. So that in years of drought, like this year and the last, whatever share of water the town-supply channel receives from the Lâlâkâl is drawn off to irrigate the fields mentioned above. This was so during my inspection, the water being prevented from going into the town by a block in the channel.

Distributary conduits within the town are out of repair.

During years of insufficient rainfall the tanks in the town are not replenished by the Lâlâkâl water.

Certain fields have the right to draw water from the town supply channel.

5. Of the proposals for the water-supply of Conjeeveram, the one first demanding consideration is the proposal to improve this ancient water-supply scheme. The first question is the quantity of water available. From information collected it would appear that the Lâlâkâl flows for only eight months in the year during a year of ordinary rainfall and for shorter periods during years of drought. It is possible that improvements in the gradients and section of the channel would permit the spring-head or basin being deepened a little. But it is doubtful whether this deepening to the permissible extent will secure a perennial supply to the town, though it may increase the yield to some extent. The original idea of the scheme was not to secure a perennial supply, but merely to fill up the tanks in the town with fresh water during the wet months, so that sufficient water for the hot weather might be stored in the tanks.

Suggested improvement of the Lâlâkâl.

First objection.—The Lâlâkâl does not flow perennially, and would not be so even after improvement.

6. The next point to be considered is how far would the improvement of the Lâlâkâl benefit the town supply? The shrotriems under the Konérikuppam tank have a right to the water of the Lâlâkâl. The portion to which they have a right is variously stated at three-fourths, two-thirds and three-fifths and the portion of water coming down the town-supply branch would therefore be from one-fourth to two-fifths of the yield from the Lâlâkâl. I gauged the flow of water in the Lâlâkâl near its head and found that to equal 360 cubic feet per minute. If the quantity available for the town-supply channel be taken at one-third the amount is 120 cubic feet per minute. This is the time of year during which the flow is at its maximum. It may therefere be assumed that the average yield to the town supply during the months when the Lâlâkâl flows, which is from six to eight, would not exceed 60 cubic feet per minute. The town-supply channel would therefore yield in a year like the present one about 15,000,000 cubic feet of water. The aggregate capacity of the various stone-built tanks in the town is, I calculate, not less than 30,000,000 cubic feet, so that in the present condition of the Lâlâkâl and provided that the water in the town-supply channel is not otherwise used, the tanks would receive not more than half of the quantity of water required. I have already said that the tanks in the town except one did not receive any supply during this year nor last; so that the greater portion of the 15,000,000 cubic feet of water brought down by the town-supply channel was used for irrigating the lands belonging to

Second objection.—The difficulty and cost of purchasing the right of the shrotriemdars to the Lâlâkâl water.

the Krishna temple which lie along the course of the channel. A proper supply of water to the tanks in the town can only be secured if the Krishna temple authorities and the shrotriemdars under the Konérikuppam tanks could be induced to surrender their rights for a consideration. I believe this is an impossibility from a financial point of view. If to this we add the cost of the improvement of the channel with the necessary masonry works which are now wanting, and look, moreover, to the fact that the town supply would still be a very primitive and defective one for other reasons also, it is thought that the results of improving the ancient water-supply would not warrant the probable cost.

Third objection.—Large cost of improvements.

7. The difficulty of inducing the shrotriemdars to surrender their right to the water of the Lâlâkâl, the necessary compensation and the cost of the improvements to the channel were evidently apparent to Mr. Donaghue, who therefore drew up a scheme to construct an independent channel; the lines of his scheme are, however, precisely the same as the ancient water-supply of Conjeeveram.

Mr. Donaghue's scheme on the lines of the ancient water-supply.

8. Mr. Donaghue's scheme is briefly as follows:—To construct a spring-head or basin on the north bank of the Végavati river, 1,520 yards below the old Lâlâkâl spring-head; to conduct the water in an open channel about $3\frac{1}{4}$ miles long to a cistern at the north western extremity of the town; to construct a masonry conduit 8,273 feet long from the cistern along the main street of Big Conjeeveram with six minor branches having an aggregate length of 3,917 feet for supplying various tanks. Twenty-one wells to be provided at convenient places over the conduit for drawing water from and it was supposed that in about nine wells the water would rise so high above ground level as to allow the water being drawn by taps; water from the remaining wells to be drawn by dipping buckets or pots into them as with ordinary wells.

Description of Mr. Donaghue's scheme.

Defects in the scheme.

9. The main points of the scheme that fail to recommend themselves for approval are as follow:—

(1) Uncertainty of a perennial yield.

(2) The proposed channel traverses irrigated land especially in its lower course where the channel is in cutting, and the water is therefore liable to contamination.

(2) Channel traverses irrigated lands.

(3) The inefficiency and insufficiency of the distributing portion of the scheme as the water let into the tanks will be as liable to pollution as at present.

(3) Channel not properly protected.

10. There is some uncertainty as to whether the new spring-head would yield a constant and unfailing supply of water even during the driest months, especially during a year of deficient rainfall like the present one. The Lâlâkâl flows only for about eight to six months in the year. The new channel, however, has its bed considerably below the bed of the old channel, but there is no certainty that the new channel is sufficiently low to secure a perennial supply. There is no doubt, however, that from the character of the soil and the conditions under which water is available at the site of the proposed spring-head that the question of the sufficiency of water resolves itself merely into a question of sufficient depth of the spring-head. But unfortunately the levels of the town do not permit of the spring-head and the

Uncertainty of the proposed spring-head yielding a constant and unfailing supply of water during summer months.

Ample water is available underground, but the levels of the town do not permit a greater depth to the spring-head.

channel being placed at a much lower level than as designed in the scheme. Mr. Donaghue is evidently not insensible to the uncertainty of a sufficiency of water, as in his report he suggests that the spring-head should be first constructed as an experiment before all other works so as to ascertain the quantity of water available before any expenditure is incurred on the other works connected with the scheme.

11. Mr. Donaghue anticipates a flow of water three inch deep even during the driest months. This flow will yield 792,000 gallons per day. This quantity, if available as anticipated, would be just sufficient to meet the wants of the permanent population *plus* the large number of pilgrims who resort to the town during the grand festival in May. But even if this quantity of water is available, the distribution part of the project is so defective and inefficient that only a very small portion of the population will benefit by it. The people living in the main street through which the conduit passes, and in its immediate vicinity would resort to it. But some parts of the town are fully $1\frac{1}{2}$ miles distant from the nearest point on the line of the conduit; persons in these portions would naturally prefer to draw their water as they do now from the nearer source, *i.e.*, the tanks. It is no doubt proposed to fill these tanks with water from the channel. But the advantages of such a course are problematical. In the first place it is doubtful whether the people will not object to these tanks being reserved entirely for drinking purposes. In reserving these tanks there is the difficulty of combating with the religious or superstitious beliefs of the people about the sacred character of the water of some of these tanks and their power to absolve the sins of those that bathe in them. This self-same religious prejudice which makes the people and especially the pilgrims bathe in these tanks, also causes the various tanks to form the source from which the water is drawn for domestic consumption. Many of these tanks are vested in the temple authorities and there is little possibility of reserving a sufficiently large number of tanks solely for drinking purposes and preventing people from bathing in them. People who live at a distance from the conduit—and their number is a large one—will have to use the water they do now—water from tanks in which people bathe and wash their dirty clothes.

The minimum quantity of water anticipated by Mr. Donaghue, if available, sufficient for the town.

The distributary part of the scheme insufficient; only a small portion of the population will benefit by it.

The proposal to fill the tanks in the town cannot be recommended.

12. How small a portion of the town will be benefited by the conduit water will be more evident by comparing the length of the conduit and the length of streets in the town. The total length of conduit, all branches included, will be two miles, while the length of streets considerably exceeds 35 miles. This distributary conduit affecting, as it will do, only a small portion of the population is far from satisfactory in itself. Where the level of the hydraulic pressure rises sufficiently above ground level, Mr. Donaghue proposes to build up the wells to certain height above the surface of the ground and draw the water by taps as from fountains. Mr. Donaghue has drawn a level line in the longitudinal section of the conduit to show the hydraulic level of water pressure. This would be correct if there was no drought on the conduit. But the moment the people began to draw the water a hydraulic gradient will be produced and will fall as the drought increases, then the hydraulic level there would be as shown by me by a dotted blue line. The loss of head with the full drought is calculated to be 3·1 feet, so that out of the 21 wells over the conduit only two wells will admit of being treated as fountains, and this on the supposition that the yield from the channel does not fall below the minimum anticipated quantity which is a matter involved in doubt. So that from almost all, if not all, the wells over the conduit water will have to be drawn in the ordinary way by dipping buckets or pots during the hot months, a

The distributary part of the project inefficient.

The system of conduit wells necessitates water being drawn by dipping pots into them.

part of the year when the necessity for water is the greatest. The plan appears to be objectionable. Dr. C. J. H. Warden, Chemical Examiner to the Government of Bengal, in his report on tube-wells embodied in G.O., No. 2708 L., of the 21st October 1890, says "what I believe to be a frequent source of contamination of well and tank waters is the introduction of dirty "lotahs" (small brass vessels). Believing as I do that the cholera bacillus is something more than a harmless comma-shaped micro-organism, and knowing from experiments which I have witnessed the rapid way in which it multiplies when placed in suitable media, there is nothing surprising to me from a "lotah" which has been placed on the ground, and taken up some minute particles of a cholera patient's dejecta, when subsequently introduced into a well or tank, contaminating the whole supply." If this is so with large bodies of water in tanks, the chances of contamination are greater when water is confined within the narrow limits of a conduit. During May, one of the driest months in the year, and when the water level in the conduit will be at its minimum, there is a large influx of people into the town who flock to attend the grand festival. The danger of contamination is augmented when a vast concourse of people of all sorts and conditions are allowed to touch the water-supply with their chatties and pots. It is also a serious matter for consideration whether the caste principles of the people will permit the use of conduit wells at the same time by the high caste and low caste people. How deeply rooted this caste prejudice is, is evident from the necessity of reserving separate tanks and wells for separate classes of people.

This plan of drawing water is liable to contaminate water.

The chances of contamination are greater during the grand festival.

13. The system of conduit wells is such as cannot be approved of from a sanitary point of view and such as will not find favour with the people on account of the caste principles. The modern system of distribution by pipes and fountains is the proper one and it would be a retrograde step to go back to an antiquated and obsolete method of distribution.

On grounds of sanitation and caste principles, pipes and fountains are preferable to conduit wells.

14. In discussing this question of conduit wells *versus* fountains and pipes, I have entered into particulars which perhaps do not strictly pertain to a professional report, but I have thought it necessary to do so, because I have been told that in a place that has been regarded with such religious veneration as Conjeeveram the modern abominations like pipes and fountains will not be viewed with complacency by the higher class of Hindus. Conjeeveram is the most sacred city in the south of India and has long been the head-quarters of Brahmins. The question of water-supply for such sacred cities like Conjeeveram is not purely an engineering one, but is closely associated with such circumstances as caste prejudice and habits of the people. There need, however, be no apprehensions about the ultimate universal use of pipe water, if introduced into Conjeeveram by all classes. In the beginning the higher class of Hindus, especially the Brahmins, may hold off, but as has been the experience in other towns where pipe water has been introduced, they are ultimately reconciled to it. This is naturally so owing to the facility of procuring water in a pipe system and its comparative purity. These two circumstances are sufficient to overcome the most deep-rooted prejudices.

Objections to a pipe system for Conjeeveram answered.

15. I will now describe what, with the information now before me, appears to be the best mode of supplying the town with water.

The mode of supplying water to the town now proposed.

16. All circumstances point to the river as the proper source from whence to derive the water-supply of the town. The sandy bed of the Végavati river extends to a considerable depth. During

The river Végavati is the proper source of the water-supply.

the driest summer months water is always procurable within a few feet from the surface of the bed. There being no uncertainty as regards the source and quantity of water, the only questions to be considered are from what point in the river the supply is to be taken and how conveyed to the town and distributed. Seeing that water obtained from the bed of a river by any arrangement has been naturally filtered through a long expanse of sand, the necessity for avoiding surface exposure and contamination subsequently is apparent. From the point of off-take in the river the water ought to enter a closed pipe and not see daylight until it is drawn at the taps. It is thus evident that the longer the distance of the off-take from the town the greater will be the cost of the scheme. At the same time the site of the off-take should be sufficiently far from the town as to be free from such contaminations as every river is liable to from towns lying on its banks. The site that appears to answer these requirements is nearly opposite the Jain temple situated in the hamlet of Tiruparattikundram. This point is just outside the western end of the town and above the place where the dhobies wash their clothes and the Hindu dead are cremated.

Position of the off-take.

17. Several ancient irrigation canals start from a spring head or basin excavated in the banks of the river. The water for the town of Conjeeveram can also be obtained from the banks of the river. This peculiarity of the bank soil is favourable because it does not necessitate the construction of works for the collection of water in the bed of the river which would be more costly and more liable to damage during floods than such works in the bank of the river. An open excavation in the bank would be the simplest method of collecting the water; but for the water-supply of a town, the collected water should be protected from exposure to air, and either the plan of collecting wells or a gallery will have to be adopted. This will however, for reasons already stated, be a simple and inexpensive work. The water thus collected could be pumped up into a compensating reservoir at the north-western extremity of the town, which is the highest point of the town, and from thence distributed into the town by gravitation by means of pipes and fountains.

18. The total lift from the river to the maximum level of water in the reservoir would be about 60 feet, and, making a provision for 40,000 people at 15 gallons per head, and assuming that the whole quantity of water required is to be lifted in eighteen hours at a uniform rate, the horse-power of engines required would be —

Probable lift of water and horse-power of engines required.

$$\frac{40{,}000 \times 15 \times 60}{18 \times 60 \times 3{,}300} = 10 \text{ horse-power}$$

Add 80 per cent. for friction &c.	8	do.
Total horse-power required ..	18	

or, say, three engines of 10 horse-power each so that one engine may always be in reserve for use during a break-down in one of the working engines.

Cost of pumping machinery and buildings.

19. A rate of Rs. 1,500 per horse-power would probably cover the cost of engines, pumps, boilers and house complete.

Length of piping required and cost.

20. I have said that the area of the town in proportion to its population as compared with other towns in Southern India is very great owing to the wide streets and the gardens and spacious backyards attached to each house. I calculate that if the water-supply is to reach all parts of the town not less than twelve miles of piping will be required including the pumping main which will be about one and a half miles. At a very low estimate a mile of piping on an average will cost not less than Rs. 12,500.

Probable cost of the scheme.

21. The probable cost of the scheme would be as below. The figures are, of course, very approximate—

	Rs.
Arrangements for collection of water	10,000
Engines, pumps, boilers and house, &c., complete, 30 horse-power at Rs. 1,500 per horse-power	45,000
Twelve miles of piping including main at Rs. 12,500 per mile	1,50,000
Compensating reservoir	20,000
Total ..	2,25,000
Contingencies including establishment	25,000
Grand Total ..	2,50,000

Possible reduction in the estimate.

Some reduction in the cost of the works may be effected by omitting one engine for the present and also some lengths of piping, leaving them for a future time; but even with these omissions the cost cannot be reduced to much below Rs. 2,00,000.

Annual working and maintenance charges.

22. One important consideration in the scheme here proposed and in all pumping schemes is the annual working charges. At the recognized rate of 10 annas per million gallons pumped one foot high, the annual cost of pumping would be about Rs. 8,500, and, adding Rs. 1,500 for maintenance of pipes and fountains, the total cost of working and maintaining the scheme would be Rs. 10,000 per annum. Probably the maximum quantity of water would not be used for some years until after the completion of the works and until then the working and maintenance charges would probably not exceed Rs. 7,500 a year.

23. I would also mention here an alternative scheme which, if the levels are favourable, possess some advantages as compared with the one above described. The idea is to pump the water from the river somewhere near the place selected by Mr. Donaghue for his spring head or even a little lower down if possible and convey the water thence by stoneware pipes under pressure to a reservoir outside the town as in No. 1 scheme and distribute water from thence by pipes. Stoneware pipes are usually tested to a head of 30 feet of water and the working head must therefore be limited to 15 feet. If, therefore, the ground between the proposed site of the pumping station and the north-west extremity of the town admits of a line of pipes being laid so that the pressure nowhere exceeds more than 15 feet, this scheme will be feasible. Of this, however, I cannot speak very definitely in the absence of the necessary information as to levels, &c. The cost of this scheme, if anything, will be slightly in excess of No. 1; but it has one great advantage to recommend it, namely, a considerable reduction in the annual cost of pumping as the water will not have as great a lift as in No. 1 scheme. The river Végavati falls considerably between the points proposed as sites for pumping in Nos. 1 and 2, and the incline of underground water-line usually follows the incline of the river. Therefore, by placing the off-take higher up the river, a higher level of water will be met with; but at the same time the length of main pipe through which water has to be forced increases with the distance of the off-take from the town. Increased length of piping means an increased head lost in friction, and therefore the second point that requires investigation in this scheme is to what extent the difference in the water level at the points of off-take in the two schemes will exceed the head lost in friction by the increased length of piping in No. 2. This scheme, however, deserves to be considered side by side with No. 1.

Financial aspect of the scheme.

24. The financial aspect of the scheme can best be considered and argued by the Collector, but I would here point out that a water-tax at the rate of 3 per cent. would probably yield Rs. 6,000 per annum. The house and land tax could also be enhanced to the maximum rate of 7 per cent., the rate now levied being 5 per cent. This would increase the revenue by Rs. 4,000.

25. Notwithstanding that circumstances tend to make the scheme costly, the anticipated cost of the scheme will compare favourably with other pumping schemes.

26. If further investigation of the schemes here proposed appears desirable to the council, it would be advisable to sanction at an early date the requisite staff for taking the necessary levels of the town and for conducting experiments so as to ascertain the lowest summer water level and the probable yield of water from the sandy stratum, &c. This year there was insufficient rainfall, and therefore the time is well suited for experimenting as the minimum available water can be ascertained. I would therefore suggest that the staff be sanctioned early enough to enable the experiments being carried out not later than May 1891.

27. The staff required for taking the necessary levels and preparing the plans for the schemes would be as below:—

	Rs.
One surveyor and draftsman at Rs. 60 for four months	240
Four lascars for two months at Rs. 7	56
Contingencies including drawing instruments, paper, &c.	104
Total ..	400

28. The cost of the experimental wells and pumping will probably not exceed Rs. 500.

29. I cannot conclude this report without tendering my thanks to the Chairman of the council and to Mr. C. N. R. Appana Aiyangar, municipal councillor, for having assisted me by accompanying me during all my inspections to long distances beyond the town. Without their aid I should have been unable within so short a time to see the various places or gather the information that was necessary.

(Signed) HORMUSJI NOWROJI,
Asst. to the Sanitary Engineer.

19*th December* 1890.

From J. A. JONES, Esq., MEM. INST. C.E., F.R.S.E., Sanitary Engineer to Government, to the Acting Collector of Chingleput, dated Fort St. George, 19th December 1890, No. 706.

I have the honour to send herewith a report from my Assistant Mr. Hormusji Nowroji, B.C.E., regarding the water-supply of Conjeeveram.

2. I regret that other duties have rendered it impossible for me to visit Conjeeveram, nor would I be able to do so for at least two months more. The report obviates any necessity for a visit by me at present.

3. The general result of the inquiry is that to obtain a pure and sufficient supply and to distribute it by pipes in Conjeeveram requires that the water be pumped from the Végavati river. The question yet to be decided is where is the most economical site for that operation. As provision for the cost of pumping will have to be made annually, I am in favour of investigating the alternative scheme; the more the cost of pumping can be reduced the better even though the original cost of the works may be in consequence increased.

4. You will see that it is estimated that it will cost Rs. 400 to investigate the schemes; if the council will sanction that amount, the work can be soon put in hand.

5. The other questions raised in the report, such as the use of the water from the pipes, the possibility of the municipality being able to afford the scheme, &c., can be better dealt with by you than by me, but I may say that my experience leads me to believe that whatever opposition may at first be raised against the use of a pipe supply that opposition will gradually die away when it is found that comfort and convenience are factors in the question.

6. I cannot recommend the acceptance of Mr. Donaghue's scheme and agree with the reasons urged in the report against its adoption.

Order—dated 30th March 1894, Mis. No. 414 M., Local and Municipal.

The papers will be referred to the municipal council for remarks. The council should state whether the Sanitary Engineer's scheme meets its wants and report in detail how it proposes to finance it.

(True Extract.)

(Signed) J. F. PRICE,
Chief Secretary.

To the Chairman, Municipal Council, Conjeeveram,
with connected papers and plan.

Read—also the following papers:—

From M.R.Ry. E. SUBRAHMANYA AIYAR Avargal, Chairman, Municipal Council, Conjeeveram, to the Chief Secretary to Government (through the Sub-Collector and Collector of Chingleput), dated Conjeeveram, 6th March 1895, No. 42-Index.

With reference to G.O., Mis. No. 1183 M., dated 1st September 1894, calling for a detailed report in connection with the water-supply scheme as to what additional income the municipality would be able to realize from house, &c., taxes, I have the honour to submit, herewith, a statement in detail, together with a copy of resolution of the council, dated 26th February 1895, on the subject.

2. It will be seen from the above that the settled demand of the house-tax as revised recently amounts to Rs. 10,969, showing an increase of Rs. 1,662 over that of 1893–94 or Rs. 5,484, the increased amount at $7\frac{1}{2}$ per cent. over the revised final demand, while that of the tax on arts as per recent revision gives Rs. 1,987 more than the actuals of 1893–94. Thus the increase under the two taxes amounts to Rs. 7,471. This being added to the water-tax of Rs. 9,416, calculated at the maximum rate of 4 per cent. on the tax on buildings and lands, gives an additional income of Rs. 16,887.

3. The amount of loan required from the Provincial funds will be Rs. 1,28,500. This will be drawn in two years by four half-yearly instalments each amounting to Rs. 32,125 and will be liquidated in thirty years. The interest for the said period will amount to Rs. 80,553–7–0, which, together with the loan of Rs. 1,28,500, makes up a total of Rs. 2,09,053–7–0. The average of this sum payable annually will be Rs. 6,968–7–2 or Rs. 6,970 in round number.

4. Deducting the said average amount from the additional income of Rs. 16,887 referred to in paragraph 1 *supra*, there will be a balance of Rs. 9,917 available to meet the maintenance charge on account of water-supply.

5. The loan application, revised, together with the detailed account of the revenue and expenditure for the past three years, is herewith submitted.

Periyapálaiyam,
14*th March* 1895.

Forwarded.

(Signed) N. S. BRODIE,
Sub-Collector.

Ref. on No. 42-Mupl.

Forwarded.

2. The figure, Rs. 16,887, calculated as the total additional income to the Conjeeveram municipality is incorrect, the correct figure being Rs. 18,548 as shown below:—

	Rs.
Increase under house-tax over the figure of 1893–94	1,662
Increase under arts tax over the figure of 1893–94	1,986
Increase of house-tax from 5 to $7\frac{1}{2}$ per cent.	5,484
Water-tax	9,416
Total ..	18,548

Taking 90 per cent. of the increased demand to be realizable, Rs. 16,693 may be taken to represent the probable additional income.

A sum of Rs. 15,000 is estimated by the Sanitary Engineer as the annual charge for the water-supply scheme as below:—

	Rs.
Repayment of capital with interest at $4\frac{1}{4}$ per cent.	7,659
Pumping charges	5,000
Maintenance charges	2,341
Total ..	15,000

The estimated additional income of Rs. 18,548 does not include the increase of tax on lands which does not appear to have been revised yet.

(Signed) N. S. BRODIE,
Acting Sub-Collector in charge.

Satyavédu,
28*th March* 1895.

To the Chief Secretary to Government,
Local and Municipal Department.

No. 559.

The Chairman is requested to return without delay the papers and plans connected with the water-supply scheme which were forwarded to him with G.O., dated 30th March 1894, No. 414 M.

(Signed) C. G. TODHUNTER,
Ag. Assistant Secretary.

26*th April* 1895.

To the Chairman, Municipal Council, Conjeeveram.

From M.R.Ry. E. SUBRAHMANYA AIYAR Avargal, Chairman, Municipal Council, Conjeeveram, to the Chief Secretary to Government (through the Sub-Collector and Collector of Chingleput), dated Conjeeveram, 27th April 1895, Ref. on memo. No. 34-Eng.

With reference to the official memo. No. 559, dated 26th April 1895, I have the honour to return the papers and plan in connection with the water-supply scheme of this town, together with a list of them, as directed therein.

Enclosure.

List of papers in connection with the water-supply scheme of the Conjeeveram municipality.

1. Report by the Assistant Sanitary Engineer to Government on the Conjeeveram water-supply scheme, dated 19th December 1890.

2. Sanitary Engineer's letter to the Collector of Chingleput, No. 706, dated 19th December 1890.

3. Sanitary Engineer's letter to Government No. 28, dated 6th February 1894.
4. Report of the Sanitary Engineer on the Conjeeveram water-supply scheme.
5. Estimate No. 14 of 1893–94 for the water-supply scheme.
6. Sanitary Engineer's letter to Government No. 2415, dated 6th November 1893.
7. Note by the Chief Engineer, Public Works Department, dated 22nd December 1893.
8. Endorsement of the Secretary to Government, Public Works Department, No. 4498 C., dated 28th December 1893.
9. Sanitary Engineer's letter to Government No. 100 of 15th January 1894.

Forwarded.

30th April 1895. (Signed) L. E. BUCKLEY,
Sub-Collector.

Forwarded.

MADURÁNTAKAM,
3rd May 1895. (Signed) C. H. MOUNSEY,
Acting Collector.

To the Chief Secretary to Government,
Local and Municipal Department.

From the Sanitary Engineer to Government, dated 3rd May 1895, No. 1248.

ABSTRACT.—Submitting copies of correspondence between him and the Chairman, Municipal Council, Conjeeveram, and requesting that early orders may be passed on the scheme for the water-supply of the town.

ORDER—dated 7th June 1895, No. 951 M., Local and Municipal.

The proposed scheme for the water-supply of the town of Conjeeveram, which is estimated to cost Rs. 2,57,000, is sanctioned.

2. The Government will be prepared to make a grant of half the initial cost of the scheme and to lend the balance at $4\frac{1}{4}$ per cent. interest repayable in thirty years.

3. The instalments in which this loan is to be taken should be fixed in consultation with the Sanitary Engineer. The amount of those in which it is to be repaid should be given as Rs. 7,659 instead of Rs. 6,968–7–2 in the loan application, and the statement of receipts and charges of the municipality should be for the years 1892–93, 1893–94 and 1894–95. A revised application should be submitted without delay with reference to these remarks. As soon as the loan is sanctioned, the grant will be made from Provincial funds.

4. The Sanitary Engineer will take the necessary steps for carrying out the work and report what funds will be required in the current year.

(True Extract.)

C Strokhunter
for *Chief Secretary.*
12.VII.95.

To the Chairman, Municipal Council, Conjeeveram.
" Collector of Chingleput.
" Sanitary Engineer (with plans and estimates).
" Public Works Department.
" Financial Department.
Editors' Table.

Exd. S. J. Pereira.

88C

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LOCAL AND MUNICIPAL.

No 4498 C4/28-12-93

Issued

Recd. Encl.

G.O., 7th June 1895, No. 951 M.

JUNE.

Water-supply.

Sanctioning, with remarks, the proposed scheme for the — of Conjeeveram estimated to cost Rs. 2,57,000, and requesting the municipal council to submit a revised application for a loan of Rs. 1,28,500 and the Sanitary Engineer to report what funds will be required in the current year.

8.8.C

Rec: 16.7.95

No. 1872 W dy 26th July 1895

Recorded.

C&RB
18-7-95

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