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Public works DEPARTMENT

G.O. No.
B.P. No. 105-W.
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Dated 8.1.1878 ~~197~~.

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

8th January 1878, No. 105 W.

Buildings and Roads.

Civil Works.

Read the following papers :—

No. 78. Endorsement of the Under Secretary to Government, Financial Department, dated 26th April 1877, No. 921.

From A. McC. WEBSTER, Esq., Acting President of the Ootacamund Municipal Commission, to the Chief Secretary to Government, dated Ootacamund, 19th April 1877, No. 45.

WITH reference to the Proceedings of Government, dated 6th February 1877, No. 431, I have the honor to forward a plan and estimate for the improvement of the northern water-supply of Ootacamund, together with a letter from the District Engineer explaining the project, and an extract from the Proceedings of the Commissioners of this date. The estimate provides for the enlargement of the Snowdon Reservoir. The subsidiary reservoirs proposed by the District Engineer and the construction of closed ducts will be estimated for hereafter.

2. Captain Morant's letter is so full that the Commissioners have nothing to dd. It will be seen therefrom that in ordinary years the new reservoir at Snowdon nd the existing one at Marlimund will provide for the wants of 10,000 people at 20 gallons per head per diem for five months and will leave a surplus of about 24,000,000 gallons; and that in bad years there will, supposing the same consumption, be a deficit of about 25,000,000 gallons, or say 2½ months' consumption. It is however to be observed that the rate of consumption of 20 gallons per head is perhaps more than ample; and if a supply of 15 gallons per head is provided, the supply in a bad year would last for eleven months; when, however, the drainage scheme is perfected we shall require more water, so it will be necessary hereafter to construct the subsidiary reservoirs at X and Y (Plan I), and the supply of water will then be amply sufficient for all purposes.

3. The estimate does not provide for Public Works supervision, which will amount to Rupees 5,732. It is, however, very necessary that the work should be carried out by the District Engineer, as owing to the position of the reservoir nothing should be left undone to prevent any possible chance of the embankment giving way. The Commissioners will not be able to provide from their current year's budget the sum of Rupees 8,672 over and above the loan of Rupees 20,000, and I trust, therefore, that Government will be able to allow the work being carried out by the District Engineer free of charge, or that, if that is not possible, they will allow any sum which the Commissioners cannot pay during the year to lie over and to be adjusted when the completion of the water-supply and the drainage projects are passed and the proposed loan for these works is sanctioned. The present proposed increase to the water-supply is urgently needed, and the work should be pushed forward with the utmost expedition so as, if possible, to get a good supply for next year.

Referred to the Chief Engineer for remarks.

(By Order,)

(Signed) J. STURROCK,
Under Secretary.

No. 78-A. Endorsement of the Acting Under Secretary to Government, Financial Department, dated 29th August 1877, No. 1,655.

From A. McC. WEBSTER, Esq., Acting President of the Ootacamund Municipal Commission, to the Chief Secretary to Government, dated Ootacamund, 24th August 1877, No. 80.

In continuation of my letter of 19th April 1877, No. 45, I have the honor to forward an estimate for the completion of the water-supply project for the northern portion of Ootacamund, together with a copy of the District Engineer's letter and of the Proceedings of the Municipal Commissioners thereon; I have also the honor to forward, for the sanction of Government, an application for a loan of Rupees 1,23,692 for the completion of this portion of the work.

2. The amount of the loan applied for in my letter to Government of 25th January 1877, No. 11, as well as the work, estimates for which were submitted with my letter of 19th April, is included in the present estimate of the Commissioners and application for a loan. In the former application for a loan of Rupees 20,000 the Commissioners proposed to repay it in twenty years, but looking to the amount now required they propose to repay it in thirty years.

3. Government will observe that the Commissioners have decided to be content for the present with the improvement and enlargement of the Snowdon Reservoir, leaving the construction of the additional reservoirs at X and Y on Plan No. 1 accompanying my letter of 19th April 1877 in the map for future execution should the present supply become insufficient owing to increase of population or other causes.

4. I have the honor to request that Government will be pleased to sanction the estimate and the loan, and will allow the work to be carried out by the District Engineer. The Commissioners venture to hope that Government will take into consideration the exceptional circumstances of the station, and will allow the wor to be carried out by the District Engineer free of cost to the Municipality. This wi reduce the cost of the work to about 1 lakh of Rupees, and the Commissioners wi be enabled to spend the remaining portion of the loan in improving the southern water supply channel and in continuing the northern supply to Kandal and Woodcock Hill.

Referred to the Chief Engineer for remarks.

(Signed) H. B. GRIGG,
Ag. Under Secretary in charge.

No. 1,709.

The Chief Engineer hoped ere this to have inspected personally the site of the proposed reservoir on arrival at Ootacamund with the Government. Until he is able to do so and submitted his report he recommends that no action be taken in the matter.

Fort St. George,
21st June 1877.

(Signed) E. A. FOORD, Colonel, R.E.,
Chief Engineer, P.W.D.

No. 1,709.

Retransmitted to the Chief Engineer with original notes of Members.

(By Order,)

8th September 1877.

(Signed) H. B. GRIGG,
Ag. Under Secretary.

No. 216 W.

MEMORANDUM.

Ootacamund Water-supply.

The proposals which have been brought forward by the District Engineer, Nilgiris, and approved by the Municipality, embrace the provision of additional storage for the supply of the northern side of the station, and arrangements for purifying the water, with its distribution under arrangements likely to preserve its purity.

2. Marlimund Reservoir.—There is at present only one reservoir, if the small tank near Snowdon House be excepted, for the storage of water for this part of the station. This is called the Marlimund Reservoir, and was constructed about seven years ago. Generally it has filled well and has surplused; but in 1875 the depth of water on the sill of the sluice did not exceed 15 feet, and in 1876 nine feet, the depth when the reservoir is full being 19¼ feet. The District Engineer estimates the contents at, in round numbers, 50 millions of gallons; but from information furnished by him two or three years ago it appears that—

Information given by Municipal Overseer.

The total contents are	7,761,000	cubic feet.
The contents below the outlet	324,000	„
Water available for use	7,437,000	„
	or 46,480,000	gallons.

The catchment basin of this reservoir is 260 acres or 0·406 of a square mile. The site is certainly much the best high level site near Ootacamund.

3. Water-yield Requirements.—To fill the Marlimund Reservoir it is necessary that a depth of 7·88 inches should flow from the whole area of the catchment basin. The District Engineer has given a table of the monthly and annual rainfall at Ootacamund, for the years 1869 to 1876 inclusive, from which it appears that its amount was in—

260 acres = 11,325,600 square feet.

$$\frac{7{,}437{,}000}{11{,}325{,}600} = \cdot 6567 \text{ feet} = 7\cdot 88 \text{ inches.}$$

Years.		Rainfall.	Rainy Days.	Average Fall of Rainy Days.	October Rainfall.	Rainy Days.	Average Fall of Rainy Days.	November Rainfall.	Rainy Days.	Average Fall of Rainy Days.
1869...	...	38·65	117	0·33	3·97	12	0·33	3·28	13	0·25
1870...	...	41·92	122	0·34	10·10	15	0·67	1·69	10	0·17
1871...	...	54·92	94	0·58	10·45	*	...	13·92	10	1·39
1872...	...	45·42	119	0·38	3·99	11	0·36	6·93	18	0·38
1873...	...	45·41	138	0·33	7·32	23	0·32	2·35	10	0·23
1874...	...	47·48	141	0·34	10·24	20	0·51	2·10	10	0·21
1875...	...	38·45	107	0·36	8·33	19	0·44	2·30	7	0·33
1876...	...	25·16	76	0·33	1·66	8	0·21	0·26	2	0·13
		337·41	914	2·99	56·06	108	2·84	32·83	80	3·09
Average	...	42·18	114	0·37	7·01	15	0·41	4·10	10	0·38

* Not stated.

The position and aspect of the catchment basin of this reservoir make the north-east monsoon rains those from which the greatest yield is obtainable, and a register of rainfall at Ootacamund, which is on the other side of the water shed, is not a very reliable criterion of the rainfall at the reservoir catchment basin, but it is the best available.

It is understood that the Municipality have a register of the water levels in the reservoir; but at present there is no series of cross sections of the tank, and consequently the actual yield of the 260 acres, and the loss by evaporation and absorption, cannot be properly deduced; and indeed to enable these latter to be approximated to, it would be useful to know what water has been issued to the channel supplying the town; and of this there would seem to be no record. The District Engineer has been asked to have the requisite sections taken and a table of capacities prepared.

4. WATER-TOWER VALVES.—The water-tower valves are not as convenient as is desirable, though apparently with slight modification a fairly accurate regulation could be effected. At present the valves which are hinged at the upper edge can be regulated to somewhat more than inches of lift, and were another disc placed at the other end of the drum of the windlass, and the holes made to alternate with those now used, the difference of lift could be halved. However it will be advisable to substitute slide valves or plugs regulated by screws, and then exactly the desired discharge can readily be obtained.

5. SURPLUS CHANNEL.—The arrangements for discharge of surplus are inadequate. The capacity of the reservoir is, compared with the catchment basin, considerable; but nevertheless the tank may be full or nearly full when a heavy fall of rain occurs, and in 1871 it was in some danger. There is no escape weir at the tank, but a masonry-lined channel, 8 feet wide, starting at F.T.L., and with no bed fall, conducts the water for a considerable distance* to a series of steps or drops, the width at the first drop being 6 feet. Thence the water is conducted by an earthen channel, altogether too small, along the hill side to a safe distance from the bund. The escape should, it is considered, be 20 feet wide with a clear overfall, and 24 feet with a channel like the present, to ensure the water level being limited to 3 feet above F.T.L. as a maximum.

* 292 feet.

6. RAINFALL REQUIRED TO FILL RESERVOIR.—It would seem that a rainfall of 12 inches in October and November are about sufficient to ensure an adequate supply to this reservoir. In 1875, a very dry year in July to September, it was about $\frac{2}{3}$rds filled, and the rainfall in the two north-east monsoon months was 10·63 inches. The average of the eight years gives 11·11 inches.

7. ENLARGEMENT OF MARLIMUND RESERVOIR.—At a comparatively small expense the available capacity of this reservoir could be increased one-half by raising the bund and F.T.L. 6 feet. The area of the present waterspread is 597,000 square feet, and 6 feet over this would contain 3,582,000 cubic feet, so probably the total additional storage would be just about half the present capacity.

The present top width of the bund is 25 feet and might be diminished to 18 feet at the raised top level. The top of the bund is 7½ feet above F.T.L., and the top of the raised bund should be 3 + 5 feet above the raised F.T.L. The interior and exterior slopes above F.T.L. may be increased to 1 to 1, and if necessary the interior slope below this point may be carried down at 1½ to 1 until the required base is obtained.

8. SNOWDON RESERVOIR.—The site of the proposed Snowdon or Snowdon House Reservoir is just below Snowdon House on the Ootacamund side of the saddle on which that house stands. The site as regards the formation of the bund is favorable, but otherwise there is not anything in its favor.

(1).—The catchment basin is only 60 acres, so the surface yield would probably not much exceed $\frac{6}{26}$ths of that of the Marlimund Reservoir, and if this be taken as 10 millions of cubic feet on the average, and one-third of that quantity in such a year as 1876, the water available would be
in an average year ... ... 2,307,700 cubic feet.
in a year like 1876 ... ... 769,230 "
the intended capacity as designed is ... 3,859,860 "

It is therefore not probable that in ordinary year this reservoir would fill. Major Morant states that the ground above the bund site is full of springs, but it does not follow that all this spring water would go to augment the water stored in the reservoir.

(2).—The capacity is small compared with the height of the bund, 56 feet, as a maximum, and the depth of water, 40 feet, at the sluice. This arises from the high level of a large part of the ground within the waterspread.

Area of waterspread 220,319 square feet.
Mean depth 17½ feet.

(3).—The cost of storage would be high, viz., Rupees ... 5,943
Per million cubic feet, even supposing the tank to fill.
The actual cost might be Rupees 8,000
the million cubic feet.
The Marlimund Reservoir cost Rupees 14,700
So the storage there was at the rate of a little under Rupees 2,000
a million cubic feet. Its capacity could be increased one-half at a cost of about 2,000 Rupees the million cubic feet.

(4).—Although it is of considerable advantage to lay 60 additional acres under contribution, this benefit would be frequently more than neutralized by the full tank level being 15 feet above the sill of the south face of the tunnel through which the Marlimund Channel runs.

The difference of aspect would be an advantage, as more water would be received from the south-west monsoon, the rainfall in which is not much less than three times that of the north-east monsoon, but spread over five months instead of two.

31·08 to 11·10.

9. OTHER SITES FOR RESERVOIRS.—There are no really good sites at a high level available. There is a site* to the west of the Marlimund Reservoir, which was inspected, and which might possibly be of use to supply Kandal and houses in that direction. The catchment basin is about 122 acres. The level of the bund site will be ascertained.

* Marked W.

Above and to the eastward of Snowdon House there are the X and Y sites mentioned in Major Morant's report; they are on extremely steep ground, and their catchment basins are 36 and 25 acres respectively. The former is on the south or Ooty side of the hills, and the latter on the north or Snowdon side. The capacity of these tanks, even with high bunds, would be very small, but a considerable portion of the yield of their catchments could be conveyed to the Snowdon House site, and in this way a reservoir constructed at this site might perhaps be adequately supplied. Another site marked Z is situated in the next valley to the south-east of that of the X site, and has a drainage basin of 54 acres. The water could be conveyed to the Snowdon House site.

There is a site below Cinchona Villa and just where a line from the stables at Lower Norwood, at right angles to the axis of the valley, would cut the stream, at which a reservoir of some considerable capacity could be formed. The area of the catchment basin is about 307 acres, and all the water of the basin of the Snowdon House site, of the X and Z sites, and of other ground would be received by it. Its adoption would entail separate filtering arrangements and distribution, but it is comparatively near the town, and the level of the stream at the bund site being 292·81,* as compared with Ooty lake surface 209·81,† the command would probably be sufficient.

10. WATER-SUPPLY REQUIRED.—The District Engineer in paragraph 15‡ notes that the Marlimund Reservoir was designed to supply 6,000 people at 30 gallons a head a day, or 180,000 gallons a day altogether. He considers it to be desirable to provide for a population of 10,000; but that with masonry conduits or pipes 20 gallons a head a day should suffice: the daily provision would then be 200,000 gallons. It is mentioned that

* Datum 200 feet below sill of lake sluice.

† The F.T.L. of Ooty lake is nearly 10 feet above sill of sluice in west bund.

‡ Letter No. 145, 18th April 1877.

in London only ⅘ths of the whole delivery enters into consumption, and that in Glasgow 18 gallons out of 32 are wasted, or the wastage is rather less than in London. Major Morant thinks that the waste at Ootacamund need not be so great. Were the delivery pipes to be similar to those of the London Companies, this conclusion might be accepted, because their pipes work under considerably greater pressure than is intended in this case. Altogether, however, it would be unwise to suppose that the Ootacamund distribution arrangements will be more efficient than those existing in England after many years' experience. The issues from the reservoirs should therefore be assumed to be at least half a million of gallons a day. In ordinary seasons it is considered by the District Engineer that the reservoirs would have to store enough water for five months' consumption; but that to ensure the station against a failure of water in bad years there should be provided a storage equal to ten months' consumption. In the former case consequently the water to be available for issue from the reservoirs would be 75, and in the latter case 150 millions of gallons.

11. LOCAL DATA WANTING.—It is particularly unfortunate that reliable data, such as the Marlimund Reservoir might have furnished, are wanting as to—

(1).—The yield of a given area of ground;

(2).—The proportion between water stored in a reservoir and that available for issue after loss by absorption and evaporation.

Information on these points for the Marlimund Reservoir would have been very greatly more valuable than deductions from English experience. The loss by evaporation is dependent upon surface area; that by absorption is influenced by the nature of the bed and the depth of water. It would, it is thought, be a very favorable site at which the losses from these two causes would be less than one-third of the quantity stored. The conclusions arrived at in paragraph 18 of the District Engineer's letter appear therefore to need somewhat radical modification.

Taking, as Major Morant has done, first an ordinary year

	GALLONS.
200,000 gallons a day for 152 days	30,400,000
Wastage based on London data	45,600,000
Quantity to be issued from reservoirs	76,000,000
*Evaporation and absorption	25,335,000
Storage required ...	101,335,000

against 45,600,000 according to Major Morant's calculation.

Secondly in the case of a very bad year like 1876

200,000 gallons a day for 304 days	60,800,000
Wastage on London data	91,200,000
	1,52,000,000
Evaporation and absorption	50,670,000
	202,670,000

against 91,200,000 as estimated by the District Engineer.

12. WHAT THE IMPERFECT DATA AVAILABLE INDICATE.—Major Morant has been asked to obtain from the office of the Municipal Commission such registers of, and information about the Marlimund Reservoir as may be available, and to have a sufficient number of sections taken to enable a table of capacities at different levels to be drawn up. It may then be practicable to approximate more or less closely to the yield of its catchment basin in 1875 and 1876, and thus to get some data for determining what area must be laid under contribution to yield the quantity of water needed. At present there is no information available, while a deduction from the fact that the water did not rise in the reservoir higher than 9 feet above the sluice sill in 1875 would indicate that it is very improbable that a sufficient area for a ten months' supply can be found at the required level. Below the sill level the mean depth is said to be 4 feet and the contents ... ... 324,000 cubic feet.

The mean depth of the tank when full is 13 feet, contents ... 7,761,000 „

It is probable therefore that with a depth of 9 feet out of 19¼ on the sill, the contents above sill level did not exceed one-third of the quantity when the tank is full, or

say	2,600,000	cubic feet
and if it be assumed that the quantity drawn off in addition was	2,600,000	„
the total receipts would be	5,200,000	„
or gallons ...	32,500,000	

from an area of 260 acres.

13. CATCHMENT BASINS OF OTHER SITES AND THEIR PROBABLE YIELD.—The areas of the basins of the other sites which have been suggested are—

		ACRES.	
W		122	*Vide plan.*
X		36	
Y		25	
Z		54	
Snowdon House site		60	
Below Cinchona Villa ...	307		
Deduct X and Z	90		
		217	
		514 say 510	

If the yield be supposed to be the same in proportion it would amount to 63·75 millions of gallons, and this quantity added to that of Marlimund would be 96·25 millions. Moreover to obtain 202·670 millions for a ten months' supply the acreage of gathering ground required would be 1,621 acres or 2·53 square miles, and this is certainly no very great area in itself for the supply of a large station, though it appears to be altogether impracticable to find it, together with sites at a suitable level at which water could be stored.

14. MAJOR MORANT'S MODIFIED PROPOSALS.—Major Morant's proposals, even as somewhat modified during the recent discussions, amount to the formation of a reservoir at the Snowdon House site, and to supplementing the supply from its own basin by conducting water to it from the X Y Z basins; but, making every allowance for more favorable aspect in the case of all but Y, which much resembles that of Marlimund, the total area of drainage would be only 175 acres, and the yield would not exceed, and would probably fall short of that of the Marlimund basin. These calculations are based on no reliable or indeed ascertained data, for such data have yet to be made available; but they will suffice to indicate that there is but little chance of making provision for the supply of water to the whole station on the scale which has been proposed. When actual data, however imperfect, are given, it will be easy to show what is likely to be feasible. The Ootacamund water-supply scheme should be based on what is demonstrably probable.

15. THE WAY IN WHICH THE YIELD OF THE SNOWDON HOUSE SITE WAS ESTIMATED.—Major Morant's calculations, from which he concluded that the proposed Snowdon House Reservoir would fill more than once from the drainage of its own basin in the event of three consecutive dry years, were based, as explained by him in a demi-official note, dated the 25th September, on English experience. From the average annual rainfall one-sixth is deducted, and the remainder is taken as the average of the three driest consecutive years, 14 inches were then deducted from this quantity for evaporation and absorption (the allowance in English mountain districts) and 20 inches were found to be the depth actually draining off, the yield being 31,630,900 gallons against 24 millions, the capacity of the Snowdon House Reservoir. The area of the basin has since been found to be 60 instead of 70 acres; and the quantity correspondin[illegible] 20 inches draining off would th[illegible]re be 27,225,000 gallons or one-eighth in ex[illegible] of the capacity of the reser[illegible] The depth of drainage required to fill the latter would be therefore a little u[illegible] 18 inches. Now it has already been shown that 7·88 inches draining off the [illegible]mund basin would

suffice to fill that reservoir, and allowing for all possible difference of aspect in the case of sites a few hundred yards apart, it is certain that Marlimund Reservoir would have filled to overflowing two or three times in 1875, and have more than filled in 1876, had these deductions from English experience been applicable to the circumstances. As a fact it did not nearly fill in 1875 and did not half fill in 1876; so whatever data are to be relied on should be obtained on the spot. To this end it is desirable that rainfall should be registered at the Marlimund Reservoir which can easily be managed, and at Snowdon House, which probably can be arranged for. A knowledge, for even a short time, of the falls at these places corresponding to the falls registered at Ootacamund will be of value in determining the effect of difference of aspect and elevation.

16. REGISTERS OF SURPLUS FROM EXISTING RESERVOIRS SHOULD BE KEPT.—It may further be noticed that registers should be kept to show what the quantity of surplus discharged from the Marlimund and Dodabet Reservoirs may be, and it will be necessary to know not only the depth at the tank end of the surplus channel, which will be found from the known reading of the sole of the channel on the water tower gauge, agreeing as this does with F.T.L., but the depth also at the lower end of the horizontal part of this channel. Similarly the depths of water, or the water levels in the channels leading from these reservoirs, should be recorded at such points as will allow of the discharge being calculated. Such data are essential to the solution of the questions relating to water-supply, and their continuous record for the past six or seven years would have afforded all that would have been necessary for dealing effectively with the questions now awaiting settlement.

17. ENLARGEMENT OF MARLIMUND RESERVOIR SHOULD BE ESTIMATED FOR.—The Marlimund Reservoir has, it would seem, received more water than it could store in five years out of seven. An addition of 6 feet to its depth will enable it to retain about as much water as the proposed Snowdon House Reservoir would hold, and it is therefore recommended that this enlargement should be estimated for at once, and, if as expected the cost will be moderate, carried out at once. Its contents will then be about 11,155,500 cubic feet 69,722,000 gallons.

18. X, Y, AND Z SITES SHOULD BE FURTHER INVESTIGATED.—In the next place the X, Y, and Z sites should have sufficient sections taken to determine how far they can be utilized as reservoir sites, and what their capacities at the levels which appear to be most suitable would be. There will, it is thought, be no objection to the construction of reservoirs at these sites if it be found that storage can be effected at a reasonable cost. The X and Z sites are within the catchment basin of the site below Cinchona Villa; but the quantity of water which they will store will not, it is thought, materially affect the supply of the lower reservoir should it be deemed desirable to construct it.

19. POSITION OF FILTERS CAN DEPEND UPON ADEQUACY OF FUNDS TO ENCLOSE CHANNELS ABOVE ST. STEPHEN'S CHURCH.—All the water from the Marlimund Reservoir and from the X, Y, and Z sites can be brought to filters situated at any point below the Snowdon House site; and it must, it is thought, depend a good deal upon what the Commissioners can afford, at what point the filters should be placed. If money for enclosing all supply channels will be available the filters can conveniently be placed a short distance below Snowdon House. Otherwise the nearer they can be placed to St. Stephen's Church the shorter will be the length of piping necessary to maintain the purity of the water after filtration. It is desirable, if financially practicable, to enclose the water channels; but it can hardly be deemed essential. To take the channel from Marlimund Reservoir to Snowdon House tunnel for instance. There are one or two short lengths which should in any case be enclosed, because more or less liable to pollution from their proximity to dwellings and gardens, but the rest of this channel runs through clean ground, and the catch drain above it would, if properly looked after and the troughs which pass this drain water across the channel kept clear, prevent much fouling. Some cross fences and frequent inspection would do the rest. The channel is certainly not in proper order, as the depths of water and velocities were found to vary greatly, which would not be the case with a channel the fall of which was equally distributed, and the waterway uniform or varied according

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to the nature of the channel lining. Similarly the channel from Snowdon House to near the Church could by means of catch drains and troughs be preserved from material fouling. The cost of enclosing the channels is estimated at 21,000 Rs., the interest on which at 6 per cent. is Rupees 1,260. Probably 360 Rupees a year in inspection and work would keep open channels in good order. Closed channels would economize water and would be altogether more satisfactory. It is simply a matter of expense.

Above tunnel	14,646
Below do.	6,374
	21,020

20. PRESENT CONSTRUCTION OF SNOWDON HOUSE RESERVOIR NOT RECOMMENDED.—The present construction of the Snowdon House Reservoir is not recommened, because the cost of storage would be great; the drainage basin is small, and it would often necessitate the passing to waste of water from the Marlimund Reservoir; for no water therefrom could be supplied to the station while that in the Snowdon House Reservoir was above [illegible]5 feet below the F.T.L. This might, as suggested by Major Morant, be remedied by closing permanently any connection between this reservoir and the tunnel and continuing a closed channel from the latter through the upper part of the bed of the latter. Then water could be conveyed to the filters from Marlimund at all times, and the reservoirs could be worked independently as might seem expedient. This arrangement does not however get rid of the cost of storage which is very high. It may ultimately be necessary to utilize this site, and nothing should be done to prejudice such future use, but until it has been demonstrated that it is not practicable to store water elsewhere more cheaply this part of the scheme may properly be held in abeyance.

21. * * * * * *

22. GENERAL CONCLUSION AND DETAILS TO BE INVESTIGATED AND PLANNED.—The general conclusion arrived at by the undersigned is that storage is not likely to be available for the supply of Ootacamund with a delivered quantity of water of 20 gallons a head for 10,000 persons for ten months, and it is thought that before any complete scheme of storage and distribution is brought forward for sanction, it is desirable that it should be considered more particularly what the Municipality propose to undertake to do, and for what purposes pure water is to be supplied. The District Engineer's letter of the 1st June 1877 brings forward proposals for a certain rough division of the water-supply above St. Stephen's Church into two parts, the one* to be carried by a high level channel to above Sylk's Hotel and ultimately on to Kandal; and the other† and larger supply past the Post Office. With these proposals estimates amounting to, in the form accepted by the Commissioners, Rupees 98,954 were submitted for enclosing the water channels and filtering the water; but these estimates evidently include only a part of the expense necessary to provide for the convenient and economical use of the water-supply. The estimates relate in fact only to a part of what may be called the principal distribution, and were so much of the work done and nothing more it would happen that by far the greater part of the supply provided at a very considerable outlay would run into the lake unused. To do much good the works contemplated will require to be supplemented at once by other works, and the following remarks will serve to indicate what are the details which have still to be planned and estimated for—

* 100,000 gallons.

† 150,000 do.

1*stly*.—For the supply of pure water to the bazaar: there should be service tanks or reservoirs capable of containing about three hours' supply of water, and from these pipes should run to street fountains furnished with taps from which alone water should be obtainable by the population. The number and capacity of the tanks should be fixed with reference to the population to be supplied by each, and to facilities of construction. The pipes supplying these service tanks should be capable of being closed, and it would seem to be proper to arrange for filling them every three hours, and in the intervals to furnish the supply to individual houses.

2ndly.—For detached house-supplies it will be needful that cisterns should be provided to be supplied by taps* which will close on the cistern becoming full. It will no, ti tis thought, be feasible to do without cisterns. If the pipes for the supply of individual houses are to be allowed to run so long as there may be water in the supply pipes, such house pipes must be extremely small in order to avoid great waste, and for convenience cisterns of some sort would be necessary. It will, it is thought, be much better to require cisterns in all cases to be provided, and to supply them under self-regulating cocks. The cisterns can then be placed in such positions and at such an elevation as will make the house service thoroughly effective. It is presumed that house-supply will include water for drinking, washing, baths, and stables, on which one rate would be charged according to the class of house and the probable wants of the residents. If water for gardens or other than domestic purposes be available and supplied, a separate and additional rate would be fairly leviable, and at any rate in dry years supplies for gardens can be afforded only to a very limited extent.

3rdly.—The intended scheme of branch pipes for the supply of the detached houses and establishments has to be worked out. There must evidently be several such lines, and the cost will not be inconsiderable. If the Commissioners propose to supply the houses on the ridge commencing with Harrow on the hill and ending with Lockend, the cost will be very material, for a great length of iron piping and probably a service tank at the off-take will be necessary. If this line of houses and the higher parts of Metoocherry are not to be supplied, a considerable part of the proposed supply of the high level channel from above St. Stephen's Church will not be required, and a proportionately less quantity will need to be stored.

4thly.—Service tanks should be constructed in connection with such a system as the circumstances of Ootacamund necessitate, whenever required to meet variations of discharge; for otherwise a good deal of water must be run to waste to prevent injury to pipes from excessive pressure. Pipes may be intended to run half or three-fourths full, but if a constant supply be issued from the principal reservoirs and if a variable quantity be drawn off from the pipes as must be the case, the variations being sometimes moderate and sometimes excessive, such service tanks to act as moderators* will be essential to the prevention of waste.

23. CEMENT PIPES.—The undersigned has seen some of General Morgan's cement pipes, which it is proposed to use in part as water conduits for the distribution of the pure water. On their general merits no opinion can be given in the absence of tests, but on two points an opinion may be offered—

1stly.—The cement pipes should be capable of standing a very much higher pressure than that due to a head of six feet as named in paragraph 10 of the District Engineer's letter of the 1st June, or to a head of 10 feet which Major Morant has mentioned has subsequently been suggested. Individual pipes ought to be capable of standing a pressure of at least two-thirds of an atmosphere or 21⅓ feet, and the pipes when joined by the saddle pieces should be water-tight under a moderate head of say 5 or 6 feet, otherwise the results of using them will not be satisfactory.

2ndly.—The interior surface of the cement pipes should be perfectly smooth; this surface as seen in the pipes at the manufactory was far too rough. A facing of cement rubbed hard would seem to be necessary.

---

* Ordinary ball cocks.

* A pure water reservoir below the filters would be of material assistance.

The undersigned is of opinion that masonry or concrete, covered, channels are preferable to pipes whether of cement or earthen ware whenever the quantities of water to be carried are considerable, and the level of the water surface can be regulated so as not to rise above the sides. In those parts of the service in which off-takes whether to branch pipes or to individual houses will be numerous, iron pipes will be alone suitable. In these pipes a head will not only be unavoidable but advantageous, and at the junction of the masonry channels, cement or earthen ware pipes, and the iron piping there should be cisterns provided with means of discharging surplus so that the head of water may be strictly regulated.

24. SUMMARY.—By way of summary to the foregoing remarks it is noted—

1stly.—That the character and extent of the water-supply of Ootacamund should be determined with reference to the supply likely to be available.

2ndly.—That all available storage sites should be examined in order to settle where water can be most economically impounded, and to what total extent, taking the probable yield of the catchment basins into account.

3rdly.—That an estimate for adding about 6 feet to the depth of water in the Marlimund Reservoir should be prepared, and, if moderate, that this enlargement should be carried out as soon as possible.

4thly.—That the scheme of distribution of the water-supply, which is, as at present drawn up, both incomplete and imperfect, should be properly matured and its cost estimated.

5thly.—That the supply of pure water should, unless in excess of the demand for purposes for which pure water is necessary, be limited to those purposes. For these there is every reason to suppose it will suffice, but it will probably be altogether inadequate to supersede the present other source of supply for cleansing drains, watering gardens, &c.

6thly.—That all calculations of yield of water from different areas of catchment basin should be based upon the data which the Marlimund Reservoir will, it is supposed, afford rather than upon English precedents which are not reliable for application to Ootacamund, and which in the case of the Snowdon House Reservoir site would clearly lead to disappointment. That also measures be at once taken for seeing what data the registers of water at the Marlimund Reservoir will afford, and for supplementing these by a table of capacities of that reservoir, a careful register of water levels, water issued and water discharged as surplus, and the registration of rainfall at this reservoir and if possible at Snowdon House, for comparison with the registers at Ootacamund itself.

7thly.—Whenever good storage sites may be found capable of storing economically a greater quantity of water than the catchment basin would be likely to yield, probably the supply may be supplemented by catch-drains to conduct water from beyond the catchment basin proper to within its boundaries.

25. ACQUISITION OF LANDS OF GATHERING GROUNDS.—It is understood that proposals have been made for the acquisition of the catchment basins on which Ootacamund may hereafter have to depend for its water-supply, in order to secure the purity of the water. The subject is one which the undersigned is not called upon to consider further than to remark that—

1st.—If such a course be deemed imperative it is essential to concentrate storage and to make the most of each site; also to limit the pure water-supply to strictly domestic purposes.

2nd.—When valuable property occupies a part of the catchment basin, it will often be feasible and preferable to drain this so as to exclude the drainage from the reservoir, than to purchase and include the area in the basin.

26. MAJOR MORANT'S ASSISTANCE ACKNOWLEDGED.—The undersigned has to thank Major Morant for the ready assistance he has afforded. His local knowledge and acquaintance with the circumstances of the supply have enabled this report to be drawn up in a much shorter time than would otherwise have been practicable.

27. ENLARGEMENT OF DODABET RESERVOIR DESIRABLE.—It may be mentioned in conclusion that the enlargement of the Dodabet Reservoir, which is connected with the supply of the south side of Ootacamund, is certainly desirable. Its drainage basin is stated to be 184 acres, and its capacity only about 3 millions of gallons, so that it would fill with a drainage of only about $\frac{5}{8}$ths of an inch. Its utmost possible enlargement will probably leave it still too small to store the average yield of the rainfall.

480,000 cubic feet.

THENCARAICOTTAI,
22nd October 1877.

(Signed) JOHN MULLINS, Colonel, R.E.,
Chief Engineer for Irrigation.

To the Secretary to Government, Public Works Department.

No. 221 W.

MEMORANDUM.

FROM a communication just received from the District Engineer, Nilgiris, it appears that the cost of the Marlimund Reservoir, as given in the memorandum, No. 216 W, dated 22nd October 1877, does not include certain items which ought to have been added to the sum therein named, and that the cost or expenditure stands thus—

	RS.
Marlimund Dam	14,680
Escape weir, &c.	2,120
Masonry drop, &c.	1,120
Total ...	17,920

It is mentioned moreover that convicts were employed in raising the dam free of all charges except Police guards, and the supply pipes under the dam were obtained cost free from the Wellington Barracks. Possibly then the cost of this reservoir should be assumed to be Rupees 20,000 when comparing it with the estimates for storing water at other sites.

MARANDAPULLY,
28th October 1877.

(Signed) JOHN MULLINS, Colonel, R.E.,
Chief Engineer for Irrigation.

To the Secretary to Government, Public Works Department.

No. 79. ORDER THEREON, 8th January 1878, No. 105 W.

HIS GRACE the Governor in Council resolves to communicate the remarks of the Chief Engineer for Irrigation to the Municipal Commissioners of Ootacamund for their careful consideration.

2. The Governor in Council is of opinion that the raising of the bund of the Marlimund Reservoir would be of doubtful utility, seeing that the bund is by no means in a substantial condition. The project would moreover involve heavy compensation for land, and would entail the stoppage of the supply of water for a long period during the progress of the work.

3. The Snowdon Reservoir project presents a more hopeful aspect. It would be an addition to the existing sources of supply, and at a high level would command most if not all the houses below. The question of compensation should be investigated, and when the cost has been carefully estimated an application for a loan can be made in the usual way.

4. The extension of the Dodabet Reservoir should also receive special attention.

(True Extract.)

Colonel, R.E.,
Secretary to Government, P.W.D.

To the Financial Department, with plans and estimates, &c.
" District Engineer, Nilgiris.
" Chief Engineer for Irrigation.

Exd. T. D. Ryan.

Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of (1878) Madra

PUBLIC WORKS.

To

THE FINANCIAL DEPARTMENT,
&c., &c.,

Dated January 8th.

Issued

Recd.

Encl.

G. O., 8th January 1878, No. 105 W.

JANUARY.
Nos. 78-79.

Ootacamund water-supply

Memo of Papers sent to the Financial Department with G O No. 105 W dated 8th January 1878 —

5 Plans —

1 Extract from Proceedings of a Meeting of the Ootacamund Municipal Commrs. held on the 19 April 1877

1 Table of Annual Annual Rainfall

5 Estimates

1 Application for loan.

1 Special Meeting of Municipal Commrs. held on the 7 June/77

1 Notice —

1 Minutes of Special Meeting of the Ooty Municipality - 7 June/77

1 Estimates & Specifications for North Water supply Filters, Culverts & piping

C/10 8395

Memo for orders . (C No. 8747)

Office note. . .

To E.W.

Ootacamund water supply

I have read the papers and am writing to the D.E. to tell him on what points information is required so that he may have the subject ready for discussion when I go up which I hope to do within a fortnight

I think in the mean time there should be a disposal of this kind

Draft [illegible]

~~The papers~~ "As the Chief Engineer P.W.D cannot conveniently go to ~~visit~~ Ootacamund at present the papers will be referred to the Chief Engr. for I who after such further discussion with the District Engineer as may be necessary will report to Govt. on the proposed Snowdon Reservoir and on the northern section of the supply of Ootacamund generally

Wy. E. I.

9-77

Ootacamund.
25th September 1877.

My dear Colonel.

I am very glad indeed that Government have asked you to give an opinion on the proposed Snowdon Reservoir, and I am very much obliged to you, amidst all your other pressing work, for entering so fully into the subject. I need hardly say that I will with pleasure do all in my power to supplement the information according to your Memorandum. In the meanwhile, I trust you will allow me to offer a few remarks:-

No information can be gathered from the working of the Markamund Reservoir, I am sorry to say. No water-levels in this reservoir have ever been registered: the tank has never been contoured. I can obtain the drainage area of its basin, but its yeild of water I can only state from English experience (say Beardmores Tables). In the same way no record has been kept of the issue of the water from the tank. And even if such a record was available it would, I fear, be of little use, because the imperceptible and incalculable waste of the water which has percolated through the bottom and sides of the open channel in which it runs to the town has been very great, and because, on account of its muddy dirty state very few persons have taken the water.

I should have stated the gathering ground of the proposed Snowdon Reservoir. It was not altogether an oversight. I did not state it chiefly because, the Snowdon reservoir is intended to be not only an impounding but also a service reservoir, receiving accessions to its natural supply from the Marlia-mund and X and Y reservoirs.

I find its drainage, area or catchment basin is 70 acres in extent. It appears from the rainfall table which accompanied my report that in Ootacamund

the average annual rainfall is 41 Inches.
the wettest annual rainfall is 55 Inches (1871)
the driest annual rainfall is 26 Inches (1876)
n of [illegible]

According to English experience these figures should be

$40\frac{1}{2}$ Inches average
$53\frac{5}{6}$ " wettest
$27\frac{1}{6}$ " driest

thus showing that the figures are suf-ficiently close to justify comparing English experience with Ootacamund practice. According to Hawksley, Beardmore and others $\frac{1}{6}$th is deducted from the average annual rainfall; this gives $41 - 6\frac{5}{6} = 34\frac{1}{6}$ or say 34 Inches: and this figure is by them taken as the average of the three driest consecutive years.

Deducting from this latter figure 14 inches for evaporation and absorption (the allowance in English mountain districts) we obtain 34 −14 = 20 inches. The available annual rainfall is thus 20 inches. Beardmore (1862 edition) page 61 table 16 gives discharge for 20 inches in gallons per diem per acre of gathering ground at 1238 gallons, or 451,870 gallons per annum per acre of gathering ground. The Snowdon Reservoir has 70 acres of gathering ground; hence the available annual rainfall to fill it will amount to 31,630,900 gallons. Its capacity is equivalent to 24 millions of gallons, above pipe level. It will therefore be more than once filled annually during an average of three consecutive driest years. But while filling the supply will be also drawn off, so that a margin is not unadvisable nor will it result in waste. The site of the proposed Snowdon Dam might be taken lower down the stream. It would then impound more water. But the dam would be higher and with all its works much more costly.

The idea of increasing the supply of water by catch drains seems a most excellent one. It occurred to me, and I intended providing for it in Reservoirs X and Y. It might easily be applied to the Snowdon Reservoir. These catch drains would, I fear, bring down large quantities of silt, just as they always do in our road catch drains. Perhaps this evil might be prevented or in a great measure mitigated by catch pits or by arrangements so that very heavy storm floods should not wholly discharge into the reservoir.

I am having all the levels reduced to the one datum you mention, viz. 100 feet below the cill of the Lake Sluice. I will also have a section taken down the proposed reservoir valley from Snowdon house.

Could you kindly return me all the Plans so that I may add to them the new datum.

The construction of the Snowdon Reservoir with its F. T. L. 15 feet above sill of Marliamund tunnel is not, I admit, a convenient arrangement. I adopted it in order to make the proposed Reservoir as large as possible. If its F. T. L was limited to the level of the sill of the Snowdon tunnel its capacity would be, very considerably reduced

and it would then be a question whether it was worth constructing so small a Reservoir there at all.

I have written to the Commissioner about General Morgan's compensation. I believe there will be no difficulty on that point.

With regard to the flushing of Sewers in the Native town I think that could best be done, by turning the main supply of the Lake into them through a culvert starting from some point near Charing Cross: this was Major Tulloch's idea. Dr Gordon proposes in the report he is now writing to Government on this town that the main Native Bazaar be removed to Kandal: If that was done a dry earth system of conservancy would in my humble opinion be the best: but if water for flushing the Kandal drains was required I think a reservoir could best be formed in the valley just below "Sandrock;" the water though impure, would do for that purpose.

I would much like to discuss with you the subject of your para 11. In order to do so effectually would it not be well for Government to put in your hands my second report and plans and estimates regarding the piping of the channels and filtering the water of the North Supply? 12.

With regard to the maximum flood discharge and width of waste weir I now give

you the following calculations:
I made the wasteweir of the Snowdon Reservoir of the same width as that of the Dodabetta Reservoir, although its drainage area is not nearly as large. I hope the following calculations are correct and will satisfy you.

I find from the records of the Commissioners Office and of my own that the following are the heaviest falls of rain in 24 hours:

From Engineers Office Records		From Commissioners Office Records
in 1871 wettest year { 4·59 / 5·55 }	on two consecutive days	have not corresponding days of 1871
		5·30

I think we should be quite safe if we took a maximum fall of 6 inches in 6 hours. According to Beardmore's Table 15 page 60 this would give, off 70 acres, a discharge of 4235 cubic feet per minute. Now turning to his table 2 page 34 a waste

weir 15 feet wide running only
1½ feet deep will discharge
5897·10 cubic feet per minute.
Our waste weir is 5 feet high to
crest of dam. It might safely
I suppose run 2 feet deep. It
is hence amply sufficient, if these
calculations are right.

[illegible]

The site of the proposed
dam is a good one. The bed
of the reservoir not the site of the
dam abounds with springs.

which will better clear with the head of water

70

19

I do not think any drainage
of the site of the dam will be found
necessary; but it could easily
be done if you consider it advi-
-sable.

Can be determined only by examination of ground

I have written these re-
-marks in the hope that you
will kindly give me your opinion
on them. I am very glad
you are coming up here to
discuss the project on the spot.

Believe me

Yours Sincerely

John Morant

generally My. E

PUBLIC WORKS DEPARTMENT.

Memorandum by the Chief Engineer for Irrigation No. 216 W dated 22nd October 1877

FOR ORDERS.

Edmd Coll RE.

Fort St George
October 1877 } Secy to Govt. PWD

Fwd. Govt. abstract. Bd. Revr. & request special & primary attention to the suggested Extension of the Marli:mund Reservoir which seems the most hopeful project. The Extension of the Dodda-bet Reservoir shd. also receive

Special attention.
The rest of Col. Mullins
Remarks shd. be
commended to the
careful considn. of the
M.C. It is evident that
the applicn. for a loan
shd. be premature.
I think these papers
shd. be sent to H.G. the
Govr. while he is at
Ootacd. (J.H. 2.11.77).

I agree generally
with the views expressed
above. Steps to [illegible]
at once
6/11

I think the sole
[illegible] (inclusion [illegible]
so objectionable to [illegible]
House — as well as
[illegible] inevitably [illegible]

[illegible] drainage
from the premises
on the State side
that it shd be
negatived & taken
out of the remaining
& be sent on to the [illegible]
Comm —
I think the raising
of the [illegible]
project of doubtful
utility as the [illegible]
is by no means in a
good state —
I after looking at the
ground & plans came
to the conclusion that
the scheme was
not worth forming —
Having the [illegible]

involves [illegible] the
compensation — & would
render the reservoir empty
during the progress of work
will be long —
The scheme would be
an addition of supply
and at an high level
sufficient to command
the rest of all the
houses —
The compensation shd
be investigated — then
cost will be known &
necessary funds can be
applied for — I now
send it to Govt. with some
remarks
27/12
[illegible]
will be done

FOR ORDERS.

Hon. W. Huddleston
Hon. Sir W. Robinson
His Grace the Governor

will be con[illegible]
[illegible] noted

R-C 5-1-78.

No. 221-W.

23

Memorandum

From a communication just received from the District Engineer Neilgherries, it appears that the cost of the Marlimund Reservoir, as given in the Memorandum No. 216 W dated 22d October 1877, does not include certain items which ought to have been added to the sum therein named, and that the cost or expenditure stands thus,

Marlimund Dam	Rupees	14,680
Escape weir &c	"	2120
Masonry drop &c	"	1120
	Total Rupees	17,920

It is mentioned moreover that convicts were employed in raising the Dam free of all charges except Police guards, and the supply pipes under the dam were obtained cost free from the Wellington Barracks.

Possibly then the cost of this reservoir should be assumed to be Rupees 20,000 when comparing it with the estimates for storing water at other sites—

Camp at
Marandapully
28th October 1877

Colonel R.E.
Chief Engineer for Irrigation

To The Secretary to Government, P.W.D.

~~Circulated in continuation of the Memorandum by the Chief Engineer for Irrigation No 216 W dated 22 October, circulated on the 31 Octr.~~

1/11

I have passed on the papers.

6/11

Cir 2.11.77

1877

From
The Chief Engineer for Irrign.

Dated 28 } Oct. 1877
Despd. 31 }
Recd. 31

No. 221 W

Marlimund Reservoir.— Nilgiri District.— Memo. mentioning the cost of the — including certain items omitted in the cost as given in this office Memo. No 216 W of 22 inst.

Circulated

Nº 216 W

2

Memorandum

Ootacamund water supply

Encls. 19

The proposals which have been brought forward by the District Engineer Nilgiris, and approved by the Municipality, embrace the provision of additional storage for the supply of the Northern side of the station, and arrangements for purifying the water, with its distribution under arrangements likely to preserve its purity.

Marlimund Reservoir.

2 . There is at present only one Reservoir, if the small tank near Snowdon House be excepted, for the storage of water for this part of the station. This is called the Marlimund reservoir, and was constructed about 7 years ago. Generally it has

Information given by Municipal Overseer.

has filled well and has surplused; but in 1875 the depth of water on the sill of the sluice did not exceed 15 feet, and in 1876 9 feet, the depth when the reservoir is full being 19¼ feet. The District Engineer estimates the contents at, in round numbers, 50 millions of gallons; but from information furnished by him 2 or 3 years ago it appears that

the total contents are 7,761,000 cubic feet
" contents below the outlet 324,000 ...... do: .....
water available for use 7,437,000 ...... do: ....
or 46,480,000 gallons.

The catchment basin of this reservoir is 260 acres or 0.406 of a square mile.

The site is certainly much the best high level site near Ootacamund.

Water yield requirements.

260 acres = 11,32,5600 sq. feet

$\frac{7,437,000}{11,325,600}$ = .6567 feet
= 7.88 inches

3 To fill the Marlimund reservoir it is necessary that a depth of 7.88 inches should flow from the whole area of the catchment basin. The District

Engineers

Engineer has given a table of the monthly and annual rain-fall at Ootacamund, for the years 1869 to 1876 inclusive, from which it appears that its amount was in,

~~year. Rainfall. Rainy days Average fall rainy days. October Rainy days Average of rainy days~~

~~1869. 38.65 117 0.33~~

year	Rain fall	Rainy days	Average fall of rainy days	October Rain fall	Rainy days	Average fall of rainy days.	November rainfall	Rainy days	Average fall of rainy days	
1869	38.65	117	0.33	3.97	12	0.33	3.28	13	0.25	
1870	41.92	122	0.34	10.10	15	0.67	1.69	10	0.17	
1871	54.92	94	0.58	10.45	*	—	13.92	10	1.39	*not stated
1872	45.42	119	0.38	3.99	11	0.36	6.93	18	0.38	
1873	45.41	138	0.33	7.32	23	0.32	2.35	10	0.23	
1874	47.48	141	0.34	10.24	20	0.57	2.10	10	0.21	
1875	38.45	107	0.36	8.33	19	0.44	2.30	7	0.33	
1876	25.16	76	0.33	1.66	8	0.21	0.26	2	0.13	
	337.41	914	2.99	56.06	108	2.84	32.83	80	3.09	
Average	42.18	114	0.37	7.01	15	0.41	4.10	10	0.38	

The position and aspect of the catchment basin of this reservoir make the N. E. Monsoon rains those from which the greatest yield is obtainable, and a register of rain fall at Ootacamund, which is on the other side of the water shed, is not a very reliable criterion of the rainfall at the reservoir catchment basin, but it is the best available.–

It is understood that the Municipality have a register of the water levels in the reservoir; but at present there is no series of croſs sections of the tank, and consequently the actual yield of the 260 acres, and the loſs by evaporation and absorption, cannot be properly deduced; and indeed to enable these latter to be approximated to, it would be useful to know what water has been iſsued to the channel supplying the town, and of this there would seem to be no record. The District Engineer has been asked to have the requisite sections taken and a table of capacities prepared.–

Water tower valves.–

4 The water tower valves are not as convenient as is desirable

though

though apparently with slight modification a fairly accurate regulation could be effected. At present the valves which are hinged at the upper edge can be regulated to somewhat more than inches of lift, and were another disc placed at the other end of the drum of the windlaſs, and the holes made to alternate with those now used, the difference of lift could be halved. However it will be advisable to substitute slide valves or plugs regulated by screws, and then exactly the desired discharge can readily be obtained.

Surplus channel.

5 The arrangements for discharge of surplus are inadequate. The capacity of the reservoir is, compared with the catchment basin, considerable; but neverthelеſs the tank may be full or nearly full when

a

a heavy fall of rain occurs, and in 1871 it was in some danger. There is no escape weir at the tank, but a masonry lined channel, 8 feet wide, starting at F.T.L and with no bed fall, conducts the water for a considerable distance× to a series of steps or drops, the width at the first drop being 6 feet. Thence the water is conducted by an earthen channel, altogether too small, along the hill side to a safe distance from the bund. The escape should, it is considered, be 20 feet wide with a clear over fall, and 24 feet with a channel like the present, to ensure the water level being limited to 3 feet above F.T.L as a maximum.

× 292 feet

Rainfall required to fill reservoir

6 It would seem that a rainfall of 12 inches in October and November are about sufficient to ensure an adequate supply to this reservoir. In 1875, a very dry year in July to September, it was about $\frac{2}{3}$rds filled, and the rainfall in the two N.E. Monsoon months was 10.63 inches. The average of the 8 years gives 11.11 inches.

Enlargement of Marlimund reservoir.

7 At a comparatively small expense the available capacity of this reservoir could be increased one half by raising the bund and F.T.L 6 feet. The area of the present waterspread is 597,000 square feet and 6 feet over this would contain 3,582,000 cubic feet; so probably the total additional storage would be just about half the present capacity.

The present top width of the bund is 25 feet and might be diminished to 18 feet at the raised top level. The top of the bund is 7½ feet above F.T.L, and the top of the raised bund should be 3 + 5 feet above the raised F.T.L. The interior and exterior slopes above F.T.L may be increased to 1 to 1, and if necessary the interior slope below this point may be carried down at 1½ to 1 until the required base is obtained.

Snowdon reservoir

8. The site of the proposed Snowdon or Snowdon House reservoir is just below Snowdon House on the Ootacamund side of the saddle on which that house stands. The site as regards the formation of the bund is favourable, but otherwise there is not any thing in its favour.

(1) The catchment basin is only 60 acres, so the surface yield would probably not much exceed 6/26ths of that of the Marlimund reservoir, and if this be taken as 10 millions of cubic feet on the average, and one third of that quantity in such a year as 1876, the water available would be

in an average year	2,307,700 Cub: Ft.
in a year like 1876	769,230 "
the intended capacity as designed is	3,859,860 "

It is therefore not probable that in ordinary year this reservoir would fill. Major Morant states that the ground above the bund site is full of springs, but it does not follow that all this spring water would go to augment the water stored in the reservoir.

Area of water-spread 220,319 sq. feet. Mean depth 17½ feet.

(2) the capacity is small compared with the height of the bund, 56 feet, as a maximum, and the depth of water, 40 feet, at the sluice. This arises from the high level of a large part of the ground within the waterspread.

(3) the cost of storage would be high viz Rupees ——— 5,943 per million cubic feet, even supposing the tank to fill. The actual cost might be ——— 8000 Rupees the million cubic feet.

The Marlimund reservoir cost Rupees ——— 14,700 so the storage there was at the rate of a little under Rupees ——— 2,000 a million cubic feet. Its capacity could be increased one half at a cost of about 2,000 Rupees the million cubic feet.

(4) Although it is of considerable advantage to lay 60 additional acres

under contribution this benefit would be frequently more than neutralized by the full tank level being 15 feet above the sill of the South face of the tunnel through which the Marlimund channel runs.-

The difference of aspect would be an advantage as more water would be received from the South West monsoon, the rainfall in which is not much lefs than 3 times that of the North East monsoon, but spread over 5 months instead of 2.- 31.08 to 11.10

There are no really good sites at i high level available. There is a * ite to the West of the Marlimund eservoir, which was inspected, and hich might pofsibly be of use to supply Kandal and houses in that direction. The catchment basin is bout 122 acres. The level of the bund site will be ascertained.-

Other site
for reserv
* marked

Above and to the Eastward of Snowdon House there are the **X** and **Y** sites mentioned in Major Morant's report; they

are

are on extremely steep ground, and their catchment basins are 36 and 25 acres respectively. The former is on the South or Ooty side of the hills and the latter on the North or Snowdon side. The capacity of these tanks even with high bunds would be very small, but a considerable portion of the yield of their catchments could be conveyed to the Snowdon House site, and in this way a reservoir constructed at this site might perhaps be adequately supplied. Another site marked **Z** is situated in the next valley to the South East of that of the **X** site, and has a drainage basin of 54 acres. The water could be conveyed to the Snowdon House site.-

There is a site below Cinchona villa and just where a line from the stables at Lower Norwood, at right angles to the axis of the valley, would cut the stream, at which a reservoir of some considerable capacity could be formed. The area of the catchment basin is about 307 acres, and all the water of the basin of the Snowdon House site, of the X and Z sites, and of other ground would be received by it. Its adoption would entail separate filtering arrangments and distribution, but it is comparatively near the town, and the level of the stream at the bund site being [*] 292.81 as compared with Ooty lake surface [⊗] 209.81, the command would probably be sufficient.-

* Datum feet below sill of Lake sluice.

⊗ the F.T.L of Ooty Lake is nearly 10 feet above sill of sluice in We bund.

Water supply required

10 The District Engineer in para 15 notes that the Marlimund reservoir was designed to supply 6000 people at 30 gallons a head a day, or 180,000 gallons a day altogether. He considers it to be desirable to provide for a population of 10,000, but that with masonry conduits or pipes 20 gallons a head a day should suffice: the daily provision would then be 200,000 gallons. It is mentioned that [⊙] in London only $\frac{2}{5}$th of the whole delivery enters into consumption, and that in Glasgow 18 gallons out of 32 are wasted or the wastage is rather less than in London. Major Morant thinks that the waste at Ootacamund need not be so great. Were the delivery pipes to be similar to those of the London Companies, this conclusion might be accepted because their pipes work under considerably greater pressure than is intended in this case. Altogether however it would be unwise to suppose that the Ootacamund distribution arrangements will be more efficient than those existing in England after many years experience. The issues from the reservoirs should therefore be assumed to be at least half a million of gallons a day. In ordinary seasons it is considered by the District Engineer that the reservoirs would be to store enough water for 5 months

⊙ Letter No 146 18th April 1877

consumption, but that to ensure the station against a failure of water in bad years there should be provided a storage equal to 10 months' consumption. In the former case consequently the water to be available for issue from the reservoirs would be 75, and in the latter case 150 millions of gallons.

Local Data wanting

11 It is particularly unfortunate that reliable data, such as the Marlimund reservoir might have furnished, are wanting as to;

(1) the yield of a given area of ground:

(2) the proportion between water stored in a reservoir and that available for issue after loss by absorption and evaporation.

Information on these points for the Marlimund reservoir would have been very greatly more valuable than deductions from English experience. The loss by evaporation is dependent upon surface area; that by absorption is influenced by the nature of the bed and the depth of water. It would, it is thought, be a very favourable site at which the losses from these two causes would be less than one third of the quantity stored. The conclusions arrived at in para 18 of the District Engineer's letter appear therefore to need somewhat radical modification;

Taking as Major Morant has done first an ordinary year;

	Gallons.
200,000 gallons a day for 152 days	30,400,000
wastage based on London data	45,600,000
Quantity to be issued from Reservoirs	76,000,000
Evaporation and absorption	25,335,000
Storage required	101,335,000

against 45,600,000 according to Major Morant's calculation.

Secondly in the case of a very bad year like 1876;

200,000 gallons a day for 304 days	60,800,000
wastage on London data	91,200,000
	152,000,000

Evaporation and absorption.... 152,000,000
50,670,000
202,670,000

against 91,200,000 as estimated by the District Engineer.-

12 Major Morant has been asked to obtain from the Office of the Municipal Commission such registers of, and information about, the Marlimund reservoir as may be available, and to have a sufficient number of sections taken to enable a table of capacities at different levels to be drawn up. It may then be practicable to approximate more or less closely to the yield of its catchment basin in 1875 and 1876, and thus to get some data for determining what area must be laid under contribution to yield the quantity of water needed. At present there is no information available, while a deduction from the fact that the

water

What
imperf
data an
=able in

water did not rise in the reservoir higher than 9 feet above the sluice sill in 1875 would indicate that it is very improbable that a sufficient area for a 10 months' supply can be found at the required level. Below the sill level the mean depth is said to be 4 feet and the contents ——— 324,000 C.Ft.

The mean depth of the tank when full is 13 feet, contents 7,761,000 "

It is probable therefore that with a depth of 9 feet out of 19¼ on the sill, the contents above sill level did not exceed one third of the quantity when the tank is full or say 2,600,000 C.ft.
and if it be assumed that
the quantity drawn off in
addition was ——— 2,600,000 "
the total receipts would be 5,200,000 "
or gallons 32,500,000
from an area of 260 acres.-

13 The areas of the basins of the other sites which have been suggested are

Catchmen basins of sites an their pro yield

W	122 acres	
X	36 "	
y	25 "	
Z	54 "	
Snowdon House site	60 "	
Below Cinchona villa		307
Deduct X and Z	90	217
		514 say 510

vide pl

If the yield be supposed to be the same in proportion it would amount to ——— 63.75 millions of gallons, and this quantity added to that of Martimund would be ——— 96.25 "

Moreover to obtain 202.670 millions for a 10 months supply the acreage of gathering ground required would be 1621 acres or 2.53 square miles and this is certainly no very great area in itself for the supply of a large station, though it appears to be altogether impracticable to find it, together with sites at a suitable level at which water could be stored.—

Major Morants modified proposals.

14 Major Morants proposals, even as somewhat modified during the recent discussions, amount to the formation of a reservoir at the Snowdon House site, and to supplementing the supply from its own basin by conducting water to it from the X.Y.Z basins; but making every allowance for more favourable aspect in the case of all but Y, which much resembles that of Martimund, the total area of drainage would be only 175 acres, and the yield would not exceed, and would probably fall short of that of the Martimund basin

These calculations are based on no

reliable or indeed ascertained data, for such data have yet to be made available; but they will suffice to indicate that there is but little chance of making provision for the supply of water to the whole station on the scale which has been proposed. When actual data, however imperfect, are given, it will be easy to show what is likely to be feasible. The Ootacamund water supply scheme should be based on what is demonstrably probable.

The way
which th
yield of
Snowdon
site was
=mated.

15 Major Morant's calculations, from which he concluded that the proposed Snowdon House reservoir would fill more than once from the drainage of its own basin in the event of 3 consecutive dry years, were based, as explained by him in a demi official note dated the 25th September, on English experience. From the average annual rainfall one sixth is deducted, and the remainder is taken as the average of the three driest consecutive years. 14 inches were then deducted from this quantity for evaporation and absorption (the allowance in English mountain Districts) and 20 inches were found to be the depth actually draining off, the yield being 31,630,900 gallons against 24 millions, the capacity of the Snowdon House reservoir. The area of the basin has since been found to be 60 instead of 70 acres, and the quantity corresponding to 20 inches draining off would therefore be 27,225,000 gallons or one eighth in excess of the capacity of the reservoir. The depth of drainage required to fill the latter would be therefore a little under 18 inches. Now it has already been shown that 7.88 inches draining off

the Marlimund basin would suffice to fill that reservoir, and allowing for all poſsible difference of aspect in the case of sites a few hundred yards apart, it is certain that Marlimund reservoir would have filled to overflowing 2 or 3 times in 1875, and have more than filled in 1876, had these deductions from English experience been applicable to the circumstances. As a fact it did not nearly fill in 1875 and did not half fill in 1876; so whatever data are to be relied on should be obtained on the spot. To this end it is desirable that rainfall should be registered at the Marlimund reservoir which can easily be managed, and at Snowdon house, which probably can be arranged for. A knowledge, for even a short time, of the falls at these places corresponding to the

falls

falls registered at Ootacamund wil be of value in determining the effect of difference of aspect and elevation

Registers of surplus from existing reservoirs should be kept.-

16 It may further be noticed tha registers should be kept to show what the quantity of surplus discharged from the Marlimund and Dodabet reservoirs may be, and it will be neceſsary to know not only the depth at the tank end of the surplus channel, which will be found from the known reading of the sole of the channel on the water tower gauge, agreeing as this does with F.T.L, but the depth also at the lower end of the horizontal part of this channel. Similarly the depths of water, or the water levels in the channels leading from these reservoirs, should be recorded at such points as will allow of the discharge being

calculated. Such data are essential to the solution of the questions relating to water supply, and their continuous record for the past 6 or 7 years would have afforded all that would have been necessary for dealing effectively with the questions now awaiting settlement.–

17 The Marlimund reservoir has, it would seem, received more water than it could store in 5 years out of 7.– An addition of 6 feet to its depth will enable it to retain about as much water as the proposed Snowdon House reservoir would hold, and it is therefore recommended that this enlargement should be estimated for at once; and, if as expected the cost will be moderate, carried out at once. Its contents will then be about ——— 11,155,500 Cubic feet
~~cubic feet or~~ ——————— 69,722,000 gallons
~~gallons~~

Enlargem
of Marlim
reservoir
should b
estimated

X.Y. and Z sites should be further investigated.

18 In the next place the X.Y. and Z sites should have sufficient sections taken to determine how far they can be utilized as reservoir sites, and what their capacities at the levels which appear to be most suitable would be. There will, it is thought, be no objection to the construction of reservoirs at these sites if it be found that storage can be effected at a reasonable cost.– The X and Z sites are within the catchment basin of the site below Cinchona villa; but the quantity of water which they will store will not, it is thought, materially affect the supply of the lower reservoir should it be deemed desirable to construct it.–

Position of filters can depend upon adequacy of funds to enclose channels above St. Stephen's Church.–

19. All the water from the Marlimund reservoir and from the X.Y. an Z. sites can be brought to filters

situated at any point below the Snowdon House site, and it must, it is thought, depend a good deal upon what the Commiſsioners can afford, at what point the filters should be placed. If money for enclosing all supply channels will be available the filters can conveniently be placed a short distance below Snowdon House. Otherwise the nearer they can be placed to St. Stephen's Church the shorter will be the length of piping neceſsary to maintain the purity of the water after filtration. It is desirable, if financially practicable, to enclose the water channels; but it can hardly be deemed eſsential. To take the channel from Marlimund reservoir to Snowdon House tunnel for instance. There are one or two short lengths which should in any case be enclosed because more or leſs liable to pollution from their proximity to dwellings and gardens, but the rest of this channel runs through clean ground, and the catchdrain above it would, if properly looked after and the troughs which paſs this drain water acroſs the channel kept clear, prevent much fouling. Some croſs fences and frequent inspection would do the rest. The channel is certainly not in proper order as the depths of water and velocities were found to vary greatly, which would not be the case with a channel the fall of which was equally distributed, and the water-way uniform or varied according to the nature of the channel lining. Similarly the channel from Snowdon house to near the church could by means of catch drains and troughs be preserved from material fouling. The cost of enclosing the channels is estimated at 21,000 Rupees the interest on which at 6 per cent is

Above tunnel } 14,646
Below do - 6374
21,020

Rupees 1260. Probably 360 Rupees a year in inspection and work would keep open channels in good order. Closed channels would economize water and would be altogether more satisfactory. It is simply a matter of expense.

Present con=
=struction of
Snowdon Hou
reservoir n
recommende

20 The present construction of the Snowdon House reservoir is not recommended because the cost of storage would be great; the drainage basin is small, and it would often neceſsitate the paſsing to waste of water from the Marlimund reservoir for no water therefrom could be supplied to the station while that in the Snowdon House reservoir was above 15 feet below the F.T.L. This might, as suggested by Major Morant, be remedied by closing permanently any connection between this reservoir and the tunnel and continuing a closed channel from the latter through the

upper

upper part of the bed of the latter. Then water could be conveyed to the filters from Marlimund at all times, and the reservoirs could be worked independently as might seem expedient. This arrangement does not however get rid of the cost of storage which is very high. It may ultimately be neceſsary to utilize this site, and nothing should be done to prejudice such future use, but until it has been demonstrated that it is not prac=ticable to store water elsewhere more cheaply this part of the scheme may properly be held in abeyance.

Site for reser=
=voir below Cin
chona villa
promises con=
=siderable ca=
=pacity

Omit
not to print

21 From a few sections which Major Morant had taken of the site below Cinchona villa it ap=pears probable that this site would allow of water being stored econo=mically and that a F.T.L. of 350 would

give a fair capacity with a moderate height of bund. This water surface would be 150 feet above the sill* of the Ooty lake sluice, or about 140⊕ feet above the surface of the lake, and the Reservoir sluice sill would be at about 295 or 85 feet above the lake surface, so the command of the bazaar would probably be sufficient.- As a reservoir for drinking water this site might not be suitable, as it would probably not be worth while to establish separate filters for cleansing it, but for washing and similar purposes it would do very well, and it is a site which, whether from the comparatively large catchment basin or from its probable capacity which has been roughly estimated at 14 millions of cubic feet or 87½ millions of gallons, it will be worth while to examine more completely, as in the dearth of good sites for storage it is likely to be wanted sooner or later.

* 200

⊕ the
between
10 feet
lake su

Good.

not good

General conclusion and details to be investigated and planned.-

22 The general conclusion arrived at by the undersigned is that storage is not likely to be available for the supply of Ootacamund with a delivered quantity of water of 20 Gallons a head for 10,000 persons for 10 months, and it is thought that before any complete scheme of storage and distribution is brought forward for sanction it is desirable that it should be considered more particularly what the Municipality propose to undertake to do, and for what purposes pure water is to be supplied. The District Engineer's letter of the 1st June 1877 brings forward proposals for a certain rough division of the water supply above St. Stephen's church into two parts, the one× to be carried by a high level channel to above Sylks' Hotel and ultimately on to Kandal, and the ⊕other and

× 100,000 gallons.

⊕ 150,000 —do:-

and larger supply past the Post office. With these proposals estimates amounting to, in the form accepted by the Commiſsioners, Rupees 98,954 were submitted for enclosing the water channels and filtering the water; but these estimates evidently include only a part of the expense neceſsary to provide for the convenient and economical use of the water supply. The estimates relate in fact only to a part of what may be called the principal distribution, and were so much of the work done and nothing more it would happen that by far the greater part of the supply provided at a very considerable outlay would run into the Lake unused. To do much good the works contemplated will require to be supplemented at once by other works, and the following remarks will serve to indicate what are the details which have still to be

planned

planned and estimated for.–

1st For the supply of pure water to the bazaar: there should be service tanks or reservoirs capable of containing about 3 hours supply of water, and from these pipes should run to street fountains furnished with taps from which alone water should be obtainable by the population. The number and capacity of the tanks should be fixed with reference to the population to be supplied by each, and to facilities of construction. The pipes supplying these service tanks should be capable of being closed, and it would seem to be proper to arrange for filling them every 3 hours, and in the intervals to furnish the supply to individual houses.–

2nd For detached house supplies it will be needful that cisterns should be provided to be supplied by taps× which

× ordinary ball cocks.

which will close on the cistern becoming full. It will not it is thought be feasible to do without cisterns. If the pipes for the supply of individual houses are to be allowed to run so long as there may be water in the supply pipes such house pipes must be extremely small in order to avoid great waste, and for convenience cisterns of some sort would be necessary. It will, it is thought, be much better to require cisterns in all cases to be provided, and to supply them under self regulating cocks. The cisterns can then be placed in such positions and at such an elevation as will make the house service thoroughly effective. It is presumed that house supply will include water for drinking, cooking, baths, and stables, on which one rate would be charged according to the class of house and the probable wants of the residents.

If

If water for gardens or other than domestic purposes be available and supplied, a separate and additional rate would be fairly leviable, and at any rate in dry years supplies for gardens can be afforded only to a very limited extent.-

3rd the intended scheme of branch pipes for the supply of the detached houses and establishments has to be worked out. There must evidently be several such lines and the cost will not be inconsiderable. If the Commissioners propose to supply the houses on the ridge commencing with Harrow on the Hill and ending with Lockend, the cost will be very material, for a great length of iron piping and probably a service tank at the off-take will be necessary. If this line of houses and the higher parts of Metoocherry are not to be supplied, a considerable part of the proposed supply of the high level channel from above St. Stephen's church will not be required, and a proportionately leſs quantity will need to be stored.

4th. Service tanks should be constructed in connection with such a system as the circumstances of Ootacamund neceſsitate, whenever required to meet variations of discharge, for otherwise a good deal of water must be run to waste to prevent injury to pipes from exceſsive preſsure. Pipes may be intended to run half or three fourths full, but if a constant supply be iſsued from the principal reservoirs and if a variable quantity be drawn off from the pipes as must be the case, the variations being sometimes moderate and sometimes exceſsive, such service tanks to act as moderators* will be eſsential to the prevention of waste.

× a pure
reservoir b
the filters
be of mater
aſsistan

Cement pipes.

23 The undersigned has seen some of General Morgan's cement pipes, which it is proposed to use in part as water conduits for the distribution of the pure water. On their general merits no opinion can be given in the absence of test but on two points an opinion may be offered;-

1st the cement pipes should be capable of standing a very much higher preſsure than that due to a head of 6 fee as named in para 10 of the District Engineer's letter of the 1st June, or to a head of 10 feet which Major Morant has mentioned has subsequently been suggested. Individual pipes ought to be capable of standing a preſsure of at least two-thirds of an atmosphere or 21⅓ feet, and the pipes when joined by the saddle pieces should be water-tight under a moderate head of say 5 or 6 feet, otherwise the results of using them will not be satisfactory.

2d the interior surface of the cement pipes should be perfectly smooth; this surface as seen in the pipes at the manufactory was far too rough. A facing of cement rubbed hard would seem to be necessary.-

The undersigned is of opinion that masonry or concrete, covered, channels are preferable to pipes whether of cement or earthen ware whenever the quantities of water to be carried are considerable, and the level of the water surface can be regulated so as not to rise above the sides. In those parts of the service in which off-takes whether to branch pipes or to individual houses will be numerous, iron pipes will be alone suitable. In these pipes a head will not only be unavoidable but advantageous, and at the junction of the masonry channels, cement or earthen ware pipes, and the iron piping there should be cisterns provided with

means

means of discharging surplus so that the head of water may be strictly regulated.-

nmary 24 By way of summary to the foregoing remarks it is noted;

1st That the character and extent of the water supply of Ootacamund should be determined with reference to the supply likely to be available.-

2d That all available storage sites should be examined in order to settle where water can be most economically impounded, and to what total extent, taking the probable yield of the catchment basins into account.-

3d That an estimate for adding about 6 feet to the depth of water in the Marlimund Reservoir should be prepared, and if moderate, that this enlargement should be carried out as soon as possible.

4th that the scheme of distribution of the water supply, which is, as at present drawn up, both incomplete and imperfect, should be properly matured and its cost estimated.

5th that the supply of pure water should, unleſs in exceſs of the demand for purposes for which pure water is neceſsary, be limited to those purposes. For these there is every reason to suppose it will suffice, but it will probably be altogether inadequate to supersede the present other sources of supply for cleansing drains, watering gardens &c.

6th that all calculations of yield of water from different areas of catchment basin should be based upon the data which the Marlimund reservoir will, it is supposed, afford rather than upon English precedents which are not reliable for application to Ootacamund, and which in the case of the Snowdon House Reservoir site would clearly lead to disappointment. That also measures be at once taken for seeing what data the registers of water at the Marlimund reservoir will afford, and for supplementing these by a

table

table of capacities of that reservoir, a careful register of water levels, water iſsued and water discharged as surplus, and the registration of rainfall at this reservoir and if poſsible at Snowdon House, for comparison with the registers at Ootacamund itself.

7th Whenever good storage sites may be found capable of storing economically a greater quantity of water than the catchment basin would be likely to yield, probably the supply may be supplemented by catch-drains to conduct water from beyond the catchment basin proper to within its boundaries.

Acquisition lands of thering grounds.

25. It is understood that proposals have been made for the acquisition of the catchment basins on which Ootacamund may hereafter have to depend for its water supply, in order to secure the purity of the water. The subject is one which the undersigned is not called upon

to consider further than to remark that;

1st if such a course be deemed imperative it is essential to concentrate storage and to make the most of each site; also to limit the pure water supply to strictly domestic purposes.-

2nd When valuable property occupies a part of the catchment basin, it will often be feasible and preferable to drain this so as to exclude the drainage from the reservoir, than to purchase and include the area in the basin.-

Major Morant's assistance acknowledge

26. The undersigned has to thank Major Morant for the ready assistance he has afforded. His local knowledge and acquaintance with the circumstances of the supply have enabled this report to be drawn up in a much shorter time than would otherwise have been practicable.

Enlargemen of Dodabet Reservoir desirable.

27 It may be mentioned in conclusion that the enlargement of the Dodabet Reservoir, which is connected

46 P 27

with the supply of the South side of Ootacamund is certainly desirable. Its drainage basin is stated to be 184 acres, and its capacity only about 3 millions of gallons; so that it would fill with a drainage of only about $\frac{5}{7}$ of an inch. Its utmost possible enlargement will probably leave it still too small to store the average yield of the rain-fall.-

480,000 Cub ft.

Camp at
Thencaraicottai
22nd October 1877

Colonel R.E.
Chief Engineer for Irrigation

To
The Secretary to Government
P.W.D.

1877.

From
The Chief Engineer for

Dated 22 } Oct 1877
Despd. 26 }

Encl
{ 13
5 plan
1

No. 216 W

5 Plans & Estim
sent to Fin l Dep
with GO - 105 No. 21
Ootacamund Water
- Nilgiris District. - Mem
reporting on the proposals m
-nection with the Snowdon
for the better supply of the ho
part of Ootacamund.

R - C 5-1-78.
Cer 31-10 - R 5-1-78

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47 P 5 P. W. D.

No 1709.

Letter from the President Ootacamund Municipality No. 45 dated 19th April 1877 referred to the Chief Engineer for his remarks with endorsement in the Financial Department No. 921 dated 26th April 1877.

The Chief Engineer hoped ere this to have inspected personally the site of the proposed reservoir on arrival at Ootacamund with the Government. Until he is able to do so, and submitted his report he recommends that no action be taken in the matter.

ort St. George }
21 June 1877 }

E A Ward Colonel R.E.
Chief Engr. P. W. D.

To
The Chief Secretary
with papers returned.

5
G.O. Attd

No 1703

Retransmitted to the Chief Engineer with original notes of members

By order

Sep 8th 1877

W. [illegible]
S. Under Secy

Fin C (??) Dept
(Municipal Water supply)
from
The Chief Engineer
P.W.D.
No 1709 ~~P 3783~~
Dated 21st June 1877
Recd 22nd June 1877
13 Enclosures

Recommends that no action be taken in the matter of the improvement of the Water supply of Ootacamund for the present.

Cho 2-12 4336/77

Retd to Fin C Deptt with G.O. 155 W D/ 8 Jany/78

R-C 5-1-78.
Re We 21-20 R 5-1-78
Cir 13-9-77.

Ootacamund,
Municipal Commissioners Office
24th August 1877.

No 80

From

A. McC. Webster Esq.
Acting President, Municipal Commission, Ootacamund

To

The Chief Secretary to Government,
Fort Saint George.

R. Ind 256 G.O. int Chief Engineers Memo No - in Circ. 17/8/77

Sir,

In continuation of my letter of 19th April 1877, No 45, I have the honor to forward an Estimate for the Completion of the Water Supply project for the northern portion of Ootacamund, together with a copy of the District Engineers' letter, and of the proceedings of the Municipal Commissioners thereon. I have also the honor to forward for the sanction of Government an Application for a loan of Rupees 1,23,692 for the Completion of this portion of the work.

2. The Amount of the loan applied for in my letter to Government of 25th January 1877 No 11 as well as the works Estimates for which were submitted with my letter of 19th April is included in the present Estimate of the Commissioners and application for a loan. In the former Application for a loan of Rs 20,000, the Commissioners proposed to repay it in 20 years, but looking to the Amount now required they propose to repay it in 30 years.

3. Government will observe that the Commissioners have decided to be content for the present with the improvement and enlargement of the Snowdon reservoir, leaving the construction of the additional reservoirs at X & Y on Plan No 1 accompanying my letter of 19th April 1877, on the map for future execution, should the present supply become insufficient owing to increase of population or other causes.

4. I have the honor to request that Government will be pleased to sanction the Estimate and the loan, and will allow the work to be carried out by the District Engineer. The Commissioners venture to hope that Government will take into consideration the exceptional circumstances of the Station, and will allow the work to be carried out by the District Engineer free of cost to the Municipality. This will reduce the cost of the work to about 1 lac of Rupees, and the Commissioners will be enabled to spend the remaining portion of the loan in improving the Southern water-supply channel and in continuing the Northern supply to Kandal and Woodcock Hill.

I have the honor to be
Sir
Your most obed. Servant,

Wm. [illegible]

Acting President
Municipal Commissioners
[illegible]

921
2569 Ref
26/4

No. 80. Finl (1877) Dep

From

The President
Municipal Comm
Ootacamund

To

The Chief Se
to Governmen
Fort Saint Ge

Dated 24th Augt 18
Recd 27th do

1508

Encl. 6.7

Water Project.

Retd to
Finl Dep
with So
10.5
8 Jan

Submitting for sanction of Government an Estimate for the completion of the Northern Water Supply project together with application for a loan of Rs 1,23,692.

~~No. 1655~~
Referred to the Chief Engineer for remarks

29/5/77

8395

R. C 5-1-79.
Cir 31-10 R 5-~~1-79~~

Ootacamund
Municipal Commissioners' Office
19th April 1877

No. 45

From

A. McC. Webster Esq
Acting President
Ootacamund Municipal Commn.

To

The Chief Secretary
to Government
Fort Saint George

Sir,

With reference to the Proceedings of Government dated 6th February 1877 No. 131 I have the honor to forward a plan and Estimate for the improvement of the Northern Water Supply of Ootacamund together with a letter from the District Engineer explaining the project, and an extract from the Proceedings of the Commissioners of this date. The Estimate provides for the enlargement of the Snowdon Reservoir. The subsidiary reservoir proposed by the District Engineer, and the construction of closed ducts will be estimated for hereafter.

2. Captain Morant's letter is so full that the Commissioners have nothing to add. It will be seen therefrom that in ordinary years the new reservoir at Snowdon, and the existing one at Marlimund will provide for the wants of 10,000 people at 20 gallons per head per diem for five months and will leave a surplus of about 24,000,000 gallons, and that in bad years there will, supposing the same

consumption, be a deficit of about 25,000,000 gallons or say 2½ months consumption. It is however to be observed that the rate of consumption of 20 gallons per head is perhaps more than ample, and if a supply of 15 gallons per head is provided, the supply in a bad year would last for 11 months, when however the drainage scheme is perfected we shall require more water, so it will be necessary hereafter to construct the subsidiary reservoirs at x and y (Plant) and the supply of water will then be amply sufficient for all purposes.

3. The Estimate does not provide for Public Works Supervision which will amount to Rs 5732, It is however very necessary that the works should be carried out by the District Engineer, as owing to the position of the Reservoir nothing should be left undone to prevent any possible chance of the embankment giving way. The Commissioners will not be able to provide from their current year's Budget the sum of Rs 8672 over and above the loan of Rs. 20,000, and I trust therefore that Government will be able to allow the work being carried out by the District Engineer free of charge, or that, if that is not possible they will allow any sum which the Commissioners

Commissioners cannot pay during the year to lie over and to be adjusted when the completion of the water supply, and the drainage projects are passed, and the proposed loan for these works ~~are~~ is sanctioned. The present proposed increase to the water supply is urgently needed, and the works should be pushed forward with the utmost expedition, so as if possible to get a good supply for next year,

I have the honor to be
Sir
Your most obedt Servt

As President
Ootacamund Municipal
Commission

43

Nº 1921.

Referred to the Chief Engineer for remarks.

(By order)

J. H. [illegible]
Under Secretary

26. 4. 77

To the Chief Engineer with 5 plans in a Tin Case

Financial Department
(Municipal - Ootacamund)

Nº 4

P.W.D.
27 APR 77
Nº 4326

To

The Chief Secretary to Government
Fort St. George

Dated 19 April 1877
Recd. 21 [illegible]

Nº 2569

Memo No. 1709 8/9

Encl: 5 plans
— " — 7 estimates &c.

Conf. [illegible] with [illegible] 105 W

Subject 8 Jan/78

Forwarding Plans and Estimates for the improvement of the Northern water supply of Ootacamund together with letters from the District Engineer explaining the project.

R-C 5-1-78
Cu 31-10. R 5-1-78

Nº 105 W Public Works Department.

52

[illegible] works. 27

PROCEEDINGS OF THE MADRAS GOVERNMENT.

UNDER date the 8th Jany. 1878.

Read the following:—

Endorsement of the Financial Depart., No. 921, dated 26th April 1877.

do do No. 1655 d/ 28th Augt. "

do do " 1707 " 8th Septr. "

From the Chief Engineer for Irrigation (H.E. No. 2764 d/ 22nd Octr. 77)
221 W – 28 Octr./77

" " " —

It is understood that His Grace the Governor [illegible] para 21 of Col. [illegible] report [illegible] the [illegible] It has [illegible] been [illegible] and [illegible] appear in [illegible]

His Grace the Governor in Council resolves to communicate the remarks of the Chief Engineer for Irrigation to the Municipal Commissioners of Ootacamund for their careful consideration.

His Governor in Council is of opinion that the raising of the bund

R.S.

bund of the Mashimand Reservoir would be of doubtful utility seeing that the bund is by no means in a substantial condition. The project would moreover involve heavy compensation for land and would entail the stoppage of the supply of water for a long period during the progress of the work.

The Snowdon Reservoir project presents a more hopeful aspect. It would be an addition to the existing sources of supply, and at a high level would command most

most if not all the houses below. The question of compensation should be investigated and when the cost has been carefully estimated an application for a loan can be made in the usual way.

The extension of the Dodabet Reservoir should also receive special attention.

EOT 4/1/77

To, The Civil Departt with plans & Estimates: 17
" D.C. Neilgherries 3
" Chief Eng for I. 9

Dispd 21-1-78

17

P.C.H.

~~5/8/78 Do 3127 [illegible]~~

G.L. 9/8/78 No 3499

19/6/79 No 1658 [illegible]

10/6/78 No 318 [illegible]

7/1/79 No 53 [illegible]

25/5/79 No 1150 [illegible]

31-5-95 (Pub) ✓

13-5-05

Govt. of {1878} Madras.

PUBLIC WORKS.

To the Financial Dept

Dated

Issued

Recd.

Encl.

G. O., 8 Jany 1878, No. 105

Nos.

…mund Water Sup…

Ootacamund Water Supply