(1) பக்கங்களின் எண்ணிக்கை 64

(2) புதுக்கித் திருப்பிய நாள் 25-8-1988

(3) ஆதாரங்குறிப்பவர் சுருக்கொப்பம்

தமிழ்நாடு ஆவணக் காப்பகம்.

தமிழ்நாடு அரசு

பொதுச் சார்பு துறை

அரசாணை எண். 2480 W
மு. கோப்புத் தாள் எண். A

அச்சகம்
பலவகை

நாள் : 14-8-1888

1987.

படிக்கவோ கண்டபடி கையாளவோ கூடாது

அரசு. கா-1—18,006—15-6-87.

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14th August 1888, No. 2480 W./A., Public Works.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Military Works.

Read—the following paper :—

Note by the Chief Engineer, Public Works Department, dated 14th August 1888, on the Bangalore water-supply.

Order—dated 14th August 1888, No. 2480 W./A., Public Works.

The foregoing Note will be communicated to Mr. Larminie, Executive Engineer, who will be directed, if he is willing to cancel the remainder of his furlough, to proceed to Bangalore and prepare in detail the estimates required under the direct orders of the Chief Engineer, Public Works Department.

2. Mr. Larminie should place himself in communication with Colonel Bowen, R.E., Superintending Engineer of Mysore, who has expressed himself willing to give any assistance in his power, and should submit, without delay, a statement of establishment required to aid him in the preparation of the estimates.

3. Mr. Larminie will be placed on duty from the date he reports his arrival at Bangalore.

(True Extract.)

Captain, R.E.,
Under-Secy. to Govt., P.W.D.

To J. C. Larminie, Esq., with copy of Note.
To the Superintending Engineer, V Circle.
" Examiner, Public Works Accounts.
" Military Department.

Exd. F. R. Bantleman.
Spare Copies

N. B— The present No. vide 2480 W. dated 14th August 1888, supersedes No 524 A of the same date which was dispatched from Ootacamund in manuscript.

BUILDINGS AND ROADS.
MILITARY WORKS.

Govt. of [1888] Madras.

PUBLIC WORKS.

Dated Augt. 1888.

Encl.

Read.

G.O., 14th Aug. 1888, No. 2480 W.
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AUGUST.

Bangalore Water-supply

Communicating to Mr. Larminie, Executive Engineer, with instructions. Note by the Chief Engineer, Public Works Department, on the —.

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NOTE ON THE BANGALORE WATER SUPPLY.

Of the many schemes which have been brought forward in response to the notification calling for essays on the subject of providing a pure water-supply for the troops in Bangalore, for the civil and military station and the pettah, only two propose a supply by gravitation. One of these, which suggests a reservoir on the Nilgiri Hills with pipes therefrom, may be rejected at once on the score of the distance and consequent cost of piping; and the other, which is merely a resuscitation of an old proposal to bring water in from the neighbourhood of Nundidroog, is open also to serious objections. All other schemes propose lifting the water, and the result of an examination of them and of the country in the neighbourhood of Bangalore leads to the conclusion that lifting the water is inevitable. The height to which it is proposed to lift the water varies in the different schemes from 100 to 400 feet, and even the greatest of these heights should not, it is considered, be viewed in the light of an insuperable objection to the scheme, if it provided really good water.

2. A great many of the schemes contemplate the improvement of Sankey's tank, which already contributes, to some extent, to the supply of the civil and military station and also the pettah, and is supposed to supply really good water; but it has to be noticed that so long as the rifle butts remain in their present position, so long will the supply to Sankey's tank be liable to contamination, as it will be impossible to prevent the catch channels being used as latrines.

3. The question of the right to the water in Sankey's tank has not yet been finally settled. The tank * was originally intended to provide a supply of pure water to the civil and military station; the population of the pettah was not provided for, but as part of the catchment area of the Dharmambudi tank on which the pettah mainly depends was to be cut off, provision was made for supplementing it by means of scour cocks in the delivery mains. The cost of the project was borne

* Memorandum by Superintending Engineer of Mysore.

by Mysore, and it was intended that "a moderate charge should be made to the municipality for water supplied, and a like charge to Government for water given to the British Forces." On the rendition of Mysore, the tank (which had proved a failure owing to causes too well known to need recapitulation here) with its catchment area was left in Mysore territory. That the Mysore Government expended nearly five and-a-half lakhs on the works constitutes a decided claim on their part to the tank-supply, but the contention of the municipality that the surplus revenues of Bangalore, which consisted of upwards of one and-a-half lakhs of rupees, may be assumed to have met the expenditure, should not be lost sight of, also that the object of the works was to supply the civil and military station with good water at a moderate charge, and the fact that had the works fulfilled their object, the site would not have been left in Mysore territory without, at all events, a fixed agreement on the part of the Mysore Government to supply the water required by the station. There seems every prospect that the question of right of supply from this source can now be satisfactorily settled, and it is essential that it should be settled at once, as there is no doubt that the tank may, at a reasonable additional cost, be made to bear its share in providing Bangalore with good water.

Government of India's letter No. 384 C., dated 25th June 1869.

4. What that share may be has now to be considered. Very careful observations have been made and recorded at Sankey's tank for a number of years by the officers of the Mysore Public Works Department, and some able papers on the subject of the water-supply have been furnished by Lieut.-Colonel Bowen, R.E., and Major Kensington, R.E. From a study of these, it appears that from the catchment area of $2\frac{1}{2}$ square miles the average available supply per square mile of catchment per annum has been 11 million cubic feet, the maximum 17 million cubic feet per square mile, and the minimum 7 million cubic feet. According to General Mullins the greater portion of the water thus received into the tank has been lost by evaporation, absorption, and leakage through the tank-bund; but Major Kensington disputes the correctness of this conclusion, and proves that a great deal of the water escaped through the high level sluice, which can be made water-tight, and thus reduce the

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quantity lost to from $12\frac{1}{2}$ to 15 million cubic feet. Of this it is difficult to ascertain how much is lost by evaporation, and how much by leakage, but it may be gathered that probably half is due to leakage. If leakage can be prevented, there would, therefore, be $11\frac{1}{4}$ million cubic feet available in the worst year, say, 70 million gallons, nearly 40 gallons a head for 5,000 people or 4 gallons a head of 50,000.

5. That leakage can, to a very great extent, if not entirely, be prevented seems beyond doubt. The Mysore Government are now constructing a dam across the valley a little below the reservoir bund, a portion of the foundations of which are on solid rock and a great portion of the water, which at present escapes through and under the bund, will be caught by this dam and made available for the pettah. Various schemes have been brought forward in the essays for preventing leakage by filling in the bed of the reservoir with puddle or concrete, and for improving the catchment by sub-soil drains with a view to storing more water, which the reservoir can easily do if leakage is stopped; but it is safe and wisest to base our actual supply for consumption on the quantity that will be available from the catchment area in the worst year recorded, and we may estimate this supply roughly in another way as follows. The actual run off the catchment area by measurement in the worst year is shown to be 7 million cubic feet per square mile or $17\frac{1}{2}$ million cubic feet altogether; deduct one-third for loss by evaporation, &c., and we have $11\frac{1}{2}$ million cubic feet or 71 million gallons available for consumption.

6. It will be well here to consider the quantity per head per diem that should be provided. In the schemes that have been proposed, this quantity varies very considerably, the highest being 20 gallons and the lowest, for drinking purposes alone, about 2 gallons. The ordinary allowance in England in non-manufacturing towns is 16 to 20 gallons, but in this country, where water is not required for closets or for washing clothes, it may be very much less. Major Kensington says: "In Mysore, according to very carefully prepared statistics, the consumption was found to be, in 1874, $1\frac{1}{4}$ gallons a head per diem at the highest estimate. Surgeon E. Nicholson, who was for a long time employed as analyst of waters in Mysore, in his report, dated 18th December 1871, on the water-supply of Bangalore, puts

down 3 gallons a head per diem for every man, woman, and child, as very liberal." The supply provided for the troops in Captain Romilly's estimates, the latest approved by Government, was about 12 gallons per head per diem, and it is considered that a very ample supply will be provided if 2 cubic feet or $12\frac{1}{2}$ gallons are allowed for the troops and 1 cubic foot or $6\frac{1}{4}$ gallons for the native population.

7. On this assumption it follows that Sankey's tank would fully supply the troops also 24,000 natives, or a native population of 34,000, and it is shown by Major Kensington that by raising the bed of the tank water could be supplied to the troops, and civil and military station by gravitation, while without any such raising, it can supply the pettah. So large a sum having been spent on the tank, it should, as a matter of course, be utilised to the fullest extent possible, and as from any other source of supply, every gallon must be raised a considerable height, the water that can be brought in by gravitation should be made to supply as much of Bangalore as possible.

8. A thorough examination of all the old schemes and also the new, amounting to 17, as well as the country in the neighbourhood of Bangalore, has led to the conclusion that the best sources of supply are to be found in the Hebbal basin near the head of Pennakinni valley, about 4 miles north of Bangalore, and in the so-called Magudi Road basin, near the head of the Arkavutty valley, about 7 miles west of Bangalore; two schemes have been brought forward in outline for the former, and two for the latter.

9. The rivers Pennakinni and Arkavutty which drain the ground adjacent to Bangalore are not here rivers in the ordinary acceptation of the term, in the beds of which water flows for some months in the year, and is to be found below the surface of the bed for the rest. They are simply drainage channels which were dammed across at frequent intervals in old days to form the tanks which cover the face of the country. Under each tank is more or less wet cultivation, either rice or garden crops as perhaps sugar-cane, and the lands thus cultivated are probably everywhere manured and near Bangalore most likely more heavily manured than land at a distance. Near the tanks are village-sites, and these sites together with the manured fields must drain into the next lower tanks. Such gathering grounds cannot be

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expected to yield absolutely pure water, though it is possible that such water, if stored in a very large volume, might be considered usable, and it may be laid down that the fewer the tanks and village-sites in the catchment area, the better the water will be, also that the further from Bangalore the better is the chance of obtaining a pure supply, the outskirts of any large town being evidently liable to contamination of the soil even beyond that due to manuring.

10. The first scheme for supply from the Hebbal basin is one which has attracted a good deal of attention, as it was proposed by General Fischer, R.E., and has received the approval of the municipality, being the only scheme apparently of those brought forward, which has been considered by that body. The scheme has not, of course, been worked out in detail, and is a mere sketch based on assumptions as well as on facts. It provides for enlarging the Hebbal tank about 5 miles to the north from the cantonment for pumping up the water from thence to the top of the muntapam hill from which, after filtration, it could be distributed by pipes to the troops, station, and pettah. The distance is stated to be about 5 miles, the lift 100 feet, and the cost without distribution three lakhs of rupees. The tank is apparently intended to hold fifteen million cubic yards or three years' supply, in addition to water required for irrigation, and the catchment area is stated to be at least ten square miles.

11. The very full information which is available in the Irrigation Branch of the Mysore Public Works Department enables the assumptions and facts of the scheme to be tested, and the result is not favorable to the scheme. The total catchment area is $12\frac{1}{2}$ square miles, of which 5,120 acres are intercepted by the tanks above Hebbal, leaving the independent drainage area of the Hebbal tank $4\frac{1}{2}$ square miles, and applying the data which have been ascertained at Sankey's tank, and the rule that in the year of lowest rainfall the run off shall determine the supply available for consumption, we have total run off from $4\frac{1}{2}$ square miles $31\frac{1}{2}$ million cubic feet, and deducting one-third for evaporation and loss 21 million cubic feet or 131 million gallons available for consumption, which would supply about 57,000 people with $6\frac{1}{4}$ gallons a day. We should not, therefore, accept this scheme as providing a sufficient supply of water. It is true that it is

proposed to enlarge the tank so as to hold three years' supply, and thus catch the surplus water of good years to supply the deficiency of bad years, but applying the data of the Public Works Department again, we have a run off of 17 million cubic feet per square mile in the year of best rainfall or a total run off from the whole catchment area of 212½ million cubic feet or 7·8 million cubic yards. The tanks above will absorb 1·9 million cubic yards of this amount leaving 5·9 million cubic yards available in the best year, which shows that a tank intended to hold 15 million cubic yards, besides 5 million cubic yards for irrigation, would never fill.

12. It may not be necessary to pursue the subject further, but a few words may be said as to the amount of the estimate. Compensation is allowed for at Rs. 40,000, but the best authority estimates the amount required, if the tank is enlarged as proposed, at three or four times that amount, and the engine and mains seem also to be insufficiently estimated. Then, if we add two lakhs for distribution works, the amount of the estimate will be, say, 6 lakhs for the supply in round numbers of, say, 60,000 people.

13. The second scheme for supply from this basin is one proposed by Major Kensington, R.E.; he takes the Nagawaram tank, the next in the series below the Hebbal tank, as the source of supply, takes up three small tanks lying to the north, and excavates a catch channel to take the water from these tanks and the surplus from the Jakkur tank, a considerable reservoir lying rather to the north and east. By this means he obtains a clear catchment area of 10 square miles and a total catchment of 51·61 square miles. He increases the storage capacity of the tank to 80 million cubic feet restricting its area to 100 acres, to minimise the loss for evaporation. He takes his supply from wells sunk on the south margin of the tank into which the water will filter, and pumps the water up to about 100 feet above the tank-bed, supplies 80,000 cubic feet per diem under moderate pressure at a level of 2,960 + M.S.L. and 20 cubic feet to be further raised and delivered at a level of about 3,050. This, he claims, will supply all parts of the civil and military station and the troops, say, 100,000 people, at the rate of 6¼ gallons per day. The water is practically the same as that in General

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Fischer's scheme, and the height to be raised, with the exception of the small supply referred to, about the same. The cost is estimated, including compensation and distribution, at six lakhs of rupees.

14. Applying the data given above, we may expect a run off in the worst year from a free catchment of 10 square miles of 70 million cubic feet. Deducting one-third for loss from evaporation, &c., we have 47 million cubic feet available for distribution; this would give about 7½ gallons per diem for 100,000 people. The estimate appears to be liberal, except in the item of distribution, and the scheme is certainly an improvement on that of General Fischer's, the only weak point in it being the enlargement of the catchment area by means of a catch channel, which, it is possible, might breach and lose a large portion of the supply; if the channel did breach, the free catchment of the tank would be rather less than that of the Hebbal tank.

15. Of the quality of the water in this basin, we have no report; all that is claimed for it is that it is as pure a supply as that obtained from any similar source, and in Major Kensington's scheme that the water being taken from wells is naturally filtered, and therefore as pure as filtered water can be. We must, however, remember that the water flows from cultivated land within four miles of a very large town, and therefore more heavily manured than ordinary land, and that the area includes several village-sites with all their impure surroundings. A fairly thickly-populated and well-cultivated catchment area in the neighbourhood of a large town could only be accepted as a gathering ground for drinking water in the absence of more favorably-situated ground.

16. We now come to the two schemes for procuring the supply from the Arkavutty valley. These were independently prepared by Mr. Standish Lee, Sanitary Engineer of Mysore, and Mr. Garrett, Executive Engineer, Public Works Department, and both propose the construction of a reservoir on a stream which crosses the Magadi road about seven miles from the cantonment. Mr. Garrett proposes to dam the stream near the road, where he says there is a catchment area of about 4½ square miles, but which he assumes for safety to be 4 square miles, and Mr. Lee about a mile below the road where he finds the catchment area to be 8·84 square miles. From inquiries

made on the spot, it seems certain that Mr. Garrett has under-estimated the area, and that Mr. Lee's estimate of area may be accepted.

17. The country here is very different in character to the Hebbal basin: the slope of the drainage is very much greater, high rocky mounds with deep valleys between break up the surface, and, for the most part, the land is waste, with a very small extent of dry cultivation, a few mere ponds, and a few very small villages. The run off must be very much greater than in the other valley, and the poor character of the soil may be seen from Mr. Garrett's statement based on the authority of the Amildar of Bangalore that to buy up about 5 square miles with all houses, trees, ponds and cultivated land would cost only Rs. 82,000. The ground is, as has been ascertained by inspection, eminently suited for a gathering ground, the valley is deep and very narrow in parts, and there are sites where it contracts below apparently fair-sized basins, where reservoirs might be formed at a very reasonable outlay. There is a little laterite to be seen at the head of the valley, but everywhere else the out-cropping rock is igneous, the bed of the streams being rocky throughout. If the few huts and the cultivated land in the catchment area were bought up, the water drained off must be as absolutely pure as any surface drainage can be.

18. As regards the quantity of water available, if we apply the data as above, the run off from 8·84 acres is 61·8 million cubic feet in the worst year of rainfall, and deducting one-third for loss from evaporation, &c., the quantity available for consumption will be 41·2 million cubic feet, or 7 gallons per head per diem for 100,000 people. It has, however, been stated above that from the character of the ground the run off must be considerably in excess of that from the comparatively level ground experiments on which determined the data, and it may, therefore, it is considered, be safely assumed that the run off in the worst year of rainfall would afford a supply of $6\frac{1}{4}$ gallons to 130,000 people, and that one year's supply could be stored without a very heavy expenditure.

The height to which the water must be raised is, however, at least double that which it is proposed to be raised on the Hebbal side. Both Mr. Lee and Mr. Garrett estimate it to be 200 feet, but it would appear that the bed of the

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stream at Mr. Lee's site is about 230 feet below the level at which water must be delivered.

19. As regards the cost of the schemes. Mr. Lee estimates in detail only the cost of supplying the troops with 60,000 gallons a day, making use of one of the Hulsur engines and pumps and part of the present delivery pipes. For this quantity he makes out the cost would be Rs. 1,65,000, and the annual outlay, including interest, Rs. 25,824. Mr. Garrett estimates that the cost of supplying the same quantity would be Rs. 4,50,000, and annual outlay, including interest, Rs. 62,600, but he allows for new engines and all new pipes, as well as for buying up the whole catchment area.

Mr. Lee has proposed by the construction of dams lower down the same stream to impound sufficient water for the supply of the whole of Bangalore, or for 150,000 people, but his catchment area would then include tanks into which part of the drainage of the pettah flows, and land occupied by tanneries, and would give anything but a pure supply, the height to which water must be raised would also be 400 feet.

Mr. Garrett also proposes to utilise the drainage to the utmost extent possible, and in conjunction with an existing reservoir to supply the whole of Bangalore. In this case he estimates that the Magadi road works with all distribution would cost six and-a-half lakhs.

20. The schemes then worked out roughly, as they, of course, must be, for the purpose for which they were intended, promise a sufficient supply of as nearly pure water as any surface drainage can be for 100,000 people at a reasonable cost, that is, about six lakhs, and, so far as can be judged from the figures, the cost per 1,000 gallons would be less than one-third of a rupee. It may be said, therefore, that they promise well.

21. Of everything, then, that has been brought forward or suggested, this seems to be the best arrangement, and one that will provide Bangalore with a good and sufficient water-supply. (1) Construct a reservoir on the tributary drainage of the Arkavutty at or about one mile below the Magadi road to contain more than one year's supply for 100,000 people, at $6\frac{1}{4}$ gallons a head a day, pump up the water to a service reservoir and stand-pipes sufficiently high to command the station and barracks, and lead the water by pipes to

the station utilising, as far as possible, the existing engines, pumps, distribution pipes &c. (2) Improve Sankey's reservoir as above indicated, by which means a supply for between 30,000 and 40,000 people can be provided. We should thus put a supply of good water almost at every door for, say, nearly the whole population; but it must be remembered, that numbers of the inhabitants will still draw their supply from wells which furnish good water, and many, however good the supply at the tap, will prefer to use the tanks to which they are accustomed, and the water in which is softer and pleasanter than any other. We cannot therefore breach the tanks and let the beds dry up, and as they must remain, it will still be our duty to conserve them and to prevent the water from spreading disease among the people. To this end it is necessary to divert the bazaar drainage entirely from the tanks, to prevent the establishment of cholera camps, tanneries, &c., on grounds which drain into the tanks, and also to prohibit all garden cultivation or any cultivation which requires manuring in the drainage area. The diversion of bazaar drainage, and buying out cultivation should form a part of any estimate for the water-supply, and once it is accomplished, ordinary conservancy on the part of the municipality will prevent the tanks being a source of danger to the inhabitants.

22. It will then remain to be settled how the supply available is to be distributed, and there seems no doubt whatever that the troops should be supplied from the Magadi road reservoir, which must give the nearest approach to absolutely pure water; and after full consideration of the subject, it seems desirable that the civil and military station should also be supplied from the same source. The main will, it is true, run past the pettah, but the pettah can best be supplied by gravitation from Sankey's tank; and even if that tank cannot be made absolutely water-tight, the leakage through and under the bund can be caught by the works now in progress under the Mysore Government, and conveyed to the pettah. The supply from Sankey's tank would, as above shown, provide 6¼ gallons a-day for a population of 34,000 or 4 gallons a-day for 50,000,—an amount which, judging from experience in Mysore, is more than ample. The best arrangement seems to be to enter into some agreement with the Mysore Government whereby all

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rights to the supply from Sankey's tank can be handed over to the Mysore Government and in return the catchment area of the Magadi road reservoir could be handed over to the Madras Government for a certain sum, which, considering the claim the troops and station may have on Sankey's tank, would be, of course, less than the actual value of the land. This might, if the respective Governments agreed, be decided by arbitration.

23. It is suggested that no time should be lost in investigating the Magadi road scheme and preparing complete detailed estimates for all works connected therewith. The estimates can best be prepared by officers acquainted with the locality and of local experience, and it is probable that the Mysore Government would not be unwilling, considering that the Madras Government have already given the services of its officers for considerable periods for purposes of investigation, to depute an officer of their Public Works Department to work out the estimate. If necessary, however, an officer from Madras could be made available, and possibly Mysore might consent to defray part of the expenses. It may, of course, prove that there are objections to the Magadi road scheme, which have not as yet been brought to light, and that the cost will be heavier than anticipated; it is desirable, therefore, that, at the same time, estimates should be prepared for Major Kensington's scheme, the cost of the two schemes compared, and analyses of the water derived from each obtained, there seems little doubt, however, that the Magadi road scheme will provide the purest supply, and that it will be worth while to pay for the best water.

As regards provision of funds for the works there is no doubt that the Government of India will be prepared to entertain any reasonable scheme for the supply of good water for the troops; but it can hardly be expected that they should pay also for the supply to the civil and military stations, and it will be necessary, therefore, to ascertain what amount the municipality should and can contribute for their supply.

(Signed) J. O. HASTED, Col., R.E.,
Chief Engineer, P.W.D.

PUBLIC WORKS DEPARTMENT,
OOTACAMUND, 14*th July* 1888.

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Of the many schemes which have been brought forward in response to the notification calling for essays on the subject of providing a pure water-supply for the troops in Bangalore, for the civil and military station and the pettah, only two propose a supply by gravitation. One of these, which suggests a reservoir on the Nílgiri Hills with pipes therefrom, may be rejected at once on the score of the distance and consequent cost of piping; and the other, which is merely a resuscitation of an old proposal to bring water in from the neighbourhood of Nundidroog, is open also to serious objections. All other schemes propose lifting the water, and the result of an examination of them and of the country in the neighbourhood of Bangalore leads to the conclusion that lifting the water is inevitable. The height to which it is proposed to lift the water varies in the different schemes from 100 to 400 feet, and even the greatest of these heights should not, it is considered, be viewed in the light of an insuperable objection to the scheme, if it provided really good water.

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* Memorandum by Superintending Engineer of Mysore.

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Government of India's letter No. 384 C., dated 25th June 1869.

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cubic feet. Of this it is difficult to ascertain how much is lost by evaporation, and how much by leakage, but it may be gathered that probably half is due to leakage. If leakage can be prevented, there would, therefore, be $11\frac{1}{4}$ million cubic feet available in the worst year, say, 70 million gallons, nearly 40 gallons a head for 5,000 people or 4 gallons a head of 50,000.

5. That leakage can, to a very great extent, if not entirely, be prevented seems beyond doubt. The Mysore Government are now constructing a dam across the valley a little below the reservoir bund, a portion of the foundations of which are on solid rock and a great portion of the water, which at present escapes through and under the bund, will be caught by this dam and made available for the pettah. Various schemes have been brought forward in the essays for preventing leakage by filling in the bed of the reservoir with puddle or concrete, and for improving the catchment by sub-soil drains with a view to storing more water, which the reservoir can easily do if leakage is stopped; but it is safe and wisest to base our actual supply for consumption on the quantity that will be available from the catchment area in the worst year recorded, and we may estimate this supply roughly in another way as follows. The actual run off the catchment area by measurement in the worst year is shown to be 7 million cubic feet per square mile or $17\frac{1}{2}$ million cubic feet altogether; deduct one-third for loss by evaporation, &c., and we have $11\frac{1}{2}$ million cubic feet or 71 million gallons available for consumption.

6. It will be well here to consider the quantity per head per diem that should be provided. In the schemes that have been proposed, this quantity varies very considerably, the highest being 20 gallons and the lowest, for drinking purposes alone, about 2 gallons. The ordinary allowance in England in non-manufacturing towns is 16 to 20 gallons, but in this country, where water is not required for closets or for washing clothes, it may be very much less. Major Kensington says: "In Mysore, according to very carefully prepared statistics, the consumption was found to be, in 1874, $1\frac{1}{4}$ gallons a head per diem at the highest estimate. Surgeon E. Nicholson, who was for a long time employed as analyst of waters in Mysore, in his report, dated 18th December 1871, on the water-supply of Bangalore, puts down 3 gallons a head per diem for every

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man, woman, and child, as very liberal." The supply provided for the troops in Captain Romilly's estimates, the latest approved by Government, was about 12 gallons per head per diem, and it is considered that a very ample supply will be provided if 2 cubic feet or 12½ gallons are allowed for the troops and 1 cubic foot or 6¼ gallons for the native population.

7. On this assumption it follows that Sankey's tank would fully supply the troops also 24,000 natives, or a native population of 34,000, and it is shown by Major Kensington that by raising the bed of the tank water could be supplied to the troops, and civil and military station by gravitation, while without any such raising, it can supply the pettah. So large a sum having been spent on the tank, it should, as a matter of course, be utilised to the fullest extent possible, and as from any other source of supply, every gallon must be raised a considerable height, the water that can be brought in by gravitation should be made to supply as much of Bangalore as possible.

8. A thorough examination of all the old schemes and also the new, amounting to 17, as well as the country in the neighbourhood of Bangalore, has led to the conclusion that the best sources of supply are to be found in the Hebbal basin near the head of Pennakinni valley, about 4 miles north of Bangalore, and in the so-called Magadi Road basin, near the head of the Arkavutty valley, about 7 miles west of Bangalore ; two schemes have been brought forward in outline for the former, and two for the latter.

9. The rivers Pennakinni and Arkavutty which drain the ground adjacent to Bangalore are not here rivers in the ordinary acceptation of the term, in the beds of which water flows for some months in the year, and is to be found below the surface of the bed for the rest. They are simply drainage channels which were dammed across at frequent intervals in old days to form the tanks which cover the face of the country. Under each tank is more or less wet cultivation, either rice or garden crops as perhaps sugar-cane, and the lands thus cultivated are probably everywhere manured and near Bangalore most likely more heavily manured than land at a distance. Near the tanks are village-sites, and these sites together with the manured fields must drain into the next lower tanks. Such gathering grounds cannot be

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expected to yield absolutely pure water, though it is possible that such water, if stored in a very large volume, might be considered usable, and it may be laid down that the fewer the tanks and village-sites in the catchment area, the better the water will be, also that the further from Bangalore the better is the chance of obtaining a pure supply, the outskirts of any large town being evidently liable to contamination of the soil even beyond that due to manuring.

10. The first scheme for supply from the Hebbal basin is one which has attracted a good deal of attention, as it was proposed by General Fischer, R.E., and has received the approval of the municipality, being the only scheme apparently of those brought forward, which has been considered by that body. The scheme has not, of course, been worked out in detail, and is a mere sketch based on assumptions as well as on facts. It provides for enlarging the Hebbal tank about 5 miles to the north from the cantonment for pumping up the water from thence to the top of the muntapam hill from which, after filtration, it could be distributed by pipes to the troops, station, and pettah. The distance is stated to be about 5 miles, the lift 100 feet, and the cost without distribution three lakhs of rupees. The tank is apparently intended to hold fifteen million cubic yards or three years' supply, in addition to water required for irrigation, and the catchment area is stated to be at least ten square miles.

11. The very full information which is available in the Irrigation Branch of the Mysore Public Works Department enables the assumptions and facts of the scheme to be tested, and the result is not favorable to the scheme. The total catchment area is $12\frac{1}{2}$ square miles, of which 5,120 acres are intercepted by the tanks above Hebbal, leaving the independent drainage area of the Hebbal tank $4\frac{1}{2}$ square miles, and applying the data which have been ascertained at Sankey's tank, and the rule that in the year of lowest rainfall the run off shall determine the supply available for consumption, we have total run off from $4\frac{1}{2}$ square miles $31\frac{1}{2}$ million cubic feet, and deducting one-third for evaporation and loss 21 million cubic feet or 131 million gallons available for consumption, which would supply about 57,000 people with $6\frac{1}{4}$ gallons a day. We should not, therefore, accept this scheme as providing a sufficient supply of water. It is true that it is

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proposed to enlarge the tank so as to hold three years' supply, and thus catch the surplus water of good years to supply the deficiency of bad years, but applying the data of the Public Works Department again, we have a run off of 17 million cubic feet per square mile in the year of best rainfall or a total run off from the whole catchment area of 212½ million cubic feet or 7·8 million cubic yards. The tanks above will absorb 1·9 million cubic yards of this amount leaving 5·9 million cubic yards available in the best year, which shows that a tank intended to hold 15 million cubic yards, besides 5 million cubic yards for irrigation, would never fill.

12. It may not be necessary to pursue the subject further, but a few words may be said as to the amount of the estimate. Compensation is allowed for at Rs. 40,000, but the best authority estimates the amount required, if the tank is enlarged as proposed, at three or four times that amount, and the engine and mains seem also to be insufficiently estimated. Then, if we add two lakhs for distribution works, the amount of the estimate will be, say, 6 lakhs for the supply in round numbers of, say, 60,000 people.

13. The second scheme for supply from this basin is one proposed by Major Kensington, R.E.; he takes the Nagaweram tank, the next in the series below the Hebbal tank, as the source of supply, takes up three small tanks lying to the north, and excavates a catch channel to take the water from these tanks and the surplus from the Jakkur tank, a considerable reservoir lying rather to the north and east. By this means he obtains a clear catchment area of 10 square miles and a total catchment of 51·61 square miles. He increases the storage capacity of the tank to 80 million cubic feet restricting its area to 100 acres, to minimise the loss for evaporation. He takes his supply from wells sunk on the south margin of the tank into which the water will filter, and pumps the water up to about 100 feet above the tank-bed, supplies 80,000 cubic feet per diem under moderate pressure at a level of 2,960 + M.S.L. and 20 cubic feet to be further raised and delivered at a level of about 3,050. This, he claims, will supply all parts of the civil and military station and the troops, say, 100,000 people, at the rate of 6¼ gallons per day. The water is practically the same as that in General

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Fischer's scheme, and the height to be raised, with the exception of the small supply referred to, about the same. The cost is estimated, including compensation and distribution, at six lakhs of rupees.

14. Applying the data given above, we may expect a run off in the worst year from a free catchment of 10 square miles of 70 million cubic feet. Deducting one-third for loss from evaporation, &c., we have 47 million cubic feet available for distribution; this would give about $7\frac{1}{2}$ gallons per diem for 100,000 people. The estimate appears to be liberal, except in the item of distribution, and the scheme is certainly an improvement on that of General Fischer's, the only weak point in it being the enlargement of the catchment area by means of a catch channel, which, it is possible, might breach and lose a large portion of the supply; if the channel did breach, the free catchment of the tank would be rather less than that of the Hebbal tank.

15. Of the quality of the water in this basin, we have no report; all that is claimed for it is that it is as pure a supply as that obtained from any similar source, and in Major Kensington's scheme that the water being taken from wells is naturally filtered, and therefore as pure as filtered water can be. We must, however, remember that the water flows from cultivated land within four miles of a very large town, and therefore more heavily manured than ordinary land, and that the area includes several village-sites with all their impure surroundings. A fairly thickly-populated and well-cultivated catchment area in the neighbourhood of a large town could only be accepted as a gathering ground for drinking water in the absence of more favorably-situated ground.

16. We now come to the two schemes for procuring the supply from the Arkavutty valley. These were independently prepared by Mr. Standish Lee, Sanitary Engineer of Mysore, and Mr. Garrett, Executive Engineer, Public Works Department, and both propose the construction of a reservoir on a stream which crosses the Magadi road about seven miles from the cantonment. Mr. Garrett proposes to dam the stream near the road, where he says there is a catchment area of about $4\frac{1}{2}$ square miles, but which he assumes for safety to be 4 square miles, and Mr. Lee about a mile below the road where he finds the catchment area to be 8·84 square miles. From inquiries

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made on the spot, it seems certain that Mr. Garrett has under-estimated the area, and that Mr. Lee's estimate of area may be accepted.

17. The country here is very different in character to the Hebbal basin: the slope of the drainage is very much greater, high rocky mounds with deep valleys between break up the surface, and, for the most part, the land is waste, with a very small extent of dry cultivation, a few mere ponds, and a few very small villages. The run off must be very much greater than in the other valley, and the poor character of the soil may be seen from Mr. Garrett's statement based on the authority of the Amildar of Bangalore that to buy up about 5 square miles with all houses, trees, ponds and cultivated land would cost only Rs. 82,000. The ground is, as has been ascertained by inspection, eminently suited for a gathering ground, the valley is deep and very narrow in parts, and there are sites where it contracts below apparently fair-sized basins, where reservoirs might be formed at a very reasonable outlay. There is a little laterite to be seen at the head of the valley, but everywhere else the out-cropping rock is igneous, the bed of the streams being rocky throughout. If the few huts and the cultivated land in the catchment area were bought up, the water drained off must be as absolutely pure as any surface drainage can be.

18. As regards the quantity of water available, if we apply the data as above, the run off from 8·84 acres is 61·8 million cubic feet in the worst year of rainfall, and deducting one-third for loss from evaporation, &c., the quantity available for consumption will be 41·2 million cubic feet, or 7 gallons per head per diem for 100,000 people. It has, however, been stated above that from the character of the ground the run off must be considerably in excess of that from the comparatively level ground experiments on which determined the data, and it may, therefore, it is considered, be safely assumed that the run off in the worst year of rainfall would afford a supply of $6\frac{1}{4}$ gallons to 130,000 people, and that one year's supply could be stored without a very heavy expenditure.

The height to which the water must be raised is, however, at least double that which it is proposed to be raised on the Hebbal side. Both Mr. Lee and Mr. Garrett estimate it to be 200 feet, but it would appear that the bed of the

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stream at Mr. Lee's site is about 230 feet below the level at which water must be delivered.

19. As regards the cost of the schemes Mr. Lee estimates in detail only the cost of supplying the troops with 60,000 gallons a day, making use of one of the Hulsur engines and pumps and part of the present delivery pipes. For this quantity he makes out the cost would be Rs. 1,65,000; and the annual outlay, including interest, Rs. 25,824. Mr. Garrett estimates that the cost of supplying the same quantity would be Rs. 4,50,000, and annual outlay, including interest, Rs. 62,600, but he allows for new engines and all new pipes, as well as for buying up the whole catchment area.

Mr. Lee has proposed by the construction of dams lower down the same stream to impound sufficient water for the supply of the whole of Bangaloro, or for 150,000 people, but his catchment area would then include tanks into which part of the drainage of the pettah flows, and land occupied by tanneries, and would give anything but a pure supply, the height to which water must be raised would also be 400 feet.

Mr. Garrett also proposes to utilise the drainage to the utmost extent possible, and in conjunction with an existing reservoir to supply the whole of Bangaloro. In this case he estimates that the Magadi road works with all distribution would cost six and-a-half lakhs.

20. The schemes then worked out roughly, as they, of course, must be, for the purpose for which they were intended, promise a sufficient supply of as nearly pure water as any surface drainage can be for 100,000 people at a reasonable cost, that is, about six lakhs, and, so far as can be judged from the figures, the cost per 1,000 gallons would be less than one-third of a rupee. It may be said, therefore, that they promise well.

21. Of everything, then, that has been brought forward or suggested, this seems to be the best arrangement, and one that will provide Bangalore with a good and sufficient water-supply. (1) Construct a reservoir on the tributary drainage of the Arkavutty at or about one mile below the Magadi road to contain more than one year's supply for 100,000 people, at $6\frac{1}{4}$ gallons a head a day, pump up the water to a service reservoir and stand-pipes sufficiently high to command the station and barracks, and lead the water by pipes to

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the station utilising, as far as possible, the existing engines, pumps, distribution pipes &c. (2) Improve Sankey's reservoir as above indicated, by which means a supply for between 30,000 and 40,000 people can be provided. We should thus put a supply of good water almost at every door for, say, nearly the whole population; but it must be remembered that numbers of the inhabitants will still draw their supply from wells which furnish good water, and many, however good the supply at the tap, will prefer to use the tanks to which they are accustomed, and the water in which is softer and pleasanter than any other. We cannot therefore breach the tanks and let the beds dry up, and as they must remain, it will still be our duty to conserve them and to prevent the water from spreading disease among the people. To this end it is necessary to divert the bazaar drainage entirely from the tanks, to prevent the establishment of cholera camps, tanneries, &c., on grounds which drain into the tanks, and also to prohibit all garden cultivation or any cultivation which requires manuring in the drainage area. The diversion of bazaar drainage, and buying out cultivation should form a part of any estimate for the water-supply, and once it is accomplished, ordinary conservancy on the part of the municipality will prevent the tanks being a source of danger to the inhabitants.

22. It will then remain to be settled how the supply available is to be distributed, and there seems no doubt whatever that the troops should be supplied from the Magadi road reservoir, which must give the nearest approach to absolutely pure water; and after full consideration of the subject, it seems desirable that the civil and military station should also be supplied from the same source. The main will, it is true, run past the pettah, but the pettah can best be supplied by gravitation from Sankey's tank; and even if that tank cannot be made absolutely water-tight, the leakage through and under the bund can be caught by the works now in progress under the Mysore Government, and conveyed to the pettah. The supply from Sankey's tank would, above shown, provide $6\frac{1}{4}$ gallons a-da for a population of 34,000 or 4 gallon a-day for 50,000,—an amount which, judging from experience in Mysore, is more than ample. The best arrangement seems to be to enter into some agreement with the Mysore Government whereby all

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rights to the supply from Sankey's tank can be handed over to the Mysore Government and in return the catchment area of the Maga road reservoir could be handed over to the Madras Government for a certain sum, which, considering the claim the troops and station may have on Sankey's tank, would be, of course, less than the actual value of the land. This might, if the respective Governments agreed, be decided by arbitration.

23. It is suggested that no time should be lost in investigating the Magadi road scheme and preparing complete detailed estimates for all works connected therewith. The estimates can best be prepared by officers acquainted with the locality and of local experience, and it is probable that the Mysore Government would not be unwilling, considering that the Madras Government have already given the services of its officers for considerable periods for purposes of investigation, to depute an officer of their Public Works Department to work out the estimate. If necessary, however, an officer from Madras could be made available, and possibly Mysore might consent to defray part of the expenses. It may, of course, prove that there are objections to the Magadi road scheme, which have not as yet been brought to light, and that the cost will be heavier than anticipated; it is desirable, therefore, that, at the same time, estimates should be prepared for Major Kensington's scheme, the cost of the two schemes compared, and analyses of the water derived from each obtained, there seems little doubt, however, that the Magadi road scheme will provide the purest supply, and that it will be worth while to pay for the best water.

As regards provision of funds for the works there is no doubt that the Government of India will be prepared to entertain any reasonable scheme for the supply of good water for the troops; but it can hardly be expected that they should pay also for the supply to the civil and military stations, and it will be necessary, therefore, to ascertain what amount the municipality should and can contribute for their supply.

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To be printed immediately
v 3 or 4 proofs sent into the
least possible delay.

Lds
7/7/88

Lds
Copy despatched
to Mackenzie with necessary
instructions.
GS
7-VII-88

Cdlr 2480 + 2487
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Note by the Chief Engineer P.W.D. dtd 14.VII.88 on the Bangalore Water Supply

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The foregoing Note with 2480/28 Communicated to Mr Lawrence Gen: Engr: who will be directed, if he is willing to cancel the remainder of his furlough, to report himself to Ch: Engr P.W.D. proceed to Bangalore, and prepare in detail the Estimates required under the direct orders of the Ch: Engr P.W.D.

Mr Lawrence should place himself in communication with Col Brown R.E. Supt Engr of Mysore under whom he has represented himself willing to afford any assistance in his power, and should in the first instance submit without delay a Statement of Estimate & Detail Drawings for the preparation of the Estimates

Mr Lawrence will be placed on duty from the date of his arrival at Bangalore.

Sd

12/7/88

J.S. Lawrence

Forwarded with Engr's Note & enclosures

Sd

Secy to Govt

Rly Branch

with P.W.D. Note

of the many Schemes which have been brought forward, in response to the Notification calling for Essays on the subject of providing a pure water Supply for the towns in Bangalore, for the Civil & Military Station & the Pettah, only two proper Estimates & Supply by Percolation are of these, which suppose a reservoir at the Hilgin Hills with pipes thereform, may be rejected at once on the score of the Distance & consequent cost of piping, and the other which is merely a selection of an old proposed Rising water in from the neighbourhood of Mudidroog is open to also serious objections. All other Schemes propose lifting the water, and the results of an examination of them & of the quality of the water in the neighbourhood of Bangalore leads one to conclude that lifting the water is inevitable. The height to which it is proposed to lift the water varies in the different Schemes from 180 to 400 feet & even the greatest of these heights should not, it is considered, be raised in the face of an insuperable objection to the Scheme, if it promised really

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food water.

2. At present many of the schemes em-
bodied in provisional of Sankey's
Tank which already entitled to
salute bills supply of the C. M. station,
and also the Palace, is supposed to
supply nearly good water, but it has
the notion that as long as the Rifle
Butts remain in their present position
so long will the supply of Sankey Tank
be liable to contamination, as it will
be impossible to prevent the cattle
drawing being used as latrines.

3. The question of the right to the water
in Sankey's Tank has not yet been
finally settled. The Tank was originally
designed to furnish a supply
of pure water only. With station,
the proposed use of the Palace was not
provided for, but as part of the
catchment area of the Thermanhalli
Tank on which the Palace mainly
depends was to be cut off, provision
has been made for supplementing it by
means of the storm water in the
drainage channels. The cost of the project
as designed was borne by Mysore
& it was intended that a moderate
charge should be made to Municipality
for water supplied, and a like charge
to Govt. for water from the British
Troops Tanks. Sd/- [illegible]

"Recd by S.S. of Mysore

Govt of India No. 384 C of 20th Jan 1869.

of Mysore, the Tank (which has proved a
failure may occasion the work known the
head of district station Hosr) with its catchment
area was left in Mysore Territory.
That the Mysore Govt. expenditure nearly
5½ lakhs on the works constitutes a
decided claim on them to the
Tank supply for the intention object
of the works, viz supplying the C. M. station
with good water at a moderate charge
and also the better lighting, and the
that had the works fulfilled their
object the Tank would not have been left
in Mysore territory without at the work
a fresh agreement with Govt of the
Mysore Govt. to supply the water required
by the station. These seem to be
Every prospect
the principal questions that the question of
right of supply from this source can
now be satisfactorily settled & it is
essential that it should be settled at once
as there is no doubt question that the Tank
may at a reasonable additional cost, be
made to bear its share in supplying
Bangalore with good water.

4. What that share may be has not been
considered. Many complaints
have been made & record at Sankey's
Tank for a number of years by the Officers
of the Mysore P.W.D. and some also
before on the subject of the water supply
have been furnished by Lt-Col Brown R.E.
& Major Cunningham R.E. From a study

For the selection of the Municipality
that the Surplus revenues of Bangalore
which consisted of upwards of one &
half lakhs of Rupees may be assumed
to have met the urban district, should not
be lost sight of, also that the

of these it appears that from the Catchment Area of 2½ Sq miles the average available supply per Sq: mile of Catchment per annum has been 11 Mill C. ft, the max: 17 M.c.ft per Sq mile, & the min 7 M.c.ft. Assuming that practically the greater portion of the water which is stored at the Tank has been brought to the Tank Bund lost by Evaporation, absorption & leakage, but Major Pennington disputes the correctness of this Conclusion & knows that a great deal of the water escaped which could be made available through the high level sluices the yearly return lost is from 12½ to 15 M C.ft. Of this it is difficult to say how much is lost by Evaporation & how much by Leakage. but it may be believed that probably ½ is due to leakage. If leakage can be prevented, there will therefore be 11½ M C.ft available in the worst year, or say 70 M. gallons. Hourly supply 40 gallons a head for 5000 people or 4 Gallons a head for 50,000.

6. That leakage can be very much reduced, if not entirely, be prevented seems beyond doubt. The Engineer first has constructed a dam across the Valley a little below the reservoir bund, a portion of the foundations of which are on solid rock and the greater portion of the water which at present escapes through & under the bund will be caught by this dam & made

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available for the Pollak. Various schemes have been brought forward in the Evidence for preventing leakage, by filling in the bed of the reservoir with puddle or concrete, and for impounding the catchment by subsoil drains with a view of storing more water, while the reservoir can easily do if leakage is stopped. but it is said that even if there was not actual supply for consumption on the penalty basis will be available from the catchment area in the worst years recorded. be may in another way Estimate this supply roughly as follows - the actual run off the catchment area by measurement in the worst year is shown to be 7 M.C.ft. per Sq: mile or 17½ M.C.ft allowing ⅓ deduct for loss by Evaporation &c and we have 11½ M.C.ft. or 71 M. gallons available for Consumption.

6. In this in order less to consider the penalty per head per diem that should be provided. Water Schemes that have been proposed this penalty varies very considerably the highest being 20 gallons & the lowest, for drinking purposes alone about 2 gallons. The ordinary allowance in England in town supplying towns is 16 to 20 gallons. but in this Country where water is not required for closets or for washing clothes it may be very much less. Major

Principles says "In proportion according to any carefully prepared statistics the consumption was found to be, in 1870, 1½ gallons a head per diem in all the hospitals below etc. Surgeon J. Middleton who was for a long time employed as Analyst of Water in Bengal, in his report dated 18th Dec. 1871 on the water supply of Bangalore says from 3 gallons a head per diem for every man woman and child, as my limit". The supply provided for the troops in Cantonments, the latter estimated by Col. Rundall etc, the latter estimated by Col. Rundall, was about 12 gallons per head per diem and it is considered that any supply like a municipal of 2 Cub. feet or 12½ Gallons can allowed for the troops & 1 C. feet or 6½ Gallons for the native population.

7. On this assumption it follows that Sankey's Tank would fully supply the troops & also 24,000 natives - or a native population of 34,000 - and it is shown by Major Kennedy's tank by raising the bed of the Tank water could be supplied to the troops by filtration. Which without any tank raising it could supply the Pettah

To keep a Gun having been spent on Sankey's Tank, therefore it should be a matter of enquiry be obtained how it follows whether possible such as from

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other sources of supply, may [illegible] must be raised a Cubic[illegible] higher, the Board should be made to supply as much of Bangalore as possible.

8. On a thorough examination of the Old Cubbons and also the Land, namely 5 17, as well as the County in the neighbourhood of Bangalore has been obtained that the best sources of supply therefore can be found in the Hebbal basin near the head of Pennakina Valley about 4 miles from Bangalore, and in the so called Nagari Road basin near the head of the Arkavathy Valley about 7 miles west of Bangalore. 2 Cubbons have been proposed in addition for the former and 2 for the latter.

9. The River Pennakina & Arkavathy which drain the land adjacent to Bangalore are not large rivers in the ordinary acceptation of the term, in the bed of which water flows for some months in the year & is then found below the surface of the bed for the rest. They are chiefly drainage channels which are dammed across or beyond which in dry days after the Tanks which cover the face of the country. Under each Tank is more or less vast subterranean deltaic mass or [illegible] as perhaps superficial

and the land there cultivated are
probably very often manured and
hence Bangalore must likely have
been named [illegible] near the Tanks
on village sites, and there also together
with the manured fields must drain
into the local town Tanks. Such
polluting sources cannot be expected
to yield absolutely harmless water, though
it is probable that such water if
stored in a very large volume,
might be considered potable, and
it may be said from that the town
Tanks of villages sites in the catchment
area the better the water will be.
Also that the pollution from Bangalore
the object is the chance of obtaining a
town supply, the outskirts of any
large town being decidedly liable to
contamination of the soil, [illegible] and
of course of running.

10. The 1st scheme for supply from the
Hebbal basin - it is on which has attracted
a good deal of attention, as it was pro-
posed by Major Pitt Taylor RE. and
has received the approval of the
Municipality, being the only scheme
apparently of those Major Pitt and
which has as yet been considered by
that body. The scheme has also
of course been worked out in detail
by a new staff which [illegible] on

assumptions, [illegible] as to quality. It
provides for supplying the Hebbal Tank
about 5 miles distant from Bangalore
the Cantonment, for pumping the
water from thence about 600 ft of the
[illegible] and for distribution
by gravitation, from which it will
be distributed by pipes about Bangalore.
Station & Pettah. The distance is stated
about about 5 miles, the lift 100 feet & the
cost about Rs 8 Lakhs of Rupees.
The Tank is apparently situated about
16 miles Rd. &c or 3 miles distant, a
distance scarcely required for irrigation, and
the catchment area is stated to be
about 10 sq: miles.

11. The very little information which is
available in the Records
of the Mysore P.W.D. besides the
assumptions & facts of the scheme above
stated, and the result is not favorable
to the scheme. The total yield was
to 12½ sq. miles of which 6/10 ccms
are intercepted by tanks above Hebbal
leaving the independent drainage area
of the Hebbal Tank 4½ square miles, and
supplying the tanks which have been
constructed at Sankey's Tank & the Race
Course in the years of worst rainfall
the run off about 1/8 of the 4½ sq miles
available for consumption, or even
taken the run off from 4½ sq miles. 3½ x 0,6
& reducing ⅓ for evaporation & use

21 m.c.ft on 131 m. Cubes available for Condemnation, which would supply about 57000 people with 60 gallons a day. It should not therefore interfere this scheme as providing a sufficient supply of water. It is the intention to prepare to enlarge the tank so as should 3 years supply & thus retain the surplus water of good years to supply the deficiency of bad years. Applying the data of the P.W.D again we have a run off of 17 m.c.ft per sq. mile in the years of least rainfall on a which we off from the whole catchment area of 212½ m.c.ft or 7.8 m.c.ft. The Tanks also with about 1.9 m.c.ft of this amount having 5.9 m.c.ft available in the least year. Which leaves for a Tank Capacities about 15 mile c.ft besides 8 m.c.ft for irrigation which never fills.

12. It may not be necessary to provide the objects pointed out & a long work may be said under the amount of the Estimate. Compensation is allowed for at Rs 40,000. Another heavy outlay in Estimate also the amount required if the Tank is enlarged as proposed as 8 m.c.ft which I omit, as the Engineer in charge does also. Also in Estimate it is proposed to lay 6 Cables for distribution from the source of the Tank with the supply is used 6 Cables and for the supply is used

[illegible] of say 10,000 persons.

2480 22

13. The 2nd Scheme for supply from this source is one proposed by Major Kensington R.E. He takes the Nagavaram Tank, the largest in the Circle when the Siddhout Tank at the source of supply, takes up 3 miles of bank laying also work & excavates to cubic channel to take the water from these tanks other supplies from the Siddhout Tank, a considerable reservoir lying between these tanks & Tank. By this means he obtains a clear catchment area of 10 sq. miles and a total catchment of 51.64 sq. miles. He increases the storage capacity of the Tank 80 m.c.ft. estimating to save 100 cases, to minimise the loss from evaporation. He then pumps the water up about 100 feet above the Tank Bed, supplies 80,000 Cub. ft per day under moderate pressure at about of 240 + MSL and 18 c.ft. the pumping & delivered at a cost of about 3,050. This Engineer also applies the limits of the C.M. section that Hooper say 100,000 persons or the net 6½ gallons per day. The water is practically the same as that in first Engineer's scheme & the Engineer also raised [illegible] with the exception of the tunnels supply & about the same. The cost of Estimate including Compensation & Distribution at 6 Lakhs of Rs.

14. Applying the data given above we may expect a run off in the worst years of from a catchment of 10 sq. m. of 70 m.c.ft. deducting ⅓ for loss from

The water his supply from wells sunk within the South margin of the Tank into which also the water wells filter.

Irrigation would obtain 47 m. C. ft. available for distribution. This would give about 7½ gallons per diem for 100,000 people. The Estimate appears ample. Liberal Exception in the item of Distribution & the Scheme is certainly an improvement on that of General Fischer, the only bad point in it being the enlargement of the Catchment area by means of a Cut channel which it is possible might breach & lose a large portion of the supply. If the channel did breach the present catchment of the Tank would be reduced less than that of the Hubbal Tank.

15. of the Quality of the water in the basin we have no report. All that is claimed for it is that it is as pure a supply as that obtained from any similar dams & in Major Blandford's opinion that the water being taken from wells is relatively polluted & therefore as pure as filtered water can be, he must however remember that the water flows from cultivated land within 6 miles of a very large town & therefore more likely to contain that ordinary land, & that moreover the area includes several Villages situated with all their insanitary surroundings. A fairly thickly populated & badly cultivated catchment area in the neighbourhood of a large town could only be accepted as a Gathering ground for pure water in the absence of better

[illegible] catchment found.

16 In the case of the 2 Schemes for increasing the supply from the Attiamby Valley there was an expenditure of Sanitary Engineers by Mr Stanley Lee & Mr Samuel Lee, C.E. & Mr. D. and both propose the construction of a reservoir on a stream which crosses the Negombo road about 7 miles from the Canton-ment. Mr Samuel proposes to dam the stream near the road where the Negombo River is a catchment area of about 44 sq. miles but which he assumes for safety about 45 sq. miles and Mr Lee about 4 miles below the road where he puts the catchment area at 0.84 sq. miles. From figures under which the above are taken it appears that Mr Samuel's estimate of area may be accepted.

The country here is very different in character to the Hubbal basin, the slopes of the Ranges is very much broken by low rocky mounds with deep valleys between them up the slopes, and the soil is not near the land is level, with a very slight slope of drainage, and a few more hillocks & a few very small villages. The soil of course be very much broken in the other valley, and the poor character of the soil may

we have from
to about been well calculated
of the Inhabitants of Bangalore that
they do about Rs. 2000 Rs. The
ground is, as has been ascertained by
inspection, singularly suited for
a filtering ground. The Valley is deep
& very narrow in parts & there can
also, when it contains below appar-
ently fine liquid beds, where
sedimentary might be found at a
very moderate outlay. There is
a little below the line of the head
of the valley the stone which close the
ascending rock is found, the
bed of the stream being rocky
throughout. After the bed is
the artificial sand is to be added
even when brought up, the bottom
Ground off must be as absolutely horizontal
as even Surface Drainage can be.

X. In regards the feasibility of water
be available, if we apply the data
as above, the run off from 8.84 acres
is 61.8 M.C.ft in the worst year
of rainfall and deducting ⅓ for loss
from evaporation &c. the feasibility
would be for Consumption with a
daily 61.2 M.C.ft or 7 gallons per

it has been
that from the area water of the ground
the run off must be considerably in excess
of that from the impounding level
ground experimented on which deliberations and the
data, and it may therefore
assumed that the run off in the worst
year of rainfall would allow a daily
of 6½ gallons to 130,000 houses of four.
one years supply would be allowed before
drawing on a very large expenditure.

The height which the water ground
be raised is known at least double
that which it is proposed the Ground
above Hebbal side and Bottle Nullah
Mr Bennett estimated at the 200 feet
but it would appear that the bed of the
Stream at and Mr Bennett site is about
230 feet below the level at which
water would be obtained.

The figures the cost of the schemes.
Mr the Bottle site in detail only the
cost of supplying the houses with 60,000
gallons a day, making use of one of the
Madras Engines & pumps & part of
the present delivery pipes. For this
scheme the pipes and the first well
Rs 1,85,000 & the annual outlay in-
cluding interest Rs 25,824. Mr Bennett
Bottle site, that the cost of supplying
the same quantity would be Rs 4,50,000
annual outlay with it Rs 62,800.
be be allowed for new Engines & all
new pipes, as well as for laying the

24 82 84

20. of Every thing, Mem. that has been brought forward, & Expected. This seems like the best arrangement we can get for the present for, as was Bangalore with a Cultivated and Good water supply till Accident & Mismanagement stopping Drainage of the watershed on or about one Mile below the Mysore Road & Certain more than one Years Supply for 100,000 persons at 6½ Gallons a head a day. pumped up the valley to the service Reservoir & thence by Cultivating Light & Command the Station & Barracks, & Cantonment by pipes below Station utilizing as far as possible the Existing Pipes, Mounts, Distribution Pipes &c. (2) Improve Sanitary Conditions by Intelligent & as clean as possible by which means, a supply for Station 30 & 40000 persons can be secured.

We should then have a supply of Good water almost at all times for the whole Population, but it is proposed to Concentrate with Numbers of the Inhabitants into the Drier Main supply from wells which provide Good water. & many, more pure than supply as the rule, the Deeper ones but Tanks & which may be connected & the water in which is better & Cleaner than City others. In

to whole will

... Mr Lee has proposed by the Construction of some lower dam the same Storage as to suggest Cultivated water for the Supply of the whole of Bangalore, or for 150,000 persons, but his calculations seem under have under Taken not to think part of the drainage of the Pettah Tanks, and have omitted by Tanneries, and would be giving anything but a pure Supply. the Lowest Tank under must be raised bank also to 400 feet.

Mr Sinnatt also proposes to utilize the Drainage of the whole valley by Irrigation & in Connection with Electricity Lighting Supply to whole of the Bangalore, as this can be Calculated that the Mysore Road under this Distribution would cost 6½ Lakhs

19. The Scheme Mem. Contained will Supply, as they of Course must be taken purpose for which they were intended, Namely the Sufficient supply of as much pure water as any Indian Drainage can be for 100,000 persons at a Cost well within, that is, about 6 Lakhs & 8 per as can be found from the figures but Cost Mem 1000 Gallons would be less than ½ of a Rupee. Having to Land, therefore, that very pure water,

The supply from Sankey Tank could as above shown provide 6 gallons a day for a population of 34,000, or 4 gallons a day for 57,000. add annual check giving how dependence in Mysore is more than ample

current Sankey Tank the Tanks & the Wells by 4th & as they would increase it will be right to make daily & another Main & Reservoir the whole scheme depending entirely upon the Tanks. If this could be done it is necessary to direct the Engineer drawing water from the Tanks, Reservoir the Health of cholera camps are found which drain into the tanks, and also to prohibit the cultivation of garden cultivation or any cultivation which requires manuring in the drinking area. The division of Engineer drawing and supply and cultivation should form a part of any Estimate for the whole Hydraulic & once it is accomplished, ordinary Endowment will be sufficient the Tanks being a source of Revenue to the Municipality with Reservoir the Tanks being a source of Revenue to the Municipality with Reservoir

~~Municipality with Reservoir the Tanks being a source of Revenue to the Municipality with Reservoir~~

~~Municipality with Reservoir the Tanks being a source of Revenue to the Municipality with Reservoir~~

21. It will then remain to be settled how the supply available is to be distributed & how much to each Cantonment but the troops should be supplied from the Mysore Road Reservoir which must form the nearest approach to which they have water; and after full consideration of the subject it seems desirable that the Civil & Military stations should also be supplied from the

Main Line. The main idea is that the Mysore Road Reservoir be the Standard and that supplies from Sankey Tank and Lake if not Tanks cannot be made absolutely under control, the Sankey supply & under what may be obtained by the water-shed be supposed under the Mysore Road & supply other Reservoirs.

The best average must decide the Estimate which must depend upon the Mysore Road Reservoir subject to the supplies from Sankey Tank can be handed over to the Mysore Road & in which the Settlement case of the Mysore Road Reservoir should be handed over to the Madras Civil for a certain sum, which considering the claim the troops will obtain may be with Sankey, but under the of Cantonment the whole value of the water. This might if the Madras Civil agreed, be dealt with by arbitration.

22. This Report will be time should be used in working the Mysore Road scheme & keeping complete detailed Estimates for all works connected with it. The Estimates are then to be prepared by Officers experienced in the Working of such schemes, and it is probable that the Mysore Road will be ready, considering the Madras Civil have already from the services of its Officers for the whole should be prepared for Mysore, &

Proceedings of the Meeting of the Legislative Department

Held by the Chief Engineer & Secretary on Monday the 30th August 1886 on the Bangalore Water Supply

Present

The Chief Engineer & Secretary

Order thereon &c.

The foregoing matter be communicated to the Executive Engineer who will be directed, if he is willing to undertake the remainder of the Fairlough to proceed to Bangalore and report to Head-Quarters the best method of bringing the Cauvery water to the City of Bangalore

2. The Executive Engineer should also ascertain and report the cost of the Bangalore Water Supply Scheme, if carried out by the Municipality, and the probable annual cost of maintenance and working

Chief Engineer & Secretary

Note on objection the Magadi Road scheme which has not as yet been brought objection & that the cost will be heavier than estimated it is desirable therefore that, at the same time, estimates should be prepared for Major Pennington's scheme, the cost of the 2 schemes thus compared, & analyses of the water derived from each obtained

Submit an opinion of this Board & with all the Estimates if necessary however an opinion from Madras Officer would also be desirable, before any further action is taken in the matter of the Bangalore Water Supply

Note by the Chief Engineer & Secretary

Before any opinion of this Board can be submitted to Government, it will be necessary to have an opinion from Madras Officer would also be desirable, before any further action is taken in the matter of the Bangalore Water Supply

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submit without delay a statement of Establishment required to aid him in the preparation of the estimates.

3- Mr. Commins will be placed on duty from the date he reports his arrival at Bangalore.

Initialled S. C. N.
11.

Signature

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25 IV 19

9/24/16

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To Mr. Commins Engr with copy of Letter
Supdg Engineer Circle
Exec Engr Mr. Scott
Military Dept

Read 16/8
Capt

24804

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Public Works

17-0

14 Encl. 1480 lb A

Bangalore Water-Supply

Communicating the Administrative Sanction to the construction and the Chief Engineer P.W.D. thereto.

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P 16/8 [illegible]

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