MADRAS SEWAGE FARM.

REPORT OF THE COMMITTEE APPOINTED IN G.O. No. 825 M., DATED 23RD APRIL 1913.

1913.

MADRAS:
PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRESS MOUNT ROAD, BRANCH.

1914.

OFFICE OF SANITARY ENGINEER TO GOVERNMENT,
CHEPAUK,
MADRAS, *26th December 1913.*

No. 2860.

From

W. HUTTON, A.M.I.C.E.,
SUPERINTENDING ENGINEER,
SANITARY ENGINEER TO GOVERNMENT AND
CHAIRMAN, MADRAS SEWAGE FARM COMMITTEE.

To

THE PRESIDENT,
CORPORATION OF MADRAS,
Madras.

SIR,

With reference to G.O. No. 825 M., dated 23rd April 1913, in which the Madras Sewage Farm Committee was constituted and were requested by Government to consider and report to the Corporation of Madras whether the Tondiarpet Sewage Farm is a source of danger to health as a cause of malaria, mosquito nuisance, or contamination of subsoil and what improvements can be made, I have the honour by direction of the Committee to forward to you their report.

The report is accompanied by a number of plans and appendices as detailed in a separate list attached to this letter.

2. The Committee invite your attention and that of the Corporation to eleven resolutions which they have drawn up as a summary of the principal conclusions arrived at by the Committee.

3. The report and resolutions have been signed by the three members of the Committee at present in India. The remaining member Dr. Maitland Gibson, after attending the earlier meetings of the Committee, had unfortunately to proceed on leave, but before doing so he was good enough to arrange for any investigation required to be carried out at the King Institute. His views were obtained before his departure and it is believed that had he been present he would also have signed the Committee's Report and the eleven resolutions.

4. The Committee found after a preliminary investigation that it was advisable to obtain an authoritative opinion on the questions whether malaria-carrying mosquito larvæ were present on the Sewage Farm and also whether non-malaria-carrying mosquitoes were breeding in numbers on the Farm.

Through the kindness of Mr. D. T. Chadwick, I.C.S., Director of Agriculture, the services of Mr. Bainbrigge Fletcher, the Government Entomologist, were fortunately obtained as the Malaria Board owing presumably to paucity of officers available were unable to immediately detach an officer for personal investigation of the Sewage Farm.

Mr. Bainbrigge Fletcher was good enough to favour the Committee with two reports which are printed as an appendix to the Committee's report and further carried out a personal investigation during a two days' inspection of the Sewage Farm.

The Committee wish to take this opportunity of placing on record their special thanks to Mr. Bainbrigge Fletcher not only for his valuable opinions, but also for the great personal interest he took in complying with the request of the Committee.

5. The Committee also desire to accord their best thanks to yourself and to Mr. A. Y. G. Campbell, C.I.E., I.C.S., for the ready manner in which information on the subject of the Sewage Farm has been supplied to them and also for the facilities granted to them at the various inspections of the Farm and the City. They also desire to thank the other officers of the Corporation for the work which they have done in complying with the Committee's requests for plans, levels and other information necessary.

I have the honour to be,
Sir,
Your most obedient servant,

W. HUTTON,
Chairman, Madras Sewage Farm Committee.

26th December 1913.

OFFICE OF SANITARY ENGINEER TO
GOVERNMENT, CHEPAUK,
MADRAS, *3rd March 1914.*

No. 2860-A.

From

W. HUTTON, A.M.I.C.E.
(SUPERINTENDING ENGINEER),
SANITARY ENGINEER TO GOVERNMENT AND
CHAIRMAN, MADRAS SEWAGE FARM COMMITTEE.

To

THE PRESIDENT,
CORPORATION OF MADRAS,
Madras

SIR,

In continuation of my No. 2860, dated 26th December 1913, and with special reference to paragraph 3, I have the honour to inform you that Dr. Maitland Gibson has since returned from leave and has signified his approval of the conclusions arrived at by the Committee and also of the Report.

I have the honour to be,
Sir,
Your most obedient servant,

W. HUTTON,
Chairman, Madras Sewage Farm Committee.

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CONCLUSIONS ARRIVED AT BY THE MADRAS SEWAGE FARM COMMITTEE AS A RESULT OF INSPECTION OF THE TONDIARPET SEWAGE FARM AND SURROUNDING AREA AND CONSIDERATION OF THE OBJECTIONS RAISED TO ITS CONTINUANCE.

1. The Committee are of opinion that the inspection and report of Mr. Bainbrigge Fletcher, the Government Entomologist, supply evidence to show that the Tondiarpet Sewage Farm is not a probable breeding ground for all the Anopheline mosquitoes which cause malaria in the adjacent area of Tondiarpet and consequently the question whether the Sewage Farm is a primary cause of malaria in the adjoining inhabited area must on this ground be answered in the negative.

2. The Committee are of opinion from the report of Mr. Bainbrigge Fletcher and from their own observations that the presence on the Tondiarpet Sewage Farm of numerous ponds and swamps, in which the larvæ of non-malaria-carrying mosquitoes were found to be present in large numbers, shows that the Farm is a contributory cause of mosquito nuisance and that the present policy of filling up ponds and swamps on the Farm should be continued and it is advisable to expedite the work by utilising the sand from the adjoining sea beach.

3. The Committee are of opinion that the subsoil water level in the neighbourhood of the Sewage Farm is raised owing to the presence of the Farm and that this raising is of great benefit to the owners of cocoanut and other plantations in the vicinity in irrigating their lands from ponds and wells.

4. They are further of opinion that this raising of the water level will increase the breeding grounds of Anopheline mosquitoes in the Tondiarpet area. So to this extent the Sewage Farm might be considered as a contributory cause of the prevalence of malaria.

5. The Committee consider that the danger of contamination of water in wells owing to the presence of the Sewage Farm can only extend to the immediate vicinity of the Farm.

6. To what distance the pollution of the subsoil water by the Sewage Farm extends cannot, owing to the ordinary pollution of the subsoil itself, be determined, but the Committee consider that in the case of Tondiarpet no well should be used for drinking purposes within 300 yards of the Sewage Farm, and that the earliest opportunity should be taken by the Corporation to see that this part of the town is provided with a sufficient piped water-supply and that the existing drinking water wells are permanently closed.

7. The Committee consider that the present rate of 50,000 gallons of sewage per acre applied to the Tondiarpet Sewage Farm is more than the land can be expected to efficiently dispose of under present conditions and that when the strength of the sewage increases, owing to the construction of the new drainage works and sanitary conveniences, the necessity for reducing the quantity of sewage applied per acre will be more evident.

The Committee consider that, as soon as necessary arrangements can be made, the quantity should be reduced to a maximum of 30,000 gallons per acre per day.

8. The Committee consider that the present Sewage Farm should be laid out and worked according to the system described in Mr. Sampson's report, till such time as the new Farm proposed in Resolution No. 11 is brought into operation.

9. The Committee are of opinion that the smell from the Sewage Farm is most evident at the open channel and is caused by the agitation of the sewage when dropped through the sluices and that it is advisable to arrange these sluices as shown in an appendix to the Committee's report so as to obviate any agitation of the sewage *en route* to the distributing channels.

10. The Committee are of opinion that owing to wave action towards the shore and the consequent erosion of the sea beach north of the harbour the suggestion that the sewage should be pumped into the sea at this place is not sanitarily sound and might result in more objections than have been raised by the presence of the Tondiarpet Sewage Farm.

11. With reference to the question of the effect on the health of the city owing to the presence of the Tondiarpet Sewage Farm, the Committee consider that the general principle that no Sewage Farm should be within a municipal area should be accepted in dealing with the question of the site of a Sewage Farm for Madras and that as the present Sewage Farm does not fulfil this general condition the Farm should be abandoned as early as practicable and a new Farm opened north of Tiruvottiyur and east of the Ennur Road to which the sewage of the city should be pumped and there disposed of on sound agricultural methods.

W. HUTTON.
H. C. SAMPSON.
W. H. HARRISON.

THE MADRAS SEWAGE FARM.

General Description.

Sewage Farms in Madras City.—The treatment of sewage on land by the Municipality of Madras is stated to have been carried out in the first instance as an experimental measure in the year 1868. In that year it is recorded that Mr. Standish Lee, the then Executive Engineer, established Farms with the view of testing the suitability of this method in satisfactorily disposing of the sewage of certain sections of the town. In the following year, 1869, the first permanent Sewage Farm was established at DeMellow's Road and following on the successful operations at this Farm new Farms in other localities were opened from year to year down to 1885. In that year one of the Farms, the Tondiarpet Sewage Farm, became the most prominent Farm in Madras owing to the construction of the open drainage scheme of Georgetown and the opening of the main or Royapuram pumping station.

This station daily pumped to the Tondiarpet Farm the sewage from the Georgetown section of the city and owing to the large quantity of sewage dealt with that Farm became a prominent feature within the city area. This Farm was apparently first named the Black Town Sewage Farm, but its designation has since been changed to Tondiarpet Sewage Farm by which name it is now well known. The site of this Tondiarpet Sewage Farm is within municipal limits at the extreme north end of the city, and on its eastern boundary immediately adjoins the open sea.

The soil is sea sand and has been found to be of an extremely porous nature and highly suitable for the treatment of sewage and the growing of grass crops.

The area of the Farm in 1885 as far as can be determined was 43·97 cawnies or 58 acres. The sewage from the Royapuram pumping station was pumped through a cast iron main 24 inches in diameter by steam pumping engines and delivered into a junction well at the beginning of an open main distributing channel whence it was distributed over the land by sub-distributors on practically the same lines as is now being followed.

In those days complaints were raised of smell from the open channel and Mr. J. A. Jones, the then Municipal Engineer, recorded his opinion that the nuisance arose from the agitation of the sewage in the junction well and that it would be necessary to cover in the channel for some distance.

The operation of sewage disposal in Madras City continued in the manner described down to the year 1906 when an important addition was made to the drainage arrangements of the city by the partial completion of the new drainage works and the opening of five new pumping stations from which the sewage from five additional sections of the city was pumped through a cast iron main, 9 miles in length, for treatment on an extended Tondiarpet Sewage Farm. The distribution on the Farm was at this time altered from a main open channel distributor to a large cast iron pipe provided with a number of 12-inch branches for supplying the

sub-distributing channels, the discharge being regulated by means of sluice valves.

The Farm, apparently, was simultaneously extended by a further area of 65·16 cawnies or 86 acres, thus making the total area of the Tondiarpet Sewage Farm, in the year 1906, 144 acres in extent. Except for increased discharge from the Royapuram pumping station no additional quantity of sewage has been pumped to the Tondiarpet Sewage Farm up to the present year.

Owing to erosion from the action of the sea the Tondiarpet Sewage Farm consists at present of only 126 acres.

Works are now being carried out by means of which an additional quantity of sewage will be pumped to the Farm, this quantity coming from the new pumping stations in the Tondiarpet section of the town.

Plans and estimates have also been drawn up for completing the drainage of Madras on the underground sewer system and for remodelling the five sections of the town alluded to above and also for sewering the Georgetown area in lieu of the present system of open drains in that area. Simultaneously the water-supply of the city is being increased from 16 to 25 gallons per head per day. The result of these alterations and improvements will mean a large increase in the volume of sewage to be dealt with on the Tondiarpet Sewage Farm and to deal with this increased quantity it has been proposed to extend the present area of the Farm by the acquisition of 126 acres to the north.

Location of the Tondiarpet Sewage Farm and nature of Soil.

The area included in the city of Madras is 27 square miles and this area extends for a distance of about 9 miles along the sea-front and for a distance of about 3 miles inland. The prevailing wind in this area is from the south-east and consequently the most suitable location of sewage disposal works would be north-west of municipal limits. But in this direction there is no suitable area of land within a reasonable distance of the city, and it has been found necessary to locate the Sewage Farm of the city to the north instead of to the north-west.

The result of so locating the Sewage Farm renders the site theoretically unsuitable during those months in the year when the wind is from the north-east. When the wind is from the prevailing direction south-east, the site of the Tondiarpet Sewage Farm is from this point of view unobjectionable so far as Madras is concerned. The western boundary of the Tondiarpet Sewage Farm adjoins an area 1,000 feet wide occupied by cocoanut plantations with a number of houses scattered throughout the area. Immediately to the west of this plantation area is the Tiruvottiyur High Road on both sides of which a large number of important houses have been constructed. Owing to the prevalence of malarial fever among the inhabitants, several of these houses have been vacated of late years, and among other causes the reason for the prevalence of the malarial fever has been ascribed to the presence of the Tondiarpet Sewage Farm in the vicinity. To the south the Farm adjoins an inhabited area called Cassimode while on the northern boundary there are no houses adjoining the Farm.

The obvious reason which, no doubt, determined the site of the Farm was the very favourable character of the soil north of the city. The soil at this place is apparently ancient sea beach and is composed of pure sand of a highly porous character. No other town of any size is believed to have such exceptional soil for sewage treatment so close to municipal limits, and the Tondiarpet Sewage Farm has been taken as the standard of natural advantages to which other places by special means attempt to aspire.

Lay out of Farm.

The Tondiarpet Sewage Farm was originally laid out on the ridge and furrow system without artificial drainage.

The Farm originally was irrigated from an open main channel from which subsidiary channels branched off along the ridges of the various plots. In 1906 the system was changed to a 33-inch cast iron main which was laid along the western boundary of the Farm and subsequently in 1911 an open masonry channel was substituted for the cast iron main distributing pipe with the object of utilising the pipe elsewhere as a rising main in connection with the new drainage works and with the additional object of allowing for increased discharge in the future while the frictional resistance of the old cast iron main was partially eliminated.

The open masonry channel now extends along the western boundary of the Farm and is provided with a flood escape sluice at its northern limit. From this sluice excess sewage in rain storms is passed into a "nulla" which skirts the northern boundary of the Farm and discharges into the sea.

At suitable intervals along the masonry channel plank sluices are provided for supplying the distributors which convey the sewage along the ridges of plots.

The ridge and furrow plots were laid out with the ridge and furrow at right angles to the open masonry channel, and provided excess sewage is not discharged on to the plots there is no escape of sewage into the sea on the eastern boundary of the Farm. The ridge and furrow system originally laid has gradually become a compromise of this system and the flat bed system and owing to want of sufficient attention to the regulation of the flow of sewage, there is considerable discharge of sewage on to the sea beach.

The oldest part of the Farm contains cocoanut topes and other parts were originally old burial grounds. Scattered throughout the area of the Farm there are numerous ponds, and the newer part of the Farm contains a considerable area of land which is so low that resulting from faulty irrigation it may now be rightly classed as a swamp. This will be easily seen by reference to the Corporation plans, sheets Nos. 2 and 3.

In the areas which have been laid out in ridge and furrow from the open masonry channel on the west to the eastern boundary adjoining the sea-shore, no stagnation of sewage occurs for any length of time as, owing to the exceptionally high porosity of the sandy subsoil, the sewage is either absorbed into the soil or assimilated by the luxuriant crops of Hariali grass which is grown on the farm and sold as hay at a considerable profit.

Quantity of Sewage treated on the Farm.

In 1884–85 and up to 1906, the sewage treated on the Tondiarpet Sewage Farm came from the Royapuram main pumping station which was constructed to remove to the Farm the sewage from the Georgetown section of the city.

The quantity of sewage daily pumped to the Farm from Royapuram pumping station was about 2¼ million gallons, and this quantity was apparently treated on an area of 58 acres. This means that each acre of the Farm was expected to dispose of an average quantity of nearly 39,000 gallons daily.

In 1906 five more pumping stations started to pump sewage to the Tondiarpet Farm from other sections of the town on the partial completion of an underground drainage system for these sections. The quantity of sewage pumped by these five new pumping stations was stated to be 3,725,000 gallons daily and, to deal with this quantity, the Tondiarpet Farm was apparently enlarged by the additional area of 86 acres making a total of 144 acres.

On the usual deduction, from this area, of the area occupied by topes, ponds, swamps and the daily area being harvested, it is presumed that possibly 100 acres were actually under crop. This gives an average number of gallons treated per acre of land under crop of 60,000. Although an additional pumping station, Law College, has been added to the Georgetown area, still, as the five pumping stations referred to above have lost in efficiency by continuous working and for other reasons and, as accurate measurements by venturi meter are now being recorded, it would appear that the amount actually reaching the Farm at present is considerably less than the quantity estimated in 1906.

The figures supplied by the Corporation show a daily treatment of sewage of 5 million gallons on an area of 80 acres, the gross area being 126, the reduction from the previously stated total area of 144 being due to erosion of the sea face of the Farm.

Assuming the irrigated area to be 20 per cent. less than the area under crop, 100 acres of the Farm will receive on the average 5 million gallons of sewage daily. This means an average daily treatment of 50,000 gallons of sewage on the effective area of the Farm.

Objections raised to the presence of the Sewage Farm at Tondiarpet.

The following objections have been raised to the presence of the Tondiarpet Sewage Farm on the site occupied by it :—

(1) The Farm forms a breeding ground for mosquitoes which are the cause of malaria in the adjoining Tondiarpet area of the city.

These mosquitoes are said by the advocates of this statement to breed in millions on the sewage farm, to hide in the day-time in the grass, especially the chappar grass, and in the evenings with the sea breeze they invade houses not only in Dhobypet (adjoining the Farm) but a mile all round.

(2) The smell emanating from the Sewage Farm and the open channel becomes intolerable in the evenings.

(3) The subsoil water in the area to the west to a distance of 3,500 feet is contaminated and this contamination is detrimental to public health as the people in this area use wells to a considerable extent as a source of water-supply owing to the deficiency existing in the piped water-supply of Tondiarpet.

(4) The drainage of Dhobypet is towards the sea but owing to the construction of the open channel and a road by its side on the western boundary of the Farm, this drainage has been interrupted and in 1911 and 1912 Dhobypet was reported to have been under water for two months each year.

Government Order forming a Committee of Investigation.

The Government of Madras at the request of the Corporation issued G.O. No. 825 M., dated 23rd April 1913, constituting a special Committee consisting of—

Mr. W. Hutton, Sanitary Engineer to Government (Chairman), Dr. F. Maitland Gibson, Director, King Institute, Guindy, Mr. W. H. Harrison, Government Agricultural Chemist, College of Agriculture, Coimbatore, and a farming expert to be nominated by Mr. D. T. Chadwick, Director of Agriculture.

In accordance with this direction, Mr. H. C. Sampson, Deputy Director of Agriculture, was subsequently nominated as a member of the Committee. The terms of reference to the Committee were stated in the Government Order appointing the Committee as follows :—

"To consider and report to the Corporation of Madras whether the Tondiarpet Sewage Farm is a source of danger to health as a cause of malaria, mosquito nuisance, or contamination of subsoil and what improvements can be made."

The Committee on its formation called on the President of the Corporation for all papers on the subject of the complaints raised against the Tondiarpet Sewage Farm and for the necessary plans illustrating the site and the surrounding areas and for the necessary surface levels and subsoil water levels. The request of the Committee was complied with as far as possible and arrangements were made by the President of the Corporation for the necessary establishment to take the levels required and to prepare the plans which were not otherwise forthcoming from existing records.

The Committee subsequently inspected the Farm and the surrounding area, discussed the questions raised in the Government Order, and considered the objections as set forth above.

In the first place, it was considered necessary, owing to the absence of plain statements of fact, to make a reference to the Malaria Board as to the actual presence on the Farm of malaria-carrying mosquitoes. As there was some difficulty felt by the Malaria Board in complying with the request of the Committee, owing presumably to the paucity of expert officers at their disposal, the Board was subsequently requested not to proceed further with the request of the Committee as the services of a competent officer had been obtained.

Thanks to the Director of Agriculture ; the services of the Government Entomologist, Mr. Fletcher, were obtained and this officer kindly favoured

the Committee with his views on the question of the breeding of malaria-carrying mosquitoes in sewage and, subsequently, Mr. Fletcher was good enough to visit the Farm and to carry out a two days' personal investigation as to the actual presence of malaria-carrying and other mosquitoes on the Farm and on the adjoining area to the west.

The Committee also arranged for the taking and analysing of samples of soil, sewage and subsoil water and inspected trial pits on the Farm. An area 10 yards square was dug over and left to weather.

The Committee also inspected the area to the north proposed for the extension of the Farm by 126 acres and continued their researches in the direction of complying with the Government Order as to present and future provision of Sewage Farms for the city and at the same time carefully considered the suggested alternative of pumping the sewage into the sea without further treatment.

Methods of Sewage Disposal.

There are three methods which may be considered in connection with the disposal of the sewage of Madras City. These are—

(1) Discharge into the sea,

(2) by recognised methods of bacterial treatment, and

(3) treatment on a Sewage Farm either with or without prior treatment in a tank.

The method of chemical precipitation need not be considered in the case of Madras owing to its cost and the fact that more satisfactory methods are available.

Discharge into the sea.—If sewage were discharged into the sea from Madras City it must be so discharged at a point either south or north of the municipal area for the reason that the discharge at any intermediate point would be most unsatisfactory as the wave action would cast up objectionable solid matter on the sandy beach in front of the town. Sewage discharged into the sea in large quantities to the south of the city would also be objectionable as it would be carried by the sea-current northward along the sea front and consequently a southern outfall is also inadvisable. The proper place for a sea outfall for the sewage is at the northern limit of the city if natural conditions prevailed. Unfortunately, at this place, the sea is eroding the land and, if sewage were discharged into the sea at this place, objectionable solid matters would be thrown back by the wave action on the eroded coast line, and the portion of the foreshore between this line and the Harbour arm, which juts out into the sea and forms a receiving bay, would become sanitarily objectionable.

Bacterial Treatment.

The method of sewage disposal by bacterial treatment is a suitable method of sewage disposal for Madras if no better method were available. The disposal works would require to be placed at some distance to the north beyond the inhabited area, or objections to the presence of the works would be raised if they were placed in proximity to the inhabited area. Such works would be prohibitive in cost for Madras and the net income from the subsequent farming operations would

be much reduced from that obtainable from an ordinary sewage farm. Also there would be the ever present disadvantage of satisfactorily disposing of the sludge which would be deposited in the tanks. The bacterial method of sewage disposal might be proposed in the absence of suitable land for direct sewage farming, but as such is not the case, this method need not be further considered.

Sewage Farming.

The treatment of sewage on a sewage farm has been called the "natural" method of sewage disposal. This term has been questioned, as it is said that it is not a "natural" process to pour sewage on to land for the purpose of growing crops. The objection is of more force in England where irrigation is not generally resorted to for the growing of crops, but in Madras where irrigation is not only generally adopted but has been customary from time immemorial, the treatment of sewage on a sewage farm only follows the usual custom of irrigating crops. The "natural" method is considered to mean the process by which the fertilising agent is returned to the land from whence it originally came. A sewage farm, for the disposal of the sewage of a town in the Madras Presidency, is considered the best method that can be devised. It is not only simple and effective but, in addition, it has resulted in actual revenue in the experience of Madras, thus returning to the town part of the expenditure incurred in the upkeep of the necessary drainage works.

The following conditions which should be complied with in sewage farming are essential for satisfactory working :—

(1) A suitable area of land must be available,

(2) The soil must be porous either naturally so or after treatment, and if necessary it must be subsoil-drained.

(3) The farm should be so situated as not to be objectionable to inhabited areas in the vicinity.

In the case of the Tondiarpet Sewage Farm, a number of objections have been raised to its continuance and it has also been proposed that the sewage of the city should be discharged direct into the sea and not treated on a farm. The reasons why this suggested alternative method of disposal cannot be adopted have already been given in this report. The objections raised to the continuance of the Tondiarpet Sewage Farm will now be dealt with seriatim.

1. "The Farm is the cause of malaria in the adjoining area of the city."

This objection has been put forward in the first instance because malaria has been epidemic in the adjoining area of Tondiarpet for some time and it has been considered that the origin of this epidemic was due to the breeding of large numbers of mosquitoes on the Tondiarpet Sewage Farm, which mosquitoes acted as carriers in the dissemination of malaria from infected persons to others. The fact that large numbers of mosquitoes breed on the Sewage Farm cannot be denied. The Committee found a number of old ponds on the Farm, which ponds contained subsoil water of a fair degree of purity thus forming suitable breeding ground. Mosquito larvæ were also found in places where,

owing to the depressions on the Farm, partly clarified sewage stagnated. These places were principally those where the coarse grass "chappar" was growing and was being utilised for cattle grazing purposes. The report of Mr. Fletcher, the Government Entomologist, shows that after a two days' inspection no larvæ of malaria-carrying mosquitoes were found on the Farm although large numbers of larvæ of non-malaria-carrying mosquitoes such as Culicine larvæ were found in the ponds and other depressions on the Farm.

The ponds on the Farm are gradually being filled up by the Corporation and as soon as this work is completed—and it should be pushed on rapidly—and the Farm is so levelled and laid out that no stagnation of sewage can occur, there is little likelihood of finding, in the future, mosquito larvæ.

The ponds found on the Farm which contained clear water, were apparently on the site before the Farm was started, and have probably always been the places where mosquitoes bred in great numbers. The starting of the Farm on its present site cannot therefore be blamed as the principal cause of malaria in Tondiarpet. Not only must the mosquitoes have bred in the old ponds on the site of the Farm prior to its formation, but the similar ponds which exist in great numbers in the adjoining inhabited area are more objectionable, owing to the fact that they contain purer water and the locality in which they are situated is better sheltered by cocoanut topes and vegetation. It would be as well for the Corporation to fill up the ponds on the Farm without delay. Such filling up should not, it is thought, be delayed until filling up material from the ordinary operations of the Farm becomes available, but the ponds should be immediately filled up with the sand from the sea-shore close at hand.

It is also advisable to lay out the whole site so that there will be no depressions in which sewage may stagnate. The filling up of the ponds and the abolishing of swamps will mean the addition of a valuable area for farming purposes.

Mr. Bainbrigge Fletcher, during his inspection of the Farm, carefully examined all possible places where adult mosquitoes could shelter, such as the long grass, undergrowth in plantations, topes, crab-holes and other places providing the usual cover from wind and light. In a mat shed at the Farm office, one or two isolated adult examples of *Anopheles rossi* were found. They are, according to Mr. Fletcher, not recognised as carriers of malaria.

As far as the records of health conditions give information as to the prevalence of fever in the city, there appears to be sufficient evidence to justify the statement that malaria was prevalent in the Tondiarpet area prior to the formation of a sewage farm. The levels of subsoil water taken by the Corporation staff at the request of the Committee show that the subsoil water level on the Farm and on the adjoining area to the west has been raised. As a result of this, the ponds and wells retain water for a longer period than would otherwise be the case and the number of breeding places is also increased. Consequently, the Farm should be recognised as a contributory cause of the prevalence of malaria in Tondiarpet.

2. "The smell emanating from the Sewage Farm and the open channel becomes intolerable in the evening in the adjoining inhabited area of the Tondiarpet section of the town."

An inspection of the Farm itself discloses that it is wonderfully free from objectionable smell of sewage. At places along the open channel there is a number of distributing sluices. At the beginning of the channel its level is some height above the level of the Farm, which is necessary in order to provide sufficient fall between the beginning and the termination of the channel at the northern extremity of the Farm. At those places where the channel is above ground, the sewage in passing from it to the sub-carriers at ground level has necessarily to be dropped from a height which at the beginning of the channel is as much as 5 feet. Further along the channel, the height the sewage is dropped gets gradually less until the level of the open channel is the same as the level of the Farm. It was observed that the dropping of the septic sewage from the open channel to the level of the sub-carriers caused agitation. The action led to considerable agitation and the result was the escape into the air of volumes of sewage gas with resulting objectionable smell. It is perhaps true to say that in any case whether the sewage is dropped at the beginning of the open channel, or is distributed at the end of the open channel without agitation, the sewage gas will still escape into the air. But this escape under the last condition will be a gradual process which will go on over a large area of the Farm so that the sewage gas will be so diffused as to be unobjectionable. The first part of the open channel has been covered in for a short distance, and a ventilating shaft has been added to allow of the dissipation of sewage gas at some height above ground. At the end of the covered portion of the open channel, there was a free space for the inlet of fresh air and this space, owing to its extent, acted as an outlet. The President has had this space filled up by a diaphragm, and the Committee recommended that a floating sheet of canvas or other resilient material might be added to completely close the space between the varying level of the sewage in the open channel and the bottom edge of the diaphragm. It is considered that it would be well to increase the height of the existing outlet iron chimney by 10 feet, as it is rather short for efficient working. The beginning of the open channel was covered in, and precautions taken, to ensure ventilation because there was an objectionable smell due to the agitation of the sewage at this place. The discharge pipe conveying the sewage from the various pumping stations discharges into the open channel, and in so doing the sewage is reduced in velocity with resulting escape of sewage gas. This is not a new objection as, in 1889, Mr. J. A. Jones referred in a report to a similar state of affairs to that which was detected lately and for which remedial measures were adopted—paragraph 118, page 33, Administration Report of Madras Municipality for the year 1889-90.

To prevent the agitation of the sewage at the distributing sluices already referred to, remedial measures have been suggested by the Committee to the President, and action has already been taken. It was proposed to distribute the sewage from the open channel by means of cast iron pipe bends provided with a sluice valve for regulating purposes so

that the discharge of the sewage on to the land would be in a horizontal direction without agitation. The proposals are illustrated in Sheets Nos. 14 and 15. These proposals, that is, the elimination of the objectionable smell at the distributing sluices and the precautions taken at the point where the sewage from the pumping main joins the open channel, will go far towards meeting the statements of those who complain of objectionable smell from the open channel. The channel itself is remarkably free from objectionable smell.

There still remains, to be answered, the general objection to the Farm on account of the smell arising from it during evenings.

The farm is so situated being bordered on one long side by the Bay of Bengal, an open sea, and on the other long side by an area of cocoanut plantations containing a few houses, on the northern boundary by open country and on the south by a sparsely populated area, that it is open to all the winds that blow.

So long as the winds are of any strength, emanations from the Farm are dissipated effectually as a rule, but under the condition of a gentle breeze blowing inland towards the inhabited area of the Tondiarpet section of the city, there is no doubt that smell from the Farm is detected at some distance inland. How much the smell which is detected is due to the action of the distributing sluices cannot be stated, but it should be accepted as a general rule that no sewage farm should be within a municipal area.

The City of Madras and especially the Tondiarpet section possesses so many open spaces and garden land adjoining houses that it is a hopeless matter to give an opinion of any value as to what effect the presence of the Farm has on the health of the inhabitants of the Tondiarpet section. If it is ultimately decided to move the Farm from its present site, the Committee realise that the cost of so doing will have to be borne by all the rate-payers of the city and that it would be reasonable, in the interests of the general tax-payer, to reassess the Tondiarpet section so as to recover from that section an increased revenue from their land and property which will presumably be worth more when the present Farm is removed.

3. The third objection raised to the presence of the Tondiarpet Sewage Farm was that "The subsoil water in the area to the west, to a distance of 3,500 feet, is contaminated, and this contamination is detrimental to public health as the people in this area use wells to a considerable extent as the source of water-supply owing to the deficiency in the existing piped water-supply of Tondiarpet."

The answer to this objection is an easy matter so far as it refers to contaminated well water. It is simply a question of obtaining analyses, both bacteriological and chemical, of the water from the wells.

Eight samples of raw sewage and subsoil water were taken by the Assistant Director of the King Institute in the immediate presence of the Sanitary Engineer to Government and were forwarded by motor-car without delay to the King Institute for investigation. The samples were taken on the lines of the two sections marked on sheet No. 1-D. Four samples were taken on each section, the first one on each section being from the open masonry sewage channel. The results are given in an appendix and

the opinion of the Director is also given. The results do not show evidence of direct contamination of subsoil water from the sewage on the Sewage Farm. The wells throughout the Tondiarpet area are not properly conserved and are located close to houses and cultivation. As there is no system of drainage in existence for this section of the town, the water of the wells and ponds cannot be expected to show satisfactory results. That they do show fairly good results is strong evidence of the purifying nature of the sandy subsoil in this area of the city. It is of course theoretically correct to say that a Sewage Farm should not be located in the vicinity of wells but it is wonderful how close to possibilities of contamination a well can be placed without showing direct evidence of pollution. This is of course due to the purifying results obtained from the passage of contaminated water through a stretch of sandy subsoil. When the contamination is immediately surrounding the well steining, the surface water passes down into the well so rapidly that the effect of the subsoil purification is inappreciable.

As the wells in Tondiarpet are located at a considerable distance from the Farm, the nearest pucca house being over 500 feet to the west, the purification which is obtained by the passage of contaminated water through this horizontal distance of sand must be very considerable. The hydraulic gradient from the Farm to a well at the nearest pucca house is so flat as to preclude the practical possibility of the direct flow of contaminated water through this long stretch of sand. It must also not be forgotten that the abstraction of water from the wells is by hand at a very slow rate, and as the subsoil water level is naturally very high in this low-lying section of the town, the chances of contamination of the water in the well from any distance is practically remote. There is of course the chance of diffusion, but this is also remote owing to the distance through which this must take place. The chance of diffusion is so small as to be negligible.

The results of the bacteriological analyses of samples, which are given in an appendix to this report, from the open channel and from ponds and wells to the west of the Farm, the further sample having been taken from a well situated to the west of the Tiruvottiyur High Road at a distance of 2,200 feet from the Sewage Farm, point to the conclusion that the contamination of subsoil water from the Sewage Farm only occurs in the immediate vicinity of the Farm.

There is a piped water-supply to Tondiarpet but, owing to the great distance from the source and the general deficiency in the city, the supply is insufficient and resort has to be made to wells. Steps are being taken, the new pipes are actually on the ground, to ensure a satisfactory supply of piped water to Tondiarpet. This new supply might be expedited as much as possible, and when it is carried out the wells which are stated to be contaminated from the Sewage Farm might be filled up to prevent their continued use after the piped supply is introduced.

4. The fourth objection raised to the presence of the Sewage Farm is a minor one and is as follows :—

"The drainage of Dhobypet is towards the sea, but owing to the construction of an open channel and a road by its side on the western

boundary of the Farm this drainage has been interrupted and in 1911 and 1912 Dhobypet was reported to have been under water."

The surface drainage of the area west of the Farm between the Tiruvottiyur High Road and the road on the western boundary of the Farm is generally towards the Farm and the sea.

The soil is sandy and like the Farm extremely porous so that in ordinary rain storms there would be no stagnation of water for any length of time.

On the 31st October 1913 there was a heavy fall of rain of 5·96 inches recorded in Madras and advantage was taken of this rain storm to inspect the Farm and the outlets from Dhobypet.

This fourth objection must be taken as proved as owing to the rain storm it was found that Dhobypet was flooded and the two outlets for storm water, one at the Farm Main Road adjoining the open channel at the end of Poondi Thayammal Street, and the other a single vent culvert near the beginning of the open channel, were blocked and there was no passage for the storm water.

It is considered that two storm outlet drains should be constructed across the Sewage Farm ; the drain along the Main Farm Road should be sectioned, and a storm outlet drain should be provided from Dhobypet to connect with Poondi Thayammal Street outlet.

Site of the Tondiarpet Sewage Farm.

The site of the Tondiarpet Sewage Farm is illustrated on two plans, one showing the site in relation to the city and the other the site with particular reference to the adjoining area and the investigation into the question of the raising of the subsoil water level.

A perusal of the first plan will show that the site of the Farm is unusually near the inhabited areas judged by English standards. When the Farm was first formed, financial considerations no doubt determined the choosing of the present site and it cannot be denied, despite the objections raised, that the Farm has been a highly successful one in disposing, at a profit, of the sewage of a large section of the city.

This success has been due to three principal reasons :—

(1) The soil was sandy, porous and suitable for the growth, with the aid of sewage, of the grass known as Hariali grass, which is a fine quality of grass capable of being made into hay suitable for the feeding of horses and cattle.

(2) The long spells of dry weather in Madras and the tropical sun have resulted in the obtaining of a luxuriant growth of grass, a crop being obtained within a month.

(3) Owing to the same long spells of dry weather, natural grass was difficult to procure in quantity in the city and surrounding districts, and consequently a market for the hay grown on the Sewage Farm was available close at hand.

The only section of the town that can possibly be considered as prejudicially affected by the site of the Farm is the Tondiarpet section and it is only on behalf of this section that objections to the present site have been raised.

Area of the Farm.

The area of the Tondiarpet Sewage Farm at present is officially reported to be 126 acres, of which only 80 acres are daily irrigated. The difference between the gross area 126 acres and the 80 acres irrigated is due to the area taken up by cocoanut topes, roads, buildings, swamps incapable of being efficiently irrigated, ponds, and the area being harvested.

The working area of the Farm can be increased in the future by the levelling up of the swamps and the filling up of ponds. The net area under irrigation allowing for rest will be at least 100 acres.

If any further area is required, it must be obtained from a new site. The area of the present Farm is being yearly reduced by the action of the sea which has already washed away a considerable portion of the old Farm. This fact is clearly shown on sheet No. 2 where the present and the former sea margins have been marked. In connection with the proposed construction of a complete system of pipe sewers in the city it has been proposed to acquire an additional area of 126 acres to the north of the present site. This extension is shown on sheet No. 1. The net area available for daily irrigation on the present and on the extended farm will therefore be the same or 200 acres in all.

Nature of Soil.

The soil of the Tondiarpet Farm as well as of the proposed extension is pure sand to a great depth. Apparently this part of the land was at one time sea beach. The natural level of the subsoil water along the sea-coast is from 6 or 7 feet below ground as is apparent from observation of ponds and wells.

Samples of the soil were taken and sent to Mr. Harrison, the Government Agricultural Chemist, and his report on the analyses and the suitability of the soil for sewage disposal is printed as an appendix to this report.

Especially on the older part of the Farm a trial pit discloses that humus from previous sewage irrigation has penetrated to a depth of 1 foot and is very evident in the first 6 inches from the surface.

The soil of the Farm is highly suitable for disposing of sewage by sewage farming. Being of pure sand of even texture no better soil could be imagined for sewage farming in the tropics.

Volume of Sewage.

At each pumping station in Madras the volume of sewage pumped daily is accurately measured by a venturi meter. While the total volume pumped to the Farm varies from day to day as obtained from the sum of the discharges at the different pumping stations, the average quantity delivered on the Farm can be taken at the round figure of 5 million gallons daily. In this connection, it would be well if a venturi meter was installed at the Farm to daily record the total quantity of sewage delivered on the Farm for treatment.

Dividing 5 million gallons by 100 acres, the area irrigable, we obtain the quantity of sewage which can be treated daily on to an acre of the

Farm as 50,000 gallons. This is an extremely high figure constituting, it is believed, a record for a Farm of any extent, and could not be reached except under similar conditions to those obtaining at the Tondiarpet Sewage Farm. It has been suggested that the sewage should be first passed through a septic tank before it is treated on the land. It is not believed that the septic tank treatment is necessary for liquefying purposes as the sewage at present arrives on the Farm in a septic condition, due to the time occupied by the sewage in passing from the house drain to the Farm *via* the street drains, pumping stations and rising mains. The septic condition may also be partly due to the stagnation of the sewage in the open drainage section of Georgetown and when this section is drained with underground sewers the sewage may become less septic than it is at present from this section. But the distance the sewage has to traverse from other sections of the town is now, and will be in the future, so considerable that it is unlikely the sewage will ever be much less septic than it is at present. The provision of septic tanks would result in the usual difficulties in the disposal of the sludge and the operations and the presence of septic tanks would be undesirable at Tondiarpet.

Again, the cost of treating the effluent and dealing with the sludge produced would materially reduce the profits as compared with those obtained from direct sewage farming. As the quantity of sewage disposed of on the Tondiarpet Sewage Farm per acre is very high and as the increase in depth of humus which has penetrated 12 inches into the sandy soil is considerable, it will be advisable to limit the quantity of sewage per acre of Farm to something considerably less than the 50,000 gallons per acre which is at present poured on to that land. It is believed Mr. J. A. Jones, who was the Engineer of the municipality when the Farm was first worked on a large scale, contemplated the limit of 30,000 gallons per acre as a maximum, looking to the fact that this quantity would be passed on to the land for all time. The Sewage Farm might be worked at a higher rate, in fact it has been worked at almost double this rate for some years, but it cannot be recommended as a permanent measure. If lands were available the rate should be reduced to a maximum of 30,000 gallons daily per acre.

In this connection, it might be well to refer to the case of the Aldershot and Nottingham Sewage Farms. The soil of the Aldershot Farm is stated to be 3 feet of coarse sand with fine sand underneath. The sewage arrives within 2 hours as a maximum at the Farm and is treated in settling tanks and the effluent is then passed on to the Farm. The Royal Commission on Sewage Disposal has stated their opinion as follows :—

"The sewage (purely domestic) is strong. It cannot be said that, for a filtration farm, Aldershot Camp was treating a *large volume* of sewage, either per acre of the 'working' daily irrigable area, or per acre of the total irrigable area ; but it was treating, both actually and relatively, a large quantity of organic matter. Moreover, the soil and subsoil (coarse sand over very fine sand) are not of the best kind for purifying a large volume of sewage, and the average filtration depth down to the drains is only about 3 feet. . . . . On the whole we consider that 25,000 gallons per acre for twenty-four hours (8,300 gallons per acre on the total irrigable

area per twenty-four hours) is too large a volume of a strong sewage to be treated by screening, settling and filtration, through about 3 feet of sand of the above nature, if completely and uniformly satisfactory effluents are to be expected, but not too large a volume of sewage per acre to yield effluents showing a high percentage (possibly even a sufficient relative degree) of purification."

In the case of Nottingham Farm it is stated that the time taken for the sewage to reach the Farm is three hours and the opinion of the Royal Commission on Sewage Disposal on this Farm was as follows :—

"The sewage (four-seventh domestic, three-seventh trade refuse) is strong. For a filtration Farm Nottingham was not treating a large volume of sewage, either per acre of the 'working' daily irrigable area, or per acre of the total irrigable area, more especially if the nature and effective internal purifying surface of the soil and sub-soil are taken into consideration ; but it was actually treating a large quantity of organic matter. The sewerage system is combined, but the Farm deals with very little of the storm water. There can be no doubt that 23,300 gallons per acre for twenty-four hours (10,750 gallons per acre of the total irrigable area per twenty-four hours) is not too large a volume of even a strong sewage to be treated by screening (partial) and filtration through about 6 feet of soil and sub-soil (sandy loam) overlying gravel and sand, of the nature of that found at Nottingham. It is pleasant to be able to call attention to the fact of a Sewage Farm working well within its limits of purifying power, and as a result yielding effluents of a highly satisfactory character."

It is thought that the quantity to be aimed at to obtain permanently satisfactory results should in the case of the Madras Sewage Farm be a maximum 30,000 gallons per acre of irrigable area per day. The higher figure has been adopted for Madras principally on the climatic conditions which causes luxuriant growth throughout the year. If this maximum amount of 30,000 gallons per acre is accepted, then the area required for the Sewage Farm to dispose of the present quantity of sewage pumped to it, 5,000,000 gallons daily, is 167 acres nét, or, allowing $\frac{1}{5}$ extra for roads, buildings, channels and area being fallow, 200 acres.

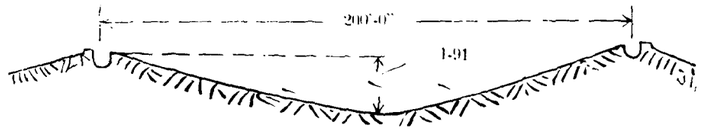
The quantity of sewage which will be pumped to the Sewage Farm in the future will increase with the construction of the new drainage works, the opening of additional pumping stations and the improvement of old stations to a maximum of 15,000,000 gallons daily. The greater part of the increase from the present quantity of 5,000,000 gallons will occur within the next 10 years, following on the completion of Tondiarpet drainage and other sections of the city.

This quantity of 15,000,000 gallons will require a Sewage Farm of 600 acres. The area proposed to be acquired north of the present Sewage Farm amounts to 126 acres making a total area including the existing Farm of 252 acres, which shows that the proposed extension is entirely inadequate.

Lay out of the Tondiarpet Sewage Farm.

It has already been mentioned that the present Farm was originally laid out on the ridge and furrow system. The following sketch of a cross

section of a plot will explain the method originally adopted for laying out a plot.



The ridges are 200 feet apart and on these ridges the distributing channels are placed. In most parts of the Farm these channels are formed of half cement pipes. The question of the best lay out of the Farm has been dealt with in Mr. Sampson's report on the suggested improvements in the working of the Farm. In this report it is proposed that the surface should be levelled during farming operations so as to form a series of terraces from the masonry channel towards the sea. The report is accompanied by two plans, sheet No. 12 and sheet No. 16. The first plan shows the method of terracing and the second is an illustration of a farming implement usually used for the operation of levelling the ground. If the Farm is to be worked to the best advantage, it seems necessary that Mr. Sampson's recommendations should be carried out.

Financial Results obtained from the Present Farm.

These results are given in an appendix and show that the net profit for last year, 1912, was Rs. 36,552. This was obtained from the present area, but in addition to the revenue from the sale of grass and hay from this area, revenue was also obtained from the lease of cocoanut trees and the right of grazing on the low-lying part of the Farm on which a coarse grass, chappar, is growing. The net revenue from the Farm appears to be about Rs. 360 per acre of cropped area.

This is obtained when the quantity of sewage applied daily per acre reaches the high figure of 50,000 gallons.

Extension of the Farm.

In connection with the construction and completion of the new drainage works which will result in the ultimate increase in the quantity of sewage to be dealt with from 5,000,000 gallons to 15,000,000 gallons, it has been proposed in the new drainage scheme to extend the Sewage Farm to the north by the acquisition of an area of sandy soil of 126 acres. As the present Farm is 126 acres in extent and deals with 5,000,000 gallons per day, the doubling of the area of the present Farm will not satisfactorily dispose of three times the present quantity of sewage dealt with even if the rate of irrigation per acre remains as at present the abnormal amount of 50,000 gallons especially when it is remembered that the erosion which is taking place at the present Farm is seriously diminishing the available area for irrigation. There is also the objection to this extension that it means the formation of a similar farm to the present one in proximity to an inhabited area. The northern limit of the new extension will be close to the important suburb of Tiruvottiyur and as the prevailing winds are as already stated from the south-east, there is no doubt the working of the extended Farm will be strongly objected to by the inhabitants of this

suburb, and the objections raised by the Tondiarpet inhabitants could be brought forward with greater force by the inhabitants of Tiruvottiyur.

As even with the extension the Sewage Farm will be unable to deal with the sewage which will be pumped to it in the future to the amount of 15,000,000 gallons daily, it is necessary to propose that a sufficient area of land should be taken up in a locality where the presence of a Sewage Farm will be least objectionable.

Site of New Farm.

A suitable area for a new farm appears to be available north of Tiruvottiyur and between the Ennur Road and the sea. This site is composed of sand similar to the sand of the Tondiarpet Farm. The site proposed is sufficiently distant north of Tiruvottiyur to be unobjectionable on that score and as the prevailing wind is from the south-east and Tiruvottiyur is to the south and south-west no objection can be advanced on this point. The northern extremity of the Farm would be about $\frac{3}{4}$ of a mile south of Ennur Railway Station and at this distance would not, it is considered, be a source of nuisance to that place.

The land available consists of open stretches of sand between casuarina and cashew plantations and there are few houses or huts which would have to be acquired. The site is a much wider one than the present Tondiarpet Farm and the area required, 600 acres, appears to be available. The Farm could be hidden from the Ennur Road by a belt of casuarinas, and it is also considered that the Farm should be surrounded on the south, south-west, and north by a sufficient margin of open land, say, $1\frac{1}{2}$ furlongs in width. This land would be acquired at the same time as the Farm and the building of houses on it by private owners would thus be prevented. It is not believed that the cost of acquisition of the proposed site will be high. The land is valueless as ordinary agricultural land but highly suitable if irrigated with sewage. The casuarina plantations can be sold by the Corporation as their site is required for irrigation.

The site of the actual Farm would require to be laid out as proposed by Mr. Sampson for the present Farm and the following arrangements would be required in order that the sewage could be delivered on the site.

The present open masonry channel would require to be covered in with reinforced concrete slabs and with an earthen embankment and would further require to be ventilated and provided with access manholes. From the end of the present open channel a conduit which would be laid underground would require to be constructed for a distance of $2\frac{1}{4}$ miles and at the end of this conduit the sewage would be pumped by, say, a Humphrey pump into main distributing channels.

Near the new Farm, quarters for the Superintendent and the work people would be required. On the assumption that the present sales of Hariali grass and hay are capable of expansion, or, that other suitable crops could be grown or sold at not less profit than Hariali grass or hay, the ultimate revenue when 15,000,000 gallons are being treated on the Farm should be, approximately, at Rs. 300 per acre net revenue, about Rs. $1\frac{1}{2}$ lakhs per annum.

A farm of this area would require very efficient management, and the Superintendent should be a man of wide experience and proved ability, to whom an initial pay of not less than Rs. 500 per mensem should be given.

The area that will be available on a farm of this size will admit of a much higher class of farming than is possible on the limited area of the present Farm. If the new Farm is acquired and laid out at the earliest date possible there is no necessity to limit the area cultivated at the rate of 30,000 gallons an acre. It should be possible to irrigate the whole area of the Farm with a much less quantity of sewage per acre and to gradually increase this quantity to the suggested maximum of 30,000 gallons per acre, as the quantity of sewage delivered at the Farm increases.

The opening of the new Sewage Farm on the site suggested would enable the present Sewage Farm to be abandoned as a Sewage Farm, and its disposal as house sites and garden land, the part of the Farm along the sea front being retained by the City for a new main road. It would be necessary, if this new road is formed, to protect it from erosion by the construction of a suitable revetment or a sea wall.

W. HUTTON.
H. C. SAMPSON.
W. H. HARRISON.

APPENDIX No. 1.

Orders of Government appointing a special committee.

(1)

[G.O. No. 825 M., DATED 23RD APRIL 1913.]

EAD—the following paper :—

Letter—from the President, Corporation of Madras.
Dated—the 18th March 1913.
No.—R.O.G.D.C. 102-Sup.

Order—No. 825 M., dated 23rd April 1913.

In deference to the wishes of the Corporation of Madras the Government are pleased to ppoint a special committee to consider and report to that body whether the Tondiarpet Sewage arm is a source of danger to health as a cause of malaria, mosquito nuisance or contamination subsoil and what improvements can be made.

2. The officers whose services will be placed at the disposal of the Corporation for the rposes of this committee will be as follows :—

(1) Mr. W. Hutton, Sanitary Engineer to Government—(Chairman).
(2) Dr. F. Maitland Gibson, Director, King Institute, Guindy.
(3) Mr. W. H. Harrison, Agricultural Chemist, College of Agriculture, Coimbatore, and
(4) a farming expert to be nominated by Mr. D. T. Chadwick, Director of Agriculture, ho will be requested at a very early date to report his nomination to Government.

(True Extract.)

C. S. ANANTARAMA AYYAR,
Under Secretary to Government.

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(2)

G.O. No. 967 M., DATED 16TH MAY 1913.

EAD—the following paper :—

G.O. No. 825 M., dated 23rd April 1913.

Order—No. 967 M., dated 16th May 1913.

In continuation of G.O. No. 825 M., dated 23rd April 1913, the Corporation will be formed that the Director of Agriculture has nominated Mr. H. C. Sampson, acting Princi- l of the Agricultural College, Coimbatore, to serve as farming expert on the Tondiarpet ewage Farm Committee. The Government are pleased to place the services of Mr. Sampson the disposal of the Corporation for the purposes of the above committee.

(True Extract.)

C. S. ANANTARAMA AYYAR,
Under Secretary to Government.

APPENDIX No. 2.

Preliminary levels and particulars regarding the existing Sewage Farm.

Letter—from P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 28th April 1913.
No.—R.O. Govt. C. No. 113/13.

I believe you are taking the necessary action with reference to G.O. No. 825 M., dated 23rd April 1913, regarding the Tondiarpet Sewage Farm. I shall be glad to give you any information which may be required in connection with the enquiry.

Demi-official—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
Dated—the 1st May 1913.

Thanks for sending me a copy of the G.O. No. 825 M., dated 23 April 1913, which I have now perused. Adverting to your demi-official, I shall want as a first instalment—

A plan showing the farm and statements of area, area irrigated, extension proposed and a copy of Madeley's Tondiarpet Drainage Report.

Any reports on statements as to actual working of the farm such as number of waterings, time taken to grow a crop, amount of crop obtained, and financial results in detail.

Any papers which show the objections taken to the present farm and what is demanded. In connection with subsoil conditions, I shall want a hydrological survey taken, that is cross sectional levels showing subsoil water level, say, one furlong apart from Tondiarpet to the sea; but I shall give further details of this as soon as I have studied the question.

Let me have any papers which can be sent me as a basis on which I can formulate requests for further information.

Demi-official—from P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 9th May 1913.

With reference to your demi-official of the 1st instant regarding the Sewage Farm, I have the pleasure to forward to you, as a first instalment, a collection of papers, as shown in the accompanying list, which contain information on the subject. An accurate plan of the existing farm is under preparation and will be sent to you in two or three days. A hydrological survey of the farm with a view to ascertain its subsoil conditions will soon be undertaken by the Engineer and its results will be communicated to you in due course.

I may add that there is a proposal to extend the farm towards the north. The present open channel will be carried northwards along the western boundary for a distance of 3,200 feet and then turned eastwards along the northern boundary ending with an outlet to the sea which will serve as an overflow during the monsoon. The area of the proposed extension is 126 acres and the system of irrigation will be similar to that laid out on the present farm.

I request you to be good enough to return the copy of the Tondiarpet drainage report when it is no longer required, as no spare copy is available in this office.

LIST OF ENCLOSURES.

1. A copy of the Tondiarpet drainage report.
2. A plan showing the ground levels of the cross sections at the Sewage Farm.
3. A copy of the note, dated the 8th May 1913 by the Superintendent of the Sewage Farm on the working of the farm.
4. A statement showing the number of waterings.
5. A statement showing the outturn of crops.
6. A statement showing the receipts from the farm.
7. Copies of the proceedings of the meetings of the Corporation held on 7th February 1913, 18th February 1913, 26th February 1913, 10th March 1913, 14th March 1913 and 18th March 1913, which contain the objections to the Sewage Farm.

Note by Evelyn Nicholas, Esq., Superintendent, Madras Sewage Farm, dated 8th May 1913.

The total area of the farm within the fence but including the Hindu burial-ground, which was not formerly included in the farm and only recently taken into use is about 109 cawnies or about 136 acres. As the farm also includes certain open spaces, roadways and

waste land we might take it as about 120 acres. Irrigation is carried on by a valve outside the open channel at its southern end and by various outlets from the channel itself. The total area irrigated in a day is about 80 acres which includes portions cultivated both with hariali and a species of coarse grass known as chappar eaten by cattle. The time taken to grow a crop is about 23 days and a statement A is attached showing the number of waterings from each outlet from the 16th to 30th April 1913.

2. Statement B shows the amount of crop obtained for the year ending 31st March 1913 and statement C the actual receipts from all sources for the same period. During the year in question the whole area was not brought under cultivation. The farm was found to be considerably neglected when taken over and nearly 40 acres of land were improved and replanted with hariali. The average area under cultivation might be placed at about 90 acres both for hariali and chappar and working on this basis the outturn per acre might be placed at $\frac{36,552}{90}$ = Rs. 406 per annum. It might be mentioned that owing to an injunction from the High Court there was a loss of Rs. 3,240 in revenue on account of toddy drawn from the cocoanut and palmyra trees on the farm—otherwise the outturn per acre would have been considerably higher.

Corporation of Madras—Grass Farm, Tondiarpet.

STATEMENT showing the number of times the valve on the southern side and the several outlets from the channel were used from the 16th April 1913 to 30th April 1913, drawn up by E. Nicholas, Esq., Superintendent, Madras Sewage Farm, on 8th May 1913 :—

Valve or Outlet No.	April 1913.															Total.	Remarks.
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
Valve No. 1 ...	...	...	...	...	...	×	×	×	×	×	×	×	×	×	×	10	
Outlet No. 1 ...	...	...	×	×	×	×	×	×	×	×	×	×	×	×	×	13	
" 2 ...	..	×	×	×	...	×	×	×	×	×	×	×	×	×	×	13	
" 3 ...	...	...	×	×	×	...	...	..	...	...	...	..	...	×	×	4	
" 4 ...	...	...	...	...	...	...	...	...	...	...	..	...	...	..	×	...	
" 5 ...	...	×	×	×	×	×	×	×	×	×	×	×	×	×	...	14	
" 6 ...	×	×	×	×	×	...	...	...	×	×	×	×	×	×	...	12	
" 7 ...	×	×	×	×	×	×	×	...	..	×	...	×	×	×	×	12	
" 8 ...	...	...	...	...	.	...	...	...	...	...	..	...	...	...	...	...	
" 9 ...	×	×	×	×	×	×	×	×	×	×	...	...	×	×	×	13	
" 10 ...	...	...	...	...	...	×	×	×	...	...	...	×	×	...	...	5	
" 11 ...	×	...	...	...	...	×	×	×	...	...	...	×	×	...	...	6	
" 12 ...	×	...	...	...	...	×	...	×	×	×	...	×	×	...	...	7	
" 13 ...	×	...	...	...	...	×	...	×	×	×	×	...	...	...	...	6	
" 14 ...	×	...	...	...	...	×	...	×	×	×	×	...	...	×	×	8	
" 15 ...	...	×	×	...	...	...	...	...	×	×	×	×	×	×	×	9	
" 16 ...	×	×	×	...	...	...	...	...	×	×	×	×	×	...	...	8	
" 17 ...	×	×	×	...	...	...	...	...	×	×	×	...	...	...	...	6	
" 18 ...	×	×	×	×	...	...	...	...	×	×	×	×	×	...	...	9	
" 19 ...	×	×	×	...	×	...	...	...	...	...	...	×	×	×	×	8	
" 20 ...	×	×	×	×	×	...	...	...	...	...	...	...	×	×	×	8	
" 21 ...	×	×	×	×	×	×	×	...	...	...	...	...	...	×	×	9	
" 22 ...	...	×	×	×	×	×	×	...	...	...	...	...	...	×	×	8	
" 23 ...	..	×	×	×	×	×	×	×	×	×	×	...	×	×	×	13	
" 24 ...	...	...	...	...	...	...	...	...	.	...	...		...	...	...	...	
	13	14	16	12	11	14	11	12	14	14	13	12	16	15	14	201	

STATEMENT showing the monthly outturn of Green Grass, Chappar and Lucerne during the year 1912–13, drawn up by E. Nicholas, Esq., Superintendent, Madras Sewage Farm, on 8th May 1913 :—

Month.		Green Grass.		Chappar.		Lucerne.		Remarks.
		TONS.	LB.	TONS.	LB.	TONS.	LB.	
April	1912	105	1,135	127	1,440	...	...	
May	"	127	569	53	1,746	...	...	
June	"	142	1,889	84	1,765	...	2	
July	"	170	216	88	40	...	...	
August	"	167	639	93	2,130	...	6	
September	"	159	1,244	71	2,204	...	...	
October	"	147	699	85	1,280	...	117	
November	"	158	1,431	93	1,330	...	362	
December	"	143	847	43	2,100	...	254	
January	1913	159	2,147	15	72	...	254	
February	"	136	805	1	660	...	169	
March	"	155	991	1	360	...	340	

Statement showing the expenditure incurred during the year 1912-13 for the maintenance of the Tondiarpet Grass Farm.

Items.	April 1912.	May 1912.	June 1912.	July 1912.	August 1912.	September 1912.	October 1912.	November 1912.	December 1912.	January 1913.	February 1913.	March 1913.	Total.
1. *Establishment* ... Superintendent in charge of the Farm at Rs. 100 per month.	Rs. A. P. 222 10 8	Rs. A. P. 270 10 3	Rs. A. P. 259 0 0	Rs. A. P. 273 4 8	Rs. A. P. 264 9 3	Rs. A. P. 252 10 8	Rs. A. P. 242 15 5	Rs. A. P. 244 8 6	Rs. A. P. 222 0 0	Rs. A. P. 222 0 0	Rs. A. P. 217 11 5	Rs. A. P. 221 0 6	Rs. A. P. 2,913 1 4
Bailiff ... per month. Rs. *60													
Overseer ... 50													
Assistant Overseer 25													
Clerk 30													
Building Maistry 15													
2. Labour (for details *see* below).	576 12 0	455 1 1	568 15 5	826 9 3	665 3 10	784 14 1	1,043 2 5	686 8 9	765 5 8	926 13 0	667 12 9	603 5 11	8,570 8 2
3. Printing and advertisement charges.	214 14 8	36 4 0	138 9 4	...	...	8 8 0	...	...	...	...	127 6 8	...	525 10 8
4. Law charges	41 12 0	...	...	...	0 14 0	...	...	...	...	...	...	...	42 10 0
5. Contingencies (consisting of cart-hire, repair of carts, purchase of sundry articles and petty works done by workshop).	115 5 9	112 2 8	118 10 0	49 12 0	74 0 3	97 14 9	162 2 3	237 2 0	50 14 0	101 1 11	82 7 0	218 15 5	1,420 8 0
6. Purchase of bullocks (6 pairs).	...	...	...	...	700 0 0	...	...	...	...	...	...	...	700 0 0
7. Maintenance of bullocks at Rs. 20 a pair for feeding and annas 10 for shoeing.	...	...	...	...	...	123 12 0	123 12 0	123 12 0	123 12 0	123 12 0	123 12 0	123 12 0	866 4 0
8. Purchase of double bullock carts.	...	230 0 0 (three carts).	...	130 0 0 (two carts).	...	...	...	...	...	...	...	...	360 0 0
9. Annual rent for telephone paid to the Oriental Telephone Company.	...	...	...	...	...	...	..	...	...	125 0 0	...	...	125 0 0
Total ...	1,171 7 1	1,104 2 0	1,085 2 9	1,279 9 11	1,704 11 4	1,267 11 6	1,572 0 1	1,291 15 3	1,161 15 8	1,498 10 11	1,219 1 10	1,167 1 10	15,523 10 2

Details of labour reported on in item 2.

Maistry at Rs 17 per month.
Issue men on Rs. 10 each per month.
Female maistry on Rs. 8 per month.
Water men on Rs. 7½ each per month.
Bundlers on Rs. 9 each per month.
Cartmen on Rs. 9 each per month.
Watchmen on Rs. 9 each per month.
Trenching coolies on Rs. 9 each per month.
Peon on Rs. 7 per month.
Coolies for bundling and carting grass at As. 2-9 a day each.
Coolies for making hay and storing it at As. 2-9 a day each.
Coolies for cutting grass for supplies and for hay at As. 3-9 a day each.

N.B.—The number employed varied at different periods.

*Service dispensed with on 23rd August 1913. Not replaced.

NOTE.—(1) Prior to the purchase of bullocks for the Grass Farm, they were obtained from the Health Department whenever available and hiring was resorted to—

For the current year, 1913-1914, the charges may be placed at Rs. 22,510, made up as follows :—

	Rs.
Establishment	3,600
Labour (coolies for cutting grass, etc.)	13,800
Contingencies including printing, etc., charges	2,500
Maintenance of bullocks	1,485
Purchase of carts	500
Purchase of bullocks to replace casualties	500
Rent for telephone	125
Total ...	22,510

Statement showing the cost of grass, etc., sold and the other income derived from the Tondiarpet Grass Farm during the year 1912–13.

Month.	Sale of grass at Rs. 16-8-0 per ton. Quantity. Tons.	Lb.	Cost.	Sale of chappar at Rs. 8 per ton. Quantity. Tons.	Lb.	Cost.	Sale of lucerne at Re. 1 per 24 lb. Quantity. Tons.	Lb.	Cost.	Sale of trees by auction.	Income from the contractor for extracting toddy and other produce of trees at Rs. 18 per day.	Sale of silt.	Income from the grazing of cattle at the Market Farm at Rs. 3 for each bull, buffalo or cow and Rs. 1-8-0 for a calf.	Sale of kuskus root grown temporarily.	Sale of vegetables grown temporarily.	Rent charged to a dhobi for using a tank in the Market Farm for starching lungees (Muhammadan cloths) at Rs. 5 a month.	Total.
1	2			3			4			5	6	7	8	9	10	11	12
			RS. A. P.			RS. A. P.			RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
April 1912	105	1,135	1,740 13 9	127	1,440	1,021 2 3	...	...	...	...	90 0 0	...	19 8 0	...	...	5 0 0	2,876 8 0
May ,,	127	569	2,099 11 1	53	1,746	430 3 9	...	...	..	..	...	...	19 8 0	2 0 0	...	5 0 0	2,556 6 10
June ,,	142	1,889	2,356 14 7	84	1,765	678 4 10	...	2	0 1 4	...	..	...	...	...	...	5 0 0	3,040 4 9
July ,,	170	216	2,806 9 5	88	40	704 2 3	...	...	..	...	18 0 0	..	49 0 0	..	...	5 0 0	3,582 11 8
August ,,	167	639	2,760 3 3	93	2,130	751 9 8	...	6	0 4 0	...	...	10 0 0	15 0 0	...	...	5 0 0	3,542 0 11
September ,,	159	1,244	2,632 10 7	71	2,204	575 13 11	..	..	..	0 8 0	...	...	39 0 0	...	6 8 0	5 0 0	3,259 8 6
October ,,	147	699	2,430 10 4	85	1,280	684 9 1	...	117	4 14 0	584 9 6	558 0 0	...	63 0 0	.	27 8 0	5 0 0	4,358 2 11
November ,,	158	1,431	2,617 8 8	93	1,330	748 12 0	...	362	15 1 4	14 0 6	540 0 0	2 0 0	49 8 0	...	...	5 0 0	3,991 14 6
December ,,	143	847	2,365 11 9	43	2,100	351 8 0	...	254	10 9 4	...	558 0 0	..	50 8 0	...	...	5 0 0	3,341 5 1
January 1913	159	2,147	2,639 5 0	15	72	120 4 1	...	254	10 9 4	21 4 0	558 0 0	..	81 3 0	...	...	5 0 0	3,435 9 5
February ,,	135	805	2,233 6 10	1	660	10 5 8	...	169	7 0 8	...	504 0 0	...	34 8 0	.	...	5 0 0	2,794 5 2
March ,,	155	991	2,564 12 9	1	360	9 4 6	...	340	14 2 8	223 8 0	558 0 0	...	16 8 0	..	...	5 0 0	3,391 3 11
Total ...	1,772	1,412	29,248 6 0	760	1,687	6,086 0 0	...	1,504	62 10 8	843 14 0	3,384 0 0	12 0 0	437 3 0	2 0 0	34 0 0	60 0 0	40,170 1 8

NOTE.—(1) The above represents the value of the outturn and is therefore in excess of the figures already furnished, which represented the actual receipts up to 31st March 1913.
(2) In column 2 " grass " includes both hay and green grass.
(3) The revenue derived from the sale of trees (column 5) will not recur this year. These trees were in the Hindu burial ground and were sold in order to clear the ground for planting.
(4) The revenue under toddy will be doubled during the current year. 1913–14, as the amount shown in the statement represents the revenue for six months only.
(5) The revenue under grazing will be considerably increased during 1913-14 owing to the chappar portion being let for grazing. An income of Rs. 10,000 is expected.
For the current year the receipts may be placed at Rs. 50,000 made up as follows :—

	RS.
Hay and grass	33,000
Grazing	10,000
Toddy	6,890
Chappar	200
Silt	25
Total ...	50,115

1912-13.

	RS. A. P.
Gross receipts	40,170 1 8
Expenses	15,523 10 2
Net reserve ...	24,646 7 6

Demi-official—from P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 24th May 1913.

I have the pleasure to forward herewith two accurate plans of the Sewage Farm as now fenced, indicating the cisterns and lines of pipes in each section and the area of the plots irrigated thereby, as promised in my letter, dated 10th May 1913. As regards the hydrological survey of the farm, I shall be obliged if you would mark on one of the plans the position of the trial holes which will have to be made in the farm with a view to ascertain its subsoil conditions.

2. The quantity of sewage discharged on to the farm is between 5 and 6 million gallons per day, all of which is put on the farm.

Demi-official—from P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 27th May 1913.

Your letter of the 23rd instant. I send herewith three sets of copies of the proceedings of the Corporation mentioned therein.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—the President, Corporation of Madras.
Dated—the 10th July 1913.
No.—1603-M.

In continuation of my demi-official in June returning a blue-print plan with the request that the hydrological survey of the Sewage Farm and the surrounding area should first be started by the taking of two sections at places marked in pencil on the plan, I have the honour to inform you that the committee have since inspected the Sewage Farm and considered what information was required and desire that the following should be supplied to them :—

(1) Cross sections of the Sewage Farm from the sea to the Tiruvottiyur High Road at a distance apart of about 400 feet. Two of the sections, one at the south and one at the north end of the farm, to be extended to 1,000 feet beyond the Buckingham Canal ; such sections to show the ground level and the subsoil water level and the cross section of the masonry channel.

(2) A site plan of the farm showing contours.

(3) A plan showing the site with reference to the city and Tondiarpet.

(4) A plan showing the city and Tondiarpet and the area north of farm as far as Ennore.

(5) A plan showing the farm with plots marked thereon and distributors.

This plan has already been received, but it is desired that the plan should have clearly marked on it the various places where surplus from the Sewage Farm runs on to the beach, and should also show all ponds and lowlying places which become ponds when sewage is run into such lowlying places. Such places can be found on inspection.

The former Sewage Farm margin should be marked on the plan with the year when such margin existed. The present margin should be marked so that the committee can judge of the extent and rate of erosion of the farm by the sea.

(6) Cross section of a plot on the old part of the farm to be found by cutting a narrow trench right across the plot (to a depth of 2 feet).

(7) An area on a suitable part of the farm (that is not in a swampy part) to be turned over and left for inspection without being irrigated.

Such area to be 10 yards square.

(8) A cross sectional plan of a plot showing typical levels of subsoil water before, during and after irrigation.

(9) Statement of quantity of sewage (minimum, average and maximum) for a dry weather month pumped on to the farm, and average area irrigated by such sewage. (The area has already been stated, but the correct area should be repeated on the statement of quantity.)

(10) Time taken by sewage at the various pumping areas in flowing from furthest house to a pumping station and time taken by sewage in flowing from each pumping station to the Sewage Farm, also time taken by sewage in flowing along the masonry channel from one end to the other.

(11) Statement of actual amount of sewage per acre put on a typical plot as disclosed from observations made from the discharge over a right-angled notch.

(12) A statement by subheads—
(i) Cost of maintenance.
(ii) Cost of permanent monthly labour.
(iii) Cost of casual monthly labour.
(iv) Cost of repairs.
(v) Income from proceeds of crop sold or other revenue derived from the Sewage Farm.
(vi) Gross expenses of the Sewage Farm.
(vii) Gross revenue of the Sewage Farm.
(viii) Net revenue of the Sewage Farm.

Certain figures have already been supplied, but the committee desire a statement in more detail so that they can judge what is the actual financial result of treating the sewage of Madras on a sewage farm.

(13) Copies of any previous reports on the Sewage Farm (if available) which recommend the growing of certain crops.

(Note.—Mr. Harrison's report has already been received.)

(14) The analyses of sewage, water, air and soil will be taken by members of the committee.

(15) The committee will be glad if the information desired is obtained as early as possible so that their report may be prepared with the least delay possible.

Letter—from A. Y. G. CAMPBELL, Esq., C.I.E., I.C.S., Acting President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 25th August 1913.
No.—R.O.G.D.C. 558-Sup.

With reference to items (3) and (9) of your letter No. 1603-M., dated 10th July 1913, I have the honour to forward a plan of the Madras City showing the site of the farm with reference to the city and Tondiarpet and a statement showing the quantity of sewage pumped on to the farm during April 1913. The correct area of the farm irrigated by the sewage has not yet been ascertained and will be reported to you later on.

ENCLOSURE.

Statement of sewage pumped on to Sewage Farm during April 1913.

	GALLONS.
Total quantity during April	114,365,000
Actual maximum quantity for one day	5,350,000
Actual minimum quantity for one day	4,160,000
Average daily quantity	4,800,000

Variation in day's flow in gallons per minute.

	MAXIMUM.	MINIMUM.	AVERAGE.
From 7 A.M. to 1 P.M....	7,500	5,700	6,666
„ 1 P.M. to 10 P.M.	3,500	2,700	3,100
„ 10 P.M. to 7 A.M.	1,500	1,150	1,330

Demi-official—from A. Y. G. CAMPBELL, Esq., C.I.E., I.C.S., Acting President, Corporation of Madras.
To—H. C. SAMPSON, Esq., Member, Madras Sewage Farm Committee.
Dated—the 30th August 1913.

With reference to our conversation about the working of the Tondiarpet Sewage Farm and to your consent to supply me with a working-plan for the farm, I find that Madeley prepared alternative schemes for the irrigation of the farm : one, estimated to cost Rs. 45,000, provided for regular terracing throughout and the other, estimated to cost Rs. 44,500, provided for what Madeley called, I think, the broad irrigation system. The Corporation approved of the latter and from Madeley's Drainage Scheme Report it appears that it has been completed at a cost of Rs. 33,085. The system is described in paragraph 60

(page 29) of the Madras City Main Drainage, 1913, Volume I—Report, an extract of which is enclosed. I presume, however, that a certain amount of terracing will none the less be necessary.

2. When will you be able to let me have your working-plan? I should like to get to work especially on the eradication of the chappar grass so as to get as much removed as possible before the north-east monsoon. You were going to kindly advise, I think, as to the best methods and implements to be employed to that end. Perhaps you could let me have a note on this earlier.

ENCLOSURE.

Extract of paragraph 60 *of the Madras City Main Drainage*, 1913, *Volume I—Report of Mr. Madeley.*

Sewage Farm Irrigation system.

The sewage from the channel is discharged into 18-inch concrete pipes laid at right angles to the channel in parallel lines 600 feet apart. These pipes are provided with manholes at every 200 feet from which sewage can be supplied either directly into open channels slightly above ground level running above and a few feet to the side of the 18-inch pipes, or by means of 9-inch underground pipes to similar open channels running parallel to the main 18-inch pipe and 200 feet on each side of it. From these open channels the sewage is turned over the surface of any part of the farm. At the same time the arrangement of the distribution system allows mowing and other agricultural machines to be worked from side to side of the farm (about 1,500 feet) without encountering any obstacle due to channels or other irrigation works.

The masonry channel terminates at the northern boundary of the Farm in an end which is provided with boards working in grooves; by this arrangement the channel is kept as full as desired, and when there is an excess of sewage, the boards are removed as required and the excess allowed to discharge into the sea.

Demi-official—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—A. Y. G. CAMPBELL, Esq., C.I.E., I.C.S., Acting President, Corporation of Madras.
Dated—the 24th September 1913.

Will you please let me know when I may expect the results of levels, plans, etc., which the Corporation are getting for the Committee as we are unable to write our report until the information required is available.

Demi-official—from A. Y. G. CAMPBELL, Esq., C.I.E., I.C.S., Acting President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 3rd October 1913.

Your letter of the 24th ultimo.

I am forwarding a roll of tracings showing the cross sections of the Sewage Farm and its contours. You have already been furnished with the plan of the farm with reference to the city and Tondiarpet. I hope to forward shortly plans showing the subsoil water-levels, plots with distributors, ponds, etc.

The other plans and information will be furnished as early as possible. Coats is doing his best to urge forward work in this matter, but his work at this time of the year is usually heavy.

Demi-official—from A. Y. G. CAMPBELL, Esq., C.I.E., I.C.S., Acting President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 22nd October 1913.

Herewith a further instalment of three tracings of the Sewage Farm Surveys.

Demi-official—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
Dated—the 27th October 1913.

In returning the plans forwarded by Campbell in connection with the Tondiarpet Sewage Farm investigation, kindly have the following marked:—

(1) The water level on each pond and canal shown on the plan crossed by level sections.
(2) A red line joining up all subsoil water levels in level sections.
(3) Red lines in tracing of site plan showing lines along which level sections were taken.

The site plan forwarded will do very well, but it would be better if, on this plan, the surrounding area was also shown. Please therefore have another tracing made to show the area to the west up to the end of the two cross sections which have been taken and also the area to the south for another 1,000 feet showing, in both cases, the houses.

In the same plan the area to the north should also be shown as far as the end of the proposed extension of the farm with the area to the west as far as the canal.

In fact what I am asking is a plan which will show the site of the Sewage Farm and the area around it. On this plan should also be marked any drainage channels which crossed the Sewage Farm from Tondiarpet and which are stated to have been interrupted by the formation of the new road to the west of the farm.

I shall be much obliged if this and other information due are sent to me at a very early date as I wish to complete the report without delay.

Letter—from P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 18th November 1913.
No.—R.O.W.D.C. 991 Sup.

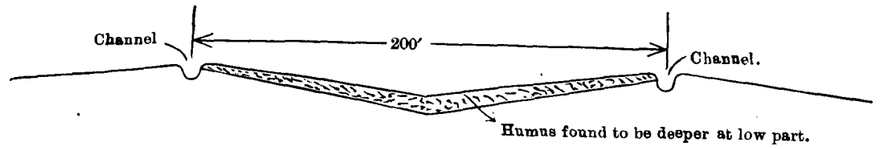
Your letter of the 27th ultimo. I am returning the tracings on which are now noted all the information you require in regard to water and subsoil water levels, etc.

The site plan will be forwarded as early as possible.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
Dated—the 20th November 1913.

Many thanks for the tracings. Please do not trouble to do any more work on the site plan as I have had one made in my office.

I am returning the longitudinal section of the farm showing the humus. What we wanted was a cross section, not a longitudinal section, to show the depth of humus.



[See sketch above.]

I wanted a narrow cutting made across a bed on old part of farm from channel to channel so that the depth of humus might be measured in inches and shown on the cross sectional plan. But as this may delay completion of the report if it cannot be done, say, in a week or ten days, please do not take any action as I want to get our work finished up.

APPENDIX No. 3.

Note compiled by W. Hutton, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee, from the Administration Reports of the Corporation of Madras with reference to Tondiarpet Sewage Farm, dated 19th July 1913.

In 1880, Mr. J. A. Jones says thus (page 85) :—"Madras had five sewage farms, but only three of these were of importance. Sewage farming was not carried on in Madras with the object of a profit being derived, but rather with the idea of efficiently disposing of the sewage and that in a mode which has as yet not shown any bad effects on those residing near the places of disposal. Were the sewage not disposed of in this way some more expensive and less sanitary methods would have to be adopted. In Appendix V, page 114, under the head 'Deaths' it is stated that the increase in death-rate as compared with 1879 is due partly to fevers but mainly to bowel complaints."

1881, page 118.—"Two new sewage farms were brought into operation during the year. All the farms were considerably extended."

In Appendix V, page 154, it is stated "that the death-rate exceeds that of the previous year."

1882—Mr. A. T. Arundel says thus (page 13) :—"The main object of these farms, viz., to get rid of great quantities of liquid sewage in a harmless manner, was satisfactorily effected."

On page 7 it is stated that "the drainage scheme for Black town was actively commenced in building the engine and pump house and the engines, pumps and a cast-iron pipe 24 inches diameter to carry the sewage from the well were put in position."

In Appendix V, page 180, under the head 'deaths' it is given that the deaths during the year were below the average of the ten previous years.

1883.—Mr. A. T. Arundel says (page 6) :—"Pump and engine house at Rayapuram, the outfall channel with a masonry weir and sewer No. 3 were practically completed."

1884–85.—Mr. G. T. Mackenzie says on page 9 of the report thus :—"The Pumping station at Rayapuram was formally opened by His Excellency the Governor on 30th June 1884. The drainage from the eastern and north-eastern sections of Black town and also the sewage taken from the main drain near the fort flows to this spot and is raised and delivered through a 2-feet main nearly one mile in length to an open elevated channel which leads it northwards to the sea. Very little sewage escapes into the sea. Almost all is supplied as a fertilizer to the land on either side of the channel."

On page 15, under the head "Sewage Farms" the same officer says :—"The sewage of several drains which formerly flowed to the beach or into the Cooum or canal, poisoning the air, is now lifted on to the grass lands where it is deodorized by the sun. This system is pursued on sanitary grounds."

Mr. R. E. Stewart Davis, Health Officer, says (page 165, Appendix VII) :—"The fevers are extremely unsatisfactory to deal with. What they represent it is hard even to conjecture; malaria will account for a few, but only a few; some are merely symptomatic of other complaints, the rest remain unknown. I do not anticipate much improvement in this, for even the best educated Registrars would fail to elucidate what many of these cases really are."

On page 169, under the head "fevers" the same officer says :—"Fevers are an indefinite class mostly symptomatic of other general and local complaints, and the broken down and weakened constitutions of those who survived that period of distress may now be giving way and thus causing high mortality under this head."

1885–86.—Mr. J. A. Jones, Acting President, says (page 14, paragraph 80) :—"The new farm at the northern end of the outfall channel was being gradually extended during the year, but the soil is very sandy, and a considerable quantity of sewage requires to be put on it before any very satisfactory results can be obtained."

Paragraph 116, page 19.—"The death-rate was highest in the first division."

Mr. N. Jesudasan, Health Officer, says in paragraph 22, page 149, "that the Black town Drainage Sewage Farm was opened at the close of 1884–85."

Again in paragraph 9, page 161, he says thus :—"That the rate of mortality was highest in the first division, though it is one of the divisions bordering on the sea, I am inclined to doubt if the high rate of mortality in the first division may not be due to its containing places like the Tinnevelly settlement and the Rayapuram Cuppam. The Tinnevelly settlement is a

collection of thatched huts placed together, as closely as possible, excepting here and there where passages have been recently opened, and is inhabited by a crowded population engaged in preparing paddy. Owing to the peculiar occupation of the people, and owing to their being crowded together, a large amount of filthy water must necessarily be produced and there is at present no proper drainage to get rid of this—the only redeeming feature being that of late the Red Hills water has been introduced into the place and is being freely used by the people. The Cassimode Cuppam is occupied by fishermen, the soil of the place is simply loose sand, which affords facilities for concealment of every variety of filth and with no attempt at drainage. Standing as it does at present close to the sea, it may be regarded as a source of permanent nuisance to the people of Rayapuram."

1886–87.—Col. G. M. J. Moore in paragraph 190, page 36, says :—"Although the first division is bordering on the sea, its death-rate has always been high and it has decidedly been highest during the past two years of 1885 and 1886. It does seem probable as surmised in the last year's report that this high death-rate in the first division is due to its containing a large collection of parcheries which form the plague spots of the city."

Again in paragraph 204, page 42, he says :—"During the year there has been an increase in deaths from fevers in the 1st, 2nd, 3rd, 7th and 8th divisions."

1887–88.—Col. G. M. J. Moore in paragraph 217, page 51, says :—"The high death-rate from fevers is principally due to overcrowding and other defects in house sanitation. The most perfect drainage and the purest water-supply will not diminish the death-rate of the city when the house sanitation is neglected."

Again in paragraph 223, page 52, he says :—"The death-rate as in the year 1886 was highest in the first division. The reason for this was given in the report for 1886."

1888–89.—In paragraph 195, page 47, the President says :—"The year under report is marked by a fall in the mortality under fevers."

1889–90.—The President Col. G. M. J. Moore in paragraph 118, page 33, says :—"Mr. Jones submitted the following report. The object is to remove the alleged discomfort caused by the smell rising from the channel. If any foul smell is emitted along the channel, it is at the junction well, where the sewage, after passing through a mile of closed pipe, discharges itself into the well with a good deal of agitation and then comes in contact with the external air. . . . . The supposed nuisance caused by the open channel is problematical. Hardly any smell can be perceived a few yards from the channel. The principles and the considerations of the climatic conditions, which lead to the preferment of open drains for streets, also apply to this question of pipe *versus* an open channel. But if it is settled that some improvement is desirable the channel must be covered for a much longer distance until it gets into a locality that is very much less inhabited than the first portion of the channel."

Paragraph 221, page 55.—During the year the mortality from fevers was something abnormal.

1890–91.—Col. G. M. J. Moore in paragraph 164, page 47, says :—"Fevers—During the year the mortality under this head amounted to 4,685 against 4,154 of the previous year. It is impossible to estimate the proportion of these deaths due to typhoid or malaria. By far the greater proportion of people in Madras do not avail themselves of skilled medical aid and from the accounts given at the Registration offices the most subtle physician would fail to discriminate all the various diseases, which the Registrar, for want of more accurate information, enters as fevers."

Again in paragraph 181, page 58, he says :—"Nearly 200 acres of land were under sewage cultivation in and about Madras during the year."

1891–92.—Col. G. M. J. Moore in paragraph 185, page 54, says :—"The first division returned not only the highest general death-rate, but also a higher death-rate under the head of every special disease than any other Municipal division, viz., fevers 21·3."

Again in paragraph 187, page 55, he says :—"The first division has an area of over 5 square miles, so it cannot be considered to be overcrowded as a whole. But a considerable part of it is laid out in gardens and under cultivation of one sort or another. It contains, however, some of the largest parcheries in the municipality with wretched huts huddled together in some cases on a soil that after a shower of rain forms a slough of liquid filth. The people are on the whole poorer than those of any other division.

1892–93.—Col. G. M. J. Moore, in paragraph 166, page 49, says :—"Although the death-rate for the year under review is lower than that of the previous year under every class except *fevers* and in every division except the second, nevertheless, it is still exceptionally high. Prolonged want due to the continued high price of food was the principal predisposing cause of the high mortality among the masses apart from the general insanitary condition of their surroundings, which was certainly not worse than usual."

In paragraph 193, page 65, he says :—"The heavy mortality in the first division is believed to have occurred specially in the paddy-boilers' hutting grounds of the centre ward."

In paragraph 181, page 57, he says :—"Fevers—The deaths from fevers numbered 6,889 or 15·2 per thousand. This number is the highest recorded in Madras and is 2,556 above the average. The enormity of the ratio will be apparent when compared with the fever rate in England which is about 0·2. Though doubtless a fair number of cases of a non-malarial type were registered under this head there can be but little doubt that most of these deaths were due to fever of a malarial type due to the polluted state of the ground and the inadequacy of the drainage of the town, insufficiency of food and clothing, overcrowding of houses and want of ventilation playing a secondary part in bringing about this result."

1893–94.—Col. G. M. J. Moore, in paragraph 64, page 20, says :—" . . . . During the year a considerable portion of the Black Town Farm was carried away by the encroachment of the sea."

In paragraph 179, page 62, he says :—"That the mortality was highest in the first division, centre ward . . . . Water drawn from some of the wells has a strong odour of sewage. The first division, centre ward, is the home of the paddy-boilers who pollute the whole place with their notoriously insanitary habits."

Again on page 70 under the head "sanitary defects," paragraph XII, he says :—"Paddy boiling—This industry consists in soaking and boiling rice for the purpose of husking it. It is believed to have a more injurious effect on the health of the town than all other trades practised therein. The paddy after fermenting for some days is heated to a point somewhat below boiling point, then piled in heaps or spread out on cowdung floors to dry. During this process a considerable quantity of liquid rich in organic matter soaks into the ground. The water in which the grain is fermented after being used several times is poured on the ground. The persons who pursue this calling are not as a rule natives of the town, but poor immigrants from Tinnevelly. They are dirtier in their personal habits than any class in Madras. Even when latrines are provided for them within an easy distance they prefer to foul the ground outside their huts. The principal centre of the industry is the first division, central ward, which had a death-rate in 1893 of 51·1 per 1,000 or over 10 per 1,000 more than the town as a whole, their fever mortality alone being 17·9.

1894–95.—Col. G. M. J. Moore, on page 21, paragraph 57, says that a considerable portion of the Black Town Sewage Farm was carried away by the encroachment of the sea.

On page 55, paragraph 176, he says thus :—"The decrease in the fever mortality is attributed to the year being a healthier one and food cheaper. For six years the mortality from fevers has risen and fallen with the price of food and there can be little doubt that within certain limits the one exercises an influence on the other though cheap food by itself cannot be expected to reduce the fever rate to the normal of a healthy town until adequate provision is made for drainage, the disposal of refuse and other sanitary requirements."

1895–96.—On page 58, paragraph 175, he says :—"The first, second and fourth divisions show the highest rates of mortality."

1896–97.—On page 9, paragraph 51, he says :—"Sewage farms—The increase (in sale price) is partly accounted for by the increased area of land to be cultivated."

On page 38, paragraph 162, he says :—"The first division suffered the most severely with a death-rate of 16·7 from fevers alone which is more than the death-rate of some towns from all causes."

1897–98.—Col. G. M. J. Moore, on page 33, paragraph 179, says :—"As in the previous years, the highest number of deaths from fevers, 1,158, was recorded in the first division with a death-rate of 16·1 from fevers alone."

1898–99.—On page 32, paragraph 174, he says :—"The deaths from fevers were practically the same as in 1897."

1899–1900.—On page 42, paragraph 186, he says :—"During the year under report the number of deaths from fevers was 3,317 against 5,489. This decrease is no longer explicable on the ground that people avoided reference to fever for fear of inquiries about plague. Either deaths attributed to fever have really for some unknown reason decreased or some other fancy influences the public when naming the cause of death."

On page 43, paragraph 187, he says :—"In connection with the *Mosquito-Malaria problem* search was made for the breeding places of anopheles with the view of ascertaining the practicability or otherwise of exterminating the genus from the city limits. Instead of the very limited distribution that one had been led to expect the larvæ were found to be very widely distributed." *This problem has been discussed in more detail and covers five printed pages.*

1900–1901.—On page 39, paragraph 181, it is stated that "fevers have reached the usual level." On page 43 the concluding paragraph on mosquitoes and malaria runs thus :—"The conclusion is forced on us that a disease which has prevailed for centuries over extensive areas cannot be exterminated offhand without enormous expenditure and measures that to the masses would seem arbitrary and uncalled for."

1901–02.—Col. G. M. J. Moore says on page 20, paragraph 153, as below—" . . . . In addition, the season appeared to be unusually unfavourable and many deaths were attributed to fever and dysentery."

On page 21, paragraph 158, under the head "fevers" it is stated that "the number of deaths registered during the year is the highest ever recorded in Madras. It is impossible to say how many of these deaths were due to malaria, for it must be remembered that 'fever' is a generic term to the Madrassi, under which every disease attended with fever is included."

1902–03.—Mr. S. D. Pears says on page 23, paragraph 163, that the first division is literally a case of "excrement sodden earth, excrement reeking air and excrement tainted water."

On page 24, "the first division has been described as the most feverish centre in the city in addition to being the haunt of all sorts of diseases."

On page 25, he says thus :—"With regard to prevalence of fever in the different parts of the city, second centre returned highest and first centre comes next. If the average of the ten previous years be taken, first centre stands far ahead of the rest.

In 1903–04.—Mr. S. D. Pears says on page 24, paragraph 171, thus :—"Once again the death-rate of the first division, centre ward, shows the extremely insanitary condition of this part of the city."

On page 26, paragraph 179, thus :—"The first centre ward returned the highest number of deaths from fevers."

1904–05.—On page 27, paragraph 168, thus :—"As usual the first division, centre ward (now the second division), returned the highest death-rate."

On page 28, paragraph 172, thus :—"The first division, centre ward, returned the highest number of deaths from fevers."

1905–06.—Mr. E. S. Lloyd says on page 10, paragraph 50, thus :—"The Cassimode Sewage Farm which was the only farm retained after 31st March 1906 and which measures, including the newly acquired area, cawnies 124, grounds 9 and square feet 1,665 . . . ."

On page 15, paragraph (Sewage Farm) :—"The lands for the extension of the Sewage Farm at Tondiarpet have been handed over by the Deputy Collector. The work to be done at the farm is well advanced."

On page 28, paragraph 152, he says thus :—"As usual the first division, centre ward, (now second division), returned the highest death-rate."

1906–07.—Mr. E. S. Lloyd says on page 11, paragraph 56, thus :—"The right of cultivation of the Cassimode Farm which is the only one to which sewage is now supplied was sold."

"The farm at present believed to be cultivable consists of 43·97 cawnies old and 65·16 cawnies new, totalling 109·13 cawnies."

On page 19, paragraph 85, thus :—"The five pumping stations built for the new drainage works were put to work and commenced pumping sewage to the Cassimode Farm in April 1906, and at the same time the old sewage farms were thrown out of use."

On page 28, paragraph 147, thus :—"The first division, centre ward (now the second division), as usual returned the highest death-rate."

1907–08, page 32, paragraph 184, thus :—"The second division (old first division, centre ward) as usual returned theh ighest death-rate."

Page 15, paragraph 74, thus :—"As a result of this experiment, the contractor was allowed to pay rent only for 100 cawnies which was decided to be the present actual irrigable area of the farm."

1908–09.—Mr. E. S. Lloyd says on page 36, paragraph 166, thus :—"As usual the highest death-rate 58·2 was returned in the second division (old first division, centre ward)."

1909–10.—Mr. P. L. Moore says on page 27, paragraph 118 (4), thus :—"The main irrigation channels at the Sewage Farm were so unsatisfactory as to make it impossible to irrigate some 25 per cent. of the farm. The new contractor complains bitterly and in consequence the Special Engineer was instructed to report the best remedy. Accordingly he submitted a new scheme which was departmentally carried out, and a larger area of the farm than ever before is now readily irrigated."

On page 38, paragraph 180, thus :—"The second division (old first division, centre ward) has been recording the highest death-rate in the city during the last 16 years and it is unquestionably the most insanitary division in the city."

1910–11.—Mr. P. L. Moore says on page 52, paragraph 234, thus :—"The second division (old first division, centre ward) has been recording the highest death-rate in the city during the last 17 years."

1911-12.—On page 31, paragraph 131 (one and two), thus :—"The irrigation of the grass farm on broad irrigation methods has been completed at a cost of Rs. 36,300. The construction of the open channel at the grass farm has been completed and serves as a carrier for the whole of the Madras sewage. The channel has replaced the 36-inch cast iron main which previously supplied the farm, but whose carrying capacity had become too small. . . . The channel was completed on 18th January 1912."

On page 32, paragraph 136, thus :—" . . . That all the subsoil in Tondiarpet is sand which allows the subsoil water to percolate freely."

On page 49, paragraph 222, thus :—"The second division (old first division, centre ward) has been recording the highest death-rate in the city for the last 18 years and it is unquestionably the most insanitary division in the city."

On page 50, paragraph 233, thus :—"Proposals are under consideration for the investigationof the causes of malaria in the northern part ofGeorgetown."

A statement is attached giving the ratio of mortality due to fevers ingeneral per thousand of population in each of the divisions of the city from 1880 to 1905 as there was no classification of fevers till then and another statement just below showing the classification of fevers from 1905-06 to 1911-12.

ENCLOSURE.

Statement showing the ratio of death-rate due to fever per mensem per thousand of population in each of the divisions of the Corporation of Madras.

Divisions.	1880.	1881.	1882.	1883.	1884-85.	1885-86.	1886-87.	1887-88.	1888-89.	1889-90.	1890-91.	1891-92.	1892-93.	1893-94.	1894-95.	1896-96.	1896-97.	1897-98.	1898-99.	1899-1900.	1900-01.	1901-02.	1902-03.	1903-04.	1904-05.
1	12·4	11·7	12·4	9·5	14·0	11·8	...	12·5	11·9	10·7	13·9	19·7	16·3	15·9	15·5	16·1	16·7	16·1	17·7	10·0	20·0	26·6	20·3	17·0	14·1
2	9·7	9·0	9·4	9·3	12·6	8·4	...	9·3	9·8	8·6	11·9	15·5	20·3	20·1	16·8	14·0	13·5	13·5	14·3	10·8	17·1	23·8	20·6	16·2	13·8
3	7·5	7·5	7·7	8·4	11·3	8·1	...	9·8	8·8	7·1	11·8	16·3	19·2	19·2	17·8	16·2	13·5	13·8	13·8	10·9	17·7	24·1	18·0	15·6	12·0
4	9·0	9·9	7·7	8·6	16·8	7·8	...	8·1	8·9	7·4	11·8	14·8	10·6	10·6	12·4	13·9	11·6	11·8	9·9	4·4	9·7	12·0	8·2	8·9	5·2
5	7·0	8·0	7·7	7·8	10·5	7·7	...	8·1	9·7	6·4	11·7	12·6	10·9	10·7	10·7	11·9	9·9	11·1	9·4	4·7	9·3	14·0	10·1	8·5	7·0
6	4·0	4·7	4·6	4·5	6·1	4·0	...	4·4	7·2	6·3	7·3	9·3	9·0	12·3	12·0	13·2	7·9	6·4	3·0	4·8	9·8	7·5	6·7	5·8	4·2
7	8·1	8·8	9·1	7·5	10·4	8·9	...	8·9	10·3	9·2	13·6	12·9	12·4	12·2	11·0	12·1	11·8	10·6	8·8	4·6	8·7	11·8	10·6	8·8	7·5
8	10·0	12·4	10·2	11·6	13·8	8·9	...	11·0	11·4	8·4	9·7	14·5	10·9	11·2	9·9	9·3	11·5	9·7	7·2	3·6	7·1	10·8	9·1	7·6	6·7

Note.—M = Malaria. E = Enteric. F = Other fevers.

Divisions.	1905 1906.			1906-1907.			1907-1908.			1908-1909.			1909-1910.			1910-1911.			1911-1912.		
	M.	E.	F.	M.	E.	F.	M.	E.	F.	M.	E.	F.	M.	E.	F.	M.	E.	F.	M.	E.	F.
1	1·9	0·8	8·3	8·8	·07	·06	7·6	·08	2·9	7·0	·06	3·3	6·4	·05	4·2	7·0	·16	6·3	7·2	·07	4·5
2	3·8	0·13	9·5	10·5	·05	2·3	8·3	·09	2·2	9·8	·09	2·1	8·0	·12	2·7	4·1	·06	8·1	8·0	·05	2·4
3	1·7	0·2	6·0	4·2	·31	1·8	5·5	·08	2·3	4·6	·09	3·6	5·2	·08	4·2	6·6	·08	5·7	5·7	·3	1·9
4	0·4	0·04	7·7	4·3	·08	1·5	6·8	·05	·15	6·3	·09	0·9	6·2	·04	1·1	4·0	...	2·8	2·6	·06	2·7
5	1·2	0·13	8·4	6·4	·08	1·3	3·9	·13	3·9	4·5	·10	3·9	4·2	·08	3·3	4·4	·08	3·3	2·9	·06	1·4
6	0·1	...	5·6	·15	·08	5·7	1·3	·13	5·1	1·9	·06	2·3	2·3	·04	2·0	1·0	·08	3·5	2·4	·07	·7
7	0·5	0·08	7·9	1·2	·09	4·6	1·3	·03	6·8	2·3	·04	6·4	1·8	·09	4·3	1·8	·03	4·2	2·5	·08	·8
8	0·3	0·03	6·6	3·2	·06	1·0	4·7	·08	...	3·0	·03	3·6	2·8	·04	3·7	4·9	·2	4·5	3·0	·19	·8

APPENDIX No. 4.

Correspondence with the Malaria Board.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—the Secretary, Malaria Board, Office of the Sanitary Commissioner, Madras.
Dated—27th June 1913.
No.—1532-M.

I have the honour to forward a note on the head of "Malaria" in connection with the enquiry of the Madras Sewage Farm Committee into the existing state of the Madras Sewage Farm and to state that the Sewage Farm Committee will feel obliged if the Malaria Board will favour them with authoritative replies to the five questions mentioned in the note.

ENCLOSURE.

Madras Sewage Farm.

In G.O. No. 825 M., dated 23rd April 1913, the Government of Madras, in deference to the wishes of the Corporation of Madras, appointed the following Committee to consider and report to that body whether the Tondiarpet Sewage Farm is a source of danger to health

(1) as a cause of malaria,
(2) mosquito nuisance,
(3) contamination of subsoil and
(4) what improvements can be made.

The following were appointed members of the Special Committee :—

Mr. W. Hutton, Sanitary Engineer to Government (Chairman).
Dr. F. Maitland Gibson, Director, King Institute, Guindy.
Mr. H. S. Sampson, Acting Principal of the College of Agriculture, Coimbatore.
Mr. W. H. Harrison, Agricultural Chemist, College of Agriculture, Coimbatore.

The consideration of the Committee was directed to enquiry under the four main heads mentioned in the Government Order and information is being collected on all points bearing on these heads and on any other points which would enable the Committee to come to definite conclusions, if possible, on all matters and thus enable the Committee to fulfil the intention of the enquiry and answer the question as to whether or not the Sewage Farm was detrimental to the health of the people living in the surrounding areas and, if not, what improvements, if any, to the farm were called for or advisable.

The following note has been written in connection with the head "Malaria" and it is considered that it would be well to obtain the opinion of the "Malaria Board" on the questions raised in the note :—

Malaria.

Government in their order constituting the Sewage Farm Committee refer to that Committee the question

Is the Sewage Farm a cause of malaria to the people inhabiting the areas of the City of Madras bordering on the farm ?

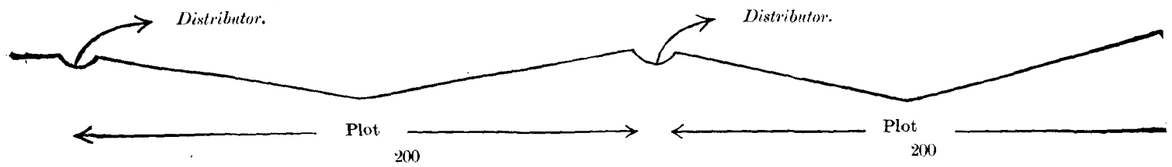
The modern idea of malaria transmission appears to be that malaria is transmitte dby a malaria carrier, usually the species of mosquito called Anopheles and by other species of mosquitoes, from a person suffering from malaria to persons free from contagion.

If Anopheles or other malaria carriers are found to breed on the Madras Sewage Farm then the Sewage Farm can *ipso facto* be considered to be a cause of malaria in the likely event of persons infected with malaria residing within a short distance of the farm. The sewage used for irrigating the farm arrives at the farm in a state of decomposition due to the lapse of time from the moment the sullage leaves the house drain till it arrives at the farm.

The sewage pumping mains discharge into an open masonry channel which has been built along one side of the farm. From this open channel the sewage is distributed on to various plots through controllers which allow the sewage to enter the small distributing channels of which there is one for each plot.

The soil of the farm is pure sand of a coarse nature and no stagnation of sewage usually occurs the excess readily soaking into the porous subsoil.

A typical section of the farm is as follows :—



It is said that sewage is run on to a plot during the day for a period of seven hours and the supply is then cut off. It is also said that owing to the porous nature of the subsoil sand all excess sewage is found to soak into the ground within two hours of the supply being cut off so that during the night the plots which have been irrigated during seven hours of the day are only moist and do not contain any stagnating sewage. During the night the plots which are being irrigated will of course contain sewage, but sewage will not stagnate on the farm for any length of time. Consequently there are no objectionable pools of sewage left to stagnate on the farm for any length of time. There may be occasionally small pools due to inequalities in the distributing channels aided by occasional temporary blockages in the channels. Such being the condition of the irrigation on the farm, it seems advisable to ask the Malaria Board for a definite statement of their opinion based on the conditions prevailing at the Madras Sewage Farm and with reference also to investigation carried out either in Madras or elsewhere as to—

(1) Whether or not Anopheles or any other malaria-carrying mosquitoes can breed in raw sullage or sewage in stagnating pools or ponds ;

(2) Whether the interruption of irrigation which results in each plot being only covered with sewage for a period of nine hours or so will not prevent the breeding of any kind of mosquito on the farm plots ;

(3) Whether the continuous irrigation of a plot for, say, 15 days of seven hours' duration each would permit the breeding of Anopheles or any kind of mosquito in the stagnating sewage of that plot assuming that if the sewage is run on for seven hours every day for 15 days and disappears from sight after two hours more the plot remains in a damp state during the night.

(4) As there are some ponds on the farm containing clear *subsoil* water, whether the existence of these ponds is not favourable to the breeding of Anopheles or other kinds of mosquitoes, as the water contained in the ponds is subsoil water the level of which has been raised by the irrigation of the farm and the water of which may be taken to be clear subsoil water contaminated by sewage percolation through sandy subsoil.

(5) The site of the Sewage Farm is an open one exposed to the sea breezes and land-winds and the adjoining inhabited area does not so inclose the farm as to permit of stagnation of air.

An inspection of the farm shows that the smell of the sewage is distinct from the open masonry channel which borders the farm but that, on irrigated plots, probably due to their open condition to the sky, the smell of sewage is not apparent. During the months of October to March the prevailing wind is north-east and this north-east wind will carry emanations from the sewage inland across the adjoining inhabited areas.

As these areas are occupied by houses of no great height and as the houses are separated in blocks from each other with considerable intervening space, it may be assumed that such emanations from the farm are in no cases confined but are on the other hand greatly diffused.

The favour of a definite answer is requested to the following question :—

Assuming that the smell of sewage can be distinctly traced on the roads surrounding the houses adjoining the Sewage Farm, will any disease of the fever type or otherwise result from the breathing of the contaminated air by the people ?

If the answer is in the affirmative or if remedial measures are suggested, it may be assumed that practical measures can be suggested to get rid of the smell of sewage emanating from the principal offender, viz., the open channel ; but as no smell of sewage is apparent on the farm itself, no practical measures for the removal of any complaint on this score can be suggested except possibly improved methods of working.

A copy of note, dated 8th May 1913, by the Superintendent of the Sewage Farm, is attached.

Letter—from Captain M. J. QUIRKE, I.M.S., Acting Sanitary Commissioner, Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 13th August 1913.
No.—1935-S.

With reference to your letter No. 1532-M., dated the 27th June 1913, I have the honour to communicate the following remarks of the Malaria Board in regard to the points noted therein :—

"The questions on pages 2, 3 and 4 of Mr. Hutton's letter cannot be answered without a local enquiry. One of our Malaria Experts (Captain Horne) is now at home on leave and the other (Major Ross) has his hands full and cannot be spared for this investigation. A special Malaria Officer will shortly be appointed for Madras City and he will be the proper official to undertake the investigation in question."

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—the Sanitary Commissioner and Secretary, Malaria Board.
Dated—the 15th August 1913.
No.—1836-M.

As the Madras Sewage Farm Committee understand that in order to answer the questions asked in my No. 1532-M., dated 27th June 1913, it would be necessary for the Malaria Board to depute some special officer to make a local enquiry, and also understand that no such officer is immediately available, I have the honour to inform you that the Madras Sewage Farm Committee have since been fortunate in securing the services of a competent officer for the purpose. In these circumstances the Committee request that the Malaria Board will take no further steps in the matter.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—the Sanitary Commissioner and Secretary, Malaria Board.
Dated—the 15th August 1913
No.—1837-M.

In continuation of my No. 1836-M., dated the 15th August 1913, I have the honour to acknowledge receipt with thanks of your No. 1935-S., dated 13th August 1913, forwarding remarks of the Malaria Board on my letter No. 1532-M., dated the 27th June 1913.

APPENDIX No. 5.

Statement by M.R.Ry. Rao Bahadur P. Thyagaraya Chetti Garu.

Letter—from M.R.Ry. Rao Bahadur P. THYAGARAYA CHETTI Garu, Tondiarpet.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman of the Special Committee for report upon the Sewage Farm at Tondiarpet.
Dated—the 30th May 1913.

Now that a special Committee has been appointed by the Government to investigate and report upon the Sewage Farm at Tondiarpet will you kindly let me know if you will record my evidence in the course of investigation as I will be able to place certain facts before you in connection with the subject.

Reply—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—M.R.Ry. Rao Bahadur P. THYAGARAYA CHETTI Garu, Tondiarpet.
Dated—the 7th June 1913.

I am in receipt of your letter of 30th ultimo on my return from tour and note contents. Your letter will be placed before the other members of the Committee and their views obtained.

I may however say that your statements on the Sewage Farm question are already available from copies of the Proceedings of the Corporation, but perhaps you wish to refer to other points which were not brought before the Commissioners during the discussion on the "Farm." If such additional points are relevant to the study of the question by the Committee, I would suggest that they should be sent to me in the form of a concise statement o facts so that I may place such statement before the Committee for their consideration.

Letter—from M.R.Ry. Rao Bahadur P. THYAGARAYA CHETTI Garu, Tondiarpet. Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 18th June 1913.

Thanking you for your letter of the 7th instant I beg to say that almost everything that can be said about malaria and the influence of the Sewage Farm on it has been said in the discussions at the meetings of the Corporation.

But lately it has come to my notice that several female labourers that were employed in the Sewage Farm for cutting grass have suffered and are suffering from swollen legs. Whether this is elephantiasis or not I cannot say; but there is the fact that several of them have even now swollen legs long after leaving their work on the farm.

Lately a private survey of wells and ponds of Dhobypet and its vicinity has been made and I send a tracing for your perusal. It will be found from it that ponds and wells close to the farm have water-levels very much higher than those farther to the west, and from the figures given on the tracing it will be found that taking a point on the road close by the channel as 50 feet, pond No. 4 which is about 250 feet from the Sewage Farm is 46·79 and the fall is gradient to 33·69 in pond No. 139 at the Railway crossing showing a difference of 13 feet within a distance of 3,500 feet which is, I think, an indication that percolation from the Sewage Farm goes as far as the Railway crossing. I may also mention that pond No. 139 is in my garden and I find no necessity for removing silt for better supply of water from the time the Sewage Farm was extended.

My experience for the last forty years or more in the locality was that in hot season, say, from May, water in wells and ponds went down to the bottom and Wodders were employed to remove silt and deepen them for supply to satisfy their requirements; but after the extension of the sewage irrigation no necessity was found to remove silt at all as water was kept up at very high level and the supply never fell short. In the garden in which pond No. 147 is, a pumping plant is now installed with a 5" pump and this plant irrigates 12½ acres of cocoanut tope in five hours and this is being done every day and water goes down 3 feet only for pumping 150,000 gallons and in a short time the water comes up to its former level.

I mention these as they will not generally go to your notice in the ordinary course of investigation.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—M.R.Ry. Rao Bahadur P. THYAGARAYA CHETTI Garu, Tondiarpet.
Dated—the 8th July 1913.
No.—1578-M.

I am desired by the Madras Sewage Farm Committee to ask you to be good enough to submit a condensed report of your views on the subject of the Sewage Farm at Tondiarpet.

Letter—from M.R.Ry. Rao Bahadur P. THYAGARAYA CHETTI Garu, Tondiarpet. Madras.

To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 12th July 1913.

In accordance with your letter of the 8th instant, I beg to submit my views on the Sewage Farm at Tondiarpet:—

(1) *Subsoil water contamination.*—With my letter to you on the 18th ultimo a plan showing the levels of subsoil water in the lands of the west of the Sewage Farm has been sent. From that it will be seen that all land up to the Railway line, a distance of 3,500 feet from the Sewage Farm, is saturated with sewage. That it is from the sewage of the Sewage Farm can be safely inferred from the fact that wells and tanks a furlong away from the Sewage Farm, both north and south, have water in much lower levels and still maintain almost their former purity whereas in the wells and tanks to the west in which water level is now kept up very high water has putrid smell with a colour that of dilute sewage. The quantity of sewage now sent to the Sewage Farm is about 5,000,000 of gallons a day and with that quantity not only the 120 acres of Sewage Farm but also all land to the west of the farm to a distance of 3,500 feet and to the north and south about a furlong is surcharged with sewage. The drainage at present carries excreta of houses except from a few flush out latrines, but if it carries all excreta from the drainage area the pollution of subsoil water will be infinitely worse. In the course of the next five years Tondiarpet and Purasavakum drainage will be complete, water-supply will be in full swing and all house latrines will be of flush out type and the quantity of sewage from the city will reach 20,000,000 gallons a day and under the existing arrangement the whole of it will have to go on the Tondiarpet Farm. If the Sewage Farm is carefully examined it will be found that the whole of it is water-logged and any additional discharge on it cannot be borne by it and it requires four times the present area to receive four times the present quantity of sewage and under these conditions the farm should at least be of 500 acres for which it will have to extend three miles further to the north in the northern end of Tiruvottiyur. There are three villages in the way, *i.e.*, Thongál Kaladipet and Tiruvottiyur and they are well populated. If a sewage farm is established by their side they will have to suffer from the same inconveniences as the people of Tondiarpet are now suffering. The subsoil water of all land between the Sewage Farm in the east and Buckingham Canal on the west will be completely saturated with sewage as the whole land is sandy and they will have the same mosquito pest and the same air contamination, and they will have one more disadvantage. They will have no Red Hill water-supply for drinking purposes at least as the people of Tondiarpet have.

(2) *Smell emanating from the Sewage Farm and open channel.*—All day and night an open channel, 5½ feet broad and a mile long, full of sewage, and a sewage farm 120 acres in extent with 25 acres being irrigated all day and night, are exposed to the air and the atmosphere on the farm and all round cannot but be vitiated. In the day, when the sun shone the stench from the channel and the farm is not very much felt, due perhaps to the sun's action on the polluted air. But with the sun going down and sea breeze setting in the stench becomes intolerable, being felt not only by the people in the locality but by people from more than a mile away on either side of the farm both north and south. From October to January when north wind blows I have felt it in midnights in my house, a mile away from the Sewage Farm, and Mr. Diwan Bahadur Adinarayanayya living close by me had complained of the same.

(3) *Mosquitoes and flies.*—There used to be mosquitoes in the north portion of Tiruvottiyur with the first rains when grass begins to grow but they used to disappear in January when it dies. But after the sewage was extended mosquito pest has become intolerable. It is not the grass mosquitoes that we find now, but mosquitoes of much bigger type and throughout the year. They are bred in millions on the Sewage Farm. In the day they are sheltered from the sun under grass especially chappar and in the evenings with the sea breeze they invade houses not only in Dhobypet, but a mile all round.

(4) *The open channel.*—The drainage of Dhobypet is always towards the sea, Tiruvottiyur High Road being a ridge, east side sloping towards the sea and the west side towards Buckingham Canal. After the open channel was built and a road made by its side, all surface drainage from Dhobypet was interrupted by them and for two months together Dhobypet was under water both in 1911 and 1912.

Letter—from A. Y. G. CAMPBELL, Esq., C.I.E., I.C.S., Acting President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 27th August 1913.
No.—R.O.G.D.C. 971/Sup.

I have the honour to forward for the consideration of the Sewage Farm Committee a copy of a letter, dated 23rd August 1913, received from M.R.Ry. Rao Bahadur P. Thyagaraya Chetti Garu regarding the subsoil water-level of the area adjoining the Sewage Farm.

ENCLOSURE.

Letter—from M.R.Ry. Rao Bahadur P. THYAGARAYA CHETTI Garu, Tondiarpet.
To—the President, Corporation of Madras.
Dated—23rd August 1913.

After my conversation with you on the Sewage Farm question on Thursday last it struck me that an examination of water levels of tanks and wells on either side of the Sewage Farm about half a mile away towards the north and the south will go to help in forming an opinion as to how far sewage from houses tends to raise the level of the subsoil water.

There are no drains anywhere towards the north of the Sewage Farm and up to more than half a mile towards the south and all house sewage sinks in the ground, and percolation is as good as in Dhobypet. I will be much obliged if you will kindly make this suggestion to the Sewage Farm Committee.

APPENDIX No. 6.

Chemical and Bacteriological analyses of samples of sewage and subsoil water.

Samples taken on 22nd August 1913 *by Mr. Seethapathy Ayyar, L. M. & S., Assistant at the King Institute, Guindy, in the presence of W. Hutton, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.*

Section 1.

Sample

No. 1.—Taken at the first sluice of the sewage channel.

No. 2.—Taken in pond at Raju Gramany's Garden, at the discharge pipe of the engine, north of Balakrishna Nayakan street. Kerosine oil was said to have been sprinkled in this pond at about 7 A.M. on the 21st August 1913 by the Corporation men and oil was seen floating on the surface of the water in the pond and suction well.

No. 3.—In pond opposite to tomb, west of Raju Gramany's Garden, north of Balakrishna Nayakan street. (In this pond oil had been sprinkled on 21st August 1913).

No. 4.—In small well, 8 feet diameter north-east of Temple Hall, N. north-west of Temple on west side of Tiruvottiyur High road.

Section 2.

No. 5.—Taken at No. 14 sluice in sewage channel.

No. 6.—Taken in small pond, 300 feet, west of sewage channel in line with No. 14 sluice.

No. 7.—From covered well fitted with a semi-rotary pump, without a platform or leading off drain to carry away the spill water, 150 feet east of Tiruvottiyur High road.

No. 8.—From a 4-feet diameter well covered with gauze, door open and gauze torn; surroundings filthy, south of Balakrishna Chetti's Garden, west of Tiruvottiyur High road.

Note by Major CORNWALL, I M.S., Acting Director of the King Institute, Guindy, on the samples of sewage collected on the 22*nd August* 1913, *dated the* 18*th September* 1913, *No.* 4503/*B.*

The samples I and V of sewage taken at the two sluices of the channel show all the features of a rich sewage both bacterially and chemically. The total counts are very high. There are 100 millions of fœcal germs per every cubic centimeter some of which indicate recent gross pollution. The figures against chlorine, ammonias and hardness are all very high.

The other six samples taken at varying distances from the channel do not show anything allied to the composition of the sewage. They all show a very high figure against chlorine which is evidently due to the proximity to the sea. In other respects they possess the quality of the waters of ordinary ponds and wells not conserved.

CHEMICAL ANALYSES.

Section I.

Physical appearances.		Sample No. I.	Sample No. II.
	Colour and Transparency.	Dark and opaque.	Yellowish but clear.
	Smell.	Smell of sulphuretted hydrogen.	None.
	Quantitative.		
Total solids	Parts per 100,000	122·000	107·000
Temporary hardness	Do. do.	30·000	30·000
Permanent hardness	Do. do.	10·000	22·500
Total hardness	Do. do.	40·000	52·500
Chlorine	Do. do.	17·040	30·530
Ammoniacal Nitrogen	Do. do.	3·080	0·134
Albuminoid Nitrogen	Do. do.	0·728	0·021
Oxygen absorbed (*Tidy's Process*)	Do. do.	4·190	0·133
Nitric Nitrogen	Do. do.	*Nil.*	0·250
	Qualitative.		
Nitrites		*Nil.*	*Nil.*
Sulphates		Present.	Present.
Phosphates		Trace.	*Nil.*
Iron, poisonous metals		Trace. *Nil.*	*Nil.* *Nil.*

Physical appearances.		Sample No. III.	Sample No. IV.
	Colour and Transparency.	Yellowish and hazy.	Yellowish but clear.
	Smell.	None.	None.
	Quantitative.		
Total solids	Parts per 100,000	140·000	191·600
Temporary hardness	Do. do.	25·000	45·000
Permanent hardness	Do. do.	25·000	17·500
Total hardness	Do. do.	50·000	62·500
Chlorine	Do. do	41·890	71·000
Ammoniacal Nitrogen	Do. do.	0·016	0·010
Albuminoid Nitrogen	Do. do.	0·089	0·016
Oxygen absorbed (*Tidy's Process*)	Do. do.	0·343	0·141
Nitric Nitrogen	Do. do.	*Nil.*	0·075
	Qualitative.		
Nitrites		*Nil.*	*Nil.*
Sulphates		Present.	Present.
Phosphates		*Nil.*	*Nil.*
Iron, poisonous metals		*Nil.* *Nil.*	*Nil.* *Nil.*

Section II.

Physical appearances.		Sample No. V.	Sample No. VI.
	Colour and Transparency.	Dark and opaque.	Yellowish and opaque.
	Smell.	Smell of sulphuretted hydrogen.	None.
	Quantitative.		
Total solids	Parts per 100,000	184·000	106·000
Temporary hardness	Do. do.	25·000	20·000
Permanent hardness	Do. do.	15·000	30·000
Total hardness	Do. do.	40·000	50·000
Chlorine	Do. do.	17·750	26·270
Ammoniacal Nitrogen	Do. do.	4·760	0·045
Albuminoid Nitrogen	Do. do.	1·120	0·056
Oxygen absorbed (*Tidy's Process*)	Do. do.	8·190	0·457
Nitric Nitrogen	Do. do.	*Nil.*	0·350
	Qualitative.		
Nitrites		*Nil.*	Present.
Sulphates		Present.	Present.
Phosphates		Trace.	*Nil.*
Iron, poisonous metals		Trace *Nil.*	*Nil.* *Nil.*

Physical appearances.		Sample No. VII.	Sample No. VIII.
	Colour and Transparency.	Yellowish but clear.	Yellowish but clear.
	Smell.	None.	None.
	Quantitative.		
Total solids	Parts per 100,000	91·400	96·000
Temporary hardness	Do. do.	30·000	17·500
Permanent hardness	Do. do.	10·000	25·000
Total hardness	Do. do.	40·000	42·500
Chlorine	Do. do.	24·850	24·140
Ammoniacal Nitrogen	Do. do.	0·045	0·009
Albuminoid Nitrogen	Do. do.	0·018	0·027
Oxygen absorbed (*Tidy's Process*)	Do. do.	0·095	0·152
Nitric Nitrogen	Do. do.	0·175	0·125
	Qualitative.		
Nitrites		*Nil.*	*Nil.*
Sulphates		Present.	Present.
Phosphates		*Nil.*	*Nil.*
Iron, poisonous metals		*Nil.* *Nil.*	*Nil.* *Nil.*

Remarks.—Water sample from Madras Corporation. Date of taking sample, 22nd August 1913. Date and time of arrival, 22nd August 1913. Taken by Sample-taker.

SECTION I.

ANALYSES.

SAMPLE I—TAKEN AT THE FIRST SLUICE OF THE SEWAGE CHANNEL.

Total colonies per cc. on agar at 37° C.—Countless.

Bile salt lactose, medium.

	+	−
1 tube of 20 cc.	1	...
2 tubes of 10 cc.	2	...
3 „ 5 cc.	3	...
3 „ 1 cc.	3	...
3 „ ·1 cc.	3	...
3 „ ·01 cc.	3	..

Fœcal bacilli in ·00000001 cc and upwards.

Vibrios present in 100 cc.

Number.	Lactose.	Saccharose.	Dulcite.	Adonite.	Inuline.	Voges and Proskr.	Indol.	Motility.	No.	Name of Bacilli.	Group and Remarks.
1	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	Group I, 3.
2	+	−	+	−	−	+	−	−	II	B. Schæfferi ...	„ II, 3.
3	+	−	+	−	−	+	−	−	II	Do. ...	„ III, 1.
4	+	+	−	−	−	+	−	−	IV	B. Coscoroba ...	„ IV, 3.
5	+	+	+	−	−	+	−	−	III	B. Neapolitanus.	
6	+	−	+	−	−	−	−	−	II	B. 40.	
7	+	+	−	−	−	+	−	−	IV	B. Coscoroba ...	Class I, 2.
8	+	−	−	−	−	+	−	−	I	B. Vesiculosus ...	„ II, 4.
9	+	−	−	−	−	+	−	−	I	Do. ...	„ III, 3.
10	+	−	−	−	−	+	−	−	I	Do. ...	Undetermined 1.

SAMPLE II—TAKEN IN POND AT RAJU GRAMANY'S GARDEN AT THE DISCHARGE PIPE OF THE ENGINE, NORTH OF BALAKRISHNA NAYAKAN STREET.

Total colonies per cc. on agar at 37° C.—Countless (13,900).

Bile salt lactose, medium.

	+	−
1 tube of 20 cc.	1	...
2 tubes of 10 cc.	2	...
3 „ 5 cc.	3	...
3 „ 1 cc.	3	...
3 „ ·1 cc.	2	1
3 „ ·01 cc.	...	3
3 „ ·001 cc.	...	3

Fœcal bacilli in 1 cc. and upwards.

No vibrios in 100 cc.

Number.	Lactose.	Saccharose.	Dulcite.	Adonite.	Inuline.	Voges and Proskr.	Indol.	Motility.	No.	Name of Bacilli.	Group and Remarks.
1	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	Group I, 5.
2	+	−	−	+	−	−	+	−	I	B. Acidi lactici ...	„ II, *nil.*
3	+	−	−	−	−	−	+	−	I	B. Vesiculosus ...	„ III, 1.
4	+	−	−	−	−	−	+	−	I	Do. ...	„ IV, 4.
5	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	
6	+	+	+	−	−	−	+	−	III	B. Neapolitanus.	
7	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	
8	+	−	−	+	−	−	+	−	I	B. Acidi lactici ...	Class I, *nil.*
9	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	„ II, 7.
10	+	−	−	−	−	−	−	+	I	B. 7	„ III, 3.

SAMPLE III—IN POND OPPOSITE TOMB, WEST OF RAJU GRAMANY'S GARDEN, NORTH OF BALAKRISHNA NAYAKAN STREET.

Total colonies per cc. on agar at 37° C—7,000.

Bile salt lactose, medium.

	+	−
1 tube of 20 cc.	1	...
2 tubes of 10 cc.	2	...
3 „ 5 cc.	3	...
3 „ 1 cc.	3	...
3 „ ·1 cc.	2	1
3 „ ·01 cc.	...	3
3 „ ·001 cc.	..	3

Fœcal bacilli in 1 cc. and upwards.

Vibrios present in 100 cc.

Number.	Lactose.	Saccharose.	Dulcite.	Adonite.	Inuline.	Voges and Proskr.	Indol.	Motility.	No.	Name of Bacilli.	Group and Remarks.
1	+	+	−	−	−	+	−	−	IV	B. Coscoroba ...	Group I, 3.
2	+	+	−	−	−	+	−	−	IV	B. 112	„ II, *nil.*
3	+	−	−	−	−	+	−	−	I	B. Vesiculosus ...	„ III, *nil.*
4	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	„ IV, 7.
5	+	−	−	−	−	+	−	−	I	B. Vesiculosus ...	
6	+	−	−	−	−	−	−	−	I	B. Mutabilis ...	
7	+	+	−	−	−	+	−	−	IV	B. Coscoroba ...	
8	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	Class I, *nil.*
9	+	+	−	−	−	+	−	−	IV	B. 112.	„ II, 5.
10	+	+	−	−	−	−	+	−	IV	B. Cocoroba ...	„ III, 3.
											Undetermined 2.

SAMPLE IV—IN SMALL WELL 8′ DIAMETER NORTH-EAST OF TEMPLE HALL, N. NORTH-WEST OF TEMPLE ON WEST SIDE OF TIRUVOTTIYUR HIGH ROAD.

Total colonies per cc. on agar at 37°C.—920.

Bile salt lactose, medium.

	+	−
1 tube of 20 cc.	1	...
2 tubes of 10 cc.	2	...
3 „ 5 cc.	3	...
3 „ 1 cc.	3	...
3 „ ·1 cc.	2	1
3 „ ·01 cc.	1	2
3 „ ·001 cc.	...	3

Fœcal bacilli in 1 cc. and upwards.

No vibrios in 100 cc.

Number.	Lactose.	Saccharose.	Dulcite.	Adonite.	Inuline.	Voges and Proskr.	Indol.	Motility.	No.	Name of Bacilli.	Group and Remarks.
1	+	+	−	+	−	+	−	−	IV	B. Lactic ærogenes.	Group I, 9.
2	+	−	−	−	−	+	−	−	I	B. Vesiculosus ...	„ II, *nil.*
3	+	−	−	−	−	+	−	−	I	Do. ...	„ III, *nil.*
4	+	−	−	−	−	+	−	−	I	Do. ...	„ IV, 1.
5	+	−	−	−	−	+	−	−	I	Do. ...	
6	+	−	−	−	−	−	+	−	I	Do. ...	
7	+	−	−	−	−	+	−	−	I	Do. ...	
8	+	−	−	−	−	+	−	−	I	Do. ...	Class I, *nil.*
9	+	−	−	−	−	+	−	−	I	Do.	„ II, 1.
10	+	−	−	−	−	+	−	−	I	Do. ...	„ III, 9.

Remarks.—Water sample from Madras Corporation. Date of taking sample, 22nd August 1913. Date and time of arrival, 22nd August 1913. Taken by Sample taker.

SECTION II.

Analyses.

SAMPLE V—TAKEN AT NO. 14 SLUICE IN SEWAGE CHANNEL.

Total colonies per cc. on agar at 37° C —Countless.

Bile salt lactose—medium.

	+	−
1 tube of 20 cc.	1	...
2 tubes of 10 cc.	2	...
3 „ 5 cc.	3	..
3 „ 1 cc.	3	...
3 „ ·1 cc.	3	...
3 „ ·01 cc.	3	...

Fœcal bacilli in ·00000001 cc. and upwards.

No vibrios present in 100 cc.

Number.	Lactose.	Saccharose.	Dulcite.	Adonite.	Inulin.	Voges and Proskr.	Indol.	Motility.	Group.	Name of Bacilli.	Group and Remarks.
1	+	+	+	+	−	+	−	−	III	B 67	Group I, 4.
2	+		+	−	−	−	+	−	II	B. Schæfferi ...	„ II, 3.
3	+	−	+	−	−	−	+	−	II	Do. ...	„ III, 2.
4	+	−	−	−	−	−	+	−	I	B. Vesiculosus ...	„ IV, 1.
5	+	−	−	+	−	−	+	−	I	B. Acidi lactici.	
6	+	−	+	−	−	+	+	+	II		
7	+	−	−	−	−	−	+	−	I	B. Vesiculosus ...	Class I, 2.
8	+	+	+	−	−	−	+	−	II	B. Neapolitanus ..	„ II, 4.
9	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	„ III, 3.
10	+	−	−	−	−	−	+	−	I	B. Vesiculosus ...	Undetermined 1.

SAMPLE VI—TAKEN IN SMALL POND, 300 FT. WEST OF SEWAGE CHANNEL IN LINE WITH NO. 14 SLUICE

Total colonies per cc. on agar at 37° C.—8,200.

Bile salt lactose—medium.

	+	−
1 tube of 20 cc	1	...
2 tubes of 10 cc.	3	...
3 „ 5 cc.	3	...
3 „ 1 cc.	3	...
3 „ ·1 cc.	3	...
3 „ ·01 cc. ...	1	2
3 „ ·001 cc.	...	3

Fœcal bacilli in ·01 cc. and upwards.

No vibrios present in 100 cc.

Number.	Lactose.	Saccharose.	Dulcite.	Adonite.	Inulin.	Voges and Proskr.	Indol.	Motility.	Group.	Name of Bacilli.	Group and Remarks.
1	+	+	−	−	−	+	−	−	IV	B. 112	Group I, 2.
2	+	+	−	−	−	+	−	−	IV	B. Coscoroba ...	„ II, *nil.*
3	+	−	−	+	−	−	+	−	I	B. Acidi lactici ...	„ III, *nil.*
4	+	+	−	−	−	−	+	−	IV	B. Coscoroba	„ IV, 8.
5	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	
6	+	−	−	+	−	−	+	−	I	B. Acidi lactici	
7	+	+	−	−	−	−	+	−	IV	B. Coscoroba ...	Class I, *nil.*
8	+	+	−	+	−	−	+	−	IV	B. 101	„ II, 8.
9	+	+	−	+	−	+	+	−	IV	B. 116	„ III, *nil.*
10	+	+	−	−	−	−	+	−	IV	B. Coscoroba	Undetermined 2.

SAMPLE VII—FROM COVERED WELL, . . . 150 FT. EAST OF TIRUVOTTIYUR HIGH ROAD.

Total colonies per cc. on agar at 37° C.—890.

Bile salt lactose—medium.

	+	−
1 tube of 20 cc.	1	...
2 tubes of 10 cc.	2	...
3 „ 5 cc.	3	...
3 „ 1 cc.	3	...
3 „ ·1 cc.	1	2
3 „ ·01 cc.	...	3
3 „ ·001 cc.	...	3

Fœcal bacilli in 1 cc. and upwards.

No vibrios in 100 cc.

Number.	Lactose.	Saccharose.	Dulcite.	Adonite.	Inulin.	Voges and Proskr.	Indol.	Motility.	Group.	Name of Bacilli.	Group and Remarks.
1	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	Group I, 4.
2	+	+	−	+	−	+	−	−	IV	Do. ...	„ II, *nil.*
3	+	+	−	+	−	−	−	−	IV	B. Gasoformans ...	„ III, 1.
4	+	−	−	−	−	−	+	−	I	B. Vesiculosus ...	„ IV, 5.
5	+	+	−	−	−	−	+	−	IV	B. Coscoroba.	
6	+	+	−	+	−	−	−	−	IV	B. Gasoformans.	
7	+	−	−	−	−	−	+	−	I	B. Vesiculosus.	
8	+	+	+	+	−	+	−	−	III	B. 67	Class I, *nil.*
9	+	−	−	−	−	−	+	−	I	B. Vesiculosus ...	„ II, 6.
10	+	−	−	−	−	−	+	−	I	Do. ...	„ III, 4.

SAMPLE VIII—FROM 4 FT. DIAMETER WELL COVERED WITH GAUZE, . . . SURROUNDINGS FILTHY, SOUTH OF BALAKRISHNA CHETTI'S GARDEN, WEST OF TIRUVOTTIYUR HIGH ROAD.

Total colonies per cc. on agar at 37° C.—1,930.

Bile salt lactose—medium.

	+	−
1 tube of 20 cc.	1	...
2 tubes of 10 cc.	2	...
3 „ 5 cc.	3	...
3 „ 1 cc.	3	...
3 „ ·1 cc.	3	...
3 „ ·01 cc.	2	1
3 „ ·001 cc.	...	3

Fœcal bacilli in ·01 cc. and upwards.

No vibrios in 100 cc.

Number.	Lactose.	Saccharose.	Dulcite.	Adonite.	Inulin.	Voges and Proskr.	Indol.	Motility.	Group.	Name of Bacilli.	Group and Remarks.
1	+	+	−	−	−	+	−	+	IV	B. Cloacæ	Group I, 1.
2	+	+	+	−	−	−	+	−	III	B. Neapolitanus ...	„ II, *nil.*
3	+	+	−	+	−	+	−	−	IV	B. Lactis ærogenes.	„ III, 3.
4	+	+	−	+	−	+	−	−	IV	Do. ...	„ IV, 6.
5	+	+	−	−	−	−	+	−	IV	B. Coscoroba.	
6	+	+	+	−	−	−	+	−	III	B. Neapolitanus.	
7	+	+	+	−	−	−	+	−	III	Do.	
8	+	+	−	−	−	−	+	−	IV	B. Coscoroba ...	Class I, *nil.*
9	+	−	−	−	−	−	+	+	I	B. Grunthal ...	„ II, 8.
10	+	+	−	−	−	−	+	−	IV	B. Coscoroba ...	„ III, 2.

APPENDIX No. 7.

Analyses of the soils of the Madras Sewage Farm made by Mr. W. H. Harrison, Government Agricultural Chemist, Coimbatore.

Letter—from W. H. HARRISON, Esq., M.Sc., Government Agricultural Chemist, College of Agriculture and Research Institute, Coimbatore, and Member of the Madras Sewage Farm Committee.
To—the Chairman of the Madras Sewage Farm Committee, Madras.
Dated—the 15th August 1913.
No.—Ref. on Cur. 354.

I have the honour to forward herewith my report on the analyses of the soils of the Madras Sewage Farm.

For the purpose of obtaining information regarding the original nature of the soil and subsoil of the Madras Sewage Farm, and the effect of prolonged sewage irrigation upon it, two series of samples were taken on July 21, 1913. Series No. I was taken from a point on the farm opposite the beginning masonry channel and 30 yards from the iron fence along the sea front, and represents soil and subsoils which have been subjected to irrigation for many years. Series No. II was taken on a line 70 feet north of sluice No. 6 and at a point in a line with the farm office, on the site of the old burial-ground, and represents soil and subsoils which have received practically no sewage.

Each series consisted of five samples taken down to a depth of four feet and each sample was examined for its Chemical and Mechanical composition and for the proportion of humus contained. The results are set forth in Tables Nos. I and II.

Mechanical analysis.—The mechanical analysis shows clearly the suitability of the soil and subsoil for sewage filtration as from about 86 per cent. to 96 per cent. of the particles present have a diameter of over 2 mm. whereas the clay and finer grade fractions constitute a negligible proportion. A soil thus constituted is eminently suited for the purpose to which it has been put and should readily treat a *minimum* of 30,000 gallons per acre per day, provided that due attention is given to the cultivation and treatment of the surface layers.

The effect of the irrigation is seen best in comparing the proportion of clay, silt and fine silt in the corresponding samples. It is evident that there has been an accumulation of these fine particles in the top foot and that no accumulation is apparent below this depth. These fine particles are probably present in the road detritus and washings which enter the sewers of the city, and in time will tend to reduce the filtering efficiency of the top layer of soil. It would probably be found advantageous to prevent a large proportion of these reaching the farm by introducing efficient silt tanks between the sewer and the farm, or on the line of sewers at the pumping stations.

Another point brought out by the Mechanical analysis is the fact that greatest variations are found in the deep subsoils at a depth of from 2—4 feet, these layers being coarser at the point nearest the sea. The effect of this is also apparent in the Analytical values of Table I, where the insoluble matter is greater, and the percentage of the oxides of iron and alumina less, in the deep samples of Series I than in the corresponding samples of Series II. This coarse layer probably has the effect of increasing the efficiency of the overlying layers as compared to the soils more inland.

Humus accumulation.—The accumulation of organic matter in soils subjected to sewage irrigation is of primary importance as affecting to a large extent the rate of filtration. An indication of the effect of prolonged irrigation is given by a consideration of the "Loss on Ignition" figures in Table I. The values obtained for the samples of Series I from 1 foot to 4 feet deep do not differ materially from the corresponding ones of Series II but, on the other hand, the values for the samples representing the soil to a depth of 1 foot are much higher in the former case, thus showing that the accumulation of organic matter is confined to the top layers.

The same conclusion is arrived at from the values for "Humus" given in Table II. These values represent the amount of organic matter which is soluble in dilute ammonia after previous treatment of the soil with 1 per cent. hydrochloric acid. Further support is by the values for total nitrogen (Table I).

The continued irrigation of the soil with sewage has therefore led to an accumulation of organic matter in the surface layers and as this organic matter is of a spongy nature the tendency is for the effective rate of filtration of the land to be reduced proportionately. This effect of the humus accumulation can be counteracted by suitably cultivating the soil, but no such system would seem to have been attempted in the past and consequently the land has suffered. This is particularly the case in the extensive swampy areas running through the farm where the surface is always under water and where the destruction of the accumulated humus must be very slight.

Future systems of irrigation must aim at removing these swamp areas and keeping the rate of accumulation of humus low by a proper system of cultivation.

Chemical analysis.—From the results of analysis set forth in Table I, it is evident that there has been a considerable retention of manurial ingredients (nitrogen, phosphoric acid and potash) within the top layers thus indicating the formation of a very fertile soil capable

of producing heavy crops. One bad feature, however, is the absence of carbonates of lime and magnesia as shown by the absence of carbon dioxide. These substances are of great importance with regard to the biological condition of a soil and their absence will retard the destruction of humus and above all will permit of acid conditions obtaining under a bad system of irrigation. Occasional dressings of lime would be advantageous to any future system of cultivation.

It is true that the irrigation has led to an increased amount of lime and magnesia being found in the surface layers but these substances are not present in combination with carbon-dioxide and are consequently inoperative in keeping the soil sweet.

TABLE I.

ANALYSIS CALCULATED TO DRY SOIL.

	Series I.					Series II.				
	Old portion.					New portion.				
Number of sample.	1	2	3	4	5	1	2	3	4	5
Depth.	0 to 6″	6″ to 1′·0	1′ to 2′	2′ to 3′	3′ to 4′	0 to 6″	6″ to 1′·0	1′ to 2′	2′ to 3′	3′ to 4′
Loss on ignition	1·99	1·12	·61	·41	·29	·70	·56	·55	·67	·55
Insolute mineral matter	93·22	93·41	95·65	97·69	97·99	97·20	97·40	96·96	95·09	95·84
Ferric oxide ($Fl_2 O_3$)	1·74	2·24	1·87	·75	·60	·76	·79	1·06	1·98	2·03
Alumina ($Al_2 O_3$)	1·74	2·32	1·30	0·78	·80	·37	·92	1·08	1·90	1·68
Lime (Ca O)	·25	·35	·19	·13	·06	·08	·09	·14	·13	·12
Magnesia (Mg. O)	·08	·17	·09	·08	·08	·04	·06	·07	·08	·13
Potash ($K_2 O$)	·58	·10	·04	·04	·03	·03	·02	·02	·01	·03
Soda ($Na_2 O$)	·21	·07	·16	·08	·13	·09	·13	·12	·14	·15
Phosphoric acid ($P O_4$)	·19	·21	·09	·04	·02	·02	·02	Trace	Trace.	·02
Sulphuric acid ($S O_3$)	Trace.	Trace.	*Nil.*	*Nil.*	Trace.	01	·01	Trace.	*Nil.*	Trace.
Carbon dioxide ($C O_4$)...	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*
Total ...	100	100	100	100	100	100	100	100	100	100·55
Nitrogen...	·075	·021	·008	·007	·007	·02	·01	·009	·013	·012
Available phosphoric acid	·091	·082	·032	·016	·008	·008	·006	·002	0·02	·001
Potash	·014	·014	·004	·004	·003	·005	·007	·013	·014	·012

TABLE II.

MECHANICAL ANALYSIS.

(*Calculated on dry soil.*)

	Series I.					Series II.					Remarks.
	Old part.					New part.					
Number of sample.	1	2	3	4	5	1	2	3	4	5	
Depth.	0 to 6″	6″ to 1′·0	1′ to 2′	2′ to 3′	3′ to 4′	0 to 6″	6″ to 1′	1′ to 2′	2′ to 3′	3′ to 4′	
Soluble in 1% hydrochloric acid.	1·51	1·47	·84	·74	·50	·55	·61	·53	·60	·53	
Humus	·86	·48	·37	·37	·32	·39	·37	·28	·31	·24	
Ash extracted with humus.	2·21	2·45	·95	1·00	·65	·80	1·02	·96	1·03	1·04	
Fine gravel	7·42	8·62	5·58	16·93	22·30	6·48	7·68	4·04	5·16	5·10	Particles from 1—3 mm. diameter.
Coarse sand	80·09	78·25	87·85	78·85	74·91	89·04	83·27	90·01	85·32	86·27	Particles from ·2—1 mm. diameter.
Fine sand	4·23	5·06	3·67	1·59	·90	1·84	1·73	3·75	5·95	5·16	Particles from ·04—·2 mm. diameter.
Silt	2·04	1·28	·29	·15	·18	·52	·23	·30	·70	·47	Particles from ·01—·04 mm. diameter.
Fine silt	1·45	2·20	·25	·17	·16	·41	·05	·09	·64	·79	Particles from ·01—·002 mm. diameter.
Clay	·19	·19	·20	·20	·08	·06	·04	·04	29	30	Particles less than ·002 mm. diameter.
Total ...	100	100	100	100	100	100	100	100	100	100	

APPENDIX No. 8.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—T. BAINBRIGGE FLETCHER, Esq., R.N., F.L.S., F.E.S., F.Z.S., Government Entomologist, Agricultural College, Coimbatore.
Dated—the 8th July 1913.
No.—1577-M.

I am directed by the Madras Sewage Farm Committee to request you will be so good as to advise the Committee on the following points :—

(1) Is it possible for Anopheles to breed in a moist sandy soil that is without any stagnant pools ?

(2) Whether Anopheles larvæ which have been bred in pools can survive in soil when the water level has sunk below the surface of the soil ?

(3) Whether Anopheles mosquitoes can breed in sewage and in clarified sewage ?

(4) Whether other species of mosquitoes can breed in sewage and in clarified sewage and, if so, what species ?

Report of Mr. T. Bainbrigge Fletcher regarding the malaria carrying mosquitoes breeding on the farm and its vicinity.

Letter—from T. BAINBRIGGE FLETCHER, Esq., R.N., F.L.S., F.E.S., F.Z.S., Government Entomologist, Coimbatore.
To—the Chairman, Madras Sewage Farm Committee.
Dated—the 9th July 1913.
No.—Dis. 165/13.

In reply to your letter No. 1577-M , dated 8th instant, I have the honour to state that, generally speaking, the questions which you ask are too general to allow of any exact replies and that the information which you evidently require concerning some limited area could only be given in any exact detail after proper inspection of such area. At least a dozen different kinds of Anopheline mosquitoes may occur in the vicinity of Madras City and their breeding-habits will vary considerably in the different species, even when they are known, and the early stages of only the commoner Anophelines are known as a rule.

2. Bearing in mind that the replies given here are of general and not of particular application, your questions may be answered as follows :—

(1) No true mosquitoes (whether Anophelines or Culicines) can breed except in the presence of water. They cannot breed in moist soil in which no free water occurs. But they could breed in any cavities (such, for example, as crab-holes) in which free water would be likely to occur in such situations below the ordinary level of the ground.

(2) This is partly answered above. If the water in which the larvæ have been living drains away and the ground is left exposed to the sun so that it becomes thoroughly desiccated, the larvæ would be killed off ; but if the ground remains moist (whether under cover of vegetation or by being in a more or less water-logged condition), the larvæ might remain alive for some time – how long could only be told by local experiment. In some mosquitoes (e.g., *Steyomyia*) the *eggs* can resist desiccation for months, the larvæ hatching when again exposed to moisture

(3) This question is best answered by the following extract from James' and Liston's "Anopheline Mosquitoes of India," with reference to *Anopheles* (*Myzomyia*) *rossi*, "its larvæ have been found in water heavily contaminated with sewage. On the sea-coast near Madras its larvæ were found in very salt water." Bentley also says of *Anopheline stephensi* (*the* malaria-carrier in Bombay City) that it adapts itself to many artificial conditions and that larvæ hatched from eggs placed on sea-water lived and developed. Ability to live in sewage or clarified sewage would depend primarily on the degree of concentration or pollution but larvæ capable of breeding in sea-water would probably stand a good deal of sewage.

(4) I have no doubt that various other mosquitoes can breed in sewage but a list of such species could only be made for any particular locality after careful inspection and experiment.

3. If I can afford you any further information I shall be glad to do so as far as possible.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—the Director of Agriculture, Madras.
Dated—the 31st July 1913.
No.—1750-M.

In connection with the investigation by the Sewage Farm Committee as to the conditions prevailing at the Madras Sewage Farm, the opinion of Mr. Bainbrigge Fletcher, Government Entomologist, has been obtained as to the breeding of mosquitoes in sewage, etc.

2. It has been suggested that owing to the importance of this question it would be well if Mr. Bainbrigge Fletcher visited the Madras Sewage Farm and gave any further opinion which he might wish to give as a result of his inspection. If this view meets with your approval the Sewage Farm Committee would be obliged if you would ask Mr. Bainbrigge Fletcher to visit the farm and give the Committee the benefit of his observations as a result of actual inspection.

Letter—from D. T. CHADWICK, Esq., M.A., I.C.S., Director of Agriculture, Madras.
To—the Chairman, Madras Sewage Farm Committee, Madras.
Dated—the7 th August 1913.
No.—Dis. 1808.

With reference to your letter No. 1750-M., dated 31st July 1913, I have the honour to inform that I have asked the Government Entomologist to arrange with you direct regarding what you wish to ascertain from him and what you wish him to see.

Letter—from T. BAINBRIGGE FLETCHER, Esq., R.N., F.L.S., F.E.S., F.Z.S., Government Entomologist, Coimbatore.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 3rd September 1913.
No.—R.O.C. 340/13.

I have the honour to forward herewith a note on the result of my examination at your request of the Tondiarpet Sewage Farm.

2. My remarks, based on a brief flying survey, must only be taken as applicable to the conditions on the farm at the time of examination. A detailed survey of the whole farm might bring to light present breeding places of Anopheline mosquitoes, which may also breed there under the wetter conditions prevalent during the north-east mousoon, when the prevailing wind would be more likely to distribute mosquitoes from the farm. But the wells in the residental area are more likely breeding places for malaria-carrying mosquitoes and require prior attention

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Inspection note by T. Bainbrigge Fletcher, Esq., R.N., F.L.S., F.E.S. F.Z.S., Government Entomologist, Coimbatore, dated 3rd September 1913, *on the Tondiarpet Sewage Farm.*

I visited the Tondiarpet Sewage Farm on 13th and 14th August in order to determine if possible (*a*) whether malaria-carrying mosquitoes were breeding on the farm in such a way as to menace the adjacent areas and (*b*) whether the conditions on the sewage farm were such as to make it a probable or possible source of such mosquitoes.

As regards (*a*), no malaria-carrying mosquitoes were found within the limits of the farm. The only Anopheline mosquitoes found were a few adult examples of *Anopheles rossi* in a shed alongside the farm office ; *Anopheles rossi* is not considered to be a carrier of malaria. No Anopheline larvæ or pupæ were found on the farm in the various collections of water examined.

As regards (*b*), the conditions necessary for the breeding of mosquitoes were probably at their worst at the time of my visit which had been preceded by a spell of hot and dry weather. Yet, although the soil is sandy and porous, it was in many places absolutely water-logged with sewage so that the low-lying parts of the farm were marshy and all depressions contained free water, in which Culicine mosquitoes were breeding freely and abundantly even when the water was practically pure sewage.

In several places on the farm are pits containing clear water (infiltrated sewage from adjacent areas) usually covered with duckweed (*Lemna*) and often shaded by trees or bushes around the edge. All such ponds contained large numbers of Culicine mosquito larvæ and pupæ and certainly appeared to be suitable breeding places for some of the malaria-carrying Anophelines although none were actually found during the brief examination made ; these ponds seem to serve no useful purpose and should be filled in.

The marshy places where the sewage is stagnant on the water-logged soil do not appear to be suitable for the breeding of Anopheline mosquitoes at this time of year. Possibly they may breed there during the north-east monsoon, but this can only be determined by detailed examination at that time of year.

To sum up as regards (*b*), I should not consider the sewage farm a probable breeding ground for all the Anopheline mosquitoes which carry malaria in the adjacent area.

The actual source of the malaria-carrying mosquitoes in the Tondiarpet area outside of the sewage farm scarcely lay within the scope of my inquiry, but it seems probable that the numerous wells in this neighbourhood form the actual and usual breeding places for such mosquitoes. This can only be proved by detailed and patient examination, and in this connection it must be remembered that only a very small number of Anopheline larvæ is found

as a rule in one collection of water. If, however, the wells prove to be the main breeding places of these mosquitoes, the introduction of small fish into such wells as cannot be screened may be recommended as at least a temporary measure. With regard to this point an examination of the ponds in and outside of the sewage farm proved very instructive; all the ponds in the sewage farm were free from fish and swarming with mosquito larvæ; whilst in other ponds, just outside the farm and containing small fish, not a single mosquito larva could be found.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—T. BAINBRIGGE FLETCHER, Esq., R.N., F.L.S., F.E.S., F.Z.S., Government Entomologist, Coimbatore.
Dated—the 30th September 1913.
No.—2130-M.

I have the honour to acknowledge receipt, with many thanks, of your interesting report No. 340/13, dated 3rd September 1913, giving the results of your examination of the Tondiarpet Sewage Farm and to say that the Committee are much obliged for the trouble you have taken and for your valuable opinion on the subject referred to you.

As I was absent from Madras on tour at Simla this acknowledgment has been delayed until now.

APPENDIX No. 9.

Suggestions for the improvement of the Sewage Farm.

(*a*) By Mr. W. H. HARRISON, Government Agricultural Chemist, Coimbatore.
(*b*) „ Mr. W. HUTTON, Sanitary Engineer to Government.
(*c*) „ Mr. H. C. SAMPSON, Principal, Agricultural College, Coimbatore.

Demi-official letter—from P. L. MOORE, Esq., C.I.E., I.C.S., President, Corporation of Madras.
To—W. HUTTON, Esq., A.M.I.C.E, Chairman, Madras Sewage Farm Committee.
Dated—the 1st May 1913.

I send herewith for your information a copy of a note on the Tondiarpet Sewage Farm by W. H. Harrison of the Coimbatore Agricultural College.

Letter—from W. H. HARRISON, Esq., M.Sc., Government Agricultural Chemist, Agricultural College and Research Institute, Coimbatore.
To—the Director of Agriculture, Madras.
Dated—the 17th April 1913.

I have the honour to report that I visited the Madras Sewage Farm on the morning of Saturday, April 5th, and to submit the following notes:—

The Sewage.—The sewage of Madras has at present a volume of about 4,750,000 gallons per day and contains the solids from only about one-eighth of the population. It is anticipated that the volume of the sewage and the total amounts of solids carried will rapidly increase and provision has been made for a volume of 15,000,000 gallons, which volume will probably be reached in 50 years. This being the case, it is evident that the sewage system is constructed for the accommodation of a much larger flow than the present one and consequently the present rate of flow is comparatively low.

In tropical countries the decomposition of organic matter is very rapid and this factor combined with the length of time the sewage remains in the sewers results in the sewage being decomposed to a great extent when it reaches the outfall. The fermentation which it has undergone is largerly anærobic in character and the sewage by the time it reaches the farm is distinctly "septic" in character and, in fact, with the exception of the amount of suspended solids it contains, it is similar in character to the effluent from a septic tank.

Septic sewage contains a large number of mal-odorous substances which cause it to give rise to objectionable odours whenever it is agitated. When it is quiescent or only flowing gently the intensity of the odour is greatly reduced.

It is to these septic conditions of the sewage that the odours complained of as arising from the Madras Farm are due, but I have many times found them stronger in England in the vicinity of houses. On the morning of my visit I did not perceive any appreciable odour until I was within 50 yards of the exit of the rising main, although there was a strong wind blowing across the latter in the direction of my approach, and if the conditions at the time were at all normal, I do not think that any appreciable nuisance can be felt in the surrounding houses. It is, however, quite possible that under abnormal conditions the odour of the sewage will carry so far.

For the present the septic condition of the sewage must be accepted as a necessary evil arising out of the peculiar circumstances, and as objections raised by land-owners and residents to the presence of sewage works in their neighbourhood, whether based on sentimental, æsthetic or sanitary grounds, have a recognised claim to consideration, every endeavour should be made by the Madras Corporation to meet reasonable objections. To this end the covering over of the open sewer at the point where the rising main discharges into the open distributor is a step distinctly in the right direction, for there is no doubt that this is the point where most nuisance is liable to arise. On the other hand, I have grave doubts about the utility of the ventilating shaft, for, if there is an induced current of air up this shaft, the tendency will be for the foul odour to be concentrated at the point of exit. high in the air, and lead to the smell being felt at a greater distance than at present. I would suggest that this shaft is not put to its intended use until it is seen whether the covering over of the sewer is effective or not.

After leaving the discharge chamber, the sewages travel in an open distributory sewer the full length of the farm but here the disturbance is not great and little odour arises. From the channel, the sewage is drawn off by means of sluices, and is discharged into the distribution channels of the farm proper. The sluices are generally well above ground level, and consequently, a great agitation of the discharging sewage takes place; and at these places the odour is very appreciably increased. It should be a comparatively simple problem to prevent this agitation and so considerably reduce the total danger of nuisance.

A point which must be carefully considered at this point is the probable condition of the sewage as years go on, *i.e.*, will the septic condition, at present so pronounced, tend to increase or decrease.

The sewage is one of moderate strength; but as the proportion of solid matter to water will increase in the future, the strength of the sewage will probably also tend to increase and, all things being equal, the danger of nuisance arising at the outfall would also tend to increase. But, at the same time, the volume of sewage is increasing and this will greatly increase the rate of flow in the sewers, thus shortening the average length of time the sewage will remain in them. The amount of decomposition taking place in the sewers will be lessened in proportion and the sewage as it reaches the works be fresher in character. Perfectly fresh water carried sewage is without objectionable odour and I therefore consider that, as time goes on, the sewage will tend to become less and less objectionable as it reaches the outfall.

A few remedial measures may be taken to mitigate the present septic condition of sewage and, of these, the most important is the institution of a regular system of flushing out the side drains in the streets and such small sewers where the rate of flow is very low, as it is probably in these situations that a large proportion of the decomposition occurs. Such flushing of the sewers is often resorted to at home whenever the gradient of the sewer is small.

The admission of trade refuse into the sewers is a problem which is often under the consideration of public bodies and very often irksome and stringent regulations must be complied with by the manufacturer before he obtains relief. Much of my experience in England was obtained with a sewage containing a very large proportion of trade refuse and, so long as the latter does not bear an undue proportion to the purely domestic portion of the sewage, there appears to be little difficulty arising in efficiently treating the sewage. Liquids containing iron in solution are very effective in preventing the rise of objectionable odours, whilst other liquids retard bacterial action and prevent undue decomposition occurring in the sewers. Effluents containing much organic matter such as those derived from abattoirs, tanneries, etc., should, however, not be allowed to enter small sewers but should be connected to a large sewer in which the flow is high. All factories entering the sewer should be compelled to construct tanks into which all the effluents of the factory are discharged and where they mutually mix and precipitate each other. The tank should be of such a size that the solid matter settles out and only the clear supernatant goes forward to the sewers, as experience shows that the solid portions of trade refuse are the most difficult to deal with.

The sewage farm proper comprises some 140 acres of land under irrigation and consists of a deep subsoil of fine porous sand and covered with a more or less earthy layer to a depth of from six to nine inches. Judging by the fact that those portions of the farm only very recently brought under irrigation are devoid of this surface layer, it is evident that it is formed from the solids filtered out of the sewage, and that it will tend to increase as years go on and become more and more earthy in character. This conclusion is supported by the evident alteration in the level of the land surrounding the distribution channels.

Notwithstanding the source of this surface layer it was without objectionable features and its main odour was earthy in character. Furthermore, the land was free from "Sewage sickness" except in a few very small areas where the sewage tends to accumulate during the process of irrigation. The organic matter of the sewage is evidently very rapidly disorganised and humified, an observation entirely in accord with my experience of wet and garden cultivation in the tropics.

The soil is eminently suited for sewage filtration and the present average rate of filtration of 34,000 gallons per acre per day cannot be accounted excessive, in fact, at present a greater rate of filtration could easily be obtained.

The method of distributing the sewage is open to criticism. The surface of the land is far from level and there is a depression running across the centre of the farm parallel to the main distributor and the sewage is distributed by means of channels running at right angles and across the depression. Such a system of distribution must tend to cause an undue proportion of liquid to reach the low parts and in fact this depression was described to me as marshy. It would be a distinct advantage to arrange the distribution more in conformity with the general contours of the farm.

At present by far the greater portion of the farm is laid down to grass and continuous and heavy croppings are being taken and, as there is a large demand for grass in Madras, considerable profits are being made. About Rs. 350 per acre is the figure quoted. This is a very satisfactory profit and I am unable to recommend any other crop which would yield similarly and at the same time permit of the high rate of filtration being maintained, although, for instance, Cambodia cotton and sugarcane would yield good profits under the conditions. Another point also to be borne in mind is the fact that the sewage during the time of irrigation is covered with a thick crop of grass which prevents the odour of the former being carried off by the wind. Cultivated crops, on the other hand, would leave the sewage exposed to the wind which is certainly not desirable with a septic sewage.

The great suitability of grass crops for Sewage Farm has long been recognized and Dr. Voelcker, so far back as 1885, summed up the situation as follows:—"Sewage is not adapted to benefit every description of crop. Indeed, it may be said with truth, and has been said, that its use should be restricted to grass crops—Italian rye grass and other grasses. It is so because it is a quick growing crop, which allows us to apply a fresh quantity of fertilizing matter as soon as a given quantity is exhausted. We can repeatedly manure grass crops and we cannot do so in the case of cereal crops. We should never get our crop ripened, never get the grain formed, if after the plant had passed through its grassy condition and arrived at some extent of maturity we were to apply sewage to it." My own experience with a Sewage Farm supports the above although I have been able to raise excellent root and cereal crops for the fattening of cattle.

This being the case, I am not disposed to recommend the growing of crops other than grass but I do consider that more attention should be paid to the cultivation of the soil than is at present the case. The accumulation of humus in the top layer of soil has been previously referred to, but no attempt appears to be made to dry off a portion of the farm and by cultivation to aerate it. Such aeration would be beneficial in many ways; it would induce nitrification and would counteract to some extent the tendency for the humus to accumulate unduly whilst after the ploughing the grass would quickly reestablish itself. Unless something of this kind is done systematically, it is probable that the maximum possible rate of filtration will materially reduce as time goes on.

Lastly all places where pools form under the present conditions should be filled in level with the surrounding land surface.

From the above it will be seen that I have no very serious criticisms to offer against the present system of disposing of the Madras sewage, but I must point out strongly that the problem is only in its initial stages and that in the very near future the Corporation of Madras must carefully consider the whole subject, decide definitely upon their future policy, and once having decided they must carry out the scheme to its logical conclusion. Any patching up or the introduction of make-shifts can only lead to disaster.

Both the strength and volume of the sewage will increase considerably in the near future and it will soon be found that the present area will be inadequate for the duty demanded from it and extensions of one kind or another must be considered. So far as I can perceive, the decision must embrace one of several systems. On the one hand, there is a large extension of the present system, which entails the acquiring of more land and farming operations on a very large scale with all its attendant disadvantages. On the other hand (1) the utilization of artificial methods of bacterial filtration, with or without land filtration, on a much smaller area of land or (2) the direct disposal into the sea, call for consideration.

Letter—from W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
To—the President, Corporation of Madras.
Dated—the 15th August 1913.
No.—1838-M.

With reference to your personal request for suggestions from the Madras Sewage Committee for improvements which might be immediately carried out, I am desired to reply as follows:—

2. The Committee find, after careful inspection, that wherever the even flow of sewage is violently disturbed or agitated the objectionable smell of sewage is apparent. It has been observed that the method adopted at most of the sluices on the open masonry channel for distributing sewage from this channel to the various field channels results in agitation of the sewage as the sewage has necessarily with the arrangement in force to drop varying distances according to the height of the open masonry channel above ground level.

The sudden drop of the sewage at the different sluices is the cause of escape into the air of considerable volumes of objectionable gas at those places and the smell can be detected at some distance. As a proof of this the Committee would point to those sluices at which owing to their level being close to the ground level of the farm there is no drop of sewage and consequently no agitation.

The Committee consider that if the sluices where the sewage is dropped some height with resulting agitation are altered to the arrangement shown on the accompanying sketches the objectionable smell which is now evident at a number of sluices will cease. One of the sketches shows the proposed arrangement where the sewage is at present dropped some height and the second sketch shows what is proposed where the drop is less.

2. In connection with the discharge of sewage from the open channel into the surplus channel at the extreme north end of the Farm the Committee think that the side of the channel towards the northern end, about 400 feet from the end, should be cut down to that level which will permit the escape of excess sewage on to the land where it would be treated in the usual way.

The arrangement would be a natural surplus requiring no manipulation and there would be no necessity for the present surplus at the extreme north end of the open channel coming into use except at the time of excessive rainfall. The length of the proposed weir would be about 10 feet but the Engineer can work out the most suitable length to agree with working conditions. The discharge channel from this weir would be so arranged that there would be no agitation of the sewage and the sewage discharged over the weir would be led away to a sufficient number of field channels so that it would be efficiently treated on lands.

3. With reference to the point about the covering in of the open channel for an increased length the Committee are not satisfied that the open channel is so objectionable at present as to require it to be covered for a longer length than has been already carried out. The effect of re-arranging of the sluice outlets should be observed before the question of the covering in of the open channel is considered.

4. With reference to your question as to the advisability of closing certain of the sluices at the beginning of the Farm the Committee do not consider that the outlets at the beginning of the Farm should be temporarily closed, as the area of the farm being already limited further limitation of the working area is undesirable.

Letter—from H. C. SAMPSON, Esq., Principal, Agricultural College, Coimbatore.
To—W. HUTTON, Esq., A.M.I.C.E., Chairman, Madras Sewage Farm Committee.
Dated—the 4th September 1913.
No.—R.C. 629.

I enclose two copies of my note on suggestions for working the existing Madras Sewage Farm. I have given a copy to Harrison and kept one myself.

I enclose also a plan drawn on section paper showing how the present levels can be adjusted. I see that there is a slight fall from W. to S. Section C is the only one which involves very considerable earth work, I gather that this goes right through the Chappar swamp. If the west end of this section is on the road, of course, it will lessen the work considerably as this is on a higher level than the plots. I return also the plan of the farm which you lent me.

I have left a blank in my note on page 1 for the number of offsets from the main channel which you might insert.

The plan and specifications for the buck scraper will be sent in a day or two.

Mr. H. C. Sampson's suggestions, dated 4th September 1913, for improving the working of the existing Madras Sewage Farm.

The Madras Sewage Farm is at present entirely a grass farm. A small area has cocoanut topes on it, but this is also underplanted with grass. No part of the area is under arable cultivation.

Existing irrigation.—A main channel which receives the sewage from the main sewer, runs northwards and parallel with the sea. The farm lies between this channel and the sea front. There are 23 offtakes from the main channel which are intended to lead the sewage on to the land. The distributaries from these offtakes are at right angles to the main channel and for a certain distance are open channels made of semi-circular cement pipes loosely set in the ground. From these, sewage is taken by earthen field channels on to the main plots. The earthen channels are again at right angles to the distributaries and the sewage is taken directly from these on to the irrigation beds. The system of irrigation is intended to be one of sewage filtration. The actual size of the minor irrigation beds varies with the level of the land. In some places these are undiscernable, in others they are long and narrow, about 6'—25', and in others again they are more or less square about 30' each way. Except however, where grass has been recently planted it is difficult to trace the outlines of these beds.

Owing presumably to defects in the levels of the land, arrangements have been made at the offtakes from the main channel to take sewage underground by pipes to the area distant from the main channel and at intervals along this line of pipes, sluice chambers have been built which are intended to bring the sewage to the surface as well as to carry it by smaller pipes to subsidiary distributors. The necessity for such an arrangement seems to emphasize the fact that the farm has never been properly levelled and graded for irrigation. The present condition of the farm corroborates this. There is an extensive artificial swamp occupying a large expanse of the farm in the centre of the area. This is covered with a coarse swamp grass (chappar) (probably panicum muticum).

The soil.—Mr. Harrison's mechanical analysis of the soil shows that this, if properly managed, is an ideal natural filter bed for purifying sewage water. Both the mechanical and chemical analyses show however that the present method of farming should be greatly improved if these natural advantages are to be maintained. A large accumulation of humus is found in the surface one foot of soil, which, if kept moist as it naturally is under a system

of sewage farming, not only checks free filtration but renders the surface liable to become saturated with water. It is essential for free filtration that the irrigation water should soak quickly into the ground, otherwise you get water-logging. If such land as this is water-logged it forms in a small degree a 'quick' sand *i.e.*, the sand particles are much freer than if only soil water were present and this lessens the efficiency of the filtration. A sand filter where irrigation is adopted is essentially different to one where there is a considerable head of water. The accumulation of moist humus also will tend to make the land sour which will not only check the growth of suitable crops but will alter the bacterial life in the soil.

It is well known that land laid down to grass tends to form humus in the surface soil and this accumulation of humus is particularly noticeable in the 'chappar swamp' where the surface has become water-logged. Hence there is a keen necessity for giving the land a periodic rest in order to dry out and partially destroy this accumulation of humus. This period of rest can also be taken advantage of to add lime to the soil which (as carbonate) is shown in the analysis to be entirely absent.

Thus to maintain the soil as an efficient medium for dealing with sewage there are two main objects:—

(1) The destruction of moist humus; and
(2) the prevention of water-logging.

Fortunately (in this instance) the destruction of humus is not a difficult matter in a tropical country with a limited rainfall. Its rapid decay can be brought about by turning up the surface soil and leaving it in a rough condition which will allow of the free penetration of air through the loosened soil, *i.e.*, plough fallowing. This process of decay will be hastened by the application of lime (say 1 ton per acre). If such a periodic fallowing were given the filtration would greatly improve both in rapidity and efficiency.

The prevention of water-logging.—The liability to water-logging will greatly decrease with the periodic drying out and destruction of humus but in dealing with irrigation water so rich in organic matter as this is, steps must be taken to prevent the surface flow of sewage from higher to lower levels and thus it is essential that the land should be graded, stepping it down from the main channel to the sea front. The levels which are available at the time of writing show that there is ample fall to allow of this being carried out if a drop of 6" or even 9" is allowed in every 200'. Such grading is an agricultural operation and could be done when the plots are bare fallowed.

It is clear also that, at each fallowing, levels would have to be adjusted as there is naturally always a larger deposition of organic matter near the irrigation channels although this will be greatly lessened with systematic irrigation.

Cropping.—Although land laid down to grass tends to form humus there is much to be said for such a crop provided the right kind of grass is grown, and in this case there is no doubt that hariali (cynodon dactylon) is eminently suitable. It is a perennial grass spreading by means of underground stems and under copious applications of liquid manure is entirely a surface feeder. With this crop, the land is capable of taking sewage throughout the year except for the drying which is necessary at the time of each cutting and, owing to the limited area of the existing sewage farm, it is essential that as large an area as possible should be under irrigation at any one time. If however the area were adequate several other crops could be suggested. Hariali grass, however, requires good drainage. It is not a swamp grass and if it is to be grown no water-logging must be allowed, otherwise it will be killed out and its place taken by coarse swamp grasses as I understand has been the case in the "chappar swamp." Care should therefore be taken to keep the hariali grass pure and free from admixtures of other grasses. Of the grasses seen on the farm "chappar" is most unsuitable. It is a very coarse grass with a woody decumbent stem which forms an almost impenetrable mat above the ground surface. *Panicum ripens* with its thickened underground stems is also fairly common on the farm and since this can also accommodate itself to swamp conditions it should be carefully weeded out. Rushes and sedges are also in evidence; but these will doubtless disappear of their own accord when water-logging is discontinued.

Suggestions for improved working—Cultivation.—As already mentioned periodic fallowing of the land is essential for the destruction of humus and for this purpose a heavy plough capable of cutting through the surface turf by its weight and capable of doing a good day's work is essential. Ransome's double furrow disc plough is the implement which I would recommend. This will do 1⅛ acres a day ploughing to a depth of 10" with a draught of four pairs of good bullocks.

In addition to this, 2 buck scrapers can be made which will be used for levelling and grading and subsequently for adjusting levels.

A cultivator will also be required for breaking up the dried sod subsequent to ploughing and further exposing the soil to the air.

A small iron plough such as Ransome's 'small holding' plough will be useful for ploughing corners and for planting grass.

It seems essential also that hay-making machinery should be used. The present method of cutting grass by employing women with sickles is both tedious and haphazard which means

that a cut plot is never really cleared and that the plot is never wholly ready to receive fresh supplies of sewage. If hay making machinery were used the plot would be ready all at the same time to take sewage. Such should consist of a mowing machine suited to the slow draught of bullocks, a swaith turner, a hay rake and a sweep. The introduction of such machinery would also ensure the proper working of the farm in the rainy season, when, it is stated, labour is often difficult to procure.

Irrigation.—The problem in connection with the existing farm is the disposal of 5,000,000 gallons of sewage a day by filtration irrigation through the soil. Allowing the farm to be 120 acres, 10 acres of this is always under bare fallow while 30 acres, allowing that 3 acres a working day are cut, will always be dry. Thus 80 acres have to take 5,000,000 which is 62,500 gallons a day, or more than double the amount that the farm was originally designed to take. With better farming I see no reason why the land should not take this amount but it may not be possible without extending the area for it to take much more than this. When the farm is once properly graded and for this purpose the buck scraper should be used, it should be possible to take the distributors the whole width of the farm, instead of leading sewage down covered pipes to the lands adjoining the sea front. I would recommend the trial of simple earthen channels in place of the semi-circular cement pipes now used. These are too confined to carry such a liquid as sewage and are liable to be blocked by any obstructive material brought down in the irrigation water. Being only set in the sandy soil they are very liable to become displaced either intentionally or otherwise and besides this they soon become blocked by the luxuriant tropical growth of a creeping grass such as hariali which can either grow up between the loose joints or overhang and be drawn into the channel. It is also difficult to lead the water out of these into beds or branch channels without removing or breaking the pipes. A wide open earthen channel would be easy to clean, to repair and to adjust for irrigation and a free flow can be obtained within the bounds of the channel. Similar, but smaller, earthen channels should take off at right angles along the lines of the steps of the graded plots. Thus each step between two offtakes or distributors can be commanded on all sides by irrigation water. Irrigation should commence at the stepped plots near the sea front, *i.e.*, at the lowest end of the main distributor and should be systematically carried up plot by plot to the main channel when the sluice at the offtake should be closed. After each irrigation it should be seen that all obstructions in the channel are removed and that it is ready to take water again down the whole length of the channel at the next irrigation. A simple method of obstructing the flow in the channel for turning the water where required is to place a piece of canvas attached to a beam in the channel. The beam rests on the sides of the channel and the canvas lies in the bed of the channel in the direction from which the water is coming. If this were used it would do away with the necessity for making temporary earth obstructions in the bed of the channel and would leave the channel practically clear and intact after irrigation.

Taking the area of the farm as 120 acres which, I understand, approximates the area which can be put under irrigation if properly treated, agricultural work can be estimated on the following basis :—

Cattle.—Reckoning that 120 acres of hariali grass gives six cuttings a year of 2 tons of hay per acre, this would mean 1,440 tons of hariali hay per annum. Allowing 250 working days in the year, this approximates 5¾ tons of hay to be made per working day or roughly 3 acres a day will have to be cut and made into hay and carted to the stackyard. This should require four pairs of cattle for this work alone—one pair or possibly two for mower, one pair for swaith turner and horse rake and two pairs for leading or carting.

Allowing for 8½ per cent. of the area being put under bare fallow per mensem, *i.e.*, 10 acres a month, this will require four pairs for 7 to 8 days ploughing and for the next year or so another four pairs for levelling and grading and finishing off the cultivation.

For sometime to come, however, hay making may not require all this labour but at the commencement it is certain that the cultivation will require more cattle labour than has been estimated for. An additional pair would be necessary for odd work and to replace any animals that were sick. These allowances have been made for really good cattle costing at present prices about Rs. 250 up to Rs. 300 a pair.

Labour—Labour for irrigation.—Taking the farm as 120 acres, only 80 acres of this are available for irrigation. Ten acres are always under bare fallow and drying the land out after cutting grass and making hay for 10 days means another 30 acres that cannot be irrigated. With a 5,000,000 gallon flow of sewage per day this means that more than 60,000 gallons per acre will have to be applied every day, or more than 120,000 a day, if only half the area is irrigated every other day, *i.e.*, considerably less than 3 inches of water per acre per day. No data are available as to the area at present irrigated but at least one man should be allowed for the area under each sluice which is opened and in preference certain sluices should be allotted to certain men so that they would get to know the lie of their own plots. As a man should be in attendance the whole time water is being irrigated, it may be necessary to work irrigation by shifts, *i.e.*, two men to each area under a sluice.

Each pair of cattle will require its own man and in addition to this probably six men will be required both as a reserve in case of sickness among the cattlemen and irrigators and for stacking or baling hay.

The cutting and sale of green grass should, I consider, be stopped as the farm is improved and all grass should be converted into hay. There will, however, always be a certain amount of hand cutting in opening out corners and cutting grass immediately adjoining the channels, *i.e.*, on the slope of the channel bunds, and probably three or four women will have to be permanently employed. If there is not enough existing demand for hay the Corporation could use the balance for their working cattle, the fodder for which now has, I understand, to be bought. The cutting of green grass means promiscuous and uneven cutting besides the handling of 3–4 times the weight of produce. The grazing of cattle should also be stopped as the chapper grass is eradicated. This will doubtless increase illicit grazing and trespass which, I am told, even now gives much trouble and the Corporation will have to take stringent measures to stop this. Possibly this system of working may reduce the gross receipts but it must be remembered that the primary object is the efficient disposal of sewage and that the profits from the farm are a secondary consideration if it interferes with the systematic and efficient working of the farm.

Buildings, etc.—Since work has to start early in the day it would be advisable to have cattle sheds near at hand, but this may not be possible until the land is properly worked and the nuisance from mosquitoes abates. Also proper buildings should be put up for implements which will soon get into disorder if left exposed—especially on a farm so close to the sea.

The officer in charge of the farm should by preference reside on the place, but this will not be possible until conditions improve. Also one or two families might live there to be a watch on the cattle and implements and the stock of hay on hand. The road which now runs northwards through the centre of the farm should be made to extend to the north boundary and be met by the road which crosses the main channel. If this were done all buildings and stacks could be located on the area west of and outside the farm which belongs to the Corporation.

The officer in charge should by preference be a trained Agriculturist and he will need an assistant who need not necessarily be trained as the work is simple if properly organised and is largely routine. They should, however, both be whole-time officers and should not be given work off the farm where their time should be fully employed. The distribution of hay sold should not be one of their duties nor be done by the cattle labour estimated for above.

Letter—from H. C. Sampson, Esq., Principal, Agricultural College, Coimbatore.
To—W. Hutton, Esq., Chairman, Madras Sewage Farm Committee.
Dated—10th September 1913.
No.—Ref. 629 of 1913.

I am enclosing an estimate and plan of the "Buck-Scraper" referred to in my note of the Sewage Farm. I am now making one for use here from these specifications and will let you know when it is completed how it works.

Estimate for making one Buck-Scraper, as per plan.

WOOD-WORK.

Body, 5 planks	5¼′ × 8″ × 1½″	About 3½ c.ft. of jungle wood = say Rs. 5.
Ends, 4 pieces	2′ × 8″ × 1½″	
Skids, 2 „	2′ × 5″ × 2″	

IRON WORK (W.I.)

Rockers face, 2	19″ × 2½″ × ⅝″ =	59⅜ c. in.
Chain straps, 4	25″ × 2½″ × ¼″ =	62½ „
Under skids, 2	21″ × 5″ × ⅝″ =	131¼ „
Over ends below rockers, 2	42″ × 1½″ × ¼″ =	31½ „
Over back wall, 1	60″ × 1½″ × ¼″ =	22½ „
Binds, inside, 3	48″ × 2″ × ½″ =	144 „
„ „ 2	24″ × 2″ × ½″ =	48 „
„ „ 1	24″ × 2″ × ½″ =	24 „
Binds, outside, back above skids, 2	22″ × 2″ × ½″ =	44 „
At ends and centre, 3	48″ × 2″ × ½″ =	144 „
End of handle, 1	19″ × 2″ × ⅜″ =	14¼ „
Under cutting knife, 1	60″ × 9″ × ⅝″ =	337½ „
Cutting knife, 1	60″ × 8″ × ⅜″ =	90 „
		1,153 c. in
		= about 320 lb.

ABSTRACT ESTIMATE.

	Rs.	A.	P.
Planks	5	0	0
320 lb. at As. 1-3 per lb.	25	0	0
About 50 bolts, say	6	4	0
Handle beam, say	1	0	0
Making charges, chain, etc., say	12	12	0
Total ...	50	0	0

SHEET No. 1A

PLAN SHEWING
TONDIARPET SEWAGE FARM MADRAS
AND SURROUNDING AREA

SCALE 1"=1600'

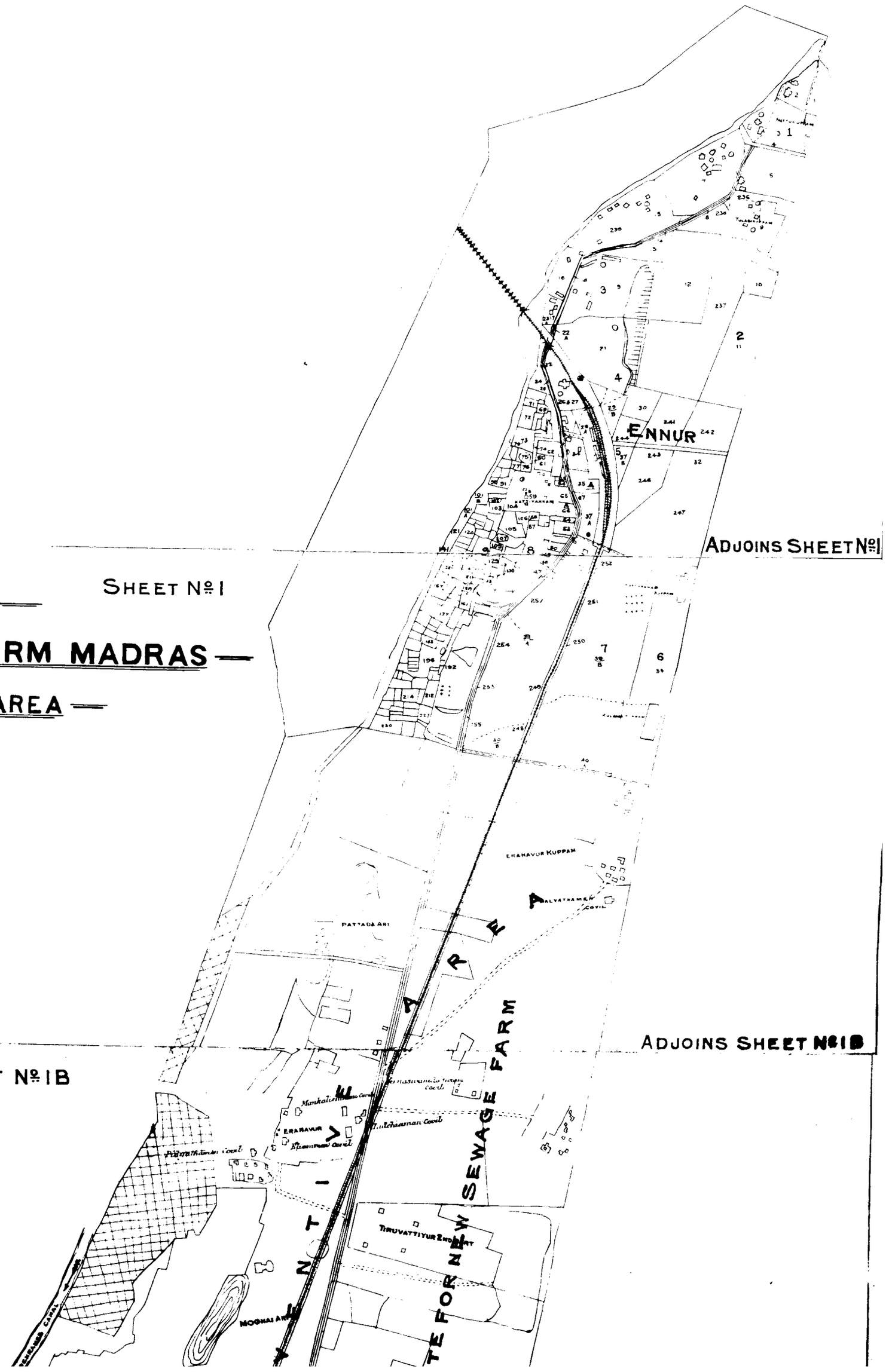
N

SHEET No. 1

ADJOINS SHEET No. 1

SHEET No. 1B

ADJOINS SHEET No. 1B



SHEET No. 1 C

ADJOINS SHEET No. 1 C

PROPOSED PARK

TRUVOTTIUR

EXISTING SEWAGE FARM

EDWORE ROAD

BAY OF BENGAL

ADJOINS SHEET No. 1 D

SHEET No. 1 D

NOTE:— SAMPLES WERE TAKEN ALONG THE GREEN LINES.

W. H. Hutton
26.12.13
A.M.I.C.E.
CHAIRMAN.
SEWAGE FARM COMMITTEE.

SHEET No 2

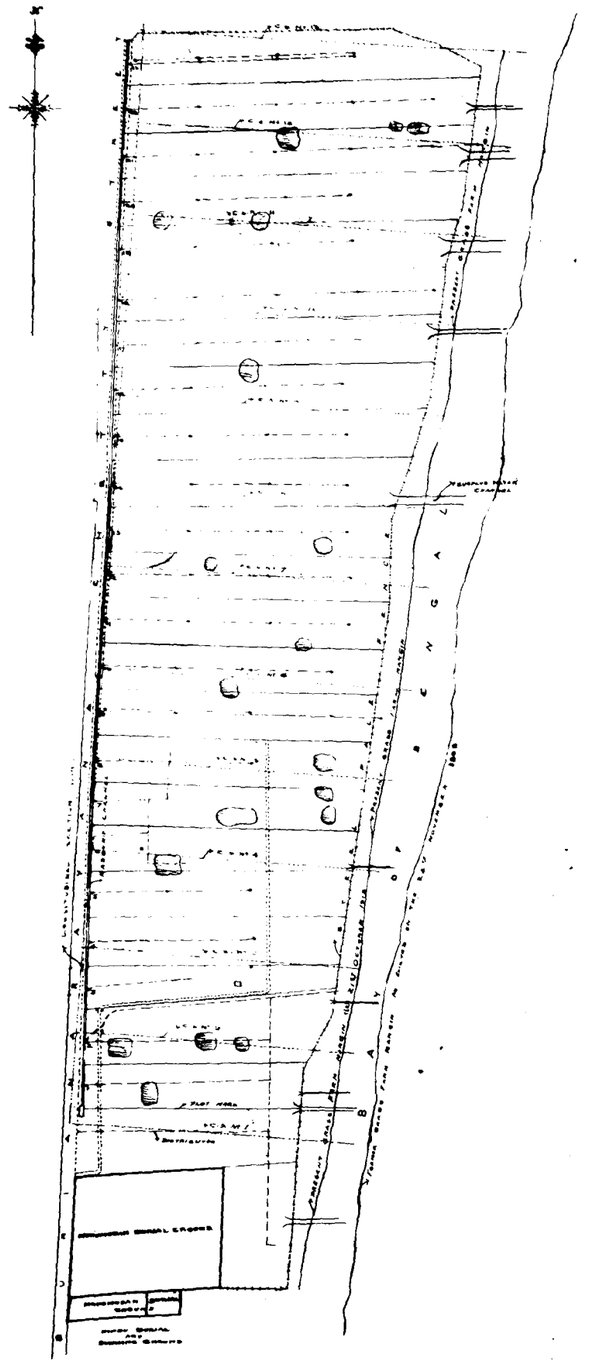
CORPORATION OF MADRAS
WORKS DEPARTMENT
TECHNICAL SECTION

SERIAL No 137
DRAWING No 7

TANDIARPET GRASS FARM

PLAN SHOWING PLOTS, DISTRIBUTORS, PONDS, ETC.

SCALE 660 Ft. TO 1 IN.



CHECKED BY

DIVISL. ASST. ENGINEER

EXECUTIVE ENGINEER

SHEET №3

CORPORATION OF MADRAS

WORKS DEPARTMENT

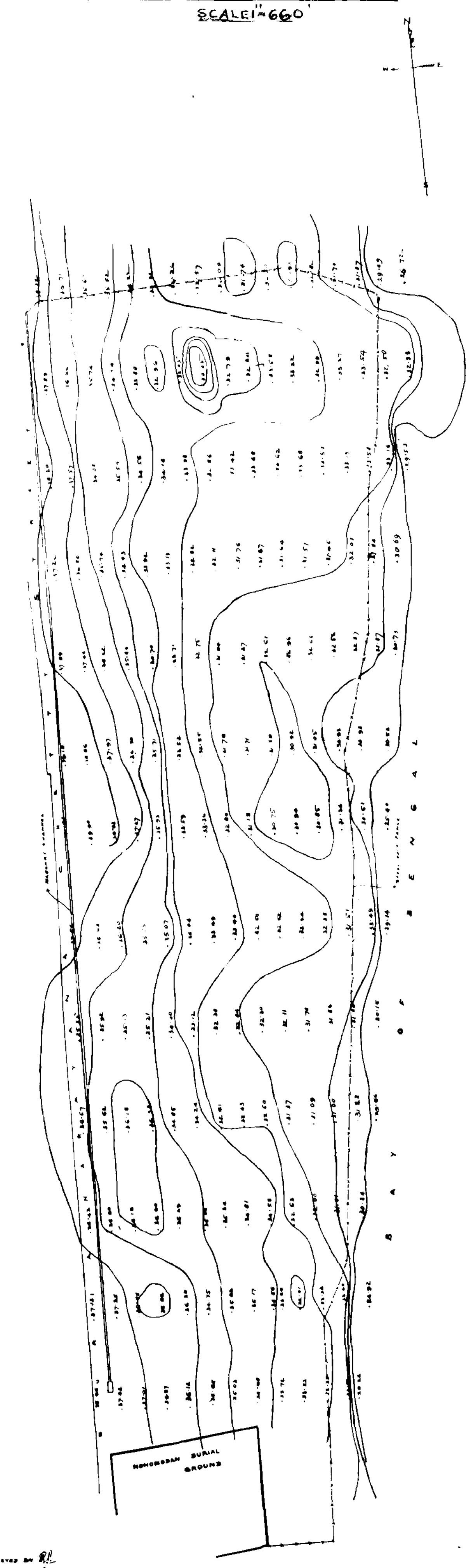
TECHNICAL SECTION

SERIAL № 12

DRAWING № 6

GRASS FARM CONTOURS

SCALE 1" = 660'



SURVEYED BY R.L.

TRACED BY R.L.

CHECKED BY

G. H. Newman

SENIOR ASST ENGINEER

James R. Coats

ENGINEER

26.9.13.

CORPORATION OF MADRAS

WORKS DEPARTMENT

TECHNICAL SECTION

SHEET No 4.

Serial No 78

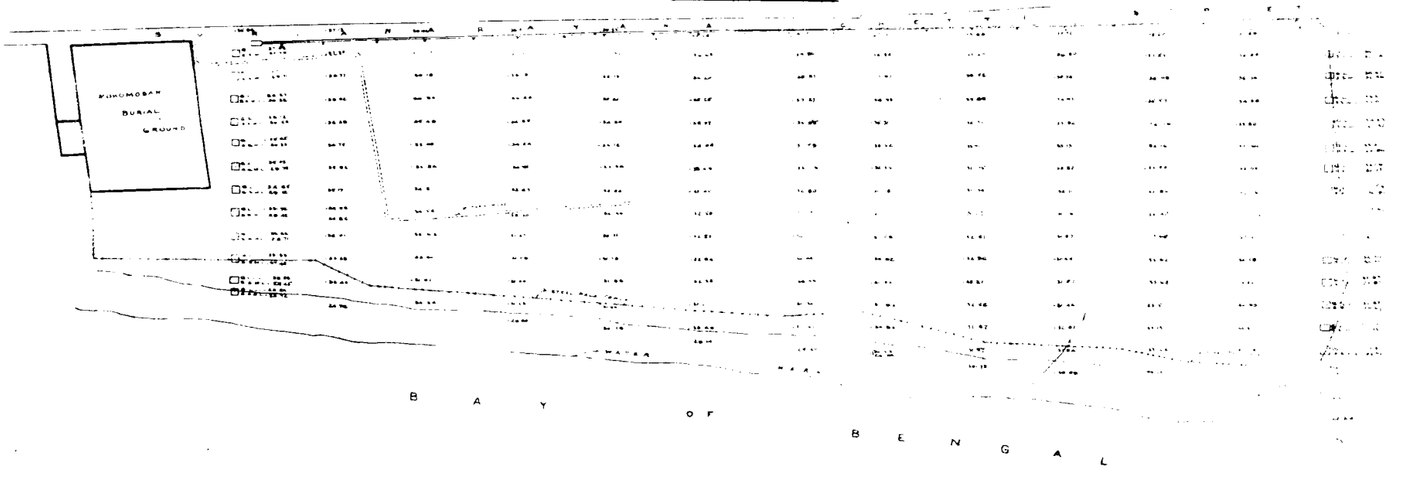
Drawing No 1

TANDIARPET GRASS FARM LEVELS

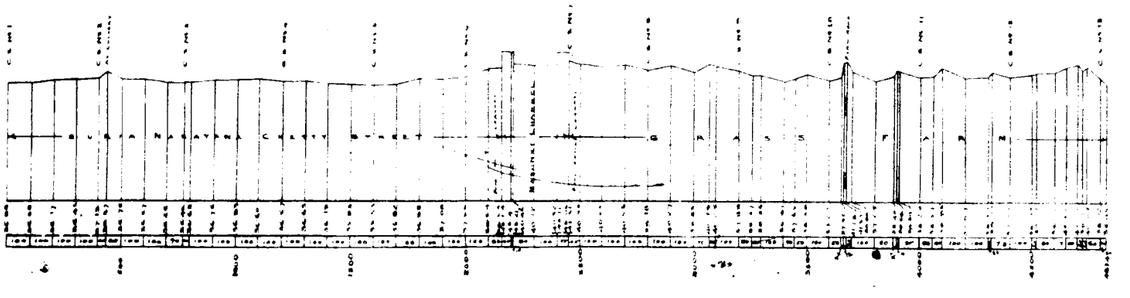
HORIZONTAL SCALE 66 FEET TO 1 INCH

VERTICAL SCALE 33 FEET TO 1 INCH

SITE PLAN with SPOT LEVELS



LONGITUDINAL SECTION



Explanation

G.L. = Ground Level

S.W.L. = Sea Water Level

G.T.S. DATUM = 50.00

Superintending Engineer

Senior Asst. Engineer

Executive Engineer

D.S.D.

SHEET No 5

CORPORATION OF MADRAS

WORKS DEPARTMENT

TECHNICAL SECTION

SERIAL No. 144

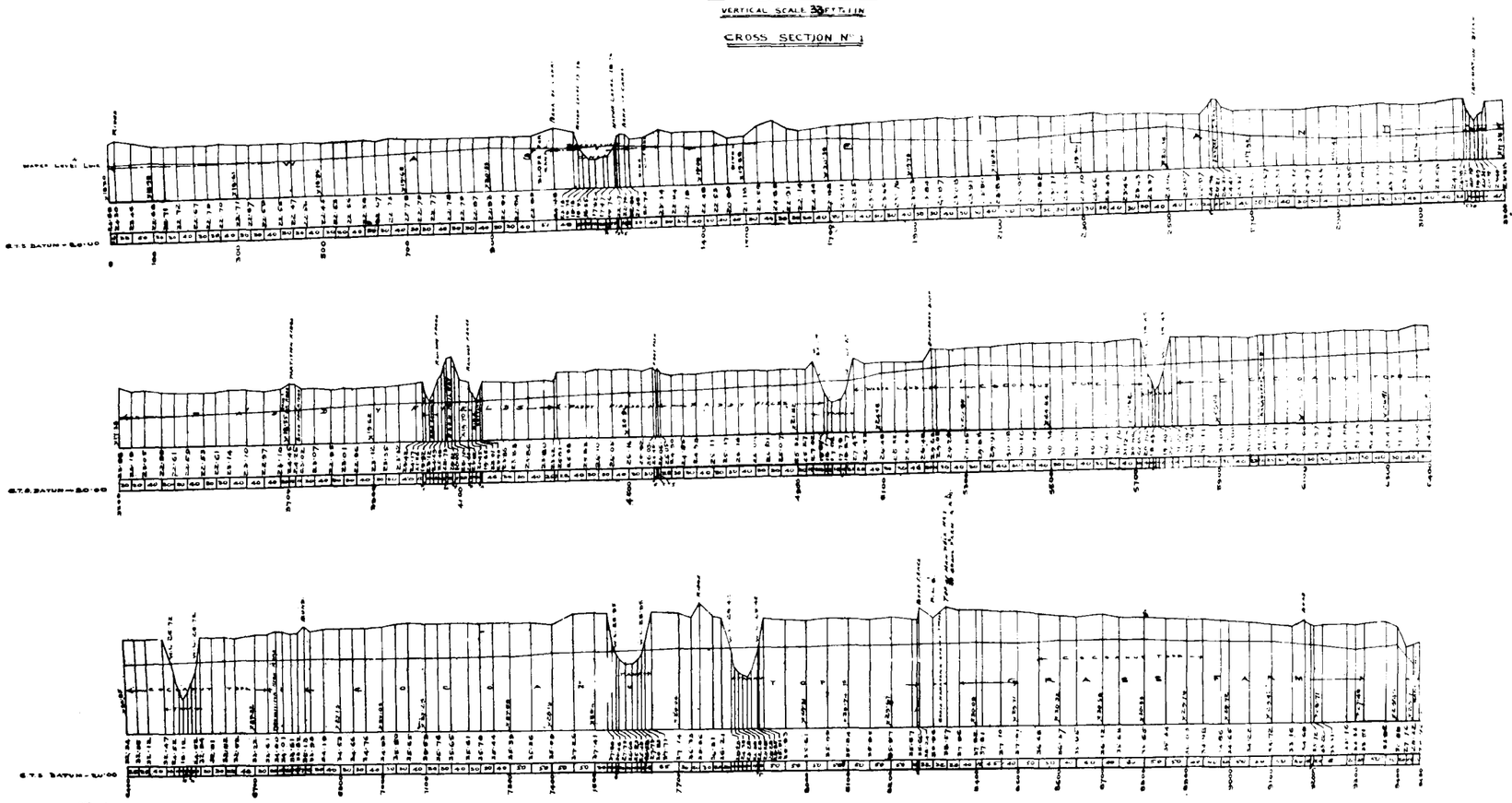
DRAWING No. 1

TANDIARPET GRASS FARM

HORIZONTAL SCALE 330 FT. TO 1 IN

VERTICAL SCALE 33 FT. TO 1 IN

CROSS SECTION No 1



SURVEYED BY
TRACED BY
CHECKED BY

SENIOR ASST. ENGINEER

ENGINEER

CORPORATION OF MADRAS

WORKS DEPARTMENT

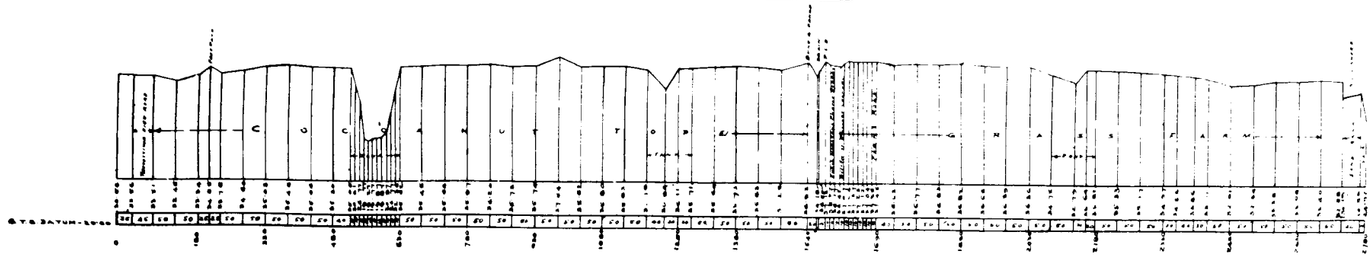
TECHNICAL SECTION

SERIAL No. 94
DRAWING No. 2

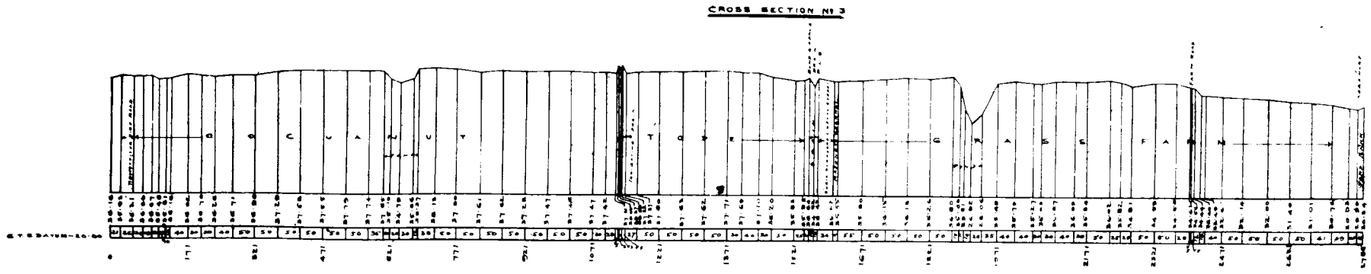
TANDIARPET GRASS FARM

HORIZONTAL SCALE 33 FT to 1 in
VERTICAL SCALE 10 FT to 1 in

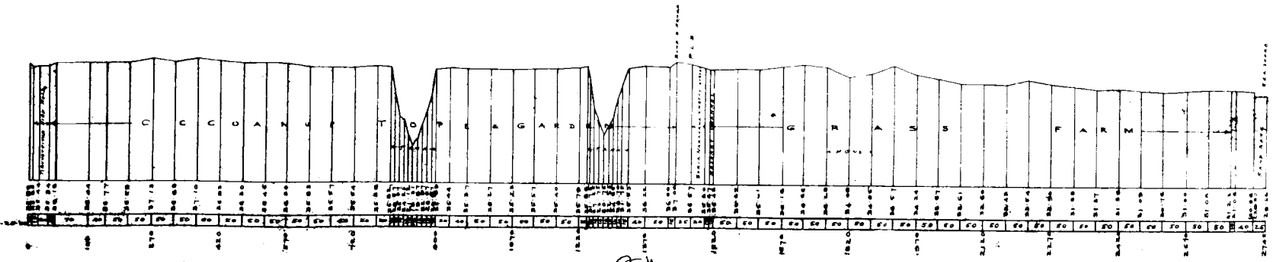
CROSS SECTION No. 2



CROSS SECTION No. 3



CROSS SECTION No. 4



DRAWN BY
TRACED BY
CHECKED BY

Senior Asst. Engineer

Asst. Engineer

SHEET No. 7.

CORPORATION OF MADRAS

WORKS DEPARTMENT

TECHNICAL SECTION

TANDIARPET GRASS FARM

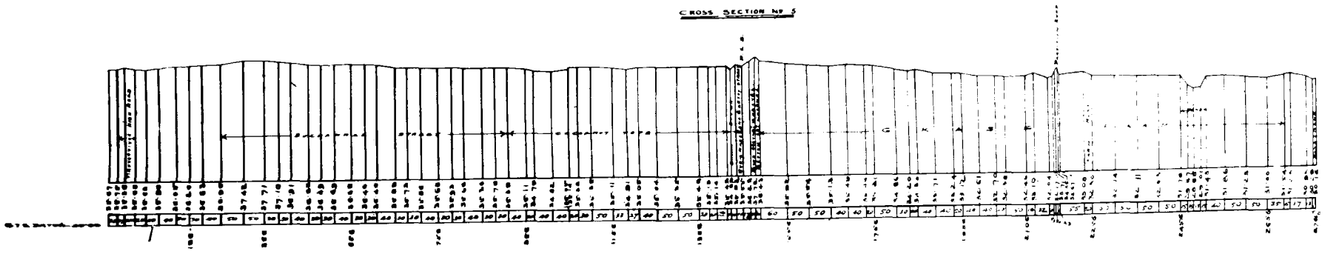
SERIAL No. 95

DRAWING No. 3

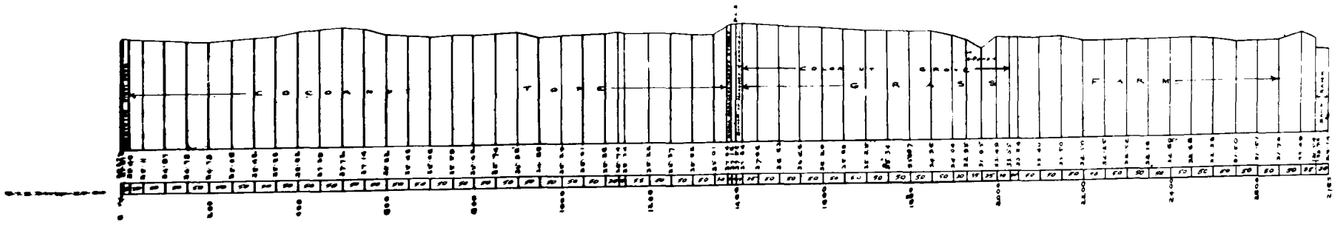
HORIZONTAL SCALE 30 FT. TO 1 in.

VERTICAL SCALE 3 FT. TO 1 in.

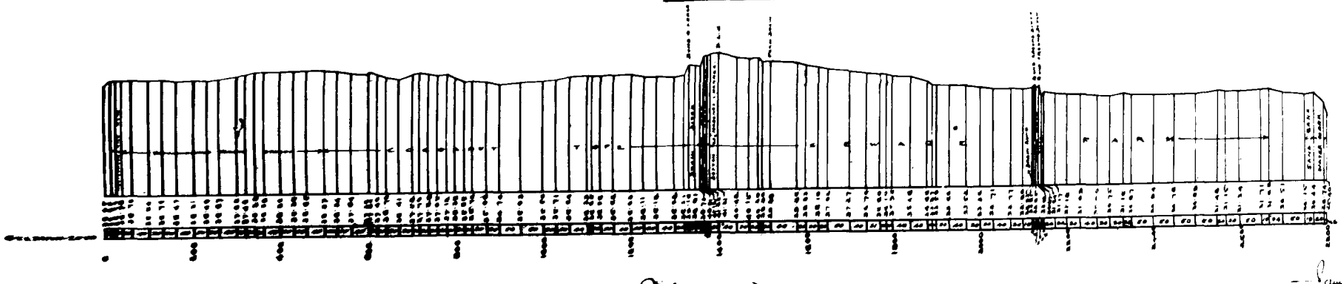
CROSS SECTION No. 5



CROSS SECTION No. 6



CROSS SECTION No. 7



Johnson

SUPDG. ASST. ENGINEER

Samuel Coates

ENGINEER

SHEET No 8

SERIAL No 116
DRAWING No 4

CORPORATION OF MADRAS

WORKS DEPARTMENT

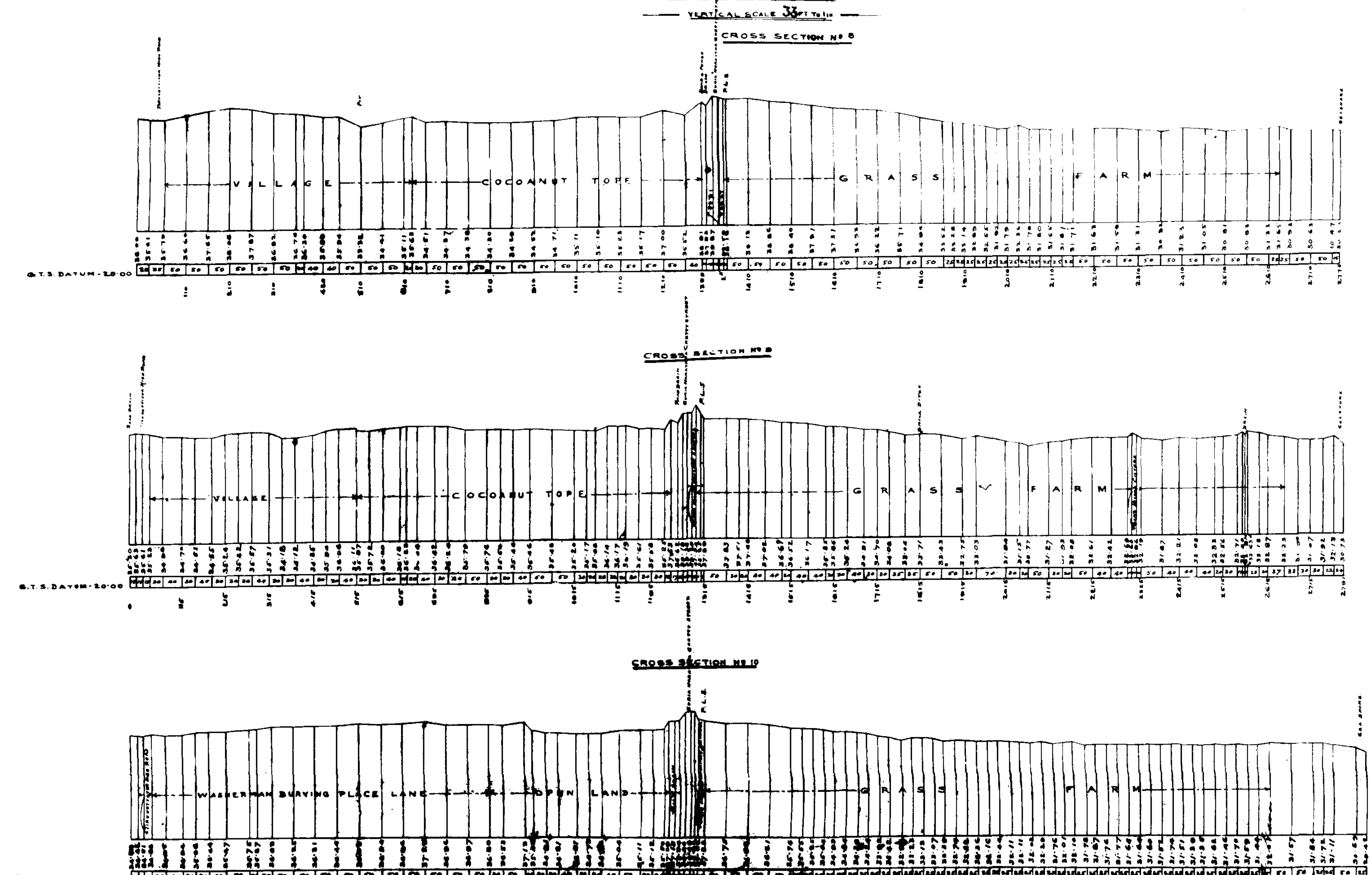
TECHNICAL SECTION

TANDIARPET GRASS FARM

HORIZONTAL SCALE 33 FT TO 1 IN

VERTICAL SCALE 33 FT TO 1 IN

CROSS SECTION No 8



ENGINEER

11-9-13

SHEET No 9

SERIAL No 108
DRAWING No 5

CORPORATION OF MADRAS

WORKS DEPARTMENT

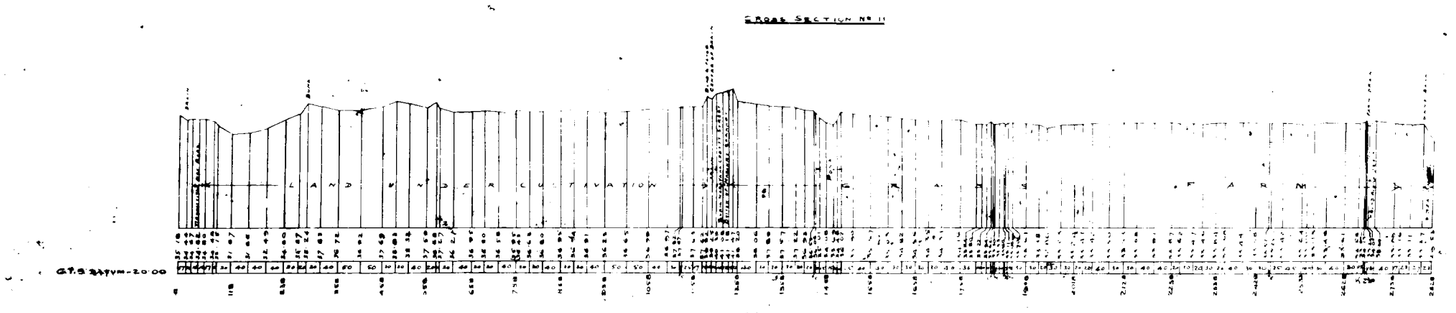
TECHNICAL SECTION

TANDIARPET GRASS FARM

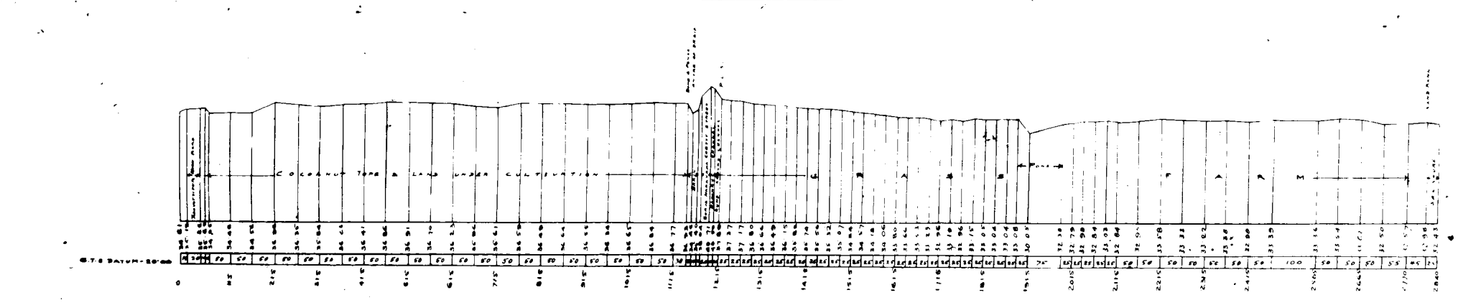
HORIZONTAL SCALE 330 FT TO 1 IN

VERTICAL SCALE 33 FT TO 1 IN

CROSS SECTION No 11



CROSS SECTION No 12



SURVEYED BY
TRACED BY
CHECKED BY

SENIOR ASST ENGINEER

13-9-13

ENGINEER.

SHEET No 10

CORPORATION OF MADRAS

WORKS DEPARTMENT

TECHNICAL SECTION

SERIAL No 138

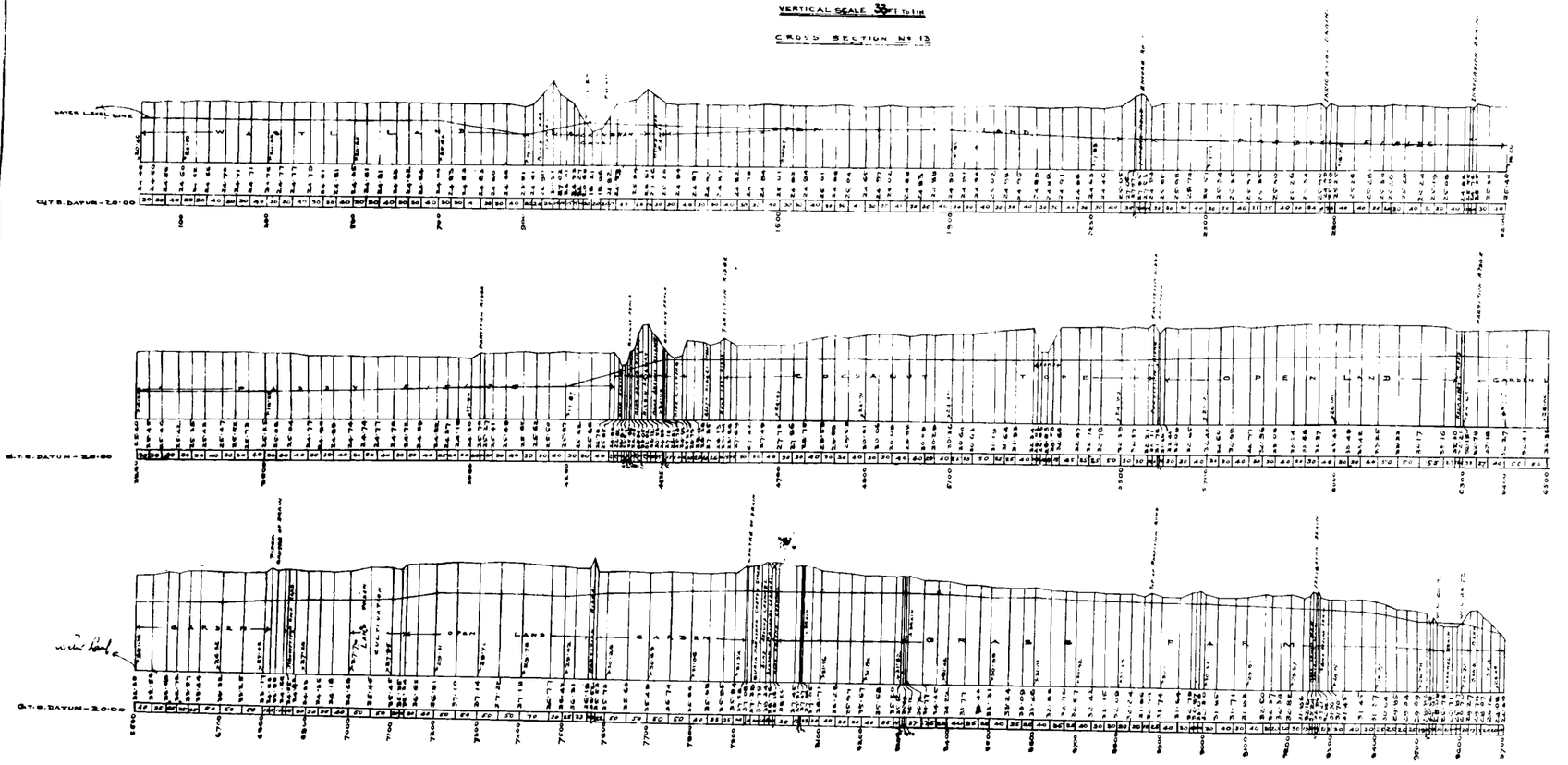
DRAWING No 6

TANDIARPET GRASS FARM

HORIZONTAL SCALE 33 ft To 1in

VERTICAL SCALE 3 ft To 1in

CROSS SECTION No 13



SURVEYED BY
TRACED BY
CHECKED BY

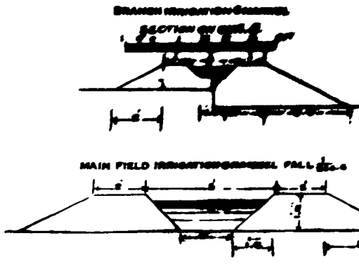
Senior Asst Engineer

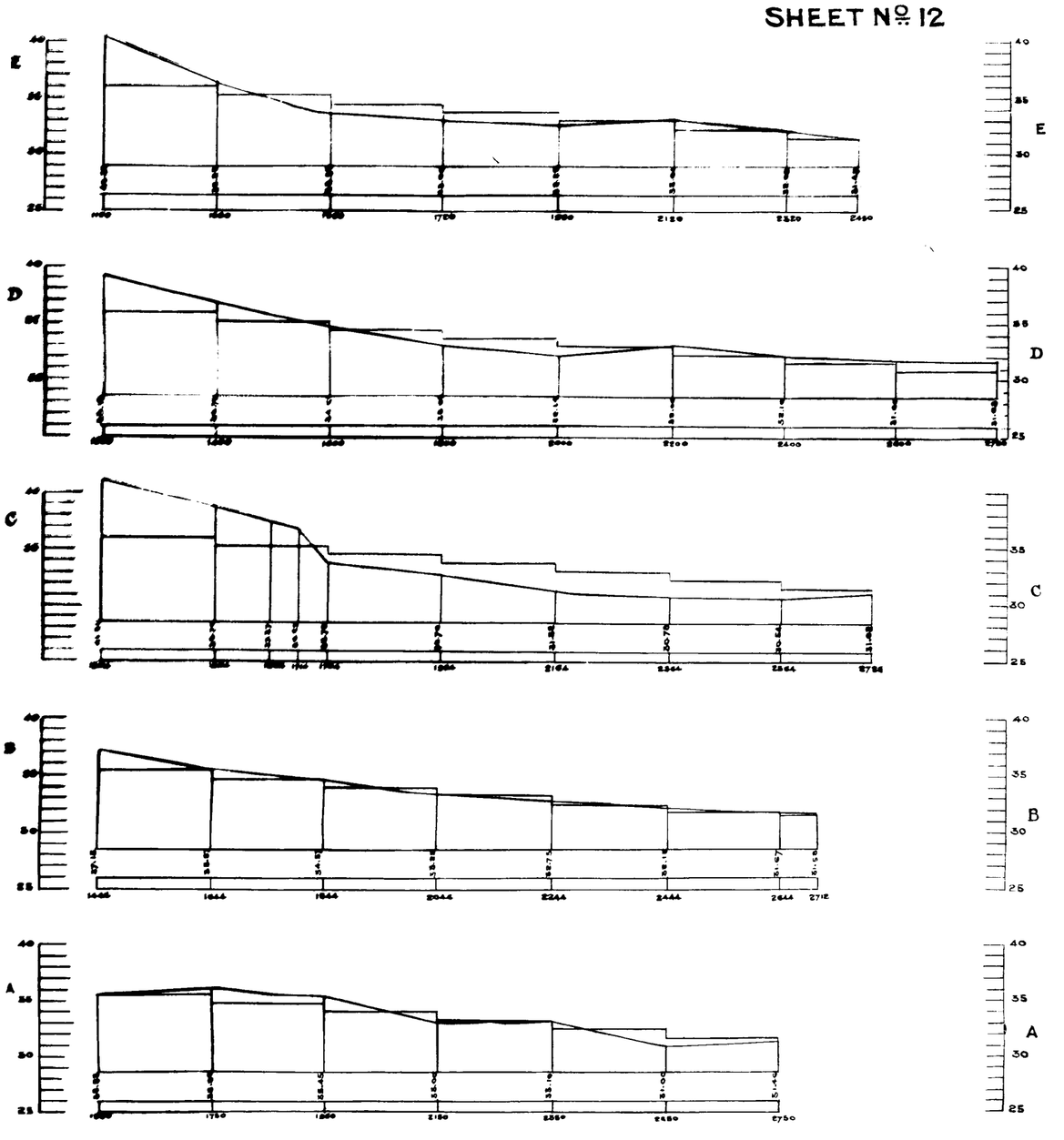
17.10.13

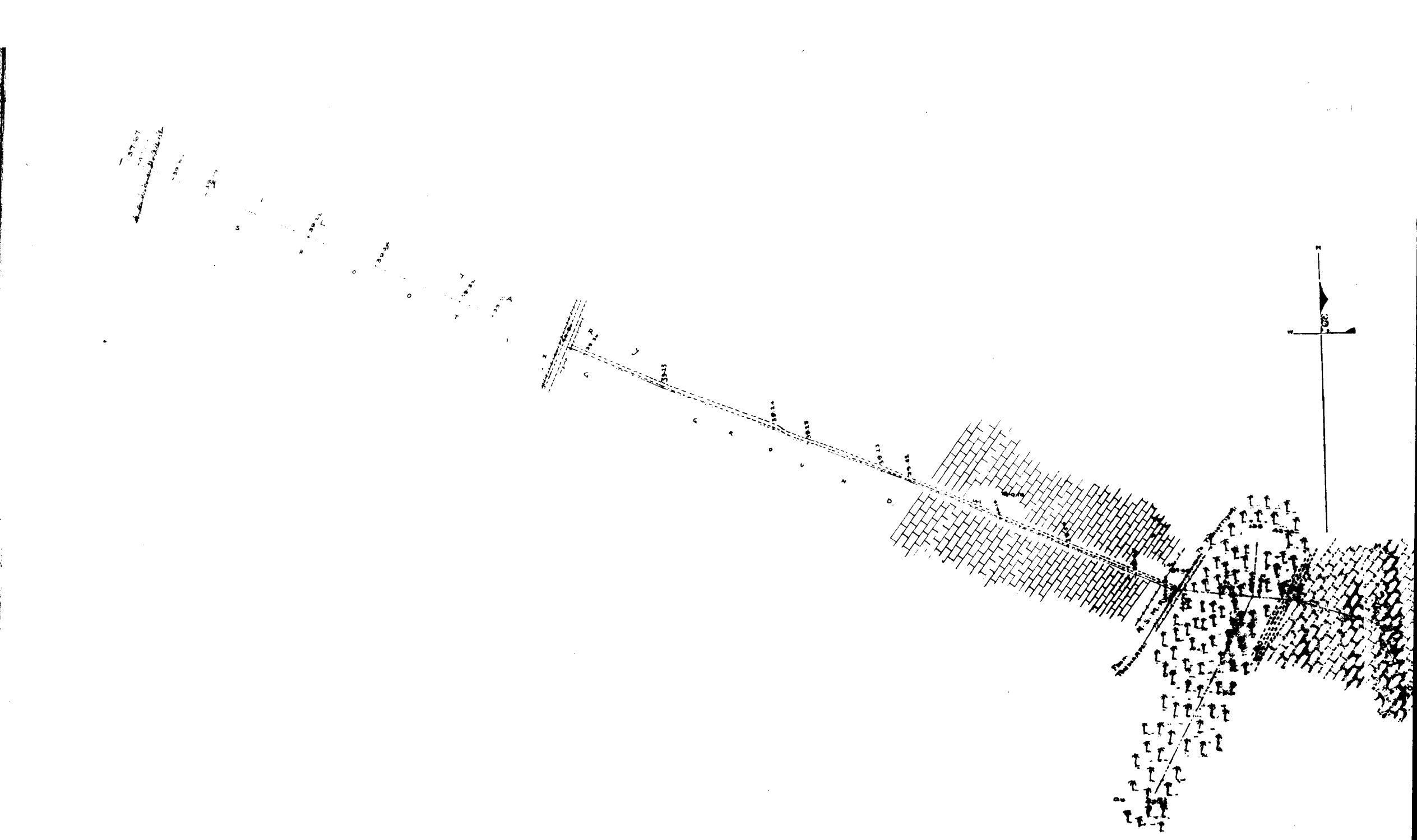
Engineer

PLAN

SHOWING CORRECTED LEVELS AFTER GRADING



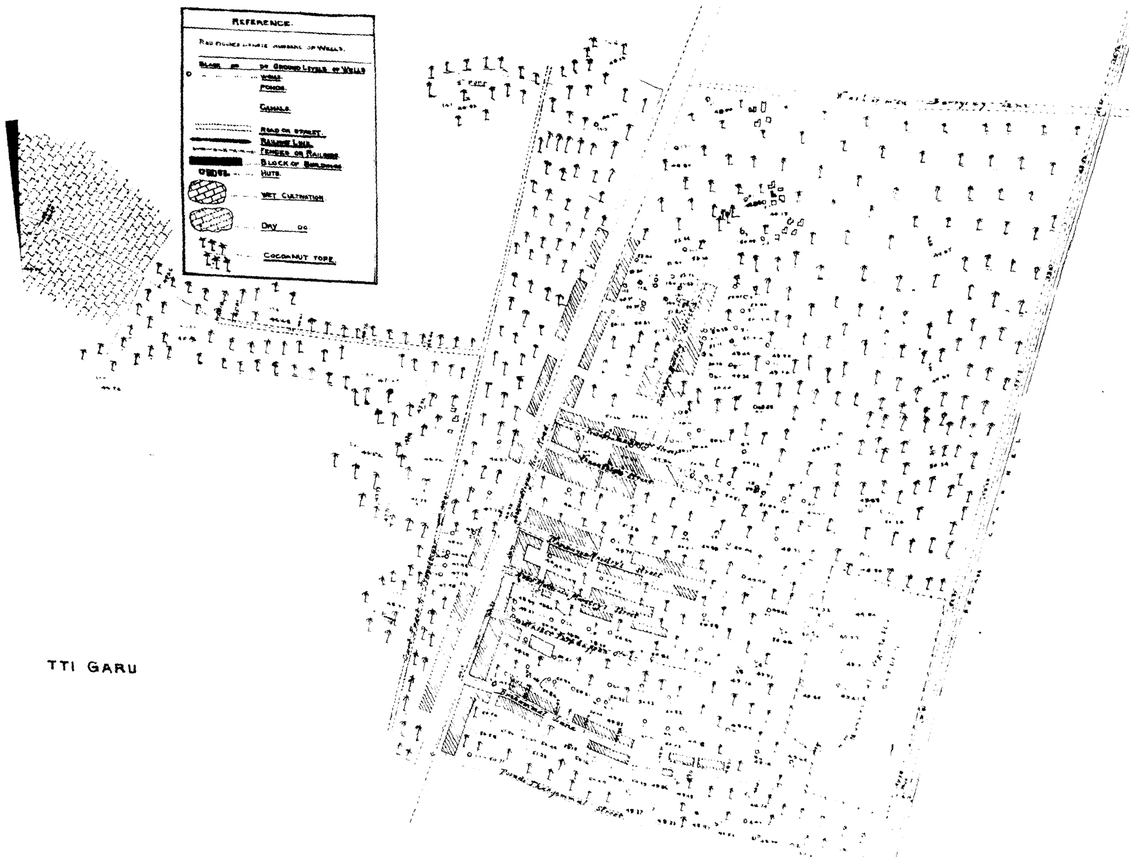




PLAN SENT BY
RAO BAHADUR P.TYAGARAYA C

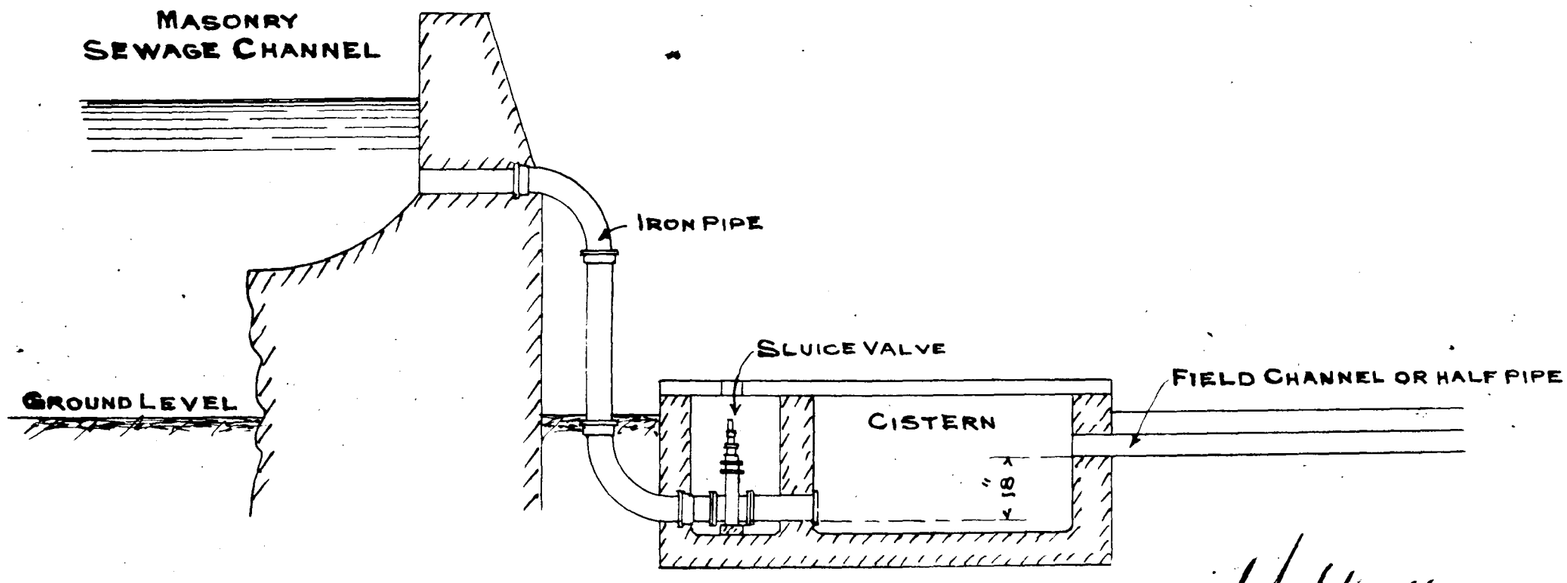
SURVEY & LEVELS OF WELLS
IN
DHOBIPET & ITS SURROUNDINGS

SCALE 1" = 500FT



SHEET Nº 14

HIGH DROP

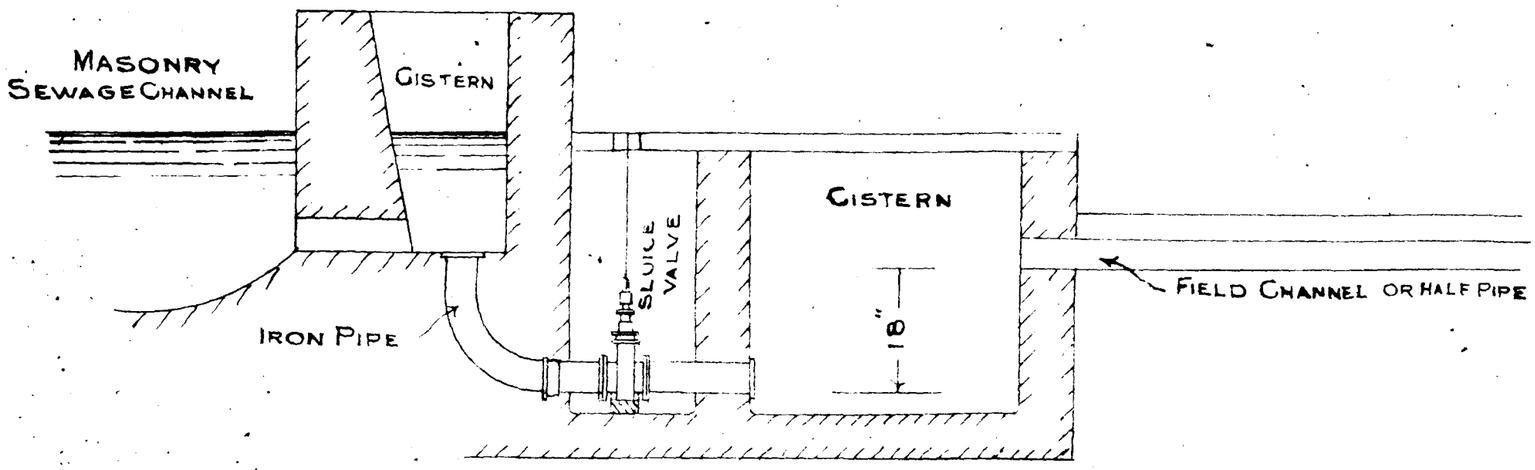


W. Hutton
15.1.14

CHAIRMAN
SEWAGE FARM COMMITTEE

LOW DROP

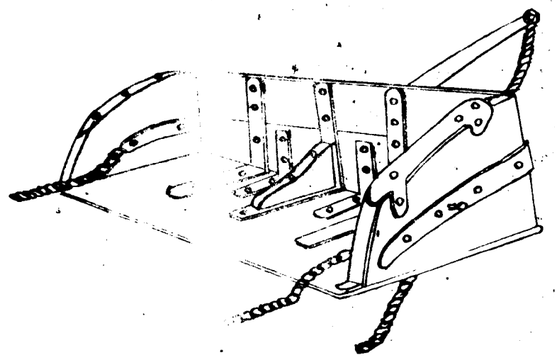
SHEET No. 15



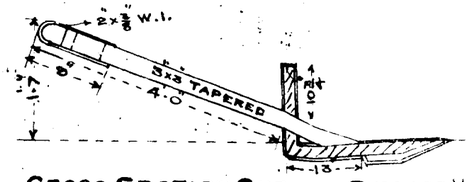
W. J. Hutton
15.1.14

CHAIRMAN
MADRAS SEWAGE FARM COMMITTEE

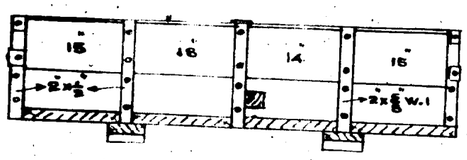
SHEET No 16



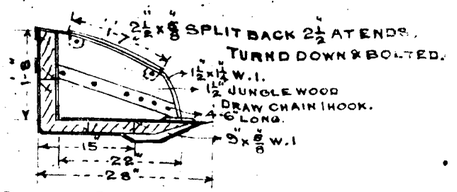
GENERAL VIEW OF BUCK SCRAPER



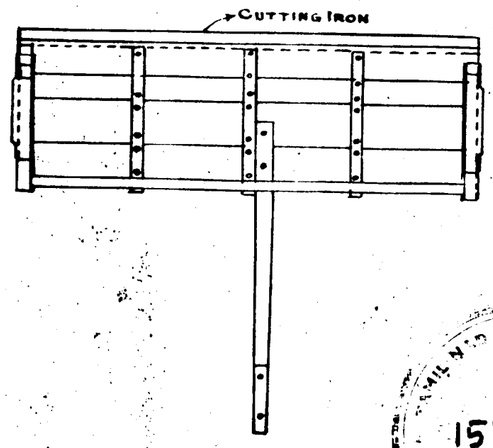
CROSS SECTION SHEWING PITCH OF HANDLE.



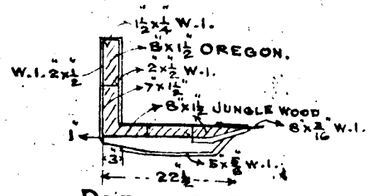
BACK VIEW



CROSS SECTION AT END.



PLAN



DETAIL OF SKID

R

a 28.211' N13 E

N14