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PUBLIC WORKS **DEPARTMENT**

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

No.

Read—the following papers:—

From the Most Honorable the Secretary of State for India, to His Excellency the Right Honorable the Governor in Council, Fort St. George, dated India Office, London, 22nd June 1882, No. 12, Statistics and Commerce.

I forward 70 * copies of a memorandum by the Army Sanitary Commission on the Report of the Madras Municipality for 1880.

* 12 by mail; 58 through the Store Department.

2. The strong remarks made in this paper on the sanitary conditions prevailing in the Presidency town, to which there is apparently no prospect of a remedy being applied by any action of the Municipality, call for the serious attention of your Excellency in Council; and I shall be glad to receive a special report from you on the whole subject at an early date.

Enclosure.

Memorandum of the Army Sanitary Commission on the Report of the Madras Municipality for 1880.

The year 1880 was not an epidemic year in the south of India, and the town of Madras had only two deaths from cholera, while the small-pox deaths were fewer than those of the preceding year. The following statistics may therefore be assumed as representing more or less accurately the death-rate from local diseases and their causes.

2. According to the census of 1881 the population of Madras was 406,117. Deaths from all causes numbered 14,907, which would give a death-rate on this census number of 36·7 per 1,000.

The following abstract gives the total deaths from the chief death-causes in 1880:—

Diseases.	Total Deaths.
Small-pox	869
Measles	105
Fevers	3,549
Dysentery	1,516
Diarrhœa	733
Cholera	2
Injuries	123
Other diseases	8,010

The different divisions of the city yielded the following varieties of death-rates :—

Divisions.	Population.	Death-ratio per 1,000.
VI.	19,390	17·2
V.	65,491	31·9
VIII.	41,482	33·9
III.	52,545	34·4
I.	65,121	36·6
IV.	9,791	37·6
II.	73,738	38·8
VII.	69,568	39·4

This abstract gives a better idea of the general sanitary state of Madras than does the death-ratio taken over the whole area, but as each division contains a number of villages, it is only by comparing the death-rates of villages with the general average death-rate that the real practical facts of the case become apparent. The village death-rates of course vary from year to year, but we shall take those for 1880 for our present purpose.

The average death-rate for Madras in this year was, as has been already stated, 36·7 per 1,000. Of village rates exceeding this proportion the following may be cited :—

Villages.	Population.	Death-ratio per 1,000.
Chintadripettah	15,120	38·3
Royapettah	5,255	39·5
Pursewalkum	19,006	39·1
Peddoo Naickpettah	65,639	43·4
Poodoopettah	3,774	45·5
Triplicane	33,258	45·7
Perambore	5,650	53·0
Meersaibpettah	2,050	57·5
Moothealpettah and Uttapaulium ...	40,957	56·3
Ráyapuram	11,989	60·7

The chief causes of these great losses of life in 1880 were endemic diseases, fevers, diarrhœas, dysenteries, &c.

These village death-rates give in a few lines the Madras sanitary problem in a non-epidemic year, and, like similar village facts all over India, they point directly to foul undrained subsoil, imperfect cleansing, and bad water as their removable causes.

3. We shall next show what has been done in the course of past years to prevent these great losses of life, and what steps are now being taken in the same direction. In the first place, although the facts have been known for many years, and although two separate surveys, reports, and drainage schemes have been before the Municipal Commissioners, not a single step, so far as can be learned from the Report, has been taken either to drain the villages or to cleanse the subsoil. The Commissioners have simply pleaded poverty, and there the matter has ended.

4. The latest aspect which the drainage question has assumed is simply adjournment *sine die*, and the adoption of a system of surface concrete channels, intended not only for removing rainfall, which is their proper function, but to receive house and court sewage, and to leave the foul subsoil as it is.

In a report given in the present year's proceedings, Colonel Sankey, R.E., Public Works Department, makes the following remarks on this scheme :—"It is impossible to overlook or disguise the fact that there may be the most perfect system for removing all offensive matter from the point at which such is discharged into the street drains, while there may exist side by side with this complete system a state of house-drains that may be little less than poisonous. It is not of course proved that such is really the case in Madras, but if not (and there is nothing to the contrary in the Report), the Native houses and courtyards must be in a very different state from what they are in all other Native towns where, away from all view, sewage is allowed to sink into the ground of the little back-yards, and produces a rotten soil, the effects of which

cannot in any way be remedied by the most scrupulous cleanliness of the street drains outside. If a thoroughly healthy state of things is to be produced in Madras, and not merely a palliative, this fact must be looked fairly in the face." In these views we entirely concur. On the question of economy, Colonel Sankey says, "It is not to be supposed that a mere skin of cement one-fourth of an inch in thickness can for a long series of years resist, not only the corroding action of the sewage acids, but the endless sources of injury to which town drains are subjected," and he proposes to substitute V-shaped drains of stone.

5. The Report under review does not contain any Officer of Health's Report on the court-yards, but in our Memorandum on the Report of the Sanitary Commissioner for Madras we have quoted part of a Report by the Commissioner which reveals a condition of matters in these courtyards absolutely incredible. And Mr. Jones, the proposer of the surface drainage scheme, now tells us, that "the house drainage itself is one of the most important sanitary questions, but its improvement forms no part of my scheme," which is simply a tacit confession that, after this surface drainage work is completed, the sanitary state of Madras will remain precisely what it now is, as shown by the deplorable village death-rates we have given above.

Such being the case, we would strongly urge the inexpediency of wasting money upon the incomplete and unsatisfactory surface drainage plan now in process of execution, which does not fulfil any conditions of a proper drainage system, and we would recommend at the same time that a complete system of town and house drainage in combination with an improved and extended water-supply for removing house sewage, separately from the rainfall, be at once adopted.

6. *Water-supply.*—Little or no improvement appears to have been effected in this important element during the year. The population of Madras exceeds 400,000, while the Report estimates that only half this number uses the pipe water. The remainder must of necessity use the impure subsoil well water. The estimated amount of pipe water-supply is 14·2 gallons per head per diem for those who use it. The following approximate analysis shows the character of the Red Hill water after it arrives in Madras :—

	Grains per Gallon.
Total solids	14·70
Volatile solids	4·90
Sodium chloride	5·32
Total hardness	6·65
Free ammonia	0·025
Albumenoid ammonia	0·028
Nitric acid as ammonia	0·336

The water contains a large proportion of organic matter and numerous large infusoria and other evidences of organic impurity.

The pipes collect silt, which has to be washed out by a scour. During one of these operations it is stated that, "a piece of iron 16 inches in area was forced out of the pipe." Much impurity in the water appears to be derived from the open channel by which the Red Hill water is conveyed to the city, in reference to which the following remark occurs :—"Its bed is still in an uneven state, and this cannot be rectified without a very large expenditure of money, or without shutting off the supply from Madras for some considerable time."

Practically this conclusion amounts to a statement that, notwithstanding the present advanced state of practical engineering, and the real economy of a good water-supply, nothing can be done to remedy the present deplorable condition of the water-supply of Madras.

7. *Conservancy.*—The work done under this head is the most satisfactory of the year's proceedings, and the Report states that, "it is by no means complete, and a very great deal remains to be done." The present cleansing staff consists of 1,068 coolies and 504 carts, at a cost for 1880 of 21,761*l.* Part of the house sewage is removed separately and part is taken by rubbish carts, so that the costs of street and house cleansing cannot be separated. There can be little doubt that the great death-rate[illegible] some of the villages point to want of thorough removal of house sewage and growing impurity in the subsoil and subsoil well water in consequence. If the cleansing were better accomplished its cost would probably considerably exceed the whole present conservancy outlay, and it would be a moderate estimate to place this cost at 20,000*l.* a year, a sum which, if capitalized at [illegible] per cent., would enable a capital of 400,000*l.* to be spent on drainage and water-supply works.

8. Year after year we have called attention to the state of Madras, and up to the present time nothing effectual has been done to protect the people of this large Presidency capital from the enormous death-rates which prevail in it. Only palliatives, such as the present Black Town surface drainage scheme, have been tried. Under the circumstances we consider it to be quite useless to make any detailed recommendations, and we would rather conclude with a similar suggestion to the one already made by us in our Memorandum on the Report of the Madras Sanitary Commissioner, viz., that as it is apparently a hopeless matter to expect any improvement from the present Municipal administration, the whole subject should be taken in hand by the Govern-

ment of Madras Presidency, and the works required for the protection of the people from well-known local disease and death-causes should be carried out as speedily as possible.

18th April 1882.

No. 567.

Referred to the President, Madras Municipality, for his early remarks.

OOTACAMUND,
14th July 1882.

(Signed) G. S. FORBES,
Acting Under Secretary.

No.

From A. T. ARUNDEL, Esq., President, Municipal Commission, to the Chief Secretary to Government, dated Madras, 4th August 1882, G. No. 566.

I have the honor, as requested, to submit my remarks on the memorandum of the Army Sanitary Commission on the Report of the Madras Municipality for 1880, a memorandum upon the perusal of which the Right Honorable the Secretary of State has requested a special report "on the sanitary conditions prevailing in the Presidency town to which there is apparently no prospect of a remedy being applied by any action of the Municipality."

2. I will first examine the memorandum of the Army Sanitary Commission, and then do myself the honor to explain the present conditions and future prospects of the Municipality in regard to sanitation, conservancy, and water-supply.

3. With regard to the first point, I have to premise that the Army Sanitary Commission have advanced certain statements which are not only incorrect, but also at variance with the facts detailed in the report that lay before them.

This I shall now proceed to prove.

4. In paragraph 3 of the memorandum, the Army Sanitary Commission state "* * * In the first place, although the facts have been known for many years, and although two separate surveys, reports, and drainage schemes have been before the Municipal Commissioners, not a single step, so far as can be learned from the Report, has been taken either to drain the villages or to cleanse the subsoil. The Commissioners have simply pleaded poverty, and there the matter has ended." Apart from the question of cleansing the subsoil, of which more anon, I must demur to the statement of the Army Sanitary Commission, and assert on the contrary that the Report narrates the various steps that were taken towards the drainage of the most important of the villages of Madras, viz., those* that unitedly form what is known as Black Town.

* Peddunaikpettah.
Big Parcherry.
John Pereira's Gardens.
Moothealpettah.
Uttapauliam.

The Madras Municipal Report for 1880 (before the Army Sanitary Commission) stated, paragraph 7, "In the course of the year under report the Vice-President, Mr. Jones, successfully completed an experimental section to illustrate the method he will adopt in carrying out the drainage of Black Town." * * *

"The section of drainage thus completed was examined by His Grace the Duke of Buckingham and by His Excellency the late Mr. Adam, and the approval expressed by the Governors personally has been recorded by Government. The scheme for the drainage of the whole of Black Town has been prepared; and it may be noted that at the date of writing this Report, application has been made to the Government for a loan of one lakh to commence the work."

In another part of the Report (Appendix IV) the following remarks by Colonel Sankey, the Chief Engineer, Public Works Department, appear:—"In G.O. of 27th October 1879, No. 2698 W., it was observed that arrangements would be made to place at disposal an officer of this department for investigating Mr. Jones' scheme for the drainage of Black Town, Madras. Captain Awdry, the officer selected, has

reported the results of his examination in his letter * * and as the detailed report on the scheme itself has now been furnished by the President, Municipal Board, the matter is ripe for the decision of Government." * *

2. Owing to the inherent difficulties of the question itself * * * the details of this scheme have been subjected to more prolonged professional investigation and discussion than probably any other of a similar kind in India." * * *

4. In doing this and availing himself of the best points of the schemes of his predecessors, especially those of Major Tulloch, R.E.,* and the late Mr. Clarke, Mr. Jones has shown a wise discretion, and has produced a scheme which in its general outlines solves to all appearances the question in the best possible way." * * So much in disproof of the statement of the Army Sanitary Commission that "not a single step so far as can be learned from the Report has been taken * to drain the villages." * *

* These are the "two separate surveys, reports and drainage schemes" referred to by the Army Sanitary Commission.

5. In paragraph 4 the Army Sanitary Commission quote paragraphs 8, 9 and 10 of Colonel Sankey's remarks, as to the absolute necessity of a complete system of house-drains and backyard-drains in conjunction with the system of street-drains, paragraph 10 ending thus—

"If a thoroughly healthy state of things is to be produced in Madras and not merely a palliative, this fact must be looked fairly in the face." The Army Sanitary Commission remark, "In these views we entirely concur." They omit to quote or refer to paragraphs 7 and 12 of the same remarks which are as follow:—

"7. The house connections and disposal of the liquid portions of the house-refuse are dealt with in paragraphs 21 to 24 and 61 to 64 of Mr. Jones' Report, from which it will be seen that by the extremely small outlay of Rs. 2 per tenant he hopes to deal in a sufficiently satisfactory manner with this, which after all is probably by far the most important, as it is certainly the most difficult, portion of any scheme for draining a native town.

"8.
"9.
"10. } Quoted by the Army Sanitary Commission.
"11. * * *

"12. From the nature of the case connected as it is more or less intimately with the private concerns of individuals, and not a little with caste prejudices, the question cannot be dealt with entirely as one of constructive devices (though of course these must be as perfect as the nature of the case admits), but must go very much further, and enlist the co-operation of all concerned; it is a matter which, though calling apparently for early and serious attention on the part of the President and Municipal Engineer in connection with this scheme, need not be further remarked on here."

It will be seen that a perusal of the passage now added from Colonel Sankey's note are essential in order to understand the drift of the whole.

6. In paragraph 5 of their memorandum, the Army Sanitary Commission have quoted a portion only of a sentence by the Municipal Engineer, Mr. Jones, omitting the remainder which contradicts their inference. They write, "And Mr. Jones, the proposer of the surface drainage scheme, now tells us that 'the house drainage itself is one of the most important of sanitary questions, but its improvement forms no part of my scheme,' which is simply a tacit confession that after this surface drainage work is completed, the sanitary state of Madras will remain precisely what it now is, as shown by the deplorable village death-rates we have given above." What Mr. Jones actually wrote was this:—"The house drainage itself is one of the most important of sanitary questions, but its improvement forms no part of my scheme, *as such expense under the Municipal Act falls on the owner and not on the general public*,* and it is only when the house-drains become a public nuisance, which they do at the junctions with the street-drains, that I have endeavoured to improve matters." Mr. Jones goes on in the next sentence to add, "The inspection and improvement of house-drainage is urgently

* The italics are mine. Sections 267 to 271 of the Municipal Act enable the Executive to compel house-owners to do what is needed at their own expense.

called for, and it was my intention to request that one or two Inspectors should be appointed, whose sole duty it would be to report as to each house-drain, and when defective to urge their reconstruction on the owners and undertake the work ourselves at their cost when they neglected to do so." * * * It is needless to say more in contravention of the charge thus made by the Army Sanitary Commission against the Municipal Engineer.

7. The Army Sanitary Commission conclude paragraph 5 as follows :—

"Such being the case we would strongly urge the inexpediency of wasting money upon the incomplete and unsatisfactory surface drainage plan now in process of execution, which does not fulfil any conditions of a proper drainage system, and we would recommend at the same time that a complete system of town and house drainage in combination, with an improved and extended water-supply for removing house sewage, separately from the rainfall, be at once adopted."

To this I would remark that the system of drainage thus condemned by the Army Sanitary Commission has been approved not only by the professional Engineer who framed it, but also by Captain Awdry, R.E., and Colonel Sankey, R.E., the latter of whom states, as already quoted, that "the details of this scheme have been subjected to more prolonged professional investigation and discussion than probably any other of a similar kind in India," and that Mr. Jones has "exercised a wise discretion in availing himself of the best points of the schemes of his predecessors, especially of Major Tulloch, R.E., and the late Mr. Clarke." It has been approved also by the Municipal Commissioners guided by the professional advice above quoted. An experimental section has been completed and examined in person with approval by two different Governors of the Madras Presidency, and finally the scheme has received the formal sanction of the Madras Government itself.

8. It seems scarcely credible that the Army Sanitary Commission should have taken upon themselves to condemn without reservation a system of drainage thus endorsed by the highest professional and official authority in the Madras Presidency without procuring and perusing a copy of the drainage scheme report itself. Yet this, it would appear, must be the case, for had the Army Sanitary Commission examined the pages of the Drainage Scheme Report they would have found not merely the letter press account of the method proposed for the drainage of the internal courts and yards of houses (which they declare to be entirely overlooked), but also a large wood-cut giving a sectional view of the interior of a native house and of the way in which such a house would be drained.

9. In paragraph 6 of their memorandum the Army Sanitary Commission discuss the water-supply of Madras. I do not propose to do more than to state, first, that the sum of Rs. 2,50,000 is now being expended in extending the Red Hills water to those parts of Madras intended to be supplied, and, second, that the Commission seem to be under a most erroneous impression that all subsoil well water in Madras is impure. So far is this from being the case, that the best drinking water is always procured from wells—not of course in densely crowded localities—and not from the Red Hills pipes.

10. In paragraph 7 the Army Sanitary Commission discuss conservancy and conclude as follows :—

"If the cleansing were better accomplished its cost would probably considerably exceed the whole present conservancy outlay, and it would be a moderate estimate to place this cost at 20,000*l.* a-year, a sum which if capitalized at 5 per cent. would enable a capital of 400,000*l.* to be spent on drainage and water-supply works."

It is difficult to discuss gravely so singular a proposition. It means the abolition of the whole existing staff and means of street and house conservancy, comprising over 500 carts and 1,000 men, in order to raise capital to carry out a system of drainage which the Government of Madras no less than the Municipal Commissioners consider unadvisable. London itself, with all its excellent drainage, would be a sorry city if the proposal now made were tried there—every dust-bin and filth heap left untouched, and every dirt and mud cart abolished.

11. In the concluding paragraph of their memorandum the Army Sanitary Commission state, "* * that as it is apparently a hopeless matter to expect any improvement from the present Municipal Administration, the whole subject should be taken in hand by the Government of Madras Presidency, and the works required to protect the people from well-known local disease and death-causes should be carried out as speedily as possible." As I have already shown that every step taken by the Municipal Commissioners has been with express approval and countenance of the Madras Government, it is needless for me to do more than to leave this final accusation of the Army Sanitary Commission to be dealt by Government, while for convenience of reference I note the following Proceedings of Government discussing and sanctioning the project :—

G.O., No.	1212,	dated 11th July	1878.
,, ,,	1506,	,, 6th August	1879.
,, ,,	2698, W.,	,, 27th October	,,
,, ,,	3351, W.,	,, 27th December	,,
,, ,,	1344,	,, 6th September	1880.
,, ,,	2953,	,, 28th December	,,
,, ,,	744,	,, 27th April	1881.
,, ,,	1199,	,, 27th June	,,
,, ,,	1569,	,, 27th August	,,
,, ,,	1821,	,, 28th September	,,
,, ,,	2505,	,, 23rd December	,,

12. I now beg leave to indicate the actual condition and future prospects of the City of Madras as regards sanitation, conservancy, and water-supply.

13. The drainage scheme for Black Town has been completed and the work is in progress. Black Town is the largest and most densely populated of the numerous towns and villages that form the aggregate called City of Madras. The City of Madras covers 27 square miles, with a population of 406,000. The area of Black Town is 1·65 miles and the population is 128,700. The scheme provides for carrying off all the liquid sewage from the houses and streets by surface drains wherever surface drains will answer the purpose, and by covered or under-ground drains elsewhere. The courts and yards of the houses will be connected with street drains under professional supervision, at the cost of the owners, by means of covered drains passing through or under the houses. The street drains will be flushed from the water pipes and will discharge their contents into three large underground sewers which will meet at a pumping station, whence the whole sewage will be forced first through a closed iron pipe over a mile in length, and then in an open channel to a large sewage farm north of the town, or into the sea, as may be desired.

14. It is not proposed by this system to drain the subsoil. No scheme yet proposed for Madras has provided for more than the most rudimentary and imperfect drainage of subsoil. Where the courts and yards are flagged the surface drain and the closed drain will each keep the yard dry, but the surface drain is preferred in this tropical climate. Where the yards are unpaved no subsoil drainage is complete unless sufficient to drain the whole area. No such scheme has ever been designed for Madras. Mr. Clarke's proposals in this respect were limited and scanty, while Major Tulloch made no provision for it at all. The subsoil is sandy almost every where in Black Town, and the ground is not water logged. Subsoil drainage cannot be effected without enormous expenditure which it is impossible for the Municipality to incur, and meanwhile the professional advisers of Government and of the Municipality consider it the immediate duty of the Commissioners to provide for the daily removal of all the liquid filth and sewage in the manner above described. The cost of the present scheme of drainage will be about Rs. 8,00,000, Rs. 1,00,000 is being spent this year, and about Rs. 3,00,000 more will, I hope, be spent in 1883.

15. There remain however other densely populated parts of Madras which are so imperfectly drained that completely new schemes must be formed and carried out for each of them. These with the approximate cost, &c., of each are as follows :—

—	Area.	Population.	Cost.
	MILES.	NO.	RS.
Ráyapuram	0·84	52,000	1,40,000
Choolay and Vepery	1·0	33,000	1,20,000
Pursewakam	0·65	16,000	60,000
Triplicane and Chintadripettah ...	1·48	63,000	3,20,000
St. Thomé	·96	20,000	80,000
			7,20,000
Add Black Town under construction...	1·65	128,000	8,07,500
	6·58	312,000	15,27,500

16. *Conservancy.*—The conservancy department now employ 532 carts of all kinds, besides four large canal barges, and 1,079 coolies for the daily removal of all solid refuse and filth throughout the town. The good done by this work cannot be over-estimated, but it is very far indeed from being complete. After the recent cholera epidemic in Madras, the Vice-President, Mr. Jones, drew up estimates of the additional staff that would be required to carry out, with thorough efficiency, the duties connected with street and house conservancy, and for the house to house cleansing of privies. For the former service above 100 more carts and 250 more men would be needed at a cost of over Rs. 40,000 per annum. For the latter the staff was estimated to cost about Rs. 60,000, about Rs. 1,00,000 per annum therefore would be required in addition to the present charges for thoroughness and efficiency in the very essentials of sanitation.

17. *Water-supply.*—The water-supply of Madras, so far as it is not obtained from wells, is derived from the Red Hills Lake, about 7 miles distant. The water is brought into Madras in a high level open channel, which is carefully protected by fence and hedge and by watchmen posted at regular intervals along its banks. Before being let from the channel into the delivery pipes the water passes through charcoal strainers. These however are insufficient to eliminate vegetable and animal products, and regular filtering beds are much required. The delivery channel runs at so high a level that the supply falls short while the lake has still a considerable depth of water available for use. A main in lieu of the channel would cost about Rs. 6,00,000, and the filtering beds would cost about Rs. 4,00,000 more.

18. The supply to Madras, though it has several times run low, has never failed except during the famine year 1877. The supply pipes are being extended throughout those portions of the whole area of Madras which it is intended to supply, but of course it is impossible to make a net work of pipes over the whole 27 square miles of town and country within the city limits. A sum of Rs. 2,50,000 is being expended during the present year in carrying out this extension of the water-supply. The water-supply loans now amount to Rs. 16,80,000.

19. *Causes of high Death-rate.*—Without going into any detailed remarks on this subject, I would note that increased efficiency in sanitation and in drainage must be looked to as a main factor in reducing the death-rate. I would call attention to the number of deaths, 869 in 1880, 1,654 in 1881 from small-pox which, under a compulsory system of vaccination would be almost entirely prevented. The Municipal Commissioners have expressed themselves in favor of such a system and await the action of Government to pass it into law.

The appointment of a Health Officer in Madras has again and again been postponed owing to lack of funds, but it may now be said to have become a necessity, and provision has been made for it in the new Municipal Bill submitted to Government.

20. *Ways and Means.*—The financial condition of the Municipality has long proved a bar to the sanitary progress that is so urgently needed. For several years the charges for Police thrown on the Municipality by Government arrested all

progress and even led to reductions of questionable wisdom. These impediments indeed are now happily removed, but no material change can take place until the income of the Municipality is largely increased. As shown above, at least Rs. 1,00,000 per annum will be required for conservancy and sanitation, while loans to the amount of 24 or 25 lakhs of rupees must be contemplated, involving further charges which may in the course of years amount to about Rs. 1,75,000 for interest and sinking funds.

The Municipal revenue requires therefore additional sources of income, capable of expansion so as eventually to bring from Rs. 2,00,000 to Rs. 3,00,000 in addition to the present income of Rs. 7,95,000.

21. This matter and my report No. 409, dated 26th May, on the impossibility of raising the needful funds except by a moderate octroi or by town duties on articles consumed within the city, are now before Government and await their decision as soon as the further information they have called for has been supplied.

No.

From T. K. ROGERS, Esq., M.B.—F.R.C.S. & F.C.S., Lond., Chemical Examiner, to the Chief Secretary to Government, Financial Department, dated Madras, 22nd August 1882, No. 319.

In continuation of my letter No. 306, dated 10th August 1882, I have the honor to forward a copy of the results obtained from the examination of samples of soil taken from various localities in Madras.

2. On account of the pressure of Judicial work, and on account of other circumstances known to Government, the method of examination adopted was not that usually resorted to in Europe. The method used may be described briefly as follows: The soils were frequently washed with water, so that all matters soluable in water were almost completely dissolved out. The washings thus obtained were subsequently chemically examined.

3. I consider the results obtained to indicate a far greater immunity from filth contamination than could have been expected.

ENCLOSURE.

HYGIENIC Examination of Soils taken at a depth of four feet from different localities in Madras.

—	Ummen Pagoda Street, Junction of Appoo Maistry Street at Xavier's Parchary.	Triplicane High Road, Junction of Wallajah Road.	Aroonachella Naick Street, Junction of Ninerpah Naick Street, Chintadrepettah.	Mint Street, Junction of Annah Pillay Street.	Thumboo Chetty Street, Junction of Oodiaalli Street.	Cox Street, Chintadrepettah.	Arnoonachella Naick Street, Junction of Iyah Moodelly Street, Chintadrepettah.	Mint Street, Junction of China Bazaar Road.	Ramanya Street, Junction of Nallapa Vaidyar Street.
Volume of Air contained .. per cent.	47	46	51	55	39	35	36	52	37
Moisture of Soil as received .. .. "	12·382	12·42	13·92	15·45	0·621	2·005	1·100	16·600	0·052
Volatile matters.. .. "	1·078	4·24	1·94	2·53	0·099	0·175	0·440	1·92	0·188
Inorganic Ammonia* .. "	0·00032	0·0006	0·0008	0·0004	0·0004	0·0005	0·0004	0·00008	0·00008
Organic do. * .. "	0·0008	0·0005	0·0007	0·0007	0*0006	0·0004	0·0004	0·0002	0·0003
Nitric Anhydride * .. "	0·02283	0·02473	0·0266	0·0305	0·0153	0·0191	0·0172	0·0607	0·0229
Chlorine as Chloride of Sodium .. .. "	0·117	0·094	1·872	0·082	0·035	0·059	0·017	0·234	0·117

* Obtained by Aqueous extraction.

(Signed) T. K. ROGERS, M.B., F.R.C.S.,
Chemical Examiner.

MADRAS,
22nd August 1882.

No. .

From A. T. ARUNDEL, Esq., President, Municipal Commission, to the Chief Engineer, Public Works Department, dated Madras, 9th September 1882, No. 1181.

With reference to your letter No. 638 E., dated 25th August, I have the honor to enclose a letter from the Vice-President, Mr. Jones, giving so far as he can the information you desire.

2. As regards the question of the connection of the house-drains with the surface-drains of the streets, Mr. Jones estimates the cost at an average of Rs. 20 per house, or Rs. 2,65,000 for 13,255 houses in Black Town, and Rs. 8,00,000 for 40,000 houses throughout Madras.

The Municipal Act makes the house-owners responsible for all such house-drain connections, and as the recovery of the cost could be spread if necessary over a series of years I see no reason why the greater portion of the expenditure should not by recovered. I have consulted with the Revenue Vice-President, Mr. Ramasawmg Chettiar, on this matter, and should say that there would be no difficulty in recoverine at least 50 per cent., and that in all probability the final burden on the Municipality would be very small. Mr. Jones' estimate need therefore to be corrected on this point, as he has debited the whole amount of Rs. 8,00,000 to the Municipality.

3. The map asked for in paragraph 8 of your letter is being prepared and will follow as soon as it is ready.

—

Enclosure.

From J. A. JONES, Esq , M.Inst.C.E., Vice-President and Engineer, Municipal Commission, to the President, Municipal Commission, dated Madras, 7th September 1882.

The following memorandum contains, as far as I am able to give it, the information required by the Chief Engineer, Public Works Department, in his No. 638 E., dated 25th August 1882.

2. The amount actually expended up to the 1st April last was as follows :—

Drainage	Rs. 24,023
Water-supply extension*	,, 12,788

* This is in addition to the Rs. 14,30,000 expended in 1869—74 on the water-supply.

3. The only estimate for drainage which has received sanction is that for the drainage of Black Town, amounting to Rs. 8,07,500, and this work is now in course of execution.

4. The estimates for the other portions of Madras are merely approximate and were determined with reference to area and population, and not with reference to actual levels or surveys. These estimates are—

	Rs.
Ráyapuram	1,40,000
Choolay and Vepery	1,20,000
Pursewakum	60,000
Triplicane and Chintadripet	3,20,000
St. Thomé	80,000
Total ...	7,20,000

5. Each of these, except a small portion of Ráyapuram which will be a portion of the Black Town area, will form an independent drainage area with its own outfall, and are shown on the accompanying* 6-inch map of Madras. The sewage is in all cases proposed to be utilized on land and raised thereto by small engines or picottahs.

* To follow.

6. The above total added to the estimate for Black Town amounts to Rs. 15,27,500, and there therefore remained at the 1st April last the sum of Rs. 15,93,477 which is roughly estimated to be required.

7. The above estimates provide only for the improvement of surface-drains to enable them to carry off sewage and storm-waters and for the necessary sewers to carry off sewage alone, the storm-waters passing on to their present outlets. The estimates do not include the improvement of the house drainage. They include a sum for altering house-drains which communicate with *existing* under-ground drains which from their low level must be altered so as to join the new open side drains. The existing house-drains are probably not in a satisfactory condition, but it is not necessary, under the present scheme, that all existing house drains should be taken up and replaced by closely jointed air tight pipes, as proposed in Mr. Clarke's scheme, at a cost of Rs. 50, nor is it necessary that these should be raised up inside the back-yards so high as to secure the exclusion of surface waters, in fact the pipe or drain must be kept below the level of the back-yard to carry off rainfall. Mr. Clarke's estimate was for pipes sufficient to carry off night-soil and other such matters which it is not now intended to carry off by house-drains, which need not therefore be of a very elaborate description. In fact if they are formed of country brick in chunam and well plastered with cement it will be sufficient. The length of these drains would probably not exceed 50 feet, and could be built, say, six inches square of new material and well plastered with cement for a sum of Rs. 28, but many of the existing drains would require little more than plastering. I have taken 50 feet, but this is probably an excessive length, as the drains end at the front of the house and not in centre of the street (as in Mr. Clarke's scheme), and I am inclined to think that if Rs. 20 per house were taken on an average it would cover all necessary expenditure under this head. This for Black Town, containing 13,255 houses, would amount to Rs. 2,65,100. Taking this amount for the whole of the portions of Madras proposed to be drained the amount would be for 40,000 houses Rs. 8,00,000.

8. *Flushing.*—The present water-supply would be sufficient to flush these drains where such supply exists, and where it does not do so they could be flushed by an ordinary pail-full of water. But in schemes where a close-jointed pipe from house to sewer form portion of the design a water-supply service to each house would be a *sine qua non* and the average cost per house may be taken at Rs. 61 as shown below :—

	Rs.	A.	P.
50 feet of 1¼-inch piping at 6 annas	18	12	0
1¼-inch stop cock and cover	18	0	0
1-inch discharge cock	8	0	0
Labour in cutting and jointing and masonry, &c.	11	0	0
Contingencies 10 per cent., say	5	4	0
Total ...	61	0	0

Cost for 13,255 houses in Black Town	8,08,000
Do. 40,000 ,, Madras	24,40,000

9. I find that the cost of extending the mains throughout each street in the district to be drained, to enable the above service to be laid on, would be Rs. 8,000 per mile, and that about 100 miles of new mains would be required, costing Rs. 8,00,000, in addition to the Rs. 24,40,000 required for house connections.

10. *Subsoil Drainage.*—The level of the subsoil water, or level of permanent saturation, stands about 1½ feet above mean sea level and slightly higher in the rainy season.

11 If the rainfall of Madras be taken as 50 inches per annum, which is about the average, and if half this amount be taken as the amount evaporated, we get 25 inches which must percolate through into the subsoil; this taken over an area of 7·48 square miles (the area to be drained) would yield a supply of 312,500 gallons per hour (Mr. Clarke proposed to carry off 248,000 per hour). In the rainy season the amount is of course much larger.

12. The major part of the sewers will have to be laid below the level of permanent saturation, and in the scheme now being carried out are at their lowest levels some 7½ feet below this line.

13. In pumping out all the waters from the pump well at Ráyapuram just constructed, which is sunk about 6½ feet below the above depth, or 15 feet below water level, I noticed that while the water in a well within 30 feet of this was not lowered a single inch, the water in the open excavation (the bottom of which was also below the level of saturation for sewer No. 4 which commences at this well, and was then excavated in length 210 feet and to a depth of about 12 inches below level of saturation and about 9 feet broad) only subsided from 3 inches to 4 inches. This well had to be pumped about every quarter of an hour at this depth and the water would rise to 5 feet (*i.e.*, from 15 feet to 10 feet below saturation level) in about a quarter of an hour.

14. Considerable difficulty has also been experienced in putting in a pumping well at Napier Park, where the level of the bottom of foundation is only 8 feet below saturation level. The discharge at this place from an area of 700 square feet was about 250 gallons per minute.

15. From these facts it may, I think, be supposed that if wells were sunk 60 feet apart (double what the two wells were at Ráyapuram) over the entire area to be drained and to 8 feet below saturation level we would probably get a constant supply of 250 gallons per minute, and on this basis we would get $\frac{250 \times 60 \times 5280^2 \times 7{\cdot}48}{60 \times 60}$ or 871,200,000 gallons per hour from the 7·48 square miles. This result is almost 300 times in excess of that determined on the basis of rainfall alone, and being deduced from a limited area cannot be made applicable except with extreme caution to the whole area to be drained. There can, however, be little doubt that the less quantity is exceedingly under the mark, and that if that quantity were drawn off regularly the level of the subsoil water would not be affected a single inch.

16. The water in the wells, as before stated, stands usually to about 1 foot to 1½ feet above mean sea level, and I think it probable that the level of the subsoil water is somewhat dependent on the sea level. At present there is a hydraulic head against the sea and fresh water can be had from wells on the shore itself. What would occur were the subsoil water lowered to any considerable extent would merely, I presume, be the introduction of salt water where fresh now is.

17. I cannot of course positively assert that such would be the case, but I do not think any other conclusion can be arrived at from a careful consideration of what has already been stated.

18. The following shows depth, length, and diameter, &c., of the sewers (as at present being constructed) under the permanent level of saturation :—

		Length.	Depth below the level of Saturation.		Mean Depth.
			HIGH END.	LOW END.	
Sewer No. 1 ...	18 inches diameter ...	2,155	1·0	2·5	1·75
	24 do. do. ...	3,732	2·5	5·0	3·75
	30 do. do. ...	1,263	5·0	6·60	5·85
Sewer No. 2 ...	18 do. do. ...	3,326	0	2·25	1·12
	24 do. do. ...	4,593	2·25	5·25	3·75
Sewer No. 3 ...	24 do. do. ...	2,498	0	7.66	3·83

19. The subsoil water could therefore be tapped to depths 6 feet 8 inches, 5 feet 3 inches and 7 feet 8 inches below permanent level of saturation, but it is not intended to allow subsoil water to pass into these sewers as their dimensions will not admit of this being done, and I believe were the means proposed by Mr. Clarke for this purpose would undoubtedly fail and the sewers would eventually be choked with sand.

20. Having regard, therefore, to all the points already noted, I am unable to give any idea of what would be the cost of subsoil drainage, nor can I see any feasible plan of carrying it out by which the level of the subsoil water would be affected in the very slightest degree.

Water Supply.

21. My report on the improvement of the Madras Water Supply, dated June 1877, gives in detail an estimate of the cost of the works necessary for pumping the water on to the summit of the hills about the Red Hills Lakes, there filtering the same and supplying Madras thence with a 27-inch main.

22. The total head which would be obtained by the scheme would be 60 feet above mean sea level, or about 30 feet above the highest ground in Madras and 40 to 50 feet above the mean level of the town. This would be sufficient pressure for all purposes, and would give an extremely good water-supply even in those distant portions of the town whither we are now extending our pipes. The additional head over our present head would be 30 feet. I would deprecate the adoption of any greater head than this, as with a very high pressure system the waste of water in Madras would be enormous and the sewers would become insufficient.

23. The extension of the distribution pipes at present being made, complete the water-supply as far as there is any present intention of doing so. It is not intended to bring any additional portion of the town within the limits of the water-supply area. There may be some cases, however, in which it would be advisable to afford a better supply within the present area and Rs. 1,00,000 would certainly meet all cases of this kind. The estimate for pumps, fitters and main was Rs. 13,66,000, and copy of the report is herewith sent for information, though it is believed that several must be available in the Government Office.

24. The total cost of necessary improvements to our water-supply, supposing the scheme of surface drainage to be adhered to, may therefore be taken at Rs. 14,66,000.

25. The following estimate No. 1 will show, having regard to the foregoing remarks, the probable cost of the works for drainage and water supply if these were carried out in accordance with the views expressed by the Army Sanitary Commission :—

No. 1 Drainage.

	Rs.
Main Sewers and Pipe Sewers in streets	45,00,000
House Drainage 40,000* at 50	20,00,000
House Service 40,000 at 61	24,40,000
Subsoil Drainage †	5,00,000
Total ...	94,40,000

Water Supply.

Extended Distribution to put main in streets to be drained so as to afford water-supply to each dwelling, 100 miles at 8,000	8,00,000
Improvement of water-supply to allow of extended service and to give increase head with proper fitting arrangement. ...	13,60,000
Total ...	21,60,000
Add Drainage	94,40,000
	1,16,00,000

* Captain Tulloch says 32,000, but he drains Rayapuram in addition to the number of houses proposed to be drained by Mr. Clarke which I make 38,000.

† I have entered the amount put down in Colonel Sankey's rough memorandum, but I doubt if anything could be done for that amount.

Captain Tulloch's scheme would cost the same amount less the amount of subsoil drainage.

Mr. Clarke's Scheme.

	Rs.
Main Sewers	
House Drainage 38,000 at 50	25,00,000
House Service water-supply 38,000 at 61	19,00,000
	23,18,000
Extension of Mains	67,18,000
Improvement of water	8,00,000
	13,60,000
Total ...	88,78,000

Present Scheme.

Street Drainage	
Add for land for farms, lifts, &c.	15,27,500
	3,00,000
House Drainage (see para 7)	18,27,500
	8,00,000
Improved water-supply, increased head and contingent extra distribution (see para 24)	26,27,500
	14,66,000
	40,93,500

26. The estimated cost of each of the four schemes would then be as follows including the necessary water-supply for each scheme as designed :—

As advocated by Army Sanitary Commission	Rs.
Major Tulloch	1,16,00,000
Mr. Clarke	1,11,00,000
Mr. Jones	88,00,000
	41,00,000

No.

From A. T. ARUNDEL, Esq., President, Municipal Commission, Madras, to the Chief Engineer, Public Works Department, dated Madras, 29th September 1882, No. 1258.

I have the honor to forward a letter, No. 1256, dated 27th September, from the Vice-President Mr. Jones, giving the information asked for in your letter, No. 742 E., dated 14th instant.

From J. A. JONES, Esq., Vice-President, Municipal Commission, to the President, Municipal Commission, Madras, dated Madras, 27th September 1882, No. 1256.

I have the honor to make the following remarks and to forward the additional information required by Colonel Sankey in his letter to you, dated the 14th September 1882, No. 742 E.

The amount of Rs. 12,788 which set down as the amount spent on water-supply in addition to the original expenditure of Rs. 14,30,000 was the amount spent up to 1st April last for new works only. Such sum does not include any payment on account of interest and maintenance of the water-supply. Such expenditure is detailed in the following table:—

		Rs.	A.	P.
From Current Revenue.	Outlay previous to 1873-74, advanced by Municipal Fund	35,715	9	9
	New works from 1873 to January 1882 ...	46,340	11	1
	Maintenance from do. do. ...	1,40,630	3	5
	Interest from 1870 to July 1882 ...	6,00,229	10	6
	Sinking Fund	3,53,390	9	2
		11,76,306	11	11
	Red Hills water from 1873 to July 1882.	25,226	2	9
		12,01,532	14	8

	Rs.	A.	P.
Loan of 1863-74	14,30,000	0	0
Loan of 1882	12,788	0	0
From Revenue	12,01,532	14	8
	26,44,320	14	8

The total up to 1st April including this amount is therefore Rs. 26,44,320-14-8.

With reference to paragraph 5 (1) of Colonel Sankey's letter, I fear I am not able to give an indisputable reply, but I will endeavour to give such facts as will enable Colonel Sankey to see exactly how the matter stands. In the first place it will be noticed that I have merely made several strides beyond Mr. Clarke's scheme as he did beyond Major Tulloch's, when he recognized the principle of having more than one outfall over a large area, by the omission of St. Thomé from the general scheme, giving it an outfall of its own. I might contend that if the principle were right as regards St. Thomé, that is to say the principle of giving places widely separated their own independent drainage and independent outfalls, there can be no reason against the extension of such a principle, but it would be unfair not to point out that in case of St. Thomé Mr. Clarke intended to allow the sewage to flow by gravitation into the sea. What would be the effect of such a manner of disposal is not difficult to foresee.

Against the fact however that in St. Thomé no pumping would be required, I have to submit that where pumping is required, as it would be in most of the independent areas I propose, we have the income from the crops raised on the land irrigated, and taking three of our farms which respectively receive the sewage of (1) Choolay and Vepery; (2) Triplicane (north of Pycroft's Road); (3) Triplicane (south of Pycroft's Road), we have the following as the results of four years' working:—

Years.	D'Mellows.		Triplicane.		Kishnampet.	
	Receipts.	Disbursements.	Receipts.	Disbursements.	Receipts.	Disbursements.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1878	1,262 3 4	1,378 4 11	1,125 10 3	965 8 6	2,641 1 7	1,843 6 5
1879	2,766 15 6	1,660 2 5	1,931 3 6	1,915 9 6	4,059 15 7	2,141 15 6
1880	1,762 13 1	1,716 1 8	1,676 12 3	2,791 10 5	3,086 8 9	2,666 10 4
1881	1,857 9 7	1,963 14 4	1,640 11 9	3,099 14 3	4,600 0 2	3,758 15 11
Total ..	7,749 8 6	6,707 7 4	6,374 5 9	8,802 10 8	14,387 10 1	10,349 0 2

This is a profit over the three farms of Rs. 2,650 in four years.

I do not imagine that when each of these portions of the town are properly drained that our present arrangements for raising the sewage by picottahs will avail, but still whatever be the cost of such raising the net income will not be less than it is now and will most probably increase.

It may be urged that the sewage wherever raised and put on land, if suitable, will produce the same income, but any place where the sewage of the whole town has to be disposed of must necessarily be at some distance from the town itself, and the crops produced would either have to be carried into the town or sold at a reduced rate on the spot.

The saving due to each separate locality having its own outfall in a town having a somewhat uniform density of population would be little, but in a place such as Madras, where the populated portions are widely separated, forming almost independent towns, the saving is very considerable, while at the same time suitable areas are rendered available for sewage farming. The saving is due not alone to the actual length of sewer saved between these detached portions, but also to the decreased size of sewers throughout.

There is another saving in having detached areas, and that I think the most important one and one which goes I think far to decide the question as to whether the extra cost involved in several pumping stations would not, when capitalized, pay for the extra cost which would be incurred in constructing continuous sewers towards one well to the north of the town; for it has been decided by all who have considered the question that no other site is feasible as a single outfall for the drainage. The point to which I draw attention is this, that where there are very long sewers the lift at the pumping station, owing to the gradient necessary for the sewers, is very much greater than when the sewers are in comparatively short lengths, and this comes to be of considerable importance, as in addition to the extra length of sewer you have this increased height to which the sewage has to be raised, and the cost of this, it appears to me, would be as great as any extra cost which would result from any extra establishment required at the different stations of independent drainage areas.

To the second question in paragraph 5 I can speak positively and reply that there is available ground for sewage irrigation contiguous to the different drainage areas, and have further to add that of such ground the major part is already in the possession of, or available for, the Municipality. The different areas are colored on the map referred to in my letter of 7th September 1882, and the land which can be used in connection with these areas is colored of a darker shade of the same color as the area whose sewage it is proposed it should receive.

Paragraph (5) 3 opens up a question on which there must necessarily be many different opinions. Sewage farming in India is not however handicapped by many of the disadvantages to which such a process is subject in England. We have in India the aid of a powerful sun throughout the year, and our experience in Madras is that the complaints arising from sewage farming are very few and far between. The chief, and I may say the only, nuisance on a sewage farm is at the lift worked by picottahs, but this is one which can be overcome by providing proper wells and means of raising the sewage, by which it would not be continually stirred up and the odours continually disseminated. When the Municipality asked some time ago to be allowed to utilize a portion of waste land belonging to the Madras Railway Company close to the Central Station as a sewage farm, the Agent Mr. Saunders and the Acting Chief Engineer Mr. West visited the farms at D'Mellows Road and elsewhere, and finding from their own observations that no nuisance was to be feared, immediately gave permission for the construction of the farm. No complaint whatever has been received from the Company as to this farm, although it has now been in existence over a year.

The following is from the Madras Manual of Hygiene compiled under the orders of Government by Dr. H. King, A.M., M.B., &c., page 226, paragraph 570:—

"Sewage irrigation yields on the whole more satisfactory results than any other of the wet methods and is more generally applicable. It requires a surface of about one acre for every 100 persons in the community, and 70 yards square will receive 2,000 gallons of sewage in 24 hours. Large crops of grasses, cereals, roots and culinary vegetables can be raised, year after year, from land thus irrigated. The sewage should be brought to the land as rapidly as possible, and putrefaction may be advantageously delayed or prevented by the addition of small quantities of carbolic acid. The liquid trickles down a prepared slope, over the ground to be irrigated, at the rate of 8 feet per hour, saturation of the soil being guarded against by deep draining unless where it is so sandy or otherwise permeable as to render the precaution unnecessary. The effluvia are rarely such as to constitute a nuisance, but it is desirable to choose ground distant from houses. Enteric fever, dysentery, and the prevalence of entozoa have been predicted as probable consequences of sewage irrigation, but there is no evidence of the occurrence of such results, nor need they be apprehended if reasonable care be used. In some places the practice has been pursued for years without any bad effect. The water is not freed from impurity by irrigation to the same extent as by filtration; but it loses its suspended matters and some of its dissolved organic impurities, if not allowed to run too quickly off the land. The financial results of this method are more satisfactory when rain and surface water are excluded from the sewage."

Coming to paragraphs 7 to 12 of Colonel Sankey's letter I must first state that Captain Tulloch has been drawn into some strange error in making the statement quoted by Colonel Sankey in regard to the house drainage. In no house I or the Sanitary Inspector have visited has the house drain ever been common to two adjoining houses or under the mean wall. Mr. Ramasawmy Chetty, the Revenue Vice-President, who has abundant opportunities for knowing, states that no house has its drain in common with an adjoining house, and that in the majority of houses there is always sufficient fall to run off the water quickly from the back portions of the house which are invariably higher there than towards the street. In the 600 houses in the experimental section of surface drainage executed no house drain was in such a position. In fact to begin with few houses have a mean wall at all, and in the majority of houses the drain is to the left hand side of the house. These remarks, I think, entirely dispose of Captain Tulloch's statement as to the position of the house drain.

In the experimental section of drainage executed as before stated about 600 houses were included. Of these I had to execute work in 14 houses, in order to alter the house drain to a proper level to allow of its flowing into the new street drain. The total length of house drains so altered was 257 feet and the total cost Rs. 76-10-7.

In order to determine the actual length of drain which would require to be altered if all the house drains had to be laid anew, I have had the house drains of all the houses in the three following streets measured with the result shown. Yedapollium Street is one of the streets already drained :—

	Number of houses.	Total length of house-drain.	Average length.
		FEET.	FEET.
Yedapollium Street	83	2,442	30
Sevarama Sastry Street	26	1,395	54
Ummen Covil Street	38	2,431	63
Mean Average			49

This is very nearly the length I gave in my former letter.

Now for 10 feet of a new 4" house drain the cost would be—

	RS.	A.	P.
Brickwork	2	8	0
Plastering	0	10	0
Excavation	0	2	0
For 50 feet ... ... Total ...	3	4	0
Breaking walls and repairs	16	4	0
Outer nozzle to drain	2	0	0
Grating	2	0	0
	1	0	0
Total ...	21	4	0

This is supposing that all drains have to be laid anew. It does not however allow for flooring back-yards, and this expense would be considerable, some houses having as many as three separate court-yards. Nor has such an expenditure been anticipated either by Captain Tulloch or the late Mr. Clarke, and therefore whatever is added to the one scheme on this account a similar amount must be added to each of the other two. Now it should be noted that all the Municipality had of necessity to expend to connect the house drains and the new surface drain in regard to 600 houses was Rs. 76-10-4. I do not claim that this amount covered all that ought to be done, for every house drain even where the level needs no alteration should be inspected and put into thorough repair, but it shows the extent to which the Municipality was actually liable. I do not see with these facts in view on what I can base a higher estimate than Rs. 20 per house for house drainage, seeing that Rs. 21 odd will on average give every house a *new* drain, which would in many, certainly 50 per cent., of the houses not be required. If flooring however is considered a necessity I would on that account add Rs. 10 per house, making in all Rs. 30 on the average for house drainage. There will be exceptional cases in which the whole flooring of the houses may have to be raised, but against this it may be said that such houses are of small size, and the length of drain would be considerably less than the average. The longest

house drain measured in any of the three streets mentioned was 135 feet, the shortest 8 feet. The longest length of drain altered in the experimental section of drainage was—

	RS.	A.	P.
82 feet, cost	21	13	5
The shortest 8 feet, cost	6	10	9
	28	8	2
Average per foot	0	5	0
For 50 feet	16	0	0

Paragraph 13 of Colonel Sankey's letter. My remark in paragraph 19 of my last letter had reference to Mr. Clarke's method of preventing sand entering sewers and not pipes and regarded the method of putting a drain pipe through the side of the sewer and packing broken brick at the end of it to prevent the entrance of sand.

I have made some experiments with the sand taken from the line of sewer now being excavated. I find that by mere oscillation in the water and without any head of water at all 100 per cent. of the sand passes through wire gauze of 256 meshes to the square inch and 80 per cent. of the sand passes through muslin of 1,600 meshes to the square inch. I do not see how it can be doubted that sand under the pressure of 6 to 14 feet head of water would be prevented entering any sewer by means of a lump of broken bricks. I must admit that Mr. Clarke's method of packing a pipe joint with well-tampered clay and covering it with concrete would prevent any sand entering.

In Calcutta the subsoil water is admitted to the sewers by no special contrivance, and the only subsoil water which is admitted is that which soaks through the brick-work, it being impossible to make sewers of country brick-work water-tight. I think therefore that it may be concluded that Mr. Clarke did not find the plan feasible, or he certainly would have adopted it in Calcutta.

It is no doubt a practice in Madras for persons building mud-huts, or huts of brick and mud, to obtain the mud clay or earth at as short a distance as possible from the building being erected. These cases however are usually confined to parcherries, and the pits are of small area. The borings carried out by Major Tulloch and the depths of soil marked "made soil" can however have no reference to such cases. It will be seen by referring to the sections that such soil is found from one end of Madras to the other up to depths of 7 to 9 feet, and in one case this soil is marked "unbottomed." In certain places it is shown above the surface, and it will be seen that it is found close to the sea and a distance of two miles north of the inhabited portions of the town. This can scarcely have connection with places which have been raised by rubbish, and it may be further noticed that where the line of the sewer crosses rubbish heaps near boring No. 8, these are distinctly marked as such, and neither in this place nor near to it is there any made ground at all. I do not understand what Captain Tulloch means by made ground, but I think it is obvious that he does not mean rubbish heaps.

The best way to deal with rubbish heaps is to cultivate crops from them, such as cholum and other coarser kinds of grain. This method more than anything else tends to remove anything that is unsanitary in the upper strata at any rate, and the more crops the deeper does the purification take place. No building would of course be allowed on such sites, and no house system of drainage would therefore be necessary.

I have replied so far as I have been able to Colonel Sankey's question, and though in reference to paragraph 5 (1) I have not been able to give a decided answer, I think I have said enough to enable a clear opinion to be formed on the matter.

No.

Note by the Chief Engineer, Public Works Department.

The Secretary of State in despatch, No. 12, "*Statistics and Commerce*," dated 22nd June 1882, calls the serious attention of the Madras Government to the condition of matters prevailing in the Presidency Town as set forth in a memorandum by the Army Sanitary Commission, dated 18th April 1882.

2. The latter body, after reviewing the Report of the Madras Municipality for 1880, observe (paragraph 5) that they "would strongly urge the inexpediency of wasting money upon the incomplete and unsatisfactory surface drainage plan now in process of execution, which does not fulfil any conditions of a proper drainage system," and "recommend at the same time that a complete system of town and house drainage in combination with an improved and extended water-supply for removing house sewage separately from the rainfall be at once adopted." They conclude their report

by observing that the whole subject should be taken in hand by the Government of the Madras Presidency.

3. The delays in regard to the drainage of Madras, which have appeared incomprehensible and unreasonable to the Army Sanitary Commission, have arisen from inherent difficulties of a very serious character, which notwithstanding the reports of such well-known professional Engineers as Major Tulloch, R.E., and the late Mr. W. Clarke, M.I.C.E., and the strenuous efforts of a succession of Government officers and Presidents of the Municipal Commission, who one and all have certainly spared no pains in their endeavours, have hitherto proved to be insuperable.

4. To state the difficulties in detail is unnecessary, but the mention of a few of the leading facts may be useful. Madras has a population of 406,000 distributed in at least six different centres over an area of 27 square miles. No portion of the latter is raised more than 24 feet, and some places are only $2\frac{1}{2}$ feet above mean sea level; during cyclones, when the surface of the sea along the coast is abnormally raised, much of the place is even below mean sea level. In ordinary times the sea is practically tideless, as even during "springs" the difference between high and low water being not more than $3\frac{1}{2}$ feet. To add to the difficulty of collecting and discharging the sewage of the many large and scattered aggregations of population the north is separated from the south of Madras by a winding river, which for the most part is a backwater receiving the contents of natural drainage channels which are shallower and if anything more straggling than itself.

5. To any one acquainted with the difficulties which for the most part have proved insuperable as regards the effective drainage of the cities and towns situated along the littoral of the Mediterranean, the bearing of the above facts will be sufficiently evident. Were Madras a flourishing commercial centre with a rapidly expanding trade, it is possible that the needful funds might be raised for dealing in some effective way with its drainage, but as the population is of the poorest, and trade not apparently increasing there, it may at once be assumed that, without Government aid, the Municipality are quite unable to carry out the needful sanitary works on a large scale, and for want of means are compelled to confine themselves to palliatives. The Government on its side have been equally unable to come to the rescue, as from the manner in which the Imperial burdens have been distributed the Provincial resources of this Presidency have hitherto been unduly starved in the interests of other provinces.

6. Major Tulloch's scheme of 1864-65, amounting to $39\frac{1}{2}$ lakhs, provided for a perfectly closed system of drainage excluding rain and storm waters. A main sewer starting from St. Thomé was to be carried under the Cooum River to a well north of the town from which the liquid sewage was to be pumped into a channel two miles in length along the course of which it was to be employed in irrigation.

7. Mr. Clarke in 1875 followed Major Tulloch's scheme in the main, but by cutting off several of the outlying tracts, and particularly St. Thomé, which was to have a separate sewer discharging direct into the sea, he was enabled to reduce his estimated total outlay to $23\frac{1}{2}$ lakhs.

8. Both Engineers however omitted from their schemes the expense of two items, one and other of which it is thought should be taken into account in estimating the total outlay required.

The first of these is a supply of water under pressure all over the town. This would be quite essential in any system such as that apparently advocated by the Army Sanitary Commission and forming part of Major Tulloch's and Mr. Clarke's schemes, where the excreta of each house are carried off by a pipe of small dimensions (exclusive of all surface drainage) discharging into a system of closed town sewers.

The second item is that of the cost of the house connections. The Municipal Act of Madras, like that of other towns where such institutions exist, confers the needful powers on the Commissioners to enforce the construction of all house connections at the cost of the proprietors; but to any one acquainted with the extreme poverty of the majority of the Madras population, it is quite clear that with a very large number it would be useless to attempt to put this provision of the Act in operation.

9. It will be observed from the correspondence which has lately taken place with the President of the Municipal Commission that both the above points have now received careful consideration, with the following results as regards probable outlay—See Mr. Jones' letter, No. 1, of 7th September 1882:—

(1) Water-supply extended so as to meet the requirements of a completely closed system—

	Rs.
(*a*) Improved arrangements to give increased head of pressure throughout the town	13,60,000
(*b*) Extension of the street mains	8,00,000
(*c*) House service 24,40,000, half, say, recoverable from householders	12,20,000
Total, Water-supply ...	33,80,000
(2) House drainage Rs. 20,00,000, of which say half would be recoverable	10,00,000
Total ...	43,80,000

N.B.—Half of the cost under (*c*) and (2) has been taken as recoverable under the opinion expressed by Mr. Arundel, President, Municipal Commission.

Major Tulloch's scheme with the above additions, but excluding arrangements for dealing with the drainage of the subsoil (of which more presently), is the only one which would apparently fully meet the requirements of the Army Sanitary Commissioners; there can however be little doubt that his estimate if put in actual execution would not cost less than 45 lakhs.

The total outlay which would have to be met from public funds is $45 + 43{\cdot}8 = 88{\cdot}8$ lakhs. Under Mr. Clarke's restricted scheme, amounting to $23\frac{1}{2}$ lakhs, the extent of house drainage and water service would be less than in Major Tulloch's. If the cost of both the latter items be taken at 40 lakhs, the total under his proposed system of works would be $40 + 23{\cdot}5 = 63{\cdot}5$ lakhs.

10. The Army Sanitary Commission lay considerable stress on the foul condition of the subsoil and the necessity of dealing with this as part of a well-designed and comprehensive scheme; but as will be observed from the letter from the Chemical Examiner, No. 319, dated 22nd August 1882, that officer is of opinion from the analysis of soils taken at a depth of 4 feet from different localities in Madras that "the results obtained indicate a far greater immunity from filth and contamination than could have been expected."

11. Again that there are considerable difficulties in deciding both as to the measures to be taken, and the probable effect of such in regard to the drainage of the subsoil waters, will be seen from the observations contained in paragraphs 12 to 20 of Mr. Jones' letter, No. 1181, of the 9th September 1882. As remarked by him in paragraph 16 the water in the wells "stands usually to about 1 foot to $1\frac{1}{2}$ feet above mean sea level," and if the result of any considerable lowering of the subsoil water lead as he supposes to "the introduction of salt water where fresh is now," the general effect would, it is thought, be extremely injurious, as the admixture of salt with fresh water is understood to increase fourfold the effect in dissolving sewage matter held in suspension.

12. This is a matter to be decided by Chemical experts, but as a question of professional engineering there can be little doubt that to deal in any comprehensive way with the subsoil water would need a very extensive net-work of underground drains which should have contrivance for admitting freely all subsoil waters and dissolved sewage matter without at the same time allowing the fine particles of sand of which the soil to a great extent consists to be washed out.

13. Looking at the question in this light it would appear undesirable to attempt anything more than the arrangement contemplated in Mr. Clarke's scheme for placing small inlet pipes, well protected, at sufficiently short intervals along the lines of main sewer so as to get rid, as far as may be possible, of the dissolved sewage matters which

may have soaked into the soil in the immediate neighbourhood of each. Should there be any sensible washing out of the sand, it is needless to say that in process of time, as one of the evil results, the stability of buildings in the neighbourhood must necessarily become endangered. On the whole, therefore, in dealing with this part of the subject, it will be best not to contemplate any very extensive works, and a sum of 5 lakhs may be assumed as the limit of necessary outlay.

14. The approximate cost of the several schemes would therefore stand as follows, taking into account the several adjustments as above :—

	RS.
(1) Major Tulloch's scheme with the cost of house water-supply service and drainage	88,80,000
Mr. Clarke's do. do. do. do. do. do. ...	63,50,000
Army Sanitary Commission's (being Major Tulloch's scheme with 5 lakhs added for dealing with subsoil water)	93,80,000

Each and all of these schemes, it must be remembered, leave out of account the following sums which would have to be borne directly by such of the house-holders as may be called on to bear the needful outlay for house connections, both water-supply and drainage, viz. :—

	RS.
Half of the house water-supply head (1) (c) above	12,20,000
Half of the house drainage head (2) above	10,00,000
Total ...	22,20,000

15. With a population taxed it is believed very nearly to the utmost, it is needless to say that the expenditure of enormous sums of this character cannot be thought of. Even were Government in any way able (which it is not) to meet the outlay demanded by the scheme understood to be advocated by the Army Sanitary Commission, it is very questionable whether in justice to the many other pressing demands on account of other matters of the highest importance to the welfare of the Presidency, it could venture to do so, and again to compel even the well-to-do inhabitants to spend over 22 lakhs out of their own pockets in addition to meeting the demands of increased taxation is to say the least chimerical.

On all accounts therefore it is necessary to consider whether there are not other means for bringing about as far as possible sound sanitation.

16. Mr. Jones' scheme is in this view the only one which has up to the present time been put forward as holding out reasonable prospects of success. As generally described, it, like both Major Tulloch's and Mr. Clarke's schemes, proposes to deal almost entirely with the removal of sewage matters, to the exclusion of the storm waters, but as with chiefly saucer-shaped open surface drains he has no need of water under pressure in each house, or of a closed system of house or street drains, excepting where for the requirements of slope the latter have to be converted into underground sewers, the cost is at once sensibly reduced.

17. Acting moreover on the principle that the sewage of each of the several centres of population shall be employed in irrigating and raising crops on available land in the immediate vicinity two very serious items of charge are minimised. In the *first* place there is no need for a very long sewer or sewers of large capacity to convey the liquid sewage to any one point for the whole town, and in the *second* the diminished height through which the sewage has ultimately to be lifted.

These and other matters connected with Mr. Jones' scheme, including the very important facts tending to show that the plan of utilizing the sewage in irrigation has been proved by actual experiment to be rather remunerative than otherwise, and to be open to but small objection on the grounds of being offensive to the public, are very fully explained in his letter, No. 1256, dated 27th September, and the map which accompanies it.

18. The method of dealing with the separate house drainage is fully and apparently satisfactorily explained, and on the whole it would be fair to accept his estimate for the work as specified by him, viz. :—

	RS.
Street drainage	15,27,000
Land for sewage farms	3,00,000
House drains 8,00,000, half cost of	4,00,000
Improved water-supply	14,66,000
Total ...	36,93,000

To which may possibly be added—

	RS.
To levelling and paving back-yards (See Mr. Jones' letter No. 1256)	2,00,000
Grand Total ...	38,93,000

This last item of two lakhs would, if admitted, have also to be added to all the other schemes if put in comparison. There can be no doubt that the drainage of the back-yards must be thoroughly dealt with if sound sanitation is to be secured, and this item must therefore apparently be included.

19. Mr. Jones is still apparently satisfied that his saucer drains will stand sufficiently well all wear and tear with a cement surface, but on this point there is room for doubt, and it would be advisable to keep in view that stone surfaced drains may as previously recommended have to be adopted, in which case not less than 2½ lakhs should be added to the probable cost of his scheme, bringing the total with the addition for floorings of the back-yards to Rs. 41,43,000. In addition to this house-holders, who can equitably be compelled under the Act to supply proper house drainage and connections, would have to incur the following items of expenditure from their private means, viz. :—

	RS.
To half cost of house drains 8 lakhs	4,00,000
Do. of levelling and paving the back-yards	2,00,000
Total ...	6,00,000

On the whole therefore it may be broadly stated that Mr. Jones' scheme would entail an outlay of not half that apparently contemplated by the Army Sanitary Commission so far as concerns the expenditure of public funds, but what is even of greater importance the compulsory outlay by private individuals would be reduced to 6 as against 22·2 lakhs. Even thus however reduced to a minimum the total charge is quite beyond the means at the disposal of the Municipality, who must consequently, unless aided by Government, content themselves with carrying out as they are now doing the Black Town portion of Mr. Jones' scheme, which is clearly the one of most pressing importance.

20. Great stress has been laid in the report by the Army Sanitary Commission on the preferability of a closed as compared with an open system of drains for Madras, but on this point there is reason to doubt whether the opinion is well founded.

21. In a hot climate the evolution of sewage gases must of necessity be much more rapid and therefore more likely to produce mischief than in a cold one, and considering the habits and the small means possessed by the natives anything approaching to a water closet system is not for a moment to be thought of.

22. On the other hand house drains which can be easily got at for daily cleansing or for occasional repair have much to recommend them both on the score of cleanliness and economy, while for the outer street drains the arguments in favor of these being kept, as far as possible, open to the action of the sun and air as also for ready scavenging appear to be unanswerable.

23. The sun which is an enemy to be dreaded with all closed pipes and drains is the reverse where organic matter is exposed, as all who have had sufficient acquaintance

with India can attest. Here in fact the sun is the best of friends, and should, if properly turned to account, do more to keep Madras healthy than perhaps anything else save the benificent sea breeze, which no doubt holds the first place as a sanitary agent. The real difficulty is how to have sufficient lengths of drain kept open and exposed to the action of the sun, as the requirements of slope demand their being but too soon converted into underground sewers.

4th October 1882. (Signed) R. H. SANKEY, Colonel, R.E.,
Chief Engineer, P.W.D.

No.

ORDER—dated 30 th October 1882, No. 2845, Public Works.

Ordered that the Secretary of State be addressed.

(True Extract.)

Col., R.E.,
Secretary to Govt., P.W.D.

To the Sd Madras M. C.
" Select Committee
deed of the Municipal Act

To the Financial Department with copy of despatch
Sanitary Commissioner for Madras

Exd. S. T. Austin.
Spare Copies

Govt. of (1882) Madras.

PUBLIC WORKS.

Dated October, th.

Recd. Encl.

G.O., 30th Oct. 1882, No. 2865 W.

OCTOBER.

Nos.

Sanitary Condition of Madras.

Ordered that the Govt be addressed on the subject of the — with my views to the remarks made by the Army Sanitary Commn on the Report of the Madras Municipality for 1880

Proceedings of the Madras Government, Public Works Department, 21st July 1863.

13

Read the following papers :—

No. 503. From W. FRASER, Esq., Civil Engineer, to Colonel W. I. BIRDWOOD, R. E., Secretary to Government, Public Works Department, dated Chepauk, 9th July 1863, No. 13.

Sir,

1. I have the honor to acknowledge the receipt, on the 6th instant, of the Proceedings of the Madras Government No. 1,741, under date the 2nd of July 1863.

2. In paragraph 3 I am directed to state the nature and amount of assistance I shall require to enable me to furnish the Plans and Estimates called for within a given period.

In paragraph 13 of my letter I stated that the Plans and Estimates connected with the Red Hill Lake Project could be prepared in two months with the aid of two or three *good* Assistants.

I consider that the work sketched out in the Government order is fully three times as much as I had contemplated when I wrote the paragraph quoted above.

3. I have calculated the probable time again, and I am of opinion that with one First Class Surveyor and three other good Surveyors, with a proper Office Establishment, the Plans and Estimates can be prepared in four or five months.

I should not wish to begin with more than four Surveyors; but, to work economically, I should not have less; after the first month I could employ more and thus shorten the time.

I am prepared with a Memorandum showing the assumed data on which this calculation is made.

4. The following Office Establishment will be necessary :—

		Rs.
1	Draughtsman	60 per month.
1	Assistant do. and Writer	35
1	Estimate-maker...	60
6	Lascars...	37
	Total per month ...	192

After much consideration I have fixed this as the lowest sum for which an efficient Establishment can be kept up. It is equal to the sum allowed for Bangalore, and less than that allowed for either the Neilgherries or the Presidency :

I will endeavour to select men who will be useful in the field when they can be spared from Office duties.

5. I do not propose any Office Establishment for the Surveyors with the exception of the Head Surveyor, who will have the Establishment of his rank in the Department; but each will require a Surveying party of at least four Lascars when in the field. These would cost :—

		Rs.
4	Lascars at 7 Rupees	28
12	Do. at 6 „	72
	Total ...	100 per month.

The average cost would not equal this as the number would be occasionally reduced.

6. I am unable to state with any degree of certainty the pay of the three extra Surveyors, but would not exceed 150 Rupees a month or for all. ... ... | Rs. 450

Travelling allowance per diem, say 2 Rupees ... ... | 180

Total ... | 630

The Surveyor, Mr. Stephenson, who was employed for a year on the Survey of Red Hill Lake under the orders of Captain Moberly was paid 150 Rupees a month and 2 Rupees a day To be of any use, the Surveyors must be quite equal to him.

7. Captain Tulloch and I have considered the question of Office accommodation, and we are strongly of opinion that the best arrangement for both Government and ourselves would be to give us an allowance for Office rent.

We shall be differently circumstanced from other Engineers in this respect, as we shall have no routine business to transact, and the work in hands will require our constant supervision.

There are many arguments in favour of this arrangement, but I will mention only these :—

When I shall be in Madras I shall have occasion to be out until 10 o'clock or later ; when this is the case one rarely goes to Office before 1 or 2 o'clock and even then, after being out four or five hours in the sun, one has little inclination to even drive out in the heat of the day, but if the Office were in my own house I could see what the Draughtsmen were doing when I come in, and give the necessary instructions. Besides, when it is not necessary for me to go out, I would do much of my own work in the early morning if I had the Plans, &c., ready to my hand.

I find that a house large enough to give the necessary Office accommodation, and a few rooms for myself, would cost from 110 to 130 Rupees a month.

Although I should not occupy half the house, I would willingly pay more than half the rent for the satisfaction such an arrangement would give. I would be quite satisfied with 50 Rupees a month.

8. Recapitulation—

	Rs.	
Office Establishment...		
Deduct sanctioned do.	192	
Pay and travelling allowance of three Surveyors	103	89
Lascars for do.		630
Office rent...		100
		50
Total per month		869

Besides the above there would be a small sum required monthly for contingent expenses. This I would preside myself until the Bills were passed.

9. I would respectfully urge that there be no delay in sanctioning the necessary Establishments and in directing Mr. Supervisor Ottman to join me ; because, unless we have the greater part of the field work done before the monsoon sets in, in October next, we shall be very much delayed, probably altogether stopped for a time.

10. I would again draw attention to the very unsatisfactory way in which I am at present working, without Assistants and without suitable Office accommodation.

You are aware that, under your orders, I had to dismiss Mr. Stephenson at the end of last month although he had then in hands the unfinished Surveys connected with the improvement of the Cooum.

I would request permission to re-employ Mr. Stephenson at once, and to retain Mr. Roberts until the work we have in hands is completed ; but even of these gentlemen I can make but little use so long as my Office, accommodation remains as it is : without great loss of time I cannot see what they are doing.

As Mr. Roberts was engaged for a year on the Survey of the Red Hill Lake, it would, especially at first, expedite my work if he were permitted to join that Survey for some time. I could release him so soon as I had got all the information from him on the ground.

No. 504. From Captain H. TULLOCH, R. E., Special Engineer, to Colonel W. I. BIRDWOOD, R. E., Secretary to Government, Department Public Works, dated Madras, 13th July 1863.

SIR,

1. As Messrs. Fraser and Kennedy have both been asked what assistance they will require to enable them to carry out the work which is entrusted to them, I conclude that the same information will be required from me. I hasten therefore to let you know what Office and out-door Establishment is necessary if I am, as I learn, to investigate the project for draining the Town of Madras.

14

2. I do not think it will be possible to work with a smaller Office Establishment than that for which Mr. Fraser has applied. Its cost is less than that of each of the Executive Officers at the Presidency. Considering, moreover, the nature of the work, and that travelling will be entailed on all, it will be difficult to procure qualified men at less salaries. I therefore request that sanction may be obtained for the following Establishment :—

	Rs.
1 Draughtsman...	60
1 Estimate-maker...	60
1 Writer	35
6 Lascars	37
Total ...	192

3. It is of the greatest importance that I should have not less than six Lascars. If four are out with me in the morning it is impossible for them to attend Office in proper time, and if they do come they will not be fit for work until the afternoon. There must be some one to attend to the Office in the meantime and some one to send on messages. In fact these two would be precisely in the position of Peons who are allowed in every Office in the Presidency.

4. I feel that work will be more satisfactorily done if I am not put to the inconvenience of driving to an Office to do my in-door work after having been out for three or four hours in the morning. As Government have sanctioned an Office allowance of 40 Rupees for each of the Executive Officers at the Presidency I trust they will do the same in my case. It is really much more necessary, because the fatigue of levelling for some hours in the morning unfits one for driving a long distance to an Office, much more than the mere inspecting of works either on horseback or in a carriage.

5. I do not know how soon the Plans of the Drainage Project may be expected by Government to be completed, and until I hear from you on this subject I will not apply for the full complement of Surveyors that may be required. But I feel that no time should be lost in placing at my disposal at least two Surveyors in addition to Mr. Martin, who I learn is to be put under my orders as soon as he arrives in Madras. Each Surveyor will require four Lascars.

6. I am anxious to set to work as soon as possible, and should be glad if all the arrangements in connection with my Office could be completed soon.

No. 505. ORDER THEREON, 21st July 1863, No. 1,971.

1. The Government grant authority for the entertainment by Mr. Fraser and Captain Tulloch respectively of the extra Establishments mentioned below for a period not exceeding four months :—

	Rs.
Office Establishment	89
Two Surveyors at 150 Rupees	300
Travelling allowances for do. at 40 Rs.	80
Three Lascars at 7 and seven at 6 Rupees including two additional Lascars for Supervisor.	63
Total ...	532 per month.

2. The Supervisors to be attached to Mr. Fraser and Captain Tulloch will be allowed, in addition to the above, the Establishment sanctioned for their grade in G. O. No. 1,599, dated 18th June 1863, viz. :—

1 Writer at 15 Rupees and
2 Lascars at 6 Rupees each.

3. For each Executive Officer a contingent allowance of Rupees 10 per mensem is provided in the Order quoted above.

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Proceedings of the Madras Government, Public Works Department, 21st July 1863.

4. The Secretary to Government in this Department will arrange for providing Office accommodation for Mr. Fraser and Captain Tulloch in the rooms occupied by the Lithographic Department. The Government hope to be able shortly to provide separate Office accommodation for these Officers.

5. The Controller is requested to pass the charges sanctioned in these Proceedings from the allotment in the Budget for the Pommel Tank.

(Signed) W. I. BIRDWOOD, Colonel, R. E.,
Secretary to Government.

Cur. 19/10 C 26/10

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Proceedings of the Madras Government, Public Works Department, 23rd June 1863.

No. 536. Proceedings of the Madras Government, dated 23rd June 1863, No. 1,646 :—

1. In their Proceedings No. 1,599, dated 18th June 1863, the Government sanctioned the following special Establishment of Officers and Subordinates with a view to working out the details of important projects with reference to irrigation or other works :—

2 First Class Executive Engineers.
2 Third Class Assistant do.
1 Third Class Sub-Engineer.
1 First Class Supervisor.
4 Second Class do.

2. On a re-consideration of the question the Governor in Council is of opinion that there would not be sufficient employment at present for so large an Establishment, and under this view he is pleased to accord sanction to the following scale, to take effect from the 1st proximo :—

	If Military.	*If Civil.*
	Rs.	Rs.
3 Special Executive Engineers	500	750
1 Supervisor	100	200
1 Assistant do.	80	150

3. Sanction is also granted to the charges mentioned below which have been omitted from the Statements embodied in G. O. of the 18th June 1863, quoted above :—

Salary and allowances of Mechanical Engineer Wait,
Do. of Mechanical Engineer Thomkinson,
Do. of Mechanical Engineer Drummond,
Do. of Boiler Maker Nolan,
} According to the present scale.

Workshop Establishment at Paumbem, ... Do.

Salaries of Indentured Apprentices, according to the scale provided for in their Covenants.

Salary of Superintendent of Stores at the Presidency, according to the present scale including Military pay.

Eight Store-keepers, one for each Division at 50 Rupees.

4. Wherever Offices and Store-yards have been built at the fixed stations of the Superintending Engineers, Office rent will of course not be passed by the Controller.

(Signed) W. I. BIRDWOOD, Colonel, R. E.,
Secretary to Government.

Proceedings of the Madras Government, Public Works Department,
23rd July 1863.

No. 602. Read the following letter from Captain H. TULLOCH, R. E., Special Executive Engineer, to Colonel W. I. BIRDWOOD, R. E., Secretary to Government, Department Public Works, dated Madras, 7th July 1863 :—

SIR,

1. I have the honor to inform you that I this day delivered over charge of the Office of Executive Engineer Presidency to Captain H. L. Prendergast.

2. I beg that you will kindly furnish me with written instructions as to the duties which I am now to perform.

No. 603. ORDER THEREON, 23rd July 1863, No. 2,018.

1. Resolved to refer Captain Tulloch to the Order of Government dated 16th February 1863, No. 398.

2. In connection with this subject Captain Tulloch is requested also to report on the drainage of Madras generally, and to prepare the necessary Plans and Estimates for improving the same by conducting the sewage which is now poured in the Cooum through various openings, into the sea mouth of Black Town if possible.

(Signed) W. I. BIRDWOOD, Colonel, R. E.,
Secretary to Government.

Proceedings of the Madras Government, Public Works Department, 14th August 1863.

No. 286. Read the following letter from Lieutenant-Colonel A. J. M. BOILEAU, R. E., Superintending Engineer 4th Division, to Colonel W. I. BIRDWOOD, R. E., Secretary to Government, Public Works Department, dated Madras, 29th July 1863, No. 1,389.

SIR,

1. With reference to the Proceedings of Government No. 1,742, dated 2nd July 1863, I have the honor to request that authority may be granted for placing under the charge of Mr. Kennedy, Executive Engineer, all the Salt Channels and Salt Platforms north of the Canal Basin and south of the Adyar, which may be said to be connected with the Coast Canal.

2. These works have heretofore been under Mr. Kennedy's management, and as he would prefer to retain charge of them, I think it right that he should do so, as by such an arrangement they are more likely to be inspected than if they were entrusted to the Range Officer.

3. All other works, such as the public Bungalows at Vaniem Chavady, works at Pulicat Light House, roads, &c., which were formerly attended to by Mr. Kennedy, should, I consider, be executed in future by the Officer within whose range the work may be situated.

4. I have, however, directed that, in accordance with Mr. Kennedy's own request, all works of the above description which are in progress, should be carried out by him to completion, an arrangement which I hope will meet with approval.

5. I have further to request that I may be informed, whether I am to obtain from Mr. Kennedy, Reports, Returns, Accounts, &c., for the works carried out by him within the limits of this Division in the same manner as from Range Officers, or whether they are to be forwarded by him direct to Government, and to the Controller and Auditor of Public Works Accounts.

Mr. Fraser.
Captain Tulloch.
Mr. Roberts.

6. The same information I also request may be supplied to me with reference to the other Special Executive Engineers employed in the 4th Division.

P. S.—From paragraph 4 of the Proceedings of Government No. 2,022, dated 24th July 1863, it is observed that Mr. Kennedy's official communications should be addressed direct to Government, but this it is concluded has no reference to the accounts of his expenditure on works within the limits of the 4th Division.

No. 287. ORDER THEREON, 14th August 1863, No. 2,300.

1. The Government approve of the works referred to in paragraph 1 of this letter being placed under Mr. Kennedy's charge, as also such as have hitherto been under his superintendence, and are now almost complete. All other works must be attended to by the Officers within whose ranges they may be situated.

2. The official communications of such Officers as have been deputed upon the investigation of special projects, should be addressed to Government direct, but their accounts of expenditure should be transmitted, through the Superintending Engineers, to the Controller and Auditor of Public Works Accounts in whose Office they will undergo the usual scrutiny.

3. Instead of the usual monthly Progress Reports, it is desirable that the Officers named in the margin, should submit monthly Diaries of their proceedings containing full particulars of the progress made by them in the work upon which they are engaged.

Mr. Fraser.
Mr. Kennedy.
Captain Tulloch.

18/8/62

Proceedings of the Madras Government, Public Works Department,
14th August 1863.

as well as such other information connected with their investigations as may be deemed useful or interesting. These Diaries should be forwarded to Government direct.

4. The Officers named above will be under the immediate orders of Government.

(True Extract.)

(Signed) W. I. BIRDWOOD, Colonel, R. E.,
Secretary to Government.

To the Superintending Engineers 2nd and 4th Divisions.
To W. Fraser, Esq.
" R. Kennedy, Esq.
" Captain Tulloch, Executive Engineer.
To the Controller and Auditor of Public Works Accounts.

Exd. S. T. Augustin.

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Proceedings of the Madras Government, Public Works Department,
15th August 1863.

No. 321. Read the following letter from Captain C. V. WILKIESON, R. E., Controller and Auditor of Public Works Accounts, to Colonel W. I. BIRDWOOD, R. E., Secretary to Government, Public Works Department, dated Madras, 6th July 1863, No. 1,210 :—

SIR,

I have the honor to bring to your notice that in the Proceedings of the Madras Government No. 1,646 of the 23rd June 1863, the special establishment of Officers and Subordinates was somewhat changed from the original sanction but nothing was mentioned about travelling allowance, although it was entered by the Committee in their scale. I have therefore to request instructions as to whether I am to pass travelling allowance to these Officers. The funds originally sanctioned being sufficient to meet the charge.

No. 322. ORDER THEREON, 15th August 1863, No. 2,318.

1. The Government are of opinion that the travelling allowance of the Officers employed on special duty should be regulated by the duties on which they may be engaged.

2. For the present, the Controller is authorized to pass to Messrs. Kennedy and Fraser the travelling allowance* of an Executive Engineer, and to Captain Tulloch the conveyance allowance of Rupees 50 sanctioned for the Officers of the Public Works Department employed at the Presidency. The Subordinates engaged on special duty will draw the travelling allowance of their rank as provided for in G. O. No. 1,599, dated 18th June 1863.

* Rupees 100.

3. The question as to the amount of travelling allowance to be passed to the Officers mentioned above should be submitted to Government by the Controller on every occasion in which they may enter upon the investigation of a new project.

(True Extract.)

(Signed) W. I. BIRDWOOD, Colonel, R. E.,
Secretary to Government.

To the Controller and Auditor of Public Works Accounts.
To R. Kennedy, Esq.,
" W. Fraser, Esq.,
" Captain Tulloch,
} Executive Engineers.

Exd. S. T. Augustin.

Proceedings of the Madras Government, Public Works Department, 21st January 1864.

Read the following papers :—

No. 480. From Captain H. TULLOCH, R. E., Executive Engineer on Special duty, to Colonel C. A. ORR, R. E., Secretary to Government, Department Public Works, dated Madras, 21st December 1863, No. 26 :—

SIR,

1. I have the honor to request that you will favorably represent for the sanction of Government, this application for a small extension to my present Office Establishment.

The permanent hands employed under me consist of—

	Rs.
1 Draughtsman on	40
1 Writer	35
4 Lascars	28
Total...	103
1 Supervisor	200
1 Writer	15
2 Lascars	12
Total...	227
Grand Total...	330

The temporary Establishment granted me for the period of four months consists of—

	Rs.
1 Draughtsman on...	20
1 Estimate-maker...	60
2 Surveyors, each 150	300
8 Lascars for Surveyors	50
2 Do. extra, allowed to me	9
2 Do. do. do. to the Supervisor	13
Total...	452

2. By the end of next month I shall have no temporary hands employed under me.

3. The extra Lascars allowed to myself and the Supervisor were dismissed a few days ago, as the four months for their employment had expired ; I beg that these may be continued to us *permanently*. Four Lascars for myself are not sufficient. Two of them are required as guards night and day over my Office, which contains a very large assortment of valuable instruments. With the other two by themselves, I am not able either to level or to survey. The only way in which I can manage now is to lend Mr. Martin two men and to retain the others in my Office, one to send on messages, the other to attend to the wants of the Clerks. It is not possible for me to go out in the field at present, as if I did I should have to make use of the Supervisor's Lascars, and should thus put an effectual stop to his own out-door work. The cost of the four Lascars would be only 24 Rupees a month.

4. With the experience that I have now gained, I am certain it will be better to employ one Surveyor permanently than two temporarily. I would not, however, recommend nearly so high a salary for him as Government have sanctioned for the temporary Surveyors now working under me. Each draws 150 Rupees monthly, besides a travelling allowance of 40 Rupees. I think 100 Rupees a month with a travelling allowance of 30 Rupees ample for the class of men at present procurable. In a year this would amount to no more than 1,560 Rupees, whereas the two temporary Surveyors for only four months will have cost Government 380×4=1,520. I will answer for it that one man after he has been with me six months will do more than two temporary Surveyors procured at the moment they may be required. It has been the only disheartening part of my duties to undo work which has taken my Surveyors many days to do. I have now checked several miles of survey only to reject the entire work. Indeed I feel certain that there is but one way to secure good Surveyors, *i. e.*, to employ them permanently. I believe Mr. Fraser's experience leads him to the same conclusion.

5. I am quite prepared now to be obliged toreject the first month's work of any Surveyor employed for the first time on a project similar in its nature to the one I am at present investigating. Just by the time each man becomes useful it is necessary to dismiss him. The experience he may have gained cannot therefore be turned to further account for Government.

6. I also respectfully submit the necessity for two more permanent Draughtsmen in my Office. Their combined pay need not be more than 80 Rupees, one on 50 Rupees and one on 30 Rupees, I would myself teach both (and indeed every man in my Office) to level and survey so as to make them useful to the utmost extent possible. In time these men would receive a special training for work in connection with the investigation of projects, and Government would then have a class of servants on whom they could depend and who would do a far greater amount of work than double their number of temporary hands.

The total extra charge to Government would be—

	Rs.
4 Extra Lascars	24
1 Surveyor (with travelling allowance)	130
2 Draughtsmen	80
Total...	234

7. It is for the sake of economy that I ask for the sanction of this extra permanent Establishment, inasmuch as if it is not granted temporary hands must ultimately be employed at a cost far exceeding in the end this regular charge. The longer a project takes to complete the greater the expense becomes to Government, and for this reason an inefficient Establishment is unadvisable.

MEMORANDUM.

Mr. W. Fraser, Special Executive Engineer, is requested to state what Establishment he considers should be attached to him after the services of the temporary Establishment now employed have been dispensed with.

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government, P. W. D.

Chepauk,
22nd December 1863.

No. 481. From W. FRASER, Esq., C. E., Special Executive Engineer, to Colonel C. A. ORR, R. E., Secretary to Government, Public Works Department, dated Red Hills, 28th December 1863, No. 75.

SIR,

1. In accordance with your Memorandum, dated the 22nd instant, I have the honor to return Captain Tulloch's letter No. 26. with the following remarks :—

My present permanent Establishment is—

	Rs.
1 Draughtsman	40
1 Writer	35
4 Lascars	28
Total...	103
1 Assistant Supervisor	150
1 Writer for do.	15
2 Lascars for do.	12
	177
Total per month ...	280

The temporary Establishment allowed to me for four months is the same as that notedby Captain Tulloch, but I have now only one temporary Surveyor, as Mr. Stephenson, one of the two employed, accepted, in the early part of this month, an appointment under the Madras Irrigation Company.

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It is not my wish to replace him by another with the sum now remaining at my disposal, because, as Captain Tulloch remarks: "By the time each man becomes useful it is necessary to dismiss him."

2. I agree with what Captain Tulloch has written regarding the uselessness for a month or two of the majority of Surveyors to be had about Madras.

They are slow and inaccurate; they have no idea of what should be represented, and what might be neglected in making a survey; and they are totally ignorant of the numerous short practical methods of overcoming little difficulties as they arise. They are paid quite as much as English Surveyors, and they get through, in an unsatisfactory way, about one-third of the work.

I have found it necessary, as Captain Tulloch has, to reject a large proportion of the work first done.

Future permanent Establishment.

3. This is a subject about which I have been anxious for some time past, as the present arrangement is expensive both in time and money. My opinions were fully explained when I proposed the appointment of Special Engineers. I particularly urged the importance of having the Establishment of Surveyors, &c., sufficient to keep us busy "*as Engineers*," and that anything less than this would involve a waste of time and money.

My present circumstances will illustrate what I mean.

With regard to the Red Hill part of the Madras water scheme I have done all that I have to do for the present *as an Engineer*.

With the aid of general levels and surveys I have settled—

I. The point on the Cortelliar where the supply channel should be taken off.
II. The line of the supply channel from the Cortelliar to Solavaram lake.
III. The extent to which this lake may be enlarged.
IV. The line by which it can be connected with the Red Hill lake.
V. The works connected with the enlargement of the latter.
VI. The general line for the channel to Madras, and
VII. The site for the proposed basin in Madras.

Mr. Ottman, the Principal Assistant, has been over the ground with me several times, he is in full possession of, and thoroughly understands, what is proposed to be done, and the detailed surveys, now in progress, can be completed by him.

As these surveys are finished, I shall have to mark upon them the details of the several designs, but in the meantime I am not wanted here.

I should now be in a position to go to the Adyar valley, where I have the Pommal and Mount tank and other questions to examine in connection with the Madras water supply, or to the investigation of the works in connection with the Cortelliar and Cooum, alluded to in the Government Minute No. 1,741.

4. There is, however, no use in my going on any of these duties unless I can bring an intelligent Surveyor with me, and this, under present circumstances, I cannot do, unless I stop the surveying here. The result is that I am now engaged in surveying, which could be just as well done by an Assistant on one-fifth of my pay. This leads us back to the former statement that true economy consists in keeping us busy *as Engineers*.

5. The strength of the Establishment of Surveyors, &c., allowed to me, will depend on the view you take of this question. If I am to have the necessary detailed surveys prepared for me, I can now employ at least six Surveyors; but if I am to survey ordinarily myself, then my present Establishment or even a smaller one will suffice. With regard to the latter supposition I would quote Captain Tulloch's last paragraph: "The longer a project takes to complete the greater the expense becomes to Government, and for this reason an insufficient Establishment is unadvisable."

6. The Surveyors I should like to have now are two good Assistants; that is, one other in addition to Mr. Ottman and four Subordinate Surveyors.

The two Principal Assistants should be of Mr. Ottman's class. They should be good Surveyors and levellers, and possessed of some departmental experience.

The four Subordinates should be good Surveyors and levellers, and able to plot their own work; but as they would be under the immediate orders of the two superiors nothing more would be required of them.

7. If I had such a staff now, I would leave Mr. Ottman here with two Surveyors to complete these plans and bring the other set with me to the Adyar or wherever they were most wanted; visiting the former occasionally to keep things straight.

8. I have thought earnestly over the best means of obtaining these Surveyors, and I would recommend that the following plan be tried. My object is to get a sufficiently trained staff at the smallest expense.

I do not think with Captain Tulloch that if we go into the ordinary Survey market of Madras, we shall get efficient men for 100 Rupees a month. The wants of the Irrigation, the Railway, and Tramway Companies have caused an increased demand for Surveyors and Draughtsmen, so that efficient hands are now difficult to be got.

Mr. Stephenson, who was getting 190 Rupees on this Survey, has just gone to join the Irrigation Company on 260 Rupees a month.

A Native Surveyor, whom, after a long trial, I did not consider worth 60 Rupees a month, is now receiving 150 Rupees a month on the Neilgherries. We must have good Surveyors, and if we go into the ordinary market for them we must compete with other employers.

9. When the Special Engineers were appointed, I suggested (to Colonel Birdwood) that we might be supplied with ordinary Surveyors from the Engineering College, on the payment of liberal travelling allowances.

I do not know what the difficulty was which prevented this idea being carried out, but supposing that the difficulty still exists, I would suggest the following modification of my first proposition.

I take it for granted that the College could supply us with a sufficient number of men so far trained that a few weeks, practical teaching would make them tolerable Surveyors. From the list of such men (supplied by the Principal) let us select the number we want, and take them on trial as probationers; under such rules regarding pay, promotion, and allowances, as you may deem right.

If these men were admitted to the Department they would receive (if I am rightly informed) 60 Rupees a month as pay, and 20 Rupees for travelling allowances, in all 80 Rupees a month.

With us their expenses would be rather more than if they were settled in Táluqs; but let us, for the present, adopt this scale of pay; the staff I ask for would then amount to:—

	Rs.
2 Department Assistants of the rank of Supervisor at 150 Rupees each and 40 Rupees travelling allowance = Rupees 190 × 2	380
4 Probationers at 80 Rupees each	320
	700
6 Sets of Lascars for the above consisting of 5 each, one at 7 Rupees and 4 at 6 Rupees a month = Rupees 31 × 6	186
Total ...	886

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10. I now come to the Office Establishment. I quite agree with Captain Tulloch regarding the inefficiency of the present Office Establishment, but we do not quite agree as to the best means of rendering it efficient. We may, however, be both right according to the different circumstances under which we are placed. You will perhaps be surprised to hear that at the Red Hills food, &c., are 30 to 50 per cent. dearer than they are in Madras. A very good Draughtsman or Estimate-maker can be had at Madras for 60 Rupees a month, or less, I cannot get one to come here for 80 Rupees a month, unless he is to be permanently employed. In order to keep proper Lascars with me I am obliged to pay some of them a Rupee each extra from my own private purse, and for all as well as for my own servants I find it necessary to keep up a supply of rice, &c., at wholesale prices.

The Office Establishment I would ask for is —

		Rs.
I.	Head Draughtsman and Estimate-maker	80
II.	Assistant do.	40
III.	Do. do. and Writer and Accountant	35
IV.	Moochi	10
V.	6 Lascars at 7 Rupees	42
	Total...	207
	Deduct present Establishment...	103
	Extra amount applied for...	104

This is 12 Rupees a month more than Captain Tulloch asks for.

The difference arises in items IV and V as he gets his Moochie's work done at the Lithographic Department (I cannot), and he asks but 6 Rupees each for two of his Lascars.

The whole amount I ask for is *just equal* to that allowed for the Executive Officer at the Presidency, and 31 Rupees less than that allowed for the Neilgherries.

I would refer to paragraph 9 of the Re-organization Committee's Report to show that in their opinion we should have a larger Establishment than that allowed to ordinary Executive Officers.

11. The sum total I ask for is—

		Rs.	Rs.
1.	Six Surveyors as explained in paragraph 9 ...		700
2.	Lascars for do. ...		186
3.	Office Establishment and Lascars, paragraph 9		207
	Total per month...		1,093
Deduct permanent Establishment at present sanctioned.			
	My own Office Establishment	103	
	1 Assistant Surveyor	190	
	1 Writer for do.	15	
	2 Lascars do.	12	
			320
	Balance...		773
Deduct temporary Establishment now sanctioned.			
	2 Surveyors at 190 Rupees	380	
	12 Lascars	71	
	Draughtsman	20	
	Estimate-maker	60	
			531
	Total extra amount now asked for...		242

12. If this Establishment is sanctioned it will enable me to get through a good deal of work satisfactorily, and at a very small cost to Government.

I would propose to supply the men selected from the College with tents, and to give to each an office table and chair.

If you approve of the idea of our getting College men, Captain Tulloch and I could probably arrange about the selection, &c., with the Principal.

I think the plan proposed ought to work well, and lead to the formation of a body of well trained Surveyors, whose services would be found most useful wherever they might be subsequently posted.

If you approve of the suggestion, I should be glad to receive early sanction.

No. 482.

ORDER THEREON, 21st January 1864, No. 237.

1. In the letters above recorded, Captain Tulloch and Mr. Fraser, Special Executive Engineers, apply for increased Office and Executive Establishments.

2. The Establishments at present attached to these Officers are as follow :—

CAPTAIN TULLOCH:

Permanent Office Establishment.

		Rs.	
1	Draughtsman	40	
1	Writer	35	
4	Lascars	28	
			103

Permanent Extra Establishment.

1	Supervisor	200	
1	Writer	15	
2	Lascars	12	
			227

Temporary additional Extra Establishment for the Madras drainage Project.

1	Draughtsman	20	
1	Estimate-maker	60	
2	Surveyors at Rupees 150	*300	
12	Lascars	72	
			452
	Grand Total...		782

* Or with Travelling Allowance at Rs. 40 each Rs. 380.

MR. FRASER.

Permanent Office Establishment.

The same as Captain Tulloch... 103

Permanent Extra Establishment.

1	Assistant Supervisor	†150	
1	Writer	15	
2	Lascars	12	
			177

† Or with Travelling Allowance Rs. 190

Temporary additional Extra Establishment for the Madras water supply Project.

The same as that allowed to Captain Tulloch for the drainage project 452

Grand Total...	732

3. The period, four months, for which the temporary Establishments were sanctioned being about to expire, it is proposed by both Officers to substitute permanent Establishments for them.

Captain Tulloch asks for—

		Rs.
1	Surveyor	100
4	Extra Lascars for himself	24
2	Draughtsmen at Rs. 50 and 30	80
	Total...	204

and would give the Surveyor a travelling allowance of Rupees 30 instead of Rupees 40 per mensem. To his Estimate however must be added four Lascars for the proposed extra Surveyor, which at Rupees 6 each, would raise the cost to Rupees 228 a month, or Rupees 224 below the present salary charges.

4. Mr. Fraser's requisition considerably exceeds the cost of his present temporary Establishment, it being as follows :—

		Rs.
1	Assistant Supervisor	150
4	Probationers at 60 Rs.	240
1	Draughtsman	80
1	Moochee	10
30	Lascars at various rates...	188
	Total...	668

	Rs.	Rs.
Proposed additional permanent Establishment	668	
Additional travelling charges	120	
		788
Present temporary Establishment ...	452	
Travelling charges	80	
		532
		256
1 Writer to be discontinued		15
Net increase...		241

With travelling allowances to the Assistant Supervisors and Probationers, which are given at Rupees 40 each for the former and Rupees 20 each for the latter (less the pay of the present Assistant Supervisor's Writer (Rupees 15) whose services Mr. Fraser apparently proposes to dispense with) the net increase charge would be Rupees 241 per mensem.

5. The Government is not prepared to accede to either application. The Establishments to be attached to Special Executive Engineers must depend on the nature and extent of the work on which such Officers may from time to time be employed, and as these will continually vary it would be neither economical nor advisable to maintain under such circumstances large and expensive permanent Establishments.

6. Provision will be made in the Budget of 1864-65 for sufficient subordinate agency for the vigorous prosecution of the important projects on which Captain Tulloch and Mr. Fraser are now employed ; but meanwhile all temporary Establishments must be discontinued from the date on which the present sanction shall expire.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

To Captain Tulloch, Special Executive Engineer.
To W. Fraser, Esq., do. do.
To the Controller and Auditor of Public Works Accounts.

Exd. S. T. Augustin.

Proceedings of the Madras Government, Public Works Department, 7th March 1864.

No. 173. Read the following letter from Captain H. TULLOCH, R. E., Special Engineer, to Colonel C. A. ORR, R. E., Secretary to Government, Department Public Works, dated Madras, 1st March 1864, No. 50:—

SIR,

1. The work in connection with the project for draining Madras is in such a forward state that little now remains but to make fair copies of the original Plans and Sections. These when completed will amount in number to about sixty drawings. I am anxious to submit my Report as early as possible, but with the present strength of my Establishment there is little hope of my being able to do so under five or six months. I beg very respectfully to urge on Government the advisability of further aid being granted me as soon as possible.

2. I have at present only three Draughtsmen, inclusive of Mr. Martin my Surveyor. The latter is employed on the few original drawings that now remain to be completed, while the other two are engaged in making copies. Of these, there are some which will occupy a Draughtsman as much as a week to finish, and there is scarcely one which can be completed in less than two days. To expedite the work I am paying a man out of my own pocket at present to do the printing on the Plans.

3. Under these circumstances I trust Government will sanction the immediate entertainment of six temporary Draughtsmen for two months, three on 30 Rupees a month and three on 20 Rupees a month. The total expense of this measure will be only 300 Rupees, while if no aid is given me the cost of the project to Government will be considerably greater. In fact in the one case there will be the pay of myself and my Establishment for two months + 300 Rupees = about 3,000 Rupees + 300 Rupees = 3,300 Rupees, and in the other the pay of myself and my Establishment for five or six months = 6 (1,500) = 9,000 Rupees. With the help which I now ask for I may almost promise to send in my Report by the 1st of May, and I should then be ready to take up any other project which Government might wish me to investigate.

4. I beg also very respectfully that Government will be pleased to allot immediately a sum of money to enable me to have borings made along the line of the main and branch sewers which I propose to lay down. It is absolutely necessary that this should be done, as otherwise we should have no knowledge of the strata which must be pierced in order to the laying down of the sewers. I would propose that from three to six borings be made along each mile of length according as we feel satisfied or not of the nature of the sub-soils. From enquiries made I find the cost of each boring or well will be from 5 to 8 Rupees. There will be in all fourteen miles of main and branch sewers, so the cost may be roughly estimated at fourteen miles + five borings + 6 Rupees = 420 Rupees. An allowance must be made for pumping, as it is almost certain that in some parts of the town we shall meet with water. I would therefore ask for the sanction of about 700 Rupees, and with this money I would set to work at once and complete the borings as expeditiously as possible. I am especially anxious on this subject as I wish the report to contain the fullest information possible on every point in connection with the project.

No. 174. ORDER THEREON, 7th March 1864, No. 693.

1. As it is desirable that Captain Tulloch's Report on the project for the drainage of Madras should be submitted at an early date, the Government sanctions the employment of the temporary Establishment of Draughtsmen applied for in paragraph 3 of this letter at a cost of Rupees 150 per mensem for a period of two months.

Three at Rs. 30	Rupees 90
Three at „ 20	„ 60
Rupees...	150

2. Sanction is also accorded for the expenditure of a sum of Rupees 700 for ascertaining the nature of the strata along the line of the main and branch sewers proposed to be laid down.

15/5/82

Proceedings of the Madras Government, Public Works Department, 7th March 1864.

The cost of this work as also of the Establishment, will be met from the balance of Rupees 4,000 available from the Income Tax Funds allotted for the Madras District. See Proceedings No. 605, dated 29th February 1864.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

To Captain H. Tulloch, Special Engineer.
To the Superintending Engineer, 4th Division.
,, Controller and Auditor of Public Works Accounts.

Exd. S. T. Augustin.

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Proceedings of the Madras Government, Public Works Department, 12th May 1864.

Read the following letters:—

No. 253. From W. FRASER, Esq., C. E., Special Executive Engineer, to Colonel C. A. ORR, R. E., Secretary to Government, Public Works Department, dated Red Hills Madras Water Works, 2nd May 1864, No. 1.

SIR,

I have the honor to request that you will be good enough to have the necessary orders passed regarding the Establishment for the performance of the special duties on which I am now engaged.

1. The Establishment I would ask for is:—

Permanent Office Establishment.	RS.
One Estimate-maker at 70 Rupees...	70
One head Draughtsman at do.	70
One Moochee...	10
Total per month...	150

These three I should wish to be on the permanent Establishment. If they are not so placed, I cannot get competent men, and my work will very much depend on the efficiency of the Estimate-maker and Draughtsman.

I would teach these men to survey, and thus, in time, train them to be useful in the field as well as in the Office.

Besides the above pay they would be entitled to the usual batta.

2.

Temporary Establishment.	RS.
At present I would ask for three surveyors at 80 Rupees a month each	240
Travelling allowance at 20 Rupees	60
Total per month...	300

These Surveyors would only be employed so long as they were wanted, and the number would be kept up or reduced according to the amount of work to be done; after some training I would expect to have a good deal of the levelling, &c., done by the Estimate-maker and Draughtsman.

For the use of Mr. Ottman, the three Surveyors and myself, 21 temporary Lascars will be required at 6 Rupees = 126 Rupees per mensem. I place all these Lascars on the temporary list, because they would be employed only when required in the field. This brings the whole temporary Establishment up to Rupees 426 a month.

3. I need not again urge the advantage of giving me such an Establishment, as I now require to enable me to get the necessary surveys made speedily for the projects I have in hand.

I will do my best to turn their labour to profitable amount.

No. 254. From Captain H. TULLOCH, R. E., Special Executive Engineer, to Colonel C. A. ORR, R. E., Secretary to Government, Department Public Works, dated Madras, 3rd May 1864:—

	RS.
3 Draughtsmen	60
3 Do.	90
Monthly ...	150
	2
For two months...	300

SIR,

1. As the period for which Government have sanctioned the Establishment, noted in the margin, will soon expire, I hasten to inform you of the progress made towards the completion of the drainage project.

2. In my last letter I mentioned that there would be in all about 60 drawings. I had hoped then to put more into each drawing than my subsequent experience shows me is practicable. There will be in

all now not less than 135 drawings, of these there are about 40 almost completed. By the day when the engagement of my extra Draughtsmen expires there will be 50 drawings ready. I now very respectfully urge that Government will be pleased to let me keep these Draughtsmen on for at least four months longer, and to grant me also six others in addition to them for that same period. This number is required since you inform me that at least six copies of the drawings must be made. I of course never contemplated such a large amount of work when I made my previous application for six Draughtsmen only or I should have asked for more help at the time. I have had some other difficulties to contend with since my former letter. Mr. Martin has been laid up for about ten days with a choleraic attack. The Easter holidays intervened by which I lost several days' work, and almost every one of my men has been ill for two or three days in consequence of this very unhealthy season. I should have had more than 60 drawings completed if these causes had not delayed the work. As it is, however, I am very little short of the amount of work I had hoped to get through.

3. If there were no necessity for completing six copies immediately I would recommend that the drawings should be lithographed, but it would take at least a year to have this done, and I trust Government will agree with me that four copies should be prepared at once, one for the Madras Government, one for the Bengal Government and two for the Home Government. Unless this is done there can be no hope of the work being commenced next year.

4. I am now accommodating eleven men, nine of these are Draughtsmen and each requires a table to himself. The Office rent that I have hitherto received is 20 Rupees a month. This sum is really so inadequate that I am quite unable to furnish my subordinates with the accommodation that they should have to enable them to work with comfort and despatch. If, moreover, Government sanction the entertainment of the six extra hands that I apply for in this letter I shall have to furnish room for fifteen Draughtsmen and two Writers besides for Peons and stores; under these circumstances I beg that a permanent Office rent of 50 Rupees a month may be granted to me, and I will always find accommodation for my subordinates whatever number they may amount to.

5. In their last Order Government sanctioned the entertainment of four lascars for two months; their pay, however, for last month is refused by the Auditor, because I believe he has no funds left in his hands. I would urge the permanent entertainment of these men for I really cannot do without them.

6. I require also an extra grant of 10 Rupees a month for contingent expenses for my Office.

7. I hope to have all the borings comp leted by the time my plans are submitted, but too much of my time is taken up with them. I require an European to superintend the work during the mornings and evenings, and would request an allowance of 20 Rupees a month to be given to one of my Draughtsmen who could look after the work and report to me as each well was ready. This man during the middle of the day would still be employed in drawing plans.

8. I do not think you can be aware that I am receiving only 50 Rupees a month for carriage allowance, while Mr. Martin under me draws 60. My work takes me to the extreme limits of Madras and is not confined to the central parts like that of the Executive Engineers at the Presidency. In consideration of this and of my having to go out often both morning and evening I beg that I may be placed on the same footing as Executive Engineers up-country, or as Mr. Fraser, Civil Engineer, who draws 100 Rupees a month.

9. For the six Draughtsmen originally sanctioned, I have supplied six chairs at 21 Rupees. For the six extra hands I shall require six more at 21 Rupees, and six tables at 10 Rupees each. Also one office table for myself at 50 Rupees.

From the foregoing Statements it will be seen that I ask for the following:—

In addition to my permanent Establishment.

	Rs.
4 Lascars on 7 Rupees each...	28
Office rent (in addition to the 20 Rupees already allowed and making in all 50 Rupees)...	30
Office Contingent allowance	10
Carriage allowance	50
Total...	118 monthly

* *Temporary for four months.*

				Rs.
1 Draughtsman at 50 Rupees including 20 Rupees carriage allowance to enable h to superintend the borings				50
1 Draughtsman for 40 Rupees...				40
4 Do.	at 30 „	each		120
6 Do.	at 20 „	„		120
				330

Or for four months 330 × 4 = 1,320 Rupees.

For Office furniture.

	Rs.
12 Chairs at 3½ Rupees each	42
1 Office Table	50
6 Drawing Tables	60
	152

These constant applications for small grants of money are as painful to me as I feel sure they must be annoying to Government. I trust, therefore, that you will think it desirable to put my Office on what you may consider a fair footing at once and for ever, in order to prevent my being obliged to trouble you on every little point as it arsies.

No. 255. ORDER THEREON, 12th May 1864, No. 1,369.

1. In the letters above recorded, Captain Tulloch and Mr. Fraser, Special Executive Engineers, address the Government again on the subject of their respective Establishments.

2. On a review of their former applications, recorded in Proceedings No. 237, dated 21st January last, the Government declined to make any change in the permanent Office Establishments of these Officers on the ground that as such Establishments must depend on the nature and extent of the work to be performed, it would be neither economical nor advisable to attach large and expensive permanent Establishments to Special Executive Engineers.

3. Now, again, however, Mr. Fraser re-opens the question by applying for the following permanent Office Establishment, in addition, apparently, to that already sanctioned:—

	Per mensem. Rs.
1 Estimate-maker	70
1 Head Draughtsman	70
1 Moochee	10
	150
Present Establishment...	103
Total...	253

4. The Governor in Council sees no reason to modify the opinion on this subject, referred to in paragraph 2 of these Proceedings, and accordingly declines to sanction the application as a permanent arrangement. His Excellency will not object, however, to the Office Establishment being temporarily increased to the extent solicited and on the understanding that it will be reduced when no longer required.

5. Captain Tulloch also applies for the permanent retention of the four Lascars sanctioned temporarily, under date the 25th January 1864, No. 269. This request the Government must likewise negative; but the Lascars may be retained till no longer required.

6. The temporary Establishments asked for by both Officers are as follow :—

CAPTAIN TULLOCH.

		Per mensem.
		Rs.
1	Draughtsman	40
1	do. ... ... Rs. 30 }	
	Special Carriage allowance „ 20 }	50
4	do. at Rupees 30	120
6	do. at „ 20	120
	Total...	330

MR. FRASER.

	Per mensem.
	Rs.
3 Surveyors at Rupees 80...	240
Travelling allowance at Rupees 20 ...	60
21 Lascars at 6 Rupees	126
Total...	426

and are sanctioned for four and six months respectively, from the 1st May 1864.

7. The Government further sanction the following charges in connection with Captain Tulloch's Establishment, with effect from the 1st May 1864.

	Rs.
Office Rent	50
Office Contingent allowance	20
Total per mensem ...	70
For Office furniture ...	152

8. As a special case, His Excellency in Council authorizes the Controller to pass to Captain Tulloch, from the 1st instant, the travelling allowance of an Executive Engineer (Rupees 100 per month) in lieu of the conveyance allowance of Rupees 50 sanctioned in Proceedings No. 2,318 of the 15th August 1863.

9. In his report dated 1st March 1864, No. 50, Captain Tulloch informed the Government that "the work in connection with the project for draining Madras was in such a forward state that little then remained but to make fair copies of the original Plans and Sections, and that only "a few original drawings"—which were then in progress—"remained to be completed." From his present report, however, submitted two months later, the Government learn that since the submission of the earlier one, it has been found impracticable to put as much as was at first intended into each drawing; that, consequently, instead of "about 60 drawings," there will be in all now not less than 135," and that more than two-thirds of that number has still to be prepared.

Recorded in Proceedings No. 693, dated 7th March 1864.

10. It would appear, therefore, that few, if any, drawings had actually been completed when the report of 1st March last was written. Captain Tulloch will be requested to explain the apparent discrepancies in his reports.

11. It will be sufficient if, for the present, Captain Tulloch has four copies made of each drawing.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

To Captain Tulloch.
„ W. Fraser, Esq.
To the Controller and Auditor of Public Works Accounts.
„ Superintending Engineer, 4th Division.

Exd. S. T. Augustin.

13/8/82

Public Works Dept
Proceedings of Govt Foreign

No 1369

Pro-of the 2d May
Govt
Public Works Dept
1865

Proceedings of the Madras Government, Public Works Department, 2nd May 1865.

No. 22. *Date 2nd May* 1865, *No.* 1,175.

MILITARY WORKS, No. 1.

1. The very unsatisfactory condition of the accounts and the extremely discreditable state, both as to progress and execution, of some of the buildings lately erected or under construction at Bangalore having been brought to the notice of Government, the attention of the Superintending Engineer will be called to the urgent necessity of his immediate and fullest consideration being given to the state of matters connected with the Department at that station. He will devise means for effecting a speedy transfer of the accounts by Captain Wood to Captain Tulloch, and for clearing up all discrepancies or deficiencies that may be found to exist in them. He will also make arrangements to ensure the early submission of all plans and estimates that are in arrears, and he will establish such arrangements as will facilitate and expedite progress, and put an end to the irregularities which have so long been permitted to disgrace the management of executive operations at Bangalore.

2. Captain Wood cannot be permitted to draw departmental salary at Bangalore for a longer period than may reasonably be required by him to give over charge of his late office in full detail, and Colonel Foord will accordingly direct Captain Wood to proceed to Madras as soon as his presence at Bangalore can be dispensed with.

3. Lieutenant Pennycuick will be at once transferred from the Presidency to Bangalore, and he will proceed there forthwith to place himself under the orders of Captain Tulloch, to whom he will afford the fullest assistance in his executive duties, and in investigating the accounts which require clearing up and adjustment, and in completing all plans and estimates that have still to be laid before Government.

4. Of these plans and estimates not the least important are those which have to be prepared in connection with the thorough carrying out of the Ulsoor Water project. The Government are aware that errors of design and mistakes in execution have been made in this work, and they will now look to Colonel Foord for the revised plans and estimates being submitted in the most complete form. He will take care that the ample power of the engine which has been supplied shall be made to do all the work of pumping to the full height to which it is necessary to lift water to ensure its free discharge by gravitation at all the points where it is required to be delivered, and he will distinctly explain the means by which this will be effected; whether by erecting on the top of the Ulsoor rock a sufficiently lofty reservoir to give effective command by gravitation of all the points in question, or whether, by employing the engine to force a stream either to the summit of a high stand pipe or direct to the various cisterns. In short, he will be careful not to omit any information that may be useful to aid Government in considering the details and general character of the project.

5. When this important, but hitherto mismanaged project has been submitted, and all matters put in proper train at Bangalore, Captain Tulloch will return to Madras to complete his Sewerage scheme, leaving Lieutenant Pennycuick in temporary executive charge at Bangalore. Meanwhile, the establishment attached

to Captain Tulloch, as an Officer employed on special duty, will remain under his orders; and, as he will not be relieved from these duties till the Sewerage project is finally disposed of, and as it is understood that he is put to considerable expense on its account, he will continue to draw special Presidency allowances.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

To the Superintending Engineer, 5th Division.
" Controller of Public Works Accounts.
" Superintending Engineer, 4th Division.

Exd. S. T. Augustin.

No. 173. Read the following Endorsement of the Superintending Engineer, 5th Division, dated Bangalore, 23rd May 1865, No. 254.

Read the following letter from Captain H. TULLOCH, R. E., Executive Engineer, Bangalore, to Lieutenant-Colonel E. A. FOORD, R. E., Superintending Engineer, 5th Division, dated Bangalore, 18th May 1865, No. 69:—

SIR,

1. I have the honor to request you will kindly forward the enclosed papers and this letter for the disposal of Government.

2. I have always understood that the Order of Government, No. 1,175 of the 2nd May 1865, authorized me to draw my former Presidency allowances until the Office establishment granted me as Special Engineer was removed from under my control. This Office has hitherto never ceased to work under me, and I, therefore, according to what I conceived was the intention of Government, submitted a bill to the Controller of Public Works Accounts, for my former carriage allowance from the date that I first took charge of the Executive Engineer's Office at Bangalore, Captain Fischer having previously objected to pass this allowance to a further date. During February, March, and April, I kept up this Office in Madras, although I was myself at Bangalore, and indeed went down to Madras once to continue the work on which I was engaged as Special Engineer.

3. I respectfully submit that Captain Fischer's construction of the order of Government, by which I have hitherto received 100 Rupees less, and Captain Wood 100 Rupees more, than we were each formerly entitled to, is not in accordance with the spirit of that Order.

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1 Memorandum.
1 Abstract.

Submitted for the orders of Government.

(Signed) E. A. FOORD, Lieut.-Colonel, R. E.,
Superintending Engineer, 5th Division.

No. 174. ORDER THEREON, 7th June 1865, No. 1,556.

ESTABLISHMENT, No. 12.

1. As on the transfer of Captain Tulloch to Bangalore, and Captain Wood to the Presidency, the former was not relieved from the duty of preparing a scheme for improving the Sewage of Madras, and the latter was not nominated to any special duty, and could be entitled to no special allowances under any circumstances till he had joined, the Government are of opinion that the Controller was in error in passing Presidency allowances to Captain Wood, more especially as, in their Order of the 10th February 1865, No. 386, the Government distinctly refused those allowances to that Officer.

2. Captain Tulloch not having been relieved from the duty on which he was engaged at Madras, and being put to some expense on its account, appears to have a substantial claim to the continuance to him of the allowances in question, and the Government direct the Controller to pass them for the period they have been withheld as well as from the date of the Orders of Government of the 2nd May 1865, No. 475.

(True Extract.)

(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

To the Superintending Engineer, 5th Division.
" Controller of Public Works Accounts.

Exd. S. T. Augustin.

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

18th November 1881, No. 2262.

Municipal Reports.

Read the following paper:—

Despatch from the Most Honorable the Secretary of State for India.

Statistics and Commerce,
No. 22 [Current No. 3040].

INDIA OFFICE, LONDON,
13th October 1881.

SIR,—I forward, for your information, 70* copies of a Memorandum by the Army Sanitary Commission on the Report of the Madras Municipality for 1879.

* 12 by mail; 58 through Store Department.

2. You will observe that, in their remarks in paragraph 9 on the drainage of Madras, the Commission refer to Captain Galton's Report on the drainage of Memphis, United States. This is now being printed, and copies will be forwarded when ready.

I have, &c.,
(Signed) HARTINGTON.

His Excellency the Honorable the
Governor in Council, Fort St. George.

ENCLOSURE No. 1.

Memorandum of the Army Sanitary Commission on the Report of the Madras Municipality for 1879.

This report is chiefly devoted to ordinary administrative details. It contains very little sanitary information, and, taken as a whole, it cannot be said to be very hopeful for future progress. There are, however, a few sanitary points in it which may be noticed.

2. The population of Madras is given in the report at 397,552, of which 194,676 were males and 202,876 were females. The numbers according to race were—

Europeans	3,613
East Indians	12,013
Native Christians	21,441
Hindus	309,521
Mahomedans	50,964

Among this population there were 16,629 births, equal to a birth-rate of 41·8 per 1,000.

3. The deaths of the year numbered 13,803, rather fewer than the annual average. The deaths according to sex were of males 6,929 and of females 6,874, the mortality being nearly the same in both sexes. The ratio of mortality was for both sexes 34·7 per 1,000. The rate is largely in excess of what is attainable even in a city such as Madras, but its reduction over the preceding averages (excluding the famine years altogether) was no doubt partly due to the clearing off by famine and its diseases of the more susceptible part of the population during that calamity.

The death-rates according to classes were—

Europeans	24·3 per 1,000.
East Indians	25·0 „
Native Christians	28·6 „
Hindus	35·9 „
Mahomedans	32·9 „

As a general proposition it may be stated, as showing the superior healthiness of European quarters in Calcutta, that the Madras rate is very much higher for Europeans than the Calcutta rate, which averaged 16·1 per 1,000 in 1878 and 17·9 per 1,000 in 1879.

These data will be sufficient to show the death-rates without further analysis until the new census of Madras is adopted in the reports.

The death-rates in different municipal divisions did not show the same excesses as in previous years, as will be seen by the following figures :—

Divisions.	Death-rates per 1,000.	Divisions.	Death-rates per 1,000.
1 ..	36·5	5 ..	28·2
2 ..	35·2	6 ..	13·1
3 ..	32·9	7 ..	34·6
4 ..	29·6	8 ..	33·0

Each division contains a number of villages, and it is among these that the most marked diversities in death-rates are to be found. The lowest rates of the year were 1·5 per 1,000 among 641 inhabitants at the Gunpowder Mills, and 1·8 per 1,000 among 1,583 people in Fort St. George; at the other extremity of the scale we have 6,087 people in Poodoopaukum, yielding a death-rate of 53·5 per 1,000, Rayapuram with 11,089 inhabitants and a death-rate of 60·8 per 1,000, and Royapettah showing a rate of 70·7 per 1,000 from among 5,255 people.

The same law appears to show itself in the separate groups of population as in the city generally, that the most susceptible persons had been cleared out by the mortality causes of preceding years.

4. The following were the deaths registered in 1879; it will be seen that Madras participated in comparative exemption from cholera which existed over the South of India :—

	Registered Deaths.
Cholera	35
Small-pox	910
Measles	10
Fevers	3,465
Bowel Complaints	1,757
Total epidemic deaths	6,177
All other deaths	7,626
Total of the year	13,803

There was a great reduction of the epidemic death-rate over the corresponding rate of 1878, which showed 10,057 epidemic deaths out of a total mortality of 18,912.

The chief death cause of 1879 was fever, a disease which appears to have been distinctly localized in certain villages, for, out of 36 villages in the tables, 10 villages yielded 2,740 fever deaths out of 3,465. As with fever, so with cholera, the 31 deaths from which were registered (excluding four in the hospitals) in seven villages; one of them yielded 19 deaths.

Bowel-complaint deaths, which, in the year 1878, after the stress of the famine had passed over, numbered 4,522, fell to 1,757, a lower number than was recorded in any year since 1870. It will be seen that, for the reasons stated above, the year 1879 was a less unhealthy year than several recent years, but it is not by this circumstance that the real sanitary standard of Madras, or indeed of any group of population, is to be judged.

5. *Sanitary Works.*—The following improvements have occupied attention in the "Public Works and Conservancy Departments" during 1879 :—

Improvement of drainage.
Improvement of water-supply.
Improvement of public and private markets.
Collection of nightsoil from private houses, &c.
Improvement of parcherries.
Extension of sewage farms.

We propose to introduce a few remarks on each of these heads.

6. *Drainage.*—Mr. Clarke's scheme for draining Madras has been finally abandoned as too costly and as unsuitable; but one reason stated for following this course is that "the Commissioners have not, I believe, hesitated about draining the city, but have so regarding the adoption of any one scheme, and it was necessary that full investigation should be made, as the city could not bear the result of a failure. The unsatisfactory state of Calcutta after the completion of its drainage was one of the causes which militated against the adoption of the late Mr. Clarke's scheme."

Caution in such matters is always necessary, and every means should be adopted to ensure the successful application of engineering details as well as of economy in great drainage works, but it is not correct to state, as a reason for rejecting Mr. Clarke's Madras scheme, that his Calcutta scheme had been "unsatisfactory" in its results. It is no part of our duty to adjudicate on questions of this kind, but year after year the Calcutta reports have shown the great improvements which the drainage has led to there, and they have also shown how "unsatisfactory" has been the surface condition of the city, not from defects in the drainage, but from the great extent of foul tank surface, which no drainage works could remove. It is quite well known that the high disease and death-rates in several districts of Calcutta are due to foul domestic water being taken from these tanks and to the deadly malaria proceeding from them, and it is also quite well known that the real remedy required is filling up the tanks with earth. The Vice-President of the Madras Departments complains that considerable opposition is experienced in improving the city, but we may suggest that is not likely to be lessened by objections against the Calcutta drainage, which might equally well be urged against the Calcutta water-supply.

7. The Vice-President, Mr. Jones, proposes as an alternative to carry out the drainage of Madras on the following principles :—

"To provide open sewers along the streets for surface water, house drainage, &c.

"To provide sewers in valleys and other necessary places to carry off the sewage alone, any storm waters being divided from it and carried to other outlets.

"To improve the present sewers, to make them more efficient for the carrying off the storm and subsoil waters.

"To pump the sewage collected and place it on land at some distance to the north of the town.

"In addition to this, the house-to-house collection of nightsoil and other conservancy arrangements hereafter detailed should make a marked improvement in the health of the town."

It will be seen that there is nothing effectual proposed to be done for the foul subsoil and its results, as described by the late Mr. Gover in his report for 1871-72, which may be described as by far the best sanitary report ever drawn up for Madras town. Mr. Gover's statement, if correct, would show that the proposed surface drainage scheme would not remove the evil, and we have frequently insisted on this. Mr. Jones quotes our last statement of the case and meets it by the following reply :—"The subsoil of the city is not in the state described by the late Mr. Gover; no doubt Mr. Gover believed that he had reasons for making the remarks he did, but these were really without any foundation whatever, and what he took for 'subsoil,' saturated with sewage, is, what can be found all over Madras, nothing less than black sand mixed with a little clay, the sand being so fine as to have the character of tin sand. The subsoil is remarkably little polluted."

8. It may be conceded that in a city spread over so large an area as Madras the subsoil condition may vary, and Mr. Jones admits some degree of pollution as general, although it would have been better to have met Mr. Gover's statement by a set of soil analyses at different points. The questions at issue all relate to *unhealthy districts* of Madras, and, after having stated what Mr. Jones says, we may be permitted to quote the following passage from Mr. Gover's report :—"Exhalations from sewage poison the air, downward percolation of sewage poisons the water. It will be almost incredible to those at a distance, yet the fact remains that large and populous portions of Madras have absolutely no drainage at all. There are nearly 70,000 persons dwelling in the parcherries of Madras, and I believe I am correct in saying that there was not a drain in any one of them. The excavations for the waterworks reveal very strikingly the evils of downward percolation of the sewage both where there are no drains and where there are. Mr. Woolley, the contractor for the works, has drawn my special attention to the fact that, in the more densely peopled and old localities, he frequently suffers great inconvenience through the soil being saturated with filth. That the workmen exhibit great disinclination to continue their labor; in some places the soil has been found as black as ink to a depth of 8 or 10 feet—as black, to use Mr. Woolley's expression, as tin sand. I have seen excavations made for other purposes in Chintadrepetta, where the same blackness was observed for several feet down. Now it is very evident that the earth does not retain this sewage as a well-corked bottle might retain wine. The sewage with which the ground is thus saturated is constantly undergoing physical changes. Poisonous gases from it perpetually rise through the upper stratum of earth; poisonous washings continually descend into the lower stratum of water defiling every well. Discoloration of the soil in this way is palpable evidence that there is real danger to those who live above the polluted ground—a danger which shows itself in perennial fevers, frequent epidemic outbreaks, and a general debility of intellect and physique among the people. It seems absurd to say more on a subject that so publicly and loudly calls for attention."

9. Where there is such diversity of view and of sanitary estimate between two officers of the same Municipality, it is not for us to decide who is right or who is wrong. What we have to do is with the facts. If the subsoil of Madras is not polluted by filth, it must be a very happy exception to the general experience of mankind, and all outlay for drainage of any kind must be waste so far as health is concerned. Unless it is shown that the blackness, as of "tin sand," is not due to sewage, but to the nature of the sand, the fact, as stated both by the late Mr. Gover and by Mr. Jones, must be accepted as proof of a dangerous condition of the subsoil. That there are odours from it no one can deny. That there are violent epidemics among the poor people living over it is shown year by year in the death returns, and last year's Madras Report (1878) shows, by the infallible well water test, that Mr. Gover's statements were correct. The analysis is here reproduced—one out of several. It is in Old Jail Street at the barracks.

	Grains per Gallon.
Total solids	14·70
Volatile	7·00
Chloride of sodium	4·69
Free ammonia	·01120
Albumenoid ammonia	·03360
Nitric acid	·06300

It is simply sand water highly charged with sewage. We must here leave the case with one remark, that, useful as a good system of impervious surface drainage may be, Mr. Jones has by no means shown that it is the only kind of drainage required for improving the health of Madras, and, to aid in the further discussion and understanding of the questions at issue, we would beg to refer to Captain Galton's report on the drainage of Memphis, United States, sent to the India Office for information in India, as indicating the methods considered to be necessary for improving a city subject, in time past, to great epidemics by authorities on the spot amply able to deal with the question.

10. It is satisfactory to be informed that the municipal authorities of Madras still hope to drain the city, and we have said sufficient to show that the surface drainage scheme need not stand in the way of proceeding with the complete drainage of every house. An obvious requirement of both schemes is more water. Without it underground drains would not work, and surface sewage drains would become offensive. But, whenever water is laid on, it must be kept out of the subsoil, and, if the surface drains are not kept sound and in good working condition, the last end may be worse than the beginning.

11. In the present state of the drainage question it is unnecessary to discuss the remaining principles, but it may be suggested that whatever outlay may be incurred in giving effect to them should be so applied that when Madras is effectually drained it may be found that the works can all be included in the completed scheme.

We may, however, call attention to the general principles of Indian drainage long ago laid down by us, and which we are glad to see have been practically carried out at Memphis, viz., that all the rainfall should be led to outlets by well-formed impervious surface drains and not by underground sewers; that underground sewers and drains should be perfectly tight and restricted solely to the conveyance of house sewage; and that drainage of the subsoil should be separately provided for.

The proposed plan for Madras would provide for the first requirement, but not for the others; and it is intended apparently to leave the subsoil as it is, and to remove the solid house sewage by hand labor, and to provide for this work by a more effective organization than at present exists.

12. The subject is fully dealt with by the Municipal Committee in a report (included in the appendix to the Municipal report), in which occurs the following important statement bearing directly on the nature and extent of all sanitary works for the city. They say: "We would remark in passing that it has been a constant error and source of expense to treat Madras as if it were a large city. This is far from the case, and it might better be described as a few densely populated villages at some distance from each other, and that therefore in all sanitary regulations the suburban and sparsely-populated should be treated apart from populous parts." No doubt this principle is a correct one up to a certain point; it applies, not to the things to be done, but to the manner of doing them. Every city, however large and however densely populated, and every village, however small, require cleanliness, dry and clean subsoil, and pure water. In villages all these requirements can be obtained, except under very special circumstances, without permanent works or expensive establishments. It is otherwise in densely-peopled towns or in large cities where all the measures require to be enforced with unceasing care for the protection of public health, and in these cases it has been long known that drainage, water-supply, cleansing, and general sanitary organization are much more economically carried out by adopting one general system of procedure. In such a case as Madras it may be possible to divide the work between the different population groups in such a way that, while the large population centres are drained and supplied with water by permanent works, the smaller groups may be dealt with

separately. In our suggestions for improving Indian villages we have stated the general principles which might be found applicable in these suburban villages, and the Memphis report shows how the larger and denser groups might possibly be dealt with.

As the case stands, supposing that Mr. Jones' scheme of surface drainage were applied to one of the larger groups of population, then the Municipality must provide against increasing subsoil, air, and water pollution by so arranging the nightsoil collection and removal as to keep the soil from touching the ground, and to remove it before the commencement of decomposition, which, when it begins, indicates the evolution of disease.

13. *Water-supply.*—The quantity of water drawn from the mains in 1879 was 144,779,000 cubic feet. The water is used by 200,000 people, or about half the population, and for this number the supply was 12½ gallons per head per diem. The total house services amount to 457, in 41 of which repairs were made during the year. The rainfall of 1879 was 40·84 inches, 27·64 inches of which took place in October and November. The tank level was lowest in August. As in many preceding years the water supplied from this country tank and gathering ground was far from being good in 1879. It contained "five or six times as much albumenoid ammonia" as the London waters, and "almost as much as the River Thames at London Bridge." The cause of this condition of the water appears to be found in a superabundance of the lower forms of organic life, either in the tank itself and its surroundings or in the open channel by which the water is conducted to Madras. It appears to be an open cutting, and the report mentions a slip of about 50 feet in length in its side "caused by rats and snakes boring holes, and by water oozing through the channel at places where it has been badly constructed, &c. The channel is a continual source of trouble to us and an obstacle to a continuous supply, produces a very considerable deterioration of the water, at the same time causes our pipes to be filled with fish, snails, &c., which we are unable to prevent with the best strainers, as when they enter the pipes they are in almost a microscopic state."

To remedy this state of matters it is proposed to replace the open culvert by a pipe main 36 inches in diameter, to extend the supply and provide filters at the tank, and also additional reservoirs. The state of the gathering ground would require careful watching to prevent pollution, and this, with the proposed works, ought to remedy the evils complained of. But to accomplish them an annual water-tax of 38,356*l.* would be required to pay off the loan and meet the establishment charges. It is proposed to lessen the amount by trusting to local wells in the outlying villages.

The whole subject, together with the future drainage, will no doubt be fully considered. There is every disposition apparently to proceed, but the former set-off, viz., poverty, is urged as a cause of inaction. All that we can say is that the existing Red Hills water-supply as described in this report is scarcely fit for any domestic purpose.

The following practical points in the domestic water services may be here introduced. The best and cheapest house service pipes are of plain iron, not galvanized, screw jointed, known as "gas tubing." For house service the largest need not exceed one inch, the smallest half an inch, with three-eighth screw-down taps. The tubes from the main to the house should be laid in a small case of wood, large enough to allow the pipe to be embedded in asphalte or Portland cement concrete. The cost of similar protection for gas pipes in London is 3*d.* per lineal yard, where also an inch pipe laid complete costs 2*s.* 9*d.* per lineal yard, and one half-inch pipe 2*s.*

An inch pipe will deliver, under a low pressure, about 480 gallons per hour, a half-inch pipe about 120 gallons per hour. A pipe two inches in diameter, laid complete and costing 5*s.* per lineal yard, will deliver 1,900 gallons per hour.

Pipes from two inches to one inch may be used as "rider mains" and have half-inch branches taken from them to the houses. As all pipes, T pieces, screw-down taps, &c., are screwed to a standard pitch and thread, any ordinary workman would soon learn to fit and repair them.

14. *Conservancy.*—The following account of this important work is given by the Acting President:—"The daily removal of rubbish and filth, and the cleansing of surface drains, &c., was carried out by a force of 944 coolies and 349 carts. The carts make two trips to the day. 369,779 cartloads, of which 37,666 were nightsoil, were removed during the year. The main sewers of Black Town and Triplicane were cleaned out at a cost of Rs. 381—456 cubic yards of silt were removed. The cost of surface cleansing, the most important part of the conservancy and sanitation of the town, was Rs. 1,53,653. The receipts from sale of rubbish and nightsoil were Rs. 4,982." We could only assent to this estimate of the importance of surface cleansing to health if it included the effective cleansing of all compounds, courts, lanes, &c., because Indian experience has long shown that it is not by dirty roads, so much as by dirty houses and their surroundings, that the public health suffers.

15. The outflow from the three largest Madras sewers is used for irrigation on five separate areas of ground. Three of these are sewage farms, from which the receipts for hay and grass were Rs. 8,308. But, as the maintenance cost Rs. 6,468 and the rents Rs. 3,182, there was a loss of Rs. 1,342, which was the sum paid for getting rid of sewage.

16. *Vaccination.*—The total successful vaccinations during the year were 17,009. As has been already stated, the deaths from small-pox were 910, or one death for about every 18¾ vaccinations.

17. Besides the points noticed in the preceding remarks, the Madras Report for 1879 shows that a large amount of detail work connected with the public health has been done in course of the year. On this we have no remark to make. Our object, as will have been seen, has been to assist as far as we can in the discussion which has been proceeding on the drainage of the city. In the present state of the question we have no recommendation to make, except that the city be drained concurrently with the water-supply extension, and that, until both works are completed, the most scrupulous attention should be given to the cleanliness of houses, compounds, lanes, and public roads and streets as the chief means of protection against epidemics. And another measure, the removal of unwholesome huts, of which we are glad to learn 204 had been removed from one hot-bed of disease, should be carried out. The owners will be compensated, the ground will be levelled and drained, and better huts erected on the site. But, like a change of camp, this measure at best is but a change of ground, and, if the future huts are to be fit for healthy occupation, suitable works for this object will have to be provided.

23rd July 1881.

ORDER THEREON, 18th November 1881, No. 2262.

A copy of this despatch and the enclosure thereto will be forwarded to the Municipal Commissioners of Madras for their consideration.

2. Copy of Captain Galton's report on the drainage of Memphis, United States, will also be forwarded when received from the Secretary of State.

(True Extract.)

R. DAVIDSON,
Chief Secretary.

To the President of the Municipal Commission, Madras.
" Sanitary Commissioner.

Copy to the Public Works Department.
" " Surgeon-General with the Government of Madras.

Exd. J. W. Fischer.

Govt. of {1881} Madras.

FINANCIAL.

To

THE PRESIDENT OF THE
MUNICIPAL COMMISSION.

Madras,

&c., &c., &c.

Dated November 1881.

Issued

Recd. *Encl.*

G.O., 18th November 1881, *No.* 2262.

NOVEMBER.

Municipal Reports.—Forwarding for consideration copy of despatch from Secretary of State and Memorandum by the Army Sanitary Commission on the Report of the Madras Municipality for 1879.

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GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

23rd December 1881, No. 2505.

Municipal Loans.

Read the following papers :—

From A. T. ARUNDEL, Esq., President of the Municipal Commission, Madras, to the Chief Secretary to Government, dated Madras, 22nd November 1881, *G. No.* 598 [*Current No.* 3234].

With reference to G.O., No. 1821, dated 28th September (Financial), I have the honor to report as follows.

2. As regards the raising of the proposed loan of three-and-a-half lakhs of rupees in 1882, the Government are aware that the Commissioners applied for a loan of two lakhs from Government for the current year 1881. This application the Government were unable to comply with under the rules of the Government of India. Pending the final disposal of the application, complete arrangements with regard to contracts, &c., were postponed, and no large outlay will be incurred this year. Such disbursements as may be necessary will be made as recoverable advances out of the ordinary Municipal revenue. Next year, however, it is proposed to expend the two lakhs originally required for 1881 and one-and-a-half lakhs in addition, or a total of three-and-a-half lakhs. Of this amount, two-and-a-half lakhs are required for Water-supply Extension, and one lakh towards the Scheme for the Drainage of Black Town. The first payments on account of iron pipes and other stores from England will fall due before the end of the first quarter of 1882.

3. As I had the honor to explain personally to His Excellency the Governor in Council at Ootacamund, the rate of interest on the loan, viz., 5 per cent, was fixed with reference to the state of the financial market and after consultation with some of the best authorities in Madras.

4. In addition to the interest on the loan, there will be a further charge on the Municipal revenue of 2 per cent. on the amount of the loan to be annually set aside as a sinking fund and to accumulate under proper investments at compound interest. The total amount of the loan would thus be accumulated in thirty years as may be seen by a statement of the Accountant-General published in G.O., No. 1789, dated 15th September 1880, giving particulars as to the existing Municipal loan which was lent by Government.

5. I have deferred answering this reference until I could make further inquiries on the subject of the proposed loan, and consider on the whole that it is advisable to fix thirty years as the period before which the loan will not be paid off. Permanency is necessary to secure investors, and it must be remembered that under the present Municipal law a Municipal debenture bond cannot be transferred by endorsement like Government paper, but the transfer must be registered in the Municipal Office, thus rendering the bond less negotiable and less valuable.

6. Referring to paragraph 3 of the Government Order under reply, I have to explain that the 2 per cent. sinking fund of the existing loan of Rs. 14,30,000 is a charge apart from, and additional to, the interest at 4 per cent. payable to Government on the loan. The accumulations of this sinking fund are annually invested in the joint names of the President and the Accountant-General, and now amount to a total of over three lakhs of rupees.

From A. T. ARUNDEL, Esq., President of the Municipal Commission, Madras, to the Chief Secretary to Government, dated Madras, 1st December 1881, *G. No.* 624 [*Current No.* 3328].

With reference to G.O., No. 1569, dated 27th August 1881 (Financial), and G.O., No. 1821, dated 21st September 1881 (Financial), it appears, from a reference to the Rules for the Local Authorities Loans Act published in *Fort St. George Gazette*, dated 25th November 1879, that there is a reasonable doubt as to whether a "District Committee" is intended to include a Municipal Corporation. It is only in the case of loans for *District Committees* that the work to be undertaken must be financially remunerative. If this be the case, there would apparently be no objection to the grant by Government of the loan of three-and-a-half lakhs of rupees now sought by the Municipal Commissioners of Madras.

2. It is practically certain that the Municipality cannot raise a loan in the market at a lower rate of interest than 5 per cent., while the Government can afford to lend at 4 per cent. As the loans required for the Drainage of Black Town and the Extension of the Water-supply will eventually amount to eleven lakhs of rupees, the difference to the Municipality between borrowing from Government and borrowing in the market will represent 1 per cent. on eleven lakhs, or Rs. 11,000 per annum.

3. I beg, therefore, that, if the rules are open to the construction I have referred to, the Government will be pleased to request the desired loan to the Municipality from the Government of India.

From H. F. CLOGSTOUN, Esq., Officiating Accountant-General, to the Chief Secretary to Government, dated Fort St. George, 20th December 1881, *No.* 5027 [*Current No.* 3635].

Book Department.

I have the honor to return the letter of the Madras Municipality received with your Official Memorandum, No. 1991, dated 13th December 1881 and to state that, according to the former document, the charge against the Municipal Fund on account of loans will, for some years, stand as follows:—

	Rs.
Interest at 4 per cent. on Rs. 14,30,000 payable to Government ..	57,200
Do. at 2 per cent. on Rs. 14,30,000 payable to Sinking Fund ..	28,600
Do. at 6 per cent. on Rs. 20,000 for Market payable to Debenture holders	1,200
Do. at 5 per cent. on Rs. 3,50,000 proposed Loan payable as the last one	17,500
Do. at 2 per cent. on Rs. 3,50,000 payable to Sinking Fund ..	7,000
Total ..	1,11,500

The first three charges, aggregating Rs. 87,000, will continue up to A.D. 1900. It is, therefore, for Government to determine whether the proposed additional charge of Rs. 24,500 can be imposed on the Municipal Fund.

ORDER THEREON, 23rd December 1881, No. 2505.

The Government observe that the "conditions" mentioned in G.O., 27th August 1881, No. 1569, had reference, *not* to the provision in the rules under the Local Authorities Loans Act regarding "District Committees," but to the following conditions imposed by Proceedings of the Government of India, Financial, dated 26th May 1879, No. 747—that "any ultimate financial responsibility will rest on the Local Government and not on the Imperial Treasury," and that, "if the Local Government desires to recommend a loan from the Public Treasury, it must, in making the recommendation, specifically undertake to make good from Provincial resources the interest

and capital repayments due from time to time in case of default by the borrowing body." This responsibility the Government of Madras are unable to accept, the Provincial grant, as now fixed, being insufficient even for the specific purposes for which it was made.

2. The proposed Municipal Debenture Loan of three-and-a-half lakhs of rupees under Section 208 of Madras Act V of 1878 is sanctioned on the terms proposed.

(True Extract.)

Chief Secretary.

To the President of the Municipal Commission, Madras.
" Accountant-General.

Exd. J. W. Fischer.

Govt. of [1881] Madras.

FINANCIAL.

To

THE PRESIDENT OF THE
MUNICIPAL COMMISSION,
Madras,

&c., &c., &c.

Dated December, 23rd.

Issued.

Recd. *Encl.*

G.O., 23rd December 1881, No. 2505.

DECEMBER.

Municipal Loans.—The proposed Municipal Debenture Loan of 3½ lakhs of rupees under Section 208 of Madras Municipal Act V of 1878 for extending Municipal Water-supply and carrying out the Drainage of Black Town, sanctioned on terms proposed.

25TH APRIL 1882, No. 339, FINANCIAL.

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following letter from A. T. ARUNDEL, Esq., President of the Municipal Commission, Madras, to the Chief Secretary to Government, dated Madras, 21st March 1882, No. 417 :—

With reference to G.O., No. 2262, dated 18th November 1881, forwarding, for the consideration of the Municipal Commissioners of Madras, a copy of a Despatch from the Secretary of State and a Memorandum of the Army Sanitary Commission on the Madras Municipal Report of 1879, I have the honor to state that, as the Army Sanitary Commission, in paragraphs 8 and 9 of their Memorandum, are evidently of opinion that the subsoil of Madras is greatly polluted by sewage, it may be desirable to set this matter at rest by a proper analysis of samples of soil taken from different parts of Madras at different depths. I have accordingly had forty different samples procured from certain specified localities at different known depths, and these are preserved in stoppered bottles ready for analysis.

2. I find, however, that if the analyses be made by the Chemical Examiner on behalf of the Municipality it will throw a charge of Rs. 1,600 on the Municipal Fund at Rs. 40 per analysis, which is the sanctioned fee for non-official work. As the analysis is proposed solely to satisfy the Army Sanitary Commission, and the result whatever it may be cannot do more than show the desirability of pressing on with the drainage scheme already commenced, I do not think the expenditure should be incurred out of Municipal funds. I beg leave therefore to refer the matter to Government, who, if it be their pleasure to do so, may order their Chemical Examiner to make the analyses as a part of his official duty.

Reference on the above, dated 3rd April 1882.

Referred for remarks to the Surgeon-General.

(By Order.)

(Signed) C. D. MACLEANE,
Under Secy. to Govt.

READ—the following letter from Surgeon-General W. R. CORNISH, F.R.C.S., C.I.E., Surgeon-General with the Government of Madras, to the Chief Secretary to Government, dated Madras, 5th April 1882, No. 164 :—

I have the honor to state, with reference to your endorsement* on No. 861 of 1882,

* Herewith returned.

that, as a difference of opinion seems to exist between the Army Sanitary Commission and the local Municipal authorities in regard to the degree of pollution of the subsoil of Madras, it would be advisable to have the question settled once for all by an analysis of selected specimens of subsoil, taken from ground covered with huts and without drainage or sanitary appliances.

2. It would probably be unnecessary to examine all the specimens collected by the Vice-President of the Municipality ; a few typical specimens would suffice.

3. Whether the Municipality should obtain the analysis at their own expense is a matter for the Government to decide.

ORDER—dated 25th April 1882, No. 339, Financial.

The Chemical Examiner to Government will be directed to make an analysis of a sufficient number of typical specimens of the subsoil of the town of Madras, which will be supplied to him in due course by the President, Municipal Commission, and to report the result.

(True Extract.)

C. G. MASTER,
Acting Chief Secretary.

To the President of the Municipal Commission, Madras.
" Surgeon-General with the Government of Madras.
" Chemical Examiner to Government.

Exd. J. Wright.

Govt. of [1882] Madras.

FINANCIAL.

Vide Ab 2825 / 2826 S 30/10/82

Order, dated 25th April 1882, *No.* 339.

Municipal—Sanitary—Directing the Chemical Examiner to make an analysis of a sufficient number of typical specimens of the subsoil of the town of Madras and to report the result.

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MONOGRAPH ON THE MADRAS WATER-SUPPLY AND IRRIGATION EXTENSION PROJECT.

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The following abbreviations have been employed :—

M.W.L. for maximum water level.
F.S.L. „ full supply level.
F.T.L. „ full tank level.
M.S.L. „ mean sea level.

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MONOGRAPH ON THE MADRAS WATER-SUPPLY AND IRRIGATION EXTENSION PROJECT. (a)

CHAPTER I.

DESCRIPTION OF THE WORKS AS EXISTING.

MADRAS is supplied with water from a reservoir known as the Red Hills Tank fed by a channel from the river Kortalayár, which passes through a reserve reservoir known as the Cholavaram Tank before it arrives at the Red Hills.

2. The Kortalayár has its origin in the surplus escape of the Kávéripák Tank, which is the principal reservoir fed by the Pálár Anicut. It has a length of about 54 miles above the dam which supplies the Red Hills Reservoir, and of about 22 miles below the dam to its outlet into the sea at Ennore, 7 miles to the north of Madrás. The area of drainage basin of the river above the anicut, including that of its principal affluent, the Nagari, which receives the Tirutani, is about 1,105 square miles; but 268 square miles of this area has to be excluded, being that of the drainage basin of the Kortalayár above the Kasavaram dam, which is 30 miles above the Thamarapak Anicut. The water coming down the river is almost all taken off at this point and turned into the Kuam River. This leaves 837 square miles as the area actually drained.* The catchment basin consists chiefly of the hilly country forming the Kárvetnagar Zemindari in the North Arcot District. This country was formerly well wooded, but most of the jungles on the slopes of Nagari Hills have now been cut to furnish firewood for the Madras Railway Company, and as they have not been replanted, the rainfall is said† to have much diminished. The average rainfall on the catchment basin may be taken at about 37‡ inches. The river is in flood during the north-east monsoon, and in an average year runs in full flood for four or five days, then with a flow of about 3 feet for thirty or forty days more, when it subsides to the small summer channel which runs, as a rule, all the year round.

* Mr. Fraser assumed 770 square miles.

† Mr. Fraser's original report.

‡ Averages of five years (1877—81) at the following stations, *vide* sketch map of Catchment Basin:—

Station.	Rainfall. IN.
Tirutani	34·70
Pólúr	37·86
Thamarapakkam	38·25
Kávéripák	33·40
Kasavaram	41·16
General Average ...	37·07

3. The dam is built at a place called Thamarapak, where the normal breadth of the river is about 500 feet. The anicut, however, is 624 feet long, with the crest at 69·86. The foundations consist of two rows of wells, 6 feet outside diameter and about 6 feet deep, on which rests a depth of 4 feet of solid brickwork.

The body wall is 6 feet high, 6 feet broad at the crest, and 7½ feet broad at the level of the top of the foundations, the batter being on the upstream side. On the downstream side there are two aprons; the first, 6 feet below the crest, being 32 feet broad and 4 feet thick; the second at the same level as the first, being 33 feet broad and 2 feet thick. There are eight under-sluices on the south side, each 7 feet × 4 feet, with their sills 6 feet below the crest of the anicut, or at 63·86. The bed-fall of the river averages 3½ feet per mile, and there are embankments on either side upstream and on the south bank downstream. The south embankment above the anicut is 2¾ miles long and the north embankment 2 miles long. In section the banks are 4 feet broad at the top, which is 5 feet above F.S.L. in the river, and have side slopes of 1½ to 1. The bank below the river is of similar section, and is 3,900 feet long.

(a) 1. All levels are in feet and decimals, and are referred to mean sea level, unless the contrary is expressly stated.
2. Volumes are given in cubic feet as a rule, but as until quite lately it was usual to state quantities in cubic yards, these have had to be retained in some cases.

4. The head-sluice to the supply channel has 10 vents, each 5 feet × 5 feet 7 inches, with their sills at the same level as those of the under-sluices. The length of the supply channel from the head-sluice to where it enters the Cholavaram Tank is 8 miles 14* chains. In section it is 30 feet in bottom width, with side slopes of $1\frac{1}{2}$ to 1. The depth of ordinary flow is $2\frac{1}{2}$ feet. The top of the retaining bank on the north side is about $8\frac{1}{2}$ feet above bed-level. The bed-fall of the channel averages 2 feet per mile, and the volume of its discharge at ordinary level is therefore 940† cubic feet per second.

* Of 66 feet.

† Kutter's formulæ.

The number and description of the masonry works between the head-sluice and the Cholavaram Tank are as follow :—

No.	Description.	Distance from Head.	Level above M.S.L.‡
		MS. CHS.	FEET.
1	Inlet, 30 feet long ...	0 20	75·12
2	Bridge (3 vents of 18 feet).	0 55	62·84 (floor)
3	Outlet, Kattankal surplus weir, 147 feet long.	1 60	65·86 (crest) 62·86 (sill)
4	Inlet, 20¾ feet long ...	1 66	67·86
5	Do. 24 do. ...	2 8	67·24
6	Do. 24 do. ...	2 39	65·98
7	Do. 20 do. ...	2 63	64·12
8	Do. 24 do. ...	2 69	63·40
9	Bridge (3 vents of 18 feet).	3 3	58·30 (floor)
10	Inlet, 24 feet long ...	3 26	62·81
11	Do. 20 do. ...	3 44	63·05
12	Do. 24 do. ...	3 68	63·79
13	Do. 24 do. ...	4 11	65·23
14	Old Busikal division ...	4 53	...
15	Outlet, Busikal surplus weir, 141 feet long.	4 64	59·69 (crest) 56·69 (sill)
16	Rámapuram Bridge ...	4 73	56·92
17	Bridge (3 vents of 18 feet).	4 79	54·39
18	Do. { do. }	5 55	53·00
19	Alacheri aqueduct ...	6 12	52·10

‡ These levels are referred to de Haviland's B.M. at Madras, which was taken at 6·83 feet above M.S.L. The correct value is now given as 7·83 feet, but the original level has been retained here for convenience of comparison.

It will be observed that there are ten inlets and two outlets. The Busikal and Kattankal are streams draining 44 square miles and 62 square miles, respectively, and have often breached the supply channel. Estimates for lengthening and improving their outlets have been sanctioned.

5. The total length of the bank of the Cholavaram Tank is 2 miles 22 chains, but the length from where the supply channel enters it to the channel leading to the Red Hills Tank is only 2 miles 5 chains. The top of the bank is 10 feet broad. The inside slope is at 1 to 1 with rough-stone revetment and a parapet wall at the top. The outside slope is at $1\frac{1}{2}$ to 1. The F.T.L. is at 61·68, and the area and contents§ of the tank at this level are respectively 67·21 million square feet and 766·405 million cubic feet. There are two irrigation sluices. The first, called the north sluice, is at 1 mile from the head of the tank, and consists of a vent 3 feet × 4 feet. The head of water over the vent at F.T.L. is 19·85 feet, its level being 41·83. The other sluice is formed by a vent 1 foot × $1\frac{1}{4}$ feet in the body of one of the weirs, 43·84 chains from the head of the tank, with its sill at 52·68 ; there is also a plug 6 inches in diameter at top and 5 inches at bottom.

§ See Chapter IV for fuller details.

There are two weirs. The first is 9 chains from the north end of the tank and 166 feet long, with its crest at 63·62. The second is 43 chains from the same end, 187 feet long, and has its crest at 61·68.

6. The head-sluice to the Red Hills Tank supply channel is, as above stated, at 2 miles 5 chains from the north end, and consists of 10 vents, each 4 feet × 3 feet, with their sills at 45·33 feet. The length of the channel is 2 miles 50 chains to the commencement of the bank of the Red Hills Tank ; the section of the channel is the same as that of the upper supply channel already described. There is a siphon sluice across the channel at 1 mile 25 chains from the head, and a girder bridge of 40 feet span and floor level 39·76, at 2 miles 29 chains.

7. The Red Hills Tank bank begins at the left wing of the north (Mr. Fraser's) weir, and is 3 miles 27 chains long. The section, speaking generally, is the same as that of Cholavaram Tank. The top of the bank is at 52·31, and there is a dry stone wall above this, raising the level to 55·31 along the deeper parts and to 54·31 along those of intermediate depth. The full tank level is at 46·31.* The greatest depth of water against the bank is over the sill of the north sluice, where it is 25·65 feet at F.T.L. There are four irrigation sluices and one sluice for the municipal supply channel in the reservoir.

* Temporarily reduced to 43·31, *vide* paragraph 11, Chapter III.

The following particulars refer to the irrigation sluices :—

No.	Distance from Head of Tank.	Level of Sill.	Description.
	MS. CHS.		
1	15		In surplus weir.
		31·42	One vent 2 feet × 3 feet.
		36·43	Two plugs ; one plug, top diameter 7¾ inches, bottom diameter 6¾ inches ; other plug, top diameter 8½ inches, bottom diameter 7½ inches.
2	32 34		North sluice.
		20·66	One vent 3 feet × 6 feet.
		30·66	Four plugs, upper diameter 10 inches, lower diameter 9 inches.
		40·66	Four do. do.
3	1 27·07	21·10	Polal sluice.
		30·10	Vent as in No. 2.
		40·10	Four plugs do.
4	3 3·25		Soorapedoo sluice.
		27·31	One vent 3 feet × 4 feet.

The municipal sluice is at 3 miles 15 chains, and contains six pipes of $2\frac{1}{4}$ diameter each, placed as follows† :—

Three	pipes	with sill at the level of	31·31
One	do.	do.	35·31
One	do.	do.	39·31
One	do.	do.	43·31

† Proceedings of the Madras Government, No. 1038 W., of April 22nd, 1882.

The reservoir has one surplus weir at the extreme north end, which is 1401·33 feet long, and has its crest at F.T.L. (46·31). In this weir there is a 10-vented surplus sluice at 21·06 chains, each vent being 6 feet × 6 feet with its sill at 31·31. These sluices, which did not form part of the original design, were deemed‡ necessary as a safeguard owing to the slips which occurred in the bank of the reservoir after it had been raised. The surplus weir is of ample capacity to discharge all the water to be disposed of, but it does not come into action until the water has risen above F.T.L. It was therefore considered to be desirable to provide means for rapidly lowering the water level, should the bank be in danger of giving way, as also to allow of the discharge of surplus without necessitating the rise of the water level in

‡ G.O., No. 2322, of August 11th, 1875.

the reservoir to as great a height above F.T.L. as would be necessary, were all such surplus to be passed over the weir.* The area and contents of the reservoir at F.T.L. are respectively 212·103 million square feet and 2744·8911 million cubic feet. The level of the lowest point of the tank-bed is about 20·00.

* Proceedings, Madras Government, No. 849 I., of December 9th, 1881.

8. The portion of the works outside the Red Hills Reservoir, that is, the Municipal Delivery Channel, are briefly described in Chapter IV, which treats of "The Town Supply of Madras."

CHAPTER II.

IMPORTANT PHASES OF ITS HISTORY.

The question of supplying Madras with an abundance of pure water was one that had occupied the attention of Government for many years before the first definite action was taken on the subject in 1866. Numerous reports and suggestions had been submitted by professional Engineers and others, either under the direct orders of Government, or from having their attention directed to the subject by the constant complaints of the gradually increasing impurity of the water drawn from the wells, which then formed the only source of supply.

The reasons for the deterioration in the quality of the well water were not far to seek. Madras being built on the belt of silicious sand which runs along the Coromandel Coast, it followed as a matter of course that a portion of the filth collected on the surface was, owing to the porous nature of the soil, washed down to the water-bearing strata during every monsoon. The Chemical Examiner to Government, who analysed the water of a very large number of wells, reported that the results showed that, with very few exceptions, the drinking water of Madras was as bad as it possibly could be.

2. The first proposal on the subject was made by Lieutenant (now Major-General) O'Connell, R.E., in 1855, who submitted a scheme estimated to cost Rs. 43,39,476. This provided for an anicut across the Kortalayár at Pushali, some distance above the crossing of the Madras Railway and 3 or 4 miles below the Kasavaram dam, which turns some of the Kortalayár water into the Kuam (or Cooum) River. The supply channel, which was to have been about 28 miles in length, was, in its course to the Red Hills, to supply the following eight tanks: Senji, Pudumavalangai, Kadambatúr, Puttalur, Tannirkulam, Pakkam, Palaveda, and Mittanemali. After supplying these tanks, the surplus water for the supply of Madras was to be stored in the Red Hills Tank, the bank of which was to be raised 9 feet. An open channel was to convey the water from the tank to two basins in Madras, whence it was to be pumped into settling reservoirs, and passed into the mains for distribution. No detailed plans of this scheme were prepared, and there were, according to Mr. Fraser, two vital objections to it—

(1) that virtually, though not admittedly, it made the storing of water for Madras a matter secondary to that of filling the eight irrigation tanks;

(2) that the supply would have been deficient had the channel been taken from the Kortalayár so close to the Kasavaram dam, which is supposed to turn most of the flood and all the summer water of the Kortalayár into the Kuam for the supply of the Chembrumbankum and other tanks.

No action was taken on Lieutenant O'Connell's proposals, and nothing further was done till October 1861, when the Municipal Commissioners drew attention to and recommended the substantially similar scheme put forward by Mr. Peter Orr, of Madras. Government, in its Proceedings of December 20th, 1861 referred the subject for the consideration of the Public Works Department, and in May 1862 Mr. Roberts, C.E., was appointed to report on the scheme. But with the exception of one trial line of levels Mr. Roberts confined his observations to the ground previously examined by Lieutenant O'Connell. In 1863, however, Mr. Fraser, C.E., suggested† the possibility of improving upon Lieutenant O'Connell's design, and he was forthwith directed to undertake the re-investigation of the whole project.

† Letter No. 1741 of July 2nd, 1863.

3. Mr. Fraser's first report was submitted with his letter, No. 50, of February 26th, 1866, and on 30th April of the same year the Madras Government, when replying to the Budget Orders of the Government of India, intimated* that it was proposed to devote Rs. 1,10,800 "to the project for the storage of water in the Cholavaram and the Red Hills Tank, with a view of increasing the capacity of those reservoirs for irrigation, as well as of providing the city of Madras, its garrison, and public establishments, with an abundant and wholesome supply of water, according to the plans and estimates which have been prepared in full detail by Mr. Fraser, C.E., and have recently received† the approval of this Government."

* Letter No. 1376 of April 30th, 1866.

† In Proceedings, Madras Government, No. 1102, of April 11th, 1866, from which most of the above details have been taken.

4. Mr. Fraser's scheme consisted of—

		Rs.
I.	The construction of a dam across the Kortalayár	30,710
II.	The construction of a channel with head and other sluices, and all requisite works from the anicut to Cholavaram Tank, a distance of 8½ miles	1,22,055
III.	The enlargement of the capacity of this tank by raising its bank 18 feet	1,38,752
IV.	The construction of a channel with sluices, bridges, &c., from the Cholavaram to the Red Hills Tank, 2⅔ miles in length.	65,964
V.	The enlargement of the capacity of this tank by raising its bank 15 feet	1,17,934
VI.	The construction of a channel with its sluices, accommodation bridges, &c., from the Red Hills Tank to the Spur Tank in Madras	28,032
VII.	Sundries, compensation for land and houses, superintendence, &c.	1,33,483
	Total ...	6,36,930

The scheme also contemplated the irrigation of between 8,000 and 9,000 acres of waste land, and it was anticipated that the returns from irrigation alone would suffice to pay a high interest on the estimated outlay.

Sanction to the project was accorded by the Government of India by telegram‡ on July 14th, 1866, and by letter§ on July 19th, 1866, No. 626 C, the total sanction being Rs. 6,11,759, Item VII of Mr. Fraser's estimate being reduced to—

‡ Proceedings, Madras Government, No. 2374, of July 27th, 1866.

§ Proceedings, Madras Government, No. 3298, of October 16th, 1866.

	Rs.
Five per cent. for contingencies	25,172
Compensation for land	83,140
Total ...	1,08,312

5. In the meantime, however, proposals had been sent to the Secretary of State for the carrying out of the works by a private Company, it being considered‖ that the financial prospects were so good that funds would be readily forthcoming. The Secretary of State replied in Despatch No. 22 of 1866, dated November 24th. He considered that the promising nature of the work was rather a reason for not seeking the co-operation of a Financial Company, even had there been any probability, which in the then state of the money market was very doubtful, that any Company would be prepared to co-operate. It appeared to the Secretary of State that if Government took upon itself the irrigation part of the scheme, it could thereby render the mere conveyance of water to a reservoir in Madras

‖ Despatch No. 46 of 1866, dated September 13th.

so profitable a business that it could afford on liberal terms to place the water in the reservoir at the disposal of the Municipality. It would then only remain for the Municipality to construct the distribution works, and if any difficulty were found in raising sufficient funds for that purpose, it appeared that Government would incur little or no risk in advancing the money on the security of water-rates, fixed sufficiently high to be likely to pay off principal and interest within a limited period. The adoption of this plan, besides preventing the water from being made needlessly dear for the profit of strangers, would, the Secretary of State considered, not improbably be beneficial in showing to the Madras Municipality the advantages which they might confer on the town by themselves providing for ordinary municipal requirements.

6. The Government of Madras accordingly recommended* to the Secretary of State that the Government of India should be authorised to raise a loan of 8 lakhs to be applied to the construction of the works comprised in Mr. Fraser's project. In reply it was pointed† out to the Government of Madras that the Government of India had full power to dispose of such questions, and application was therefore made‡ to the Government of India to sanction the loan of 8 lakhs. As, however, the requirements of the project for the year (1867-68) had been stated§ to be not more than 3 lakhs, the Government of India appeared to think‖ that the loan was unnecessary, and that funds could be provided in the ordinary way.

* Despatch to Secretary of State, No. 7 of 1867, dated February 8th.

† Letter from Government of India, No. 40 I., of March 25th, 1867, in Proceedings, Madras Government, No. 1139, of April 13th, 1867; also Despatch from Secretary of State, No. 13, dated April 8th, 1867, in Proceedings, Madras Government, No. 1455, of May 14th, 1867.

‡ No. 967 of March 27th, 1867.

§ Telegram of March 8th, Proceedings, Madras Government, No. 696.

‖ Letter No. 40 I.

7. The Municipality, however, required a loan for the construction of the distribution works. Mr. Standish Lee, the then Municipal Engineer, prepared the scheme for these, which were estimated to cost Rs. 12,80,000, and application was accordingly made¶ to the Government of India for a loan for this amount.

¶ Letter No. 3410 of October 30th, 1868.

The Government of India, in replying to the proposal as regards the loan, suggested** that the Municipality should become joint owners with the Government of the work. The case was stated thus:—

** No. 55 A.I. of March 11th, 1869, in Proceedings, Madras Government, No. 1014, of March 24th, 1869.

"The whole additional supply of water stored is 2,700 millions†† cubic feet; of this 1,431 millions are to be used by the Government and 864 millions by the Municipality, besides 405 millions which are of no use; in all the Municipality has 1,269 million cubic feet stored for its purposes. If, therefore, the cost (8 lakhs) be divided in the proportion of 53 to 47 (1,431 to 1,269), it gives 4¼ lakhs for Government and 3¾ lakhs for the Municipality; it is then proposed that the Municipality shall be considered as joint proprietors of the reservoirs, and be allowed to pay the interest on the above capital, *plus* a proportional share of maintenance charge."

†† Stated in cubic yards in original.

The Municipality declined,‡‡ however, to accept the offer of joint proprietorship, and the loan of Rs. 12,80,000 was sanctioned§§ by the Government of India on the terms originally proposed by the Madras Government, viz., at 6 per cent. per annum, 4 per cent. to be considered as interest for the money and 2 per cent. to be credited to a sinking fund for the liquidation of the debt, the Municipality being further required to pay Rupee 1 per 27,000 cubic feet for the supply of water received from the reservoirs. This latter point was strongly insisted‖‖ on. "The Municipality has elected to be treated as a customer in respect to the water supplied, and it cannot therefore reasonably, hope to enjoy more favourable terms than those granted to the public generally. The

‡‡ Proceedings, Madras Government, No. 1622, of May 17th, 1869.

§§ Proceedings, No. 126 A.I., of June 25th, 1869, in Proceedings, Madras Government, No. 2327, of July 17th, 1869.

‖‖ Government of India Resolution, No. 126 A.I., of June 25th, 1869.

Governor-General in Council, moreover, requests that it may be distinctly pointed out to the Municipality that the free use of water from the Government reservoirs must not be looked for."

8. As the works in connection with the storage progressed, it became evident that the original estimate for them would prove wholly insufficient, and a revised estimate, amounting to Rs. 10,42,640, is noticed in Proceedings, Madras Governmont, No. 1100, of April 26th, 1870. This, however, was not forwarded to the Government of India, as doubts had been thrown on the estimated returns from irrigation, and it was considered advisable that a definitive decision should be come to on this point before any revised estimate was submitted for sanction. But as it was not possible to delay the progress of the works, the outlay soon largely exceeded the sanction, and the revised estimates were repeatedly called* for. Not being ready, the Government of India ruled† that all expenditure after January 1st, 1871, should be debited to the Ordinary Agricultural grant instead of to the Extraordinary (Loan Funds) grant, from which the previous expenditure had been met.

* Proceedings, Madras Government, No. 2697, of November 10th, 1870.
Proceedings, Madras Government, No. 2909, of December 2nd, 1870.

† Proceedings, Madras Government, No. 233, of January 26th, 1871.
Proceedings, Madras Government, No. 520, of February 21st, 1871.

9. The Madras Government eventually decided‡ that a Committee should be appointed to report on—

(1) the complete outlay required in order to place the works in a satisfactory condition;
(2) the total return to be equitably credited to the works;
(3) the charge for maintenance.

‡ Proceedings, Madras Government, No. 939, of May 29th, 1871.

The Committee's Report§ is dated July 14th, 1871, and was forwarded to the Government of India with letter No. 2172 of August 23rd, 1871. It is therein stated that the estimated total cost had risen to Rs. 12,25,558 owing to—

§ Proceedings, Madras Government, No. 2171, of August 23rd, 1871.

(1) increased rates;
(2) improvements in design;
(3) additional rates;
(4) increase in land compensation.

The estimated return had also fallen from Rs. 1,12,166, at which it was taken in 1870, to Rs. 49,000. It was suggested that the portion of the expenditure on which this return would pay 6 per cent., or Rs. 8,16,666, should be met from Loan Funds, leaving the balance, Rs. 4,08,892, to be defrayed from Ordinary.

10. The Government of India did not, however, approve of the latter part of this proposal, considering‖ it to be unfair to tax the public in the Madras Presidency generally with one-third of the cost of a project undertaken principally on behalf of the city of Madras, and for which there seemed no doubt the city could well afford to pay. An enhancement of the price to be paid for the water by the Municipality was therefore recommended. It was pointed out that in Calcutta only about 2,440 gallons of water were obtained per rupee, and in Bombay only about 8,000 gallons, against 168,750 gallons per rupee, which would be the rate in Madras. In reply to this the Government of Madras pointed¶ out that a distinct engagement had been made with the Municipality not to charge more than Rs. 32,000 per annum for the water, on which understanding it had declined** to become a joint proprietor, and that, moreover, the cost of supply should be estimated on the volume used, not on that available. In

‖ Letter No. 695 I. of November 10th, 1871, in Proceedings, Madras Government, No. 65, of January 10th, 1872.

32 million cubic yards = 5,400 million gallons for Rs. 32,000.

¶ Letter No. 1015 of April 18th, 1872.

** Letter No. 1015 of April 18th, 1872.

regard to this it was said that the supply was not expected to reach more than 312,000* inhabitants, and even assuming that each person took as much as 20 gallons a day, this would only give a yearly consumption of 2,277 million gallons, or at the rate of 16,824 gallons per rupee.

* Out of a population of 397,000. The Census of 1871 showed that the supposed population of Madras was very much larger than proved to be the case.

11. The Government of India accepted this reasoning, and with letter No. 05 I. of May† 10th, 1872, forwarded a copy of a letter it had addressed to the Secretary of State recommending that the proposal should be adopted that 8 lakhs of the expenditure should be met from Loan Funds, and the balance from the same source in the first instance, but to be repaid by annual instalments of 1 lakh, one-half of each instalment being met from the Ordinary grants to the Madras Government for Agricultural Works, and the other by a reduction of the Provincial Assignments to that extent.

† Proceedings, Madras Government, No. 1452, of June 12th, 1872.

12. The Secretary of State did not, however, approve of this proposal. In his despatch‡ No. 59 of July 10th, 1873, after reviewing the circumstances of the case, he said he regretted he could not concur as to the mode in which the difficulty should be met, it being entirely opposed to the policy under which expenditure on remunerative works was permitted to be undertaken from borrowed money, that any portion of the cost of a work which is shown to be unremunerative should be debited against Loan Funds. It was therefore ordered that no part of the principal or interest of the money laid out should be eventually debited to Extraordinary Funds.

‡ Proceedings, Madras Government, No. 162 B., of January 24th, 1874.

13. The Government of India, in forwarding a copy of this letter from the Secretary of State to the Government of Madras, remarked that the Accountant-General, Public Works Department, had reported that the ultimate expenditure was likely to amount to more than 15 lakhs, instead of Rs. 12,25,558 as reported by the Committee of 1871, owing to no provision having been made in the estimate for establishment and tools and plant charges. The actual outlay to the end of 1872-73, combined with the grant for 1873-74, showed the following results:—

No. 854 I. of December 9th, 1873, in Proceedings, Madras Government, as above.

—	Loan Funds.	Ordinary.	Total.
	Rs.	Rs.	Rs.
Works	8,45,616	3,71,989	12,17,605
Establishment	1,64,231	1,05,045	2,69,276
Tools and Plant ...	7,901	9,123	17,024
Total ...	10,17,748	4,86,157	15,03,905

The refund to be made accordingly amounted to Rs. 10,17,748, and, with a view of affording every assistance in its power to the Government of Madras, the Government of India authorised the Accountant-General, Public Works Department, to debit the Ordinary and credit the Extraordinary grant with Rs. 5,70,000 in the accounts for 1872-73 for the Madras Water Supply Project. This left Rs. 4,47,748 still to be refunded, which it was suggested should be done in the following way: 2 lakhs from Provincial Funds by annual amounts of Rs. 50,000, commencing from 1874-75, and the balance in three instalments from the Ordinary grant under Agricultural. Subsequently all Irrigation works, including Agricultural, were included under Imperial, and the refund had therefore to be made entirely from Provincial. It has been carried out in the following§ way:—

§ Proceedings, Madras Government, No. 849 I., of December 9th, 1881.

	Rs.
By transfer in 1876-77	50,000
Do. in 1878-79	50,000
Do. in 1879-80	1,00,000
Do. in 1880-81	1,00,000
Do. in 1881-82	1,00,000
Do. in 1882-83	* 47,748
Total ...	4,47,748

* Entry in Budget for 1882-83.

14. But this does not constitute the whole refund. The estimate, amounting to Rs. 12,25,558, sanctioned in Government of India letter, No. 695 I, of November 10th, 1871, only included works and petty establishment charges, the regular establishment charges, and those for tools and plant having been omitted, as well as all indirect charges. It was found also that several of the component works required extension or modification, so that an additional provision under works was necessary, and a revised estimate to include all these additions was called for. Great delay occurred in submitting it, and it was not till the 9th of December 1881 that the revised estimate was forwarded for the sanction of the Government of India. It amounted to Rs. 18,54,463, divided thus:—

Proceedings, Madras Government, No. 849 I.

	Rs.
1. Anicut and Head Works	95,839
2. Cholavaram Tank Supply Channel	2,45,670
3. Cholavaram Tank	2,67,367
4. Red Hills Tank Supply Channel	1,32,882
5. Red Hills Tank	2,98,609
6. Distribution	27,201
7. Land other than for the Madras Municipality	1,45,079
8. Miscellaneous	58,596
9. Items chargeable to Provincial	96,573
	13,67,816
Deduct amount charged to Works, which belongs to Establishment	24,866
Total, Works ...	13,42,950
Establishment	2,19,255
Tools and Plant	8,201
	15,70,406
Less Receipts on Capital Account	1,167
Total, Direct Charges ...	15,69,239
Capitalised Abatement of Land Revenue	2,13,320
Interest	71,904
Grand Total, Direct and Indirect ...	18,54,463

The total of this estimate is divided as follows:—

	Rs.
Imperial	9,82,105
Provincial	8,72,358

so that the whole of the charges having been originally met from Imperial, and only Rs. 4,47,748, as above stated, added to Rs. 23,214 originally met from Provincial, having been refunded of the Provincial share, there is still a refund of Rs. 4,01,396 to be made. This, it has been ordered,* is to be carried out in the Civil Accounts, by continuing to refund one lakh year by year, including 1882-83, until the whole debt has been paid.

* Letter from Government of India, No. 228 A-G, of June 5th, 1882.

CHAPTER III.

ACCOUNT OF THE ENGINEERING DIFFICULTIES ENCOUNTERED, AND OF THE MANNER IN WHICH THEY WERE OVERCOME.

THE project has suffered from its commencement to quite an unusual extent, both from the accidents owing to floods of unexpected severity to which every irrigation work is liable, and also from mistakes made in the original method of execution, the two reservoirs comprised in the project being formed by additions to old works, and requiring therefore exceptionally careful treatment, which unfortunately they did not receive, to ensure homogenity between the old work and the new. The difficulties arising from these two causes will be taken separately.

I. DAMAGES FROM FLOODS.

2. In October 1870 a very heavy flood came down the Kortalayár, the water rising to 16 feet above the sluice sill, or 10 feet above the crest of the anicut, and 4 feet above the flood-level as originally estimated. The anicut was but slightly damaged, but the upstream wings of the head-sluice were carried away, and a large breach was formed behind them. The roadway of the head-sluice, being only 15 feet above the level of the sluice sills, was 1 foot under water. The supply channel from the river was also breached in several places by the land drainage brought into the channel by the two streams called the Kattankal and Busikal, the existing works being insufficient to pass the discharge across the channel.*

* Proceedings, Madras Government, No. 2774, of November 18th, 1870.

3. In November 1882 a still higher flood occurred, the water rising to 13 feet above the crest of the anicut, and also over the banks on both sides of the river Kortalayár. The flood turned the north wing of the anicut, and breached extensively the south flood-bank above it, causing, in consequence, considerable damage to the supply channel. The anicut itself sustained no injury, but a small portion of the wing-wall which was turned was carried away. The breaching of the south flood-bank let a large volume of water into the country beyond, which found its way into the Kattankal and Busikal, thence into the supply channel, which was breached, and so back to the Kortalayár. The additional works which the flood showed to be necessary consisted of —

† Proceedings, Madras Government, No. 2132, of August 26th, 1873. The actual cost was Rs. 23,437.

(1.) Lengthening the anicut by 150 feet, making it 624 feet long. The estimate for this amounted to Rs. 25,000.†

(2.) A further raising of the roadway of the head-sluice to the supply channel, which had only been 6 inches above the flood of November 1872. The necessary raising was recommended,‡ to be effected by closing the spaces between the piers which carry the shutter gear, and by raising the earthworks at either end to the level of the tops of the parapets of the wings.

‡ Proceedings, Madras Government, No. 2132, of August 26th, 1873.

(3.) Raising the flood-banks on each side above the anicut and on the south side below it. The banks above were raised to 5 feet above the level of the 1872 flood, that on the south side having its terminus on the Veliyur Tank bank, and that on the north side on a village boundary mark. Below the anicut on the south bank there was a flood embankment extending three-fourths of a mile to comparatively high ground, but the upper part of this bank was much too low. The flood-level below the anicut reached 80·83, or 2·03 feet below that above the dam. As 10,300 feet, or rather less than 2 miles, its level was 76·96, so that the surface fall was 1·97 feet per mile, and to the proposed terminus of this bank, a length of 3,900 feet, the fall would be 1·16 feet, making the flood level here 79·37. The ground here was at 81·32, giving a margin of 1·9

* Proceedings, Madras Government, No. 1222, of May 7th, 1874.

† Proceedings, Madras Government, No. 2132, of August 26th, 1873.

feet, but on the whole it was considered* safer to make the bank here 3 feet higher or, say, 84·31. This high ground had to be connected with the left bank of the supply channel, as in 1872† the water in the Kortalayár had risen considerably above the level of the crests of the then existing weirs. The level of the top of this connecting bank was also fixed at 84·31 feet. The estimates for these banks were—

		Rs.
Flood-bank north of Kortalayár above anicut	...	5,550
Do. south do. above and below do.	...	6,800

and were sanctioned in G.O., No. 1222, of May 7th, 1874.

4. In October 1874 a higher flood even than that of 1872, occurred in the Kortalayár, the levels of the water in each case being given‡ as —

‡ Proceedings, Madras Government, No. 2011, of July 15th, 1875.

	1872.	1874.	Difference.
At 1 mile 1,293 yards above anicut	87·32	90·85	3·53
Anicut	82 86	84·20	1·34

The embankments above the anicut were not much damaged, only three small breaches, which perhaps were intentionally caused by the villagers, having been made in the south bank, but it was discovered that the terminus of this bank did not fulfil its purpose, as it proved capable of being turned. Estimates amounting to Rs. 2,558 for completing the right flood-bank, and to Rs. 4,900 for extending it, were sanctioned in G.O., No. 368 I., of October 3rd, 1877. The anicut suffered more than the embankment, but principally from local scour. The foundations of the crest wall were undermined for a length of about 120 feet, the front row of wells disappearing almost entirely, and the second row settling considerably. The crest wall went out of the upright, parts of it also being carried away, and a crack appeared in the rear apron. The remedy proposed§ besides the restoration of the damaged portion, was to lay an apron of rough stone 21 feet wide and 2 feet thick at a gentle slope on the upstream side of the crest. The supply channel was also damaged, owing to the impossibility of discharging through it, when the Kortalayár is in high flood, all the land drainage coming into it. The drainage basin of the Kattankal is estimated at 62‖ square miles and that of the Busikal at 44 square miles, and it was calculated that, allowing M.W.L. in the channel to be 10½ feet above the bed or 4½ feet above F.S.L., weirs of 280 feet and 216 feet in length, respectively, would be required to discharge the drainages. This was supposing the weirs to have flush crests, but by adopting self-acting revolving shutters for the vents the lengths were reduced to 144 feet and 135 feet, respectively, and estimates for these improvements, amounting to Rs. 18,400,¶ for the Kattankal escape and to Rs. 16,900** for the Busikal escape were sanctioned in G.O., No. 2785, of October 17th, 1876. Their execution had, however, to be deferred pending the sanction of the revised estimates. The proposed arrangements, even when carried out, do not promise to be wholly satisfactory, but it is impossible to devise adequate arrangements at a reasonable cost. Should the river be in extreme fresh when the local rainfall approaches a maximum, the discharge of the drainages cannot be disposed of without exceeding the proposed M.W.L. in the channel, and on the rare occasions when these unfavourable circumstances may combine, the left bank of the channel will probably breach at points which will be left exceptionally low so as to fix the site of the breaches.††

§ Proceedings, Madras Government, No. 2011, of July 15th, 1875.

‖ Proceedings, Madras Government, No. 2785, of October 17th, 1876.

¶ Subsequently increased to Rs. 19,000.
** Do. do. Rs. 17,400.

†† Proceedings, Madras Government, No. 849 I., of December 9th, 1881.

5. An estimate, amounting to Rs. 2,135, for raising the connecting bank between the flood-bank of the Kortalayár below the anicut and the bank of the supply channel,

the necessity for which had been shown by the same floods of 1874, was sanctioned in G.O., No. 368 I., of October 3rd, 1877. The condition of the river embankments, of the anicut, and of the supply channel was generally satisfactory on the occasion of the inspection of the works by the Chief Engineer for Irrigation in November 1881.

II. Damages to the Reservoirs.

(1.) *Red Hills Tank.*

6. In February 1870 leakage was first noticed in the bank of the Red Hills Tank near the north end, when only $4\frac{1}{4}$ feet depth of water above the old calingulah crest had been admitted to the tank out of the additional depth of 15 feet which it was designed to hold. The leakage was considerable for a length of 867 feet, and for an additional length of 4,596 feet the water passed through or under the bank in smaller quantity. The new earthwork which had been placed on the top of the old bank had, it was supposed, been rendered impermeable by means of a puddle wall, but it appears to have been taken for granted that the old earthwork below this puddle wall would also be impermeable even under the pressure due to the increased depth of water. In those portions which were composed of clay soil no leakage took place, but under certain portions of the embankment laterite gravel and rock crops up, and there the water found its way through. The remedies proposed and carried out were—

(1.) At 5 or 6 feet from the foot of the revetment a trench from 8 to 9 feet wide was carried down to a little below the original ground surface and filled in with puddle. The soil between this puddle and the revetment was then removed to a depth of 4 feet in short lengths at a time, and also filled in with puddle, the whole of the excavated earth being then placed over the puddle, well watered and rammed. The cost of this was estimated at Rs. 14,595.

(2.) Low retaining walls were built at the foot of the rear slope where the leakage was heavy to prevent slips. The cost of this was Rs. 1,905.

Proceedings, Madras Government, No. 1959, of Aug. 17th, 1870.

7. In November 1871 about 178 feet of the bank of the Red Hills Tank settled slightly, owing, it was supposed, to heavy rain having sunk down to the new earth in the rear of the puddle wall. The settlement was slight and no danger was apprehended.

Proceedings, Madras Government, No. 72, of January 11th, 1872.

8. In October 1872 another settlement occurred* in precisely the same spot, the maximum subsidence being 0·95 of a foot. Exaggerated reports as to the subsidence were current in Madras and excited some alarm, but the Chief Engineer for Irrigation reported (1) that the tank was in no danger of breaching, and that (2) even did it breach, the water would not inundate Madras, but would find its way into the Ennore backwater, some 5 miles to the north of the city. Certain remedial measures were proposed, but before they could be completely carried out very heavy rain again fell and the bank again slipped on October 14th to 18th in the same place. This time the slip was more serious, and the sinking consequently greater. A length of 437 feet was disturbed, the depression being greatest at the two ends, where it was 2·11 feet and 1·41 feet on the north and south sides respectively. The slip was attributed to the use of clay with a large admixture of inferior yellow soapy soil for the bank, together with the absence of a gravel backing that should have been provided to the revetment. A searching inquiry was ordered in Proceedings, Madras Government, No. 3014, of December 18th, 1872, the results of which are given in Proceedings, Madras Government, No. 1926, of August 1st, 1873. A note by Major Scott, R.E., who had been in charge of the works for many years during their construction, is printed therein, which throws much valuable light on the causes of failure. The new work having been raised on the old bank, obviously hung on an inclined plane represented by the back slope of the old bank, so that when the new work settled on being permeated by water under pressure, the old work did not participate in the movement, and dislocation therefore took place,

* Proceedings, Madras Government, No. 2466, of October 19th, 1872.

the line of fracture being along the back slope of the old bank. The failures were favoured by the slippery blue clay which formed the lower part of the backing, as the water would naturally have a tendency to travel along the line of junction of the old and new works, especially if assisted in its passage by the remains of roots of trees, grass, or vegetable soil. Dislocation having once taken place in this way it is easy to see that the addition of earth to make up the bank to its proper level would, by adding to the weight of the mass in a state of unstable equilibrium, tend to renew the slide downwards. This is what actually occurred, the bank continuing to sink as fast as earth was added. The slips were due partly to an error in design and partly to errors in execution. It would have been preferable to provide for the additions to the bank being made on the inner instead of on the outer slope, as the pressure of water would then have held the new earthwork against the old bank. But even if this were not done, as in the case of the work as executed, failure might have been guarded against had the old bank been thoroughly cleared and broken up to ensure junction with the soil added.

9. On December 2nd, 1873, another and very extensive slip occurred,* 1,600 feet north of the Polal sluice, or about half way between it and the slips of the previous year, very heavy rain having fallen during the previous few days and saturated the bank. A quantity of what was described as "utter boggy stuff," which had been covered by sound earth, was exposed. The remedial measures adopted were similar to those previously ordered, viz., the drainage of the fallen mass so as to form a sort of retaining bank, and the reformation of the bank with sound earth.

* Proceedings, Madras Government, No. 238, of February 2nd, 1874.

10. The bank stood well during the heavy rains of October 1874, and was not subjected to any further severe test till 1877, when, on November 17th, a slip again occurred, due† to the saturation of the lower part of the rear of the bund, resulting from the porous laterite subsoil. The drainage of the bank where the slip took place was again ordered.

† Proceedings, Madras Government, No. 38 I., of January 14th, 1878.

The new sluices in the waste weir failed‡ on the same occasion, owing to water working under the covering stones of the vents and forcing them up by hydrostatic pressure. The insertion of these sluices for the purpose noticed in the 7th paragraph of Chapter I had been sanctioned in Proceedings, Madras Government, No. 2322, of August 11th, 1875, at an estimated cost of Rs. 17,100. It was discovered in 1877 that the concrete foundations on which the piers of the vents stood had to a great extent been washed out, having been made of bad material. When the floods had subsided a coffer-dam of earth was put round the sluice-vents pending the preparation of the estimate for all the repairs the tank was held to require.

‡ Proceedings, Madras Government, No. 38 I., of January 14th, 1878.

11. In May 1879, however, a cyclonic storm passed over Madras, the fall of rain being very heavy, with the result that a portion of the coffer-dam was washed away. The breach was with difficulty closed. In passing orders on the papers reporting this occurrence, Government signified a desire§ to have complete information on the following points before deciding what further work should be undertaken for the security of the reservoir:—

§ Proceedings, Madras Government, No. 374 I., of July 1st, 1879.

(1.) The cost of draining the rear portion of the bank which had been reported by the Chief Engineer for Irrigation in September 1878 to be still saturated with moisture for a considerable distance.

(2.) The cost of raising the parapet wall of the tank. The top of the bank referred to M.S.L. is 52·31, but there was a dwarf parapet wall of laterite stone at the top of the revetment which made the margin above F.T.L. nearly 7 feet. It was considered that it would add considerably to the safety of the reservoir to raise this parapet to 55·31 along the deeper parts of the tank, and to 54·31 along those parts which are of intermediate depth.

(3.) The cost of repairing the surplus sluices in the waste weir of the tank.
(4.) The cost of rendering the tank bank completely secure from the right wing of the surplus weir to the end of the apparent leakage a short distance south of the Polal sluice by the insertion of a puddle core wall in the bank with a longitudinal drain at the back of the puddle wall, and cross drains to the rear toe of the bund at intervals of from 50 to 75 feet according to the amount of leakage manifested.

Until this information had been furnished it was directed that the surplus sluices should be left unrepaired and the surplus weir kept at its then level of 43·31,* water being retained as near to the F.T.L. of 46·31 as circumstances might indicate to be prudent by means of temporary arrangements, as had been done since the first failure of the sluices in 1877.

* The crest of the weir had been lowered temporarily to 43·31 in November 1877.

12. The preparation of the estimates required by Government as mentioned above involved borings being made in the bank, and these confirmed the previous evidence of the very mixed character of the material used in the formation of the embankment, and showed moreover that the old as well as the new portion was constructed in a very unreliable manner. In two of the borings water was met with at 22 feet from the top of the bank or at 14 and 12 feet, respectively, below the actual water level, and in one bore hole the water rose to about 6 inches below the water level, indicating a very unsafe freedom of communication between the water in the tank, and the interior of the bank.† This proved very conclusively that a puddle core wall could not be inserted in the bank without first lowering the water level in the tank considerably. Nor did it appear at all certain that the insertion of a puddle wall would be sufficient to stop the leakage. Its effect would be to cut off all but subsoil leakage from the bank behind it, and such leakage might, it was evident, be disposed of by means of drains. But the front part of the bank would still remain in its then condition, *i.e.*, in some parts of the consistency of butter, and settlements might therefore take place at any time which would involve the rupture of the puddle wall and admit water to the rear part of the bank. It seemed, therefore, that nothing less than the formation of a properly constructed bank inside the existing bank at the places where the latter was rotten could render the tank secure, and to carry this out it would have been necessary to empty the tank and to keep it empty for many months. But to do so, and by so doing to cut off the supply of water to the city of Madras, was out of the question, even had the necessary supply of material been forthcoming, which was not at all certain.

† Proceedings, Madras Government, No. 406 I., of June 24th, 1880.

Whatever remedial measures might be ultimately adopted, it was certain, however, that transverse drains under the unstable portion of the bank would have to be inserted, and in view of the above-mentioned difficulties it seemed advisable to see first what would be the effect of these. It was considered possible that they would so far induce consolidation of the bank as to allow of a connecting longitudinal dry stone wall being inserted on the line of the inner ends of the drains, which would have the effect of securing freedom from water to all the rear part of the bank, and to ensure its stability. The result would then be a front part of the bank not much, if at all, altered in condition, and a rear part so arranged as to afford the front part adequate support; between this support in rear and the water pressure in front practical stability might be found to exist.

13. In accordance with the above recommendations the following estimates were sanctioned in Proceedings, Madras Government, No. 406 I., of June 24th, 1880 :—

		Rs.
(1.)	Parallel drain in rear of south part of bank	90
(2.)	Fifty transverse drains in bank	6,000
(3.)	Longitudinal drain and dry stone wall	8,200
(4.)	Channel to lower the water level of pool in rear of bank to 21·00.	300
	Total ...	14,590

14. The following is a copy of the specification for carrying out the above works :—

"*Transverse drains.*—These drains will start at the level of 21·00, at which level the sole of the drains at their outfall will throughout be fixed at all places at which there is a pool or lower ground in rear of the bund. Where the ground level is higher than 21·00 a drain parallel to the bund will be cut along low ground not less than 30 feet from the toe of the rear slope with a fall of 1 foot* in 10 chains starting with the level of 21·00 at the lower end. The head of this drain to have a width of bottom of 1 foot and side slopes of 1 to 1. The bottom width to increase by 6 inches at the end of every 10 chains, *i.e.*, at 10 chains from the head it will be 1½ feet wide, at 20 chains 2 feet wide, and so on. The soles of the transverse drains at their outfall will be 0·50 foot above the bottom of the parallel drain. All open transverse drains to have a fall of 1 in 330.

* 8 feet a mile.

"All drains filled with stone to have a fall of 1 in 30. The transverse drains under the bund to be run into a line 22½ feet from the rear face of the bund parapet. As the lengths and starting levels of these drains will vary, so will the sole level at the inner end.

"2. *Excavations for transverse drains.*—These drains outside the toe of the bund to be 1½ feet wide at bottom with side slopes of 1 to 1.

"The cuttings into the bund to be at right angles to its alignment and to be 3 feet wide. Taking the rear slope as on the average 2 to 1, the cutting will be about 3 feet deep at 6 feet deep from its commencement, and, so far, the sides may be left unsupported. All the cutting beyond this to be supported by close planking with struts or distance pieces at 6 feet apart horizontally or in the direction of the length of the plank, and vertically according to circumstances.

"The simplest arrangement will be to lay the planks parallel to the sole of the drain. As soon as about 30 feet in length of the cutting for a drain has been completed down to sole level, the stone for the drain should be laid in and handpacked. This stone should be in irregular roundish lumps, 4 to 6 inches in diameter. Turf sods should be laid vertically at the sides, with the grass next the stone, and on removing the planks the space left vacant should be filled in with good soil well tamped. The stone to be covered in with turf sods, grass downwards, and the bund reformed to section, the planks being removed one by one as the filling in progresses; the soil to be carefully tamped in 3 or 4 inch layers. The stone at the end of each length of drain thus formed to be protected from being obstructed by the earth by a plank placed vertically against the stone and edge of turf; this plank will be removed when the next length of stone is about to be laid down.

"Should much water be met with as the cutting progresses, the drain should be laid in with stone, and the bund reformed over it in shorter lengths, say of 10 feet, so as not to leave any greater length open at one time than can be quickly closed and completed, should the adjacent soil show signs of being washed out by the water. The width of the cutting being only 3 feet it is probable that the face of the bund at its end, which may be cut at a slope of ¼ to 1, will stand without support, but preparations must be made for supporting it by short pieces of plank, with cleats fastened to the side planking if necessary. All the planks will be 2 inches thick, so these planks for the face should be 2 feet 7½ inches long, and wedges should be driven between the ends and the side planking to hold the short planks until the cleats have been fixed.

"3. *Longitudinal dry stone wall.*—On the completion of cutting for a transverse drain, it will be seen what the nature of the bund at this point is, as also whether water finds its way through only at the bottom or at points above the level of the drain. It will then be determined whether a longitudinal dry stone wall is to be inserted or not. If this be ordered the excavations for it will be made in lengths of 10 or 12 feet at a time, on either side of the head of the transverse drain, commencing from the top of the bund, with a lining of close planking on either side of the trench and struts. The trench to be 3 feet wide down to the level of the surface of the natural soil or ground level, below which a width of 2 feet will suffice. The bottom of the wall to be laid at 23·00, except where original ground level is reached at a higher level, in which case it will be not less than 2 feet below ground level, the exact depth being determined from the nature the soil which, if porous, will necessitate excavation being carried lower. The wall will be in some cases founded lower than the head of the transverse drain. The dry stone wall will not be a necessity where the bund above the level of the transverse drain is water-tight and its height may be according to circumstances, viz., to the level at which the bund is good and water-tight. It may therefore be anything from the 2 feet of a simple longitudinal drain to that which would approximate to F.T.L. Generally it may be considered unlikely that it will need to be carried much above the surface of the old bund, but in all cases it should cut off from the bund in rear all water passages, so that the rear of the bund may be left dry and stable.

"4. *Order of execution of work.*—The longitudinal open drain in rear of the bund must be completed before the transverse drains having an outfall thereinto are commenced. The transverse drains into the bund must be formed before a longitudinal drain or a longitudinal dry stone wall is put in because the transverse drains are required to carry off all water tapped or met with in excavating for the L drain or dry stone wall. The excavations for these latter are to be so arranged as to afford uninterrupted drainage to the transverse drains on either side. Care to be taken that the heads of the transverse drains are not choked by silt from the excavations.

"5. *Drainage of pool in rear of bund.*—Arrangements are to be made by an outfall channel to keep the water level down to 21·00 as a maximum, and to this end the sole of the outfall channel at its head must not be higher than 20·50 and it may have to be lower. On the plan (tracing), dated 2nd September 1879, of the tank there is a drainage from the pool marked, but there is nothing to indicate that it is effective, and it is not shown as running into any channel which would carry the water away."

15. A report regarding the works as executed is contained in Proceedings, Madras Government, No. 307 I., of May 10th, 1881. From these it appears that 50 transverse drains and about 1,000 running feet of longitudinal drain had been completed, but that the 2,000 running feet of dry stone wall allowed for in the original estimate had not been found necessary, the longitudinal drain being found on examination of the interior of the bund to fulfil the required purpose. The cost of the works was therefore reduced to Rs. 9,800.*

* Proceedings, Madras Government, No. 498 I., of August 6th, 1881.

The parapet wall, the raising of which had been recommended as stated in paragraph 11, had been completed at a cost of Rs. 2,384. The Chief Engineer for Irrigation, who inspected the tank in November 1881, remarked that: "the transverse drains which have been inserted in the bank have acted well, but until the water has risen to somewhat above F.T.L., their sufficiency must not be taken for granted." The weir crest was then only at 43·31 or 3 feet below F.T.L., being so maintained as a measure of precaution pending the completion of the surplus sluices. Provision for this has been included in the revised estimate for the project printed in Proceedings, Madras Government, No. 849 I., of December 9th, 1881.

16. The dangers to which the Red Hills Tank has been exposed, and the difficulties that have been experienced in meeting them as summarised above, afford a very valuable precedent to Engineers engaged on similar works, and it may be well to point out briefly the causes of the difficulties that have arisen and the precautions that should have been originally taken.† Unfortunately the mistakes of the past are hardly capable of being entirely remedied in the present. The slips that have occurred at several points were undoubtedly due to water getting into the bank, whether at points above ground surface or through sub-soil leakage has not been very clearly ascertained, but probably both. The origin of the leakage is to be found in the omission to provide—(1) an adequate puddle wall in the first instance, (2) for the freedom from soakage of the base of the rear slope, while (3) the widening of the bank was made on both sides instead of only on the tank side, and (4) the puddle wall was placed in rear of the revetment and its backing, but was carried down only into the foreshore of the old bank instead of below original ground level; its thickness and height were likewise inadequate. Seeing that much of the old bank was founded on porous laterite, it is probable that no puddle wall placed as above mentioned would have been fully effective, for water would have been liable to pass through the sub-soil and to come to the ground surface under the bank The proper arrangements would therefore have been—

† Inspection Notes of the Chief Engineer for Irrigation, dated September 30th, 1878.

(1.) To have aligned the enlarged bank so that all, or nearly all the necessary widening should have been on the tank side of the old bank.

(2.) To have placed the puddle wall on about the centre line of the new bank with its foundations 4 or 5 feet as a minimum below original ground level.

(3.) To have constructed a longitudinal drain at ground level immediately in rear of the puddle wall, with cross drains at intervals, to carry leakage away to the rear of the bank. These precautions, if carried out at the time, would not have added much to the cost, and so arranged the bank would have been perfectly stable.

(2.) *Cholavaram Tank.*

17. The circumstances as regards the Cholavaram Tank have been very similar to those of the Red Hills, though in a minor degree. The bank of the Cholavaram Tank slipped badly for a length of 80 feet and to a less extent for a length of 112 feet more near the south end, commencing at a point about 900 feet north of the head-sluice to the delivery channel, after the heavy rains of October 1870.

No water was found in the bank, and it was therefore considered* probable that the slip was not due to any percolation of tank water, but to the rain having found its way down the cracks to the lower part of the new bank, which in settling might have been pushed outwards by the rear slope of the old bank. The remedies consisted in—

* Proceedings, Madras Government, No. 2774, of November 18th, 1870.

(1.) Making transverse cuts 3 feet wide down to 3 feet below the level of the water in the rear of the bank, and filling these in with large lumps of laterite;

(2.) Cutting a longitudinal trench from end to end of the slip in rear of the bund, also to a depth of 3 feet below the water level, and in this building a dry stone wall 6 feet high, with width of base 6 feet, and of top 3 feet, the batter being towards the rear of the bank. The face of this wall at the original ground level was on a line with the toe of the rear slope of the bank where undisturbed. The soil below this wall was well consolidated, that over the transverse cuts being also carefully filled in, so as to give additional support to the wall.

(3.) The earth of the slip was consolidated by means of rammers, and stepped so as to give a firm base for the new earth required to bring the bank to section.

(4.) The bank was raised to the height at which it stood before the slip occurred, the new† earthwork being removed from the back to the front of the old bank, and the rear slope brought to section. The cost of these repairs, charged as new work, was Rs. 30,675.

† Paragraph 5 of Major Scott's Memorandum in Proceedings, Madras Government, No. 1926, of August 1st, 1873.

These precautions proved successful, and during the monsoon of 1871 no further signs of failure were apparent.

18. But during the rains of 1872, when as stated in paragraph 3 the Red Hills bank slipped, the Cholavaram bank also slipped at a point a short distance to the north of the slip of 1870. The portion then repaired continued to stand well, and the new slip was considered‡ to be due to the nature of the soil, a light-colored clay of the regur class, of which the new bank was composed at that point. The portion that had slipped was cleared away, and new soil was in process of being added when the continuation of the slip was announced§ and a full report on the preventive measures to be adopted was called for. Slight slips occurred at the same spot in 1873, but these were not of much importance and were considered‖ to be due rather to the evaporation of the water used in remaking the bank than to leakage through the bank. It was eventually decided¶ to reform that portion of the bank which had slipped by advancing it 33 feet in the same way as had been done by Major Scott for the first slip of 1870. The estimate for this re-formation amounted to Rs. 30,675** and was sanctioned in Proceedings, Madras Government, No. 271, of February 4th, 1874.

‡ Proceedings, Madras Government, No. 1926, of August 1st, 1873.

§ Proceedings, Madras Government, No. 3014, of December 18th, 1872.

‖ Proceedings, Madras Government, No. 1045, of April 23rd, 1874.

¶ Proceedings, Madras Government, No. 2876, of November 27th, 1873.

** Actual cost Rs. 29,832.

19. The Cholavaram Tank bank stood very well during the heavy rains and floods of October 1874, only a small general settlement occurring§ where the bank had been turned over, and as it has given no further cause for anxiety since that date it may now be considered as stable. When inspected by the Chief Engineer for Irrigation in November 1881, although reported as "by no means in good order," this referred solely to the general condition of the bank, which ordinary repairs would suffice to put right, and not in any way to the sinking of or leakage through the bank, both of which have now quite ceased.

†† Proceedings, Madras Government, No. 2011, of July 15th, 1875.

CHAPTER IV.

THE TOWN SUPPLY OF MADRAS.

THE town supply and the principal phases of the history of the project are naturally so intimately connected that a good deal concerning the former has inevitably been stated in Chapter II. The circumstances with regard to it may now be amplified and completed so far as the records of the Irrigation Office render possible, but it must be premised that as the Public Works Department has nothing to do with the supply when once it has left the Red Hills Tank, the account must necessarily be confined to statements of the volumes supplied, the price paid, and so on, and cannot go into the details of distribution.

2. In Mr. Fraser's original scheme 40 million cubic yards* constituted the Municipal share of the assumed total additional supply of 100 million cubic yards.† The population of Madras was then supposed to be 470,000,‡ and assuming it to be half-a-million, and allowing 20 gallons a day per head, which he stated to be a very liberal allowance, Mr. Fraser found that the required supply was 585,686,295 cubic feet. The difference was to make up for waste, loss by evaporation, special cases of consumption, &c.

* 1,080 million cubic feet.

† 2,700 million cubic feet.

‡ Paragraph 10 of report, but see paragraph 10 of Chapter II, and Note.

3. In preparing its distribution scheme, however, the Municipality preferred to adopt the principle of distribution by gravitation in order to escape the expenditure entailed by the use of steam-power in raising the water and delivering it under artificial pressure. This advantage was necessarily gained by a sacrifice of quantity, the water having, in consequence, to be drawn off from the Red Hills Reservoir at a level 6 feet above that that originally contemplated. The supply available was thereby reduced to 864 million cubic feet, and the question of municipal supply was also affected in another way. There is no doubt that it was not contemplated originally to make any charge for the water supplied, and it was not till the raising of the level§ of delivery of the water, and the consequent loss of 418½ million cubic feet of storage, that the question of payment for water actually delivered arose. This change in level reduced the estimated returns from irrigation under the works to Rs. 53,000, and it was considered that they could not be deemed remunerative unless 7 per cent., or Rs. 56,000, was realised on the then estimated expenditure of 8 lakhs. There was thus a deficit of Rs. 3,000, and it was proposed that this should be met by charging the Municipality the same price as that estimated to be yielded by irrigation, or at the rate of Rs. 7 per 189,000 cubic feet, or 7,000 cubic yards, which was the volume said to be required for the irrigation of one acre. The Government in affirming the proposed charge said that it recognised a prior claim on behalf of the Municipality to 864 million cubic feet per annum.‖ The charge to be made was finally confirmed in G.O., No. 2327, of July 17th, 1869, on letter from the Government of India, No. 126-A.I., of June 25th, 1869, in which it was said that the price would be at the rate of Re. 1 per 1,000 cubic yards or 27,000 cubic feet. No doubt a great mistake was made,¶ from a Public Works point of view, in the wording of G.O., No. 3409, of October 30th, 1868, for it would only have been equitable that the Municipality should have paid for the whole of the 864 million cubic feet (32 million cubic yards) which were reserved for it. But there is also no doubt it was then supposed that the whole volume would be utilised every year, for in all the many calculations of profit that were made at and after this time, Rs. 32,000 were invariably entered among the probable receipts. The population to

§ Paragraph 2 of G.O., No. 2981, of October 21st, 1875.

‖ Proceedings, Madras Government, No. 4309, of October 30th, 1868.

¶ Proceedings, Madras Government, No. 1287, of May 5th, 1875.

be supplied had been shown by the Census returns of 1871 as not likely to exceed 312,000,* the higher number that had been assumed by Mr. Fraser being attributable to the erroneous ideas held as to the number of inhabitants of Madras in 1866.† The 864 million cubic feet were held to be quite sufficient for the wants of 312,000 people, though why that exact volume was fixed upon is not very clear. It appears to have been purely arbitrary, and the reduced supply required might more properly have been assumed at 675 million cubic feet or 25 million‡ cubic yards, which would have allowed an ample margin even for the development of Mr. Clarke's Drainage Scheme, which was prepared in 1875, but which has not yet been, nor is at present likely to be carried out, owing to the inability of the Municipality to provide the necessary funds. Under these circumstances even the reserve of 675 million cubic feet was clearly excessive. In the letter of the President of the Municipality, No. 271 G., of July 21st, 1875, printed in Proceedings, Madras Government, No. 2981, of October 21st, 1875, it is stated that the Commissioners hope by the extension of pipe-laying to reach ultimately a consumption of 20 gallons per head per day for a population of 312,000, or a total of 364·5 million cubic feet per annum, but, it is added, they neither desire nor expect to exceed that consumption to any considerable extent. In the same letter it is stated that the actual consumption was then 9 gallons per head per day for 280,000 consumers. In the report of the President, printed in Proceedings, Madras Government, No 620, of April 4th, 1876, the consumption is said to amount to 920,376 cubic feet (34,088 cubic yards) per diem, equivalent to 20 gallons per head for a population of 280,000 or 12½ million cubic yards per annum. The reason for this sudden increase in consumption is not stated, and there is probably some discrepancy in one of the returns, but at the present time it may be said that the actual consumption is not likely to exceed 12 million§ cubic yards annually, and by G.O., No. 598-A.I., of October 10th, 1879, it was settled that no more water than at present would need to be reserved for municipal use.

* *Vide inter alia* Proceedings, Madras Government, No. 1287, of May 5th, 1875.

† Proceedings, Madras Government, No. 2981, of October 21st, 1875.

‡ Proceedings, Madras Government, No. 2981, of October 21st, 1875.

§ Paragraph 2 of G.O., No. 492 I., of August 5th, 1881.

4. The following table shows the consumption year by year up to end of 1881. Water was first supplied to the Municipality from the reservoir during May to September 1872, but no record of the volume used is extant :—‖

‖ Proceedings, Madras Government, No. 1287, of May 5th, 1875.

Periods.	Quantity in Million Cubic Yards.	Quantity in Million Cubic Feet.
From January 1873 to December 1873 ...	5·25	141·75
From „ 1874 to „ 1874 ...	5·36	144·72
From „ 1875 to March 1875 ...	1·36	36·72
From April 1875 to „ 1876 ...	11·986	323·622
From „ 1876 to „ 1877 ...	5·698	153·846
From „ 1877 to „ 1878 ...	3·428	92·556
From „ 1878 to „ 1879 ...	5·693	153·711
From „ 1879 to „ 1880 ...	5·07	136·89
From „ 1880 to „ 1881 ...	6·006	162·162
From „ 1881 to December 1881 ..	3·835	103·545

5. It was stated in the last paragraph of Chapter II that the total cost of the project has been divided in certain proportions between Imperial and Provincial Funds, and the reasons that led to this division, the proportions adopted, and how they were obtained may now be explained. A brief recapitulation of paragraphs 12 and 13 of Chapter II is necessary as a preliminary. When, in 1873, it was found that the

actual expenditure amounted to Rs. 12,25,558, Rs. 10,17,748 of which had been met from Loan Funds, it was proposed by the Government of India in a despatch to the Secretary of State, No. 27, of February 21st, 1873, to charge only 8 lakhs, the amount of the original estimate, finally against Loan Funds, and to recover the balance from the Ordinary Agricultural and Provincial assignments. This proposal, however, did not meet with the approval of the Secretary of State, who directed in his despatch No. 59, of July 10th, 1873, that no part of either principal or interest of the money laid out on the scheme should be eventually debited to Extraordinary Funds. The Government of India in giving effect to these instructions informed the Government of Madras in letter, No. 854 I., of December 9th, 1873, that it was considered that 2 lakhs of the outlay from Loan Funds should be made good from Provincial Funds, leaving the balance, which then amounted to Rs. 8,17,748, to be met from the Ordinary Imperial grant. The theory, that Provincial Funds should bear the share of the total cost represented by the proportion of the volume reserved for the use of the Municipality to the total volume stored, appears to have been first stated in paragraph 17 of the Note of the Chief Engineer for Irrigation, printed in Proceedings, Madras Government, No. 1548, of June 2nd, 1875. It is there said: "with the town supply Agricultural Funds have properly nothing to do, and Provincial Funds appear to be the only other source from which this share of the cost can be defrayed." The principle being admitted, it only remained to determine the volume of water that had to be reserved for the Municipality.

* Proceedings, Madras Government, No. 21, of January 5th, 1876.

6. The necessary calculation was made in 1876. The total capacity of the two tanks was stated* to be as follows:—

	Millions of Cubic Yards.	Millions of Cubic Feet.
Cholavaram Tank	28·47	768·69
Red Hills do.	101·98	2,753·46
Total ...	130·45	3,522·15

† Proceedings, Madras Government, No. 21, of January 5th, 1876.

and the capacity of the tanks before the commencement of the project having been†—

	Millions of Cubic Yards.	Millions of Cubic Feet.
Cholavaram	3·36	90·72
Red Hills	20·48	552·96
Total ...	23·84	643·68

the additional storage provided amounted to 106·61 million cubic yards or 2,878·47 million cubic feet. One-fifth of the total capacity was assumed as the extra supply during the year, making the total amount stored 156·54 million cubic yards, or 4,226·58 million cubic feet, and the additional amount stored 132·7 million cubic yards, or 3,582·9 million cubic feet. The sill of the lowest municipal pipe being at 31·31, or 15 feet below F.T.L., there remained 20·48 million cubic yards, or 552·96‡ million cubic feet, below this, which in any case would have to be reserved to keep up the town supply. Further, it was found that a head of not less than 3 feet§ above this sill was required to ensure a proper flow down the municipal channel, rendering a further reserve of 11·06 million cubic yards, or 298·62 million cubic feet, necessary. Finally, from certain calculations that had been made of the issues and receipts of water,

‡ 547·917 million cubic feet, according to Col. O'Connell's table given in Appendix A.

§ A head of 6 feet had been decided on as necessary in G.O., No. 2981, of October 21st, 1875, and no authority is quoted for the reduction.

combined with the contents of the tanks at different dates, it appeared that the proportion of issues to consumption averaged 1 to $2\frac{1}{2}$,* so that 12 million cubic yards, or 324 million cubic feet, being the estimated yearly supply required by the Municipality, $12 \times 2\frac{1}{2} = 30$ million cubic yards, or 810 million cubic feet, would have to be reserved for it. Thus altogether $20{\cdot}48 + 11{\cdot}06 + 30 = 61{\cdot}54$ million cubic yards, or 1,661·58 million cubic feet of the additional storage was the total estimated amount required to be reserved for the town, leaving 71·2 million cubic yards, or 1,922·4 million cubic feet, as the average annual amount available for irrigation.†

* The necessity for allowing for evaporation had been strangely lost sight of in all previous calculations. The proportion assumed is very nearly correct—*vide* paragraph 4 of Chapter VI.

† Proceedings, Madras Government, No. 1090, of May 1st, 1876.

7. The total additional supply provided by the works being, as above stated, estimated at 132·7 million cubic yards, the portions reserved for the purposes of municipal supply and irrigation were respectively $\frac{61{\cdot}5}{132{\cdot}7}$ and $\frac{71{\cdot}2}{132{\cdot}7}$, or in round numbers 46 and 54 per cent. This therefore became the proportion in which the shares of Capital and Revenue expenditure had to be divided.‡

‡ It will be shown in Chapter VI, paragraph 6, that the assumption that one-fifth more than the full capacity is received annually is incorrect, and that the additional amount stored is therefore less than 132·7 million cubic yards. The municipal share of the expenditure should properly, therefore, be higher than 46 per cent.

Of the total of the revised estimate, printed in Proceedings, Madras Government, No. 849 I., of December 9th, 1881, amounting to Rs. 18,54,463, the Provincial share is thus Rs. 8,72,358, divided into—

	Rs.
Direct charges	7,36,295
Indirect do.	1,36,063

§ Proceedings, Madras Government, No. 849 I., of December 9th, 1881.

The share of the annual maintenance charges debitable to Provincial is Rs. 3,342,§ so that the charges against Revenue amount to—

	Rs.
Interest on Rs. 7,36,295 at 4½‖ per cent.	33,133
Maintenance charges	3,342
Total ...	36,475

‖ Under recent orders the charge for interest will be reduced to 4 per cent.

Against this the receipts from the Municipality are not likely to exceed ultimately Rs. 12,000, so that the Government contribution to the water-supply of Madras will be but little under Rs. 24,500 a year, and at the present time it is considerably more.

8. The following is a brief description of the arrangements for the conveyance of the town supply from the Red Hills Reservoir to within municipal limits. Mr. Fraser's original proposal was to take the municipal supply channel from the reservoir to the Spur Tank in Madras, and thence through properly prepared filter beds into a covered-in water basin. From this basin, which was to have held three or four days supply, the water was to pass to the pump well, placed at some central point, whence it might have been raised into an elevated cistern, and so distributed to various parts of the city.¶ The area of land to be taken up by the supply channel of this design was 56·2 acres.

¶ Proceedings, Madras Government, No. 1102, of April 11th, 1866.

But this arrangement did not suit the Municipality, which wished to have the water delivered at a higher level, so as to be able to distribute it by gravitation throughout the town, and thus avoid all the expense of pumping. A new line was therefore chosen, which however took up an area of 160·28** acres, and increased the land compensation from Rs. 15,887 †† to Rs. 42,270.‡‡

** 156·98 acres actually taken (Proceedings, Madras Government, No. 849 I., of December 9th, 1881).

‖ Proceedings, Madras Government, No. 492 I., of August 5th, 1881.

¶ Proceedings, Madras Government, No. 849 I., of December 9th, 1881.

9. The water on issuing from the municipal sluice in the Red Hills Tank is discharged into a basin 80 feet in diameter, which is divided by two parallel walls 6 feet apart. The space between was intended to be filled with charcoal, and thus act as a filter, but as this horizontal filtration proved to have no effect whatever on the water, the filtering medium was removed. The water in this basin is usually at a depth of $2\frac{1}{2}$ feet. From the basin the water falls over an ordinary shutter weir into the municipal supply channel. In section, this channel, which is not however very regular, is 6 feet broad at bottom, with side slopes of 2 to 1. The depth from the level of the top of the banks is $7\frac{1}{2}$ feet, so that the extreme breadth between the banks is 36 feet. The depth of flow is $3\frac{1}{2}$ feet. The outside slopes of the retaining banks are $1\frac{1}{2}$ to 1, whether in cutting or embankment. The length of the channel is 6 miles $33\frac{1}{3}$ chains, and the fall being at the rate of 3 inches per mile,* the level of the bed of the channel where it ends is 29·61.†

* The observed velocity is 58 feet per minute.

† The level of the sill of the municipal sluice is 31·31.

The water from the channel is delivered into a circular well 22 feet in diameter, called the masonry shaft. From this well, which is within municipal limits, the distribution takes place. The head available is 29·61 feet, the level of the bed of the channel, *plus* $3\frac{1}{2}$ feet, the depth of water in it, or a total of 33·11 feet above mean sea level. The main pipe from the masonry shaft is 42 inches in diameter and 1,485 yards in length. It there divides into two pipes of 36 and 30 inches diameter, respectively, from which minor offtakes proceed.

10. Large numbers of the inhabitants whose houses are situated in the vicinity of mains have the water brought into their houses. These house services, which are paid for by the house-owners, cost from Rs. 50 to Rs. 200 each, and in some cases as much as Rs. 700. Their adoption is developing, the figures being—

	No.
Up to April 1878	240
To end of April 1878	292
„ of „ 1879	428
„ of September 1880	574

In some cases people have joined together and paid the total cost of the main in their street as well as for the separate house services. The amounts so paid have been as high as Rs. 4,000. The water-tax is at the rate of 4 per cent. on the rental, and the amount allowed is 1,000 gallons for each 4 annas paid, but there is practically no measurement. For public use, cisterns, wall taps, and pillar fountains are employed, the numbers of each being 42, 84, and 113. The cisterns do not answer.

Water for non-domestic purposes is charged 2 annas per 1,000 gallons, and from Rs. 1,200 to Rs. 1,500 yearly is collected from this source.

11. The actual cost of the municipal distribution works has been Rs. 14,30,000 against the original estimate of Rs. 12,80,000—*vide* paragraph 14 of Chapter II. It is universally admitted however that the works need to be improved. An offtake from the Red Hills Reservoir at a lower level, a closed pipe to Madras, and pumping and filtering works, would seem to be what are most required, but the Municipality is scarcely in a position to devote the necessary funds to these objects. A scheme for the improvement of the works was prepared by the Municipal Engineer in 1877, at an estimated cost of Rs. 13,66,334, but no action regarding it has yet been taken.

This account of the municipal works is from the Municipal Engineer's (J. A. Jones, Esq.,) report, printed in Proceedings, Madras Government, No. 1038 W., of April 22nd, 1881.

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CHAPTER V.

THE IRRIGATION UNDER THE WORKS.

The only point that need be noticed with regard to the irrigation under the project is the various estimates that have been formed from time to time of the area that might be irrigated. The point is one that has always been of the highest importance in connection with the works, for on account of the small demand for water made by the Municipality, and the extremely low price at which the supply has been given, the project has always virtually depended on the returns from irrigation to cover the charges for maintenance. Nevertheless, as the project was primarily undertaken for the supply of water to the city of Madras, the volume available for irrigation has of necessity been directly dependent on that which has had to be reserved for municipal consumption.

2. In Mr. Fraser's original estimate 60 million cubic yards* were said to be available for irrigation. This at 7,000† cubic yards per acre, which was Sir Arthur Cotton's allowance, would suffice for 8,571 acres, on which the increased assessment, assumed at Rs. 7 per acre, would amount to nearly Rs. 60,000 a year. The raising of the sill of the municipal sluice in the Red Hills Tank 6 feet (from 25·31 to 31·31), noticed in the last chapter, involved however the sacrifice of $15\frac{1}{2}$ million cubic yards‡ available for irrigation. On the assumptions, that about 53§ million cubic yards would thus be left for use, and that the irrigating duty and water-rate remained as above stated, the probable return was thus reduced to Rs. 53,000.‖

* 1,620 million cubic feet.

† 189,000 cubic feet.

‡ 418½ million cubic feet.

§ 1,431 million cubic feet.

‖ Minute by His Excellency the President in Council (Lord Napier), dated October 1868.

3. The Committee appointed in 1871, (G.O., No. 1518, of June 5th,) to report on the estimates for and the probable return from the works, arrived at a very different calculation of profit. Major Ryves, then Acting Chief Engineer for Irrigation, took¶ 160 million cubic yards as the average quantity of water stored by the tanks in one year, from which he deducted 45 million cubic yards for loss by evaporation, and 32 million cubic yards as the reserve for the town supply, leaving 83 million cubic yards available for irrigation, or enough for about 11,000 acres. The then estimated average area of old wet cultivation was 4,980 acres, so that about 6,000 acres of additional area were expected to be cultivated. The average increased assessment was now however reduced to Rs. $3\frac{2}{3}$, so that the net profit became only Rs. 18,000, thus:—

¶ Proceedings, Madras Government, No. 2171, of August 23rd, 1871.

	Rs.
6,000 acres at Rs. $3\frac{2}{3}$	22,000
Add average remission saved on old wet	7,500
	29,500
Deduct for maintenance ...	11,500
Net profit ...	18,000

4. In 1876 more reliable calculations as regards the amount of water available for irrigation were made, as was stated in the last chapter. The volume that could be depended upon amounted, it appeared, to 71·2 million cubic yards, or 1,922·4 million cubic feet. The former average area of irrigation was now assumed as 3,284 acres, though it is not very clear whence these figures were derived, and on the assumption that the increased water-supply available for irrigation would suffice for an area

Note.—The figures in this chapter, so far as regards acreage and revenue, refer to the project as a whole.

proportionate to that irrigated by the volume contained by the tanks when unimproved, the total area of irrigation was taken at 9,852 acres, giving an increased area of 6,568 acres, which would yield a gross revenue of Rs. 26,272.

The net return thus became :—

	Rs.
Irrigation revenue	26,272
Add average remission	7,500
	33,772
Deduct for maintenance ...	11,500
Total ...	22,272

5. It was not however till the revised estimates were submitted in 1881* that the correct return was calculated. The irrigable area is therein taken at 9,852 acres as above, but the average old cultivation is increased to 3,829 acres, leaving 6,023 as the ultimate increased irrigated area. Of this it is estimated that 4,926 acres will be double cropped, and the ultimate gross receipts are taken at Rs. 24,741. From this maintenance and collection charges have to be deducted. The average maintenance charges from 1870-71 to 1879-80 have been Rs. 8,969, excluding 1871-72 and 1873-74, in which years the outlay was abnormal. From this amount the assumed cost of maintenance of the old tanks, Rs. 1,704,† has to be deducted, leaving Rs. 7,265. This again has to be divided into the proportions of 54 per cent. chargeable to Irrigation or Imperial, and 46 per cent. chargeable to Provincial, for reasons that were explained in the last chapter. The irrigation share is thus Rs. 3,923. To this has to be added the charge for collection at 7·2 per cent. on revenue, or Rs. 1,781, making the total ultimate charge against revenue account Rs. 5,704, and the net ultimate earnings due to Irrigation Rs. 19,037. The revised estimate amounts to Rs. 18,54,463, and the Imperial share of this in the above-mentioned proportion of 54 per cent. is Rs. 9,82,105, divided into—

	Rs.
Direct charges	8,32,944
Indirect charges	1,49,161

The estimated return from irrigation therefore amounts to 2·28 per cent. on Direct charges, and to 1·9 per cent. on Direct and Indirect charges.

6. The last year for which actual figures are available is 1879-80, and then the irrigated area under first crop was 2,648 acres, and under second crop was 2,769 acres. The gross receipts were Rs. 12,149, the maintenance charges were Rs. 3,441, and the collection charges Rs. 875, total Rs. 4,316, leaving Rs. 7,833 as the net receipts.

7. A description of the irrigation sluices has been given in Chapter I. The following is the description and cost of the conservancy establishment maintained for the works :—

		Rs.
1	Superintendent	25
1	Do.	15
4	Lascars at 7 rupees	28
2	Do. at 6 "	12
4	Do. at 5 "	20
	Total per month ...	100
	Total per year ...	1,200

* Proceedings, Madras Government, No. 849 I., of December 9th, 1881.

† Works, at 10 per cent. on average old revenue 1,311
Establishment, &c., at 30 per cent. on works 393
Total ... 1,704

Proceedings, Madras Government, No. 2650, of October 2nd, 1876.

CHAPTER VI.

HYDRAULIC DETAILS.

It will be sufficient to confine the hydraulic information to be given in this chapter to that which concerns the Red Hills Tank, which is by far the largest and most important of the two reservoirs. Colonel O'Connell's tables of area and contents at ½ foot intervals for the Cholavaram Tank are however given in Appendix C, as well as the corresponding information for the Red Hills Tank in Appendix B.

In addition to these tables the Monthly Statements of Receipts and Issues have been abstracted for the last five years in Appendix A, and after having first briefly explained how the abstract has been prepared, the conclusions to be drawn from it will then be summarised.

2. Colonel O'Connell's tables for the Red Hills (Appendix B) only show the difference of area and contents at each half-foot, but for the purposes of Appendix A it has been assumed that for each half-foot the differences between each 0·1 of a foot proceed in arithmetical progression. On this basis the contents at the levels shown in column 2 for the beginning of each month and in column 8 for the end of each month have been calculated and are therefore approximately correct to 0·05 of a foot. The method adopted does not give absolutely correct results, but is accurate enough for all practical purposes.

Similarly columns 16 and 17 show the areas corresponding to the contents in columns 3 and 9. Columns 4 and 5 show respectively the receipts through the supply channel and by means of rainfall. The former are obtained by direct measurement of the depth of water passing over the sill of the head-sluice in Cholavaram Tank ; the latter by deducting these from the total receipts as calculated by the differences of water level. Column 6 shows the total receipts, and column 7 the sum of these receipts and of the volume in the tank at the beginning of the month.

Column 10 shows the loss during the month, *i.e.*, the difference between the above sum and the volume in the tank at the end of the month.

Columns 11 and 12 show the issues during each month to Irrigation and to the Municipality respectively by direct measurement.

Column 13 shows the total of these, and

Column 14 the difference between this and the total loss, which is therefore the loss due to evaporation and overflow.

Column 15 gives the proportion that the total volume lost bears to the total volume issued.

Column 18 gives the *mean* area of the tank during the month.

Column 19 shows the total depth over the mean area lost by evaporation during the month, and lastly

Column 20 shows the average depth evaporated daily.

3. The figures entered as above stated show discrepancies here and there; as for instance in June 1877 when the total at the end of the month is more than the sum of the receipts and of the volume in the reservoir at the beginning of the month ; or as in December 1879, when the difference between the beginning and the end of the month is less than the consumption. But in a long series of somewhat elaborate measurements which cannot be constantly checked by a responsible officer, it is inevitable that some such discrepancies should occur, and they are not numerous enough to prejudice the general accuracy of the results.

Again, as the discharge over the weir and through the weir vents has not been gauged, no calculation has been made as regards the amount of evaporation for those months in which surplus is discharged. This removes to a certain extent the monsoon months—October, November, and December—from the calculations, to which may be added September, when heavy rain often falls.

The general result obtained is however as follows.

That in the five years the average daily evaporation is 0·28 of an inch, and as the average mean area is 149·5026 million square feet, it would result that the average daily loss by evaporation is 3·4884 million cubic feet.*

* But see next paragraph.

The average result month by month is as follows :—

How obtained.	Average daily evaporation. INCHES.
From four Januarys	0·24
„ two Februarys	0·24
„ five Marchs	0·26
„ five Aprils	0·3
„ five Mays	0·37
„ four Junes	0·3
„ four Julys	0·33
„ five Augusts	0·32
„ one September	0·38
„ two Octobers	0·27
„ one November	0·27
„ two Decembers	0·13

Taken as a whole these results accord very fairly with what might be expected, the evaporation increasing gradually up to the hot months and then gradually subsiding. The figures for September, for which it has been possible to make only one calculation, are undoubtedly too high.

4. The statement further shows that the proportion the average volume lost bears to the average volume used is as high as 5·8 to 1, but this includes 1877 when the issues to irrigation were stopped for some months and those to the Municipality were very limited owing to the low level of water in the reservoir, and when therefore the issues in each case were very much below the average (see below). Excluding 1877 this proportion that the volume lost bears to the volume used is 2·888 to 1.

The average receipts during the five years were :—

	Million Cubic Feet.
From Supply Channel	889·2994
Rainfall	627·7973
Total ...	1,517·0967

The average issues were—

	Million Cubic Feet.
To Irrigation	405·591
„ Municipality	131·8222
Total ...	537·4132

The proportion of average issues to average receipts is thus 1 to 2·82, which shows a very close agreement with what is practically the same proportion last given. The proportion issued to the Municipality to that used for Irrigation is as 1 to 3·07.

The difference between the receipts and issues *should* represent the loss by evaporation *plus* the discharge over the weir. This difference is on the average 979·6835 million cubic feet a year, while the average evaporation obtained from column 14 of Appendix A is 913·4078 million cubic feet. This leaves 66·2757 million cubic feet as the average yearly surplus discharge. The average yearly evaporation as last given represents a daily evaporation of 0·208 of an inch as against 0·28 of an inch as given previously. From this the general conclusion may be derived that the daily loss of depth due to evaporation is over 0·2 of an inch and under 0·3. Probably one-quarter of an inch might be assumed with fair accuracy.

5. The following figures show the quantity of water draining into the tank after a heavy fall of rain. They are obtained from Colonel O'Connell's report on the cyclone of May 1877, printed in Proceedings, Madras Government, No. 38 I., of January 14th, 1878. This is the only occasion on which observations have been made on

this interesting point, and though results of a like nature might be deduced from the figures given in Appendix A, it is not considered that the conclusions so derived would be sufficiently reliable to be of value. In calculations of this sort, a somewhat near approach to accuracy is essential, and this can scarcely be considered as attained, unless observations have been specially taken with reference to the object in view.

The rainfall at the Red Hills Tank during the cyclone of May 1877 was :—

	INCHES.
On May 17th	1·00
Do. 18th	12·03
Do. 19th	4·88
Total ...	17·91

The rise in the surface of the water during this cyclone was entirely due to the drainage from the catchment basin of 23 square miles, which includes the area of the reservoir itself.

The rise and the corresponding drainage are shown in the following table :—

Date.	Level of water surface at 6 A.M.	Corresponding volume in million cubic feet.	Daily difference of level of water surface in feet.	Additional volume entering reservoir.		Drainage in inches over catchment of 23 square miles, which includes reservoir, represented by column 5.
				Per day in million cubic feet.	Cubic feet per second.	
1	2	3	4	5	6	7
May 17th	27·30	253·6886	...	...	..	...
Do. 18th	30·95	517·0018	3·65	263·3132	3,047	4·92
Do. 19th	34·25	838·0862	3·30	321·0844	3,766	6·009
Do. 20th	34·79	921·3674	0·74	83·2812	964	1·56

The quantity draining off in the three days amounts to a total of 12·489 inches. Water continued to run slowly off the catchment basin for nearly a week after the rain had ceased to fall, but the total quantity thus run off did not exceed one-third of an inch, so that the total quantity run off fell short of 13 inches. Taking each day separately the figures in column 7 for the 18th and 19th of May give coefficients of discharge of 377 and 466 respectively for Ryves' formula

$$D = CM^{\frac{2}{3}}$$

and co-efficients of 290 and 359 respectively for Dickens' formula

$$D = CM^{\frac{3}{4}}$$

It is more than probable however that these co-efficients are too small to represent the maximum discharge, which, especially in the case of cyclonic rain, would doubtless considerably exceed the average discharge from which they are obtained.

The table shows that the average rate at which the rain was discharged from the drainage basin between the 18th and 19th of May was 6·009 inches per diem.

The figures given above furnish the nearest reply possible to the information asked for in paragraph IV (V) of Circular No. XXX, dated September 24th, 1880, from the Government of India. The percentage which the volume stored bears to the volume falling on the catchment area, excluding that of the reservoir, after certain recorded falls of rain is there referred to. But accurate information on this point is almost impossible to obtain except in the case of a very small catchment. In the case of a large area no reliance could be placed on the results unless the rainfall were registered at several stations. In the instance given it has been supposed that the whole of the rain that fell was stored, but if the registered rainfall at the reservoir of 17·91 inches was taken over the whole catchment, the percentage stored would be 69.

6. The following figures comparing the average consumption for irrigation and municipal use with the storage reserved will be of interest.

The capacity of the reservoir when full is 2,744·8911 million cubic feet, of which 2,191·9311 are increased capacity due to the improvements. This increase divided in the proportions of 54 and 46 as explained in Chapter IV gives 1,183·6428 million cubic feet as reserved for irrigation, and 1,008·2883 for municipal use. The average annual consumption in each case given in paragraph 4 above is therefore 34·2 per cent. and 13 per cent. of the reserve respectively.

But it is to be observed that the proportions in which the whole volume is divided do not appear to be correct. It was assumed in making the calculation, as explained in paragraph 6 Chapter IV, that ¼ more than the whole contents of the reservoirs was annually stored, but from paragraph 4 above it appears that the average annual volume stored in the Red Hills Reservoir, which may be taken as representative, is only 1,517·0967 million cubic feet, or 69 per cent. of the whole capacity of the reservoir. As, however, the level of the water is never supposed to fall below 34·31, it would be sufficient to assume the full reservoir as the volume annually available, and the average amount actually reserved for Municipal use would then be :—

	Million Cubic Feet.
Volume below *34·31 ... ... =	851·58
†2·888 times average consumption	380·70
Total ...	1,232·28

† Paragraph 4 above. * *Vide* paragraph 6 of Chapter IV.

which is rather more than 56 per cent. of the increased capacity. This therefore leaves only 44 per cent. of the storage available for irrigation, and the proportion of volume used to volume reserved becomes 42 per cent. for irrigation and 10·7 per cent. for municipal use.

7. This Monograph is followed by three Appendices—

APPENDIX A.—Statement of Receipts and Issues of the Red Hills Reservoir from 1877 to 1881.

" B.—Colonel O'Connell's Tables of Area Contents at Half-foot intervals for Red Hills Reservoir.

" C.—Colonel O'Connell's Tables of Area Contents at Half-foot intervals for Cholavarum Reservoir.

Also by two plates—

PLATE I.—Catchment Basin of System.

" II.—Component Works of System.

June 1882.

(Signed) C. VINCENT,
for Chief Engineer for Irrigation.

Statement

ration.

Months.	Water Level in Reservoir at beginning of Month.	Corresponding Volume.	Receipts during Supply Channel.	Receipts during Rainfall	Evaporation in Inches over Mean Area during Month, Column 14 ÷ Column 18.	Average Daily Evaporation in Inches.	Remarks.
1	2	3	4	5	19	20	21
1877.							
January ..	30·65	488·571	..	..	7·52	0·24	The discharge over the weir and through the weir vents not having been gauged, and the weir moreover having been breached in November 1877, the figures for those months in which surplus water was discharged are valueless. The fact of discharge is noticed in each case when recorded.
February ..	29·81	424·8108	..	..			
March	29·02	363·1727	..	..			
April	28·35	318·1883	..	..	9·6	0·34	
May	27·49	266·8321	119·583	705·1611	7·59	0·24	
June	36·33	1,083·267	221·1	..	8·85	0·29	
July	38·07	1,327·943	..	..	20·53	0·66	Cyclone. { Rainfall on 17th 1 inch. Do. 18th 12·03 inches. Do. 19th 4·88 do.
August	37·07	1,188·8481	..	..	..	..	
September ..	36·4	1,096·295	..	..			
October ..	38·26	1,342·1912	18·1696	..			
November ..	42·6	2,049·3403	26·65	..	11·35	0·36	
December ..	42·84	2,074·6947	756	·54	7·74	0·25	
Totals ..	416·89	12,518·1342	1,141·5036	925·077	..	..	
Averages ..	34·74	1,001·5111	..	..	..	..	The waste weir was breached.
1878.					76·94	2·51	
January ..	43·28	2,162·054	..	..	3·62	0·21	
February ..	42·31	1,988·8038	9·311	..			
March	42·78	2,074·6947	..	..			
April	41·77	1,904·3838	..	..	8·58	0·27	
May	40·36	1,675·7727	..	..	..	..	
June	39·39	1,519·7741	..	10·687	6·45	0·2	
July	38·08	1,327·943	..	..	10·19	0·34	
August	37·46	1,243·6927	..	114·036	7·13	0·23	
September ..	37·04	1,175·3677	..	103·836	9·07	0·3	
October ..	41·89	1,921·2688	605·197	322·844	12·43	0·4	
November ..	42·66	2,067·5175	127·27	161·263	12·30	0·39	
December ..	42·88	2,092·1666	208·656	..	11·28	0·38	
Totals ..	489·0	21,143·3444	950·4340	712·666	7·59	0·25	
Averages ..	40·82	1,761·9453	..	..	8·34	0·27	
1879.					4·40	0·14	
January ..	42·22	1,971·9238	..	17·235	97·96	3·17	
February ..	41·54	1,854·5978	..	..	8·51	0·29	
March	40·89	1,756·1746	219·033	19·57			
April	41·36	1,838·0025	..	..	7·92	0·26	
May	40·26	1,659·7492	..	115·923	3·65	0·13	
June	39·96	1,612·6915	..	..	7·01	0·22	
July	39·06	1,474·48	..	73·046	6·25	0·21	
August	38·49	1,385·7281	12·15	34·984	7·48	0·24	Cyclone; rainfall on 20th, 3·75 inches.
September ..	38·38	1,371·1188	6·917	..	6·99	0·23	Do. on 21st, 0·5 do.
October ..	41·66	1,887·7885	..	260	8·2	0·27	
November ..	43·45	2,179·9788	..	852·719	2·81	0·09	
December ..	43·16	2,144·5821	..	..	..	..	Surplus over weir on 31st.
Totals ..	490·43	20,136·7167	238·100	1,374·177	..	..	Do. almost throughout the month.
Averages ..	40·87	1,678·0596	..	..	..	..	
1880.					50·34	1·64	
January ..	43·02	2,1 9·6384	..	27·446	6·29	0·205	
February ..	42·29	2,005·086	..	..			
March	42·06	1,895·0383	..	..			
April	41·03	1,788·7909	..	..	5·08	0·49	
May	39·23	1,606·3	..	..	6·13	0·16	Evaporation for this month evidently incorrect, so omitted from averages.
June	36·09	1,068·1006	..	..	9·05	0·30	
July	36·89	1,096·295	..	..	11·4	0·36	
August	35·85	998·0587	690·62	24·32	12·74	0·45	
September ..	37·11	1,188·8481	..	8·3	..	..	
October	36·95	1,161·8872	947·194	54	5·71	0·15	
November ..	44·24	2,326·6845	144·886	..	..	..	The loss by evaporation is so high that the figures are evidently wrong, and the averages are therefore not taken.
December ..	472·51	18,536·5332	1,782·68	114·066	..	..	Difference (Column 19) less than consumption. Discrepancy not explained.
Totals ..	39·37	1,544·5948	..	..	..	..	Surplus over weir on 28th, 29th, and 30th.
Averages ..	43·8	2,251·6779	..	..	31·89	1·07	Surplus over weir on several days.
1881.					9·64	0·29	
January ..	43·74	2,233·7531	..	..	..	..	
February ..	43·17	2,113·5321	..	..			
March	42·28	1,971·9238	..	..			Surplus over weir throughout the month.
April							

Appendix B.

RED HILLS TANK.

Table showing Water Surface, Areas, and Cubical Contents at half foot vertical intervals up to crest of new Calingulah.

Height above Mean Sea Level.	Difference of Area for each half foot.	Area at Level in Column 1.	Difference of Cubical Contents at each half foot.	Contents at Level in Column 1.
1	2	3	4	5
FEET.	MILLION SQ. FT.	MILLION SQ. FT.	MILLION C. FT.	MILLION C. FT.
22·31		25·503		25·5015
22·81	3·847	29·350	13·6970	39·1985
23·31	4·117	33·467	15·6873	54·8858
23·81	4·387	37·854	17·8125	72·6983
24·31	4·657	42·511	20·0729	92·7712
24·81	4·927	47·438	22·4682	115·2394
25·31	5·197	52·635	24·9987	140·2381
25·81	2·160	54·795	26·8557	167·0938
26·31	2·203	56·998	27·9465	195·0403
26·81	2·247	59·245	29·0590	224·0993
27·31	2·290	61·535	30·1932	254·2925
27·81	2·334	63·869	31·3491	285·6416
28·31	2·377	66·246	32·5267	318·1683
28·81	3·459	69·705	33·7912	351·9595
29·31	3·548	73·253	35·5329	387·4924
29·81	3·635	76·888	37·3184	424·8108
30·31	3·723	80·611	39·1477	463·9585
30·81	3·811	84·422	41·0208	504·9793
31·31	3·899	88·321	42·9377	547·9170
31·81	3·580	91·901	45·0528	593·9698
32·31	3·651	95·552	46·7604	639·7302
32·81	3·722	99·274	48·5036	688·2338
33·31	3·792	103·066	50·2824	738·5162
33·81	3·864	106·930	52·1968	790·6130
34·31	3·935	110·865	53·9468	844·5598
34·81	4·177	115·042	56·4762	901·0360
35·31	4·255	119·297	58·5842	959·6202

Table showing Water Surface, Areas, and Cubical Contents at half foot vertical intervals up to crest of new Calingulah—*cont.*

Height above Mean Sea Level.	Difference of Area for each half foot.	Area at Level in Column 1.	Difference of Cubical Contents at each half foot.	Contents at Level in Column 1.
1	2	3	4	5
FEET.	MILLION SQ. FT.	MILLION SQ. FT.	MILLION C. FT.	MILLION C. FT.
35·81	4·332	123·629	60·7308	1,020·3510
36·31	4·409	128·038	62·9160	1,083·2670
36·81	4·486	132·524	65·1398	1,148·4068
37·31	4·564	137·088	67·4022	1,215·8090
37·81	3·542	140·630	69·4592	1,285·2682
38·31	3·587	144·217	71·2414	1,356·5096
38·81	3·631	147·848	73·0462	1,429·5558
39·31	3·676	151·524	74·8736	1,504·4294
39·81	3·721	155·245	76·7236	1,581·1530
40·31	3·767	159·012	78·5962	1,659·7492
40·81	2·835	161·847	80·1173	1,739·8665
41·31	2·859	164·706	81·5407	1,821·4072
41·81	2·884	167·590	82·9766	1,904·3838
42·31	2·910	170·500	84·4250	1,988·8088
42·81	2·934	173·434	85·8859	2,074·6947
43·31	2·960	176·394	87·3593	2,162·0540
43·81	5·723	182·117	89·6239	2,251·6779
44·31	5·815	187·932	92·5083	2,344·1862
44·81	5·906	193·838	95·4841	2,439·6703
45·31	5·997	199·835	98·5513	2,538·2216
45·81	6·088	205·923	101·7098	2,639·9314
46·31	6·180	212·103	104·9597	2,744·8911

APPENDIX C.
CHOLAVARAM TANK.

TABLE showing Water Surface, Areas, and Cubical Contents at half foot vertical intervals up crest of new Calingulah.

Height above Mean Sea Level.	Difference of Area for each half foot.	Area at Level in Column 1.	Difference of Cubical Contents at each half foot.	Contents at Level Column 1.
1	2	3	4	5
FEET.	MILLION SQ. FT.	MILLION SQ. FT.	MILLION C. FT.	MILLION C. FT.
43·68				
44·18	1·147	17·415	9·000	26·123
44·68	1·183	18·562	9·583	35·123
45·18	1·221	19·745	10·184	44·706
45·68	1·257	20·966	10·803	54·890
46·18	1·293	22·223	11·441	65·693
46·68	1·331	23·516	12·096	77·134
47·18	1·284	24·847	12·743	89·230
47·68	1·317	26·131	13·394	101·973
48·18	1·349	27·448	14·060	115·367
48·68	1·382	28·797	14·743	129·427
49·18	1·414	30·179	15·442	144·170
49·68	1·447	31·593	16·157	159·612
50·18	1·241	33·040	16·829	175·769
50·68	1·263	34·281	17·455	192·598
51·18	1·286	35·544	18·092	210·053
51·68	1·309	36·830	18·741	228·145
52·18	1·332	38·139	19·401	246·886
52·68	1·354	39·471	20·073	266·287
53·18	1·194	40·825	20·710	286·360
53·68	1·211	42·019	21·311	307·070
54·18	1·228	43·230	21·920	328·381
54·68	1·245	44·458	22·538	350·301
55·18	1·262	45·703	23·165	372·839
55·68	1·279	46·965	23·800	396·005
56·18	1·532	48·244	24·502	419·804
56·68	1·556	49·776	25·273	444·306
		51·332		469·579

Table showing Water Surface, Areas, and Cubical Contents at half foot vertical, &c.—*cont.*

Height above Mean Sea Level.	Difference of Area for each half foot.	Area at Level in Column 1.	Difference of Cubical Contents at each half foot.	Contents at Level in Column 1.
1	2	3	4	5
FEET.	MILLION SQ. FT.	MILLION SQ. FT.	MILLION C. FT.	MILLION C. FT.
57·18	1·580	52·912	26·058	495·637
57·68	1·604	54·516	26·854	522·491
58·18	1·628	56·144	27·661	550·152
58·68	1·651	57·795	28·481	578·633
59·18	1·520	59·315	29·277	607·910
59·68	1·539	60·854	30·071	637·981
60·18	1·559	62·413	30·875	668·856
60·68	1·579	63·992	31·689	700·545
61·18	1·599	65·591	32·513	733·058
61·68	1·619	67·210	33·347	766·405

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Irrigation.

No. 13.

READ—the following Note by the Acting Chief Engineer for Irrigation, dated Ootacamund, 24th July 1882, No. 68 I. :—

The accompanying Monograph on the Madras Water-supply and Irrigation Extension Project, compiled by Mr. Vincent, under instructions by Colonel Mullins, has been prepared in compliance with letter No. 159 M., dated 23rd May 1881, from the Assistant Secretary to the Government of India, and is submitted to Government.

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Chief Engr. for Irrigation.

To the Joint Secretary to Government, Public Works Department, Irrigation Branch.

No. 14.

ORDER—dated 2nd August 1882, No. 603 I., Public Works.

Ordered that the Monograph on the Madras Water-supply and Irrigation Extension Project be forwarded to the Government of India, with reference to their letter No. 159 M., dated 23rd May 1881.

2. Ordered also that a copy of these Proceedings be forwarded for the information of the Secretary of State.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

To the Chief Engineer for Irrigation.
" Superintending Engineer, Fifth Circle.
" Examiner of Public Works Accounts.
" Financial Department.
" Revenue do.
" Board of Revenue.

No. 15.

ENDORSEMENT—dated 2nd August 1882, No. 604 I., Public Works.

Forwarded to the Government of India.

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

Exd. S. T. Austin.
Spare Copies

IRRIGATION.

Govt. of {1882} Madras

PUBLIC WORKS.

Dated August, 2nd.

Recd. *En*

G.O., 2nd August 1882, No. 6041

AUGUST.

Nos. 13—15.

Madras Water-supply.

Monograph on the — and Irrigation Extension Project.

57

30TH OCTOBER 1882, No. $\frac{45}{2846}$ W., PUBLIC WORKS.

PUBLIC WORKS DEPARTMENT.

LETTER—to

THE MOST HONORABLE THE SECRETARY OF STATE FOR INDIA.

MY LORD MARQUIS,

We have the honor to acknowledge the receipt of your Lordship's Despatch No. 12 (Statistics and Commerce), dated 22nd June 1882, forwarding copies of a Memorandum by the Army Sanitary Commission on the Report of the Madras Municipality for 1880, and directing the submission of a special report with reference to the remarks on the sanitary condition of the district over which it exercises jurisdiction.

2. In reply, we have the honor to forward for your Lordship's information copies of the accompanying papers from the Municipal officers and from our Chief Engineer, reviewing the report of the Sanitary Commission, and explaining the present condition and future prospects of the Municipality in regard to sanitation, conservancy, and water-supply. We would particularly invite attention to Colonel Sankey's Note, the last paper in the series, from which it will be apparent that the delay in grappling with the question of drainage and water-supply of Madras is due, apart from financial considerations, to the engineering difficulties presented by the generally low level of the ground on which Fort St. George and Black Town, with the surrounding far scattered group of villages, collectively known as Madras, are built, and by the tideless character of the sea into which the sewage, if not utilised for irrigation, has to be discharged. These difficulties have hitherto been found to be insuperable, at any thing like a reasonable outlay, notwithstanding the high professional talent which has been employed to surmount them; and looking to the financial condition of the Municipality, it seems utterly hopeless to expect that any really effective remedy of a sufficiently comprehensive character can be applied by that body. It remains therefore to consider whether the Government should come to the aid of the Municipality, and to what extent.

3. The lowest of the approximate estimates framed by the Municipal Engineer, and adopted by our Chief Engineer with slight modifications, is so large in amount that the resources of this Government are wholly inadequate to afford any material aid, having regard to the many pressing demands to be met from Provincial Funds throughout the Presidency.

4. We therefore see no prospect of any complete scheme of drainage and sanitation being carried out, unless the burdens now borne by Imperial and Provincial Funds respectively are readjusted to the advantage of the latter.

Current No 2242/82

From Resident Madras Municipality d/ 4 August 1882.

The Secretary of State's recent Despatch relative to the Army Sanitary Commissioner's remarks upon the Madras Municipality Report of 1880 having been sent to Mr Arundel, that Officer now replies at length to the criticisms.

The papers circulated for perusal pending receipt of a reply from the Chemical Examiner to the

* d/ 22 June 1882 No 12

instruction sent
last April to C.O. 25 April 82
make an analysis No 339 T.R.
of typical speci-
mens of the sub-
soil of the Town
Subdivs. This
information seems
very necessary
for the final dis-
posal of the ques-
tion.

A reminder
has been sent to
the Chemical Ex-
aminer.

Gill

The fact remains after Sr Arundel
has had his say that Madras is one of
the filthiest of civilized Cities.

The introduction of the Octroi would be
a step so fruitful of mischief, in my judgment,
to all South India, that nothing short of
a direct order from Superior authority would
make me consent to it.

It does not follow that because Sr
Arundel sees no help except in an Octroi
some better Municipal financier might not
do so; but I am persuaded that Madras
cannot do its work without help. I would
rent to the Municipality spending £[illegible] an
additional Lac or Lac & a quarter in
Conservancy & make it a considerable grant
in aid for drainage proper. Sr Arundel's

remarks should go home but not without a Report from Govt on the whole subject, explaining what it will cost to make Madras decently clean & healthy, how many years it will require, what yearly provision will have to be given - & so forth.

I think the papers should be handed over to some one who understands engineering work & order him up & submit a report to Govt, which report can if approved by us be submitted to the Sec of State. I would place him (officer on special duty) at his disposal & he should visit & inspect on the spot working &c &c in detail the report

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to be furnished. I would in fact let Secretary of State to decide whether he would authorize an £ — data the loan by the Govts & at what expence make Madras a decent City or whether he would like the Sanitary Commission that Govts must foster on the old way - getting Hawks with better.

MEP

Aug 12/82

All Govt wanted is an addl Municipal revenue of from 2½ to 3 Lacs a year - The Octroi will do it - It produces 6 Lacs, I hear, in Bombay - There is no alternative tax open but - We have a heavy income tax already, & a house tax of 16 percent on annual rental. If fresh taxation, other than the Octroi, is

impossible - I don't trust that the S. of S. will give us leave to have it - How can he refuse, with the Bombay example before him? As to our giving 9 Lacs a year or about that out of Provincial - Just means that every useful branch of the Admin. may look to Govt.

Let Arundel go to Bombay & find out how he does it worked, as this - without the least complaint from Bombay patriots.

II. In regard to the Engineering Report on the town of Madras with K. Ex. the Govr. desires may be made, I believe here is already every information on the subject, in existing Reports - which might however be abstracted into one readable Précis - Colonel Lankey will be able to tell us how this is - & I shd. propose that when Papers be brought by him & the Chancellor into Council - on Thursday 21st. must before Govr. proceeds on tour

Ad. 16/8/2

C. T. W/ 21/8

W/A

65 I. W. Sept.

No.

To,
The Most Honorable
The Secretary of State
for India.

My Lord Marquis,

We have the honor to acknowledge the receipt of your Lordships' Despatch No. 12 (Statistics and Commerce) dated 22nd June 1882 forwarding copies of a Memorandum by the Army Sanitary Commission on the Report of the Madras Municipality for 1880, and with reference to remarks on the sanitary condition

This is a very important Despatch. Have it fair copied with the corrections & additions suggested by me & let us settle it in Council

MEW

of the ~~Presidency Town~~ Madras
the district commonly called the Madras jurisdiction
calling for a special report
on the whole subject.

2. In reply we have the
honor to forward for your
Lordship's information copies
of the accompanying papers
from the Municipal officers
and our Chief Engineer
reviewing the Report of the
Sanitary Commission, and
explaining the present condition
and future prospects of the
Municipality in regard
to sanitation, conservancy
and water supply. We
would particularly invite
attention to Colonel
Sankey's Note, the last
paper in the series, from

which it will be apparent
that the delay in grappling
with the question of drainage
and water supply of the
~~town~~ of Madras is due,
apart from financial
considerations not the least
important of the problems
to be solved to ~~certain~~ the
Engineering difficulties
presented by the generally
low ~~elevation~~ of the ground
on which ~~the Town~~ is built
the ~~scattered~~ nature of the
~~settlement~~ and tideless
character of the sea into
which the sewage, ~~has~~ if
not utilized for irrigation
has to be discharged. These
difficulties have hitherto

Fort St George, Blacktown
with the surrounding ~~few~~ scattered
groups of villages ~~and suburbs~~
collectively known as Madras
are built

Madras if town indeed
is a proper designation for
the group of ~~few~~ scattered
& very poor villages ~~which~~
are inhabited by the bulk
of the population of about
which little is known
is scattered over within the
municipal limits of Madras

been found to be insuperable,
at anything like reasonable
outlay, notwithstanding
2. the high professional
talent which has been
employed to surmount
them - and looking to
the financial condition
of the Municipality,
it seems utterly hopeless to expect
that any really effective
remedy of a sufficiently
comprehensive character
can be applied by that
body. It remains therefore
to consider whether the
Government are prepared
to aid, and to what
extent.
3. The lowest of the

approximate estimate
framed by the Munic
Engineer and adopted
our Chief Engineer wit
slight modifications a
so large in amount th
the resources of the Gove
wholly
-ment are inadequate to
afford any material ai
having in view the many
preseng demands to be
met from Provincial
funds throughout the
Presidency.
4. We therefore see no
prospect of any complete
scheme of conservancy be
carried out unless such
redistribution of the Imp
burdens be made

the burdens now borne by Imperial
& Provincial Funds respectively
are re-adjusted to the advantage
of the latter

has already been
suggested in letter to
Government of India No.
dated
which has been submitted
for your Lordship's consideration -
The most pressing
needs of the Town will
however be attended to
under the scheme which
has been framed by the
Municipal Engineer for
the drainage of Black-
town - but we are very far
indeed from considering that

7/10/82

when that is finished
very much will still
require to be done
as soon as it is in any
way possible to accomplish it.
We are quite aware
that the Sanitation of Madras

To be despatched
with Municipal
Map.

we afraid that [illegible] we
[illegible] not [illegible]
[illegible]

Information [illegible]

campaign is very unfavourably with that
of most civilized capitals of great
cities to remedy a state of things
in which we only acquiesce from
our utter inability to invent the least [illegible]
[illegible] which it is impracticable
to deal successfully with it.

India Office,
London, 22nd June 1882.

Statistics and Commerce,
No. 12

To His Excellency The Right Honourable The Governor in Council, Fort St. George.

SIR,

* 12 by mail; 58 through the Store Department.

Para. 1. I forward 70* copies of a Memorandum by the Army Sanitary Commission on the Report of the Madras Municipality for 1880.

2. The strong remarks made in this paper on the sanitary conditions prevailing in the Presidency town, to which there is apparently no prospect of a remedy being applied by any action of the Municipality, call for the serious attention of your Excellency in Council; and I shall be glad to receive a special report from you on the whole subject at an early date.

I have the honour to be,
Sir,
Your most obedient humble Servant,
(Signed) HARTINGTON.

ENCLOSURE.

MEMORANDUM of the Army Sanitary Commission on the Report of the Madras Municipality for 1880.

1. The year 1880 was not an epidemic year in the south of India, and the town of Madras had only two deaths from cholera, while the small-pox deaths were fewer than those of the preceding year. The following statistics may therefore be assumed as representing more or less accurately the death-rate from local diseases and their causes.

2. According to the census of 1881 the population of Madras was 406,117. Deaths from all causes numbered 14,907, which would give a death-rate on this census number of 36·7 per 1,000.

The following abstract gives the total deaths from the chief death causes in 1880 :—

Diseases.	Total Deaths.
Small-pox - - - -	869
Measles - - - -	105
Fevers - - - -	3,549
Dysentery - - - -	1,516
Diarrhœa - - - -	733
Cholera - - - -	2
Injuries - - - -	123
Other diseases - - -	8,010

The different divisions of the city yielded the following varieties of death-rates :—

Divisions.	Population.	Death-ratio per 1,000.
VI. - - -	19,390	17·2
V. - - -	65,491	31·9
VIII. - - -	41,482	33·9
III. - - - -	52,545	34·4
I. - - - -	65,121	36·6
IV. - - -	9,791	37·6
II. - - -	73,738	38·8
VII. - - -	69,568	39·4

This abstract gives a better idea of the general sanitary state of Madras than does the death ratio taken over the whole area, but as each division contains a number of villages, it is only by comparing the death-rates of villages with the general average death-rate that the real practical facts of the case become apparent. The village death-rates of course vary from year to year, but we shall take those for 1880 for our present purpose.

The average death-rate for Madras in this year was, as has been already stated, 36·7 per 1,000. Of village rates exceeding this proportion the following may be cited :—

Villages.	Population.	Death-ratio per 1,000.
Chinladrípettah - - -	15,129	38·3
Royapettah - - -	5,256	39·5
Pursewalkum - - -	19,006	39·1
Peddoo Naicks pettah - -	65,639	43·4
Poodoopettah - - -	3,774	45·5
Triplicane - - -	33,258	45·7
Perambore - - - -	5,650	53·0
Meersaibs pettah - - -	2,050	57·5
Mpotheal pettah and Uttapaulum -	40,957	56·3
Royapuram - - -	11,089	60·7

The chief causes of these great losses of life in 1880 were endemic diseases, fevers, diarrhœas, dysenteries, &c.

These village death-rates give in a few mes the Madras sanitary problem in a non-epidemic year, and, like similar village facts all over India, they point directly to foul undrained subsoil, imperfect cleansing, and bad water as their removable causes.

3. We shall next show what has been done in the course of past years to prevent these great losses of life, and what steps are now being taken in the same direction. In the first place, although the facts have been known for many years, and although two separate surveys, reports, and drainage schemes have been before the Municipal Commissioners, not a single step, so far as can be learned from the Report, has been taken either to drain the villages or to cleanse the subsoil. The Commissioners have simply pleaded poverty, and there the matter has ended.

4. The latest aspect which the drainage question has assumed is simply adjournment *sine die*, and the adoption of a system of surface concrete channels, intended not only for removing rainfall, which is their proper function, but to receive house and court sewage, and to leave the foul subsoil as it is.

In a report given in the present year's proceedings, Colonel Sankey, R.E., Public Works Department, makes the following remarks on this scheme:—"It is impossible to overlook or disguise the fact that there "may be the most perfect system for removing all offensive matter from "the point at which such is discharged into the street drains, while "there may exist side by side with this complete system a state of house "*drains that may* be little less than poisonous. It is not of course "proved that such is really the case in Madras, but if not (and there is "nothing to the contrary in the Report), the Native houses and court-"yards must be in a very different state from what they are in all other "Native towns where, away from all view, sewage is allowed to sink "into the ground of the little back-yards, and produces a rotten soil, the "effects of which cannot in any way be remedied by the most scrupulous "cleanliness of the street drains outside. If a thoroughly healthy state "of things is to be produced in Madras, and not merely a palliative, this "fact must be looked fairly in the face." In these views we entirely concur. On the question of economy, Colonel Sankey says: "It is not "to be supposed that a mere skin of cement one fourth of an inch in "thickness can for a long series of years resist, not only the corroding "action of the sewage acids, but the endless sources of injury to which "town drains are subjected," and he proposes to substitute V-shaped drains of stone.

5. The Report under review does not contain any Officer of Health's Report on the courtyards, but in our Memorandum on the Report of the Sanitary Commissioner for Madras we have quoted part of a Report by the Commissioner which reveals a condition of matters in these courtyards absolutely incredible. And Mr. Jones, the proposer of the surface drainage scheme, now tells us that "the house drainage itself "is one of the most important sanitary questions, but its improvement "forms no part of my scheme," which is simply a tacit confession that, after this surface drainage work is completed, the sanitary state of Madras will remain precisely what it now is, as shown by the deplorable village death-rates we have given above.

Such being the case, we would strongly urge the inexpediency of wasting money upon the incomplete and unsatisfactory surface drainage plan now in process of execution, which does not fulfil any conditions of a proper drainage system, and we would recommend at the same time that a complete system of town and house drainage in combination with an improved and extended water-supply for removing house sewage, separately from the rainfall, be at once adopted.

6. *Water-supply.*—Little or no improvement appears to have been effected in this important element during the year. The population of Madras exceeds 400,000, while the Report estimates that only half this number uses the pipe water. The remainder must of necessity use the impure subsoil well water. The estimated amount of pipe water-supply is 14·2 gallons per head per diem for those who use it. The following approximate analysis shows the character of the Red Hill water after it arrives in Madras:—

	Grains per Gallon.
Total solids	14·70
Volatile solids	4·90
Sodium chloride	5·32
Total hardness	6·65
Free ammonia	0·025
Albuminoid ammonia	0·025
Nitric acid as ammonia	0·336

The water contains a large proportion of organic matter and numerous large infusoria and other evidences of organic impurity.

The pipes collect silt, which has to be washed out by a scour. During one of these operations it is stated that, "a piece of iron 16 inches in area was forced out of the pipe." Much impurity in the water appears to be derived from the open channel by which the Red Hill water is conveyed to the city, in reference to which the following remark occurs: "Its bed is still in an uneven state, and this cannot be rectified "without a very large expenditure of money, or without shutting off "the supply from Madras for some considerable time."

Practically this conclusion amounts to a statement that, notwithstanding the present advanced state of practical engineering, and the real economy of a good water-supply, nothing can be done to remedy the present deplorable condition of the water-supply of Madras.

7. *Conservancy.*—The work done under this head is the most satisfactory of the year's proceedings, and the Report states that, "it is by no "means complete, and a very great deal remains to be done." The present cleansing staff consists of 1,068 coolies and 504 carts, at a cost for 1880 of 21,761*l.* Part of the house sewage is removed separately and part is taken by rubbish carts, so that the costs of street and house cleansing cannot be separated. There can be little doubt that the great death-rates in some of the villages point to want of thorough removal of house sewage and growing impurity in the subsoil and subsoil well water in consequence. If the cleansing were better accomplished its cost would probably considerably exceed the whole present conservancy outlay, and it would be a moderate estimate to place this cost at 20,000*l.* a year, a sum which, if capitalized at 5 per cent., would enable a capital of 400,000*l.* to be spent on drainage and water-supply works.

8. Year after year we have called attention to the state of Madras, and up to the present time nothing effectual has been done to protect the people of this large Presidency capital from the enormous death-rates which prevail in it. Only palliatives such as the present Black Town surface drainage scheme have been tried. Under the circumstances we consider it to be quite useless to make any detailed recommendations, and we would rather conclude with a similar suggestion to the one already made by us in our Memorandum on the Report of the Madras Sanitary Commissioner, namely, that as it is apparently a hopeless matter to expect any improvement from the present municipal administration, the whole subject should be taken in hand by the Government of Madras Presidency, and the works required for the protection of the people from well known local disease and death-causes should be carried out as speedily as possible.

18th April 1882.

(Spare Copy)

From

The Secretary State

No 567 P8

No 12

Referred to the Resident
Madras City for his
early Remarks.

By 22 June
By 14 July 1882

By
14 July 82

S.I.R.
17.7.82

Forwards 90 copies
of a memorandum by
the Army Sanitary Commr
on the Report of the
Madras Municipality for 1880

Rect 1882. Dept Sanitary Drainage

Madras Municipality.

FROM

THE PRESIDENT,
Municipal Commission,
MADRAS.

To

The Chief Secretary
to Government
Fort St George

G. No. 566/P

Dated. 4th
Despd. 5th } August 1882.
Recd. 9

Enc. one copy.

CURRENT No. 2242

Subject.

Submits his remarks on the Memorandum of the Army Sanitary Commission on the Report of Madras Municipality for 1880.

G. No. 566 810

Municipal Office, 74

Madras, 4th August 1882.

From

C. T. Arundel Esqr.
President, Municipal Commission,

To

The Right Honble C. E. Master,
Chief Secretary to Government,
Fort St George.

Sir,

I have the honor, as requested, to submit my remarks on the Memorandum of the Army Sanitary Commission on the Report of the Madras Municipality for 1880, a Memorandum upon the perusal of which the Right Honble the Secretary of State has requested a Special report on the sanitary condition prevailing in the Presidency Town to which there is apparently no prospect of a remedy being applied by organization of the Municipality.

2. I will first examine the Memorandum of the Army Sanitary Commission, and then do myself the honor to explain the

Aug 1882. Dept
Sanitary Drainage

Madras Municipality.

From

The President,
Municipal Commission,
MADRAS.

To

The Chief Secretary
to Government
Fort St George

G. No. 566/

Dated. 4th
Despd. 5th } August 1882
Recd. 9

Exc. order.

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Madras, 4th August 1882.

From

A. J. Arbuthnot Esqr:
President, Municipal Commission,

To

The Hon'ble C. G. Master,
Chief Secretary to Government,
Fort St George.

Sir,

I have the honor as requested,
to submit my remarks on the Memorandum
of the Army Sanitary Commission on
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for 1880, a Memorandum upon the
perusal of which the Right Hon'ble
the Secretary of State has requested
a "Special report on the sanitary Condition
prevailing in the Presidency Town to
which there is apparently no prospect
of a remedy being applied by any action
of the Municipality."

2. I will first examine the Memorandum
of the Army Sanitary Commission, and
then do myself the honor to explain the

present condition and future prospects
of the Municipality in regard to Sanitation
Conservancy and Water Supply

3. With regard to the first point
above referred to I am to state that the Army
Sanitary Commission have a concise and clear
statement which will not only present
itself at once with the facts
detailed in the Report that lay
before them.

4. This shall now proceed to frame.

4. In para 3 of the Memorandum
the Army Sanitary Commission state

" In the first place although the
topography has been known for many years,
and although two separate surveys,
reports, and drainage schemes, have
been before the Municipal Commissioners,
not a single step so far as can be found
from the Report has been taken to effect
the drainage

[illegible]

[illegible]

[illegible]

of Buckinghams and (by His Excellency the late Mr Adam, and (the approval expressed (by the Governors personally has been passed (by Government.

The scheme for the drainage of the whole of Black Town has been prepared, and (at may be noted (that at the date of writing this report application has been made to the Government for a loan of one lac to commence the work."

In another part of the Report (Appendix N), the following remarks by Colonel Pauley, the Chief Engineer & Inspector, "In G.O. of 27th October 1879, No 269 W, it was observed (that arrangements should be made to place at disposal an officer of this department for investigating Mr Jones' scheme for the drainage of Black Town Madras. Captain Chaley, the officer selected, has reported (the result of his investigations in the letter

2

should have now been furnished (by the President Municipal Board (the matter is ripe for the decision of Government. 2. owing to the inherent difficulties of the question generally & the details of the schemes have been subjected (to more prolonged professional investigation and discussion than probably any other of a similar kind in India. 3. In doing this and (availing himself of the best points of the schemes of his predecessors Captain Chaley has produced a more theoretical, and (the practical scheme which in its general outlines appears to me admirable the question in the first place is

4 Shewanthus Sanitary Commissioner

page 55 of Council proceedings of the Government of the Madras Presidency Chaley's report is dated 27th August 1879 and the Government Order thereon is dated 27th October 1879 (No 269 W)

to be treated from the Report has been taken

4 to drain the villages &c."

5. The paragraphs in the Army Sanitary

Commence in quick succession, and Colonel Sankey's remarks to the absolute necessity of a complete system of house drains and backyard drains in connection with the system of street drains, para 10 ending thus:—

"To thoroughly healthy state of things is to be produced and maintained entirely by a palliative, the great work to be done is fairly in the face. The Army Sanitary Commission remark "In these towns the filthy cause" Steps must be quickly and effectually taken, and (2 of the same remarks which are as follows:—

"The house connections and disposal of the liquid portion of the house refuse are dealt with in paragraphs 21 to 24 and 61 to 64 of Mr. Jones' report from which it will be seen that by the extremely small outlay of £2 per tenement it is proposed to deal in a sufficiently radical manner with the difficulty which affects all or

probably by far the most important and the most difficult part of any scheme for drainage and

9. } Quoted by the Army Sanitary Commission
10. }

11. "

12. "From the nature of the case (as the main drains are necessarily intimately connected with the private concerns of individuals, and not a little with their prejudices, the question cannot be dealt with entirely as one of combined drains (though of course there must be as perfect as the nature of the case admits) but must go very much further, and (with the co-operation of all concerned) it is a matter which, though calling apparently for early and (serious attention on the part of the President and (Municipal Engineer in connection with the scheme, need not be further remarked on here." It will be seen that a perusal of the passages now added from Colonel Sankey

note as recorded in order to understand the drift of the whole.

b. In paragraph 2 of their Memorandum the Army Sanitary Commission have quoted a portion only of a sentence by the Municipal Engineer, Mr Jones, omitting the remainder which explained their reference. The words "and Mr Jones, the inspector of the surface drainage, pointed out to me that the house drainage involved one of the most important questions, but its improvement forms no part of my duties" which is simply a fact confessing that after this surface drainage work is completed the sanitary state of Upton will remain precisely what it now is, as shown by the deplorable village death-rate, not least among the children.

What Mr Jones actually wrote was this:

"The house drainage involved one of the most important of sanitary questions, but its improvement forms no part of my duties, as such expenses under the Municipal Act falls on the owner and not on the Council public" and it is only when the house drains become a public nuisance that the Council at the instance of the Local Board have jurisdiction to improve matters. Mr Jones goes on in the next sentence to add, "The inspection and improvement of house drainage is usually called for, and it was my intention to request that one of two inspectors should be appointed whose sole duty it would be to report as to each house drain, and when defective, to urge their reconstruction on the owners and tenants to the end that work may be done at their cost when they neglect to do so."

"It is needless to say more in contravention of the charge thus made by the Army Sanitary Commissioners against the Municipal Engineer.

7. The Army Sanitary Commissioners

7 The italicised portion, section 18 page of the Municipal Act annexed to the Local Government Order, puts the whole matter at their own expense.

concludes para 6 as follows:—

"Such being the case we would strongly urge the importance of working steadily upon the incomplete and unsatisfactory surface drainage plan now in process of execution, which does not fulfil any conditions of a perfect drainage system and we would recommend at the same time that a complete system of town drainage in combination with an improved and extended water supply for removing house sewage, separately from the rainfall, be at once adopted."

To this I would remark that the system of drainage thus condemned by the Army Sanitary Commission has been approved not only by the professional Engineer who framed it, but also by Captain Crosby R.E. and Colonel Scott R.E. the latter of whom states as already quoted that "the details of this scheme have

been subjected to much anxious consideration and discussion than probably any other of a similar kind in India" and that Mr Jones has exercised much discretion in availing himself of the best points of the schemes of his predecessors, especially of Major Pollock R.E. and the late Mr. Clarke." It has been approved also by the Municipal Commissioners guided by the professional advice and quoted the Superintendent Section has been completed and examined in person with approval by two different Governors of the Madras Presidency, and finally the scheme has received the formal sanction of the Madras Government ibidg.

8. It seems scarcely credible that the Army Sanitary Commission should have taken upon themselves to condemn without reservation a system of drainage thus endorsed

by the highest professional and official authority in the Madras Presidency without procuring and perusing a copy of the drainage scheme Report thereof. If this, it would appear, must be the case, for had the Drainage Sanitary Commissioner examined the pages of the Drainage Scheme Report they would have found not merely the bottom figure account of the works proposed for the drainage of the internal areas and parts of towns which they declare to be entirely overlooked, but a complete record containing a perfect view of the entire of a native town and of the way in which such a town would be treated.

In paragraph 8 of this memorandum the Army Sanitary Commissioner says the Madras public do not appear to do more than to state, that

that the sum of Rs 2,50,000 is now being expended on extending the Red Hills Water to those parts of Madras intended to be supplied, and second that the Commissioner seems to be under a most erroneous impression that all enhanced water in Madras is impure. So far is this from being the case that the best drinking water is always procured from wells - not of course in densely crowded localities - and not from the Red Hills pipes.

10. In paragraph 9 the Army Sanitary Commissioner discusses Conservancy and concludes as follows:

"If the cleansing were better accomplished the cost would probably considerably exceed the whole present conservancy outlay, and it would be a moderate estimate to place this cost at 20,00 £ a year, a sum which if capitalized at

5 per cent upon (viable capital of
4,00,000 £ to be spent on drainage and
sewerage works." It is difficult
to discover gravely so singular a propo-
sition. It means the abolition of the
whole existing staff and system of
Sewerage and Conservancy comprising
over 500 Carts and 1000 men, in order to
raise capital to carry out a system of
drainage which the Government of Madras
no less than the Municipal Commissioners
consider unadvisable. Consider it duly
with all the excellent drainage works
in a City if the proposals now made
were tried then, many deaths and sickness
must take place, many dwellings and filth
must be left untouched, and every dirt and
nuisance cart abolished.

11th In the concluding paragraph of this
Memorandum the Acting Sanitary Commissioner
states, "that as it is apparently a debatable
question, to expect any improvement from any

the present Municipal Administration, the
whole subject should be taken in hand
by the Government of Madras Presidency,
and the works required to protect the
people from well known local diseases
and death cause should be carried out
as speedily as possible." We have
already shown that every step taken by
the Municipal Commissioners has been
with express approval and Countenance
of the Madras Government, it is needless
for us to do more than to leave this
final accusation of the Acting Sanitary
Commissioner to be dealt with by Government,
while for convenience of reference we note
the following Proceedings of Government

discussing and sanctioning the project.

G. O. No. 1212 dated 11th July 1878.
" 1505 " 6th August 1879.
" 2698W " 27th October 1879.

Ch. C. No 3351 W Lake 27th December 1879 — no effy
— " — 1344 — " — 6th September 1880 — Main not laid
— " — 2953 — " — 28th December 1880 — no effy
— " — 706 — " — 27th April 1881
— " — 1199 — " — 27th June 1881
— " — 1569 — " — 27th August 1881
— " — 1821 — " — 28th September 1881
— " — 2505 — " — 23rd December 1881

12. I now beg leave to indicate the actual condition and future prospects of the City of Madras as regards sanitation, Conservancy and water supply.

13. The drainage scheme for Black Town has been completed and the work is in progress. Black Town is the largest and most densely populated of the numerous towns and villages that form the aggregate called City of Madras. The City of Madras covers 27 square miles with a population of 450,000. The area of Black Town is 6 miles and the population is 128,000

5. 118 82

14. The scheme provides for carrying off all the liquid sewage from the houses and by streets by surface drains wherever surface drains will answer the purpose, and by covered or underground drains elsewhere. The courts and yards of the houses will be connected with street drains under professional supervision at the cost of the owners by means of covered drains passing through or under the houses. The street drains will be flushed from the water pipes and will discharge their contents into three large underground sewers which will meet at a Pumping station whence the whole sewage will be forced first through a cast iron pipe over a mile in length, and then in an open channel to a large sewage farm north of the Town, or into the sea, as may be desired.

15. It is not proposed by this system to drain the subsoil. No scheme yet proposed

daily removal of all the liquid filth and sewage in the manner above described.

The cost of the present scheme of drainage will be about Rs 800,000 - Rs 100,000 is being spent this year, and about Rs 200,000 more will I hope be spent in 1883.

15. There remain however other densely populated parts of Madras which are so imperfectly drained, that completely new schemes must be formed and carried out for each of them. These with the estimated cost of each are as follows:-

	Area in Acres	Population	Cost Rs
Royapooram	0·94	52,000	140,000
Cholay and Vepery	1·0	32,000	120,000
Purasawakam	0·65	16,000	60,000
Triplicane & Chindadripettah	1·68	13,000	320,000
Pt. Plons	·96	20,000	80,000
			720,000
Add Black Town under Construction	1·08	178,000	807,500
	6·35	312,000	1527,500

16. Conservancy.

The Conservancy Department consists of 532 Carts of all kinds, besides 4 large

Canal barges and 1079 Coolies for the daily removal of all solid refuse and filth throughout the Town. The good done by this work cannot be over-estimated but it is very far indeed from being complete. After the recent cholera epidemic in Madras, the Vice President, Mr Jones, drew up estimates of the additional staff that would be required to carry out with thorough efficiency the duties connected with Conservancy and for the house to house cleansing of privies. For the former service about 100 more carts and 250 more men would be needed at a cost of over Rs 40,000 per annum. For the latter the staff was estimated to cost about Rs 60,000. About Rs 100,000 per annum therefore would be required in addition to the present charges for thoroughness and efficiency in the necessaries of sanitation.

17. Water Supply.

The water supply of Madras, so far

as it is not obtained from wells, is derived from the Red Hills lake about 9 miles distant. The water is brought into Madras via a high level open channel which is carefully protected by fences and hedges and by watchmen posted at regular intervals along its banks. Before being let from the channel into the delivery pipes the water passes through charcoal strainers. These however are insufficient to eliminate vegetable and animal products, and regular filtering beds are much required. The delivery channel runs at so high a level that the supply fails short while the lake has still a considerable depth of water available for use. A main pipe of the channel would cost about Rs 6,00,000 and the filtering beds would cost about £4,00,000 more.

18. The supply to Madras, though it has several times run low, has never failed except during the famine year 1877. The supply pipes are being extended throughout

those portions of the whole area of Madras which it is intended to supply, but of course it is impossible to make a net work of pipes over the whole 27 Square miles of town and country within the City limits.

A sum of Rs. 2,50,000 is being expended during the present year in carrying out this extension of the water supply. The water supply loans now amount to Rs. 11,80,000.

19. Causes of high death rate. Without going into any detailed remarks on this subject I would note that increased efficiency in sanitation and in drainage must be looked to as a main factor in reducing the death rate. I would call attention to the number of deaths, 869 in 1880, 1654 in 1881 from small-pox which under a compulsory system of Vaccination would be almost entirely prevented. The Municipal Commissioners have expressed themselves in favor of such a system and await the action of Government to pass

A public law.

The appointment of a Health officer in Madras has again and again been postponed owing to lack of funds, but it may now be said to have become a necessity and provision has been made for it in the new Municipal Bill submitted to Government.

20. Ways and Means. The financial condition of the Municipality has long proved a bar to the sanitary progress that is so urgently needed. For several years the charges for Police thrown on the Municipality by Government arrested all progress and resulted in reductions of questionable wisdom. These impediments pulled are now happily removed, but no material change can take place until the income of the Municipality is largely increased. As shown above at least Rs. 1,00,000 per annum will be required for Conservancy and sanitation, while loans to the amount

of 24 or 25 Lacs of rupees must be contemplated, involving further Charges which may in the course of years amount to about Rs. 175,000 for interest and sinking funds.

The Municipal revenues require therefore additional sources of income capable of expansion pro rata annually to bring from Rs. 2,00,000 to Rs. 3,00,000 in addition to the present income of Rs. 7,95,000.

21.— This matter and my report No. 409 dated 26th ult. I pray on the impossibility of passing the needful Funds except by a moderate Octroi or by Town Duties on articles consumed within the City are now before Government and await their decision as soon as the further information they have called for has been supplied.

I have the honor to be,

Sir,

Your Most Obedt Servant.

H. T. Arundel.

President

Municipal Commission

cor. Ellor

No. 319

CHEMICAL EXAMINER'S OFFICE,

MADRAS, 22nd August 1882.

From

T. K. ROGERS, Esq., M.B.—F.R.C.S. & F.C.S., Lond.,

CHEMICAL EXAMINER,

MADRAS.

To

The Chief Secretary to Government

Financial Department.

Sir,

In continuation of my letter No. 306 dated 10th August 1882, I have the honour to forward a copy of the results obtained from the examination of samples of soil taken from various localities in Madras.

2. On account of the pressure of Judicial work, and on account of other circumstances known to Government, the method of examination adopted was not that usually resorted to in Europe. The method used may be described briefly as follows. The soils were frequently washed with water, so that all matters soluble in water were almost completely dissolved out. The washings thus

obtained were subsequently chemically examined.

3. I consider the results obtained to indicate a far greater immunity from filth contamination, than could have been expected.

I have the honour to be
Sir
Your Most Obedient Servant.
T R Rogers M. B. F. R. C. S.
Chemical Examiner

No. (1882) Revd
Chemical Laboratory
Madras 22nd August 1882

From

The Chemical Examiner

Madras

To

The Chief Secretary
to Government
Financial Dept.

No. 319

Dated 22nd August 1882

Received 23 ——

CURSORY No. 2468.

Subject

Forwarding Copy of
Results obtained from
Examination of Soils
in different localities
in Madras.

Enclosure

23

Hygienic Examination of Soils taken at a depth of four feet from different localities in Madras

		Vinnum Pagoda Street Junction of Hospital Road Street and Xavier's Pandaram	Kistiama High Road Junction of Pallayah Road	Arumachella Naick Street Junction of Nineapark Naick Street Chintadrepettah	Naick Street Junction of Annuck Pillay Street	Thumbu Chetty Street Junction of Cadacalle Street	Cox Street Chintadrepettah	Arumachella Naick Street Junction of Ayah Mudaly Street Chintadrepettah	Naick Street Junction of Elisa Bazaar Road	Ramayya Street Junction of Vallaya Kaliyan Street
Volume of Air contained	p.c	47	46	51	55	39	35	36	52	37
Moisture of Soil as received	"	12.382	12.42	13.92	15.45	0.621	2.005	1.100	16.600	0.052
Volatile Matters	"	1.078	4.24	1.94	2.53	0.099	0.175	0.440	1.92	0.188
Inorganic Ammonia	"	0.00032	0.0006	0.0008	0.0004	0.0004	0.0005	0.00008	0.0002	0.00008
Organic Ammonia	"	0.0008	0.0005	0.0007	0.0007	0.0006	0.0004	0.0004	0.0007	0.0003
Nitric Anhydride *	"	0.02283	0.02473	0.0266	0.0305	0.0153	0.0191	0.0172	0.0305	0.0229
Chlorine as Chloride of Sodium	"	0.117	0.094	1.872	0.082	0.035	0.059	0.017	0.234	0.117

* Obtained by Aqueous extraction.

(True copy)

Madras 22nd August 1882.

J K Roger M. B. F. R. C. S.
Chemical Examiner

8

P. W. C. No. 1181

824

Municipal Office,

PUBLIC WORKS AND CONSERVANCY DEPARTMENT.

Madras, 9 September 1882. 89

From A. T. Arundel Esq^r^
President, Municipal Commission.

To Colonel C. F. Dawkes, R.E.
Chief Engineer P. W. Department.

SIR,

With reference to your letter No. 638 C dated 25th August I have the honor to enclose a letter from the Vice President Mr Jones giving so far as he can the information you desire.

2. As regards the question of the connection of the house drains with the surface drains of the streets Mr Jones estimates the cost at an average of Rs 20 per house, or Rs 2,65,000 for 13,255 houses in Black Town and Rs 8,00,000 for 40,000 houses throughout Madras.

The Municipal Act makes the house owners responsible for all such house drain connections, and as the recovery of the cost could be spread

if

if necessary over a series of years, I see no reason why the greater portion of the expenditure should not be recovered. I have consulted with the Revenue Vice President Mr Ramasamy Chettiar on this matter and should say that there would be no difficulty in recovering at least 50 per cent. and that in all probability the final burden on the Municipality would be very small. Mr Jones's estimate needs therefore to be corrected on this point, as he has debited the whole amount of Rs 8,00,000 to the Municipality.

3 The map asked for in para 8 of your letter is being prepared and will follow as soon as it is ready.

I have the honor to be
Sir,
Your Most Obdt Servt

A. Arundel

President Municipality

Letter
Cm

C. No. 1181 12/9 No. 6241

From
The President
Madras Municipal
Commission

No. 1181

9/9th Sept. 1882.
Rec. 12th

Encl: 1

Furnishing information in connection with the outlay on the drainage & water supply projects.

—

Ack. 20.9

P. W. C. No. 1 No. 25

Municipal Office,

PUBLIC WORKS AND CONSERVANCY DEPARTMENT.

Madras, 7th September 1882.

From J. A. Jones Esq—
Vice President, Municipal Commission.

To A. J. Arundel Esq—
President, Municipal Commission
Madras.

SIR,

The following Memorandum contains as far as I am able to give it, the information required by the Chief Engineer D. O. W. in his No. 638 & dated 25th August 1882.

2. The amounts actually expended up to the 1st April last was as follows:—

Drainage— 24,023
*Water Supply Extension— 12,788

[*This is in addition to the Rs 14,30,000 expended in 1869-74 on the water supply]

3. The only estimate for Drainage which has received sanction is that for the drainage of Black Town amounting to Rs 8,07,500 and this work is now in course of execution.

4. The estimates for the other portions of Madras are merely approximate and

and were determined with reference to area and population and not with reference to actual levels or surveys. These estimates are

Royapooram	Rs 1,40,000
Chindadripett & Vepery	1,20,000
Purseewaukum	60,000
Triplicane & Chintadripett	3,20,000
Black Town	80,000
Total Rs:	7,20,000.

Each of these, except a small portion of Royapooram which will be a portion of the Black Town area, will form an independent drainage area with its own outfall as shewn on the accompanying six inch map of Madras. The sewage in all cases is proposed to be utilized on land and raised thereto by small engines or pecottahs.

6. The above total added to the estimate for Black Town amounts to Rs 15,27,500 and there therefore remained at the 1st April last the sum of Rs 15,03,477 which is roughly estimated to be required

The

92

7. The above estimates provide only for the improvement of surface drains to enable them to carry off sewage and storm waters and for the necessary sewers to carry off sewage alone — the storm waters passing on to their present outlets. The estimates do not include the improvement of the house drainage. They include a sum for altering house drains which communicate with existing underground drains which from their low level must be altered so as to join the new open side drains. The existing house drains are probably not in a satisfactory condition but it is not necessary under the present scheme that all existing house drains should be taken up and replaced by closely jointed air tight pipes, as proposed in Mr Clarke's scheme at a cost of Rs 50, nor is it necessary that these should be raised up inside the backyards so high as to secure the exclusion of surface waters — in fact the

pipe

pipe or drain must be kept below the level of the backyard to carry off rainfall. Mr Clarke's estimate was for pipes sufficient to carry off night soil and other such matters which it is not now intended to carry off by house drains which need not therefore be of a very elaborate description. In fact it is they are formed of country brick in chunam and well plastered with cement it will be sufficient. The length of these drains would probably not exceed 50 feet and could be built say 6" square of new material and well plastered with cement for a sum of Rs 28 but many of the existing drains would require little more than plastering. I have taken 50 feet but this is probably an excessive length as the draining end at the front of the house and not in centre of the street (as in Mr Clarke's scheme) and I am inclined to think that if Rs 20 per house were taken on an average it would cover all necessary

expenditure

expenditure under this head. This for Black Town containing 13,255 houses would amount to Rs 2,65,100. Taking this amount for the whole of the portions of Madras proposed to be drained the amount would be for 40,000 houses Rs 8,00,000.

8. Flushing. The present water supply would be sufficient to flush these drains where such supply exists and where it does not do so, they could be flushed by an ordinary pail full of water. But in schemes where a close jointed pipe from house to sewer form portion of the design a water supply service to each house would be a "sine qua non" and the average cost per house may be taken at Rs 61 as shewn below

	Rs. a. p.
50 feet of 1¼" piping at 8 annas	18-12-0
1¼" Stop Cock and Cover	18-0-0
1" Discharge Cock	8-0-0
Labor in Cutting & Jointing and Masonry &c	11-0-0
Contingencies 10% say	5-4-0
Total Rs	61-0-0

Cost for 13,255 houses in Black Town Rs 8,08,000

" 40,000 " Madras " 24,40,000

9. I find that the cost of extending the mains throughout each street in the district to be drained to enable the above services to be laid on would be Rs 8,000 per mile and that about 100 miles of new mains would be required costing Rs 8,00,000 in addition to the 24,40,000 Rs required for house connections.

10. Subsoil Drainage. The level of the subsoil water or level of permanent saturation stands about 1½ feet above Mean Sea Level and slightly higher in the rainy season.

11. If the rainfall of Madras be taken as 50" per annum which is about the average and if half this amount be taken as the amount evaporated we get 25" which must percolate through into the subsoil; this taken over an area of 27·48 square miles (the area to be drained) would yield a supply of 3,12,500 gallons per hour (½" [illegible] Clarke proposed to carry off 2,48,000 per hour) In the rainy season the amounts is of course much larger.

The

12. The major part of the sewers will have to be laid below the level of permanent saturation and in the schemes now being carried out are at their lowest levels some 7½ feet below this line

13. In pumping out all the water from the Pump Well at Royapuram just constructed which is sunk about 6½ feet below the above depth or 15 feet below water level I noticed that while the water in a well within thirty feet of this was not lowered a single inch the water in the open excavation (the bottom of which was also below the level of saturation for Sewer No 4 which commences at this well, and was then excavated in length 210 feet and to a depth of about 12" below level of saturation and about 9 feet broad) only subsided from 3" to 4". This well had to be pumped about every quarter of an hour at this depth and the water would rise to five feet (i.e. from

15' 4"

15' to 10' below saturation level) in about a quarter of an hour.

14 Considerable difficulty has also been experienced in putting wi a pumping mill at Napier Park where the level of the bottom of foundation is only 8 feet below saturation level. The discharge at this place from an area of 700 square feet was about 200 gallons per minute.

15 From these facts it may, I think, be supposed that if wells were sunk 60 feet apart (double what the two mills were at Rozapuram) over the entire area to be drained and to 8 feet below saturation level we would probably get a constant supply of 200 gallons per minute and on this basis we would get $\frac{200 \times 60 \times 5280^2 \times 7 \cdot 48}{60 \times 60}$ or 8,71,200,000 gallons per hour from the 7·48 square miles. This result is almost 300 times in excess of that determined on the basis of rainfall alone and being deduced from a limited area cannot be made applicable except

except with extreme caution to the whole area to be drained. There can however be little doubt that the less quantity is exceedingly under the mark and that if that quantity were drawn off regularly the level of the subsoil water would not be affected a single inch.

16 The water wi the wells as before stated stands usually to about 1 foot to 1½ feet above Mean Sea Level and I think it probable that the level of the subsoil water is somewhat dependent on the sea level. At present there is a hydraulic head against the sea and fresh water can be had from the wells on the shore itself. What would occur were the subsoil water lowered to any considerable extent would merely, I presume, be the introduction of salt water where fresh now is.

17 I cannot of course positively assert that such would be the case, but I

do

do not think any other conclusion can be arrived at from a careful consideration of what has already been stated.

The following shews depth, length and diameter &c of the sewers as at present being constructed under the permanent level of saturation.

		Length	Depth below level of saturation. Highest and Lowest		Mean depth
Sewer № 1	18" diameter	2155	1·0	2·5	1·75
	24" do	3732	2·5	5·0	3·75
	30" do	1263	5·0	6·[illegible]	5·85
Sewer № 2	18" do	3326	0	2·25	1·12
	24" do	4593	2·25	5·25	3·75
Sewer № 3.	24" do	2498	0	7'-66	3·83

19 The subsoil water could therefore be tapped to depths 6'-8", 5'-3" and 7'-8" below permanent level of saturation but it is not intended to allow subsoil water to pass into these sewers as their dimensions will not admit of this being done and I believe, were the subsoil water admitted there

1880 96

is no means by which the fine sand could be prevented entering; the means proposed by Mr Blanker for this purpose would undoubtedly fail and the sewers would eventually be choked with sand.

20 Having regard therefore to all the points already noted I am unable to give any idea of what would be the cost of subsoil drainage, nor can I see any feasible plan of carrying it out by which the level of the subsoil water would be affected in the very slightest degree.

Water Supply.

21 My reports on the improvements of the Madras Water Supply dated June 1877 gives in detail an estimate of the cost of the works necessary for pumping the water on to the summit of the Pallo about the Red Hills Lakes there filtering the same and supplying Madras thence with a 27" main.

The

I do not think any other conclusion can be arrived at from a careful consideration of the whole has already been stated.

The following shews depth, the length and diameter &c of the sewers as laid at present being constructed under the permanent level of saturation.

		Length	Depth below level of saturation. High and Low end	Mean depth
Sewer No 1	18" diameter	2155	1·0 2·5	1·75
	24" do	3732	2·5 5·0	3·75
	30" do	1263	5·0 6·[illegible]	5·85
Sewer No 2	18" do	2326	0 2·25	1·12
	24" do	4693	2·25 5·25	3·75
Sewer No 3.	24" do	2498	0 7·66	3·83

The subsoil water could therefore be tapped to depths 6'-8", 5'-3" and 7'-8" below permanent level of saturation but which is not intended to allow subsoil water to passage into these sewers as their dimensions will not admit of this being done and I believe, were the subsoil water admitted there

there is no means by which the fine sand could be prevented entering; the means proposed by Mr Blanks for this purpose would undoubtedly fail and the sewers would eventually be choked with sand.

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The

22. The total head which would be obtained by this scheme would be 60 feet above Mean Sea Level or about 30 feet above the highest ground in Madras and 40 to 50 feet above the mean level of the town. This would be a sufficient pressure for all purposes and would give an extremely good water supply even in those distant portions of the town whither we are now extending our pipes. The additional head over our present head would be 30 feet. I would deprecate the adoption of any greater head than this as with a very high pressure system the waste of water in Madras would be enormous and the sewers would become insufficient.

23. The extension of the distribution pipes as present being made, complete the water supply as far as there is any present intention of doing so. It is not intended to bring any additional portion of the town within the limits of the water

Supply

Supply area. There may be some cases however in which it would be advisable to afford a better supply within the present area and Rs 1,00,000 would certainly meet all cases of this kind. The estimate for Pumps, Filters and Mains was Rs 13,66,000 and copy of the report is herewith sent for information, though it is believed that several must be available in the Government Offices.

24. The total cost of necessary improvements to our water supply, supposing the scheme of surface drainage to be adhered to, may therefore be taken at Rs 14,66,000.

25. The following estimate A. No 1 will show having regard to the foregoing remarks the probable cost of the works for Drainage and Water Supply if these were carried out in accordance with the views expressed by the Army Sanitary Commission

No 1 Drainage

* Captain Tulloch says 32,000, but he drains 2 apurams in addition to the number of houses proposed to be drained on Mr Clarke's which I make 38,000.

Main Sewers & Pipe sewers in streets		40,00,000
House drainage 40,000 @ 50 *		20,00,000
House Service 40,000 @ 61/		24,40,000
† Subsoil Drainage		5,00,000

† I have entered the amount put down in Col Banker's rough memo but I doubt if anything could be done for that amount.

Total Rs: 94,40,000

Water Supply

Extended Distribution to push drains in Streets to be drained so as to afford water supply to each Dwelling 100 miles @ 8000 = 8,00,000

Improvements of water supply to allow of extended service and to give increased head with a proper fitting arrangement - 13,60,000

Total Rs: 21,60,000

add Drainage 94,40,000

Rs 116,00,000

Captain Tulloch's scheme would cost the same amount less the amount of subsoil drainage.

Mr Clarke's scheme

Main Sewers	25,00,000
House Drainage 38,000 @ 50/	19,00,000
House Service water supply 38,000 @ 61	23,18,000
	67,18,000
Extension of mains	8,00,000
Improvements of water	13,60,000
	88,78,000

Present Scheme

Strict Drainage	15,27,500
Add for Land for farms lifts &c	3,00,000
	18,27,500
House Drainage (see page 5)	8,00,000
	26,27,500
Improved Water Supply, increased head and contingents extra distribution (see page 13)	14,66,000
	40,93,500

26 The estimated cost of each of the four schemes would then be as follows including the necessary water supply for each scheme as designed

As advocated by Army Sanitary Commissioner	116,00,000
Major Tulloch	111,00,000
Mr Clarke	88,00,000
Mr Jones	141,00,000

J Jones M Inst CE
Municipal Engineer

elm

P. W. C. No. 1268

Municipal Office,

PUBLIC WORKS AND CONSERVANCY DEPARTMENT.

Madras, 29th September 1882.

From

A. J. Arundel Esqr.

President, Municipal Commission.

To

Colonel E. H. Bamber R.E.

Chief Engineer, P.W. Department.

SIR,

I have the honor to forward a letter No 1260 dated 27th September from the Vice President Mr Clarke giving the information asked for in your letter No 742 E dated 14th instant.

I have the honor to be

Sir,

Your most Obedt Servant

A. J. Arundel.

President Municipal Com

Cattle Shipment for Japan

Cattle Shipment No 6800.

From

The President

Municipal Commrs.

Madras.

No. 1258

Dt/ 29th Septr 1882.

Rec'd 2nd Octr

Encls: 1.

Forwarding a letter from the Vice President giving further information in connection with the Water Supply & drainage of Madras.

Rd 1.10.

P. W. C. No. 1256

Municipal Office,

Public Works and Conservancy Department,

Madras, 27th September 1882.

From

J. A. Jones Esqr

Vice President, Municipal Commission.

To

A. T. Arundel Esqr

President, Munl. Commission

Sir,

I have the honor to make the following remarks and to forward the additional information required by Colonel Dankey in his letter to you dated the 14th September 1882 No 742 E.

The amount of Rs 12,788/- which, set down as the amount spent on Water Supply in addition to the original expenditure of Rs 14,30,000 was the amount spent up to 1st April last for new works only. Such sum does not include any payment on account of interest and maintenance of the Water Supply. Such expenditure is detailed in the following table:-

Table

Outlay previous to 1873/74 advanced
by Municipal Fund 35,715-9-9

New works from 1873 to Jan'y 82 46,340-11-1

Maintenance from —— do —— 140630-3-5

Interest from 1870 to July '82 6,00,229-10-6

Sinking Fund 3,53,390-9-2.

11,76,306-31-11

Red Hills Water from 1873 to July '82 25,226-2-9

12,01,532-14-8

The total up to 1st April
including this amount is therefore Rs 26,44,320-14-8

With reference to Para 5(1)
of Colonel Dankey's letter, I fear I am not
able to give an indisputable reply but I
will endeavour to give such facts as will
enable Colonel Dankey to see exactly how
the matter stands. In the first place it
will be noticed that I have merely made
several studies beyond Mr Clarke's scheme
as he did beyond Major Tulloch's, when he
recognized the principle of having more
than one outfall over a large area, by
the

Loan of 1869-74 : 14,30,000
Loan of 1882. 12,708
Loan of Income ——— 12,01,532-14-8
26,44,320-14-8

the omission of Saint Thomé from the general
scheme, giving it an outfall of its own. I
might contend that if the principle were right
as regards Saint Thomé, that is to say the
principle of giving places widely separated
their own independent drainage and indepen-
dant outfalls, there can be no reason against
the extension of such a principle, but it
would be unfair not to point out that
in case of Saint Thomé Mr Clarke intended
to allow the sewage to flow by gravitation
into the Sea. What would be the effect
of such a manner of disposal is not
difficult to foresee.

Against the fact however
that in Saint Thomé no pumping would
be required, I have to submit that where
pumping is required as it would be in most
of the independent areas I propose, we have
the income from the crops raised on the land
irrigated by and taking three of our farms
which respectively receive the sewage of
(1) Choolay and Vepery, (2) Triplicane (north
of

of Pyrcroft's Lead) or Tripleane (south of Pyrcroft's Lead) We have the following as the results of 4 years working:-

Years	D'Mellows		Tripleane		Kislingbury	
	Receipts	Disbursements	Receipts	Disbursements	Receipts	Disbursements
	£ s d	£ s d	£ s d	£ s d	£ s d	£ s d
1878	1362 2 4	1378 4 11	1125 10 3	965 8 6	2641 1 7	1843 6 5
1879	2766 16 6	1660 2 5	1931 3 6	1945 9 6	4059 15 7	2141 15 6
1880	1762 13 1	1716 1 8	1676 12 3	2791 10 5	3056 8 9	2606 10 4
1881	1857 9 7	1952 14 4	1640 11 9	3099 14 3	4600 0 2	3756 15 11
Total	7749 8 6	6707 7 4	6374 5 9	8802 10 8	14357 10 1	10349 0 2

There is a profit over the three farms of £2650 in four years.

I do not imagine that where each of these portions of the town are properly drained that our present arrangements for raising the sewage by Pectlabo will avail, but still whatever be the cost of such raising the net income will not be less than it is now and will most probably increase.

It may be urged that the sewage wherever raised and put on land, if suitable, will produce the same income, but any place where the sewage of the whole town has to be disposed of must necessarily be at some distance from the town itself, and the crops produced would either have to be carried into the town or sold at a reduced rate on the spot.

The saving due to each separate locality having its own outfall in a town having a somewhat uniform density of population would be little, but in a place such as Madras where the population portions are widely separated, forming almost independent towns, the saving is very considerable, while at the same time suitable areas are rendered available for sewage farming.

The saving is due not alone to the actual length of sewer saved between these detached portions, but also to the decreased size of sewers throughout.

There is another saving in having detached areas, and that I think one the most important one are and which goes

I think for to decide the question as to whether the extra cost involved in several pumping stations would not, when capitalized, pay for the extra cost which would be incurred in constructing continuous sewers towards one well to the north of the town; for it has been decided by all who have considered the question that no other site is feasible as a single outfall for the drainage. The points to which I draw attention is that that where there are very long sewers the lift at the pumping station owing to the gradients necessary for the sewers is very much greater than when the sewers are in comparatively short lengths and this comes to be of considerable importance, as in addition to the extra length of sewer you have this increased height to which the sewage has to be raised, and the cost of this, it appears to me, would be as great as any extra cost which would result from any extra establishment required at the different stations of independent drainage

drainage areas. No 37 - 004

To the second question in Para 5 I can speak positively and reply that there is available ground for sewage irrigation contiguous to the different drainage areas and have further to add that of such ground the major part is already in the possession of, or available for, the Municipality. The different areas are colored on the maps referred to in my letter of 7th September 1882, and the land which can be used in connection with these areas is colored of a darker shade of the same color as the area whose sewage it is proposed it should receive.

Para (5) 3 opens up a question on which there must necessarily be many different opinions. Sewage farming in India is not however handicapped by many of the disadvantages to which such a process is subject in England. We have in India the aid of a powerful sun through-out

-ork the year and our experience in Madras is that the complaints arising from sewage farming are very few and far between. The chief and, I may say, the only nuisance on a sewage farm is ah the filth worked by peculiahs, Ahh this is one which can be overcome by providing proper wells, and means of raising the sewage, by which it would not be continually stirred up and the odours continually disseminated When the Municipality asked some time ago to be allowed to utilize a portion of waste land belonging to the Madras Railway Company close to the Perbal Station as a sewage farm, the Agent Mr Saunders and the acting Chief Engineer Mr West, visited the farms ah Dr Mellows Road and elsewhere and finding from their own observations that no nuisance was to be feared, immediately gave permission for the construction of the farm - No complaints whatever has been received

from the Company as to this farm although it has now been in existence over a year.

The following is from the Madras Manual of Hygiene compiled under the orders of Government by Dr N King a.m.m.B &c. Page 226. Para 570.

"Sewage irrigation yields on the whole more satisfactory results than any other of the wet methods and is more generally applicable. It requires a surface of about one acre for every 100 persons in the community and 70 yards square will receive 2000 gallons of sewage in 24 hours. Large crops of grasses, cereals, roots and culinary vegetables can be raised, year after year, from land thus irrigated. The sewage should be brought to the land as rapidly as possible and putrefaction may be advantageously delayed or prevented by the addition of small quantities of carbolic acid. The liquid trickles down a prepared slope, over the ground to be irrigated, ah the rate of

of 8 feet per hour, saturation of the soil being guarded against by deep draining unless where it is so sandy or otherwise permeable as to render the precautions unnecessary. The effluvia are rarely such as to constitute a nuisance, but it is desirable to choose ground distant from houses. Enteric fever, dysentery, and the prevalence of enteron have been predicted as probable consequences of sewage irrigation, but there is no evidence of the occurrence of such results, nor need they be apprehended if reasonable care be used. In some places the practice has been pursued for years without any bad effects. The water is not freed from impurity by irrigation to the same extent as by filtration; but it loses its suspended matters and some of its dissolved organic impurities, if not allowed to run too quickly off the land. The financial results of this method are more satisfactory when rain and surface water are excluded from the sewage."

Coming to para 97 to 102 of Col. Donkey's letter I must first state that Captain Tulloch has been drawn into some strange error in making the statements quoted by Col. Donkey in regard to the house drainage. In no house I or the Sanitary Inspector have ~~=~~ visited has the house drain ~~end~~ been common to two adjoining houses or under the mean wall. Mr. Ramasawmy Chetty, the Revenue Vice President who has abundant opportunities for knowing, states that no house has its drain in common with an adjoining house and that in the majority of houses there is always sufficient fall to run off the water quickly from the back portions of the house which are invariably higher there than towards the street. In the 600 house in the experimental section of surface drainage executed no house drain was in such a position. In fact to begin with few houses have a mean wall at all and in the majority of houses the drain is to the left hand side of the house. These remarks,

I

I think, entirely dispose of Captain Tulloch's statement as to the position of the house drains.

In the experimental section of drainage executed as before stated about 600 houses were included. Of these I had to execute work in 14 houses in order to allow the house drain to a proper level to allow of its flowing into the new street drain. The total length of house drains so altered was 257 feet and the total cost £76-10-7.

In order to determine the actual length of drains which would require to be altered if all the house drains had to be laid anew, I have had the house drains of all the houses in the three following streets measured with the result shewn. Eyedapollium Street is one of the streets already drained.

	No. of houses	Total length of house drains Feet	average length Feet
Eyedapollium Street	88	2442	30
Devarana Dairy Street	26	1395	54
Ummen Loud Street	38	2431	63
Mean average			49

This is very nearly the length I gave in my former letter.

Now for 10 feet of a new 4" house drain the cost would be

Brickwork	£2-0-0
Plastering	0-10-0
Excavation	0-2-0
	3-4-0
For 50 feet	16-4-0
Breaking walls and repairs	2-0-0
Outer nozzle to drain	2-0-0
Grating	1-0-0
	£21-4-0

This is supposing that all drains have to be laid anew. It does not however allow for flooring back yards and this expense would be considerable, some houses having as many as three separate cook yards. Nor has such an expenditure been anticipated either by Captain Tulloch or the late Mr Clarke and therefore whatever is added to the one scheme on this account a similar amount must be added to each of the other two. Now

It

It should be noted that all the Municipality had of necessity to expend to connect the house drains and the new surface drain in regard to 600 houses was Rs 76-10-4. I do not claim that this amount covered all that ought to be done, for every house drain even where the land needs no alteration should be inspected and put into thorough repair ~~for~~ ~~forth~~, but it shows the extent to which the Municipality was actually liable. I do not see with these facts in view on what I can base a higher estimate than Rs 20 per house for house drainage seeing that Rs 21 odd will on average give every house a new drain which would in many certainly 50% of the houses not be required. If flooring however is considered a necessity I would on that account add Rs 10/- per house making in all Rs 30/- on the average for house drainage. There will be exceptional cases in which the whole flooring of the houses may have to be raised but against this it may be said that such houses are of

small

small size and the length of drain would be considerably less than the average. The longest house drain measured in any of the three streets mentioned was 135 feet, the shortest 8 feet. The longest length of drain altered in the experimental section of drainage was

82 feet — cost	Rs 21-13-15
the shortest 8 feet cost	6-10-9
	28-8-2
Average per foot	0-5-0
For 50 feet	Rs 16-0-0

Para 13 of Colonel Pantony's letter-my remarks in para 19 of my last letter had reference to Mr C Clarke's method of preventing sand entering sewers and not paper and regarded the method of putting a drain paper through the side of the sewer and packing broken brick at the end of it to prevent the entrance of sand

I have made some experiments with the sand taken from the line of sewer now being excavated. I find that by more oscillation in the water and without any head of water at all 100% of the sand

passes

passes through wire gauze of 256 meshes to the
square inch and 80% of the sand passes thro'
muslin of 1600 meshes to the square inch. I
do not see how it can be doubted that sand
under the pressure of 6 to 14 feet head of water
would be prevented entering any sewer by
means of a lumps of broken bricks. I must
admit that Mr Clarke's method of packing
a pipe joint with well tempered clay and
covering it with concrete would prevent any
sand entering

In Calcutta the subsoil
water is admitted to the sewers by no spe-
cial contrivance and the only subsoil water
which is admitted is that which soaks through
the brickwork it being impossible to make
sewers of country brickwork water tight. I
think therefore that it may be concluded
that Mr Clarke did not find the plan feasible
or he certainly would have adopted it in Calcutta

It is no doubt a practice
in Madras for persons building mud huts

or

or huts of bricks and mud to obtain the mud
clay or earth as short a distance as possible
from the building being erected. These cases
however are usually confined to Pariah cherries
and the pits are of small area. The borings
carried out by Major Pollock and the
depths of soil marked "made soil" can how-
ever have no reference to such cases. It
will be seen by referring to the sections that
such soil is found from one end of Madras
to the other up to depths of 7 to 9 feet and
in one case this soil is marked "unbottomed".
In certain places it is shewn above the
surface and it will be seen that it is found
close to the sea and a distance of two miles
north of the inhabited portions of the town.
This can scarcely have connection with
places which have been raised by rubbish
and it may be further noticed that where
the line of the sewer crosses rubbish heaps
near Boring N°8 these are distinctly marked
as such and neither in this place nor near

to

to it is there any made ground at all. I do not understand what Captain Tullock means by made ground but I think it is obvious that he does not mean rubbish heaps.

The best way to deal with rubbish heaps is to cultivate crops from them such as Cholum and other coarser kinds of grain. This method more than anything else tends to remove any thing that is unsanitary in the upper strata at any rate and the more crops the deeper does the purification take place. No building would of course be allowed on such sites and no house system of drainage would therefore be necessary.

I have replied so far as I have been able to Colonel Dantzig questions and though in reference to Para 5 (1) I have not been able to give a decided answer I think I have said enough to enable a clear opinion to be formed on the matter.

I

43 110

I have the honor to be

Sir,

Your most Obed[t] Servant

[signature] M.L.C.

Vice President M.C.

LSM

CM

No.

744 111

- Note by the Chief Engineer -

8/4 "82

The Secretary of
State in Despatch No. 12
"Statistics and Commerce"
dy 22nd June 1882 calls the
serious attention of the Mad-
ras Government to the
Condition of matters pre-
vailing in the Presidency
Town as set forth in a
Memorandum by the Army
Sanitary Commission dy
18th April 1882.

2. The latter body after
reviewing the Report of
the Madras Municipal-
ity for 1880 observe (para 6)
that they "would strongly
"urge the inexpediency of
"wasting money upon
"the incomplete and un-

satisfactory surface drainage plan now in process of execution which does not fulfil any conditions of a proper drainage system" and "recommend at the same time that a complete system of town and house drainage in combination with an improved and extended water supply for removing house sewage separately from the rainfall be at once adopted". They conclude their report by observing that the whole subject should be taken in hand by the Government of the Madras Presidency.

3. The delays in regard to the drainage of Madras which have appeared incomprehensible and unreasonable to the Army

Sanitary Commission have arisen from inherent difficulties of a very serious character which notwithstanding the reports of such well known professional Engineers as Major Pulloch R.E. and the late Mr W. Clark M.S.C.E. and the strenuous efforts of a succession of Govt Officers and Presidents of the Municipal Commission, who over and all have certainly spared no pains in their endeavours, have hitherto proved to be insuperable. 4-To state the difficulties in detail is unnecessary but the mention of a few of the leading facts may be useful. Madras has a population of 406,000 distributed in at least different centres, over an area of

of 27 square miles. No portion of the latter is raised more than 24 feet and some places are only 2½ feet above mean sea level; during cyclones when the sea along the coast is abnormally high the surface of the sea is raised much of the place is then below mean sea level. In ordinary times the sea is practically tideless as it is during "springs" the difference between high and low water being not more than 3½ feet. To add to the difficulty of collecting & discharging the sewage of the many large and scattered aggregations of population the north is separated from the South of Madras by a winding river which for the most part is a backwater receiving

the contents of natural drainage channels which are shallower and if anything more straggling than itself.

5. To any one acquainted with the difficulties which for the most part have proved insuperable as regards the effective drainage of the cities and towns situated along the littoral of the Mediterranean the bearing of the above facts will be sufficiently evident

Here Madras a flourishing commercial centre with a rapidly expanding trade it is possible that the needful funds might be raised for dealing in some effective way with its drainage, but as the population is of the poorest and trade not apparently increasing there, it may

may at once be assumed that without Government aid the Municipality are quite unable to carry out the needful sanitary works on a large scale, and for want of means are compelled to confine themselves to palliatives. The Government on its side have been equally unable to come to the rescue, as from the manner in which the Imperial burdens have been distributed the Provincial resources of this Presidency have hitherto been unduly starved in the interests of ~~Bombay~~ ~~Madras~~ other ~~provinces~~ provinces -

6- Major Tulloch's scheme of 1864-65 amounting to 39½ lakhs provided for a perfectly closed system of drainage ex-cluding rain and storm waters. A main sewer

starting from St Thomé was to be carried under the Cooum River to a well north of the town from which the liquid sewage was to be pumped into a channel two miles in length along the course of which it was to be em-ployed in irrigation -

7- Mr Clark in 1875 followed Major Tulloch's scheme in the main, but by cutting off several of the out-lying tracts, and particularly St Thomé, which was to have a separate sewer discharging direct into the sea, he was enabled to reduce his estimated total outlay to 23½ lakhs.

8- Both Engineers however omitted from their schemes the expense of two sluices over and other of which

it is thought should be taken into account in estimating the total outlay required

The first of these is a supply of water under pressure all over the town. This would be quite essential in any system such as that apparently advocated by the Army Sanitary Commission and forming part of Major Tulloch's and Mr Clarke's schemes; where the effete of each house are carried off by a pipe of small dimensions (exclusive of all surface drainage) discharging into a system of closed town sewers.

The second item is that of the cost of the house connections. The Municipal Act of Madras like that of other towns where

such institutions? R48 115

such institutions grant confers the needful powers on the Commissioners to enforce the construction of all house connections at the cost of the proprietors; but to any one acquainted with the extreme poverty of the majority of the Madras population it is quite clear that with a very large number it would be useless to attempt to put this provision of the act in operation.

Q It will be observed from the correspondence which has lately taken place with the President of the Municipal Commission that both the above points have now received careful consideration, with as regards probable outlay the following results. See Mr Jones' letter No 1 of 7th September 1882

(1) Water Supply Extended so as to meet the requirements of a completely closed system

(a)

(a) Improved arrangements to give increased head of pressure throughout the town - Rs 13,60,000

(b) Extension of the street mains 8,00,000

(c) House service 24,40,000
Half say recoverable from householders . . 12,20,000

Total water supply . 33,80,000

(2)- House drainage Rs 20,00,000
of which say half would be recoverable . . . 10,00,000

Total Rs 43,80,000

Major Tulloch's scheme with the above additions, but excluding arrangements for dealing with the drainage of the subsoil of which more presently is the only one which would apparently fully meet the requirements of the Army Sanitary Commissioners, there can however be little doubt that his estimate if

N.B. Half of the cost under (c) and (2) has been taken as recoverable under the opinion expressed by the Arundel President, Municipal Commission

put in actual execution would not cost less than 45 lakhs.

The total outlay which would have to be met from public funds is 45 + 43.8 = 88.8 lakhs. Under Mr Clark's restricted scheme amounting to 23½ lakhs the extent of house drainage and water service main in Major Tulloch's would be less. If the cost of both the latter items be taken at 40 lakhs the total under his proposed system of works would be 40 + 23.5 = 63.5 lakhs.

10 The Army Sanitary Commission lay considerable stress on the foul condition of the subsoil and the necessity of dealing with this as part of a well designed and comprehensive scheme; but as will be observed from the letter from the Chemical Examiner No 319

d/ 22nd August 1882, that officer is of opinion from the analysis of soils taken at a depth of 4 feet from different localities in Madras that "the results obtained indicate a far greater immunity from filth and contamination than could have been expected"

4- Again that there are considerable difficulties in deciding both as to the measures to be taken & the probable effect of such in regard to the drainage of the subsoil waters will be seen from the observations contained in paras 12 to 20 of Mr Jones' letter No 1181 of the 9th September 1882 - As remarked by him in para 16 the water in the wells stands usually to about 1 foot to 1½ ft above mean sea level," and if the result of any considerable lowering of the subsoil water ~~level~~ as he supposes to "the introduction of salt water where fresh is now" the general effect would it is thought be extremely injurious as the admixture of salt with fresh water is understood to increase fourfold the effect in dissolving sewage matter held in suspension -

12- This is a matter to be decided by chemical experts, but as a question of professional engineering there can be little doubt that to deal in any comprehensive way with the subsoil waters would need a very extensive network of underground drains which should have contrivances for admitting freely all subsoil waters and dissolved sewage matter

without at the same time
allowing the fine particles of sand of which
the soil to a great & deep
consists to be washed out
13 Looking at the question
in this light it would
appear undesirable to
attempt anything more
than the arrangement
contemplated in Mr Clark's
scheme for placing small
inlet pipes, well protected,
at sufficiently short inter-
vals along the lines of
main sewer so as to get
rid, as far as may be
possible, of the dissolved
sewage matters which may have soaked into the soil
in the immediate neighbour-
hood of each. Should
there be any sensible
washing out of the sand
it is needless to say
that in process of time,
as one of the evil results,
the stability of buildings
in the 1857 18 neigh-
-bourhood must necessarily
become endangered. On the
whole therefore, in dealing
with this part of the sub-
ject, it will be best not
to contemplate any very
extensive works, and a
sum of 5 lakhs may be
assumed as the limit
of necessary outlay.

14 The approximate cost
of the several schemes
would therefore stand
as follows, taking into
account the several ad-
justments as above:-

(1) Major Sullocks scheme
with the cost of house
water supply service &
and drainage &c. 88,50,000

Mr Clarke's - Do - 63,50,000

Army Sanitary Commission's
(being Major Sullocks scheme
with 5 lakhs added for deal-
ing with subsoil water) 93,50,000

Each and all of these
schemes it must be re-
membered leave out of

do

without at the same time
allowing the fine par-
ticles of sand of which
the soil to a great & deep
consists to be washed out
13- Looking at the question
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there be any sensible
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that in process of time
as one of the evil results,
the stability of buildings

in the [illegible] 1857 118 neigh-
-bourhood must necessarily
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whole therefore, in dealing
with this part of the sub-
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to contemplate any very
Extensive works, and a
sum of 5 lakhs may be
assumed as the limit
of necessary outlay.

14- The approximate cost
of the several schemes
would therefore stand
as follows, taking into
account the several ad-
justments as above:-

(1) Major Sullocks scheme
with the cost of house
water supply service &
and drainage &c - 88,80,000

Mr Clarks - do - - 63,50,000

Army Sanitary Commissions
(being Major Sullocks scheme
with 5 lakhs added for deal-
ing with subsoil water) - 93,80,000

Each and all of these
schemes it must be re-
membered leave out of

account the following sums which would have to be borne directly by each of the house holders as may be called on to bear the wordful outlay for house-connections, both water supply and drainage, viz-

Half of the house water supply head (1) above. 13,20,000

Half of the house drainage head (2) above } 10,00,000

Total Rs 22,20,000

15 with a population fixed it is believed very nearly to the utmost it is needless to say that the Expenditure of enormous sums of this character cannot be thought of. Even were Government in any way able (which it is not) to meet the outlay demanded by the schemes understood to be advocated as to the Army Sanitary Commission it is very question-

whether in justice to the many other pressing demands on account of other matters of the highest importance to the welfare of the Presidency, it could venture to do so, and again to compel even the well-to-do inhabitants to spend over 22 lakhs out of their own pockets in addition to meeting the demands of increased taxation, is to say the least chimerical.

On all accounts therefore it is necessary to consider whether there are not other means for bringing about as far as possible sound sanitation.

6. Mr Jones' scheme is in this view the only one ~~at all feasible~~ which has up to the present time been put forward as holding out reasonable prospects of success.

As

generally described, ie, like both Major Tulloch's and Mr Clark's schemes, proposes to deal almost entirely with the removal of sewage matters, to the exclusion of the storm waters, but as with chiefly saucer shaped open surface drains he has no need of water under pressure in each house, or of a closed system of house or street drains, excepting where for the requirements of slope the latter have to be converted into underground sewers, the cost is at once sensibly reduced.

In acting moreover on the principle that the sewage of each of the several districts of population shall be employed in irrigating and raising crops on available land in the immediate vicinity two very serious items

of charge are minimised. In the first place there is no need for a very long sewer or sewers of large capacity to convey the liquid sewage to any one point for the whole town, and in the second the diminished height through which the sewage has ultimately to be lifted.

These and other matters connected with Mr Jones' scheme, including the very important facts tending to shew that the plan of utilizing the sewage in irrigation has been improved by actual experiment to be rather remunerative than otherwise, and to be open to but small objections on the grounds of being offensive to the public, are very fully explained in his letter No 1256 d/27th September, and the map

which accompanies it.
2. The method of dealing with the separate house drainage is fully & apparently satisfactorily explained, and on the whole it would be fair to accept his estimate ~~of 11 Lacs~~ for the work as specified by him viz-

		Rs.
Street Drainage		15,27,000
Land for Sewage Farms		3,00,000
House drains	800,000	
Half Cost of . . .	}	4,00,000
Improved water supply		14,66,000
	Total	36,93,000

To which may possibly be added

To levelling & paving back yards (See Mr Jones' letter No 1256)		2,00,000
	Grand Total	38,93,000

This last item of 2 lakhs would, if admitted, have also to be added to all the other schemes if put in comparison. There can be no doubt that the drainage of the back yards must be thoroughly

dealt with if sound sanitation is to be secured & this item must therefore apparently be included.

Q. Mr Jones is still apparently satisfied that his sewer drains will stand sufficiently well, all wear & tear with a cement surface, but on this point there is room for doubt, and it would be advisable to keep in view that stone surfaced drains may as previously recommended have to be adopted, in which case not less than 2½ Lakhs should be added to the probable cost of his scheme, bringing the total with the addition for flooring of the back yards to Rs 41,43,000. In addition to this house holders who can equitably be compelled under the act to supply pucca per house drainage & connections

connections would have to incur the following items of expenditure from their private means. viz.

2o half cost of house drains 8 lakhs . . Rs 400,000

2o half cost of levelling and paving the back yards, 200,000

Total 600,000

On the whole therefore it may be broadly stated that Mr Jones' scheme would entail an outlay of not half that apparently contemplated by the Army Sanitary Commission so far as concerns the expenditure of public funds, but what is even of greater importance the compulsory outlay by private individuals would be ~~reduced~~ to ~~6 lakhs~~ as against 22.2 Lakhs. Even these however reduced to a minimum the total charge is quite beyond

at his disposal means of the Municipality who must consequently su- -less aided by Government content themselves with carry- -ing ~~with drooping~~ as they are now doing out the Black Town portion of Mr Jones' scheme which is clearly the one of most pressing importance.

2o Great stress has been laid in the report by the Army Sanitary Commission on the preferability of a closed as compared with an open system of drains for Madras, but on this point there is reason to doubt whether the opinion is well founded.

In a hot climate the evolution of sewage gases must of necessity be much more rapid and there- -fore more likely to pro- -duce mischief than in a cold one, and considering the habits, and the small

of

possessed by
the natives anything
approaching to a water
Closet system is not for
a moment to be thought
of.

On the other hand
house drains which can
be easily got at for daily
cleansing or for occasional
repair have much to re-
commend them both on
the score of cleanliness
and economy, while for
the outer street drains the
arguments in favor of these
being kept, as far as pos-
sible, open to the action
of the sun and air
as also for ready scavenging
appear to be unanswerable.

The sun which is an enemy
to be dreaded
with all closed pipes & drains
is the reverse where organic
matter is exposed, as all
who have had sufficient
acquaintance with India
can attest. Hence in fact

1856

the sun is the best of friends,
and shower, if properly
turned to account, do more
to keep Madras healthy than
perhaps anything else save
the beneficent sea breeze,
which no doubt holds the
first place as a sanitary
agent. The real difficulty
is how to have sufficient
lengths of drain kept open
and exposed to the action
of the sun, as the requirements
of slope demand their being
but too soon converted into
underground sewers.

W. Lawley
C.E.

4/10/82

No 2845 W

(24

PUBLIC WORKS DEPARTMENT.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

UNDER date the 30th Oct 82

Read the following:—

Despatch from the Right Hon'ble the Secy. of State for India (No No 12 Statistics and Commerce dy 22d June 1882)

Letter from the President Municipal Commissioner, Madras (" " G. No 566 dy 4th Augt 1882)

Do from the Chemical Examiner, Madras (" " 319 dy 22d " ")

Do from President Municipal Commissioner, Madras (" " 1181 dy 9th Septr ")

Do do (" " 1258 dy 29th " ")

Note by Chief Engineer P. W. Dept (" " dy 4th Octr ")

57

Ordered that the Secretary of State be addressed

President, Madras M.C. Select Committee for the amendment of the Municipal Act

Legislative Dept with the copy of Despatch

J. for 16/11/82

P. W. Dept

45.

No 2846 W. of 30 October 82

To,

The Most Honble

The Secretary of State for India

My Lord Marquis,

We have the honor to acknowledge the receipt of your Lordships' Despatch No 12 (Statistics and Commerce) dated 22nd June 1882 forwarding copies of a Memorandum by the Army Sanitary Commission on the Report of the Madras Municipality for 1880, and directing the submission of

a special report with reference to the remarks on the sanitary condition of the district over which it possesses jurisdiction

I am to request that you will be good enough to forward for your Lordship's information copies of the accompanying papers from the Municipal Office and from our Chief Engineer reviewing the Report of the Sanitary Commission, and explaining the present condition and future prospects of the Municipality in regard to sanitation, conservancy, and water supply.

We would particularly invite attention to

last paper in the series, 126
from which it will be apparent that the delay in grappling with the question of drainage and water supply of Madras is due, apart from financial considerations, to the Engineering difficulties presented by the generally low level of the ground on which Fort St. George and Black Town, with the surrounding far-scattered group of villages collectively known as Madras, are built, and by the tideless character of the sea into which the sewage, if not utilised for irrigation, has to be

a special report with reference to the remarks on the sanitary condition of the district over which it exercises jurisdiction.

2. In reply we have the honor to forward for your Lordship's information copies of the accompanying papers from the Municipal officers and from our Chief Engineer reviewing the Report of the Sanitary Commission, and explaining the present condition and future prospects of the Municipality in regard to sanitation, conservancy, and water supply. We would particularly invite attention to Col. Sankey's Note, the

with Mad. No. 12

last paper in the series, from which it will be apparent that the delay in grappling with the question of drainage and water supply of Madras is due, apart from financial considerations, to the Engineering difficulties presented by the generally low level of the ground on which Fort St. George and Black Town, with the surrounding far-scattered group of villages collectively known as Madras, are built, and by the tideless character of the sea into which the sewage, if not utilized for irrigation, has to be

discharged. These difficulties have hitherto been found to be insuperable, at any thing like a reasonable outlay, notwithstanding the high professional talent which has been employed to surmount them; and looking to the financial condition of the Municipality, it seems utterly hopeless to expect that any really effective remedy of a sufficiently comprehensive character can be applied by that body. It remains therefore to consider whether the Govt should come to the aid

B3

Municipalities [V]

of the ~~Corporations~~, and to what extent.

3. The lowest of the approximate estimates framed by the Municipal Engineer, and adopted by our Chief Engineer with slight modifications, is so large in amount that the resources of this Government are wholly inadequate to afford any material aid, having in view the many pressing demands to be met from Provincial funds throughout the Presidency.

4. We therefore see no prospect of any complete scheme of ~~conservancy~~ drainage & Sanitation being

carried out, unless the
burdens now borne by
Imperial and Provincial
funds respectively are
readjusted to the advantage
of the latter.

5. In the meantime, how-
ever, the most pressing
and immediate needs of
Madras will be met under
the scheme which has been
framed by the Municipal
Engineer for the drainage
of Black Town; but
we are very far indeed
from considering that,
when that is finished,
very much will not still
require to be done, and
done as soon as it is
in any way possible to

do it.

6. We are quite aware
that the sanitation of
Madras compares very
unfavourably with that
of most civilised capitals,
and are most anxious
to remedy a state of things
in which we only acquiesce
from our utter inability
to meet the vast outlay
without which it would
be impracticable to
deal successfully with
it.

To be despatched 15/11/92
with Municipal Map.

E. Ed.

Govt. of [1882] Madras.

PUBLIC WORKS.

Received
& Entered
in Main Diary

G. O. 30th Oct. 1882, No. 2845 & 2846.

Nos. 201 to 203

Forwarding with observations papers from the Municipal Officers & Town Engineer reviewing the Memorandum by the Army Sanitary Commission on the Report of the Madras Municipality for 1880.

Entd in Receipt Register