In consequence of this failure the Arthur Crawford Markets had again to be lighted with Gas.

Lighting the city with electricity.

A portion of the city was for a short time lighted by Electricity. The budget for 1891-92 had a provision of Rs. 32,500 for experimentally lighting certain portions of Bombay with Electricity. In the same year the Municipal Commissioner was asked to prepare a special report on the subject of carrying out experimental electric lighting in the city and to apply to Government for the temporary services of an Electrician. As the Government Engineer declined to advise the Corporation on the subject, the Commissioner was authorised to obtain the temporary services of some other Electrician. The services of the Electrical Engineer of the G. I. P. Ry., having been obtained, tenders were invited for experimentally lighting the city by Electricity,

In May 1891, the Corporation recorded their opinion that the consideration of lighting a certain portion of the city with electric light, should be postponed *Sine Die*. A few months later the Corporation asked the Municipal Commissioner to inform the Corporation whether there exists in Bombay tidal or other water power as would supply motor power for lighting the whole or a part of Bombay with Electric lights.

The Commissioner's report which is quoted at page 583, Vol. XV. Corporation Record, shows that it would be cheaper to work with steam than with water power.

Lighting of the municipal offices and Arthur Crawford Market.

The Corporation in 1894, sanctioned an initial expenditure of Rs. 20,000 for providing additional machinery and plant for lighting the Municipal Offices and the Arthur Crawford Markets by Electricity. Then finally comes the renewal of the lighting contract, the details of which is given in extenso.

Lighting of the city; Committee's report thereon

The Committee appointed by the Corporation to consider the subject of the future lighting of the city, reported as follows :—

"It appeared to the Committee that the enquiry should embrace —

(*a*) Electric lighting.

(*b*) Ordinary gas lamps and kerosine lamps as at present, but the latter to have duplex burners.

(*c*) "Welsbach" incandescent gas lamps and kerosine lamps with duplex burners.

(*d*) Kerosine lamps only with duplex burners.

Mr. Murzban's valuable and exhaustive report shows that the capital expenditure and annual cost for lighting by (*a*), (*b*), (*c*) and (*d*) would be —

	Capitalized Expenditure.	Annual cost.
(*a*)	Rs, 25,50,000.....	Rs. 6,73,200
(*b*)	At present contract rates....	,, 3,51,307
	At proposed rates.....	,, 3,29,805
(*c*)	Rs. 2,04,325..... including 10 per cent. for contingencies.	,, 2,97,329
(*d*)	Rs. 63,989..... including 10 per cent. for contingencies.	,, 2,24,445

It would seem from the above that the electric light—irrespective of other considerations—is from the large initial expenditure required and heavy annual cost, beyond the present means of the Corporation ; and that the present system (*b*) considering its poor illuminating power and heavy cost as compared with (*c*) and (*d*) systems need not be further considered.

The question therefore, in the opinion of your Committee, resolves itself into the adoption of Welsbach incandescent gas lamps instead of the present gas lamps, and the substitution of duplex for single burners in the kerosine lamps now in use, or the non-renewal of the Gas Company's contract and the lighting of the city by kerosine lamps with duplex burners.

After careful consideration of the advantages and disadvantages of the two systems your Committee advise—

(1) Provided the Gas Company revise their rates as requested by the Commissioner, or offer such rate as on further enquiry by the Commissioner may appear fair to him ; the Commissioner may enter into a contract with the Company for ten years, and make arrangements for replacing the present gas-lamps with Welsbach incandescent gas-lamps, such replacement to be completed within three years.

(2) Should the Gas Company decline to reconsider their rates the Commissioner to arrange to light the city by kerosine lamps with duplex burners.

G. COTTON.
DINSHA EDULJI WACHA.
IBRAHIM RAHIMTOOLA.
R. H. VINCENT.

Bombay,
15*th December* 1894.

I concur with the above, but think the new form of lighting might be carried out in a less period than three years.

S. REBSCH.

I also concur, and only wish to add that if the Corporation is recommended to sanction the adoption of the incandescent gas-lamps in substitution for the present gas-lamps, it may also be recommended to sanction the conversion of all the single kerosine burners into duplex burners.

20*th December* 1894. ARDASIR F. UNWALLA.

I agree with this report, but I wish to entirely reserve my liberty of action if the Gas Company do not come to terms. The city would be in a terrible fix were the kerosine oil supply in America to fail, as recent reports show, is not impossible. In that event Russian oil would become enormously dearer, and probably lighting by kerosine oil would become more expensive than gas even at present rates.

G. W. ROUGHTON.

22*nd December* 1894.

I agree with the above.

THOMAS BLANEY.

Proposed by George Cotton, Esq., seconded by Ardasir F. Unwalla, Esq.—

"That the report of the Committee of the Corporation on the question of the future lighting of the City be approved and adopted, provided the Gas Company revise their rates as proposed by the Commissioner, or offer such rates as, on further enquiry may appear fair to him, he be authorised to enter into a contract with the Company for the period of ten years, and make arrangements for fitting the present gas lamps with Welsbach incandescent gas lamps.

"That the Corporation will be prepared, on the recommendation of the Standing Committee, to sanction the sum required for such conversion, *viz.*, of Rs. 2,04,325. That in the event of the Gas Company declining to consider their rates, the Commissioner be authorised to arrange for lighting the City by kerosine lamps with duplex burners.

"That the Standing Committee report from what source the cost of converting the gas lamps should be met."

Carried.

RENEWAL OF THE LIGHTING CONTRACT.

The Sub-Committee appointed by the Standing Committee, on 10th April 1895, as per margin, beg to report that they agree with the Municipal Commissioner in the opinion that all the Municipal gas lamps should be converted into incandescent burners in one year instead of in three years.

That a Sub-Committee consisting of the following gentlemen be appointed to consider and report on the proposals contained in the Commissioner's letter to the Secretary, No. 29624, dated 26th March 1895, on the subject of new contract with the Gas Company for lighting the City :—

The Chairman ; Cowasjee Hormasjee Esq.; Harkisondas, Narotumdas, Eq.; Ibrahim Rahimtoola, Esq.; S, Rebach, Esq.

The Sub-Committee recommended that the Corporation should be advised to provide the Rs. 2,17,842 required for the work, by sanctioning payment of that amount from the invested surplus cash balance of Rs. 17,04,134, and providing for the repayment of the same, by yearly payments extending over four years, from the money which will be saved on gas lighting, so soon as the lamps are all fitted with the Welsbach burners.

BHALCHANDRA KRISHNA.
S. REBSCH.
IBRAHIM RAHIMTOOLA.
HURKISANDAS NURROTUMDAS.
COWASJEE HORMUSJEE.

BOMBAY,
10th April 1895.

GIRGAUM, *April 15th*, 1895.

MY DEAR MR. BARROW,— On reconsidering and discussing the question of contract of lighting, I have come to the conclusion that the Committee's report is based on insufficient information on the subject, which was not available that day, and I think it should not be adopted in its present form. I beg, therefore, to express my dissent from the views of the Committee, and I don't feel justified in subscribing to them. I trust that you will kindly put this dissent of mine before the meeting of the Standing Committee on Wednesday, the 17th instant.—

Yours, &c.,
BHALCHANDRA KRISHNA.

Proposed by Abdulla M. Dharamsi, Esq., seconded by the Honourable Mr. Fazulbhoy Visram—

"That, with reference to the Corporation's Resolution, No. 10792 of the 3rd January last, and letter No. 29624 of 26th ultimo, from the Commissioner to the Secretary, the Standing Committee agree with the Municipal Commissioner in the opinion that all the Municipal gas lamps should be converted into incandescent burners in one year instead of three years.

"2. That the Corporation be recommended to sanction (1) the entering into a contract with the Bombay Gas Company for lighting the street lamps and certain other lamps belonging to the Municipality for the period of ten years from the 1st of July 1895, at the following rates per lamp :—

	Rs.	a.	p.
Ordinary gas lamp, whole month	83	0	0
" " part month	66	0	0
Incandescent lamp, whole month	70	0	0
" " part month	58	12	0

(2) The conversion within the period of one year, of

the present ordinary gas burners into Welsbach incandescent gas lamps, at the estimated cost of Rs. 2,17,842; and (3) to the expenditure of such sum from invested balances.

" 3. That the Corporation be informed that the Executive Engineer estimates that, when the conversion is completed, there will be a net average annual saving on the cost of gas lighting of Rs. 37,798, namely, Rs. 22,791 on account of the reduction in the price of gas and Rs: 15,007 on account of savings in consumption consequent on the adoption of the incandescent light."

Carried.

The Corporation at their meeting held on the 22nd April 1895, sanctioned the recommendation of the Standing Committee.

With reference to paragraph 3 of the Corporation's Resolution No. 981, dated 22nd April 1895, the Acting Commissioner handed in the draft new contract with the Gas Company, and the Secretary was requested to read the proviso which had been added to section 12 securing a reduction in the price of gas if inferior or cheaper gas could hereafter be produced with the same amount of brilliancy as in the case of the better gas. The rates to be paid under the contract are Rs. 5 per thousand cubic feet less 5 per cent.

Ordinary whole month lamp	Rs.	83	0	0	per annum.
Part time do.	,,	66	0	0	,,
Incandescent light whole time	,,	70	0	0	,,
Do. part time	,,	56	12	0	,,

The Committee expressed their approval of the proviso in question, and the Secretary was directed to return the draft to the Acting Municipal Commissioner accordingly.

Nothing definite has as yet been decided about lighting the city with electricity.

Lighting of Private Streets.

The question of lighting the Private Streets was disposed of in accordance with the legal opinion obtained on the subject (see under the heading of legal opinions.)

Details of lamps, &c., in Bombay.

1. The current contract with the Gas Co., is dated 1st July, 1895, and will last for a period of 10 years from that date.

2. The work of converting the ordinary gas lamps into incandescent gas lamps was commenced as soon as the contract was signed, and completed within one year.

Power of incandescent gas lamps.

3. The ordinary gas light gave light equivalent to only 11 candle power, while the illuminating power of the present incandescent gas light is 25 candles at the lowest.

Number of gas lamps in Bombay.

4. There are now 3,920 gas lamps. Out of these 736 are what are called whole month lamps, *i. e.*, they are lighted throughout the night during the entire year. The rest, *viz.*, 3184 lamps are what are called part month lamps, *i. e.*, they are not lighted on moonlight nights during the dry months of the year. A whole month lamp is lighted for 3907·85 and a part month for 3102·75 hours per annum.

Kerosine lamps in Bombay.

5. In addition to these gas lamps, there are at present 1,768 kerosine oil lamps, out of which 1,332 lamps are part month lamps, and 436 lamps whole month lamps. For the last 10 years, this lighting is carried out departmentally and only 150° Snowflake oil is used.

THE WATER SUPPLY OF BOMBAY.

In May 1824, there was a water famine in consequence of which the watering of the roads within the limits* was stopped and instructions were issued to allow of free access to all public wells. Captain Dickenson (then the Revenue Surveyor) informed the Bench that he had received general instructions from Government to convey the rain water running from any of the high roads into the tanks and Reservoirs and that those measures were in progress. At a meeting of the Quarter Sessions held on 6th October 1824, a letter was read from Government requesting the opinion of His Majesty's Justices as to the measures which might be considered desirable and practicable to diminish and control the consumption of fresh water in the Island.

Water famine of 1824.

The Bench after mature deliberation came to the following conclusion :—

"That the Bench is of opinion that it would not be advisable to impose any restrictions at present upon the ordinary expenditure of water from the public tanks by the inhabitants, for domestic purposes, further than not to allow them to wash themselves or their clothes at the Reservoirs or in their immediate neighbourhood but to take the water for such purposes to their own houses. In order to secure which the Government should be recommended to direct the Police Magistrates to station peons at the principal wells and tanks.

Deficient water supply.

2. "That no private wheels be permitted on the public tanks this year, nor the water taken away in great quantities for the purpose of cultivation.

3. "That no water fit for domestic purposes be on any account allowed to be expended on the streets or roads."

The Bench also deliberated on the expediency of stopping all masonry work, but reflecting that the adoption

* In those days the Town was divided in two parts, *i. e.*, "within the limits" and "without the limits".

of this measure would throw out of employment a great number of the labouring class of almost every description and consequently increase the public distress, did not recommend it.

Water famine of 1845.

In 1845, Government were again alarmed at the deficiency of the water supply of the Town, that a Committee composed of Doctors Graham and Leith were appointed to report on the state of the wells in the Island, the quality of water in them, and the quantity remaining for consumption. Both these gentlemen submitted their report, in which they acknowledged the great want of water prevailing in the Town and the great distress felt by the people from the deficiency; they pointed out, moreover that the water was, as a rule, bad in quality, in some instances brackish, and in others, tainted by the Drainage from the streets. The following were the recommendations made:—

Use of wells.

"That the use of some private wells in Girgaum should be secured for the public by compensating the owners; that the wells on the Esplanade where cattle were watered should be reserved for man; and that other wells in the same locality which had been closed should be reopened."

Three days after this report was sent in, the Government passed a resolution calling upon the Chief Engineer for the time being to report on the subject.

Before however, the Chief Engineer submitted his report, one Mr. L. C. C. Rivett of the Civil Service proposed a remedy for the evil in his project on the practicability of obtaining a supply of good water for the native Town of Bombay.

Collection of rain water during the monsoon.

Mr. Rivett pointed out that it was hopeless to attempt to add to the supply by means of wells; that in order to keep the tanks in the Town full up to a certain level during the whole year, the only plan was to collect rain water during the monsoon; and that the principal desiderata were "an elevated position for a reservoir" "a large surface from which to fill this reservoir" and "facility of conveying the water from this reservoir to the tanks in question."

Mr. Rivett wrote:—"The principal points at which, at first sight present themselves for such an object appear

to be Nowroji Hill at the back of the Goal, the Hill above Mazagaon, the Chinchpokli Hills, the Hill above Parel, Malabar Hill adjacent to the Parsi Cemetery and the Hill above Colonel Dunstervilles' House." Calculating the areas of the important tanks on which the Town depended for its supply, Mr. Rivett found they amounted to 6,72,000 square feet and he considered it would be necessary to supply each tank with water to the depth of 16 feet. Proceeding then on the supposition that the rainfall was 6½ feet in the year, and that only half of it could be collected, and assuming that the reservoir should hold a 3 years supply he found he should require a gathering ground of 240 acres. This would enable him to collect 20,00,00,000 gallons. As none of the sites mentioned offered this extent of collecting area, he proposed that a reservoir should be built on a hill standing on the Peninsula called "The Neat's Tongue," better known as Trombay."

Proposed Reservoir at "The Neat's Tongue" (Trombay.)

He estimated the cost of the work at £68,940 or about 7 lacs of rupees. No action was taken on Mr. Rivett's proposal.

Then came the project of Colonel Jervis, the Chief Engineer, it was :—

"To provide three reservoirs in the following situations which afford sandstone strata, which are saturated with water throughout the year—1st, the Dhobee's Tank on the Esplanade, 2nd, some eligible spot to be purchased in the Girgam Oarts; 3rd, the Cocoanut Oarts of Mahim. The first for the supply of the Fort; the second for the supply of the Native Town from the verge of the Esplanade to a line running east and west from the Mambadevi Tank; the third for the supply of Parel, Byculla, Mazgaon and the native town, north of the line above mentioned. The water to be pumped from the reservoirs by steam engines and conveyed through iron pipes to the different quarters. The reserviors to be covered over by the engine rooms and other buildings to prevent evaporation and to preserve the water pure."

This scheme also fell to the ground. On the 24th September 1845 Government directed the attention of the Court of Petty Sessions to the subject of the water supply of the Town and requested them to consider the measures to be taken for husbanding, the supply of water, and for keeping it pure and wholesome.

The Court of Petty Sessions reported that in order to prevent waste, the tanks in the Town should be guarded by peons; that a spring, which there was at the Cooperage

Guarding of Tanks by Peons.

should be reported on; that the shipping should be made to water at Elephanta or Salsette; and that Government should issue a proclamation which was practically to the effect that the people should not drink more water than was good for them, and that they were not to spill more in the act of drinking than they could possibly help. The people were allowed to take away as much water as they wanted, but having got it into their houses, they were to take great care of it.

Proposed Reservoir at Gowalia Tank.

In 1846, Captain Turner submitted, yet, another project, it was to intercept the rain falling—1st on a portion of that side of Malabar Hill which faces Back Bay; 2nd on the hill near that on which the Parsi Tower of Silence stands; 3rd on some ground lying directly north of the Gowalia Tank. Having intercepted the rain, Captain Turner proposed to lead it into a reservoir 400 feet square to be built close to the Gowalia Tank. The total supply calculated to be obtained from this project, which was probably intended for only a portion of the Town, was 2,90,00,000 gallons, or, as Captain Turner put it, sufficient at the rate of 5 gallons a day for 62,222 people during 90 days.

This project of a short life and a merry one also fell through.

The Two Tanks at Duncan Road.

The water supply of the Island continued to be a source of great anxiety, and tanks were built, to impound water. The history of the two tanks at Duncan Road is interesting. They were built previous to the year 1823, and were originally supplied with water conveyed by means of an acqueduct from the Cowasji Patel Tank. The name of Major Hawkins appears to have been connected with their construction. He was apparently an officer in the service of the East India Company and was engaged in superintending the construction of the tanks for Government. Those tanks, it appears, were made partly at any rate, from money bequeathed in trust by *one Huslaji Subanji (a mahomedan gentleman) and the balance required for their construction as well as for the construction of the acqueduct was probably provided by Government. These tanks appear to have been from the very first, intended for, and, devoted to, the use of the public.

* Refer "Bombay Samachar," 24th May 1824.

To wards the hot weather as water became scarcer, the supply from the Cawasji Patel Tank was insufficient and in consequence of this, one Mr. Framji Cowasji, then a very wealthy Parsi Merchant, seems to have proposed to Government that he should be allowed to undertake the supply of water to the tanks in question. For this purpose, he purchased the Mugbhat Oart, in which he sank three large wells which he fitted with the necessary apparatus, *viz.* a Steam Engine and four wheels with cattle to draw water, and a channel for carrying the water into the acqueduct already made from the Cowasji Patel Tank, at an outlay of Rs. 30,000 and a monthly charge of about Rs. 200 under the guidance of Major Dickinson.

As some recognition of his public spirit in undertaking the expense of this charitable work and of maintaining the supply of water for the future, Government in the year 1824, on his application, consented to relinquish the Government tax on the trees (cocoanut palms) then growing and thereafter to be planted in the Mugbhat Oart, on the condition that such exemption from tax should cease in the event of the acqueduct from whatever cause not being supplied with a sufficiency of water from the Oart.

Mr. Framji Cowasji continued to supply water for the tanks in Duncan Road from the wells in Mugbhat Oart up to the time of his death which occured on the 12th February 1851, having, however, in 1831, made an arrangement with Government for securing the supply permanently by making the expense a charge upon other valuable property. This arrangement came about in this manner :—In 1831, Mr. Framjee Cowasjee was lessee of an estate in Salsette called the Pawai Estate, on which he had expended large sums in agricultural operations and was desirous of converting his estate into freehold. In October of that year, he accordingly proposed to Government that he should be allowed to purchase the annual rent of Rs. 4,600 which he paid as lessee of the Pawai Estate for 10 years purchase viz., Rs. 46,000 and that the property should be conveyed to him as a freehold; and he stated that if Government sanctioned this enfranchisement of the Pawai Estate he intended to charge upon that estate, in perptutity, the expenditure of keeping up the water supply to the Duncan Road Tanks.

Eventually Government agreed to this proposal and by a deed dated 15th February 1837, granted the Pawai Estate to Mr. Framji Cowasji as freehold, he covenanting to execute such deed for securing the due supply of water to the Duncan Road Tanks as might be deemed reasonably expedient by the East India Company. Accordingly on the 20th September 1837, Mr. Framji Cowasji in fulfilment of his covenant executed another deed, whereby he granted the rents, issues and profits of the Pawai Estate to the East India Company, their successors and assigns subject to a proviso that, so long as he (Mr. Framji Cowasji) his heirs, executors, administrators and assigns should duly continue to keep up the supply of water to the two Tanks as in the deed prescribed, he and they might continue to enjoy such rents, issues and profits as though the deed in question had not been executed.

Mr. Framji by his will appointed his sons Mr. Pestonji Framji and Mr. Nanabhoy Framji, trustees for the purpose of carrying on the charity after his death, that is to say for the purpose of maintaining the supply of water from the Mugbhat Oart to the two Tanks; and they have more or less regularly continued to do so until recently. It is believed, however, that they have by no means applied to the purposes of the Trust all the monies which they have from time to time received by way of income from the Mugbhat Oart, and contributions from the Pawai Estate on account of this Trust. Mr. Pestonji Framji is now dead and Mr. Nanabhoy Framji is the present trustee. The estate of Framji Cowasji was the subject of litigation in an administration suit instituted by members of the family against Pestonji Framji and Nanabhoy Framji, his executors, and by the decree passed in that suit all the properties belonging to the estate were directed to be sold.

The actual extent of the charge created on the Pawai Estate for keeping up the water-supply to the Two Tanks being somewhat doubtful, the matter was argued in the High Court in an administration suit with the result that by an order made in that suit on the 23rd December 1880, it was held, that for the purpose of supplying water to the Tanks in question, "the lands and hereditaments of the Testator Framji Cowasji in the proceedings mentioned situate in Salsette and comprised in and granted to him by a certain indenture bearing date the 15th day of February

1837 and made between the Honourable East India Company of the one part and the said Testator of the other part are chargeable with such amount only as is actually necessary to defray the expenses of keeping up the supply of water to the said reservoir after applying to that purpose the rents, issues and profits of the Mugbhat Oart mentioned in the Will of the said Testator.

There were further petitions to the Court on the subject, but whatever the result may have been, it is of no interest to the Municipality as by Section VI of Act XIV of 1842, the Governor in Council was empowered from time to time by proclamation "to declare what tanks or wells shall be deemed public and also which of such public tanks or wells may be used for the purpose of bathing and washing linen therein. By a proclamation dated 11th April 1854 made in pursuance of this power it was declared that certain tanks and wells enumerated in list No. 1 might be used for bathing or washing purposes, but that in those referred in list No. 2, bathing or washing of clothes would be allowed. In list No. 2 the two tanks are found described as "2 wells (circular) Framji Cowasji new town district, situation at the junction of the Grant and Duncan Roads in charge of the Superintendent of Repairs."

A fountain has now been erected on the spot and bears the following inscription :—

"This fountain was erected by the
Municipal Corporation of Bombay
in the year 1899
to mark the site of an old well
built partly from money bequeathed by
a person named Huslaji
and
partly at the expense of Government.
Water was supplied to this tank from
certain wells on the Mugbhat Estate of
the late Mr. Framji Cawasji Banaji."

Act XIV of 1856, Section 73, provides that all public tanks, reservoirs, cisterns, wells, acqueducts, conduits, tunnel, pipes, pumps and other water works existing &c. &c. shall be vested in and belong to the Commissioners (*i. e.* the Municipal Commissioners mentioned in the Act.)

Tanks, Wells &c., vested in the Municipal Commissioner.

Captain (afterwards Col.) Crawford submitted three projects :—

The first was to intercept the water of the stream which formerly took its rise near the village of Vehar, at a point

Reservoi r s at Kurla.

not far from Kurla. Here the water was to be pumped up and brought under pressure into Bombay by iron pipes. The dam was not to be built to retain any large quantity of water, but merely to give sufficient depth to pump from. This supply every year could last so long only as the stream continued to flow, or from the setting in of the monsoon up to about December. For the supply of the town during the other months a series of reservoirs were to be formed along the course of the stream above the dam, and as the stream dried up, the water in these reservoirs was to be led down to the lowest one where the pumps were to be placed.

An alternative scheme suggested by him was to drain the Kurla valley by a system of underground channels to the point where the water was to be pumped up.

His second project was to erect an engine at a favourable point on a Hill in the village of Vehar near Kurla (12th milestone from Bombay) and to convey water to Bombay by pipes. This project was estimated to cost £ 52,063.

His third project of 1850, was the raising of the water near Kurla by mechanical contrivances to the height of 80 feet. He considered it would be better to avoid the cost of pumping, to go higher up the stream and to build his Dam at a point 80 feet above the level of the Bund. If after a time the supply did not prove sufficient, he recommended that the construction of a series of Bunds still higher up the stream should be undertaken, and if even this failed to meet the demands of the Town, then the water in the lower part of the Valley should be utilized by the help of pumps.

In 1851, Lieut. De Lisle reported on Capt. Crawford's project. There is no doubt that the present works are merely the embodiment of Capt. Crawford's ideas. However this may be, Lieut. De Lisle's reservoir with a Dam of 50 feet high was to impound in round numbers 1,00,00,00,000 gallons and he proposed in the event of this supply not proving sufficient, to raise the Dam ten feet higher and thus to obtain double the above quantity. He assumed a yearly rainfall of 76 inches of which 16 inches would be lost by evaporation, absorption etc., and of which the remaining 60 inches would be available over an extent of gathering ground of seven square miles. On this

data the quantity of water flowing into and falling in the lake would amount to 6,00,00,00,000 gallons or 6 times the quantity required to be impounded by the 50 feet dam. The water was to be brought into the town under pressure by a cast iron pipe 24 inches in diameter, 14½ miles long and the whole cost of the work was calculated to be £ 1,20,000. There was no end of projects submitted, as there is a record of another one from Mr. Conybeare. He was of opinion that water obtained from surface collection being unfit for drinking until filtered, the springs in the littoral conglomunt formation in the Island should be made available to the Town. He proposed that wells should be built in the water bearing strata and that these wells should be connected by iron pipes with large reservoirs to be made in the solid strap underlying the superficial deposits. Mr. Conybeare proposed, that many of the tanks and reservoirs should be roofed over and that they should be supplied with water from filtering wells. He also suggested that spring bearing strata in Salsette should be thoroughly examined before recourse was had to surface collection.

The Board of Conservancy in forwarding Mr. Conybeare's report to Government took an altogether different view of the subject. They expressed doubts as to whether a sufficient quantity of water could be obtained in the Island in the manner proposed by him and they added that even if it could be obtained, it would require to be sent into the Town at great expense and from many sources. They were of opinion that none of the water in the public tanks excepting one could be considered wholesome that they were all more or less filled by drainage, at the best of times impure, and subject to the taint of a large town.

In 1855 Mr. Conybeare submitted his second report on the water supply of Bombay. It was on this report that action was at last taken, and that the Vehar Water Works were carried out. Forming part of Mr. Conybeare's project was a distributing scheme for carrying the water by iron pipes to nearly all parts of the Town. In most of the Districts the delivery was to be on the constant service system with all the modern conveniences of fire plugs, stand pipes, &c. The outlying Village were to be supplied by means of draw wells kept constantly full by

Vehar Water Works.

small stoneware pipes or masonry conduits, in which the water was to be admitted from time to time through sluices in the main pipe so arranged as to deliver the water without pressure. The total cost was estimated at £ 2,45,916 which amount, as it will hereafter appear, was considerably exceeded.

After Mr. Conybeare's project had been prepared it was submitted to Capt. Crawford and he on the 22nd April 1855 gave his general approval to the proposed works. Mr. Conybeare was then sent by Government to England where the designs for the outtet works were altered, and some modifications were made in the plans. The pipes were selected and sent out under his directions. He never returned to India. The contract was drawn up in England by the Hon'ble Court of Directors and was given by them to Messrs. Bray and sons and Champney, of Leeds. Mr. Walker was appointed Resident Engineer and Mr. Conybeare was made the referee for all disputes between the Government and the contractors. A great deal of correspondence took place between the Bench and Government as to the extent of the liability of the Bench in respect of the Vehar Water Works. In 1857 Government were distinctly informed that the Bench were not prepared to pay more than Rs. 25 Lacs for this purpose.

In 1856 (2nd December) Mr. Secretary Hart in a letter to the Justices stated "I am commanded to observe, H. M.'s Justices will recollect that the letting of earth works which had been deprecated both by the Government and the Bench has been let by the Honorable Court of Directors without reference to the Government of Bombay." In 1856 the Bombay Government stated to the Board of Directors that the Government of India had authorised the construction of the water works on the understanding that the total sum to be advanced will be Rs. 25 Lacs; if a greater outlay than Rs. 25 Lacs should appear to be requisite, the Bench to have an opportunity of considering the point of difference.

Author i't y for Construction of Water works.

On the 1st August 1856 Capt. Rivers informed the Bench that the earth work and masonry were let for £ 67,230 as against £ 17,411 Mr. Conybeare's estimate. That nearly £ 57,000 had been saved in the cost of the casting by reducing the size of the mains from 41 inches to 32 inches.

On the 15th October 1856, the Vehar water works Committee reported that over 33 lakhs had at that time been either spent or contracted for. In consequence of this a memorial was sent to the Secretary of State for India in Council urging that the excess over Rs. 25 Lacs be wholly borne by the Government of India, as it was caused by the acts of the Hon'ble Court of Directors who were regularly informed of the progress of the works under the management of Mr. West, yet they in opposition to the remonstrances of the Bombay Government and the Bench let the works in England at a ruinous price and made no stipulation for the payment of the actual outlay, whereby Rs. 73,645-8-0 were recklessly lost and handed over to the contractors. By Mr. Conybeare, the Bench and Board of Conservancy were regarded as obstructions and he took credit for having had the works let in England. The contracts were so drawn up that neither the Government, Bench, or Board of Conservancy had any control over the Contractor or his works. This was entrusted to a person wholly unfit for the office. Col. Crawford had stated that the whole of the work could have been completed for 25 Lacs of rupees and the local Government and Bench were restricted by the Acts of the Courts of Directors from any control over and from the letting of the works.

Besides this question, the subject of the injurious consequences likely to arise from conveying water by leaden pipes from the Vehar water works was considered, and Government was informed that the service pipes and cisterns for the conveyance and deposit of the Vehar water would be tinned inside.

In 1859 Government informed the Bench that in consequence of the representations which have been submitted against the use of leaden pipes, measures have been taken to obtain from England the necessary supply of tinned piping.

Introduction of Vehar Water in Bombay.

It was intended to introduce Vehar water into the Town in 1858, but as there was no urgent necessity for doing so, the water was brought in the year following.

In consequence of the low level of the surface of the lake at the expiration of the monsoon of 1871, it was found absolutely necessary to enforce every means of

Restricted supply of water in 1871.

preventing waste; the watering of roads by means of Vehar Water was for the most part stopped, public Urinal connections were removed altogether, and all irrigation services were cut off (unless the water was supplied through a meter), but notwithstanding all these precautions the low pressure in the main was most sensibly felt all over the Island; the water would not in most cases rise to the first floor, whereas in the preceding year it had gone up to the third. This together with rapidly decreasing quantity stored up in the Lake at Vehar, induced Dr. T. Blaney to make a proposition to the Bench that the Tulsi Valley should be considered as an auxiliary to Vehar, which was carried unanimously.

Dipping Wells in the City.

In the year 1871 there were 150 dipping wells, drinking fountains and stand pipes in the city. Thirty two handsome stone and iron drinking fountains was generously presented by Mr. Cowasji Jehangir Readymoney C. S. I. worth some Rs. 20,000 and these were erected at various convenient points in the Island.

Embankment No. 3 of the Vehar Lake was commenced by the Public Works Department, but was subsequently handed over to the Water Works Department of which Mr. Conybeare C. E. was the Consulting Engineer. For some reason or other this embankment was not made water tight as it never held water from the time the lake filled. The quantity which leaked at first was not sufficient to cause any serious uneasiness, but year after year, the leakage increased, until at last it became so serious that in 1865, Government appointed a committee of Military and Civil Engineers to report on the best remedial means to be adopted to stop the leakage. The Committee decided that the whole of the inside face of the dam, above low water, should be coated with two or three feet of puddle.

The work was completed before the rains of that year when the embankment was pronounced to be in a tolerably safe state. The cost was about Rs. 46,000.

Mr. Arthur Crawford, the Municipal Commissioner in his report of 1869 states:—

"As to the condition of the Vehar Water Works Department, I regret to be obliged to state, I found, to my great surprise, that it was not (if it ever has been) properly prepared for a serious job of this kind. There were no suitable appliances of

any kind. The only pulley block was the private property of Mr. Pyne, the Chief Inspector and was barely equal to lift one length of pipe, so we had to borrow a travelling crane from the Baroda Railway Company. The led smelting pots were so small that only one joint could be run at a time. There was no appliance for breaking up thick piping. Added to this I consider it unpardonable that for a very long time there was no proper reserve of branches and bends, as bends were in use, however improbably."

The question of affixing meters to economise the supply of Vehar Water was first considered in the year 1866. Every mill, factory and company was then forced to affix a meter. Meters were affixed to all Government connections. Every person using Vehar water for irrigation purposes was also forced to affix a meter. In the case of large chawls or tenant houses, where water was largely wasted, the use of meters was insisted upon. The result was very satisfactory.

Affixing of Meters.

In conseqnence of the affixing of meters to mills it was ascertained that the daily consumption of water in the year 1866 was 2,50,000 gallons or about 3 per cent of the entire water supply of Bombay at that time.

In 1868, Mr. Russel Aitkins, the Executive Engineer to the Municipality, in compliance with instructions from Mr. Arthur Crawford, the Municipal Commissioner submitted a report on the extension of the Bombay Water Works. In his report he proposed four different schemes for consideration. They were as follows :—

The Shewla Scheme.
The Kennery Scheme.
The Tulsi Scheme.

The Shewla scheme.
The Kennery scheme.
The Tulsi scheme.
and
The Pawai scheme.

The cost of the Shewla scheme was as follows :—

			Rs.
Reservoirs and Works	....	....	10,97,292
Steel main 56 miles long	....	....	1,24,78,611
Land	....	....	449,280
Total		....	1,40,25,183

The Kennery scheme provided for a total annual snpply of water of 4,201 million gallons.

The Tulsi scheme comprised of the construction of a dam in the River Tasso just below the village of Tulsi, whereby the waters of the upper portion of that river could be diverted into the Vehar Lake, which would thus having its gathering increased by 1,600 acres so that the supply from Vehar might be increased.

The Pawai scheme was to cost Rs. 85½ Lakhs. In forwarding Mr. Aitkins report to Government on 12th October 1868, the Municipal Commissioner said "I must reluctantly pronounce the construction of the Shewla scheme pecuniarily impossible to Bombay at present" and Mr. Crawford recommended the carrying out of the Kennery scheme at a cost of Rs. 41½ Lakhs.

The Pawai Scheme.

Government then appointed a Commission of the following gentlemen to take evidence and report on the water supply and the Drainage of Bombay :—

The Hon'ble A. R. Scoble, Chairman.
Col. W. Kendall.
Lieut. Col. J. S. Trevor.
Dr. W. G. Hunter M. R. C. P.

With reference to the former scheme, the duty of the Commission was to consider Mr. Russel Aitkins schemes for increasing the water supply and to report on their relative general advantages, and to examine and discuss the details of that which they might consider most suitable, should they be of opinion that either of them was calculated to effect satisfactorily the object in view.

The Commission considered the Shewla scheme to be too gigantic a work to be undertaken by the Municipality.

Of the Kennery and Pawai schemes, they said, "The Kennery and Pawai schemes are both open to the objection that they are mere patches upon Vehar and incapable of extension from time to time to meet the growing requirements of the city. The enormous height of the impounding dam at Kennery and the quantity of valuable land that would be submerged at Pawai, are additional reasons against the adoption of either of these projects ; and the Commission are of opinion that neither of them is calculated to effect satisfactorily the object in view."

To sum up the report of the Commission, they were of opinion that by greater economy of distribution and the addition of Tulsi Water much could be done to alle-

viate the evils of the scanty water supply of Bombay and that no time should be lost in securing a full and permanently reliable supply of water to the Town. Even with the addition of Tulsi the supply from Vehar would be sufficient only for an intermittent service, a minimum supply for domestic use, and an unreliable supply in case of fires. A continuous service, at full pressure, is what is required for Bombay, and Bombay should be satisfied with nothing else. This the Commission considered would be most securely obtained by a low level reservoir from which the water should be brought by a masonry conduit to Bombay and they recommended that surveys should be made without delay with a view to carrying out this proposal. With such a reservoir not only could the supply of water to Bombay be made to keep a head of any possible increase of the population, but all the water not required for Bombay might be made available for the service of the Towns, on the road, for the supply of Railways, and for Irrigation. In this point of view, the work might fairly he regarded as an Imperial work, and not one of a merely local Municipal character.

Government approved of Tulsi Scheme.

On this report of the Commission, Government on the 31st March 1870 issued a resolution rejecting the shewla scheme; that the construction of the Kennery and Pawai schemes would only be a half measure; and that a very substantial addition to the Vehar Lake, at an expenditure which is within the means of the Municipality might however, be made by the execution of Tulsi scheme and Government concurred with the Commission that this would be the best practical arrangement.

On receipt of this Government Resolution, the Municipal Commissioner took action and had a careful survey made of the Tulsi Valley.

In July 1870 the plans and estimates were ready, and the Bench of Justices then appointed a Committee composed of Major General Tremenheere, R. E., Mr. Ormiston, C. E., Mr. Lemesurier, C. E. and Dr Lyon, to report on the scheme.

This Committe came to the conclusion that not more than four gallons per diem per head of the population could be obtained from the Tulsi Valley and they estimated the cost of the work to secure this supply at Rs. 25

Lacs. On the general question of water supply they expressed themselves thus:—

"We are of opinion that Tulsi should not be undertaken unless it be shown conclusively that no better scheme is practicable. This has not been done yet; and we therefore recommend that in the first place the Kennery scheme be carefully worked out as soon as possible. To do this, it will be necessary to have an accurate contoured survey of the Valley &c. If while this is in progress, Capt. Tulloch can find another site more favourable, he should report on it."

In 1871, Mr. Rienzi Walton, the Executive Engineer was called upon to report on the capabilities of the Tulsi Valley.

Mr. Walton was of opinion that about 1,34,00,00,000 gallons yearly or 36,70,000 gallons daily could be obtained for use, this would be equivalent to 4½ gallons per head per diem during a 12 month for the supposed population at that time.

In his first project, Mr. Walton did not propose to impound any water for use in the Tulsi Valley but to throw the entire supply into the Vehar Lake. In his second project, it was proposed to impound water to such a height (64 feet) as to utilize the ridge of hills between Vehar and Tulsi as a Waste Weir so that the surplus water after the new reservoir became full, might pass into the Vehar Lake.

No. 3 project differed from No. 2 only in having higher dams (74 feet) and consequently increased storage.

Commencement of Tulsi Works.

In the year 1872, the Tulsi Water Works, as an addition or auxiliary to Vehar was commenced. The portion of the Tulsi Water Works necessary to divert the flow of the Tassoo river into Vehar *i. e.* the Dam across the Tassoo the open cutting and the tunnel under the dividing ridge, received the sanction of Government on the 25th March 1872 as per Government Resolution No. 1378.

The following is an extract of the Government Resolution:—"But there does not appear to be any objection to accede to the wish of the Justices to proceed at once with those parts of the scheme which have been agreed to *i. e.* Mr. Walton's Tassoo Dam and Mr. Walton's tunnel and channel, without, however, now undertaking any sluices, or arrangements for such, either in the tunnel or channel."

This work was sanctioned on 8th April 1872. The contract for it was given to Messrs. Scott McCelland and Co., and the work was commenced on Wednesday 10th April 1872 under the supervision of Mr. O. Deacon, Clark, Assoc. Inst. C. E., Acting Deputy Executive Municipal Engineer.

Application was made to Government for 5 lacs of Rupees. Government offered the Bench four laks only which amount is referred to in clause VII of Act II of 1872, for the purpose of providing a storage Reservoir at Tulsi.

Passing of Tulsi Water into Vehar Lake.

A large portion of the rainfall of the Tulsi Valley was passed into the Vehar Lake in the rains of 1872.

As the scheme then stood Tulsi was only an auxiliary to Vehar.

Tulsi Water supply.

It would be interesting to know that Mr. Russell Aitkin originally suggested in 1868, that the Tulsi Lake should be constructed as an auxiliary to Vehar, and Dr. Blaney in his letter dated 14th July 1869 proposed to make Tulsi an independent source of supply with a Dam 70 feet high and a 24 inch main from Tulsi 21 miles long. On the 4th December 1874, Mr. W. G. Peddar, the then Municipal Commissioner, forwarded to the Town Council, Mr. Waltons and his own final proposals for the Tulsi Water supply project, expressing a hope that a speedy decision may be come to by the Town Council and the Corporation.

The capacity of the Tulsi Lake was estimated at about 1,450 millions of gallons to distribute which, at the rate of 26 gallons per head per diem to a population of 1,50,000 a 20 inch main was considered necessary. The approximate cost of the whole scheme was estimated as under:—

Cost of Tulsi....	Rs.	5,70,000
Cost of Outlet Tower to Tulsi	,,	1,20,000
20 inch Main to Malabar Hill ...	,,	16,00,000
20 inch main from junction of Warden and Nepean Sea Roads to storage Reservoir	Rs.	20,000
Storage Reservoir	,,	1,00,000
Cost of 32 inch Main to connect Reservoir with 32 inch Vehar Main	Rs.	1,00,000
Carried forward	*Rs.*	25,10,000

Brought over Rs.		25,10,000
15 inch Main from top of Malabar Hill as far as Church Gate street.	Rs.	2,50,000
12 inch Main from Church Gate street to Middle Colaba	Rs.	85,000
9 inch Main from Middle Colaba to Light House	Rs.	37,000
Cost of catchment Drain at Vehar	,,	50,000
Cost of new outlet at Vehar....	,,	1,78,713
		31,10,713
10 per cent. contingencies	,,	3,11,071
Total	Rs.	34,21,784

The proposal of the Municipal Commissioner was on 16th January 1874 referred by the Works Committee for the professional opinion of a Committee consisting of Colonel Fife R. E., Wilson Bell Esq., and T. Ormiston Esq. C. E.

The following is the report of this Committee :—

" The Committee having previously met in Bombay, proceeded to Tulsi and Vehar on the 4th April for the purpose of examining the works already constructed at these places, and ascertaining as far as possible, by actual inspection, the nature of the ground and the difficulties to be contended with in carrying out the various proposals which have been made from time to time for rendering the reservoirs and the conveyance of the water to Bombay and its distribution as efficient as possible.

" The Committee on that occasion was accompanied by Mr. Walton the Executive Engineer to the Municipality and has since met on various occasions to discuss the subject and obtain as complete information on every point as practicable.

" The following are the conclusions at which the Committee has arrived on the principal point to which its attention was requested by the Commissioner.

" First.—That the Tulsi reservoir should be provided with an independent main 22 inches in diameter, to Bombay.

" Second.—That the Town supply from Tulsi should, as a rule, be passed in the first instance to a service reservoir on Malabar Hill, for convenience of distribution to the higher levels, but that a direct connection should be made between the Tulsi and Vehar mains at Grant Road, in order to admit of the Vehar distributing pipes receiving a supply of Tulsi water in the event of interruption in the Vehar supply.

Malabar Hill Service Reservoir.

" Third—The service Reservoir at Malabar Hill should be of the capacity of the smallest given in No. 3 Estimate (*i. e.* to contain one day's supply to 6,50,000 people at 17 gallons a head

—estimated cost Rs. 1,23,530) attached to the Executive Engineer's report, dated 1st April 1874.

"Fourth—The improvement to the water supply contemplated in Mr. Peddar's report, given in the Blue Book of 1873, can, with the modifications in the arrangements now recommended by the Committee be effected for about 40½ lakhs of rupees, exclusive of any charges which may be incurred for land."

Then the Committee entered into the details of how the figure of 40½ laks had been arrived at.—(see Blue Book issued on December 22nd 1874.)

In December 1874, Mr. Peddar the Municipal Commissioner, submitted for the consideration of the Town Council definite proposals for the completion of the Tulsi water supply, estimating the cost at Rs. 41,70,000, excluding Rs. 50,000, for catchment drains to increase the area of the gathering ground at Vehar.

In his annual report for 1875, the Municipal Commissioner stated:—

"No progress was made during the year with the Tulsi Works, the main dam having been raised to its full height, and it being impossible to go on with the rest of the work till the question of the manner in which the project should be completed was decided.

"I am glad to add that this is now the case. After long and careful discussion Mr. Walton's original designs for the work have been fully approved by the Government of Bombay and Government of India; the latter Government has agreed to advance the necessary funds on very liberal terms accepted by the Corporation; the work will now be pushed on as rapidly as possible and I hope there is a chance that it will be completed, and the Tulsi water brought into city, by the end of the hot weather of 1878.

"The long delay and vigorous criticism of a project finally accepted without modification has caused a loss of time which cannot but be regretted, as it has, delayed by at least a year, the much needed improvement of the water supply; but on the other hand, the advantage has been gained that the Corporation and the public will be fully convinced that the project adopted is a thoroughly sound one."

The Tulsi project included the construction of the Malabar Hill Reservoir.

Vehar Works, Tulsi Works, cost of.

To summarise the total cost of both the Vehar Water Works and the Tulsi Works they work out as under:—

Vehar Water Works	Rs.	45,42,394
Tulsi Water Works	,,	87,61,888

The Vehar water works is a debt charge which is paid by the Corporation to Government by monthly instalments of Rs. 14,600 the total debt is repayable by interest. Counsel's opinion on the subject will be found under that heading.

Capacity of Vehar Lake.

Vehar Lake.—Area of gathering ground 2,500 acres; No. of Dams 3; height of lowest draw-off on the T. H. D. 232·5; capacity available for supply when the lake is full 8,800 million gallons; amount of water available (in 1900) 4,400 million gallons; mean rain fall during past 38 years (ending 1900) 84·70 inches, and during past 7 years 97·10 inches. This is the first of the lakes constructed for the supply of the city, it was finished in 1860. The water is conveyed to the city by means of cast iron pipes of 24 inches and 32 inches in diameter laid generally above the level of the ground. The 24 inch pipe discharges directly into the distributing mains and the 32 inch into the Bhandarwada Reservoir.

Capacity of Tulsi Lake.

Tulsi Lake.—Area of gathering ground 1,385 acres; number of dams 2; height of lowest draw-off on the T. H. D. 400; capacity available for supply when the lake is full 2,306 million gallons; amount of water available (1900) 600 million gallons; mean rainfall during the past eighteen years (ending 1900) 103·82 inches; mean evaporation 36⅜ inches; rainfall (in 1900) 44·80 inches. This work was completed in 1879. The water is brought into the city by means of a cast iron pipe 24 inches in diameter, laid generally above the level of the ground and discharging into the Malabar Hill Reservoir.

Re-Payment of Tulsi Loan.

As regards the Tulsi Loan, the circumstances are different. Government advanced the Municipality Rs. 86 lacs (Act II of 1880 to amend Act II of 1872) bearing interest at the rate of Rs. 4½ per cent. The whole of this loan was paid off in the year 1893 by raising another loan in the open market @ Rs. 4 per cent thus effcting a saving to the Municipality of ½ per cent.

The Pawai scheme.

Even with the addition of Tulsi, the cry for more water did not abate, as ten years after its completion, the Standing Committee was presented with the following:—

"We certify that, having regard to the present state of the Vehar Lake, the probable replenishments thereof by means of average rainfalls and the quantity of water required for the increasing needs of the city, it is, to the best of our judgment

absolutely necessary that special measures should be taken to provide against an almost certain deficiency in the supply during the hot weather of 1892, and a possible deficiency during the hot weather of 1891; and we have elsewhere indicated the measures which in our opinion should be taken to guard against the evils which would be occasioned by the present lake supply running short in either of these years."

Anticipated deficient supply of water in 1891.

(Sd.) E. C. K. Ollivant.
,, S. Tomlinson.
18th November 1889. ,, W. Clerke.

The measures indicated in this certificate was the Pawai Valley Scheme by which it was intended to secure the water flowing from 1700 acres of ground forming part of the Pawai Estate and situated immediately to the South East of the Vehar Lake. There is a special report on the Pawai project which is available in either the Municipal Commissioner's office or the Water Works Department.

To briefly summarise the proposals, they were :—

1. The construction of a masonry dam with the top water level at 190 T. H. D. and the draw-off at 170 T. H. D. The capacity of the Reservoir to be approximately 580 millions of gallons and its area about 450 acres.

2. The provision of two Worthington Triple Expansion Pumping Engines with Babcock's Boiler. Each pump to be capable of lifting 4 millions of gallons per day 100 feet high.

3. The building of suitable houses for the protection of the machinery.

4. The laying of a 48 inch main to join the new dam, the pumping station, and the existing 32 inch Vehar main with connections to the Vehar 24 inch main, &c.

5. The acquisition of the gathering ground of 1950 acres with the huts &c. and timber thereon; also of the land on the west of the Vehar Saki Road required for the connections to the existing pipe lines.

6. The arrangement of the Pumping Station so that at any time, the additional supply in the Vehar main could be taken. A supplementary estimate was given amounting to Rs. 23,000 for works.

The advantage of this scheme is thus referred to in paragraph 36 of Mr. Tomlinson's report:—

"This pumping scheme has advantages over any gravitation in that the first cost is very much lower and the

second cost—fuel &c.—will only be incurred when the water is actually required, whereas the interest on capital invested must always be paid whether the water is needed or not."

The standing Committee at their meeting held on 20th November 1889 recommended the Corporation to sanction Mr. Tomlinson's scheme for bunding a water supply from Pawai into the Valley below the Vehar Dams, and of pumping the impounded water into the Vehar storage Reservoir and the mains leading therefrom at a cost of Rs. 4,55,000. This estimate was exclusive of cost of land to be submerged admeasuring about 500 acres.

The work was so urgent that within five days of the Standing Committee's recommendation the Corporation at a meeting of urgency sanctioned the project as recommended.

Subsequently a Committee of the Corporation was appointed to consider the question of the acquisition of the ground required, and that Committee reported that it was to the interest of the Municipality financially, that the whole area of 2,070 acres should be acquired. Accordingly the Corportion on 10th March 1890 sanctineod the recommendation of the Committee.

The Health Officer's opinion on the quality of the Pawai water is contained in the following report of his :—

Letter, dated 7th July 1890 to the Commissioner, as under :—

Quality of Pawai water.

SIR,—I have the honor to submit an opinion on the quality of the water from Pawai and the Goper dam. The water is of better quality than was expected. I ascribe this to :—

(*a*)—The heavy rainfall.

(*b*)—The use of the sludge pipe.

(*c*)—The precautions taken before the rains to remove causes of impurity.

My last examinations show the water to be of fair quality judged by the standards of Vehar and Tulsi.

		Parts per million,
Pawai—Free amonia	... ...	·04
Albuminoid ammonia	... ...	·13
Goper— Free ammonia	... ...	·35
Albuminoid ammonia	... ...	·15

In my judgment the water may be distributed.—T. S. WEIR, Health Officer.

The following is the capacity of the Pawai Reservoir:— Capacity of Pawai Reservoir.

Gathering ground above Lake...	...	1334 acres.
Overflow level of Reservoir ...	...	190 T. H. D.
Level of lowest Inlet to Tower	...	165 T. H. D.
Capacity of overflow level ...	...	696 Mills Gallons.
Area of water at overflow level	...	366 Acres.

Area of gathering ground 1235 acres; 1 Dam; height of lowest draw-off on T. H. D. 165·0 ; capacity available for supply when the lake is full, 696 million gallons; amount of water available (1900) practically all; rainfall in 1900, 32·97 inches; evaporation, probably the same as Vehar. This may be termed an emergency reservoir, having been constructed to mitigate an anticipated water famine in 1891 before Tansa water was introduced. There is a pumping station in connection with this supply, as the lake is at too low a level to permit of the water gravitating into the city at a sufficient pressure to ensure a proper supply.

The Standing Committee visited the Pawai Lake and their minute will be found on the proceedings of 14th May 1890. Visit of the Standing Committee to Pawai Lake.

The Pawai scheme had a short and a merry life.

The engines were offered for sale in 1892 but as there were no purchasers they were, dismantled.

The Tansa scheme was first started in connection with a notice of motion from Dr. Blaney which was as under :— Tansa scheme.

" That the water supply available from the Vehar and Tulsi storage reservoirs being insufficient for the present ordinary domestic wants of the city apart from its trades, industries, sewerage system and increasing population, it is desirable to provide an additional and permanent supply from a high level source which will give the city a continuous service at full pressure, and that the Municipal Commissioner be requested to furnish the Corporation with a scheme for such increased water supply."

On the motion of Dr. Blaney seconded by Mr. M. N. Banaji the Commissioner was asked to state what sum would be necessary to prepare working plans of Tansa.

Mr. (Now Sir Charles) Ollivant then reported stating that the total cost including one lakh for survey would amount to one crore.

The Town Council accepted the Commissioner's opinion which was forwarded to the Corporation with Mr. Ollivant's

suggestion that Major Tulloch should be invited to carry out the scheme.

The Commissioner's report was referred to the Finance Committee.

It was as under :—

No. 2904 OF 1884—85.

TO THE SECRETARY, TOWN COUNCIL.

SIR,—I have the honour to inform the Town Council, with reference to their Resolution No. 339, dated 28th May 1884, and the Resolution of the Corporation No. 1087 of the 10th August 1883, as I have already stated verbally, that no advantage is likely to be gained by waiting for the elaboration of some new scheme of water-supply for Bombay. In my absence Dr. Weir asked the Engineers for certain information, which has still to be supplied ; but the fact is that short of the execution of detailed surveys and the preparation of contract plans, Major Tulloch's excellent treatise on the water-supply of Bombay gives all the information that is necessary for a preliminary consideration of the subjects.

2. I have elsewhere incidentally given my reasons for thinking that for the *present* population an additional minimum supply of eight million gallons per diem should be obtained. But in determining what the source or means of supply should be, the wants of the future as well as of the present must be borne in mind. Members of the Town Council and Corporation who have read Major Tulloch's book must be aware that in the opinion of that able officer if any new lake supply is to be resorted to, the Tansa scheme is the one which should be preferred.

3. I say nothing here about Artesian wells, for in speaking and writing I have already expressed my views on that subject, and have made a reference to Government in terms already reported to the Town Council. Assuming that a lake supply giving a minimum of eight million gallons per diem is to be obtained, and that Tansa is the lake to be chosen, I have to point out that the first step which must be taken towards arriving at an accurate estimate of the probable cost of the work is to make provision for a complete detailed survey. As far as I have been able to form an opinion from information supplied to me the outside cost of such a survey (including the preparation of contract plans and specifications) would not be more than one lakh of rupees.

4. But it would be useless to enter upon such a proceeding as this, or to incur any expenditure in connection therewith, unless the Corporation saw their way to carry out the work upon completion of the preliminaries, provided these preliminaries should satisfy them that the project could be carried out within a certain given cost. For present purposes I may assume that

the total cost (including the one lakh for survey operations) would amount to one kror of rupees. It certainly is not likely to be more.

5. To pay off a kror of rupees, principal and interest in 40 years, (interest at five per cent.), an annual appropriation of six lakhs would be necessary. Assuming that nothing will be available for this purpose out of present sources of revenue, I will ask the Town Council to consider how financial provision can best be made.

6. The consolidated rate is now at the minimum fixed by law, *viz.*, 8 per cent.; if raised to the maximum, *viz.*, 12 per cent., the difference would yield six lakhs per annum.

7. The present revenue from water is six lakhs per annum, and the present daily supply may be estimated at 20 gallons per head of population, though in fact it is less. With an addition of 10 gallons per head, we should, at a proportionate increase of revenue, receive Three Lakhs more. I think that this increase may reasonably be expected, partly from the extra quantity available for supply on measurement and partly from a revision of the present scale of water rates.

3 Lakhs.

8. If the present Town Duty on ghee were raised from 6 annas per Bombay maund to 10 annas per Bombay maund (the present legal limit), the increase in revenue would be Rs. 80,000. If one per cent. extra were levied on sugar and one anna extra per candy on firewood and one anna extra per candy on grain the increase in revenue would be Rs. 50,000, Rs. 40,000 and Rs. 30,000 respectively, or Rs. 1,20,000 in all; but the sanction of the legislature would be necessary to all or any of the three last named enhancements.

2 Lakhs.

9. Government might be asked in view of the object to be attained, and the great effort which it must entail on the city, to revise the sum now paid as Abkari compensation, and to raise this sum to an amount corresponding with the Abkari revenue actually collected. This concession would benefit the Municipality to the extent of half a lakh annually. As an alternative, Government might possibly be disposed to advance to the Municipality the total sum required at 4½ per cent., or half per cent. less than the Municipality might expect to pay by borrowing in the open market. The annual payments would thus be reduced by half a lakh of rupees.

½ Lakh.

10. Application might be made to the legislature on the Municipal Act being amended to sanction the imposition of a special fire rate, which on an average of Rs. 2 per house (though in fact it would be graduated) would amount to at least half a lakh of rupees. For measures against fire, expenditure could not be more appropriately incurred than in improving the

water-supply. Or in lieu of this, and of one half of the increases suggested in my eighth paragraph, an addition of one per cent. might be made to the Consolidated Rate. Such addition would yield one and a half lakhs of rupees per annum.

11. With this brief sketch before them the Town Council will be in a better position to consider what is the best course financially to recommend to the Corporation. Until the question of finance has been considered and disposed of no practical steps can be taken by the Executive. If it be determined that funds are to be provided and the work proceeded with I should strongly advocate the creation of a distinct fund to be called the Tansa Fund, to which any revenue from extra taxation should be credited. Adjustment could then be made from time to time, and people would know exactly what they were getting for their money.

12. As far as I can ascertain the surveys, &c., might be expected to occupy two years and the work four more. I think that in the first instance Major Tulloch should be given the option of carrying out the schome from beginning to end, if his services can be spared.—I have, &c.

E. C. K. OLLIVANT
Municipal Commissioner.

On the motion of Dr. Peterson seconded by Dossabhoy Framji Esquire :—

It was proposed to accept the Committee's recommendations with regard to the first sum of Rs. 3 lacs. To postpone the consideration of the other proposals and to recommend the Corporation to sanction a grant of Rs. 10,00,000 for the purpose of preparing plans.

An amendment by Mr. G. Geary seconded by Dr. Blaney was carried to the effect that the report of the Finance Committee be forwarded to the Corporation with a recommendation to sanction Rs. 1,00,000 for the survey. The Corporation thereupon sanctioned Rs. 1,00,000 for the survey.

On the 19th November 1885, on the motion of Dr. Blaney sanction of the Corporation was accorded to the Tansa water scheme for a daily supply of 17 million gallons, at a cost of Rs. 1,23,00,000 and the Municipal Commissioner was requested, to solicit the sanction of Government for raising a loan of the said amount and to request that if possible Government itself would be pleased to advance the contemplated loan as well as to lengthen the time of the repayment of the remaining portion of the

Vehar debt so that it may extend over the period during which the proposed Tansa debt was to run.

On the 10th December of the same year, the Corporation proceeded to consider the Town Council's recommendations for the carrying out of the Tansa Water Works. They sanctioned an increase of 12 annas per cent. in the consolidated rate. The Town Duty on ghee was raised from 6 to 10 annas per Bombay maund. Government was asked to legislate with a view to provide a Town Duty on Sugar of 8 annas per cwt. instead of a duty of 1½ per cent. on tariff value ; and to modify the schedule of Town Duties so that the maximum duty on grain of all sorts may stand at 6 annas per candy instead of 4 annas. On the same day on the motion of Dr. Blaney the Corporation sanctioned an advance of Rs. 3 lacs from Cash Balance for the commencement of work to be subsequently replaced from the loan.

On the 23rd December 1885 the Commissioner was authorized to enter into a contract with a Testing Officer in England for the testing of the iron works required for the Tansa Water Works and to engage the services of Mr. MacEwen for the construction of a road from the line of the G. I. P. Railway to the site of the Lake.

On the 13th January 1886 the Corporation accepted the tender of Messrs. T. Glover & Co., for the excavation of the foundation and the construction of the masonry dam at Tansa. The work commenced on the 18th of the same month, and made good progress before a month was over.

Meanwhile on the 12th February 1886, a reply was received to the communication made to Government by the Municipal Commissioner regarding the Tansa Water Works Loan. The Government of India, though fully recognising the great benefits to be anticipated from a scheme such as that proposed, regretted that the resources at their disposal were not sufficient to permit the grant of a loan, and suggested that the necessary funds might be borrowed under the provisions of the Local Authorities Loan Act. Consequently the Town Council requested the Finance Committee to report on the best means of raising the new loan. The Committee were of opinion:—

(1) That the Corporation should be advised to make a further representation to the Government of India, and if necessary, to the Secretary of State, with a view to induce the Government of India either to raise or guarantee the loan required. (2) That the attention of Government should be drawn to the fact that no answer has been given to the request of the Corporation regarding the extension of the period for the repayment of the remaining Vehar debt. (3) That Government should be asked to expedite the legislation necessary to give effect to the wishes of the Corporation as to raising additional revenue for meeting the required revenue. (4) That no time should be lost in obtaiuing the required sanction from Government to raise such portion of the whole loan (not exceeding 17 lacs) as is necessary to prosecute the work up to the monsoon of 1887.

This was adopted by the Town Council.

The Municipal Commissioner addressed Government accordingly and the requisite sanction was given to raise the loan under the Local Authorities Loan Act. A letter from Government was received later on informing the Corporation that the Governor-General in Council regretted that they did not feel justified in modifying the existing arrangements for the repayment of the loan for the Vehar Water Works.

On the 5th April 1886, the Corporation, believing it to be most important to the interest of the City, that the Government of India should lend its assistance in raising or guaranteeing the loan required for carrying out the Tansa scheme for increasing the water supply of the City, decided to make a fresh representation to the Government of India, and if necessary to make an application to the Secretary of State for India on behalf of the City and appointed a Committee to draw up a memorial. An able memorial was duly drawn up and was adopted by the Corporation on the 28th May 1886.

A reply to the memorial was received in October of the same year, to the effect that the Government of India could neither lend nor guarantee the loan required for the Tansa Water Works, but the Governor General in Council, however, was willing to extend the term for the repayment of the Vehar Water Works Loan. Thus ended the effort to get a loan from the Government of India.

The construction of the Tansa Dam was entrusted to Messrs. Glover & Co., as mentioned before. The Pipes required were supplied by Messrs. Macfarlane Strang & Co. There remained only one large contract to let for the completion of the Tansa project, namely the construction of the Tansa Duct from the Tansa Dam to Ghat Kooper, and this work consisted of (1) Tunnels and conduits (2) Pipe-track and pipe laying (3) Bassein Creek Bridges. Out of 3 tenders received for this work, that of Messrs. Walsh, Lovett, Mitchell & Co., being lowest was accepted on 28th July 1886, by the Town Council at a a total cost of Rs. 42,00,000 together with a bonus of Rs. 8,000 for each month (but not exceeding Rs. 60,000), by which the date of actual completion of the 3 tunnels should precede the 1st January 1891. The only work which then remained to be provided for, was the continuation of the main from Kurla to such point or points as may be determined upon, for which purpose Rs. 3,00,000 were reserved.

For the next year and a half the Tansa Water Works made good progress. But in April 1888 a new and unforeseen difficulty arose. Out of the total loan of 123 lacs required for the Tansa project, the Commissioner had already raised, from time to time with the sanction of the Government of India, a loan of 47 lacs running for a period of 60 years. Early in the year 1888, the Comissioner was making preparation for raising a further loan of 25 lacs, when, on the 19th April of the same year, a letter was received from the Government of India refusing to sanction the issue of any more debentures for the term of 60 years, and directing that for the future no loan was to be raised by the Municipality for a longer period than 40 years. The Corporation were taken with surprise. But this was not all. The Government of India, in a later communication, intimated their sanction to raise the loan of 25 lacs, subject however to the condition that an annual amount be set aside by way of Sinking Fund *sufficient for the repayment of the present loan, together with the former loans of 17 and 30 lacs in 40 years from the 1st January 1893.*

Period of loan.

Before the receipt of the last mentioned communication, the Corporation had appointed a Committee to draft a memorial to be submitted to Her Majesty's Secretary of

State in Council of India. A suitable memorial, showing the inconsistency and inexpediency of the procedure of the Government of India, with regard to the raising of the remaining portion of the Tansa Water Works Loan, was submitted to the Corporation on the 9th August 1888. With reference to the last communication from the Government of India a Postscriptum was added to the memorial protesting against any change being made in the term of the loan already issued. The memorial was then adopted and forwarded to the Government of India for submission to the Right Hon'ble Viscount Cross G. C. B. the then Secretary of State. A reply from the Government of India acknowledging the receipt of the memorial, intimated with reference to the Postscritum, that the Government on reconsideration decided to withdraw the condition imposed as to the term of 40 years for the repayment of the 47 lacs loans. Early in the year 1889 a reply to the memorial was received. The Secretary of State in a despatch to H. E. the Governor General of India, declared that after careful consideration of the memorial he was unable to see any sufficient reason for a modification of the orders issued by the Government of India.

A final attempt to get the orders of the Government of India changed with regard to the term prescribed for the Tansa loans to run, was made on the 22nd December 1890, when on the motion of Dr. T. Blaney a deputation of the Corporation was appointed to wait on His Excellency the Viceroy for the purpose of pointing out the hardship inflicted on the Corporation by the resolution of the Government of India, which restricted the period of the currency of the Tansa Water Works Loan to 40 years, and of soliciting that an extension of the period to 100 or 80 years might be granted. The President was requested to communicate with the Private Secretary to His Excellency the Viceroy, requesting that the deputation may be received on any day in February next, which may be convenient to His Excellency. The Private Secretary informed the Corporation that the Viceroy was unwilling to receive the deputation as in the opinion of His Excellency, the deputation was not likely in the course of an interview to throw such additional light upon the question as would be commensurate with the expenditure of money, time and trouble which would be involved. Should the

Corporation be of opinion that they could support their contention by arguments not hitherto brought to the notice of the Government of India, it was open to them to make such fresh representations as they may consider pertinent, through the Bombay Government. The Corporation were further informed that the question had been fully and carefully considered and dealt with by the Government of India, in accordance with a policy deliberately adopted several years ago.

Thus a further representation to the Government of India on the subject was futile and the Bombay Municipality was left to struggle on with the Tansa project as best it could.

Cost of Tansa Water Works.

The total cost of the Tansa scheme was Rs. 1,50,00,000.

Opening of the Tansa Works.

The Tansa Water Works was opened by Lord Lansdowne on the 31st March 1892.

Memorial Archway at Tansa.

The following inscription was put upon a memorial archway at Tansa :—

" The Tansa Water Works, estimated to supply the City of Bombay with 21 millions of gallons of water per diem, through a duct 55 miles in length, from a lake 6 square miles in area, were first designed and reported on by Major Hector Tulloch, R.E., Executive Engineer of the Municipality in 1872.

" They were undertaken in pursuance of a resolution moved by Dr. Thomas Blaney, and passed by the Corporation on the 10th August 1883 during the Commissionership of Mr. E. C. K. Ollivant (now K. C. I. E.) and Mr. W. J. B. Clerke, (now C. I. E.), being the Engineer.

" They were completed at a cost of Rs. 1,50,00,000 during the time that Mr. H. A. Acworth, C. S., held the office of Commissioner.

" And were opened by H. E. the Marquis of Lansdowne, G. C. M. G., G. M. S. I. E., G. M. I. E., Viceroy and Governor General of India, on 31st March 1892.

"The Contractors were:—for the Dam Works, Messrs. T. Glover & Co., for the Duct line, Messrs. Walsh, Lovett, Mitchell & Co."

Contractors for the Tansa Works.

In recognition of Mr. Clerke's services in bringing to a successful termination the Tansa Water Works the Corporation voted a sum of money for presentation to him of a suitable silver plate with an inscription thereon. He was also made a C. I. E. by Government. Mr. (now Sir Charles) Ollivant was Municipal Commissioner throughout the construction of this gigantic work immediately after the opening of which he was Knighted.

Cost of Malabar Hill Reservoir.

The original cost of the construction of the Malabar Hill Reservoir was Rs. 7,09,661 while the estimated value at present is Rs. 10,84,863.

Cost of Bhandarwada Reservoir.

The present cost of the Bhandarvada Reservoir is estimated at Rs. 11,90,540.

Tulsi Forest.

A proposal to transfer the Tulsi Forest to Government was accepted by Government under their Resolution No. 4762, Revenue Department dated 1st June 1894.

Mr. Santo Crimp's Report on the water Supply. Commissioner's Report thereon.

Mr. Santo Crimp, submitted the following Report on the Water supply :—

Subject.

" In accordance with the request of the Corporation, I have the honour to report upon the question of the Water-Supply of the City and Island.

Inspections.

2. In order to make myself acquainted with the existing sources of supply, I have inspected all the lakes, a large proportion of the supply mains and conduits, the filter beds, and the settling basins and distributing reservoirs.

Plans.

3. I have also had placed at my disposal a large number of plans, reports, and other documents relating to the subject.

Projects.

4. I have also carefully considered the projects for the improvement of the supply now under the consideration of the Corporation.

Tansa especially good.

5. In order to elucidate the subject, it is necessary to describe as briefly as is consistent with accuracy, the existing works. I do not propose to offer any criticisms on projects that have been carried out in the past, when the information available was scanty and not perhaps always reliable. Indeed, I think, the great Tansa scheme is one that reflects the greatest credit upon all concerned in its inception and execution. It is a work of which the Bombay Municipality may be justly proud. At the same time in a year like the present, when, by reason of the failure of the monsoon, lakes Vehar and Tulsi are even now much depleted of water, and a water-famine—if not complete—at least partial must be faced during the coming year, one cannot but regretfully contemplate the fact that although the water in great abundance is stored in Tansa lake, it is beyond the reach of those requiring it in Bombay, except to the limited extent of some 21 million gallons daily.

Development of Tansa supply.

6. It will be inferred from these remarks that I consider the development of the Tansa supply a matter of pressing importance, and the future policy of the Corporation with regard to water-supply should be directed to that end. I am aware that works in connection with the up-keep and maintenance of the other sources of supply must be carried out from time to time, but in

laying out large new works in connection with the distribution of the water within the Island, the question should always be asked—does this proposal further the development of the Tansa supply?

Descriptive.

7. It is desirable now to give a short description of the existing lakes and conduits and other works; the information is already in the possession of the Corporation, but it is difficult to present an intelligible report without a brief summary for reference.

Vehar Lake.

8. *Vehar Lake.*—Area of gathering ground, 2,500 acres; number of dams, 3; height of lowest draw-off on the T. H. D., 232·5; capacity available for supply when the lake is full, 8,800 million gallons, amount of water available now, 4,400 million gallons; mean rainfall during past thirty-eight years, 84·70 inches; mean evaporation, 36⅝ inches; rainfall this year, 36·26 inches. This is the first of the lakes constructed for the supply of the City; it was finished in 1860. The water is conveyed to the City by means of cast-iron pipes of 24 inches and 32 inches in diameter laid generally above the level of the ground. The 24 inches pipe discharges directly into the distribution mains; the 32 inches into the Bhandarwada Reservoir.

Tulsi Lake.

9. *Tulsi Lake.*—Area of gathering ground, 1,385 acres; number of dams, 2; height of lowest draw-off on the T. H. D., 400; capacity available for supply when the lake is full 2,306 million gallons; amount of water available now, 600 million gallons; mean rainfall during past eighteen years, 103·82 inches; mean evaporation, 36⅝ inches; rainfall this year, 44·80 inches; this work was completed in 1879. The water is brought into the City by means of a cast-iron pipe, 24 inches in diameter, laid generally above the level of the ground, and discharging into the Malabar Hill Reservoir.

Pawai Lake.

10. *Pawai Lake.*—Area of gathering ground, 1,235 acres; number of dams, 1; height of lowest draw-off on T. H. D., 165·0; capacity available for supply when the lake is full, 696 million gallons; amount of water available now, practically all; rainfall this year, 32·97 inches; evaporation probably the same as Vehar. This may be termed an emergency reservoir, having been constructed to mitigate an anticipated water-famine in 1891 before Tansa water was introduced. There is a pumping station in connection with this supply, as the lake is at too low a level to permit of the water gravitating into the City at a sufficient pressure to ensure a proper supply. I understand the water of this lake will shortly be used for industrial purposes. The lake is much too shallow to permit of good water for domestic purposes being obtained.

Tansa Lake.

11. *Tansa Lake.*—Area of gathering ground, 33,600 acres; number of dams, 1; height of lowest draw-off on the T. H. D., 380 feet; capacity available for supply when the lake is full, 18,600 million gallons; amount of water available now 14,940

million gallons; mean rainfall during past seven years, 108·66 inches; (Vehar during same period 97·10 inches); rainfall this year, 40·07 inches; evaporation about 8 feet. The water is brought into the City by means of a masonry conduit as far as practicable. The syphons across the valleys are of cast-iron pipes, 48 inches in diameter, laid generally upon the surface of the ground.

Rainfall.

12. With regard to the rainfall, it ought to be noted for the guidance of those who may in the future design works in other places upon the Bombay basis, that the position of the gauge at Tansa is on the lowest part of the catchment area, namely at the dam; and, under these circumstances, it is highly probable that the average rainfall upon the gathering ground is greater than that indicated by the gauge, for, as a rule, rainfall increases with elevation. The Tulsi rain-gauge is at an elevation of 468 feet T. H. D., and is placed at a bungalow about the centre of the gathering ground, and possibly gives an average result for that catchment area. The effect of elevation is clearly shown when comparing these three cases:—Tulsi lake, elevation of gauge, 468 T. H. D.; average rainfall during past seven years, 117·05 inches. Tansa Lake, elevation of gauge, 435 T. H. D.; average rainfall during past seven years, 108·66 inches. Vehar Lake, average elevation of gauges, 350 T. H. D.; average rainfall during past seven years, 97·10 inches.

Temperature.

13. It is of interest to note that there is not a material rise of temperature in the water passing from lakes Vehar and Tulsi to the service reservoirs in the City. The maximum summer temperature of the lakes is about 88° and the rise of temperature is about one degree only.

Capacity of Mains.

14. With regard to the capacity of the various conduits and supply mains, that from Tulsi can convey more water than the lakes can furnish in a dry season such as that now being experienced; but the Tansa conduit is a composite construction, whilst the masonry portion can convey water to Ghat Cooper at the rate of 40 million gallons per day, the supply actually available is that which can pass through the cast-iron syphons above that place, and these cannot discharge more than 21½ million gallons per day. It should be noted that all cast-iron mains lose carrying capacity with age, in consequence of rust.

Quality of Water.

15. The quality of these various waters may next be touched upon as leading to the question of filtration, but I do not propose to encroach upon the domain of the bacteriologist, I shall merely deal with the subject from the engineer's point of view, that is to say, as relates to the general design and working of the filters. But before discussing this subject, I have assertained that Tansa water is of such excellent quality as to need no filtration; that Vehar water comes next in quality, and Tulsi last, but that these waters need filtration must be obvious to any one who inspects the lakes, the water

containing very large quantities of suspended matter of vegetable origin. Further, with regard to Vehar, I was much concerned on observing the immense amount of vegetation growing in the water at the northern portion of the lake where the water is comparatively shallow. I fear that unless the removal of this vegetation is at once undertaken, the conditions of 1865 will be reproduced, when in May the water was said to be "thick with vegetable matter and offensive to taste and smell"—(Blaney). The same authority stated that the death-rate during that month rose to twice the average. Three remedies were proposed by Dr. Leith's Committee, formed to deal with this matter:—

Remedies.

(*a*) To remove as effectually as possible the existing rank vegetation. The theory of this process is that a new and active growth will spring up, during the rapid spread of which organized oxygen will be freely liberated, with the power of oxidising or fixing any existing impure or noxious matter.

(*b*) To provide extensions of the sand-bed filter for use in dry months.

(*c*) To introduce some weed of unusually rapid growth to act as ordinary new vegetation, &c.

I venture to think the last remedy suggested would be worse than the disease.

Vegetable Matter in Tansa.

16. I observed, when on the Tansa Lake, that there were quantities of suspended particles of vegetable origin in the water, and it is a matter that should receive the careful attention of the Corporation; for, if this matter is increasing in quantity, it may well be that the time will arrive when it will become necessary to filter the water.

17. This last consideration should be one of the factors in determining the volumes to be discharged at the service reservoirs, in developing the Tansa supply, because the areas available at the proper elevations in Bombay for the construction of filter-beds is very limited.

Filtration.

18. With regard to the rate at which water should be filtered, this is a matter purely of experience. As the suspended matters accumulate upon the surface of the filters, the rate falls off, until finally the surface must be skimmed, and the filters are then re-started. Obviously, therefore, the amount that can be effectively filtered by any given filter depends upon the amount of suspended matter to be removed. It is of little practical use to compare the great London filters with those of Bombay, because much of the London supply is derived from rivers which are frequently turbid. I am informed that at Bombay, the experience already gained suggests a limit of about 500 gallons per square yard per day, allowing for filters

out of work, and that limit is quite consistent with what one would expect under the circumstances and should be adopted tentatively in the design of new works. The Berlin supply is derived from lake Muggel, it is filtered, and the maximum rate is fixed at 440 gallons per yard per day.

Settling Tanks.

19. Before the water received at Malabar Hill is filtered, it is passed through a settling tank, which permits of some of the suspended matters to settle, thus relieving the filters of part of the work, but settling tanks are not to be commended, because the organic matters thus intercepted become decomposed and might deteriorate the quality of the water. The settled water is then in part passed through the filters, and is received in distributing reservoirs and passes finally into the supply mains.

Tansa supply direct.

20. The Tansa water, however, is not discharged into the reservoirs, but the supply main is connected directly with the distributing mains.

Distributing Mains.

21. The distributing mains are laid in accordance with the usual practice, but are naturally not as well proportioned as would be the case if the City had been supplied from the great main source in the first instance. This circumstance, however, is not peculiar to Bombay. It is possibly true of every great progressive city in the world; my firm have certainly had to advise on many similar cases.

House Supplies.

22. The supply to the houses is in some cases laid on to every floor; in others a stand pipe with one or more taps is placed at a convenient point in the street from which groups of houses are supplied. There are also meters in many cases, about 11½ per cent. of the water being thus measured, the revenue from which amounts to upwards of 50 per cent. of the whole.

Quality necessary.

23. We may next consider the question of the amount of water necessary for a city like Bombay. We have, in addition, to the demand of the people themselves, other requirements to meet. These are mainly in connection with manufactories and trades; bullocks, horses, and other animals; and general sanitary purposes such as road-watering, sewer-flushing, &c. A comparatively small quantity is also supplied to the shipping using the Port. From meter observations in Bombay, taken during recent years, we know that the consumption by human beings varies from 8 gallons to 15 gallons per head per day, and averages 12 gallons. Therefore, the present population of 8,21,000 require about 10 million gallons per day. We may add for the other requirements mentioned 4½ million gallons in round figures, or a total of 14½ million gallons. But there must be some waste even in a perfect system, and more water is used in the hot season than in the cold. Therefore we may adopt 20 million gallons per day as a safe basis for Bombay for the hot weather requirements of the present population.

24. I have before me details relating to other Indian Towns namely :— Other Indian Towns.

Average consumption in gallons per head per day.

Madras	11·80	Portion of town badly supplied.
Poona Cantonment	18·00	Warm weather.
" " ...	11·00	Cold weather.
Nagpur	7·50	
Trichinopoly ...	8·00	
Tanjore	7·50	
Madura	7·15	

Obviously each town takes what it wants for its own particular requirements. Moreover, with regard to Madras the supply is admittedly defective; we do not know that the other towns are perfectly supplied.

The average amount of water delivered in the Island is, however, no less than 35 million gallons daily, of which I am of opinion 15 million gallons are preventable waste, leading to a loss in many directions; water is lost, pressure is lost, there is a great deal more sewage to be pumped, and generally the works are lessened in efficiency. It is quite consistent with the facts of the case to say that practically the whole of the water supplied by Tulsi and by Vehar is wasted. My frequent inspections of the city lead me to believe that nearly all this is due to leaky taps and services and to the habit many persons have of leaving the taps open. Of course, if they see a leaky tap wasting water, they will not trouble to close a sound one. In the meantime they are being educated to waste, rather than to conserve the water. I think one step in the right direction would be for the Corporation to insist upon all taps being of an approved pattern of the best quality. Waste.

25. Now I have shown that the reserves in the various lakes amount to 19,940 million gallons at the present time. There is, therefore, sufficient for 997 days' supply if the water could be properly distributed, and fairly used, and waste prevented. Reserves.

26. Much however is wasted, and the remainder is not properly distributed, because the Tansa water and part of Vehar water is not discharged into a distribution reservoir, but directly into the distributing mains.

27. With regard to the necessity for discharging the water from the impounding reservoirs into "balancing" or distributing reservoirs, the full discharging capacity of a supply main can be obtained in that way only. The draught upon the service mains is very variable throughout the daily period of 24 hours, and is, during the period of maximum demand, rather more than twice the average. I have before me a diagram showing the hourly draught upon an ordinary constant supply service main in Bombay, which shows that from noon to 4 p. m., the supply is about the mean, there is then a steady increase in the demand until 6-30 p. m., when it begins to decline, reaching the average Necessity for service reservoirs.

at 7-30 p. m. and steadily declining until the minimum which is less than one-tenth of the maximum is reached at 2 a. m. There is then little variation until 4-30 a.m. when there is a sharp rise, the average rate being reached at 5-30 a. m. and the maximum at 8-30 a. m., when, as before stated, the demand is upwards of double the mean. This continues for about two hours, when there is a steady decline.

Very large mains wanted if service reservoirs not provided.

28. It is obvious, therefore, that if the supply is to be maintained at an effective pressure, without the aid of balancing reservoirs, this desirable object can only be accomplished by means of supply mains of twice the size of those necessary when balancing reservoirs are employed, and then during many hours of the night these mains would be for all practicable purposes dead. The system is opposed to all modern practice, and cannot be defended. Let us consider this from another point of view: the Tansa main can bring into the City 21½ million gallons per 24 hours, but the demand upon this main during the hours of maximum supply is double, or 43 million gallons.

The main cannot furnish this volume, and as a result the water is drawn-off during the periods of maximum demand at the lower levels only, leaving the upper floors of the higher buildings depleted of water. There is practically no control, and even the limited control obtainable by means of valves upon the mains is fraught with danger, because of the shock resulting from arresting the momentum of the water in the large supply mains, when the valves are shut, which sooner or later leads to bursts, with their attendant risks and inconveniences. That most desirable want, constant supply at high pressure, is impossible under such circumstances.

Constant supply.

29. The advantages of a constant supply are now so well understood that I purpose to touch upon the subject very shortly. In the first place, the advantages from the sanitary point of view outweigh all others, although there are some which are also of great importance.

30. I have noticed repeatedly since I have been in Bombay that upon opening the tap in the bath-room used by me, that not only has there been no water in the service pipe, but that there is a partial vacuum, the suction being frequently very strong sufficiently so indeed, to empty a tumbler of water. Now, it is common knowledge that in a large system of mains and service pipes, undergoing a steady process of deterioration, from the day they are laid, that leaks are of common occurance, and must, of necessity, for ever take place.

Risk of pollution.

31. Many of the distributing mains and services are laid in ground polluted with sewage, "laid on" to the soil as described more particularly in my report on "Sub-soil water," and there is a grave risk of drawing some of this polluted water into the water-supply under the circumstances referred to.

32. There are further risks of pollution of the general supply due to taps being left open in insanitary dwellings, and even of the water drawn from the taps and stored in utensils of various kinds when there is a short supply; upon sanitary grounds, therefore, an intermittent supply cannot be too strongly condemned.

Damage to mains.

33. Upon what may be termed mechanical grounds, the system of intermittent supply is bad, because of the risk of the great supply mains being damaged by the shock caused by shutting the valves. As you are aware more than one accident of the kind has occurred in Bombay quite recently, with grave consequences to the consumers, who were for days in a serious plight. A great fire, under these circumstances, would be appalling in its results.

Less waste in good constant supply.

34. Finally, although it may at first appear to be paradoxical, there may be less waste with a constant supply at good pressure than with an intermittent supply, because an efficient system of waste prevention is the natural complement of the constant supply system.

Waste.

35. When the water is only supplied at irregular intervals as is the case in Bombay, taps are frequently left open upon the chance of some water being obtained, and in that way much water is undoubtedly wasted. With regard to waste prevention generally I feel I can add nothing to the extremely able reports of Mr. S. Tomlinson. In these reports, the latest English practice is fully described, and examples of the application of the system to Bombay are given. The reports shew, conclusively, that a constant supply, under proper supervision, and with an adequate staff for the detection and prevention of waste, is conducive to great economy in the consumption of water.

Bristol

36. I could give examples in the practice of my own firm and of other Engineers, but I feel that one or two for reference is sufficient. My firm, for a great many years, have been Engineers for the City of Bristol Water-supply, the population is one-half of that of Bombay, the water-supply for all purposes does not exceed 22 gallons per head per day: a result entirely due to constant supply with efficient waste prevention. Bristol, too, is drained, and fully watercloseted.

Leicester.

37. The case of Leicester—a Midland town, with a population of 203,000 in 1894, is interesting, because there, according to Mr. Griffith, the Engineer, in charge, the consumption was reduced to 17·56 gallons per head per day, by the simple expedient of dividing the water area into 331 districts, each having a valve for isolating it from the main supply. These valves are examined by night inspectors by means of a stethoscope, and if leakage is found, it is reported to a day inspector, who follows the matter up. No meters are used upon the mains for detecting waste in this case. The supply is constant. At Shoreditch, London, with a population of 87,000 the consumption of water was 36·8 gallons per head per day to 14·1, by means of the waste meter system.

London.

Chatham.

38. Another supply under the charge of my own firm is that of Chatham and the surrounding districts. Here the supply for all purposes is less than 20 gallons per head per day. In all these cases the results are unquestionably due to a perfect system of waste prevention of the kind fully detailed in the report.

House meters.

39. With regard to the house-hold meter system, I can add nothing to the voluminous reports upon this question, which have already been presented to the Corporation. The subject has been exhaustively dealt with by Mr. Tomlinson in his report of April 1893 and by the Executive Engineer in his masterly analysis of December 1893. I will merely say I am of opinion that if the development of the supply is proceeded with upon the sound grounds of a constant supply, with an adequate staff for the detection and suppression of waste, house-hold meters will not be necessary. The punishment of offenders is, I admit, difficult, but I cannot help thinking some method might be found to meet the case.

House meters good for waste.

40. At the same time it cannot be denied that the house-hold meter system is the most effective method of checking waste known. The subject was fully discussed at the Institution of Civil Engineer in 1891; the paper with the discussion may be found in Volume CVII. of the Proceedings.

Recapitulation.

41. We may now recapitulate the main features of the existing supply under the following heads :—

(*a*) Storage.
(*b*) Delivery.
(*c*) Filtration.
(*d*) Distribution.

42. (*a*) The present storage amounts to 29,706 millions gallons when the lakes are full, omitting Pawai.

(*b*) The delivery mains can bring into the City 36 million gallons per day.

(*c*) The filters can effectually filter 11½ million gallons per day.

(*d*) The distribution is faulty, in as much as the Tansa supply and part of Vehar supply is uncontrolled, except by means of valves upon the supply mains.

Storage.

43. We may next consider such of deficiencies of the present system as require to be urgently dealt with. Observing the same order as was adopted in the recapitulation, we find that as regards storage the impounding reservoirs will suffice for many years to come.

44. When the time for extensions arrives, the Tansa dam can be raised, without endangering its safety, 15 feet, when the volume of stored water would be increased by at least 12,400 million gallons.

45. With regard to the filters, the area provided at Bhandarwada is ample in extent, but at Malabar Hill there is a deficiency of about 4,000 square yards. I am of opinion that this should be immediately remedied. Filters.

46. With regard to the supply mains I am informed that the present mains are in good order with the exception of the Vehar 32-inch, which is becoming weak from corrosion, and has already burst in several places. Supply mains.

47. The proposal to convey Tansa water direct into the Malabar Hill and Bhandarwada Reservoirs is not only sound in principle, but is absolutely necessary for the proper development of the Tansa Supply, followed, as it should be, with the construction of a new outlet from the Malabar Hill Reservoirs of adequate capacity, to join the existing distributing mains at Chowpati. I think these proposals should be carried out forthwith. I also think the high level areas supplied from Malabar Hill should be provided with a tank to receive and store the water pumped by the turbine. Development of Tansa.

48. The proposal to lay a new main from Vehar is also sound, because this really means a duplication of the Tansa main for several miles from Bhandup to Koorla, and forms part of the general idea for the development of the supply, which should be followed in the future. I understand the Railway Company will divert that part of the present main which is laid within their property, which would be joined with the proposed new Vehar main. I approve of this proposal. New Vehar Main.

49. Lastly, as regards distribution, this will unquestionably be improved and placed upon a more satisfactory basis when the proposals enumerated have been carried out, so far as the supply to the southern part of the Island is concerned; but I do not approve of the present method of drawing from the supply mains for the requirements of the central and northen part of the Island. Distribution.

50. I am of opinion that the development of the supply of that part of the area should proceed upon a proper system of distribution from a balancing reservoir. A good site for this may be found upon the hills on the east of Old Government House, Parel, and the proper course at first would be to cause the present 24-inch main from the Vehar lake to discharge filtered water into this reservoir from the existing filters at Vehar. Parel Service Reservoir.

51. Eventually this suggested reservoir would form the natural termination of the duplicated Tansa main.

52. There must be an obvious loss of economy in conveying all the water to the south of the Island, and then back again, as would be the case if all the supply mains were made to discharge into the present reservoirs.

53. In conclusion, I may say that, so far I feel I have but re-iterated much that has been already placed before the Corporation, in the voluminous and excellent reports by their Executive Engineers, by Mr. Tomlinson, Mr. Fairlie Bruce, and others.

Definite Plan for future Developments.

54. What I desire to impress upon the Corporation is the necessity for forming a definite and comprehensive policy for the future development of the water-supply. It is not conducive either to efficiency or economy to relieve the necessities of parts of the City as they arise, in a piece-meal and inharmonious manner. Changes take place both in the Corporation and its personnel, but these changes should not interfere with the general development of the scheme in the direction of some settled and definite plan. I do not, for a moment, suggest that a large expenditure should be at once incurred in providing for the requirements of the population, say 50 years hence, but Bombay must and will grow, and more water will be yearly demanded, but the extensions should form part of a carefully considered scheme, so that the final result may be attained with the maximum of efficiency, and at the same time at the least cost to the community.

General Idea.

55. I am of opinion that future developments should proceed upon the following general lines :—

(*a*) The pernicious system of drawing from the supply mains should be suppressed, all such mains should deliver directly into balancing reservoirs, from which the water should be supplied at constant pressure.

(*b*) The supply of the northern part of the Island should not be taken to the south to Malabar and Bhandarwada, and back again, but this part of the Island should take its own supply from reservoirs and filters to be constructed on Parel Hill, which should also receive the water from the Tansa main when it is finally duplicated, and in the meantime from the 24-inch Vehar main, with a branch from the proposed new main.

Steel Mains.

56. Finally, with regard to the use of steel mains in lieu of cast-iron, the position is much the same as when reported upon by Mr. Mansergh in 1892. The gist of that report lies in these sentences—"There is no experience to justify the belief that any precaution in the way of coating would bring steel up to the same platform as cast-iron." But, * * * "under these circumstances, I believe the steel main may be preserved practically undeteriorated for a long term of years at slight cost, and as the Engineers have shewn by their estimates a substantial saving in cost by the use of steel * * * I have no hesitation in confirming their recommendations."

57. The "special circumstances" referred to were the facts that the proposed main was to be laid above the ground, and were much cheaper.

Birmingham.

58. Now I had an opportunity in March last of visiting the great works being constructed by Mr. Mansergh for the supply of Birmingham, and found cast-iron mains were being used, except in some special cases where the pressure will be exceptionally great when the works are brought into operation.

London.

59. But great as these works are, they are small compared with the great London works, which now supply upwards of five million persons. The population supplied by these works is increasing by

more than half a million persons each ten years, and the consumption of mains in extensions is enormous. As these great works are in the hands of private Companies, there is not much information published with regard to them. It is not in the interests of the Companies to supply information, which obviously might be used to their disadvantage in the event of their undertakings being purchased compulsorily.

60. But my firm have designed and constructed some of the works for two of the Companies, which are not among the least in magnitude and importance. Apart from that, I know generally what is being done, and I can say that steel is used only in exceptional cases.

61. Our own practice in many other towns is consistent with the general statement made above, and I think I may say that in the United Kingdom, generally, the practice of Engineers is in accordance with this view. But there are "special circumstances" in Bombay; so far as the mains aboveground are concerned they are accessible for protection, and I have no hesitation in advocating the use of steel in lieu of cast-iron; but in the case of those to be laid beneath the surface, I think some steps should be taken to ascertain, whether in the case of those to be laid in ground which not long since was covered by the sea, there is salt in the subsoil in sufficient quantity to lead to a rapid destruction of the mains. If there is, I venture to think, it would be safer to lay mains of cast-iron.

In conclusion, I have to thank the Executive Engineer, Mr. Murzban, and Mr. Bruce, for their assistance, and to say that if I have failed to deal adequately with any part of the subject, I shall be happy to elucidate the matter in a subsequent report."

Resolution of the Corporation, No. 10986, *dated the 18th January* 1900:

"That, with reference to his letter No. 28696, dated the 12th December 1899, the Commissioner be requested to favour the Corporation with his remarks and suggestions on Mr. W. Santo Crimp's report on the water-supply and its distribution, together with estimates of the cost of such proposals as he would recommend to be taken in hand at once."

Resolution of the Corporation, No. 10988, *dated the 18th January* 1900:—

"That the Resolution of the Standing Committee, No. 6311, dated the 4th October 1899, recommending proposals for meeting the cost of mains sanctioned by the Corporation under Resolution No. 4385, dated the 14th August 1899, be forwarded to the Commissioner, with a request that he will consider the matter in making any proposals on Mr. W. Santo Crimp's report on the water-supply and its distribution."

Resolution of the Corporation, No. 10989, *dated the* 18*th January* 1900 :—

"That paras. 1, 2 and 3 of the Resolution of the Standing Committee, No 7768, dated the 8th November 1899, regarding the laying of certain mains for ensuring a better supply of water to the public, be forwarded to the Commissioner with a request that he will consider the recommendations made by the Standing Committee in formulating his proposal on Mr. W. Santo Crimp's report on the water-supply and its distribution.

* * * *

Resolution of the Corporation, No. 12837, *dated the* 19*th February* 1900:—

"That the *Ad-interim* Report of the Committee of the Corporation on the question of adopting the meter system for the distribution of water, be forwarded to the Commissioner, with reference to Corporation Resolution No. 10986, dated the 18th January 1900, with a request that he will consider the remarks and recommendation of the Committee in submitting his observations and suggestions on Mr. W. Santo Crimp's report on the water-supply and its distribution and place definite proposals before the Corporation."

No. 11413 OF 1900-1901.

BOMBAY, 2*nd August* 1900.

TO THE MUNICIPAL SECRETARY.

SIR,—As requested by the Corporation in their Resolution No. 10986 of the 18th January last, I have the honour to submit my remarks on Mr. Santo Crimp's report on the Water-Supply of Bombay, and on the other subjects relating thereto which were also referred to me by the Corporation Resolution Nos. 10988, 10989 and 12837, dated the 18th January, 18th January and 19th February 1900 respectively.

2. It is no doubt a matter of congratulation that the Corporation should learn from Mr. Crimp that he has, with one or two minor exceptions, no new facts to put before them, and that in the able reports which have from time to time, and more especially during the last 15 years, been submitted to them from various Executive and Water Engineers, there will be found sufficient material to enable them to come to what will, I hope, be a definite and final conclusion on the important matters which have so long been awaiting settlement. Mr. Crimp has, as was to be expected, dealt with the subject on general lines and avoiding details which might only tend to confuse, has enunciated the broad principles which should, in his opinion, guide the future policy of the Corporation and to which all subsidiary schemes should be made to conform.

3. Before I proceed to discuss the more important general questions which have to be considered, it is desirable to state

that the vegetable matter which Mr. Crimp observed in the shallow water at the northern part of the Vehar Lake has been removed, and that advantage has been taken of the fall in the Tansa Lake to cut down as many as possible of the standing trees. The suspended particles of vegetable origin in the latter lake referred to in para. 16 of the report, appear to have been algæa matter, as there is no other vegetable growth in the lake, and recent chemical and bacteriological examinations of the water by Dr. Cayley have shown that during the hot weather it steadily improved in quality. It is impracticable to deal with matter of this kind in any other way than by filtration, and there is at present no reason to anticipate that the growth of algæ will render this course necessary.

4. Mr. Crimp lays down in the commencement of his report a proposition which no one will dispute, *viz.*, that the future policy of the Corporation with regard to the water supply should be the development of the Tansa system, and he remarks that it is a matter of regret that only some 21 million gallons can be drawn from that lake daily. The Tansa project has always been looked on as a final one as far as the present and future requirements of the City are concerned, but it was unnecessary and would, from a financial point of view, have been both difficult and extravagant to do more than provide for the reasonable wants of the City for a period of some 30 years. The wisdom of providing ample storage accommodation once for all was undoubted, and the construction of the masonry conduit to carry an increased supply in future was economical, but the duplication of the syphons so as to admit of a greater draw off was postponed until such time as, allowing for a proper use of the water, an increased supply might justly be asked for, and from Mr. Crimp's estimate of the quantity of water deliberately wasted, I assume that he cannot be of opinion that the time for a further expenditure of some 50 or 60 lakhs has yet come. The works which he indicates as being at present desirable in furtherance of the general scheme (excluding works for purposes of distribution) are a substitution of a larger main for the Vehar 32-inch from Vehar to Coorla, and the provision of a service reservoir in Parel or Chinchpokli Hill for the storage of water for the northern portions of the City. I shall deal more fully with the first of these items in my remarks on the report of the Water Mains Committee, and it is only necessary to explain here the connection of this larger main (48 inches recommended by the Committee) with the Tansa system by saying that it will at once convert Vehar into a *safety* reservoir in case of any breach in the Tansa line north of Coorla, and will eventually, when it is necessary to draw in increased supply from Tansa, form part of the new line, the additional water being poured into the Vehar Lake. The second item I discussed with Mr. Crimp, and he finally came to the conclusion that the new reservoir is not at present

necessary, and that all that need be done is to keep the project in view and perhaps purchase the land required. I am not prepared to recommend any expenditure in this direction at the present juncture, since until some thing more definite is known as to the probable rate of development of the northern suburbs and the consequent prospective increase of population to be provided for, no scheme with any element of accuracy could be formulated, and it must always be remembered that at present and probably for a long time to come, our straitened resources will require the limitation of capital expenditure to such work as are of an essentially necessary character. The operations of the Improvement Trust in the areas notified under their schemes, Nos. V and VI will be our best guide in this particular matter, and it is desirable to wait until further progress is made before we consider what steps need be taken. The Vehar 24-inch main which can supply 3 million gallons a day is sufficient for all purposes of the present and the immediate future.

5. Taking now the heads under which the report is summed up, we find that the storage capacity of the lakes is sufficient for many years to come, and that the only further work that can be foreseen, as ever likely to be required, is the raising of the Tansa dam which was in the first instance so designed and constructed as to admit of this being done. The supply mains however can deliver under the most favourable conditions no more than 36 millions gallons daily, *viz.* :—21½ from Tansa, 4½ from Tulsi and 10 from Vehar, and in years of scanty rainfall such as that of 1899, the supply from Tulsi is always liable to be reduced by about one-half. The average daily supply for the last year I take to be about 34¼ million gallons and the possibility for this partial failure must be always borne in mind. In respect of these two matters, storage and delivery, Mr. Crimp has no recommendations to make. As regards filtration it has to be noted that the existing filter beds can deal with about 10¾ million gallons daily as shown below :—

Bhandarwada	7
Malabar Hill	2½
Vehar	1¼
Total ...	10¾

It will thus be seen that all the water delivered by the Vehar 32-inch main at Bhandarwada, about 50 per cent. of the Tulsi water when a full supply is being drawn, and all the water drawn through the Vehar 24-inch main in the cold weather when the mill tanks are full, are filtered. When the full supply is being drawn through the Vehar 24-inch main none of it can be filtered, and in the event of considerable increase in the population of the northern wards, the extension of the filter beds at

Vehar will be a necessity. The Tansa water is all unfiltered, and the only possible site for filter beds is a few miles on this side of the lake, where land has been reserved. It is no doubt a desideratum that all water for drinking purposes should be filtered as experience and experiments have shown, that the risk of water borne diseases is thereby practically eliminated. The careful analyses made during the last year have, however, shown that the Tansa water, under what may be taken as almost the worst possible conditions, is still a good drinking water, and there is nothing in the present circumstances of the case to justify an expenditure of some 9 or 10 lakhs of rupees for the extra security of filtration. The lake is not ordinarily exposed to the danger of contamination, and with a systematic examination such as is being conducted at present, we should at the worst have to face the cutting off of the supply for a few days. Mr. Crimp's only recommendation in connection with this subject is that the filtering area at Malabar Hill should be extended so as to admit of all the Tulsi water being dealt with. This subject has been several times discussed by the Corporation and more recently by the Standing Committee, and the difficulty in the way of a settlement has been the uncertainty as to the maximum possible rate of filtration of which, of course, the accommodation to be provided depends. The Corporation decided some time ago that systematic experiments should be carried out, but it has not been possible as yet to do so, first on account of all the filters not being in working order, and secondly because the draw off from Tulsi having been reduced this year the necessary pressure could not have been maintained. It is probable that 600 gallons per square yard may be a sufficiently accurate rate for all practical purposes, but I have been and am reluctant to advise the Corporation to enter on this expenditure, inasmuch as if efficient means of stopping or reducing waste can be devised, we could very well afford for some time to come do without that part of the Tulsi water for which the extra filtering area is now proposed. If, however, waste is to be left unchecked, there can be no doubt as to the necessity for stopping the supply of unfiltered Tulsi water which is not potable at the best of times.

6. I come now to the last subject which Mr. Crimp discusses, *viz.*, the distribution of water supply, and this must be taken to include all the works (except filtration) which have to be arranged and provided for to secure that the best possible use is made of the water delivered by the supply mains. The object to be attained and that towards which the Tansa scheme was directed, is the provision of a constant supply at full pressure in every part of the City. The evils of an intermittent supply, such as existed in the City before the introduction of Tansa water, and such as has now unfortunately again been brought into existence, have been so frequently explained, that I need do no more than classify them as (1) risk of polluted matter being drawn into mains on the establishment of a negative pressure, (2)

danger of bursts owing to the constant manipulation of sluices, (3) impossibility of maintaining sufficient pressure for fire extinguishing purposes and (4) the risk of water collected and stored during the hours of supply becoming affected on account of the insanitary conditions of most of the houses in the native town. The extreme inconvenience and hardship likely to be caused by the second of these risks under existing conditions was fully exemplified last October, when a combination of accidents on the 32-inch main in Grant Road necessitated not only the shutting off of Tansa water from the southern part of the City, but also prevented water from Bhandarwada being distributed through the ordinary channels to a great part of the native town, and it cannot be too strongly asserted that, so long as some 30 sluices and valves have to be opened and shut, in order that every part of the town may have water, we must always be prepared for accidents caused by the carelessness of workmen, and the consequent excessive strain put on some part of the distribution system. The remedies which Mr. Crimp proposes, and which have for years past been urged by successive Commissioners and Engineers, are the discontinuance of direct supplies from the delivery mains and the prevention of waste. The relative importance of these two measures has, in my opinion, been incorrectly estimated in some of the former reports to the Corporation; the latter is a much more urgent need than the former, inasmuch as if waste be effectively checked, the abundance of the Bombay water supply would more than make up for limited storage accomodation, so far as the ordinary daily supply is concerned, while no amount of storage within the limits of the possible delivery of the present supply mains could do more than slightly reduce the deficiencies caused by waste. In connection with the first of these measures, it should be mentioned that service reservoirs in addition to admitting of some regulation of pressures as explained in paras. 27 and 28 of Mr. Crimp's report, serve also the purpose of storing surplus water for use in case of fires or breaks on the supply lines, and it is of course very desirable to have them for all these purposes. At present practically all the Tulsi water is taken direct to Malabar Hill, and the water brought by the 32-inch Vehar main to Bhandarwada, while the whole of the Tansa water is drawn off directly into the distributing mains. In placing the Tansa scheme before the Corporation, Sir Charles Ollivant specially withheld the subject of a service reservoir for future consideration, and it was settled that financial consideration rendered it impossible to undertake the work as part of the Tansa project. The matter however was not lost sight of, and in 1887 Sir Charles Ollivant and Messrs. Clerke and Tomlinson submitted a joint report to the effect that the only suitable site within the City for the reception of the bulk of the Tansa water was at Malabar Hill. This view has, I think, been generally accepted,

but up to the present time no steps have been taken to give effect to it. Last year, however, the partial failure of the Tulsi supply and the consequent complaints from the Fort and Colaba brought the project, which had been subordinated by the water Mains Committee to that of taking a smaller quantity of Tansa water to Bhandarwada into prominence again, and the Standing Committee recommended that immediate measures should be taken for the delivery of Tansa water into the Malabar Hill as well as the Bhandarwada Reservoir. Mr. Crimp has strongly supported this recommendation, and no objection can be urged against its ultimate adoption; from a scientific point of view it is a necessary part of the distribution system, but the necessity is not so pressing now as it will be later when the legitimate demand of an increased population will reduce the margin available for waste, and when it will be essential to adopt every device that makes for economy in the use of water. I should be glad if these works and the extension of the accommodation at Malabar Hill for the storage of 10 million gallons more could be undertaken at once; I shall give details of the cost later on, and it will be for the Corporation then to consider whether they are in a position to undertake them. The point however, which I wish to press most strongly now is that the rectification of this one defect will not by itself remove the present causes of complaint. The danger from bursts will be reduced and it will be possible to regulate pressure better than now and to improve the distribution at the expense of districts that are most favourably situated at the present time for drawing off the maximum quantity from the Tansa main. That however is the most that can be hoped for, and I am afraid that the result, after an expenditure of many lakhs of rupees, will fall far short of what is really required. We have seen that the introduction of an extra supply of 21½ millions has had no more than a temporary effect; within seven years we had to revert to the former unsatisfactory system of intermittent supply, and I can see no reason to hope that the delivery of the Tansa water at Malabar Hill and Bhandarwada will of itself assist us very far towards the solution of the problem of how to maintain a constant supply at full pressure. I am for the same reasons opposed to any attempt being made to improve the system of distribution mains before waste is checked: to do so would merely bring on the Corporation clamorous demands for an increased supply from Tansa, which cannot be regarded as financially possible for many years to come.

7. It will be gathered from the preceding para. that in my opinion the development of the Tansa system in the direction of delivery at the existing reservoirs, and the improvement of the general system of distribution in the City by the laying of additional distributing supply mains or the substitution of larger for smaller mains are of much less importance than the

prevention of waste. I cannot help coming to the conclusion that any attempt to ameliorate the present conditions by measures which are not directed towards economy in the use of water is doomed to failure, and that the only result will be, after a transitory improvement, more disappointment and popular clamour than before. I have heard it frequently remarked at meetings of the Standing Committee and Corporation that when Tansa water was introduced a promise was given that there would never be any more scarcity of water. I have not succeeded in tracing this promise to any official source, and I do not think any one can have seriously contemplated that with unlimited waste any given quantity would suffice. I find on the contrary that Mr. Tomlinson in 1887 and Mr. Walton again in 1891 pointed out that at the existing rate of increase of consumption (including waste) and given a constant supply, the Tansa supply, would all be absorbed by about 1897. We know now that as a matter of fact this estimate was much too sanguine, and that in the hot weather of 1898 the full static head at Ghatkoper was never approached, a fact which as Mr. Tomlinson pointed out showed conclusively that the full supply could have been absorbed in the City at less than full pressure. This of course meant that a constant supply could not be maintained in localities or houses where high pressure was required, owing to the latter being exhausted at lower points of delivery. In 1897 the late Mr. Newton showed that at the time of maximum draw off the loss of head in the Tansa main varied between 70 and 100 feet, and it is hardly necessary to say that since then there has been no improvement. Mr. Tomlinson in 1898, on consideration of the observation already referred to and foreseeing the future accentuation of the evil, adopted the natural course of proposing that the most stringent measures should be taken to economise the use of water, and I would commend his very able report, No. W. 2712 of the 28th April 1893, to those who care to study the subject. The Corporation decided that any action at that time would be premature, but the experience of later years will probably induce them to come to a different decision now, and it should be borne in mind that in the intervening period the number of connections has increased by about 14 per cent. and the consequent legitimate demand in the same proportion.

8. It will probably not be seriously questioned that the defects of the present system, including all the disadvantages of an intermittent supply, of over-working the pumps at Love Grove, of the restriction of the water carriage system, and of water-logging the soil are directly due to excessive waste. There is no doubt that ordinarily 35 or 36 million gallons of water are delivered in the City every day; this was at one time disputed though the method of measurement was fully explained by the Water Engineer, but Mr. Crimp's pronouncement on the subject should suffice to set all doubts at rest. It will also be safe to accept Mr. Crimp's estimate of the actual daily requirements

of the City for all purposes (*viz.* 20 million gallons) as it agrees fairly closely with those of the Engineers of considerable local experience. The total daily waste may therefore be put down at 15 or 16 million gallons—43 or 44 per cent. of the total supply —a quantity which, if saved, would secure the maintenance of a constant supply at full pressure for many years to come without additional delivery mains, and would also admit of a reasonable increase in revenue by sales for purposes of trade. Mr. Snow's proposals as to the method of securing these valuable results were before a Committee of the Corporation for some 18 months, and the only result arrived at was a recommendation that all premises with gardens in the City should be charged by measurement. Now, considering that this measure involved only the metering of some 449 premises, all the clubs and hotels and many premises with gardens being already metered, it is apparent that the information to be deduced from the figure of consumption in these few instances would not carry the Committee much further in their researches, and while I am ready to admit that the recommendation is in itself good, and has, in fact, been adopted, I think it falls far sort of the requirements of the situation. The quantity of water delivered and of water really necessary for all purposes being settled, as I think they may be taken to be, the only questions which require elucidation are first the causes of the waste and second the most suitable method of preventing it. The first of these seem to have been a serious stumbling block to the Committee, and notwithstanding the undoubted fact that it is only necessary to go into almost any house in the native town to see taps running water to waste full bore, they have not been able to bring themselves to subscribe to the theory that any practice of this kind exists. They impugn the accuracy of the estimate of 40 gallons a head on the grounds that in some sections of the native town the consumption is not much more than 20 gallons, and that the major portion of the waste is due to leakage from mains and fittings. I confess I am unable to follow the first of these arguments, the figures relied on are part of the very figures on which Mr. Snow's estimate was based, and as the number of premises with gardens remaining to be metered was relatively small, the logical conclusion would have been the selection for metering of one or all of the sections which showed a consumption much above the average. As regards leakage from fittings the Committee do not seem to have understood quite clearly that it is the duty of consumers to keep their fittings in good repair, and that it is essential to make it also their interest to do so. The leakage from this cause is of course not included in the allowance of 10 per cent. made by Mr. Snow. It must also be mentioned that the remarks made by the Municipal Commissioner in 1884, quoted in para. 4 of the Committee's report had reference to conditions that then existed, and that as for years past much attention has been given by a special establishment to loss from this cause, the state of fittings generally

has greatly improved, and with the enforcement of a better type of taps the improvement may be expected to steadily continue. Now, with reference to the 10 per cent. allowance for leakage from mains and reservoirs—3,600,000 gallons daily—which has been called in question by the Committee, the Corporation will, no doubt, be glad to learn that during the last two years every main which is provided with a Deacon's meter has been systematically examined by the Water Engineer, and the larger mains have been carefully sounded with the result that only three leaks of possibly old standing have been discovered. Mr. Bruce is now of opinion that including the loss from the reservoirs (about 3 lakhs daily) the total loss from this cause is not more than 4 per cent. Mr. Crimp, whose views I specially asked for on this point was not disposed to put down leakage from mains alone at more than one per cent. and he was very strongly of opinion, based on his survey of the Bombay subsoil, that any considerable quantity of water set free in the soil in this way must come rapidly to the surface when, of course, the discovery of the leak would follow. It will be for the Corporation to come to their own conclusion on the widely divergent opinions of their Committee on one hand, and Mr. Bruce and Mr. Santo Crimp on the other. For my part I have no hesitation in stating that I consider it established that the waste in excess of 4 per cent. is due to taps being deliberately left open and in some measure to defective fittings.

9. The crucial question of how waste can be prevented still remains, and there are only two proposals—to employ a large waste prevention establishment, or to insist on the affixing of meters. The former is supported by Mr. Crimp, the latter by the Municipal Engineers who have from time to time dealt with the subject, and I would invite special attention to the fact that among the latter is included Mr. Murzban whose knowledge of the customs and wants of the people of Bombay is probably unique. As to what is the most efficacious method of preventing waste there can be no doubt; Mr. Crimp admits that the household meter system holds the field, but his experince of the working of the other system in England has led him to hope that it can be adopted with success in Bombay. I should have hesitated to differ from Mr. Crimp had it not been for the fact that the system he advocates has already been tried and I think pushed to the utmost limits of practical efficiency in Bombay. Mr. Tomlinson between 1886 and 1894 spared no effort to check waste with the assistance of a special staff, and I would invite the attention of any one who wishes more detailed information on the subject to his admirable reports which were placed before the Corporation during the period referred to. As I knew that it was only with the greatest reluctance he brought himself to recommend the use of meters for domestic supplies, I enquired the cause of his change of opinion and will quote his own words in reply :—

"Like Mr. Santo Crimp I came out from home loth to think of meters for domestic supplies. From 1886 to the introduction

of Tansa supply I held out against recommending the meter system, although there was much evidence of its being needful, but when I saw on the introduction of the Tansa supply that consumption which could not be touched by the Waste Prevenrion Staff was swallowing the whole of the magnificient supply without giving us any revenue for it, and deprived us of full pressure, although the supply was constant then, I could not hesitate to say that only the meter system would meet the case. Waste prevention work will always be necessary to deal with that unseen waste which goes on night and day; it cannot be extended to deal with the far larger quantity which is wasted during the day." The gist of the whole matter lies in the last clause. Leaks on the mains and leaky fittings can be discovered by examination made at night; leakage from taps left open during the day is not susceptible of discovery in the same way, and cannot be traced during the day except by the employment of an enormous establishment armed with powers of house to house inspection and summary methods of punishment. The latter must be either by prosecution or immediate cutting off of the supply without the circumlocution of obtaining the sanction of the Standing Committee. On these lines some good might be effected, but I would leave it to the Corporation to consider whether they can contemplate seriously the possibility of operations of this kind. I think I may safely say that the situation would be intolerable and the City would require a staff of special magistrates to hear on the one hand complaint of waste, and on the other probably as many complaints of extortion, assault and such other offences as the resentment of consumers might suggest. The meter on the contrary is a silent inspector and recorder of facts and in very few cases are its observations incorrect. I am aware that an outcry has recently been raised against them locally, but a general condemnation of them can have no solid foundation, inasmuch as they have stood the test of years in all parts of the world. The inferential meter is no doubt not quite as accurate as the positive, but the variation is in nearly every case in favour of the consumer, and any one who pleases can obtain a positive meter and use it. In several cases which I have investigated since all premises with gardens were metered, I found that excess consumption which was ascribed to the inaccuracy of the meters was really due to defective fittings or careless waste, and the meter is quite as accurate a guide to defective fittings and supplies a much more constant test than the sounding rod of Waste Preventing Establishment. I do not doubt that the introduction of the meter systsm will be attended with some difficulties in the beginning, but I believe they are not insurmountable if we proceed without undue haste, and I prefer this system to the other as interfering less with the privacy of the people and being at the same time the more efficacious. I would therefore urge most strongly on the Corporation that the

absolute necessity of proceeding without delay to consider the proposal made by Mr. Snow in his letter No. 5107 of the 4th June 1898. I have made no attempt to go into details as unless the Corporation declare for meters, it would be useless to do so. If they decide to make the experiment in one ward a small committee could thresh the whole question out in a few days.

10. Proposals for the new works in the lists given are now before the Corporation. Those in list A were recommended by the Water Mains Committee* and have been sanctioned by the Corporation, those in list B are the result of the enquiries made by the Standing Committee last October and November when in consequence of the partial failure of the Tulsi supply there was a scarcity of water in the Fort and Colaba. Both lists have been referred to me for opinion in connection with Mr. Santo Crimp's report.

List—A.

	Revised estimate. Rs.
(1) Cast Iron Main from Ghorupdeo Road to Sewree Cemetery Road 12-inches for 5,080 feet and 4-inches for 1,359 feet	55,300
(2) Main along Kala Chowkey Road from Parel Road to Ghorupdeo and along Reay Road to Bhandarwada Reservoir of 18-inches diameter except for 600 feet for which 24-inches Cast Iron Pipes in stock are to be used. The 18-inches to be Cast Iron for half the distance and Steel for the other half. The main to have an emergency connection with the 48-inches Bhandarwada outlet	1,40,200
(3) 9-inches Service main connected at one end with Bhandarwada Reservoir and at the other with the Sewree Road 12-inches main and supplemented by a 9-inches main in Connaught Road connected with the 16-inches main in Parel Road	51,150
(4) Replacing 32-inches Vehar main for 1½ miles partly by 48-inches Steel Pipes and partly by 2,000 feet of 48-inches Cast Iron Pipes in stock.	3,26,400
(5) 9-inches main in DeLisle Road	18,550
(6) 4-inches main in Khara Tank Road	6,550
Total ...	5,98,150

List—B.

(1) 22-inches Steel main from the 48-inches Tansa main at Chinchpokli to Grant Road, there connecting with existing 27-inches and continued to Malabar Hill with 32-inches Steel main ...	2 07,300
(2) 32-inches Steel outlet main, Malabar Hill to Chowpati	32,150
Total ...	2,39,450

* *Vide* Vol. XXIII, Part I, pages 312 to 319, Record 1899-1900.

The Water Mains Committee, while of opinion that the present practice of allowing the supply mains to be drawn from direct is altogether wrong, decided that it was desirable to complete the works for the delivery of Tansa water to Bhandarwada first and that the Malabar Hill scheme should stand over. The reasons for this conclusion are not clear, and I am of opinion that in view of the fact that the Tulsi supply is more liable to fail than the Vehar, the direct delivery of Tansa water at Malabar Hill is the more pressing requirement. Of the eight works entered in the two lists, Nos. 2 and 3 in list A and both those in list B are in pursuance of the policy of delivering all the water in the first instance to service reservoirs. Item No. 1 in list A is required for the supply of water to the Mills at Sewree, the present 4 inches main being in a very bad condition and giving very little water; items Nos. 5 and 6 in the same list are also required for the supply of water for trade purposes. If the Corporation decide to adopt the recommendation of the Standing Committee either independently of or in conjunction with those of the Water Mains Committee, it will be necessary to limit the direct draw off from the Tansa main as much as possible, and the following works should be carried out:—

(1) 15 inches main from 24 inches Vehar main at Parel Bhoiwada to Parbhadevi Road and 9 inches thence to Century Mill at a cost of steel Rs. 55,750 or Cast Iron Rs. 76,580.

(2) 10 inches and 9 inches main in Grant Road to enable Kamatipoora to be supplied from Bhandarwada at a cost of Rs. 14,100.

(3) 9 inches main in Tardeo Road from Forgett Road to Falkland Road for the supply to Mills in the vicinity at a cost of Rs. 9,300.

If these works be carried out, the direct draw off from the Tansa main will be reduced to about one million gallons daily, but no greater reduction is possible until the 32 inches main from Bhandarwada is laid to a further distance in the Parel Road so as to admit of the district round Jacob's Circle being supplied from that reservoir. The only work in the list not dealt with above is that of replacing 1½ miles of the Vehar 32 inches main with 48 inches pipes. This is part of the project which involves the substitution of a 48 inches main for the existing 32 inches. The advantages to be gained by this scheme are:—

(1) That Vehar can be temporarily drawn on for a full supply in case of a breach on the Tansa line north of Coorla;

(2) that in ordinary circumstances the draw off from Vehar can be slightly increased and considerably so in the hot weather; and

(3) that the new 48 inches main will ultimately form part of the duplicated Tansa line.

The Committee have recommended, in view of financial consideration that only that portion of the main which is in a very bad condition should be replaced, and I consider this a very urgent work. It is impossible to say how much longer this main may hold out, but as the Corporation are aware it has been looked on with suspicion for a good many years past, and if any considerable number of lengths gave way, the inconvenience from the loss of the Vehar supply for a long period would be very severely felt. This with the mains in DeLisle Road and Khara Tank Road are the only works which I can recommend to be taken in hand before the question of waste is dealt with.

11. It will be observed that Mr. Crimp has not given a very positive opinion regarding the desirability of laying steel mains below ground, but he does not apparently altogether disapprove of this, except in cases where salt in considerable quantities is present in the sub-soil. I do not think the evidence is sufficient to enable the Corporation to come to a satisfactory decision, and it will, in my opinion, be advisable to refer the matter to an expert again as was done before, full details regarding the circumstances of the various lines of mains being furnished. I attach a table marked A* of estimates from which the desirability from a financial point of view of laying the large mains of steel will be apparent.

12. In view of recent discussions in the Corporation and Standing Committee, and of some public comments on the subject of the inequality of the charges for water, it will not be out of place if I touch briefly on a few points connected with the finances of the Water Department. In the statement marked B* will be found details of all items of revenue and expenditure from 1885-86 to 1898-99 both years inclusive. The net result is a deficit of some 37¼ lakhs of rupees and I think it will be readily admitted that this Department has in the past been worked on lines that were much too favourable to consumers as a class. The approximate figures for 1899-1900 show that for the first time since the commencement of the period under review, there is a real equilibrium between revenue and expenditure. There is in point of fact a book surplus of over two lakhs of rupees, but for purposes of equitable comparison I eliminate the whole of this against the excess of charges over cost price for water supplied for Municipal purposes. This satisfactory result may be chiefly attributed to increased sales for trade purposes on account of less water being available form tanks and wells, but there is no reason to believe that we shall be able to maintain the revenue at this level unless we take measures to make a larger quantity than at present available at lower rates

* See Record of proceedings.

than twelve annas per 1,000 gallons. This can, as already explained, be easily done by controlling the waste. The most unsatisfactory feature, however, of the present system is the enormous revenue levied from water sold by measurement in proportion to the quantity supplied, as compared with that which is paid for by the tax on valuation. The average daily sales by measurement last year were 3·26 million gallons or about 10 per cent. of the total supply to the public, while the revenue from this source amounted to nearly 59 per cent. of the total receipts from the public. The remaining 90 per cent. of the water is sold (and half of it wasted) at the rate of about one anna per thousand gallons. It is perfectly clear from this that all those who have metered connections have grave cause of complaint, except perhaps, where only the four-anna rate is charged. Rates of 12 annas for trade purposes and 9 annas for chawls and bungalows are far too high and should undoubtedly be reduced. There should also be a minimum rate on valuation for the double object of preventing the reduction of consumption by the poorer classes below what is actually required and of making every property pay for the general advantage to the City of a good water-supply. The mere reduction of the water rates on sales by measurement will perhaps pacify one section of the public, but it will also increase the loss on the Department, and will not strike at the root of the evil. The whole scale of charges requires revision and any reduction that is made in the rates by measurement must be compensated for by an increase in the tax on valuation, or preferably by larger receipts from the surplus water that will be available for trade purposes if excessive waste is stopped. The Corporation have already before them Mr. Snow's proposals for a revised method of charging, and as I have already stated above, if the Corporation declare for meters, the details can be settled without much difficulty. If they refuse to attack seriously the question of preventing waste, it is a certainty that the water difficulty will become more acute and neither I nor the Municipal Engineers can suggest any other method of improvement.

I have, &c.,
W. L. HARVEY,
Municipal Commissioner.

The question of the water supply was discussed, as under, at a meeting of the Corporation held on 24th June 1901 in the Municipal Hall, Mr. D. E. Wacha presiding.

The Hon. Mr. Mehta said that the rest of the items on the special agenda were all connected with each other and referred to the important question of the water supply. He found that there was a very strong feeling among members of the Corporation after having received a report from the Deputy Executive Engineer, Water Works, that a report should be obtained from the Commissioner and the Executive Engineer. In the ordinary

course of business this report should have been submitted to the Executive Engineer and then after his remarks should have gone to the Commissioner and he thought they would have expected that the Commissioner should have sent that report to the Corporation with his observations. In a portion of the report there were serious charges, both against the department of the Executive Engineer and against the Commissioner and they must bear in mind that although the Commissioner never dies, just as the king never dies, still the Commissioner to whom these remarks would apply would be an absent Commissioner. He thought it was remembered that the Deputy Executive Engineer worked under the Executive Engineer. The water department was a department under the Executive Engineer and it was unfortunate that the Deputy Engineer should have sent his report straight to the Commissioner. To come to a definite conclusion on the matters involved it was necessary that they should have materials before them upon which they could judge what were the administrative defaults of the Department. Though it might be said that the matter would be again delayed, he thought in a matter of this character a delay of a week or a couple of weeks would not be of so great a character. The Corporation ought not to proceed to consider the question without full materials before them and he therefore moved that the consideration of the items on the special agenda be postponed and that in the meantime the Municipal Commissioner be requested to obtain and submit to the Corporation a report from the Executive Engineer on the statement of the Deputy Executive Engineer, Water Works, together with the observations of the Commissioner at as early a date as possible.

Mr. Shroff in seconding the motion said that besides charges against the Executive Engineer the statement of the Water Engineer also contained serious charges against the Corporation itself. If they accepted this document as it was, it would form a precedent and not only the Deputy Executive Engineer, Water Works, but the Drainage Engineer would consider it his right in future to send such statements direct to the Commissioner.

Mr. Cuffe confessed that he could not follow the argument of the Hon. Mr. Mehta in regard to this matter, because it seemed that there was absolutely nothing in common between the defence put forward by the Water Engineer, which they could consider at any time with the aid of the reports of the Executive Engineer and of the Commissioner, and the immediate requirements of the City. Measures were what were wanted at the present time and not mere unseemly wrangling as to the particular form which is to be observed in reports coming to the Corporation. They were met that day to bring some finality to the water question. What were they going to do? They were going to adjourn and put off perhaps for a fortnight or more an important public matter, a matter, he was told, on which the patience of

the public was fast being tried. What possible connection was there with the quality of the Tulsi water and the letter from the Deputy Executive Engineer for Water works. They were surely competent that day to deal with that matter without deferring the consideration of the whole subject until the other report was brought forward. They had before them the report of the Water Committee making various recommendations and the letter of the Water Engineer had no bearing on them and there was nothing to prevent them from dealing with the Water Committee's report that day. There were recommendations made in regard to the mains and it was perfectly competent for them to deal with them that day even though they deferred the consideration of the Water Engineer's letter until a later stage.

Dr. Jehangir J. Cursetji said that there were certain allegations in the Water Engineer's report both against his own subordinates as well as against the Executive Engineer and the Commissioner and it was necessary that the question should be postponed in order to give the Engineer and the Commissioner the opportunity to explain these allegations after due enquiry.

Sir Balchandra Krishna said the tensions of the public mind on this subject had come almost to the breaking point and it would have been advisable to proceed with the debate on this occasion but, there was something in Mr. Mehta's argument that the serious allegation contained in the Water Engineer's report should be first attended to and the Executive Engineer should have the opportunity of having his say on the subject as well as the Commissioner. He would, however, only support the proposition if Mr. Mehta accepted a rider to his motion that the report he asked for be submitted within a fortnight. They could not shelve this question much longer, they must deal with it effectively. The public expected them to find an effectual remedy for the matters complained about, and if they went on shelving the question they would be failing in their duty.

Mr. Mehta accepted the rider.

Mr. Hormusjee Vakil said that as there had been complaints against the Water Department it was only fair that the head of that department should be heard in his defence. He had been attacked for months but he had now opened his mouth and the Corporation should see whether the allegations he made were well founded or not. If they were well founded then the Water Engineer established his innocence because he was absolutely helpless.

Mr. Mehta in reply to Mr. Hormusjee said he would include in his motion asking for a report the words "especially with reference to the allegations in paragraph twelve."

Mr. Lund could not understand that the question of the complaints about the non-supply of water was so mixed up with the defence of the Water Engineer that they were as Mr. Hormusjee said absolutely inseparable. He quite agreed that the Water

Engineer's defence and report should have careful consideration from the Corporation but that shoud not prevent them going on with the other questions. He therefore proposed as an amendment that the report of the Executive Engineer, Water Works, be postponed pending the receipt of the report asked for by Mr. Mehta and that the consideration of the other items of the water question be proceeded with forthwith.

Mr. Wadia seconded the amendment.

Mr. Petit and Mr. Khote spoke in support of the original motion.

Mr. Baptista did not see why such great importance was given to the report from the Water Engineer. The duty of the Corporation should be to consider the requirements of the City on the assumption that the administration was perfect and then make provision for the City's requirements. (laughter.)

Mr. Baptista : The Hon. Mr. Mehta laughs.

Mr. Mehta : Several other people laugh (renewed laughter.)

Mr. Baptista urged that there was no better opportunity than the present to show to the public they did not mean to shelve this question.

Rao Bahadur Dhakji Cassinathji asked if there was no connection between the Water Engineer's letter and the Water Question why was there such hurry in submitting it to the Corporation in an informal way. Unless they had the opinion of the superior officers no action could be taken upon it. There were a lot of complaints about the water supply, and the Water Engineer stated that if there were proper arrangements and his subordinates had carried out orders, there would never have been any reason for complaints. They should know whether this was a fact or not.

Mr. Kazi Kabiruddin supported the amendment.

Mr. Aitken said he agreed with almost everything that had been said about the importance of dealing with the letter from the Water Engineer. He agreed with both sides. It was said that the Water Engineer attacked the Executive Engineer and the Commissioner and it was also said that the Water Engineer had been attacked. These were all reasons why the letter should be considered. But the only connection he could see between that letter and the other subjects on the agenda was that they were about water. They had got a report from the Water Committee dealing with the purity of Tulsi water and the question of waste and suggesting remedies. They had got proposals put before them looking to the future. The letter of the Engineer gave certain reasons for a state of things in the past. He could not see why they should mix up the Water Engineer's defence as to why he did not do things in the past with the question now before them as to what should be done in the future. The greater part of the Water Engineer's report was taken up in

saying that he and his predecessors put certain proposals consistently forward. Members had come there expressly to deal with this great water question and this letter came in their way. One of the objections to it was that it had not come through the proper channel. In Government service the way of dealing with it in such an event would be by writting on the bottom returned for submission through the proper channel.

Mr. Mehta: We can't do that: because the Commissioner submitted it to us.

Mr. Aitken: Then too much stress should not have been laid on that point. This matter, he added, did not concern them there and they should put it aside for the present. They had a report from the Water Committee and several resolutions on the paper, and if after meeting to discuss these things they went away after postponing the subject; he did not know what the public and the newspapers would say.

Haji Yusuf Haji Ismail said the public would be disappointed if they did not deal with the question that day.

Dr. Sukhia was surprised to hear gentlemen who usually supported discipline making remarks such as had been utterered. Europeans were, as a rule, the best for descipline, but in this matter they were not.

Mr. McDonald: I would ask whether this is a right and proper thing?

Mr. Kabraji while agreeing that the Water Engineer's report should be deferred did not see why they should put off the consideration of the other questions. The Engineer's report was unsympathetic and one in which the fault-finding tendency prevailed.

Mr. Hormusjee: Is Mr. Kabraji in order in discussing the report?

Mr. Kabraji: No. (much laughter) I only submit that the report be sent back to the Water Engineer and that we proceed to consider the other report.

The Hon. Mr. Mehta in replying on the debate observed that it was common sense to ask that a report which dealt not only with the Water Department and its deficiency, but also with question of mains, which was dealt with in the Water Committee's report, should be considered with those points. Were they to divide these matters up? He was afaid Mr. Lund had not read the letter of the Deputy Engineer which comprised various other matters besides those connected with the administration of the Department. What were they to do with these matters?

Mr. Lund: Consider them when it comes forward again.

Mr. Mehta said that members had not considered the papers before them when they raised objection to his proposal.

The Corporation would not be carried away by any threats or any intimidation of the public or the press. (Hear, hear.) The only question before them was were they doing their duty. He did not care what the public or the press might say to-morrow if he was satisfied in his own conscience, that they were having this question discussed in a proper way. In asking that the report of Mr. Bruce be deferred and the consideration of the other questions be proceeded with, Mr. Lund had forgotten that he (Mr. Mehta) had a notice of motion which raised the question of the character of the water distribution. Were they going to deal with that notice without discussing the questions which Mr. Bruce had raised ?

Mr. Kabraji : That question can be also postponed (laughter.)

Mr. Mehta : Oh, yes ; I am perfectly prepared to see another member get up and say that the report of the Water Committee be postponed on account of the question of mains. So far as the mains for bringing Tansa Water to the existing reservoir the speaker stated that had already been decided, a resolution having been passed on the subject.

Mr. Cuffe : Are we on the main question ?

Mr. Mehta : Mr. Cuffe referred to this matter himself. He said you must discuss that question and now he prevents me discussing it, Am I in order in discussing it or not.

The President : Perfectly in order (laughter).

Mr. Mehta proceeding said he did not consider much about the discoloured water which was supplied for a few days. The question was a much larger one and concerned waste. The Corporation had said that the application of meters for the prevention of waste was not suitable to the habits of the people of this city. It had always been the belief of the Department and he charged Mr. Harvey with obstinacy on this point that meters would do the work. But they had pointed out and Mr. Santo Crimp had pointed out that measures for the inspection and prevention of waste would be nearly as good as the introduction of meters. (Hear, hear). The charge that he brought against the Water Department was that they had persistently refused ; because they could not get what they asked, to employ the Inspection Staff the Corporation had given them for the purpose of going into houses and preventing waste. That was one question which he would raise on Mr. Bruce's report and the report of the Committee. The attitude of the Corporation had been absolutely misrepresented in this matter, and it had been said over and over again in the much vaunted press that the Corporation had refused to do anything. That was perfectly untrue. The position of the Corporation has been that while admitting that theoretically the adoption of meters would be a good measure it was unsuited for a large native city like Bombay. Mr. Santo Crimp went into the question ; it was perfectly true that he was inclined to say introduce meters, but when he went round the

native town and saw the habits of the people he said it would never do. In his report he told them that inspection and prevention of waste would do. He (Mr. Mehta) went against the water administration, they had taken one view and persistently held their hands and had not taken a measure which though it would not have fully stopped waste would have considerably diminished it. Mr. Bruce had attacked his subordinates and his superiors; and if his letter was so purely irrelevant to the other points as was stated why was Mr. Bruce in such a hurry to bring it forward on the very day when the subject of the water supply would be discussed.

On a division being taken Mr. Lund's amendment was negatived and Mr. Mehta's motion deferring the consideration of the whole subject on being put as a substantive proposition was carried with only one active dissentient.

Condition of the Pipe Water.

The following report of Dr. Cayley, the Divisional Health Officer, on the water supply for the month of June 1901, was considered by the Standing Committee of the Municipal Corporation on 17th July 1901.

The report stated:—"In the interval since the last report was submitted, over 20 inches of rain have fallen, which have effected a considerable improvement in the Vehar and Tansa waters, but only a slight improvement in the Tulsi water. The Vehar and Tansa waters are now both fairly good potable waters, but the Tulsi water, as delivered at the Malabar Hill Reservoir, still has a bad smell and a dark yellow colour. At the instance of the Water Engineer several examinations of the Tulsi water are made from samples taken—1 from the lake, 2 from different points in the course of the main, and 3 from the Inlet Reservoir at Malabar Hill. These examinations were made with the object of discovering, if possible, where the contamination of the Tulsi water, which caused the change in the colour and the offensive smell, had taken place. The smell which was most marked in the sample taken from the air cock at Marole, was the smell of decomposing matter, and resembles the smell of Hydrogen Sulphide. The change in the colour of the water was found to be due to iron which had been dissolved from the pipes. From these examinations it was evident that the water was being contaminated while passing along the main, and that it was this contamination which had made the water so offensive and of such a bad colour.

Further examination of the pipes and pipe water were made by Water Engineer, and some samples of water from the pipe at Marole were submitted to undersigned on 25th June, and also several small tins, which were filled with matters taken from the interior of the pipe at this place. These matters were found to consist of pieces and flakes of iron some as large as walnuts, which had evidently rusted away from the interior of the pipe. They were covered with a black slimy mud, which had a distinct smell of Hydrogen Sulphide. This black slimy matter was found

to consist of a mixture of Sulphide of Iron with mud and organic debris. The samples of water taken from the pipe at this spot also had a distinct smell of Hydrogen Sulphide, and the same smell was noticed when the pipe was first opened, in order to take the samples. When this slimy matter was removed from the lumps and flakes they were found to consist of rusty pieces of iron which were very brittle and readily crumbled to a powder between the fingers. It was apparent then that the chief cause of the smell of decomposition in the Tulsi water was Hydrogen Sulphide gas, which had either been formed in the pipes or had been introduced into them from outside. The yellow colour, as previously stated, was due to the iron absorbed by the water from the rusted lining of the pipes. Material from the interior of the pipes was collected also from a point about 1-2 mile above Marole. The pieces here were found to be pieces of rusted iron and they were not covered with the black slimy mixture of Sulphide of Iron and mud. The only way in which I can account for the presence of this Hydrogen Sulphide gas in the pipes is that the mud from the bed of the Tulsi Lake contains some sulphur, and that, when this decomposed in the pipe in the presence of the loose flakes of Iron, Hydrogen Sulphide gas was formed, which combined with the iron to produce the Sulphide of Iron.

This does not explain why the fragments of iron, taken from the pipe 1-2 a mile above Marole, were not also covered with Sulphide of Iron. The water from the lake itself had a slight smell also, so it is extremely probable that the mud forming the bed of the Lake contains some sulphur, which is given off as Hydrogen Sulphide gas when decomposition occurs in it. The only other explanation is that Hydrogen Sulphide gas gains access to the water in the pipe at Marole from outside.

Colonel Weir in one of his reports records that a strong smell of Hydrogen Sulphide was noted one day on the flats at the north of the Island of Bombay. Hydrogen Sulphide might similarly be given off from the soil in the neighbourhood of Marole, although this does not appear ever to have been noticed. Even if the presence of this gas had been noted here I do not think it would possibly find its way into the pipe, and even if it did, it would not be likely to enter in such quantities as to produce the effect that has been observed in the Tulsi water. It seems evident that the smell in the Tulsi water is caused by the decomposition in the main of sulphur containing mud from the bed of the Lake, which had collected on the rusted fragments off the interior of the pipe, where Sulphide of iron has been formed which keeps up the smell in the water. The yellow colour of the water is undoubtedly due to the absorption of iron from the rusted interior of the pipe. A thorough cleaning of the pipe with a removal of all loose pieces and flakes of iron coated with this Ferrous Sulphide would undoubtedly have a good effect on the Tulsi water and would not only get

rid of the smell, but would also make the water a better colour. The bacteriological examination of the Tulsi water showed that a considerable reduction had taken place in the numbers of the bacteria present in the water. This has been the result of the dilution of the water by the rain that has fallen during the past month. In the bacteriological examination of the Vehar water large numbers of vibrios were found growing in the form of long spiral threads. This is the first time that these vibrios have been found to any extent in any of the waters since September of last year. The effect of the rains has been to reduce the numbers of bacteria present in both the Tulsi and Vehar waters. There has not been much difference in the Tansa Water. As regards the characters of the individual bacteria found, the most noticeable feature was the presence of a large number of vibrios in the Vehar water. Also in all the waters there was a marked absence of a chromogenic bacteria which had been present in large numbers in the dry weather."

Sir Bhalchandra Krishna said that the city was at one time led to believe that it was on account of the vegetable growth in the lake that the water was contaminated. They were now indebted to Dr. Cayley, who deserved best thanks for ascertaining the real cause of the contamination, which was due to the presence of Hydrogen sulphite gas.

The Municipal Commissioner (Mr. Sheppard) said that it was Dr. Turner, the Health Officer, whose attention was first drawn to the colour of the water and detected the presence of iron in it and who drew the attention of Dr. Cayley.

Sir Bhalchundra Krishna said that it was an advantage to have at the head of the department an officer, who had a thorough knowledge of things and was a trained scientific man. Thanks were due to Dr. Turner and Dr. Cayley for their report. The cleaning of the pipes would bring clear water into the City next year. The health Officer ought to try and find out whether the hydrogen sulphite gas was generated in any particular place and that it existed all along the pipe line. If it was generated in the lake, then it must run all along the pipe line.

Dr. Ismail Jan Mahomed said that thanks were due to both Dr. Turner and Dr. Cayley for the light they had thrown in the matter. He desired to know if the presence of hydrogen sulphite rendered the water impure and unfit for drinking purposes and whether that was the cause of the prevalence of diarrhœa in the city. He had recently seen two cases of guinea worms, which were extinct ever since the water had been brought down from Vehar by means of pipes.

Dr. Dadachanji agreed with the former speakers in complementing Dr. Turner, but he could not extend the same amount of courtesy to Dr. Cayley, who was at one time of opinion that the offensive smell of the water was due to the soil of the

lake being impregnated with organic matter, but who had now changed his opinion and said that it was due to incrustations in the pipe line. The speaker asked why these pipes had not been cleaned with self cleaning scrapers.

After some further discussion, on the motion of Sir Bhalchundra it has agreed that the Commissioner be requested to ask the Health Officer to report, whether the presence of hydrogen sulphite was injurious to the health of those who consumed the water.

Further debate on the water question.

The water question was further discussed at an adjourned meeting of the Corporation held on 25th July 1901, Mr. D. E. Wacha presiding. It had been decided that questions in regard to the water supply should be specially considered at this meeting and there was an interested gathering of members of the public.

The President intimated that copies of the resolutions passed at the meeting of ratepayers in regard to the meter question had been received.

The Secretary (Mr. Wadya) having read these resolutions, the President proceeded to intimate the procedure to be followed in the discussion of the water question. He suggested that they should take all the notices of motions on the agenda in the shape of one comprehensive resolution.

Mr. Mehta said they were going to consolidate the motions, but it was at the same time desirable that everybody should have an opportunity of putting forward their views. All the propositions would be taken at once and discussed, but when the time came for voting, each part would be taken separately.

Mr. Hormusjee Vakil said members were not aware that the notices of motions had been consolidated. All the members had not signed the minutes and those who were not parties to them ought to have the right of beginning the discussion. Each side would thus have two innings.

The President said the procedure as laid down by Mr. Mehta was quite correct. Everybody would have a right of speaking according to his lights, Mr Mehta's motion on the paper was really a very comprehensive one, embracing many things included in the several similar motions and he therefore asked Mr. Mehta to move his proposition.

Mr. Mehta said he considered this occasion to be of such a character that one should not be tempted to make an oration. He was not going to approach the discussion of this very important subject except in a very sober and practical manner; so that the object they had at heart might be fully discussed and some solution found for the difficulty in which they were placed. He appealed to members to devote themselves to the consideration of the real question before them irrespective of all

extraneous and personal considerations. It was their duty to approach the subject with the single-minded purpose of seeing if they could find a solution of the difficult question which stared them in the face in regard to the Municipal administration of this City. The question was really not one of meters as unfortunately it had been reduced to, though of course meters would very largely enter into the discussion of the question. The real question was to find some means for the purpose of remedying the loud and just complaints they were constantly hearing from the ratepayers as to the insufficient and irregular supply of water. In the circumstances of the City of Bombay, with the system of house connections being introduced, water should be supplied to such an extent that there may be no difficulty in meeting the sanitary requirements of the City. It was on the initiative of the City and Corporation, and not on that of the Executive Officers of the Municipality that the ratepayers were subjected to an additional and large expenditure for the purpose of securing a constant and full supply of water. He reviewed the development of the water supply and the successive adoption of the Vehar, Tulsi and Tansa lakes as sources of supply. It was at very heavy cost that they brought in that large supply from Tansa, which enables the City to take credit for having one of the most magnificent water supplies in the world and they ought to try their best to find remedies for the complaints which were now made. He had been very much disappointed to see that in the deliberations on a question of this difficult character the members of the Corporation had not got the assistance they should have got from the public press. They had had articles abusing them to a certain extent; perhaps abusing was too strong a word, but coming down upon them. It was intimated that they did not take a particular view and ought to be turned out; that was the way in which one of the leading Anglo-Indian papers had referred to this question. He attached great weight to public opinion and he was glad to have the resolutions from the public meeting but there again he was disappointed. He would like to have seen arguments advanced at that meeting that would have strengthened his opinion that meters should not be introduced in the City. Instead of that he found that the principal speaker had absolutely given away the whole case. He was horrified to find that after a very long speech the gentleman came to this end: "Put your meters in but only charge us our assessment rate." The burden of the speech was "have your meters but don't charge us more than the present assessment rate."

Mr. Hormusjee Vakil asked that the passage in the speech should be read.

Mr. Mehta read from the speech as reported in a vernacular paper.

Mr. Sukhia asked if it was in order to refer to what took place at the ratepayers' meeting?

The President: The resolutions of the ratepayers' meeting are before us and it is perfectly in order.

Mr. Mehta proceeding said he believed some ratepayers' representatives were at that meeting and a gentleman got up and said if they didn't hold the opinion he was setting forth they should resign their seats. He should have told them to go to their constituents, explain their views and if the voters were not satisfied with the explanation give them an opportunity of electing some body else who represented the voters' views. The speakers at the Ratepayers' meeting had supplied arguments to strengthen the hands of their opponents. The gentleman who made the remark just quoted also said that he was acquainted with most European towns and in no civilized city was the meter system introduced.

Mr. S. C. Dhondy interrupting observed that they did not object to the experiment with meters if it was done at the cost of the Corporation and not at the expense of the public.

Mr. Mehta: If members believe that, and that we are not to charge more than four per cent. on the assessment, then the difficulty can be met. There appeared, he said, to be a misapprehension. No Municipal officer had suggested that meters should be introduced in the whole city, but only in one ward. There never had been a proposal for the metering of the whole city for a long time to come. Mr. Snow and Mr. Tomlinson pointed out that it would take a long time for the metering of one ward to be carried out. At the public meeting the real point was never grappled with. Nobody seemed to have considered the question from the point of view which Mr. Murzban presented and which Mr. Snow afterwards adopted. Mr. Murzban pointed out that if they were going to introduce meters their rates of charge must be radically altered. Very great and right stress was laid upon the point that the natives of India are of so thrifty a character that if they had to pay more they would not take sufficient water for purposes of cleanliness. But it must be also borne in mind that in Mr. Snow's report there was a remedy for that evil. The system recommended was that in the first instance there must be a minimum charge for a certain quantity of water which everybody must take, sufficient for all normal purposes. That quantity was calculated at twenty gallons per head; that quantity every body is bound to pay for, and therefore everybody will take it. What was the use therefore of saying that the people would not take sufficient water for sanitary purposes when those who proposed the meter scheme had already met that difficulty.

The great fear was that the proposal to adopt meters was a way of getting additional revenue out of the ratepayers. That was partly true and partly incorrect so far as the officials were concerned. But it was entirely incorrect so far as the report of

the Water Committee was concerned. It had never entered their minds to discuss the matter from the point of view of revenue. The law prohibited the Corporation making a profit out of their water revenue. Mr. Harvey proposed to raise the water tax, but the Standing Committee threw out the proposal. The object of the Water Committee, in recommending the experiment with meters was only to ascertain if the different views about wastage of water could be reconciled by information obtainable by the experiment. It was stated that the Corporation were bound to go by the opinions of their experts. There was a time when he held such a view but he said now that the Corporation was not to be bound hand and foot to experts. The Corporation were in a very unenviable position in regard to expert advice for whether they followed it or not, they were made the scapegoat. The City had suffered not a little from following the opinions of experts, and as instances in point he referred to the sewage outfall, the flats and the adoption of the European pattern of house connections. But was it correct that all expert advice had been on the side of the introduction of meters? Mr. Santo Crimp, who had all the materials before him including Mr. Tomlinson's reports and had Mr. Murzban at one ear, and Mr. Bruce at the other, did not say that meters were absolutely necessary. He said "although it may appear paradoxical, there may be less waste with a constant supply than with an intermittent supply, because an efficient system of waste prevention is a necessary consequence of a constant supply." He (Mr. Mehta) was quite prepared to admit there was a certain amount of negligence in the use of water taps, but if water was sent to houses in the night surely nobody would expect working people to sit up waiting for the water (Hear, hear). Mr. Santo Crimp said that given a constant supply with an adequate staff for prevention of waste, household meters would not be necessary. (Hear, hear). It had however to be considered that the waste prevention staff would have to enter houses and might not a great deal of harassment and oppression be alleged? (Certainly) Mr. Harvey dwelt on that, but he (Mr. Mehta) agreed with Mr. Santo Crimp in thinking that a practical method of dealing with the difficulty could be devised. Mr. Santo Crimp admitted that the household meter system was the most effective method of checking waste—(Hear, hear).—but did it follow that they should introduce it. One strong argument againt its introduction, unless absolutely necessary, was the cost. Mr. Snow calculated that it would require Rs. 42,000 to meter a section of Bhuleswar ward with a population of 38,363. On that basis, the cost for the whole city would be something like fifteen lakhs of rupees, which on the estimated life of a meter would have to be renewed every twenty-five years, unless they provided a sinking fund. The necessary staff would cost Rs. 3,769 per annum.

Dr. Sukhia pointed out that Mr. Tomlinson stated that to