

GOVERNMENT OF MADRAS

PUBLIC WORKS DEPARTMENT

REPORT
ON
THE MALAMPUZHA PROJEC



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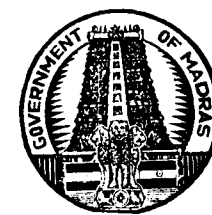
19, Mount Road, MADRAS

1950

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MALAMPUZHA PROJECT — An artist's view of the Dam and Reservoir when completed.



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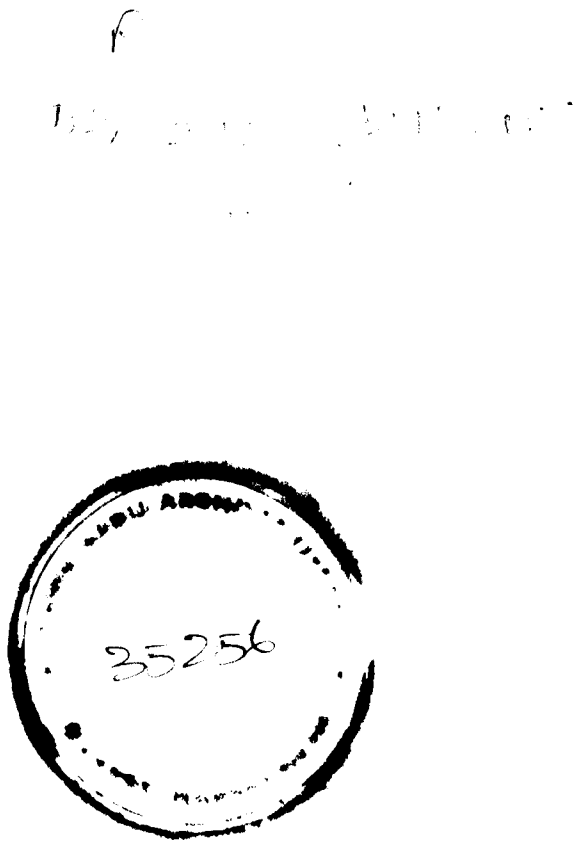


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MALAMPUZHA PROJECT

NOTE

Details of the Design of Dam, Spillway and other appurtenant works, as mentioned in this report, have since undergone some slight changes. These changes are incorporated in the "Specification for Malampuzha Project" separately under print. Similarly, the alignment of the main Canal has also been modified and improved subsequently.

July 4, 1950

1. INTRODUCTION:

Irrigation schemes in Malabar are somewhat costly as sites for storages with flat terrain are not easily available, lands to be irrigated are very undulating and acquisition of costly topes and wet land is generally involved. Further, rainfall is generally bountiful in this locality and sufficient to grow a rainfed crop. Failures of this crop have, nevertheless, occurred at times, frequently of late, due to bad distribution or failure of monsoon. To prevent such failures, especially when the need for growing rice and other food crops is great, there has been an insistent demand for the construction of irrigation projects. It may be mentioned here that an irrigation project in Malabar and South Kanara does not need so much of water as in the East coast for the main crop, as it is required only to supplement rainfall in the season between South-west and North-east Monsoons and also at the fag end of the North-east Monsoon i.e. in December and January. But the difference that these supplies will make to the crop is very great in the yields. These factors have led to the re-examination of schemes in the West coast with a view to taking them up for execution. Of these the most important is the Malampuzha Project, consisting of a storage Reservoir, formed by constructing a dam across the Malampuzha river, some distance upstream of its crossing with the South Indian Railway line from Coimbatore to Shoranur and of a canal with distributaries.

2. TOPOGRAPHY:

The Malampuzha River has its source in the hills due north of Palghat taluk, extending up to the boundary of Coimbatore district. The stream lies between longitude 76 degrees 39 minutes and 76 degrees 42 minutes and latitude 10 degrees 48 minutes and 10 degrees 55 minutes and joins the Korayar in Kadukkankunnu village of Palghat taluk, 2 miles east of Olavakkot Railway Station. The Korayar below the infall of the Malampuzha is known as Kalpathipuzha and in its lower reaches as Bharathapuzha. About 3 miles upstream of its infall into the Korayar (i.e. about 1½ to 2 miles upstream of the railway bridge across the river between miles 329 and 330 of Madras Shoranur Railway line,) the Malampuzha has a good site for the construction of a dam. At this place, on the west side of the stream, there is the Kazhukothu Malai and on the east there is a line of small hills and rocky outcrops with larger hills beyond. By building a dam across the stream, connecting the hills on the two sides, a reservoir is proposed to be formed.

3. HISTORY:

3.1. The project has been under consideration in some shape or other, ever since 1914. It was first thought of in 1914-1915 and a preliminary examination was made. Owing to the uncertainty of realising revenues under the revenue law then existing in Malabar, and also of the then financial conditions, further investigation was restricted to the verification of the quantities of waters available in the river. Gaugings were done during the years 1917 to 1920, and working tables prepared but no definite conclusions were arrived at. A preliminary report with approximate estimate was prepared in 1925, the amount of the estimate being about Rs. 60 lakhs but special Establishment for 6 months was required for a more detailed investigation. The Government in G.O. No. 291 I dated 11-6-1926 directed however that the investigation of this project should be postponed till the requirements of the Ceded districts were attended to. In 1938, the Malabar District Board passed a resolution requesting the Government of Madras to execute the Malampuzha and two other projects in Palghat taluk without delay. The matter was examined by the Chief Engineer (Irrigation) and the Board of Revenue and the latter's recommendation was that the execution of any large projects in Malabar must be preceded by legislation on the model of the Irrigation Bill of 1924 and the Bhavani Reservoir Irrigation Cess Act in view of the peculiar conditions obtaining in Malabar. The Government in G.O. No. 2831 P.W.D. I dated 12th December 1939, directed that the investigation of this and other projects should be postponed and thus the scheme was not pursued until 1944 when the Post-war Reconstruction Committee was formed to advise the Government generally on post-war planning. This Committee included twelve irrigation schemes throughout the Madras Presidency and among these the Malampuzha Project was one. Its inclusion in the list of post-war schemes and the urgent necessity for increasing food production have resulted in the revival of the project.

3.2. Before the scheme could be taken up for execution, however, a more comprehensive investigation than was done at any time before was considered necessary and a special establishment comprising one Sub-Divisional Officer and three Supervisors was sanctioned in G.O. No. 3185 Ms. dated 11-12-1945. The investigation was taken up in February 1946 and completed in September 1947. The plans and estimate were submitted by the Superin-

tending Engineer in September 1947 and they were submitted to Government for sanction in February 1948. The Government have now sanctioned the scheme for execution in G.O. No. 590 Public Works, dated 19-2-1949—Appendix III.

4.6. AVAILABILITY OF SUPPLY AND REQUIREMENTS OF IRRIGATION:

The requirements of supply is explained in subsequent paragraphs.

4.1. NATURE OF CROP AND WATER REQUIREMENTS:

4.11. There are no irrigation systems in Malabar from which the crop requirements or duty figures can be arrived at. The area is subject to heavy but ill-distributed rainfall. The cultivation, as at present carried out, is entirely dependent on rainfall. All low lying lands which can retain some moisture raise two crops, while the high level lands raise only one crop. The first crop is called Kanni or September Crop coinciding with the South-west monsoon and the second crop is called Makaram or January Crop coinciding with North-east monsoon. The September Crop is mainly broadcast in the month of May after 2 or 3 showers. The January Crop is entirely transplanted. Immediately after the first crop is harvested in September, the land is got prepared for the transplantation of the second crop which is completed in October. The second crop is harvested in January-February.

4.12. The Palghat taluk receives rains both in the South-west and North-east monsoons. The average is about 70 inches with a minimum of 49 inches in 1870 and a fall of more than 100 inches in some years. The average for the past 24 years i.e. from 1922 to 1945 for which complete records are available is 85.4 inches. The lowest rainfall in this period of 24 years is 55.62 inches in 1928. In most years the rainfall is badly distributed. There is a gap between the South-west and North-east monsoons varying from about 3 to 4 weeks and after November there is little or no North-east monsoon rainfall.

4.13. An examination of the rainfall records for the years 1916 to 1945 shows that September rain is inadequate in most years. Even in the most favourable year with a well distributed monsoon an examination of the actual rainfall shows that the crop would have done better with an addition of 6 inches to 8 inches water. In the worst years like 1870, 1923, 1928, 1934 assistance to the extent of over 22 inches is required. In about 25 out of 30 years assistance of 12 inches or more of water to the two crops are found necessary. For the remaining 5 years, assistance to the extent of 21 inches and more is required. Statement I of Appendix IV shows the rainfall in Palghat station and Statement IV of the same appendix shows the water requirements for the proposed ayacut to supplement the rainfall.

4.2. CAPACITY OF THE RESERVOIR:

4.21. As stated above, the demand for water for the ayacut is a fluctuating one. In very bad years the benefit of irrigation will be most appreciated. The maximum demand on the reservoir will be, in a year like 1928, 27 inches. The capacity of the reservoir has therefore been fixed with reference to this maximum demand with allowance for absorption, evaporation and transmission losses. The capacity required is found to be 4,500 million C. ft. as per working tables for irrigating an area of 40,000 acres (Vide Appendix IV Statements V and VIII) and this is obtained for an F.R.L. of (plus) 362.50 vide Statement VI (capacity calculations) of Appendix IV.

4.22. With the storage of the Reservoir fixed at 4,500 million C. ft. there will always be a certain surplus, and this surplus is proposed to be utilised for growing perennial crops like sugarcane, betel-vine, etc. which are badly needed in this taluk and a third crop on extents varying from 5,000 to 30,000 acres. Statement VII of Appendix IV shows the extents of perennial and III crops that could have been raised in the years 1916-1918, 1919-1920 and 1923-1945 with the 4,500 million C. ft. capacity reservoir.

4.3. WORKING TABLES:

4.31. The Malampuzha stream was gauged for four years 1916 to 1919 but records are available only for 1916, 1917 and 1919. Even for these three years daily discharges are available only for 1916 while for 1917 and 1919 monthly totals of discharges alone are available. No records are available for 1918. Hence the working tables have been prepared on a monthly basis for the years 1916-1918 and 1919-1920 from the total monthly discharges available in old files, Appendix IV—Statement VIII.

There was no rainfall station anywhere in the catchment area at this time to compare the gauged discharges with the run off from the catchment.

Note: (i) Gauging of the stream in May 1917 is not available. But as there was a rainfall of 7.64 inches at Palghat in that month, the discharge in the stream has been assumed as under:—

$$\begin{aligned} &\text{Discharge in May: } \frac{\text{Gauged discharge in June 1917.}}{\text{Yield as per Strange's table of run off for daily rainfall in June.}} \times \\ &\quad \times \text{Yield as per Strange's table of run off for daily rainfall for May 1917.} \\ &= 856.91 \times \frac{1.88}{3.93} = 458 \text{ M. C. ft.} \end{aligned}$$

(a) the formation of the diversion road to "Elival" that has to be given effect, is cheaper and easier.

(b) there is a saving in the acquisition of wet lands between the first site and the finally approved site (approximately Rs. 80,000).

The capacity lost by selecting the higher site is only 340 million C. ft. As this capacity is all below (plus) 300.00 (which is the sill level of the sluice) it does not affect the effective capacity of the reservoir.

Borings and calyx drill holes have been put in along the finally approved dam line and it has been found that excellent sheet rock exists throughout.

The site of the dam was inspected by the Superintending Geologist Dr. Krishnan on 21-12-1946 and he has given his considered opinion that the site is well suited for the construction of a dam. Vide Appendix V.

The total length of dam finally selected is 4,707 ft.

6. SURVEYS:

6.1. As already mentioned, the investigation which was started in February 1946 was for a reservoir of 1,082 million C. ft. on the basis of G. O. No. 291-I dated 11-6-1926. The F.R.L. for a reservoir of this capacity is (plus) 336.00. Levels were therefore taken up to (plus) 350.00. When instructions were issued by the Chief Engineer for Irrigation that the capacity has to be increased, the original cross sections were extended in a few places. This had to be done in the monsoonic period, and the levels available in the original survey (vide G. O. No. 291-I dated 11-6-1926) were also made use of, as those levels agreed with the levels now taken. These levels are plotted to the nearest foot.

6.2. The nature of the country being a series of hills and valleys is extremely difficult for survey work. The valleys are all stepped and are converted into wet lands, while the hills are thickly grown with high and low jungle. An attempt was first made to trace (plus) 330.00 contour on ground and take cross sections at right angles to this line, extending from (plus 350.00) to the deep bed of the river. This had to be given up after a couple of days' work, as the preliminary line itself could not be fixed without cutting heavy jungle and no progress could be made. It was therefore decided to fix the base line in an open country as far as possible and to take cross sections across the base line at right angles or at other angles fixed by compass bearing. As there are some details in village maps, station points in base lines were fixed in village maps with the help of village menons.

6.3. Contours for 10 feet intervals have been drawn with these levels and reservoir capacities have been worked out.

6.4. The main features of the country remained the same, up to about (plus) 400.00 level to the foot of the main hills, i.e., stepped wet lands in valleys and jungle and trees in hillocks.

6.5. In the inspection notes of the Chief Engineer dated 7-11-1946, instructions were issued that the proposals for the dam should be so formulated as to permit of the F.R.L. of the reservoir being ultimately raised to (plus) 380.00 in three stages.

7. SUBMERSION:

The F.R.L. of the reservoir for the first stage of construction for a capacity of 4,500 million C. ft. is (plus) 362.50. This will submerge lands in Kadukankunnu and Kottakad villages. The extents submerged for (plus) 362.50 are detailed below:

Single wet	..	607	acres
Double wet	..	1,260	"
Dry	..	1,605	"
Garden	..	76	"
Unassessed Waste	..	453	"
Poramboke	..	106	"

The area of waterspread will be 6.32 sq. miles.

8. MAXIMUM FLOOD DISCHARGE AND METHOD OF DISPOSAL:

The catchment area at site is 57 sq. miles. Assuming a value of 1,000 for C in Ryves formula, the discharge works out to 14,811 cusecs. Calculating from observed flood levels, the discharge works out to 12,980 cusecs. In order to be on the safe side the run off from the catchment for a maximum rainfall of 12 inches in 24 hours has been adopted vide Chief Engineer's inspection notes No. 2882-46 B-3 dated 7-11-1946. This works out to 18,392 cusecs. Provision has been made in the design for disposing of this quantity through the overflow section in the dam. In the preliminary proposal, the surplus was proposed to be taken along the valley through a low saddle at the left flank. Now that the F.R.L. is proposed to be raised to (plus) 362.50 there will be a 35 ft. drop in the rear of the overflow section. From

trial pits excavated along this line it is seen that rock is met with at a reasonable depth only for 140 feet from the centre line of the dam. For the rest of the valley which is cultivated wet lands, the soil is hard gravel upto 7 feet to 10 feet depth up to which only trial pits could be taken, due to high subsoil water table. As protective works to prevent erosion will have to be done in the place and as (due to the short length of the course from the spillway to the river) retrogression is likely, it is not desirable to have the surplus works located in this place. Another reason for giving up this high level spillway is that the left side channel has also to be taken up in the same alignment, dropped into surplus course and picked up again by an anicut. For the above reasons, the spillway will be formed in the river bed portion of the main dam and the surplus discharged over it.

9. DETAILS OF DESIGN -- BULKHEAD SECTION:

As per Chief Engineer's instructions, the design for the dam will be so made so that it can ultimately be increased to hold 8,000 million C. ft. with an F.R.L. of (plus) 380.00. This will be done in 3 stages as detailed below:

- (i) 1st stage F.R.L. (plus) 362.50 spillway portion.
M.W.L. (plus) 370.00
Top of dam (plus) 380.00 Bulkhead portion.
- (ii) 2nd stage F.R.L. and M.W.L. (plus) 370.00.
Top of dam (plus) 380.00 shutters 7½ feet high will be provided.
- (iii) 3rd stage F.R.L. and M.W.L. (plus) 380.00 spillway will be (plus) 372.50 and 7½ feet shutters will be provided.
Top of dam (plus) 390.00 Bulkhead portion.

The design proper is therefore for the final F.R.L. of (plus) 380.00 with top of dam (plus) 390.00. Half uplift has been provided for in the dam design as per Chief Engineer for Irrigation's instructions. The specific gravity of masonry has been taken as 2.25. The maximum stress, Reservoir Empty and Reservoir Full are 7.10 tons and 7.50 tons respectively. These are well within the usual 10 tons per sq. foot allowed.

10. Impervious masonry with cement mortar 1 : 2½ has been provided for 4½ feet width from the upstream vertical face, as in the case of Tungabhadra Dam. Below (plus) 322.50 the downstream masonry is with cement mortar 1 : 4 and above this level the masonry is with cement mortar 1 : 5. The upstream face is proposed to be given deep pointing with cement mortar 1 : 2 as the masonry is to have watertight joints. On the downstream, provision for pointing has not been made, as the rubble stone masonry will be finished flush as the masonry progresses.

These provisions are similar to the Tungabhadra design.

11. SPILLWAY:

11.1. The spillway is designed for an F.R.L. at 380.00 with a Creager curve. As the head of discharge is only 7.5 feet the X and Y co-ordinates as per Creager's table extends only upto 46.65 feet and 33.75 feet from top respectively. The masonry line has been continued down suitably and tentative designs have been made out for bucket, baffle wall etc. This will be finalised only after experiments in Poondi Research Station are conducted.

11.2. The Creager's section with upstream face vertical, as in Tungabhadra design is insufficient for stability. Hence necessary additional width has been provided for on the upstream face. The stresses have been calculated graphically. The maximum stresses are 8.25 tons per sq. foot Reservoir full and 6.76 tons per sq. foot Reservoir empty.

11.3. The crest of the spillway has to be kept at (plus) 362.50 as per the proposals for the first stage and so the crest is smoothly joined on to the Creager's masonry line at this level. The ultimate gearing platform level will be (plus) 390.00 for the shutters to be erected in the second stage. The piers will be constructed upto (plus) 380.00 even now, with necessary corbelling on the upstream faces. The impervious masonry will be 5 feet thick from the top upstream face and for the entire batter in front. The remaining masonry will be in Random rubble in cement mortar 1 : 4. R.C.C. Cap 4 feet thick has been provided for the top and cut stone lining on the face of the Creager spillway and bucket. R.C.C. baffle 2 feet thick and pavement beyond have also been provided for. River walls and revetments in continuation have also been provided.

11.4. MEASURES FOR PREVENTING UPLIFT:

Half uplift pressure has been allowed for in the design. Bore holes will be drilled in the rock under foundation below the front face of the dam in two lines staggered at 20 feet intervals and 20 feet and 40 feet deep respectively and grouted with cement under pressure.

12. ROAD OVER DAM:

As there is no other access to the main sluice on the left side, a road over the dam is necessary. This is therefore provided for, and the width between parapets is 12 feet. The bridge is to be of 30 feet span of the Plate Girder type. These girders will first be used for a temporary bridge 16 feet wide across the river below the dam, for access to the left side during the period of construction. Steel trough-decking is provided for, so that the decking can be removed later, when the dam is raised to the final level of (plus) 390.00.

13. SLUICES:

The main ayacut is on the left side. 3 sluices of size 7 feet x 10 feet with sill at (plus) 300.00 are provided for.

On the right side, there is existing irrigation to an extent of 300 acres from a private anicut called 'Pattani' anicut above the proposed dam. It was originally proposed to have a right side channel also to irrigate about 6,000 acres. As the levels taken for this alignment, Chief Engineer's Inspection notes No. 2882-46-B-3 dated 7-11-46. showed that the channel will have to skirt along the foot of hills, and a number of drainage crossings and heavy embankments at heavy cost are necessary, it is not proposed to excavate this channel in the present scheme. But it will be taken up later when the necessity for the same is felt. However sluices for irrigating the existing ayacut of 300 acres and for future development of irrigation at a later stage, are proposed to be provided on the right side also. The discharge required will be 100 cusecs at 60 duty for a maximum possible ayacut of 6,000 acres. Two sluices 4 feet x 6 feet size will be provided with sill at (plus) 302.50 which is the bed level of the existing channel. There is no necessity to have a higher sill as more lands cannot be irrigated due to proximity of hills.

14. Pipes for hydro-electric power development will be provided now itself even though actual power generation will be taken up only when the F.R.L. is (plus) 380.00 and dam top level (plus) 390.00. The water from this hydro-electric pipe will be utilised for irrigation purposes for the left side channel. Lump sum provision has been made in the estimate and other details will be filled in later in consultation with Electricity Department who have been addressed in the matter.

15. MATERIALS FOR DAM CONSTRUCTION:

Roughstone required for the work can be blasted from the nearest hills. Sand can be taken from the Malampuzha river bed where small quantities alone are available and the main supply will be from the Korayar bed about 1½ to 2 miles from the site of the dam. Bricks required for construction of quarters, workshops etc. can be manufactured locally at a distance of 1 to 1½ miles from the dam site. Firewood is available in plenty in the forests in the submerged extent of the reservoir wherefrom the major supply is now made for Palghat Town and the surrounding villages. Cement, iron etc. can be unloaded at Olavakkot railway station where a store shed and loop-line have to be constructed. Electric power can be supplied from the Pykara system by extending the power line from Olavakkot and constructing a sub-station at the site of the Dam.

Lime is not available locally and has to be brought from Kozhinjampara in Cochin State with a lead of 21 miles if necessary.

16. TRANSPORT AND COMMUNICATIONS:

16.1. The existing road from Olavakkot to the Dam site is a third class road and is also very narrow in many places. It is therefore proposed to form a road 24 feet wide to the Dam site. As portions of the existing road in the Agattethara villages are narrow and not capable of widening without heavy acquisition, new roads outside village limit will be formed in these places. These proposals are included in the estimate for camps and buildings.

16.2. For transport of sand and stone, tram lines will be laid and the cost of these will be provided for in the estimate under special tools and plant.

16.3. As already mentioned above, a bridge will be provided for, across the stream below Dam line for access to the left side during the construction period. After the completion of the Dam, the girders will be removed and re-erected over the dam and the road will be over the Dam itself.

17. LABOUR:

Skilled labour is not available in the district to any appreciable extent. They will therefore have to be imported mainly from the Coimbatore District.

18. QUARTERS FOR STAFF, ETC.

Quarters for staff will be provided for in the Kadukkankunnu village limits on the way to the Dam on the right side of the river. Quarters for the supervising staff and also the Labour Camp etc. will be located on the two sides of the road and will be about 1½ miles from the Dam line. Workshops, electrical sub-station etc. will be provided for at the site itself.

19.0. ESTIMATES:

19.1. A. PRELIMINARY EXPENSES:

The incidental expenditure for necessary survey work, demarcation of the submer-sion area, clearing site, alignment of dam, constructing temporary quarters for officers and subordinates, till permanent ones are built, are included under this head. Further expenditure required for calyx drill operations, has also been provided for.

19.2. B. LAND ACQUISITION:

The cost of the acquisition of lands under the foreshore submer-sion, as also for camps and buildings, noted in the estimate, are based on figures obtained from the Revenue Divisional Officer.

19.3. K. BUILDINGS:

The dam site is malarial and at present none except the hill tribes stay in this locality during nights. Even if malarial operations are conducted in advance, there is no site near the dam line for the construction of quarters for the entire staff required for the project. There are two fairly compact sites on opposite sides of the road about one mile below the Dam line and these sites are proposed for the quarters of the departmental staff. Additional land for the quarters of the contractors' labourers, can be had on the left side of the river, north of the railway line. There is also some extra space available for further construction or other amenities. Provision has been made for the construction of the buildings noted below at head works:—

(1) Quarters for Superintending Engineer	..	..	..	1 No.
(2) Quarters for Executive Engineers	..	..	..	2 Nos.
(3) Quarters for Assistant Engineers	..	..	..	7 Nos.
(4) Quarters for high grade subordinates	..	..	..	50 Nos.
(such as Supervisors, Accountants, Head Clerks, etc)				
(5) Quarters for lower grade subordinates and work establishment family and non-family type	..	..	..	70 Nos.
(6) Quarters for maistries	..	..	..	50 Nos.
(7) Quarters for peons	..	..	..	50 Nos.
(8) Buildings for mess cafeteria and other miscellaneous quarters and additional quarters	..	..	..	..
(9) Hospital Buildings	..	..	..	1 No.
(10) Police Station and Treasury	..	..	..	1 No.
(11) Post and Telegraph Office	..	..	..	1 No.
(12) Store sheds (Nissen huts or other military type sheds)	..	..	..	30 Nos.
(13) Workshop, power house and compressor house	..	..	..	1 No.
(14) Office blocks	..	..	..	1 No.
(15) Rest-house	..	..	..	1 No.
(16) Tourist sheds—dormitory type	..	..	..	10 Nos.
(17) Coolies huts.	..	..	..	500 Nos.

Excepting the rest-house, and a few quarters for the officers and clerks all the build-ings will be of a temporary type.

Spot levels could not be taken in the proposed camp area, as it is covered with heavy jungle, and the owners objected to cutting these, even for taking a few lines of levels. The sites are well above M.F.L. of the river and are quite suitable.

19.4. M. PLANTATIONS:

This head makes provision for Rs. 10,000 for the plantation of avenue trees and gardens.

19.5. O. MISCELLANEOUS:

19.51. The road from Olavakkot goods yard to the dam line is a third class road with a bit of trunk road at the Olavakkot end. All traffic from the goods yard has to pass two level crossings, one in the trunk road and one at the other end of the railway station. As Olavakkot Railway station is a busy junction with frequent train services and shunting of goods trains, the gates at the railway crossings will be closed very often and road traffic held up and delayed. It is therefore proposed to have our own goods shed, unloading platform, and railway siding on the north side of the main railway line. Three alternative proposals are possible.

19.52. To have our own goods yard with unloading platform in Olavakkot junction itself in the Government site now belonging to the Forest Department, and improve the road XYEFGK (portion YEF has to be newly formed on land newly acquired). The total length

of road comes to about $3\frac{1}{4}$ miles. This does not take into account the roads in the camp area and by the side of the dam line which have to be anyhow formed.

19.53. To have our own goods yard with unloading platform etc. at the site marked A with a spur taken off from the main line and shown red in the enclosed tracing and to improve the road A B E F G K. (Portions A B and E F have to be newly formed on newly acquired land). The length of the road will be $2\frac{5}{8}$ miles. This alignment was inspected by the Superintending Engineer on 20-11-1946 and it was also discussed with the Special Permanent Way Inspector (S. I. Railway) and the proposal was found practicable.

19.54. To take a spur from the Kottakad Flag Station east of Olavakkot Junction and run a road along the line A' B' C' P' joining it to the feeder road at the left flank of the dam line. This involves the formation of road in difficult country, and the road has also to run on ghat for some distance. Assuming the workshop and the stores as the central spot to which all machinery and materials have to be conveyed, the distance to be covered across--

Route (a) would be 4 miles 5 furlongs

Route (b) would be 4 miles.

Route (c) including ghat portion would be 2 miles.

(b) is considered to be most convenient and has been adopted for preparation of plans and estimates. Anyhow detailed estimates will be prepared for the 3 alternative routes and the most economical one adopted during execution.

19.55. As access from Palghat for inspecting officers, labourers etc. would be very necessary it is desirable to improve the third class road from Z Z'B taking off from the trunk road up to the railway crossing at B. Provision for the same has been included in the estimate.

19.56. As the railway spur from the main line has got to be operated by the railway staff provision for establishment charges have been made for them in the project estimate.

19.57. The road will be metalled for a width of 16 feet with 4 feet berms on either side. Soling and metalling have been proposed where such do not exist, and 3 inches metalling will be done, where the existing surface is in good condition. Four-inch thick cement concrete will be laid on the top of it, to take the heavy wear and tear, on the main road from the goods yard up to workshops and stores. The other portions of the road will have a metalled width of 12 feet and water bound macadam. Mileage rates have been adopted for these roads in the estimate. Detailed plans and estimates will be prepared before execution.

19.58. Diversions have been proposed wherever the road runs through thickly populated places in villages. Land to the extent necessary for maintaining the width of road specified above will be acquired.

19.59. ELECTRIC TRANSMISSION LINES:

The power required for the various camps and buildings, machinery, power house etc. is proposed to be obtained from the Pykara system. The power has got to be tapped near Olavakkot railway station and the high tension line has to be connected to the Power house near the dam line. In the Power house it will be stepped down by Transformers and distributed to the various places required. The total length of the high tension line will be about 9 miles and of the distribution low tension lines will be 10 miles. Superintending Engineer (Pykara) Coimbatore, has been addressed. A provision of Rs. 1,86,000 is made for electric transmission lines and power house equipments.

19.60. TELEPHONES:

The inspection sheds at Headworks will be given telephonic communications from the transport shed at Olavakkot and offices at the camp site. Connections will also be given to the quarters of the Executive Engineer, Medical Officers, Police Station, Post Office and Hospital buildings.

19.61. SANITATION:

The latrines will be of the hand flushing type and the sewage will be disposed of through septic tanks and dispersion trenches and the affluent utilised for the irrigation of farm. For officers', clerks', and mechanics' quarters, individual latrines will be provided in all quarters while community latrines will be provided for the labour camps with separate enclosures for men and women.

19.62. In places where the sub-soil is rocky and it is not possible to provide underground sewers, dry earth latrines will be constructed and the faecal matter discharged into sewers through dumping chutes located at suitable places. The sullage will be taken in open drains and connected to underground sewers through drain junctions.

19.63. WATER SUPPLY:

The Malampuzha river is perennial and there will be at least 30 to 40 cusecs available even in the driest part of summer. The pump house will be $\frac{1}{2}$ mile below the dam and sufficiently away from the labour camp where the river supply is not likely to be polluted.

The water from the river will be pumped to coagulation tanks located at 430.00 level on the right side hill and the purification plant worked under gravity. The pure water reservoir will be at 410.00 level so that water can be easily supplied even to the topmost level of the dam.

19.64. OTHER EXPENDITURE:

The provision under this head includes the cost of boats, experiments and tests, etc.

19.7. P. MAINTENANCE:

A lump sum of Rs. 10,000 for the maintenance of works during the construction period is provided.

19.8. Q. TOOLS AND PLANT:

All the heavy tools and plant required for the head works are included under this head. The details of heavy plant and machinery are based on what has been considered necessary for similar projects.

CANALS:

20. CANALS FOR IRRIGATION:

In the preliminary proposals formulated in 1926 two canals were contemplated, one on the right side for 6,000 acres and the other on the left side for 34,000 acres. During the investigation of the right side channel, it was observed that the channel had to traverse very difficult country, with hills and valleys alternating at short intervals with the result that even with a 40 miles canal, it was found difficult to get 6,000 acres of irrigable area. Also the canal had to be taken along the foot of the hills and a very large number of cross drainages negotiated. It was therefore decided to keep this canal in abeyance and restrict the investigation to the left side canal and to bring in the entire area of 40,000 acres under it. Two sluices have, however, been provided on the right side in the dam proper. On the right side even now 300 acres are being irrigated from a private anicut higher up the river and water will be supplied from the right side sluice to this ayacut for the present and the channel extended later if found necessary.

21. LEFT SIDE CANAL:

The main irrigation under the dam will be from the left side canal. Two vents of 7 feet x 10 feet will be enough to discharge the required quantities but three have been provided to meet future extensions.

CAPACITY OF CHANNEL:

For arriving at the capacity of the reservoir, working tables have been prepared, in which the depths of water required for paddy during the cultivation period have been noted. The maximum depth of water in inches required in any month is 8 inches for the first two crops, and this works out to a discharge of 448 cusecs. Adding $12\frac{1}{2}\%$ for transmission losses, the total discharge required is 504 cusecs. There is, however, a provision to raise the F.R.L. to plus 380 at the final stage in which case there will be enough water in the reservoir for raising a third crop in the entire ayacut of 40,000 acres. The depth of water required during the months of February-April for short term third crop will be 10 inches. This is equivalent to a supply of 630 cusecs for the entire ayacut of 40,000 acres including $12\frac{1}{2}\%$ extra for transmission losses. Due to the steep fall of the country and porous nature of the soil, it is considered desirable to design the channel on a duty of 60. This is also the working duty realised in the irrigation systems belonging to Cochin State in Chittoor taluk adjoining Palghat. For this duty the discharge required will be 667 cusecs and with $12\frac{1}{2}\%$ extra for transmission losses, the total draw will be 750 cusecs. The canal system is, therefore, designed for the higher of the two discharges. This has also been approved by the Chief Engineer for Irrigation. If more water is required, the same can be drawn with slightly greater depth in the canal.

22. ALIGNMENT OF CANAL:

The main left side canal is 20 miles half a furlong in length.

22.1. The Malabar district has peculiar physical features with hills and valleys alternating throughout in close succession. It has not been found possible to align the canal strictly along the contour as it involves very long detours. The best alignment that is possible has therefore been adopted keeping the radius of curves at 20 times the bed width. Even so numerous heavy cuttings and high embankments have become inevitable the maximum cutting being 33 feet and the maximum embankment 28.5 feet. Provision has been made in the estimate for rock cutting where necessary. Rock is met with in cuttings in five places. In the first three of them it is proposed to line the canal with 3-inch thickness of cement concrete including the bed so that the section could be reduced without loss of head. Giving steep slopes in these cuttings will involve greater depths of cutting in the lower reaches. In

the last two rock cuttings in reach VI and VII steeper falls have been allowed in the canal and lining is not therefore necessary.

22.2. The embankments and cuttings are discussed below:—

22.21. **CUTTING BETWEEN L. S. 0/7 to 1/1:**

Here the canal has to cross a saddle. The country is generally falling towards west but the spur on the west side of the canal at this site extends right up to the river and cannot be detoured.

The cutting will have vertical faces from ground level down to M.W.L. and side slopes of $\frac{1}{2}$ to 1 below to facilitate anchorings of the lining. The bed width will be reduced from 60 feet to 30 feet at the cutting. With the bed and sides fully lined the reduced section is adequate for passing a discharge of 750 cusecs. The approaches and exits of the rock cutting portions will be bell-mouthed to prevent turbulence and formation of eddies.

22.22. **EMBANKMENT BETWEEN 1/3 $\frac{1}{2}$ to 2/3:**

The canal crosses the Korayar river a L.S. 1/7 $\frac{1}{2}$. A site with rocky outcrops in the river bed itself has been selected for the crossing. After crossing the railway line the canal approaches the river by a curve with a radius 20 times the bed width. An alternative line with a radius less than 20 times the bed width was examined and given up as it involves 2 furlongs extra length of canal and extra cost for land.

22.23. **EMBANKMENT BETWEEN 4/2 $\frac{1}{2}$ to 4/5:**

The canal has to make a sharp bend here to suit the contours. A smooth crossing over Kalleppulli thodu has been adopted.

22.24. **CUTTING BETWEEN 5/1 $\frac{1}{2}$ to 5/4:**

The canal here crosses a saddle and passes through a gap in the village site avoiding costly tiled houses and a temple.

22.25. **CUTTING BETWEEN 7/2 and 7/5 $\frac{1}{2}$:**

The canal crosses a ridge in this reach. The alignment is along the line involving least depth of cutting. Borings were taken at this site and rock has been met with only below theoretical bed level.

22.26. **EMBANKMENT BETWEEN 8/0 and 8/2 $\frac{1}{2}$:**

In this reach the canal crosses the Kannadi river. By shifting the crossing higher up the height of embankment would be reduced but the canal will have to cross the Vandithodu stream and cross and recross Palghat-Chittoor road. The site of crossing has therefore been fixed below the junction of Vandithodu with Kannadi river. The embankment is high as the river margins have been used for brick manufacture and ground level has been lowered in consequence. A lower crossing about $\frac{1}{2}$ mile below was tried but it had to be given up, because even though the levels were more favourable on the right side of the river, the embankment of the left side was not only high but extended for more than a mile.

22.27. **EMBANKMENT BETWEEN 9/7 and 10/3:**

The ground falls off rapidly on either side of the thodu. If the alignment is taken higher up, some houses will have to be acquired and a bridge constructed in the road from Kannadi to Kollengode road.

22.28. (a) **CUTTING BETWEEN 12/0 to 12/6:**

The canal has been aligned so as to be well away from costly house sites. The bed width is reduced to 25 feet for the rocky portion. The bed and sides will have to be lined and approaches bell-mouthed as in the case of rock cutting between 0/7 $\frac{1}{2}$ to 1/1. There is nearly 15 feet of rock cutting in this reach. During execution comparative cost of acquiring the houses and taking the canal line on a lower contour, and running the canal along the proposed line will have to be worked out and the cheaper one adopted.

(b) **CUTTING BETWEEN 14/3 to 14/4 $\frac{1}{2}$:**

Here is a ridge running East to West and it is proposed to be crossed at the lowest saddle avoiding house sites and temple etc. Here also, the canal bed width is reduced to 25 feet width for the rock cutting and the bed and sides etc. lined as in the case of the cuttings above.

22.29. (a) **EMBANKMENT BETWEEN 16/0 to 16/6:**

The canal has to be taken across on the outskirts of Koduvayur town avoiding built up areas and bazaar sites. Hence embankments cannot be avoided.

(b) **EMBANKMENT BETWEEN 17/1 $\frac{1}{2}$ to 17/6 $\frac{1}{2}$:**

The line is taken avoiding village house sites. Due to two big drainage courses the embankment is high.

(c) **CUTTING BETWEEN 19/2 $\frac{1}{2}$ to 20/0:**

The canal is taken along a saddle with the minimum cutting.

An alternative alignment was tried along the west side of Vamalai and other adjoining hillocks in Kakkayur and Pallasena villages was tried and dropped as it was found to involve very heavy embankment and heavy and long cuttings.

23. **HYDRAULIC PARTICULARS OF REACHES:**

The canal has been divided into 7 reaches with the hydraulic particulars as below: The sections of the canal have been designed a per Kutters formula with the value of 0.0225 for "n" and the wetted perimeter checked with Lacey's formula $Q = \frac{P.W^2}{7}$. The velocities are all critical velocities.

	Reach I	Reach II	Reach III	Reach IV	Reach V	Reach VI	Reach VII
Mileage	0 to 6 $\frac{1}{2}$	6 $\frac{1}{2}$ to 6/5 $\frac{1}{2}$	6/5 $\frac{1}{2}$ to 10/3 $\frac{1}{2}$	10/3 $\frac{1}{2}$ to 11/6	11/6 to 14/4 $\frac{1}{2}$	14/4 $\frac{1}{2}$ to 18/7 $\frac{1}{2}$	18/7 $\frac{1}{2}$ to 20/0 $\frac{1}{2}$
Ayacut	40,000	36,790	34,990	31,090	21,890	6,910	3,600
Discharge	750	704	657	592	425	143	70
Bed/width	60'	60'	56'	55'	44'	25'	12'
F.S.L. depth	5.0	4.75	4.75	4.50	4.25	3.00	3.00
Bedfall	1 in 5,280	1 in 5,280	1 in 5,280	1 in 5,280	1 in 5,280	1 in 4,874	1 in 3,960
Velocity	2.46 ft./sec.	2.38 ft./sec.	2.37 ft./sec.	2.30 ft./sec.	2.17 ft./sec.	1.73 ft./sec.	1.72 ft./sec.

24. At the sites of all embankments there are costly wet lands. In the estimate for land acquisition, no extra provision has been made for acquiring lands for putting borrow pits for the necessary earthwork, as this will involve very heavy land acquisition charges. The earth required is therefore either to be trammed from the nearest cutting or obtained by lowering the high level adjacent lands giving temporary compensation for the removal of earth, if found necessary. Excavators and bull-dozers are proposed to be used for excavation.

25.0. The canal being a contour one, the main bank is only on the right side. This bank will be an inspection bank. It will have to be used as a road for conveying manure to the fields and the produce to the villages. Hence its width will be kept at 15 feet and metalled surface provided if found necessary later on. In places where there is heavy cutting the spoil bank will be suitably sectioned to give easy approach from lower to higher levels and *vice versa*. The top of bank as noted in cross sections in cutting portions is only tentative and will have to be lowered suitably depending on the quantity of earth to be trammed to the adjacent embankments during execution.

25.1. Wherever the canal runs in embankments and where at F.S.L. conditions, there is submersion of wet lands, a left bank has been provided.

25.2. The top widths and heights of banks have been increased to suit the height of embankment as detailed below:—

HEIGHT OF EMBANKMENT	TOP WIDTH OF RIGHT BANK	TOP WIDTH OF LEFT BANK	FREE BOARD-OVER M. W. L.
Upto to 5'-0"	15'-0"	6'-0"	3'-0"
5 to 7 $\frac{1}{2}$	15'-0"	6'-6"	3'-3"
7 $\frac{1}{2}$ to 10'-0"	15'-0"	7'-0"	3'-6"
10 to 12'-6"	15'-0"	7'-6"	3'-9"
12'-6" to 15'-0"	15'-0"	8'-0"	4'-0"
15'-0" to 17'-6"	15'-0"	8'-6"	4'-3"
17'-6" to 20'-0"	15'-0"	9'-0"	4'-6"
20'-0" to 22'-6"	15'-0"	9'-6"	4'-9"
22'-6" to 25'-0"	15'-0"	10'-0"	5'-0"
25'-0" to 27'-6"	15'-0"	10'-6"	5'-3"
27'-6" to 30'-0"	15'-0"	11'-0"	5'-6"

25.3. The M.W.L. of the canal is kept 1 foot above the F.S.L. and outlets are provided to discharge the drainage water that flows into the canal with 0.5 foot head.

25.4. Provision has also to be made for increasing the supply in the canal if necessary for short period in the dry season for the irrigation of III crop. Below the VIIth reach, the surplus waters of the main canal falls into the Gayathri river. About 5 miles below this point in the Gayathri river, an anicut scheme called Cheramangalam anicut scheme is in progress. The area under this scheme can be increased if additional supplies of water are let

down into the river from the Malampuzha canal. To permit greater discharge being sent down the VIth reach will be given a free board of 3 feet above M.W.L. against 2 feet usually allowed.

26.0. CROSS DRAINAGES:

The canal, being a contour canal intercepts all the cross drainages. The drainage flow has been calculated on the basis of $\frac{1}{2}$ inch rainfall per hour. The drainage courses are all very small, and during heavy rains water invariably spreads over the wet fields on either side of the stream. These wet fields generally have wide field bunds and act as good flood moderators. The run off calculated at $\frac{1}{2}$ inch per hour can be taken as quite safe for all practical purposes. The outlets have been designed to discharge the estimated flow with 0.5 foot head but as a further measure of safety the actual M.W.L. adopted is 1 foot over F.S.L.

26.1. Where the canal runs in embankment, it is found that at F.S.L. conditions water will back up and submerge costly wet lands. In these places it is cheaper to provide undertunnels instead of absorbing the drainages and providing outlets, as the submerged wet lands on the left side have also to be acquired. Embankments at all such sites are therefore proposed for both sides of the canal and undertunnels provided. Due to the undulating nature of the country many such undertunnels have become inevitable. These are detailed in the L.S. and in the statement of cross drainage works.

26.2. Where minor ridges are crossed with valleys on both sides, the drainage from the higher valleys has been proposed to be diverted into the lower valley by excavating a side channel.

26.3. Where the canal runs in a saddle or sidelong ground in deep cutting, the drainage will flow into the canal, outlets being provided at convenient places for disposing of this drainage.

27.0. MAJOR CROSSING OF RIVERS:

The canal crosses two big rivers, viz. the Korayar at L.S. 1M/7F 200 feet and Kannadi river at 8M/3F. The canal is taken across the rivers through aqueducts with 20 feet trough width, supported on R.C.C. open spandrel arch ribs of 60 feet clear span. In the case of Ellis Saddle surplus in Mettur Dam and also for the bridge across Tungabudra below the dam under construction 60 feet span has been considered an economical span for this type of construction. Open spandrel type has been adopted as there is sufficient headway over the M.F.L. of the rivers. The approaches and exits of the channel at sites of aqueducts have been flumed. The design will be finalised after the E.E., Research station, Poondi carries out the experiments and decides on the fluming ratios etc. to be adopted. A trough width of 20 feet is necessary as it has to carry a road way (with B class loading) over the trough. The road way is over bearers supported on R.C.C. columns.

27.1. Six spans of 60 feet clear has been adopted for the Korayar crossing, and seven spans (60 feet) for the Kannadi.

27.2. The lengths of the troughs at approach and exit of the aqueducts have been extended, for giving connections to the motorable right bank of the canal. In the case of Kannadi aqueduct there is a cart track on the left side of the canal also and it is proposed to be taken over this aqueduct, to save the provision of a separate bridge.

28.0. THODU OR VAGU CROSSINGS:

The canal crosses seven defined drainage courses. Vents have been provided on the basis of $\frac{1}{2}$ inch rainfall per hour which is ample, as the catchment is entirely of terraced wet lands the bunds of which act as flood moderators. The details of the drainage course with provision for the disposal of drainage are detailed below:—

S.No.	Name of thodu.	L.S.	Max. flood discharges cusecs.	Provision of vent way
1	2	3	4	5
1.	Undertunnel for thodu above river Korayar	1/6	121	2 Nos. 3'-0" dia. pipes.
2.	Do. Kallepalli thodu	4/3-405	1613	4 Nos. vents 9'-0" x 6'-6"
3.	Do. Karingarapalli thodu	6/7-500	404	1 vent. 9' x 6'-6"
4.	Do. Thodu above river Kinaseeri thodu	10/1-200	1330	3 vents 9'-0" x 6'-6"
5.	Do. Erimayur thodu 1st Branch	17/2½	1050	2 vents 9'-0" x 6'-6"
6.	Do. do. II Branch	17/7	1330	3 vents 9'-0" x 6'-6"
7.	Do. do. III Branch	18/6	1210	-do-

29. RAILWAY CROSSINGS:

The canal crosses the Madras-Mangalore Broad Gauge Railway line at L.S. 1 mile 2 furlongs 420 feet. The bed level of the canal is plus 298.62 (F.S.L. depth 5 feet) and the

rail level at the site is plus. 303.70. The canal is syphoned at this site and the bed width is reduced to 29 feet by a three vented box culvert. The length of the tunnel is 24 feet. A level crossing has also been provided for the through running of the roadway on the right bank.

30. The canal also crosses the Palghat-Pollachi meter gauge line at L.S. 10/7½ where three vents of 9 feet x 5 feet 6 inches are provided with a level crossing. Necessary loss of head has been allowed for these box culverts.

31. ROAD CROSSINGS:

The canal crosses the following metalled roads:—

1. Palghat-Coimbatore road at L.S. 6/2½.
2. Palghat-Chittur road at L.S. 7/7-200.
3. Palghat-Kollengode road at L.S. 11/1.
4. Palghat-Koduvayur road at L.S. 11/2-530.
5. -Do- L.S. 11/7.
6. -Do- L.S. 12/6-450.
7. Koduvayur - Kuzhalmannam Road at L.S. 15/0.
8. Alathur-Koduvayur road at L.S. 15/7½.

Provision has been made for bridges with B class loading at all these sites. For the crossing at 11/7, the road is to be diverted to 11/6 to cross over the Regulator and Bridge at 11/6. A lineal water way of B plus $\frac{1}{2}$ D. has been allowed for these bridges and there is therefore no loss of head. At site of item (4) it is possible to take the road on the top of the right bank, and the bank from L.S. 11/2-530 to 12/6-450 can carry a road way in which case the bridges at sites (4) and (5) can be omitted. This can be considered during execution.

32. The canal crosses also a number of cart tracks and 'C' class bridges have been provided for these crossings. The cart track from Palghat to Pudunagaram crossing the canal at 9M./3F. is diverted over the 'C' class bridge at L.S. 9/7½, and the cart track is taken along the toe of the left bank for which extra acquisition had been provided for.

Besides the bridges provided for the main roads and cart tracks, some foot bridges may be found necessary near villages, for crossing the canal. These can be decided only during execution. A L.S. provision has been made for the same in the estimate.

33. REGULATORS:

Two Regulators are provided for at L.S. 11/6 and 14/4½ where important branch channels Nos. 7 and 9 with ayacuts 9,200 and 13,000 acres respectively take off. For purposes of emptying the canal in an emergency, a regulator with vents and a surplus escape have been provided for at L.S. 8M./5F. Provision has also been made for excavating a leading channel from the surplus work to the Kannadi river.

34. BRANCH CHANNELS:

Pending block level survey of the ayacut, the total ayacut available has been computed from the survey of India sheets excluding the uncommandable lands and house sites. Two-third of the net available lands after the above exclusions have been taken into account for assessing the irrigable extent under the different branch channels. Even in the G.O. 291-I dated 11-6-1926, the extent of lands available was taken as 40,000 acres and as there have been further conversion of dry into wet lands during all these years, this extent can be safely assumed as available for irrigation. The Tahsildar, Palghat, has given a list of existing private irrigation sources in the taluk. From the list it is observed that there are no private irrigation sources in the proposed ayacut.

35. SLUICES:

Eleven branch channels take off from the main canal. For all these, head sluices have been provided. In addition to them, 11 pipe sluices with ayacut ranging from 40 to 220 acres under each are provided for. All the sluices, excepting those for branches 7 and 9 at offtake of which there are regulators in the canal, are designed for half supply level in the main canal. The sills of all the sluices are kept at the bed level of the canal, so that even during periods of low supplies full supply can be drawn through all sluices. Screw gearing shutters will be provided for all the sluices.

36.0. BUILDINGS:

36.1. Provision has been made in the estimate for quarters for one Executive Engineer, 4 Assistant Engineers and 16 Section Officers besides lascars shed etc. Their exact location will be decided during execution.

36.2. The Rest House at the head works will be retained even after the construction of the Dam. The canal runs close to Palghat Town at 6/2½. An Inspection Bungalow will be constructed in Palghat Town at a suitable place. There is a District Board T. B. in Koduvayur village near L.S. 16/0½. One inspection bungalow will therefore be constructed near 11/6 in Tenniseri village.

37.0. ESTIMATE FOR LEFT SIDE MAIN CANAL:

37.1. *Land acquisition:* The cost of Land Acquisition works out to Rs. 7.1 lakhs. The rates for the wet, dry and other classifications adopted are as per the rates fixed by the Tahsildar, Palghat for the Cheramangalam anicut channel. 15 per cent. extra for solatium for compulsory acquisition has also been provided for.

37.2. *Earth work:* In the earth work rate an average of 4 extra leads and 4 extra lifts have been provided for. A lump sum provision has also been made for tramping earth. Rock cutting has also been provided for in the estimate.

37.3. MASONRY WORKS:

Cost of masonry works has been based on estimates made out for typical designs. As the abutments and wings remain constant, extra cost has been worked out at R. foot rate of extra width of span and extra added for piers also where necessary.

38. ESTIMATE FOR DISTRIBUTARIES:

The estimate for distributaries is worked out on the basis of the average for Vandithodu and Cheramangalam anicut schemes. The total ayacut under direct sluices is 980 acres and as field bothies are required for these, the cost can be taken as Rs. 100 per acre and for the rest of the ayacut of 39,020 acres under the scheme, the cost is taken as Rs. 225 per acre.

39. RATES:

Rates have been worked out from current schedule of rates. Average leads have been allowed for all masonry works in the canal except for the Korayar and Kannadi aqueducts for which individual leads have been allowed. As skilled labour is not available in the district to necessary extent 50 per cent. extra has been allowed for the cost of skilled labour for necessary charges for importation of this labour.

40. ESTABLISHMENT:

The project is to be completed in 3 to 4 years with one Superintending Engineer and 2 Executive Engineers with their subordinate staff. One more Executive Engineer with his staff will complete the preliminary work in six months' time. Due to the monsoon being heavy from June to August and then again in October and November, intensive construction work is possible only from November to May. During the monsoons, the staff will be engaged on indoor work such as preparation of detailed designs, working out quantities and planning for work after the monsoon. Provision for special allowances to the staff on the basis of those sanctioned for the staff of the Lower Bhavani Project is also necessary to serve as an incentive to better work and to ensure speedy completion of the project.

41. REVENUE RETURNS:

The return is worked out on the basis of a water tax of Rs. 7-8-0 for the first two crops together and Rs. 5 for the third crop. The possibilities of increasing the tax to Rs. 7-8 for the third crop also in view of the high cost of the scheme remains to be examined.

The reservoir can irrigate an average extent of 13,455 acres of third crop and 2,000 acres of perennial crops. The perennial crop of 2,000 acres will be charged at Rs. 12-8 per acre for the full year. Taking the remaining 38,000 acres at the rate of Rs. 7-8 for the first two crops together and the average extent of 13,455 acres of third crop at Rs. 5, the revenue will be as under:—

	Rs.	Rs.
38,000 acres of 1st and 2nd crop at Rs. 7-8-0 per acre	...	2,85,000
2,000 acres of Perennial crop at Rs. 12-8-0 per acre	...	25,000
13,455 acres of average 3rd crop at Rs. 5/-	...	67,275
		3,77,275
Deduct maintenance charges at 1-0-0	...	40,000
Collection charges	...	18,863
		58,863
Net Revenue	...	3,18,412
Cost of the scheme	...	380 lakhs
Return	...	0.84%

APPENDIX I

MALAMPUZHA PROJECT—CLASSIFIED ABSTRACT

Sub-head	Amount	Total
	Rs.	Rs.
1. Head works	...	2,01,25,000
2. Main canals and branches	...	75,75,000
3. Distributaries, etc.	...	69,00,000
		3,46,00,000
Total works	...	3,46,00,000
Establishment charges including special leave and travelling allowances	...	20,00,000
Tools and plant ordinary 2%	...	6,92,000
Audit & Accounts 1%	...	3,46,000
Pensionary charges 12½% on establishment	...	2,50,000
Abatement of land revenue	...	1,12,000
		3,80,00,000
	Rs. 380 lakhs.	
1. HEAD WORKS.—		
A. PRELIMINARY EXPENSES	...	96,000
Unforeseen	...	4,000
		1,00,000
B. LAND.—		
Cost of acquisition	...	29,93,300
Unforeseen	...	56,700
		30,50,000
C. WORKS: COST OF WORKS	...	1,16,70,000
K. BUILDINGS As Per Estimate	...	16,67,500
Unforeseen	...	32,500
		17,00,000
M. PLANTATIONS	...	10,000
O. MISCELLANEOUS As Per Estimate	...	13,71,500
Unforeseen	...	13,500
		13,85,000
P. MAINTENANCE	...	10,000
Q. SPECIAL TOOLS & PLANT	...	22,00,000
		2,01,25,000
2. MAIN CANALS AND BRANCHES.—		
A. PRELIMINARY EXPENSES	...	35,000
B. LAND	...	7,10,000
D. REGULATORS AS PER DETAILED ESTIMATE	...	1,02,800
Unforeseen	...	7,200
		1,10,000
F. CROSS DRAINAGE WORKS.—		
As per details	...	16,98,000
Unforeseen	...	32,000
		17,30,000
G. BRIDGES.—		
As per details	...	7,58,000
Unforeseen	...	22,000
		7,80,000
H. ESCAPES AS PER DETAILS	...	26,000
Unforeseen	...	4,000
		30,000
K. BUILDINGS AS PER DETAILS	...	2,50,000
Unforeseen	...	50,000
		3,00,000
L. EARTHWORK	...	30,20,000
M. PLANTATIONS AS PER DETAILS	...	25,000
Unforeseen	...	15,000
		40,000
O. MISCELLANEOUS	...	1,00,000
P. MAINTENANCE	...	20,000
Q. SPECIAL TOOLS & PLANT	...	7,00,000
		75,75,000
Total 2 Main canal & Branches	...	
3. DISTRIBUTARIES INCLUDING MASONRY WORKS AND FIELD BOTHIES	...	69,00,000
		69,00,000

Sub-head.	Amount.	Total.
	Rs.	Rs.
I. HEAD WORKS		
I. A. PRELIMINARY EXPENSES.		
Cost of preliminary investigation ...		96,000
II. B. LAND.		
(a) Acquisition of land in the submersion area ...		24,74,950
(b) Acquisition of land for camps & buildings ...		98,000
(c) Acquisition of land for the formation of roads ...		19,940
(d) Compensation for Pattani anicut ...		10,000
(e) Compensation of 15% solatium ...		3,90,410
		<u>29,93,300</u>
III. C. WORKS.		
(1) Dam—Non over flow section ...		92,70,000
(2) Dam—Over flow section ...		24,00,000
		<u>1,16,70,000</u>
IV. K. BUILDINGS.		
(a) EMPLOYEE HOUSING FOR THE VARIOUS CLASSES OF EMPLOYEES (FAMILY TYPE: NON FAMILY TYPE OR DORMITORY TYPE—NUMBERS TO BE DECIDED DURING CONSTRUCTION ACCORDING TO REQUIREMENTS.)		
1. No Quarters for one Superintending Engineer ...	37,500	Each 37,500
2. Nos. " for Executive Engineer ...	25,000	" 50,000
7. Nos. " for Asst. Engineers ...	12,500	" 87,500
2. Nos. " for Medical Officers... ..	12,500	" 25,000
50 Nos. " for High grade subordinates such as Supervisors, Accountants, Head Clerk, Police Officers (family type)—U. D. C. Type ...	5,000	" 2,50,000
70 Nos. " (family type and non-family bachelors) dormitory type for lower grade subordinates and work establishment such as drivers, mechanics and chargemen ...	3,750	" 2,62,500
50 Nos. " for Maistries... ..	1,875	" 93,750
50 Nos. " Peons	1,250	" 62,500
Buildings for mess cafeteria & other Miscellaneous quarters & additional quarters ...	L.S.	50,000
(b) CIVIC GROUP OF BUILDINGS.—		
1 No. quarters Hospital Buildings ...		10,000
1 No. Police Station & treasury ...		20,000
1 No. Post & Telegraph Office ...		10,000
(c) STORES & WORKSHOP BUILDINGS.—		
30 Sheds. Stores shed (Nissen huts or other Military type sheds of different kinds) ...		1,00,000
Workshops, power house and compressor House ...		75,000
(d) OFFICE AND ADMINISTRATION BLOCKS.—		
Office block of different kinds, control office buildings, field office and information office ...		75,000
(e) REST HOUSE BUILDINGS.—		
1 No. Malampuzha House (Project Rest house) ...	31,250	Each 31,250
10 Nos. Rest & tourist sheds—dormitory type (inspection shed) ...	6,000	" 60,000
(f) WORKMEN'S QUARTERS AND LABOUR COLONY.—		
500 Nos. Coolies' huts ...	625	" 3,12,500
Maintenance charges for three years ...		55,000
		<u>16,67,500</u>
V. M. PLANTATIONS.		
Providing park and avenue trees ...		10,000

Sub-head.	Amount.	Total.
	Rs.	Rs.
VI. O. MISCELLANEOUS.		
1. Constructing a bridge across Malampuzha ...		1,00,000
2. Constructing a bridge across left side canal ...		25,000
3. Constructing a bridge across the Right side canal if found necessary ...		15,000
4. Forming new roads and widening the existing roads & surfacing the top with cement concrete where necessary as per detailed estimates ...		3,94,920
5. Forming camp roads within head works ...		1,03,500
6. Improving the existing road culverts ...		10,830
7. Maintaining the main roads ...		38,250
8. Maintaining the roads in the camp area ...		15,000
9. Telephone at Headworks & Offices ...		10,000
10. Railway siding ...		80,000
11. Drainage, Sanitation, Public Health, conservancy including antimalarial operations and upkeep of hospital, etc. ...		1,67,000
12. Water supply to camp area including maintenance ...		2,00,000
13. Boats for works ...		5,000
14. Light for works ...		10,000
15. Experiments and tests ...		10,000
16. Electrical transmission lines and power house equipments ...		1,86,000
17. Playgrounds ...		1,000
		<u>13,71,500</u>
VII. P. MAINTENANCE OF WORKS DURING EXECUTION ...		10,000
VIII. Q. SPECIAL TOOLS & PLANT.—		
(1) Air compressors, accessories and equipment complete with pneumatic tools ...	1,50,000	
(2) Tramway plant, track, rolling stocks wagons, etc. ...	3,50,000	
(3) Mixers & disintegrators ...	2,00,000	
(4) Workshop equipment ...	50,000	
(5) Shifting & lifting tractors ...	30,000	
(6) Pumps ...	25,000	
(7) 18 Lorries, 1 staff wagon & 1 Jeep ...	3,00,000	
(8) Tractors, Calyx drills, excavators, grouting machines, conveyors, concrete batching and placing plants ...	10,10,000	
(9) Maintenance and repairs ...	85,000	
	<u>22,00,000</u>	<u>22,00,000</u>
Note.—The items are illustrative and actual requirements may be varied according to needs of works during execution.		
2. MAIN CANAL AND BRANCHES.		
I. A. PRELIMINARY EXPENSES ...	35,000	35,000
II. B. LAND.— Acquisition for main canal ...	5,83,700	
15% Solatium ...	87,555	
Cost of huts & buildings ... L.S.	38,745	
	<u>7,10,000</u>	<u>7,10,000</u>
III. D. REGULATORS.— Regulator at 8/5 ...	32,000	
Regulator & Bridge, 11/7 ...	50,800	
Regulator, 14-4-330 ...	20,000	
	<u>1,02,800</u>	<u>1,02,800</u>
IV. F. CROSS DRAINAGE WORKS.—		
Aqueduct across Koraiyar at 1-7-200 ...	4,30,000	
Aqueduct across Kannadi at 8-3-0 ...	6,13,000	
Masonry undertunnel at 4-3-405 ...	1,17,000	
6-7-500 ...	37,000	
10-1-200 ...	81,000	
17-2-330 ...	81,000	
17-4-0 ...	81,000	
18-6-0 ...	81,000	
Pipe undertunnel at 0-5-0 ...	8,700	
1-6-0 ...	9,500	
3-0-0 ...	9,500	
3-7-330 ...	9,500	
5-0-530 ...	8,900	
5-5-330 ...	5,900	
6-4-330 ...	6,000	
8-5-460 ...	6,000	
9-1-330 ...	6,000	
9-5-0 ...	5,900	
10-6-0 ...	5,900	
11-7-0 ...	6,000	

Sub-head.	Amount.	Total.
IV. F. CROSS DRAINAGE WORKS—Contd.		
Pipe undertunnel at	13-0-0 ... 9,000	
	13-4-0 ... 5,000	
	14-0-0 ... 5,000	
	14-6-330 ... 8,600	
	15-1-0 ... 5,500	
	16-3-0 ... 5,700	
	17-0-0 ... 4,400	
	17-4-40 ... 5,700	
Outlet at	6-0-0 ... 5,000	
-Do-	11-4-330 ... 8,500	
-Do-	12-6-330 ... 11,200	
-Do-	15-7-0 ... 5,200	
-Do-	19-1-0 ... 5,200	
-Do-	20-0-330 ... 5,200	
	16,98,000	16,98,000
V. G. BRIDGES.—		
	Rs.	Rs.
Syphon Bridge at 1-2-300 for Broad Gauge railway line	2,50,000	
Box culvert at 10-7-330 for Metre Gauge railway line	2,50,000	
14 'B' class and 'C' class Bridges, 7 'B' class bridges at (1) 6/2½; (2) 7/7-200 (3) 11/1 (4) 11/2-530 (5) 12/6-450 (6) 15/0 & (7) 16/0-½ & 7 'C' class bridges at (1) 3/6 (2) 5/3½ (3) 7/4½ (4) 9/7½ (5) 14/3½ (6) 16/7 & (7) 19/5	2,27,000	
Foot Bridges	18,000	
Add extra depth for foundations	13,000	7,58,000
VI. H. ESCAPE—Surplus sluice	26,000	26,000
VII. K. BUILDINGS.—		
1. No. Quarters for the Executive Engineer	25,000	25,000
4 Nos. -Do- Asst. Engineers	12,500	50,000
16 Nos. -Do- Supervisors	5,000	80,000
L. S. Lascars quarters, Telephone sheds	L.S.	57,500
2 Nos. Inspection Bungalow	18,750	37,500
		2,50,000
VIII. L. EARTHWORK.	30,20,000	30,20,000
IX. M. PLANTATIONS.	25,000	25,000
X. O. MISCELLANEOUS.—		
Constructing 11 pipe sluices	23,430	
Providing diversion roads & fixing mile and furlong stones	20,980	
Providing telephone connections	55,590	
		1,00,000
XI. P. MAINTENANCE.—	20,000	20,000
XII. Q. SPECIAL TOOLS & PLANT.—		
2 Nos. Excavators 10 R.B. size	70,000	
2 Nos. Bull dozers D. 7	1,00,000	
Tramway plant and tipping wagons, etc.	1,20,000	
L. S. Mixers, pump and tractors	45,000	
1 No. Staff wagon	10,000	
L. S. Maintenance and Repairs	10,000	
L. S. Elevating graders etc., and unforeseen works L. S.	3,45,000	
	7,00,000	7,00,000
Note.—The items are illustrative and actual requirements may be varied according to needs of works during execution.		
3. DISTRIBUTARIES.—		
Excavation including acquisition masonry works, bothies etc.	69,00,000	69,00,000

APPENDIX II

Abstracts of Estimates :

Quantity	Particulars	Rate Rs. A. P.	Per	Amount Rs.
HEAD WORKS				
A. PRELIMINARY EXPENSES :				
1.	Preliminary expenses for necessary surveys, demarcation of the area of submergence, clearing site, and marking alignment of dam, constructing temporary quarters for officers and subordinates till permanent ones are built			
	Cost incurred up to date 15,000		L.S.	90,000
	Cost required for further work 75,000		L.S.	5,000
2.	Establishment for the valuation of Reservoir waterspread area		L.S.	1,000
3.	Foundation-stone and opening ceremony		L.S.	
	Total Rs.			96,000
B. LAND COMPENSATION :				
1.	For acquisition of lands in submerged area			
(a) 607	ac Single wet lands	800	acre	4,85,600
(b) 1260	ac Double wet lands	1000	"	12,60,000
(c) 1605	ac Dry lands	250	"	4,01,250
(d) 76	ac Garden lands	300	"	22,800
(e) 453	ac Poramboke lands			
(f) 106	ac Unassessed waste lands	50	"	5,300
(g)	Acquisition of buildings in the above lands			3,00,000
	Total			24,74,950
2.	Acquisition of lands for camps and buildings :			
(a) 7	ac Double wet	2000	"	14,000
(b) 280	ac Dry lands	300	"	84,000
	Total			98,000
3.	Acquisition of lands for the formation of roads :			
(a) 3.5	ac Double wet lands	2000	"	7,000
(b) 11.4	ac Dry lands	300	"	3,420
	Acquisition of buildings on sides of road	L.S.	"	9,520
	Total			19,940
	Compensation for " Pattani " anicut	L.S.		10,000
	15% solatium for compulsory acquisition			3,90,410
	Total Rs.			29,93,300
C. WORKS :				
DAM (A) NON OVERFLOW SECTION.				
Units				
1549	Earthwork excavating foundation in gravelly soil	15-4-0	1000 Cft.	23,622
1552	Excavating foundations in hardrock...	20-0-0	100 "	4,31,040
2781	Benching rock in foundations	29-0-0	100 "	80,649
8704	Leading away spoils	3-4-0	1000 "	12,038
14203	Random Rubble in cement mortar (1 : 2½)	75-0-0	100 "	10,65,225
49165	Random Rubble in cement mortar (1 : 5)	63-0-0	100 "	30,97,395
32047	Random Rubble in cement mortar (1 : 4)	67-0-0	100 "	21,47,149
2532	Upstream face finish	8-0-0	100 Sq.ft.	20,256
394	Coursed Rubble in cement mortar (1: 2½)	90-0-0	100 Cft.	35,480
34204	P.C.C. blocks (1 : 2 : 4) for copings and string courses	1-4-0	100 "	42,755
4931	Cutstone work in cement mortar (1 : 2)	309-0-0	100 "	15,236
6377	R. C. Slab 1 : 2 : 4 for slabs over sluice	4-0-0	C.ft.	25,508
L.S.	Earthwork filling in front and rear of dam	L.S.		15,000
L.S.	Contraction joints	L.S.		70,000
L.S.	Pumping foundations	L.S.		1,00,000
L.S.	Drilling holes and special grouting	L.S.		1,00,000
L.S.	Laying the tram lines shifting the same and maintaining	L.S.		2,00,000
L.S.	Architectural finish on top of dam	L.S.		30,000
L.S.	Blasting rock and forming road on the hills portions of the dam at 380.00 (connecting the 3 lengths of dam lines and diversions road on the right flank of dam)	L.S.		1,00,000
L.S.	Provision of shutters for the right side and left side sluices and H. E. Pipes	L.S.		1,50,000
	Add Extra for the extra cost of cement now prevailing			10,35,000
	Contingencies and petty supervision			4,73,647
	Total			92.7 lakhs.

Quantity	Particulars	Rate Rs. A. P.	Per	Amount Rs.
(B) OVERFLOW SECTION :				
4040	Excavating foundations in hard rock	20-0-0	100 Cft.	80,800
121	Excavation in gravelly soil	15-4-0	1000	1,845
404	Benching rock	29-0-0	100	11,716
525	Leading away spoil	3-4-0	1000	1,706
16136	Reinforced concrete 1 : 2 : 4 mix	4-0-0	Cft.	64,544
9117	Random Rubble in Cement Mortar 1 : 2½	75-0-0	100	6,83,775
10381	Do do 1 : 4	67-0-0	100	6,95,527
567	Cutstone in cement mortar 1 : 2	309-0-0	100	1,75,203
998	Coursed Rubble in cement mortar 1 : 4	85-0-0	100	84,830
1769	Plum concrete with 50% boulders plus 50% - 2½ gauge stones mix (1 : 4 : 8)	61-0-0	100	1,07,909
52	Tons. Iron works-girders, angles, troughing, etc.	500-0-0	Ton	26,000
1776	G.I. Pipes 2" Dr. for hand rails	1-8-0	Rft.	2,664
33	Rft. Wearing coat of 3" concrete or 2" shell crete	40-0-0	100 Sit.	1,320
89	Face work with special chisel dressed face stones including pointing with cement mortar 1 : 2	32-2-0	100	2,859
330	Upstream face finish of spillway	8-0-0	100	2,640
L.S.	Contraction joints	L.S.		6,000
L.S.	Boring holes pressure grouting in foundations	L.S.		6,000
L.S.	Pumping in foundations			10,000
L.S.	Diversion work in river bed and surplussing arrangements during construction			25,000
L.S.	Providing channel grooves for future installation of shutters on the spillway			5,000
	Contingencies and petty supervision			94,662
Total				20,90,000
or				20.90 lakhs :
L.S. Add extra for extra cost of cement				3.10 lakhs
				24.00 lakhs

Total cost for the dam A+B=92.7+24.0 = Rs. 116.70 lakhs.

M. PLANTATIONS- Providing Parks and Avenue Trees:

Rs. 10,000

O. MISCELLANEOUS

1. CONSTRUCTING A BRIDGE ACROSS MALAMPUZHA RIVER.

1. 83 Units	Earthwork excavating in gravelly soil	15-4-0	1000	1,266
2. 54	E. W. excavation in hard rock	20-0-0	100	1,080
3. 23	Benching rock in foundations	29-0-0	100	667
4. 89	Leading away spoil	3-4-0	1000	289
5. 756 Cft.	Cutstone work in cement mortar (1 : 2)	300-0-0	100	2,268
6. 373 Units	Coursed rubble in cement mortar (1 : 4)	85-0-0	100	31,705
7. 250 Cft.	R. C. C. Work 1 : 2 : 4 mix	4-0-0	Cft.	1,000
8. 20 Tons	Iron work, including hoisting, fixing, painting, etc., complete	500-0-0	Ton	10,000
9. (a) 33 Units	Rough stone dry packing	28-8-0	100	941
(b) 17 Units	Gravel backing	15-8-0	100	264
10. L.S.	Coffer dam and pumping	L.S.		3,000
11. 31 Units	E.W. for forming embankments to approaches	14-0-0	1000 Cft.	434
12. L.S.	Fixing tramway connections and forming roadway over the bridge	L.S.		3,000
13. L.S.	Contingencies and Petty supervision	L.S.		3,086
	Extra for extra cost of cement and fluctuation in rates etc.			4,000
				1,00,000
2.	Constructing a bridge across left side canal with two spans of 30 ft. cost of two span-bridge			25,000
3.	Constructing a bridge across right side canal with one span of 30 ft. Cost of single span bridge			15,000
4. 5 M 3 F	Forming new roads and widening the existing roads and surfacing the top with cement concrete wherever necessary			3,94,920
5. 5 Miles	Camp roads: Forming new camp roads 12' wide over 6" soling with 6" metalling			1,03,500
6. 3 Nos.	Improving the existing road culverts			10,830
7. 6½ Miles	Maintaining the main road for 3 years	...2000 per year, per mile.		38,250
8. 5 Miles	Maintaining camp roads for 3 years	...1000		15,000
9. L.S.	Telephone at Head works and offices			10,000
10.	Railway siding east of Olavakkot station, including laying an additional loop line constructing a transport shed etc., complete			80,000
11.	Sanitation: Drainage arrangements for camps including maintenance			67,000
	Public Health and Conservancy including antimalarial operations			50,000
	Upkeep of hospital			50,000
12.	Water supply to camps including maintenance			2,00,000
13.	Boats for works			5,000
14.	Light for works			10,000
15.	Experiments and tests			10,000
16.	Electrical transmission lines and Power house equipment			1,86,000
17.	Playgrounds			1,000

P. MAINTENANCE.—

L.S.	Maintenance of works during construction	L.S.	10,000
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2. Main Canal and Branches.

Item No.	Quantity.	Description of work.	Rate	Per	Amount
1	2	3	4	5	6
A. PRELIMINARY EXPENSES.					
			Rs.		Rs.
1.		Preliminary expenses for necessary demarcation stones along the alignment of channel, clearing site, etc.	L.S.		5,000
2.		Proportionate cost of preliminary investigation up-to-date	L.S.		10,000
3.		Establishment for the acquisition of lands for the canal system	L.S.		10,000
4.		Detailed investigation of Distributaries	L.S.		10,000
					35,000
B. LAND COMPENSATION.					
(a) 211 acres.	Double wet lands	...	2200	acre	4,64,200
(b) 23	Single wet lands	...	1500		34,500
(c) 205	Dry lands	...	400		82,000
(d) 1	Garden lands	...	3000		3,000
Total					5,83,700
Add 15% for solatium					87,555
L.S. Add cost of huts and small buildings to be acquired					38,745
					7,10,000

Constructing a Regulator with 2 vents 8'-0" x 3'-6" at L.S. 14 M. 4½ Fur. of Malampuzha Left side canal.

1. L.S.	Earthwork excavating in foundations and forming banks	L.S.			260
2. 28.00 Units	Concrete broken stone in cement mortar mix 1 : 4 : 8	79-0-0	Cft.	100	2,212
3. 106.50	Random rubble in cement mortar 1 : 4	79-8-0			8,467
4. 202 Cft.	Reinforced cement concrete 1 : 2 : 4	4-10-0	Cft.		934
5. 16.50 Units	Rough stone revetment 1'-6" thick over 0'-6" gravel backing	45-5-0	Cft.	100	748
6. 153 Cft.	P. C. C. Concrete	1-8-0	Cft.		230
7. 4.00 Units.	Plastering with cement mortar (1 : 3) ¾" thick	14-8-0	Sqft.	100	58
8. L.S.	Providing Teakwood shutter with screw gearing arrangements etc., complete				2,000
9. L.S.	Contingencies & Petty supervision				751
10. L.S.	Add for unforeseen, etc.				4,400
					20,000

D. REGULATORS.—

1. 190 Sft.	L.S. 8/5 Regulator with 5 vents 8'-0" x 4'-9"	...15600+24			
	For piers	...300			
	Add Extra cost of cement etc.	...3 x 1500			
		4700			
2.	L.S. 11/7 Regulator & Bridge 4 vents of 8'-0"				50,800
3.	L.S. 14/4½ Regulator with 2 vents 8'-0" x 3'-6" as per detailed estimate				20,000

Korayar Aqueduct -6 spans of 60'-0" each R. C. C. open spandrel arch-ribbed Type.

1. a. L.S.	Earthwork excavating foundations in gravelly soil and forming banks	L.S.			1,000
b. 124.00	Blasting rock for taking foundations in hard rock	20-0-0	Cft.	100	24,80
2. L.S.	Leading away spoil	L.S.			1,000
3. 131.00 Units	Concrete broken stone 1½" size in cement mortar 1 : 4 : 8	61-8-0	Cft.	100	80,57
4. 549.00	Random rubble in cement mortar 1 : 4	62-0-0			34,587
5. 306.50	Coursed rubble in cement mortar 1 : 4	72-8-0			22,221
6. 66.00	Plastering with cement mortar 1 : 3 ¾" thick	14-0-0	100 Sqft.		924
7. 29550 Cft.	Reinforced concrete work Mix. 1 : 2 : 4	5-0-0	Cft.		1,47,750
8. 12200 Cft.	Reinforced cement concrete work Mix. 1 : 1.2/3 : 3.1/3.	5-4-0	Cft.		64,050
9. 67.00 Units.	Random rubble in cement mortar 1 : 4 for aprons and revetments	63-0-0	Cft.	100	4,221
10. L.S.	Provision for diversion works, coffer dams pumping for foundations, expansion joints and unforeseen works.	L.S.			19,000
11. L.S.	Contingencies and petty supervision				14,740
Add for extra cost of cement and modification in design etc.					1,10,000
Total					4,30,000

Kannadi Aqueduct 7 Spans 60'-0" open spandrel R. C. C. ribbed type.

1	2	3	4	5	6
			Rs.		Rs.
1. a. L.S.	Earthwork excavating foundations in gravelly soil and forming banks	...			1,000
b. 228.00	Blasting rock	...	20-0-0	Cft.	4,560
2. L.S.	Leading away spoil	...		100	500
3. 126.50	Concrete broken stone in cement mortar 1 : 4 : 8	...	60-8-0	"	7,653
4. 539.00	Coursed rubble in cement mortar 1 : 4	...	72-0-0	"	38,808
5. 1484.5	Random rubble in cement mortar 1 : 4	...	62-8-0	"	92,781
6. 33530	Reinforced cement concrete 1 : 2 : 4 including formwork, bending and tying grills etc., complete	...	5-0-0	Cft.	1,67,650
7. 12894	Reinforced cement concrete mix 1 : 1.2/3 : 3. 1/3 including formwork bending etc.	...	5-4-0	"	67,694
8. 27 Units.	Plastering with cement mortar (1 : 3) 3/4" thick	...	13-12-0	Sft.	371
9. 6700 Cft.	Random rubble in cement mortar 1 : 4 for apron and revetments	...	62-8-0	Cft.	4,188
10. L.S.	Provision for diversion works, coffer dam, pumping in foundations, expansion joints, etc., and unforeseen works	...			20,000
					4,05,205
11. L.S.	Contingencies and Supervision	...			19,795
	Add for extra cost of cement fluctuation in rates, modification in designs etc.	...			1,88,000
	Total Rs.				6,13,000
Constructing an undertunnel across Kallepulli Thodu. 4-3-405'					
1. L.S.	Earthwork excavating foundations and forming banks	L.S.			300
2. 217.00 Units	Concrete broken stone in cement mortar 1 : 4 : 8	...	79-0-0	Cft.	17,143
3. 6800 Cft.	Reinforced cement concrete Mix. 1 : 2 : 4	...	4-10-0	Cft.	31,450
4. 460 Units.	Random rubble in cement mortar 1 : 5	...	76-8-0	100	35,190
5. 34,000 Units.	Rough stone revetment 1'-6" thick over 0'-6" gravel backing	...	45-5-0	"	1,541
6. 360 Cft.	Cutstone 2 lines dressed set in cement mortar 1 : 3	...	308-0-0	"	1,109
7. 122.0 Units.	Plastering with cement mortar 3/4" thick 1 : 3	...	14-8-0	100	1,769
8. L.S.	Contingencies and Petty supervision	...			3,498
	Add extra cost of cement and fluctuation in rates and modification in designs	...			25,000
	Total				1,17,000
Constructing a pipe undertunnel at L.S. 1 M/6 F. of Malampuzha left side canal.					
1. L.S.	Earth work excavating foundations in ordinary soils, and forming banks	L.S.		Cft.	150
2. 21.50 Units	Concrete broken stone in cement mortar mix 1 : 4 : 8	...	79-0-0	100	1,698
3. 30.50 "	Random rubble in cement mortar 1 : 5	...	76-8-0	"	2,333
4. 4.50 "	Rough stone pitching 1'-6" thick over 0'-6" gravel backing	...	45-5-0	"	204
5. 350 Rft.	Supplying and fixing 3'-0" dia. pipes with necessary collars etc.	...	16-0-0	Rft.	5,600
6. 6.50 Units.	Second class brick in cement mortar 1 : 5	...	75-0-0	100	488
7. 110 Cft.	Cement concrete 1 : 2 : 4	...	1-8-0	Cft.	165
8. L.S.	Contingencies and petty supervision	...			362
	Total				11,000
	Cost of undertunnel excluding cost of pipes. 11000-5600	...			5,400
Outlet at L.S. 12 M. 6 1/2 Fur. of Malampuzha left side canal.					
1. L.S.	Earthwork excavating foundations in gravelly soil and forming banks	...		L.S.	150
2. 220 Cft.	Concrete broken stone 1 1/2" size in cement mortar mix. 1 : 4 : 8	...	79-0-0	Cft.	1,738
3. 55.00 Units	Random rubble in cement mortar 1 : 4	...	79-8-0	"	4,373
4. 1350 Cft.	P. C. C. 1 : 2 : 4	...	1-8-0	Cft.	2,025
5. 4850	Rough stone pitching 1'-6" over 0'-6" gravel backing	...	45-5-0	100	2,198
6. L.S.	Contingencies and Petty supervision	...		L.S.	716
	Total				11,200
F. Cross Drainages Malampuzha left side canal. Masonry undertunnels.					

1	2	3	4	5	6
			Rs.		Rs.
1.	L.S. 4/3 F. 405' Undertunnel for Kallepulli Thodu ventway (4 vents 9' x 6'-6") 4 Vents.	...			1,17,030
2.	L.S. 6/7-500 undertunnel for Karingavapulli Thodu (1 vent 9' x 6') ...	...			37,000
3.	L.S. 10/1-200 Kinasseri Thodu 3 Vents 9' x 6'-6" ...	...			81,000
4.	L.S. 17/2 1/2 Undertunnel for Erimayur Thodu 1st branch (3 vents 9' x 6'-6") ...	...			81,000
5.	L.S. 17/4 Undertunnel for Erimayur Thodu 2nd branch (3 vents 9' x 6'-6") ...	...			81,000
6.	L.S. 18/6 Undertunnel for Erimayur Thodu 3rd Branch (3 vents 9' x 6'-6") ...	...			81,000

PIPE UNDERTUNNELS.—Length of Pipes.

R.C. HUME pipes including transport to site.					
1.	220	Rft.	L.S. 0/5-2 Rows of 2'-6" dia. 110' long		
2.	240	"	L.S. 1/6-2 Rows of 3'-0" dia. 120' "		
3.	240	"	L.S. 3/0-2 Rows of 3'-0" dia. 120' "		
4.	240	"	L. S. 3/7 1/2		
5.	228	"	L.S. 5/0-530 2 Rows of 2'-6" Dia. 114' long.	For	
6.	114	"	L.S. 5/5 1/2 1 Row of 2'-6" Dia. 114' long.	Total	
7.	114	"	L.S. 6/4 1/2 1 Row of 3'-0" Dia. 114' "	Cost	
8.	114	"	L.S. 8/5-460	Vide	
9.	114	"	L.S. 9/1 1/2	Classified	
10.	114	"	L.S. 9/5	Abstract.	
11.	114	"	L.S. 10/6		
12.	114	"	L.S. 11/7		
13.	210	"	L. S. 13/0 2 Rows 3'-0" Dia. 105' long.		
14.	105	"	L.S. 13/4 1 Row 3'-0" Dia. 105' "		
15.	105	"	L.S. 14/0		
16.	180	"	L.S. 14/6 1/2 2 Rows 3'-0" Dia. 90' long.		
17.	90	"	L.S. 15/1 1 Row of 2'-6" Dia. 90' long		
18.	90	"	L.S. 16/3 1 Row of 3'-0" Dia. 90' "		
19.	90	"	L.S. 17/0 1 Row of 2'-0" Dia. 90' "		
20.	90	"	L.S. 17/4 1 Row of 3'-0" Dia. 90' "		

OUTLETS.—(Vide classified abstract).

' B' Class Bridge at L.S. 15/0 of Malampuzha left side canal.

1.	L.S.	Earthwork excavating in foundations and forming banks	...	L.S.		200
2.	13.50 Units	Concrete broken stone in cement mortar 1 : 3	...	79-0-0	100	1,067
3.	52.00 "	Random rubble in masonry in cement mortar 1 : 4	...	79-8-0	"	4,134
4.	850 Cft.	Reinforced cement concrete 1 : 2 : 4	...	4-10-0	Cft.	3,931
5.	10.00 Units	Dry stone revetment 1'-6" thick over 0'-6" gravel backing	...	45-5-0	100	453
6.	120 Cft.	Cement concrete 1 : 2 : 4	...	1-8-0	Cft.	180
7.	L.S.	Forming approaches, soling and metalling and providing guard stones, etc.	...	L.S.		500
8.	L.S.	Contingencies and Petty supervision	...			535
						11,000

Rate for ' C ' Class Bridge of clear span 26'-6"

Rate for ' B ' Class bridge. Rs. 11,000/.

Width of slab for ' B ' Class Bridge 22'-0"

Do. ' C ' do 14'-0"

Proportionate cost for " C " Class Bridge $\frac{11,000 \times 14}{22}$

7,000

" G " BRIDGES.—

S. No.	L.S. (Mile-age)	Class of Bridge	Description of place	Lineal waterway	Rate for standard Bridge of 28'-6" clear span	Additional cost for extra span	Extra cost for piers etc.	Total cost
1	2		3	4	5	6	7	8
1.	3/6	' C ' Class	Cart track from Kottakad ...	Feet 62.0	7000	35.5 x 70 or 2500	1000	10,500
2.	5/3 1/2	' C ' Class	Cart track from Pudusseri to Palghat ...	62.0	7000	2500	1000	10,500
3.	6/2 1/2	' B ' Class	Palghat Coimbatore road ...	62.0	11000	35.5 x 111 or 4000	1200	16,200
4.	7/4 1/2	' C ' Class	Cart track to Kodumba ...	58.0	7000	31.5 x 70 or 2200	1000	10,200
5.	7/7-200	' B ' "	Palghat Chittur road ...	58.0	11000	3500	1200	15,700
6.	9/7 1/2	' C ' "	Cart track to Pudunagaram ...	58.0	7000	2200	1000	10,200
7.	11/1	' B ' "	Palghat Kollangode road ...	58.0	11000	3500	1200	15,700
8.	11/2-530	' B ' "	Palghat Koduvayoor road ...	58.0	11000	3500	1200	15,700

1	2	3	4	5	6	7	8
9.	12/6-450' B' Class	Palghat Koduvayur road ...	46.0	11000	19.5 x 111 or 2200	1200	14,400
10.	14/3½ 'C' ..	Koduvayur Mannathukavu road ...	46.0	7000	1400	1000	9,400
11.	15/0 'B' ..	Koduvayur Kuzhalmannam road ...	26.5	11000	...	...	11,000
12.	16/0-½ 'B' ..	Alathur Koduvayur road ...	26.5	11000	...	...	11,000
13.	16/7 'C' ..	Pallassena road ...	26.5	7000	...	...	7,000
14.	19/5 'C' ..	Palghat Alathur road (via) Koduvayur ...	13.5	7000	(--1000)	...	6,000
		Add for fluctuation in rates and extra cost of cement, etc. ...					63,500
				Total			2,27,000

H. ESCAPES.

Item No.	quantity.	Description of work	Rate	Per	Amount
			Rs.		Rs.
		Malampuzha Left side canal.			
		Surplus sluice of 2 vents 8 feet x 4.75' at L.S. 8/5 of Malampuzha left side canal with S.G. Shutters etc., complete. (Based on regulator rate) ...			15,000
		Add extra for stepped apron in rear and protecting sides of surplus channel and excavating leading channel 800 feet long to Kannadi river ...	L.S.		5,000
		Add for extra cost of cement, modification in design ...			6,000
			Total		26,000

Malampuzha Main Canal I. Earthwork.

1.	105209	Earthwork excavating and depositing on bank in hard stiff clay, black cotton hard red earth, shales, murams, ordinary gravel stony earth and earth mixed with 50% fair-sized boulders as per S.S. 20 with 4 average extra leads and 4 average extra lifts ...	20-10-0	Unit.	21,69,936
2.	L.S.	Add for tramping earth to sites of embankments ...	L.S.		1,00,000
3.	L.S.	Add for special consolidation for embankments ...	L.S.		50,000
4.	L.S.	Temporary compensation for taking earth if necessary ...	L.S.		30,000
5.	23446 Unit.	Blasting rock ...	20-0-0	Unit of 100Cft.	4,68,920
6.	440	Lining with cement concrete 1 : 3 : 6 for floor and sides	112-0-0	100	49,280
7.	L.S.	Contingencies and Petty supervision ...	L.S.		1,51,864
		Total	L.S.		30,20,000

M. PLANTATIONS. Malampuzha left side canal.

L.S.		Planting goat foot creepers and grass and turfing in heavy embankments ...	L.S.		25,000
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Typical Estimate for constructing a pipe sluice (at L.S. 1 M./3 Fur.).

1.	L.S.	Earthwork excavating foundations and banks forming	L.S.		50
2.	475	Concrete broken stone in cement mortar mix (1 : 4 : 8) for foundations ...	79-0-0	Cft.	375
3.	950 Cft.	Random rubble in cement mortar 1 : 5 ...	76-8-0	"	727
4.	50	Second class bricks in cement mortar 1 : 5 ...	75-0-0	"	38
5.	39 Rft.	Supplying and fixing in position 18" dia. R.C.C. Hume pipes with necessary collars, etc., complete. ...	7-0-0	Rft.	273
6.	L.S.	Providing cement concrete vent stone at front face of pipes and cill stone ...	L.S.		20
7.	L.S.	Supplying and fixing R.S. cut beams at top of platform including hoisting and fixing with necessary M.S. Angles for guide beams ...	L.S.		100
8.	L.S.	Providing screw gearing shutters with locking arrangement ...	L.S.		266
9.	350 Cft.	Rough stone dry packing for apron and revetment over 6" gravel backing. ...	45-5-0	Cft.	159
10.	13 Cft.	Cement concrete coping (1 : 2 : 4) ...	1-8-0	Cft.	20
		Petty supervision and contingencies at 5% ...			102
		Total			2130

O. MISCELLANEOUS. Malampuzha left side canal.

1.	11 Nos.	Constructing 11 Nos. pipe sluices at the rate worked out for typical sluice ...	2130	each	23,430
2.	L.S.	Providing diversion roads for shifting bridge sites etc., as proposed in the L.S. ...	L.S.		20,980
3.	L.S.	Providing Telephonic communications between the Head works Regulators and officers quarters ...	L.S.		55,590
		Total			1,00,000

P. MAINTENANCE. Malampuzha left side canal.

L.S.		Maintaining of works during the construction period for 3 years ...	L.S.		20,000
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APPENDIX III

Copy of G. O. Ms. No. 590 P.W. dated 19th February 1949.

Sub.:—Projects — Malabar-Malampuzha Project — Execution sanctioned.

Read the following:—

From the Chief Engineer (I) No. 2326/47B-I. dated the 11th February 1948.

From the Board of Revenue, No. H.I. 4368/47, dated 30th March 1948.

From the Board of Revenue, B.P. Rt. No. 7016, dated 21st October 1948.

Order:—

His Excellency the Governor of Madras approves an expenditure of Rs. 3,80,00,000 (rupees three crores, eighty lakhs only) including direct and indirect charges on the construction of reservoir across the Malampuzha river in Palghat taluk of Malabar District together with the connected distributary channels.

2. The expenditure is debitable to "68, construction of Irrigation, Navigation, Embankment and Drainage Works—Irrigation Works — Unproductive — Post-War Reconstruction — Other than Tungabhadra Project. c. works—Malampuzha Project." The expenditure during the current year will be met by re-appropriation from the lump sum provision of Rs. 38 lakhs made under "68. Construction of irrigation etc." in the Budget Estimate for 1948-49 for irrigation schemes.

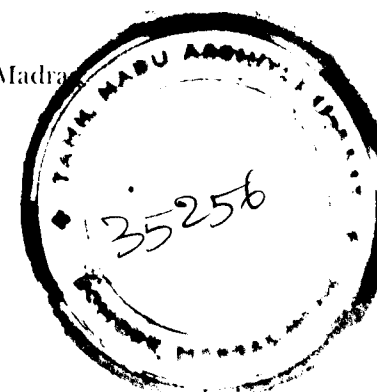
3. The Chief Engineer (I) is requested to submit proposals immediately for the necessary re-appropriation of funds to meet the expenditure on the work in the current year. A token grant will also be obtained from the Legislature. Meanwhile, the Accountant-General is requested to admit the expenditure in audit.

4. Suitable rates of water cess to be charged on lands benefited will be fixed in due course. It is also proposed to levy betterment fees in due course in respect of the lands that will be benefited by the scheme in accordance with the general orders to be issued shortly. The Chief Engineer (I) and the Board of Revenue are requested to see that the widest publicity is given to the Government's intention in this regard.

(By Order of His Excellency the Governor)

T. A. VARGHESE,
Secretary to Government.

To the Chief Engineer (I), Madras



Copy of letter No. 2326/47-B-I, dated 11-2-1948 from the Chief Engineer for Irrigation, Madras, to the Secretary to Government P.W.D., through the Board of Revenue.

Sub:- Irrigation - Malabar - Palghat Taluq - Malampuzha Project - Plans and estimates - Submitted.

I submit herewith an estimate for Rs. 380 lakhs with three reports (1) for constructing a dam across the Malampuzha river (2) for camps, buildings, roads, tools and plant etc. and (3) for excavating a canal with necessary distributaries on the left side to irrigate an area of 40,000 acres, for sanction of Government. A general site plan is also enclosed. The details of the scheme have been explained at length in the reports.

2. The construction of the dam is proposed to be in 3 stages as detailed below:-

1st stage:	F.R.L.	..	362.50	
	M.W.L.	..	370.00	
	Top of dam	..	380.00	
2nd stage:	F.R.L.	}	370.00	} Shutters for 7½ feet height to be provided.
	M.W.L.			
	Top of dam			
3rd stage:	F.R.L.	}	380.00	
	M.W.L.			
	Top of dam	..	390.00	Spillway section crest will be at 372.50 and 7½ feet shutters will also be provided.

The dam will be built even in the first stage to a section that will accommodate raising it to the final height in the third stage without any difficulty.

3. The original idea was to have two canals, one on either side, to command a total area of 40,000 acres. But due to the difficult nature of the country on the right involving long length of canal with insufficient area of commandable lands, the entire area is now proposed to be located under the left side channel. Two sluices will, however, be provided on the right side to irrigate the existing ayacut of about 300 acres and for any future extension.

4. The canal, which will be 20 miles half furlong long eventually falls into the Gayatri river. About 5 miles below this point, proposals for an anicut scheme have been so framed that if additional supplies can be made available from Malampuzha scheme, the anicut scheme could be further extended. The anicut scheme has been submitted to Government in this office No. 2779/47-B-5 dated 28-10-1947.

5. *Financial Aspects:* This has been furnished at the end of the report accompanying the estimate. The assessment adopted is as per decision of the conference held on 6-6-47 at Palghat. With the above assessment the return is 0.84% on the cost of the scheme including all charges. If the height of the dam is increased in the second and third stages and the development of power is also taken into consideration the return is likely to increase. The cost of all schemes in Malabar is bound to be very high due to rugged nature of the country and cost of acquisition of lands through which canals have to be dug. The increase in price of cement recently made increased the cost of work substantially.

6. This is one of the schemes included in the post-war scheme and also in the part II scheme for 1948-49.

7. It is difficult to forecast the extra food production by this scheme correctly and it can be assessed only after the scheme is actually completed in view of the fact that it is mainly intended to supplement supply to the existing areas of first and second crops besides bringing additional extent under second and third crops to the extent possible. The extra food production is roughly estimated as 20,000 tons.

8. The scheme will greatly assist production of food crops in Malabar which is entirely dependent on the vagaries of the monsoon for proper supply of water. The scheme is also the first of its kind in Malabar where it is proposed to store the plentiful rainfall during the monsoon period to assist irrigation and successful harvesting of second and third crops. Incidentally the scheme would also benefit the first crop in years when the monsoon is freakish and the rainfall ill-distributed.

The Cochin Government is interested in the appropriation of waters in this river, for correspondence on the subject please see 2168/45-B-38. It is presumed Cochin will have no objection.

9. I recommend the scheme for sanction of Government after examination by the Board of Revenue and Agricultural department.

Copy to the Secretary, P.W.D.

Copy to the S. E. Coimbatore Circle. Technical remarks will follow.

APPENDIX IV

STATEMENT-I

Statement showing monthly rainfall at Palghat in inches.--

Year Month.	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
January	...	...	*	0.06	...	...	0.62	0.06	0.05	...
February	...	5.69	...	...	...	...	0.25	...	...	...
March	...	1.18	1.01	0.91	1.57	...	0.04	2.06	1.63	2.50
April	3.14	0.10	...	2.18	3.81	4.78	1.02	2.06	1.16	0.55
May	2.67	7.64	18.08	1.78	2.15	0.85	12.40	0.40	4.09	1.07
June	*6.14	17.53	13.52	13.12	17.76	*	30.64	13.77	24.71	12.29
July	14.78	12.09	5.54	14.36	44.21	16.79	48.49	35.14	53.85	19.22
August	15.27	9.09	9.63	15.37	7.46	23.40	5.32	28.14	13.57	15.78
September	8.30	18.77	2.97	7.07	1.53	4.75	5.35	4.77	8.81	3.71
October	4.18	7.32	5.52	9.96	5.98	6.63	9.11	4.77	1.26	6.48
November	5.96	*	7.51	4.61	8.74	4.11	5.68	2.45	7.44	1.44
December	0.03	0.47	0.85	0.13	...	...	0.03	...	...	1.28
Total	60.47	79.88	64.63	69.55	93.21	61.31	118.95	93.62	116.57	64.32

*No record for.--

1. 1st to 19th June 1916
 2. November 1917.
 3. January 1918.
 4. June 1921
- Maximum rainfall (period 1922 to 1945) = 118.95 inches in 1922.
Minimum rainfall = 55.62 inches in 1928.
Average rainfall 24 years (1922 to 1945) = 85.4 inches

Year Month.	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
January	0.34	...	...	...	...	...	...	...	0.21	...
February	...	0.07	2.01	0.18	0.26	...	0.70	...	...	0.03
March	...	0.07	0.04	0.70	1.04	...	0.18	0.61	...	...
April	1.32	1.36	0.08	7.43	0.19	0.93	3.62	3.03	3.48	4.42
May	4.03	4.36	0.51	0.69	9.27	0.84	10.29	10.46	6.36	0.91
June	8.52	18.83	13.48	31.48	16.35	10.07	10.67	22.51	26.77	7.81
July	24.97	32.18	13.07	29.67	10.33	15.65	28.75	26.32	12.73	21.22
August	20.24	15.39	17.78	8.88	8.57	35.00	10.96	14.03	14.42	4.98
September	6.23	6.73	0.58	8.10	10.82	3.19	11.93	15.75	0.76	10.82
October	7.41	4.17	6.74	11.12	9.58	5.39	10.33	12.85	9.82	7.95
November	3.74	2.42	1.33	2.55	10.57	6.76	9.03	2.52	0.72	7.93
December	0.67	...	...	...	3.55	3.53	0.06	0.01	...	0.15
Total	77.47	85.58	55.62	100.80	80.53	81.36	96.52	108.09	75.27	66.22

Year Month.	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
January	...	...	...	0.11	...	0.22	...	5.71	...	...
February	...	0.12	3.31	...	...	...	...	0.03	1.36	0.29
March	4.94	3.02	0.34	0.22	...	...	0.30	0.51	1.76	...
April	...	5.86	2.00	7.17	5.09	1.91	3.30	4.92	1.71	2.02
May	3.88	1.25	5.12	3.26	9.14	9.18	7.03	18.36	8.58	1.48
June	20.98	8.18	21.28	9.68	17.29	22.92	20.98	15.42	10.20	7.32
July	22.88	24.99	18.11	24.97	24.54	22.63	32.68	24.36	22.27	25.95
August	13.03	10.67	10.85	16.04	18.82	21.69	9.40	3.30	47.34	7.93
September	4.87	1.61	4.94	2.94	1.28	6.60	2.62	6.54	6.44	3.53
October	11.47	12.80	7.35	9.14	5.80	10.31	14.45	15.27	8.04	5.83
November	4.35	3.15	0.76	8.87	7.01	3.43	0.27	2.68	4.09	8.82
December	...	0.52	0.49	0.80	0.99	3.56	5.32	...	1.33	0.09
Total	86.40	72.17	74.55	83.20	89.96	102.45	96.35	97.10	73.12	63.26

APPENDIX IV—Contd.

STATEMENT—II

Statement showing the monthly rainfall of Sappal Station in inches.—

Year Month.	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932
January	5.80	...	...	0.40	...	...	...	...	...	...
February	0.30	...	...	...	...	...	...	...	...	1.20
March	1.40	1.10	3.28	...	1.00	...	...	...	...	...
April	...	...	3.80	1.80	1.10	...	...	...	...	2.40
May	1.40	6.40	6.00	5.60	4.20	0.60	...	0.30	4.00	8.40
June	18.40	40.84	28.80	17.60	28.00	15.80	18.40	26.00	24.00	21.30
July	58.40	90.32	42.20	49.52	10.00	22.40	42.80	25.20	20.80	43.20
August	44.00	29.52	27.40	33.40	18.00	42.80	16.40	5.60	49.60	28.00
September	6.60	19.16	18.32	15.00	12.40	4.00	17.60	26.80	6.00	18.00
October	10.80	11.16	9.68	9.20	7.20	4.60	7.60	26.80	11.20	15.20
November	...	10.00	3.28	2.10	12.00	1.80	0.20	16.80	5.20	16.00
December	...	...	1.20	...	...	0.20	0.20	1.20	2.80	0.20
Total	147.10	208.50	143.96	134.62	93.90	92.20	103.20	128.70	123.60	153.90

Note.—Rainfall station located in 1923.

Monthly figures only are available upto and including October 1941. Daily figures are available from November 1941 onwards.

Maximum rainfall period 1923 to 1945=277.5 inches in 1944.

Minimum rainfall period 1923 to 1945=79.70 inches in 1935.

Average rainfall—23 years 144.5 inches.

Year Month.	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942
January	...	0.30	...	...	...	...	...	...	...	...
February	...	...	...	...	...	0.94	...	...	...	...
March	...	...	...	4.70	1.10	1.20	...	...	...	...
April	3.20	2.40	5.00	...	5.70	0.30	4.80	5.50	2.70	0.90
May	20.40	3.20	2.00	12.80	...	4.70	1.90	10.20	0.50	5.60
June	21.60	37.20	12.20	25.50	14.60	40.50	21.20	34.00	54.60	67.00
July	27.20	17.20	30.70	28.84	56.00	82.70	45.80	61.90	40.00	70.80
August	8.50	20.80	18.60	26.80	16.30	23.70	33.00	44.00	31.00	31.20
September	26.50	...	...	17.70	10.00	17.00	9.15	2.60	19.70	9.60
October	22.00	8.40	8.00	11.20	22.10	14.40	25.10	11.00	12.80	6.80
November	5.40	1.40	3.20	5.20	2.90	1.80	7.30	10.60	5.40	...
December	...	...	...	...	...	...	2.20	...	...	6.00
Total	134.80	90.90	79.70	134.74	128.70	187.24	148.25	182.00	176.70	197.90

Year Month.	1943	1944	1945							
January	14.60	...	...							
February	...	4.40	...							
March	...	6.50	...							
April	7.80	1.60	5.40							
May	31.00	7.00	0.60							
June	76.50	34.80	19.10							
July	77.20	48.60	39.20							
August	27.60	11.80	15.30							
September	17.00	11.00	8.60							
October	14.80	7.20	19.70							
November	11.00	5.60	9.60							
December	...	...	...							
Total	277.50	138.50	117.50							

2-9-46.

APPENDIX IV—Contd.

STATEMENT—III

Statement of Run off in Million Cubic feet in the Malampuzha River for the corresponding monthly rainfall of Sappal station.—

Taking 80° run off from the catchment area of 57 sq. miles.—

Year	May	June	July	August	Sept.	Oct.	Nov.	Decr.	Jan.	Feb.	March	April
1923-24	148.3	1949.3	6186.9	4661.4	699.2	1144.2	1059.4	...	...	...	116.5	...
1924-25	678.0	4326.6	9568.5	3127.3	2029.8	1182.5	1025.5	...	42.4	...	347.5	402.6
1925-26	635.6	3051.1	4470.7	2902.8	1940.8	1025.5	347.5	...	...	...	...	190.6
1926-27	593.3	1864.5	5246.1	3538.4	1589.1	974.6	222.5	...	...	...	105.9	116.5
1927-28	444.9	2966.3	1059.4	1906.9	1313.6	762.8	1271.5	...	...	...	...	...
1928-29	63.6	1673.9	2373.1	4334.2	423.8	487.3	190.7	...	...	...	...	...
1929-30	...	1949.3	4534.2	1737.4	1864.5	805.1	21.2	...	...	...	...	...
1930-31	31.8	2794.4	2669.7	593.3	2839.2	1271.1	21.2	...	...	...	...	...
1931-32	423.8	2542.6	2203.6	5254.6	635.6	1186.5	550.9	...	...	...	...	...
1932-33	889.9	2256.5	4576.6	2966.3	1906.9	1610.3	1695.0	...	...	127.1	...	...
1933-34	2161.2	2288.3	2881.6	900.5	2807.4	2330.7	572.1	...	31.8	...	...	...
1934-35	339.0	3940.9	1822.1	2203.6	889.9	889.9	148.3	...	...	...	497.9	...
1935-36	211.9	1292.5	3252.4	1970.5	ble.	847.5	339.0	...	...	...	116.5	...
1936-37	1356.0	2701.5	3055.3	2839.2	1875.1	1186.5	580.9	...	...	99.6	127.1	...
1937-38	...	1546.7	5932.6	1726.8	1069.4	2341.3	307.3	...	...	...	...	...
1938-39	497.9	4290.6	8761.2	2510.8	1800.9	1525.5	190.7	...	...	...	...	...
1939-40	201.3	2245.9	4852.1	3496.0	969.4	2659.1	773.4	...	...	...	...	...
1940-41	1081.6	3601.9	6557.7	4661.4	275.4	1165.3	1122.9	...	...	...	...	...
1941-42	52.9	5784.3	4237.3	3284.1	2087.0	1356.0	572.1	...	...	...	...	...
1942-43	593.2	7098.0	7500.6	3305.3	1017.0	720.4	1165.3	...	1546.7	...	...	...
1943-44	3284.1	8104.4	8178.6	2923.9	1800.9	1567.9	1165.3	...	...	466.1	...	...
1944-45	741.6	3686.7	5148.6	1250.0	1165.3	762.8	593.2	...	...	...	...	...
1945-46	63.5	2023.4	4152.8	1620.8	911.0	2087.0	1017.0	...	...	...	...	...
Monthly total	14493.4	73939.6	109223.0	63915.5	31011.3	31457.9	14490.7	1473.1	1620.9	692.8	2000.0	5762.9
Monthly average	630.1	3214.8	4748.8	2779.0	1348.3	1367.7	630.0	64.1	70.5	30.1	87.8	250.5

APPENDIX IV—Contd.

STATEMENT—IV

Statement of depth of irrigation required over and above rainfall—May to January in ayacut area.—

Particulars	May	June	July	August	Sep-tember	October	Novem-ber	Decem-ber	January of subse-quent year	Total depth of irriga-tion required	REMARKS
1	2	3	4	5	6	7	8	9	10	11	12
1916-17											
Rainfall during month	2.67	6.14	14.78	15.27	8.30	4.18	5.96	0.03	...	...	The requirements of cultivation has been taken as a total of 6" per month, with rains off and on and 8" per month with little or no rain.
Supplemental depth of water required ...	1.00	...	...	...	...	2.00	...	8.00	4.00	15"	
Total ...	3.67	6.14	14.78	15.27	8.30	6.18	5.96	8.03	4.00	15"	
1917-18											
R.F. in month ...	7.64	17.33	12.09	9.09	18.77	7.32	Not available assumed 4" 2.00	0.47	...	...	
Supplemental depth of water required ...	...	...	...	...	...	...		2.00	8.00	4.00	
Total ...	7.64	17.33	12.09	9.09	18.77	7.32	6.00	8.47	4.00	14"	
1918-19											
R. F. in month ...	18.08	13.52	5.54	9.63	2.97	5.52	7.51	0.85	0.06	...	
Supplemental depth of water required...	...	...	1.00	...	3.00	1.00	...	8.00	4.00	17"	
Total ...	18.08	13.52	6.54	9.63	5.97	6.52	7.51	8.85	4.06	17"	
1919-20											
R. F. in month ...	1.78	13.12	14.36	15.37	7.07	9.96	4.61	0.13	...	...	
Supplemental depth of water required...	2.00	...	...	...	...	...	2.00	8.00	4.00	16"	
Total ...	3.78	13.12	14.36	15.37	7.07	9.96	6.61	8.13	4.00	16"	
1920-21											
R. F. in month ...	2.15	17.76	44.21	7.46	1.53	5.98	8.74	...	...	...	
Supplemental depth of water required ...	1.00	...	...	...	5.00	1.00	...	8.00	4.00	19"	
Total ...	3.15	17.76	44.21	7.46	6.53	6.98	8.74	8.00	4.00	19"	
1921-22											
R. F. in month ...	0.85	Not avail-able.	16.79	23.40	4.75	6.63	4.11	...	0.62	...	
Supplemental depth of water required ...	3.00		...	...	...	2.00	...	2.00	8.00	4.00	
Total ...	3.85	...	16.79	23.40	6.75	6.63	6.11	8.00	4.62	19"	
1922-23											
R. F. in month ...	12.40	30.64	48.49	5.32	5.35	9.11	5.68	0.03	0.06	...	
Supplemental depth of water required ...	...	...	...	1.00	1.00	...	1.00	8.00	4.00	15"	
Total ...	12.40	30.64	48.49	6.32	6.35	9.11	6.68	8.03	4.06	15"	
1923-24											
R. F. in month ...	0.40	13.71	35.14	28.14	4.77	4.77	2.45	...	0.05	...	
Supplemental depth of water required ...	3.00	...	...	...	2.00	2.00	4.00	8.00	4.00	23.0	
Total ...	3.40	13.71	35.14	28.14	6.77	6.77	6.45	8.00	4.05	23.0	
1924-25											
R. F. in month ...	4.09	24.74	53.85	13.57	8.81	1.16	7.44	...	...	...	
Supplemental depth of water required ...	...	...	...	...	...	5.00	...	8.00	4.00	17"	
Total ...	4.09	24.74	53.85	13.57	8.81	6.16	7.44	8.00	4.00	17"	

APPENDIX IV—Contd.

STATEMENT—IV—Contd.

Statement of depth of irrigation required over and above rainfall—May to January in ayacut area.—Contd.

1	2	3	4	5	6	7	8	9	10	11	12
1925-26											
R. F. in month ...	1.07	12.29	19.22	15.78	3.71	6.48	1.44	1.28	0.34	...	The requirements of cultivation has been taken as a total of 6" per month, with rains off and on and 8" per month with little or no rain.
Supplemental depth of water required ...	2.00	...	...	...	3.00	...	5.00	6.00	4.00	20"	
Total ...	3.07	12.29	19.22	15.78	6.71	6.48	6.44	7.28	4.34	20"	
1926-27											
R. F. in month ...	4.03	8.52	24.97	20.24	6.23	7.41	3.74	0.67	...	...	
Supplemental depth of water required ...	...	...	...	...	...	...	3.00	8.00	4.00	15"	
Total ...	4.03	8.52	24.97	20.24	6.23	7.41	6.74	8.67	4.00	15"	
1927-28											
R. F. in month ...	4.36	18.83	32.18	15.39	6.73	4.17	2.42	...	...	...	
Supplemental depth of water required ...	...	...	...	...	...	2.00	4.00	8.00	4.00	18"	
Total ...	4.36	18.83	32.18	15.39	6.73	6.17	6.42	8.00	4.00	18"	
1928-29											
R. F. in month ...	0.51	13.48	13.07	17.78	0.58	6.74	1.33	...	...	...	
Supplemental depth of water required ...	3.00	...	...	...	7.00	...	5.00	8.00	4.00	27"	
Total ...	3.51	13.48	13.07	17.78	7.58	6.74	6.33	8.00	4.00	27"	
1929-30											
R. F. in month ...	0.69	31.48	29.67	8.88	8.10	11.12	2.55	...	...	...	
Supplemental depth of water required ...	3.00	...	...	...	...	...	4.00	8.00	4.00	19"	
Total ...	3.69	31.48	29.67	8.88	8.10	11.12	6.55	8.00	4.00	19"	
1930-31											
R. F. in month ...	9.27	16.35	10.33	8.57	10.82	9.58	10.57	3.55	...	...	
Supplemental depth of water required ...	...	...	...	...	...	...	...	3.00	4.00	7"	
Total ...	9.27	16.35	10.33	8.57	10.82	9.58	10.57	6.55	4.00	7"	
1931-32											
R. F. in month ...	0.84	10.07	15.65	35.00	3.19	5.39	6.76	3.53	...	...	
Supplemental depth of water required ...	3.00	...	...	...	3.00	1.00	...	3.00	4.00	14"	
Total ...	3.84	10.07	15.65	35.00	6.19	6.39	6.76	6.53	4.00	14"	
1932-33											
R. F. in month ...	10.29	10.67	28.75	10.96	11.93	10.33	9.03	0.06	...	...	
Supplemental depth of water required ...	...	...	...	...	...	...	...	8.00	4.00	12"	
Total ...	10.29	10.67	28.75	10.96	11.93	10.33	9.03	8.06	4.00	12"	
1933-34											
R. F. in month ...	10.46	22.51	26.32	14.03	16.75	12.85	2.52	0.01	0.21	...	
Supplemental depth of water required ...	...	...	...	...	...	...	4.00	8.00	4.00	16"	
Total ...	10.46	22.51	26.32	14.03	16.75	12.85	6.52	8.01	4.21	16"	
1934-35											
R. F. in month ...	6.36	26.77	12.73	14.42	0.76	9.82	0.72	...	...	...	
Supplemental depth of water required ...	...	...	...	...	6.00	...	6.00	8.00	4.00	24"	
Total ...	6.36	26.77	12.73	14.42	6.76	9.82	6.72	8.00	4.00	24"	
1935-36											
R. F. in month ...	0.91	7.81	21.22	4.98	10.82	7.95	7.93	0.15	...	...	
Supplemental depth of water required ...	2.00	...	...	2.00	...	...	...	8.00	4.00	16"	
Total ...	2.91	7.81	21.22	6.98	10.82	7.95	7.93	8.15	4.00	16"	

APPENDIX IV—Contd.

STATEMENT—IV—Contd.

Statement of depth of irrigation required over and above rainfall—May to January in ayacut area.—Contd.

	1	2	3	4	5	6	7	8	9	10	11	12
1936-37												
R. F. in month		3.88	20.98	22.88	13.03	4.87	11.47	4.35	...	...	...	
Supplemental depth of water required		...	...	...	...	2.00	...	2.00	8.00	4.00	16"	
Total		3.88	20.98	22.88	13.03	6.87	11.47	6.35	8.00	4.00	16"	
1937-38												
R. F. in month		1.25	8.18	24.99	10.67	1.61	12.80	3.15	0.52	...	...	
Supplemental depth of water required		2.00	...	...	...	5.00	...	3.00	8.00	4.00	22"	
Total		3.25	8.18	24.99	10.67	6.61	12.80	6.15	8.52	4.00	22"	
1938-39												
R. F. in month		5.12	21.28	18.11	10.85	4.94	7.35	0.76	0.49	0.11	...	
Supplemental depth of water required		...	...	...	...	2.00	...	6.00	8.00	4.00	20"	
Total		5.12	21.28	18.11	10.85	6.94	7.35	6.76	8.49	4.11	20"	
1939-40												
R. F. in month		3.26	9.68	24.97	16.04	2.94	9.14	8.87	0.80	...	...	
Supplemental depth of water required		...	...	...	...	4.00	...	...	7.00	4.00	15"	
Total		3.26	9.68	24.97	16.04	6.94	9.14	6.87	7.80	4.00	15"	
1940-41												
R. F. in month		9.14	17.29	24.54	18.82	1.28	5.80	7.01	0.99	0.22	...	
Supplemental depth of water required		...	...	...	...	5.00	1.00	...	7.00	4.00	17"	
Total		9.14	17.29	24.54	18.82	6.28	6.80	7.01	7.99	4.22	17"	
1941-42												
R. F. in month		9.18	22.92	22.63	21.69	6.60	10.31	3.43	3.56	...	...	
Supplemental depth of water required		...	...	...	...	...	...	3.00	3.00	4.00	10"	
Total		9.18	22.92	22.63	21.69	6.60	10.31	6.43	6.56	4.00	10"	
1942-43												
R. F. in month		7.03	20.98	32.68	9.40	2.62	14.45	0.27	5.32	5.71	...	
Supplemental depth of water required		...	...	...	...	4.00	...	6.00	1.00	...	11"	
Total		7.03	20.98	32.68	9.40	6.62	14.45	6.27	6.32	5.71	11"	
1943-44												
R. F. in month		18.36	15.42	24.36	3.30	6.54	15.27	2.68	...	...	...	
Supplemental depth of water required		...	...	...	3.00	...	...	4.00	8.00	4.00	19"	
Total		18.36	15.42	24.36	6.30	6.54	15.27	6.68	8.00	4.00	19"	
1944-45												
R. F. in month		8.58	10.20	22.27	7.34	6.44	8.04	4.09	1.33	...	...	
Supplemental depth of water required		...	...	...	...	...	...	2.00	6.00	4.00	12"	
Total		8.58	10.20	22.27	7.34	6.44	8.04	6.09	7.33	4.00	12"	
1945-46												
R. F. in month		1.48	7.32	25.95	7.93	3.53	5.83	8.82	0.09	...	...	
Supplemental depth of water required		2.00	...	...	...	3.00	1.00	...	8.00	4.00	18"	
Total		3.48	7.32	25.95	7.93	6.53	6.83	8.82	8.09	4.00	18"	
1946-47												
R. F. in month		0.76	25.20	19.52	27.17	5.80	5.92	6.33	8.74	...	...	
Supplemental depth of water required		3.00	...	...	...	1.00	1.00	...	...	4.00	9"	
Total		3.76	25.20	19.52	27.17	6.80	6.92	6.33	8.74	4.00	9"	

The requirements of cultivation has been taken as a total of 6" per month, with rains off and on and 8" per month with little or no rain.

APPENDIX IV—Contd.

STATEMENT V

Requirements of water for ayacut in inches and draw in Millions of Cft. from Reservoir—40,000 acres from May to January—12½% added for transmission losses.—

Year	May	June	July	August	September	October	November	December	January	Total requirements for the year	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
1916-17	1.13" 163	...	...	...	...	2.25" 327	...	9" 1307	4.5" 653	16.88" 2450	For transmission losses 12½% has been added to depths of water or the figures in statement IV and noted as numerator in this statement.
1917-18	...	...	...	...	...	...	2.25" 327	9" 1307	4.5" 653	15.75" 2287	The denominator represents the quantity in millions Cft. for the depths noted in the numerator.
1918-19	...	...	1.13" 163	...	3.38" 490	1.13" 163	...	9" 1307	4.5" 653	19.12" 2776	
1919-20	2.25" 327	...	...	...	...	...	2.25" 327	9" 1307	4.5" 653	18" 2614	
1920-21	1.13" 163	...	...	...	5.63" 817	1.13" 163	...	9" 1307	4.5" 653	21.39" 3103	
1921-22	3.38" 490	...	...	...	2.25" 327	...	2.25" 327	9" 1307	4.5" 653	21.38" 3104	
1922-23	...	...	...	1.13" 163	1.13" 163	...	1.13" 163	9" 1307	4.5" 653	16.89" 2449	
1923-24	3.38" 490	...	...	...	2.25" 327	2.25" 327	4.5" 653	9" 1307	4.5" 653	25.88" 3757	
1924-25	...	...	...	...	...	5.63" 817	...	9" 1307	4.5" 653	19.13" 2777	
1925-26	2.25" 327	...	...	...	3.38" 490	...	5.63" 817	6.75" 980	4.50" 653	22.51" 3267	
1926-27	...	...	...	...	...	...	3.38" 490	9" 1307	4.5" 653	16.88" 2450	
1927-28	...	...	...	...	...	2.25" 327	4.5" 653	9" 1307	4.5" 653	20.25" 2940	
1928-29	3.38" 490	...	...	...	7.78" 1143	...	5.63" 817	9" 1307	4.5" 653	30.29" 4410	
1929-30	3.38" 490	...	...	...	...	...	4.5" 653	9" 1307	4.5" 653	21.38" 3103	
1930-31	...	...	...	...	...	...	...	3.38" 490	4.5" 653	7.88" 1143	
1931-32	3.38" 490	...	...	...	3.38" 490	1.13" 163	...	3.38" 490	4.5" 653	15.77" 2286	
1932-33	...	...	...	...	...	...	...	9" 1307	4.5" 653	13.5" 1960	
1933-34	...	...	...	...	...	...	4.5" 653	9" 1307	4.5" 653	18" 2613	
1934-35	...	...	...	...	6.75" 980	...	6.75" 980	9" 1307	4.5" 653	27" 3920	
1935-36	2.25" 327	...	...	2.25" 327	...	...	...	9" 1307	4.5" 653	18" 2614	
1936-37	...	...	...	...	2.25" 327	...	2.25" 327	9" 1307	4.5" 653	18" 2614	
1937-38	2.25" 327	...	...	...	5.63" 817	...	3.38" 490	9" 1307	4.5" 653	24.76" 3594	
1938-39	...	...	...	...	2.25" 327	...	6.75" 980	9" 1307	4.5" 653	22.50" 3267	
1939-40	...	...	...	...	4.50" 653	...	...	7.78" 1143	4.5" 653	16.78" 2449	

APPENDIX IV—Contd.

STATEMENT V—Contd.

Requirements of water for ayacut in inches and draw in Millions of Cft. from Reservoir—40,000 acres from May to January—12½% added for transmission losses.—

Year	May	June	July	August	September	October	November	December	January	Total requirements for the year	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
1940-41	...	...	...	...	5.63" 817	1.13" 163	...	7.78" 1143	4.5" 653	19.04" 2776	For transmission losses 12½% has been added to depths of water or the figures in statement IV and noted as numerator in this statement.
1941-42	...	...	...	...	...	...	3.38" 490	3.38" 490	4.5" 653	11.26" 1633	The denominator represents the quantity in millions Cft. for the depths noted in the numerator.
1942-43	...	...	...	...	4.5" 653	...	6.75" 980	1.13" 163	...	12.48" 1796	
1943-44	...	...	...	3.38" 490	...	...	4.5" 653	9" 1307	4.5" 653	21.38" 3103	
1944-45	...	...	...	...	...	...	2.25" 327	6.75" 980	4.5" 653	13.5" 1960	
1945-46	2.25" 327	...	...	...	3.38" 490	1.13" 163	...	9.00" 1307	4.5" 653	20.26" 2940	
1946-47	3.38" 490	...	...	...	1.13" 163	1.13" 163	...	...	4.50" 653	10.14" 1469	

APPENDIX IV—Contd.

STATEMENT VI

Malampuzha Reservoir—Capacity Tables.

Contour.	Area in sq. in. in water spread map scale 1"=660 ft.	Area in Million sq. feet.	Average area in Million sq. ft.	Depth in feet.	Volume between contours in Mill. Cft.	Proposed total volume in Million Cft.	Remarks.
300	5.43	2.365	...	...	...	...	
310	24.88	10.838	6.60	10'	66.00	66.00	
320	69.18	30.155	20.49	10'	204.90	270.90	
330	129.81	56.545	43.34	10'	433.40	704.30	
340	214.84	93.584	75.06	10'	750.60	1454.90	
350	292.32	127.335	110.46	10'	1104.60	2559.50	
360	379.47	165.297	146.32	10'	1463.20	4022.70	
362	403.48	175.756	170.53	2'	341.06	4363.76	
362.5	...	...	172.10	2.5'	430.30	4453.0	
370.0	520.76	226.843	196.07	10'	1960.70	5983.4	
380.0	596.54	259.852	243.05	10'	2433.50	8421.9	4500 M. Cft. has been assumed as the capacity of the Reservoir at 362.50.

STATEMENT VII

Statement of Perennial and third Crop extents between the years 1923-45.

Year.	Crop area.	Remarks.	Year.	Crop area.	Remarks.
1	2	3	1	2	3
			B.F.	1,20,000 acres	
1923-24	9,000 acres	Column (2) includes a perennial crop of 2000 acres.	1933-34	14,000 "	Perennial crop upto 5,000 acres can be irrigated.
1924-25	14,000 "		1934-35	5,000 "	
1925-26	14,000 "		1935-36	14,000 "	
1926-27	10,000 "		1936-37	14,000 "	
1927-28	12,000 "		1937-38	14,000 "	
1928-29	5,000 "		1938-39	7,000 "	
1929-30	8,000 "		1939-40	14,000 "	
1930-31	14,000 "		1940-41	16,000 "	
1931-32	20,000 "		1941-42	20,000 "	
1932-33	14,000 "		1942-43	30,000 "	
			1943-44	14,000 "	
			1944-45	14,000 "	
C.O.	1,20,000 acres		Total	2,96,000 acres	

Average third and perennial crop for the period 1923-45 = 13,455 acres.

STATEMENT VII—Contd.

Statement of Perennial and 3rd Crop extents between the years 1916-18 and 1919-20.

Year.	Crop area.	Remarks.
1	2	3
1916-17	18,000 acres	Col. (2) includes a perennial crop of 2,000 acres.
1917-18	14,000 "	
1919-20	10,000 "	
Total	42,000 "	

Average crop extent = 14,000 acres.

APPENDIX IV—Contd.

STATEMENT VIII

Working Tables for Malampuzha Reservoir Capacity of Reservoir 4500 Million Cft. for the years 1916-18 and 1919-20.

Month and year.		Balance in reservoir in M. Cft.	Inflow.	Total Storage.	Draw for Irrigation.		Evaporation and absorption losses.		Total of (6) & (8)	Balance in reservoir.	Remarks.
					In Inches.	Quantity inclusive of 12½% transmission losses.	In Inches.	Quantity.			
1	2	3	4	5	6	7	8	9	10	11	
June 1916	200	2264*	2464	...	...	7"	79	79	2385	* gauged figures taken from files.	
July	2385	3203	4500	...	...	6"	90**	90	4500	** losses drawn from surplus.	
August	4500	4010	4500	...	...	6"	90	90	4500		
Sept.	4500	2350	4500	...	...	6"	90	90	4500		
Octr.	4500	1450	4500	2"	327	5"	75	402†	4500	† drawn from surplus.	
Novr.	4500	1091	4500	...	...	4"	60	60	4500		
Decr.	4500	560	4500	8"	1307	4"	60	1367	3693‡	‡ drawn from surplus.	
Jan. 1917	3693	...	3693	4"	653	4"	46	699	2994		
Feb.	2994	...	2994	10"††	735	4"	45	780	2214	†† ayacut : Perennial crop 2,000 acres.	
Mar.	2214	...	2214	10"	735	7"	73	808	1398	Third crop : 16,000 acres.	
Apr.	1398	...	1398	10"	735	9"	71	806	592		
May	592	...	592	...	...	10"	36	36	556	Total 18,000 acres.	
June	556	957	1513	...	...	7"	55	55	1458	10" in February. 10" in March. 10" in April. 6" in May. There is 7.64 of rain in May.	
July	1458	1201	2659	...	...	6"	64	64	2595		
Aug.	2595	1004	3599	...	...	6"	80	80	3519		
Sept.	3519	1913	4500	...	...	6"	90	90	4500		
Octr.	4500	1358	4500	...	...	5"	75	75	4500		
Novr.	4500	715	4500	2"	327	4"	60	387	4500	Drawn from surplus.	
Decr.	4500	...	4500	8"	1307	4"	60	1367	3133		
Jan. 1918	3133	...	3133	4"	653	4"	47	700	2433		
Feb.	2433	...	2433	10**	572	4"	40	612	1821	* 3rd crop : 14,000 acres.	
March	1821	...	1821	10"	572	7"	58	630	1191		
Apr.	1191	...	1191	10"	572	9"	57	629	562		
May	562	...	...	10**	...	10"	44	44	518	**There is 18.08" of rain in May.	
No particulars of rainfall of Sappal station, or gauged discharge are available for 1918-19. Hence working table is not prepared.											
June 1919	200	418	618	...	...	7"	29	29	589		
July	589	2350	2939	...	...	6"	71	71	2868		
Aug.	2868	2701	4500	...	...	6"	90	90	4500		
Sept.	4500	2313	4500	...	...	6"	90	90	4500		
Octr.	4500	1253	4500	...	...	5"	75	75	4500		
Novr.	4500	...	4500	2"	327	4"	60	387*	4500	* drawn from surplus	
Dec.	4500	...	4500	8"	1307	4"	60	1367	3133		
January 1920	3133	...	3133	4"	653	4"	43	696	2437		
Feb.	2437	...	2437	10"	409	4"	37	446	1991		
Mar.	1991	...	1991	10"	409	7"	62	471	1520	Perennial and 3rd crop 10,000 acres.	
April	1520	...	1520	10"	409	9"	70	479	904		
May	904	...	904	1"	368	10"	60	428	476		
for 30000 6" for 10,000 acres.											

No particulars of rainfall of Sappal station, or gauged discharge are available for 1918-19. Hence working table is not prepared.

June 1919	200	418	618	...	...	7"	29	29	589	
July	589	2350	2939	...	...	6"	71	71	2868	
Aug.	2868	2701	4500	...	...	6"	90	90	4500	
Sept.	4500	2313	4500	...	...	6"	90	90	4500	
Octr.	4500	1253	4500	...	...	5"	75	75	4500	
Novr.	4500	...	4500	2"	327	4"	60	387*	4500	* drawn from surplus
Dec.	4500	...	4500	8"	1307	4"	60	1367	3133	
January 1920	3133	...	3133	4"	653	4"	43	696	2437	
Feb.	2437	...	2437	10"	409	4"	37	446	1991	
Mar.	1991	...	1991	10"	409	7"	62	471	1520	Perennial and 3rd crop 10,000 acres.
April	1520	...	1520	10"	409	9"	70	479	904	
May	904	...	904	1"	368	10"	60	428	476	

No rainfall particulars or gauged discharges are available for 1920-23. Hence working table is not prepared.

APPENDIX IV—Contd.

STATEMENT IX

Working Tables for Malampuzha Reservoir for the years 1923-47. Capacity of Reservoir : 4500 M. Cft.

Month and year.	Balance in reservoir in M. Cft.	Inflow.	Total Storage.	Draw for Irrigation.	Evaporation and absorption losses.	Quantity inclusive of 12½% transmission losses.	In Inches.	Quantity.	Total of (6) & (8)	Balance in reservoir.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	
1923											
June	200	1949	2149	...	...	7"	73	73	2076		
July	2076	6188	4500	...	...	6"	90	90	4500		
August	4500	4661	4500	...	...	6"	90	90	4500		
Sept.	4500	699	4500	2"	327	6"	90	417	4500		
Octr.	4500	1144	4500	2"	327	5"	75	402	4500		
Novr.	4500	...	4500	4"	653	4"	60	713	3787		
Decr.	3787	...	3787	8"	1307	4"	54	1361	2420		
1924											
Jan.	2420	...	2420	4"	653	4"	41	694	1726		
Feb.	1726	...	1726	10"	368	4"	33	401	1325		3rd and perennial crop, 9,000 acres.
Mar.	1325	...	1325	10"	368	7"	55	423	902		
Apr.	902	...	902	10"	368	9"	47	415	487		
May	487	678	1165	6" for 9,000 acres	221	10"	70	291	874		
June	874	4327	4500	...	...	7"	105	105	4500		
July	4500	9569	4500	...	...	6"	90	90	4500		
August	4500	3177	4500	...	...	6"	90	90	4500		
Sept.	4500	2030	4500	...	...	6"	90	90	4500		
October	4500	1182	4500	5"	817	5"	75	892*	4500		* drawn from surplus.
November	4500	1059	4500	...	...	4"	60	60	4500		
December	4500	...	4500	8"	1307	4"	60	1367	3133		
1925											
January	3133	...	3133	4"	653	4"	43	696	2437		
February	2437	...	2437	10"	572	4"	37	609	1828		3rd and perennial crop 14,000 acres.
March	1828	3475	1828	10"	572	7"	64	636	1192		
April	1192	4026	1192	10"	572	9"	70	642	550		
May	550	636	1186	2" for 26,000 acres 6" for 14,000	555	10"	70	625	561		
June	561	3051	3612	...	...	7"	93	93	3519		
July	3519	4471	4500	...	...	6"	90	90	4500		
August	4500	2903	4500	...	...	6"	90	90	4500		
September	4500	1941	4500	3"	490	6"	90	580*	4500		* drawn from surplus.
October	4500	1025	4500	...	...	5"	75	75	4500		
November	4500	348	4500	5"	817	4"	60	877	3971		
December	3971	127	4098	6"	980	4"	56	1036	3062		
1926											
January	3062	42	3104	4"	653	4"	45	698	2406		
February	2406	...	2406	10"	572	4"	41	613	1793		Perennial and 3rd crop, 14,000 acres.
March	1793	...	1793	10"	572	7"	58	630	1163		
April	1163	...	1163	10"	572	9"	66	638	525		
May	525	593	1118	6" for 14,000 acres.	342	10"	80	422	696		
June	696	1865	2561	...	...	7"	82	82	2479		
July	2479	5246	4500	...	...	6"	90	90	4500		
August	4500	3538	4500	...	...	6"	90	90	4500		
September	4500	1589	4500	...	...	6"	90	90	4500		
October	4500	975	4500	...	...	5"	74	75	4500		
November	4500	222	4500	3"	490	4"	60	550	4500		Inflow is not reckoned.
December	4050	...	4050	8"	1307	4"	55	1362	2688		
1927											
January	2688	...	2688	4"	653	4"	42	695	1993		
February	1993	...	1993	10"	409	4"	37	446	1547		3rd and perennial crop, 10,000 acres.
March	1547	106	1547	10"	409	7"	56	465	1082		Inflow of 106 M.Cft. not taken into account.
April	1082	117	1082	10"	409	9"	48	457	625		Do. 117 M. Cft. do.
May	625	445	1070	6" for 10,000 acres.	245	10"	60	305	765		

APPENDIX IV—Contd.

STATEMENT IX—Contd.

Working Tables for Malampuzha Reservoir for the years 1923-47—Capacity of Reservoir: 4500 M. Cft.

1	2	3	4	5	6	7	8	9	10	11	
1927											
June	765	2966	3731	...	...	7"	94	94	3637	drawn from surplus.	
July	3637	1059	4500	...	...	6"	90	90	4500		
August	4500	1907	4500	...	...	6"	90	90	4500		
September	4500	1314	4500	...	...	6"	90	90	4500		
October	4500	763	4500	2"	327	5"	75	402	4500		
November	4500	1271	4500	4"	653	4"	60	713	4500		
December	4500	...	4500	8"	1307	4"	60	1367	3133		
1928											
January	3133	...	3133	4"	653	4"	47	700	2433	Perennial and 3rd crop, 12,000 acres.	
February	2433	...	2433	10"	490	4"	42	532	1901		
March	1901	...	1901	10"	490	7"	63	553	1348		
April	1348	...	1348	10"	490	9"	73	563	788		
May	788	...	788	3" for 28,000 acres. 6" for 12,000 acres.	637	10"	47	684	104		
June	104	1674	1778	...	...	7"	66	66	1712	300 M. Cft. drawn from surplus.	
July	1712	2373	4085	...	...	6"	83	83	4002		
August	4002	4534	4500	...	...	6"	90	90	4500		
September	4500	424	4500	7"	1143	6"	88	1231	3569		
October	3569	487	4856	...	...	5"	69	69	3987		
November	3987	191	4178	5"	817	4"	57	874	3304		
December	3304	21	3325	8"	1307	4"	49	1356	1969		
1929											
January	1969	...	1969	4"	653	4"	37	690	1279	3rd & perennial crop, 5,000 acres.	
February	1279	...	1279	10"	182	4"	28	210	1069		
March	1069	...	1069	10"	182	7"	42	224	845		
April	845	...	845	10"	182	9"	45	227	618		
May	618	...	618	3" for 35,000 acres. 6" for 5,000 acres.	552	10"	47	599	19		
June	19	1949	1968	...	...	7"	72	72	1896		
July	1896	4534	4500	...	...	6"	90	90	4500		
August	4500	1737	4500	...	...	6"	90	90	4500	**drawn from surplus.	
September	4500	1864	4500	7"	1143	6"	90	1233	4500		
October	4500	805	4500	...	...	5"	75	75	4500		
November	4500	21	4500	5"	817	4"	60	877	3644		
December	3644	21	3665	8"	1307	4"	53	1360	2305		
1930											
January	2305	...	2305	4"	653	4"	42	695	1610		*3rd and perennial crop 8,000 acres.
February	1610	...	1610	10**	290	4"	32	322	1288		
March	1288	...	1288	10"	290	7"	52	342	946		
April	946	...	946	10"	290	9"	52	342	604		
May	604	32	636	...	...	10"	48	48	588		
June	588	2754	3342	...	...	7"	87	87	3255	there is 9.27" rain in Palghat.	
July	3255	2670	4500	...	...	6"	90	90	4500		
August	4500	593	4500	...	...	6"	90	90	4500		
September	4500	2839	4500	...	...	6"	90	90	4500		
October	4500	2839	4500	...	...	5"	75	75	4500		
November	4500	1780	4500	4"	653	4"	60	713**	4500		
December	4500	127	4500	8"	1307	4"	60	1366	3260		
1931											
January	3260	...	3260	4"	653	4"	47	700	2560	*3rd and perennial crop, 14,000 acres.	
February	2560	...	2560	10**	572	4"	39	611	1949		
March	1949	...	1949	10"	572	7"	64	636	1313		
April	1313	...	1313	10"	572	9"	73	645	668		
May	668	424	1092	3" for 26,000 6" for 14,000	555	10"	72	627	465		
June	465	2543	3018	...	...	7"	79	79	2929	††drawn from surplus.	
July	2929	2204	4500	...	...	6"	90	90	4500		
August	4500	5255	4500	...	...	6"	90	90	4500		
September	4500	636	4500	...	...	6"	90	90	4500		
October	4500	1187	4500	...	...	5"	75	75	4500		
November	4500	551	4500	...	...	4"	60	60	4500		
December	4500	297	4500	3"	490	4"	60	550	4247		

APPENDIX IV—Contd.

STATEMENT IX—Contd.

Working Tables for Malampuzha Reservoir for the years 1923-47—Capacity of Reservoir: 4500 M. Cft.

1	2	3	4	5	6	7	8	9	10	11
1932										
January	4247	...	4247	4"	653	4"	58	711	3536	3rd and perennial crop: 22,000 acres.
February	3536	...	3536	10" for 22,000 acres.	898	4"	53	951	2585	
March	2585	...	2585	10"	898	7"	74	972	1613	
April	1613	...	1613	10"	898	9"	80	978	635	
May	635	890	1525	...	...	10"	67	67	1458	
June	1458	2257	3715	...	...	7"	94	94	3621	
July	3621	4577	4500	...	...	6"	90	90	4500	there is 10.29 of rain.
August	4500	2966	4500	...	...	6"	90	90	4500	
September	4500	1907	4500	...	...	6"	90	90	4500	
October	4500	1610	4500	...	...	5"	75	75	4500	
November	4500	1695	4500	...	...	4"	60	60	4500	
December	4500	21	4500	8"	1307	4"	60	1367	3154	
1933										
January	3154	...	3154	4"	653	4"	47	700	2454	3rd and perennial crop: 14,000 acres.
February	2454	...	2454	10"	572	4"	42	614	1840	
March	1840	...	1840	10"	572	7"	62	634	1206	
April	1206	339	1206	10"	572	9"	73	645	561	
May	561	2161	2722	...	...	10"	118	118	2604	
June	2604	2288	4500	...	...	7"	105	105	4500	
July	4500	2882	4500	...	...	6"	90	90	4500	there is 10.46" of rain- fall.
August	4500	900	4500	...	...	6"	90	90	4500	
September	4500	2807	4500	...	...	6"	90	90	4500	
October	4500	2331	4500	...	...	5"	75	75	4500	
November	4500	572	4500	4"	653	4"	60	713*	4359	
December	4359	...	4359	8"	1307	4"	58	1365	2994	
1934										
January	2994	...	2994	4"	653	4"	47	700	2294	*3rd and perennial crop: 14,000 acres.
February	2294	...	2294	10"*	572	7"	73	645	1649	
March	1649	...	1649	10"	572	9"	73	645	1004	
April	1004	...	1004	10"	572	9"	56	628	376	
May	376	339	715	...**	...	10"	47	47	668	
June	668	3941	4500	...	...	7"	105	105	4404	
July	4404	1822	4500	...	...	6"	90	90	4500	**There is 6.36" of rain.
August	4500	2204	4500	...	...	6"	90	90	4500	
September	4500	...	4500	6"	980	6"	90	1070	3430	
October	3430	890	4320	...	...	5"	71	71	4249	
November	4249	148	4397	6"	980	4"	58	1038	3359	
December	3359	...	3359	8"	1307	4"	49	1356	2003	
1935										
January	2003	...	2003	4"	653	4"	37	700	1303	3rd and perennial crop: 5,000 acres.
February	1303	...	1303	10"	182	4"	25	207	1096	
March	1096	...	1096	10"	182	7"	42	224	872	
April	872	...	872	10"	182	9"	45	227	645	
May	645	212	857	2" for 35,000 6" for 5,000	408	10"	53	461	396	
June	396	1293	1689	...	...	7"	64	64	1625	
July	1625	3253	4500	...	...	6"	90	90	4500	†To be drawn from surplus water.
August	4500	1971	4500	2"	327	6"	90	417†	4500	
September	4500	...	4500	...	...	6"	90	90	4410	
October	4410	848	4500	...	...	5"	75	75	4500	
November	4500	339	4500	...	...	4"	60	60	4500	
December	4500	...	4500	8"	1307	4"	60	1367	3133	
1936										
January	3133	...	3133	4"	653	4"	47	700	2433	Perennial and 3rd crop: 14,000 acres.
February	2433	...	2433	10"	572	4"	39	611	1822	
March	1822	...	1822	10"	572	7"	58	630	1192	
April	1192	...	1192	10"	572	9"	57	629	563	
May	563	1356	1919	6" for 14,000 acres.	343	10"	100	443	1476	
June	1476	2702	4178	...	...	7"	101	101	4077	
July	4077	3055	4500	...	...	6"	90	90	4500	††drawn from surplus.
August	4500	2839	4500	...	...	6"	90	90	4500	
September	4500	1875	4500	2"	327	6"	90	417††	4500	
October	4500	1187	4500	...	...	5"	75	75	4500	
November	4500	551	4500	2"	327	4"	60	387	4500	
December	4500	...	4500	8"	1307	4"	60	1367	3133	

APPENDIX IV—Contd.

STATEMENT IX—Contd.

Working Tables for Malampuzha for the years 1923-47—Capacity of Reservoir: 4500 M. Cft.

	1	2	3	4	5	6	7	8	9	10	11
1937											
January	...	3133	...	3133	4"	653	4"	47	700	2413	*3rd and perennial crop: 14,000 acres.
February	...	2413	...	2413	10"	572	4"	39	611	1802	
March	...	1802	...	1802	10"	572	7"	58	630	1172	**There is no water for 1st crop in May un- less April inflow is taken into account.
April	...	1172	...	1172	10"	572	9"	57	629	543	
May	...	543	...	543	6** for 14,000 acres	342	10"	38	380	163	
June	...	163	1547	1710	...	...	7"	65	65	1645	
July	...	1645	5932	4500	...	...	6"	90	90	4500	
August	...	4500	1726	4500	...	...	6"	90	90	4500	
September	...	4500	1059	4500	5"	817	6"	90	907	4500	
October	...	4500	2341	4500	...	...	5"	75	75	4500	
November	...	4500	307	4500	3"	490	4"	60	550	4257	
December	...	4257	...	4257	8"	1307	4"	58	1365	2892	
1938											
January	...	2892	...	2892	5"	653	4"	47	700	2192	†3rd and perennial crop: 14,000 acres.
February	...	2192	...	2192†	10"	572	4"	38	610	1582	
March	...	1582	...	1582	10"	572	7"	56	628	954	There is 5.12" rainfall.
April	...	954	...	954	10"	572	9"	58	630	324	
May	...	324	498	822	6" for 14,000 acres.	343	10"	50	393	429	
June	...	429	4290	4500	...	...	7"	105	105	4500	
July	...	4500	8761	4500	...	...	6"	90	90	4500	
August	...	4500	2511	4500	...	...	6"	90	90	4500	
September	...	4500	1801	4500	2"	327††	6"	90	417	4500	††drawn from surplus.
October	...	4500	1521	4500	...	...	5"	75	75	4500	
November	...	4500	191	4500	6"	980	4"	60	1040	3651	
December	...	3651	...	3651	8"	1307	4"	48	1355	2296	
1939											
January	...	2296	...	2296	4"	653	4"	42	695	1601	*3rd and perennial crop: 7,000 acres.
February	...	1601	...	1601	10"	286	4"	31	317	1284	
March	...	1284	...	1284	10"	286	7"	52	339	946	for 7,000 acres.
April	...	946	...	946	10"	286	9"	45	331	615	
May	...	615	201	816	3"	86	10"	40	136	680	
June	...	680	2246	2926	...	...	7"	82	82	2844	
July	...	2844	4852	4500	...	...	6"	90	90	4500	
August	...	4500	3496	4500	...	...	6"	90	90	4500	
September	...	4500	969	4500	4"	653	6"	90	90	4500	
October	...	4500	2659	4500	...	...	5"	75	75	4500	
November	...	4500	773	4500	...	...	4"	60	60	4500	
December	...	4500	...	4500	7"	1143	4"	60	1203	3297	
1940											
January	...	3297	...	3297	4"	653	4"	47	700	2597	3rd and perennial crop: 14,000 acres.
February	...	2597	...	2597	10"	572	4"	42	614	1983	
March	...	1983	...	1983	10"	572	7"	64	636	1347	*9.14" of rainfall.
April	...	1347	...	1347	10"	572	9"	70	642	685	
May	...	685	1081	1766	*	...	10"	92	92	1674	
June	...	1674	3602	4500	...	...	7"	105	105	4500	
July	...	4500	6558	4500	...	...	6"	90	90	4500	
August	...	4500	4661	4500	...	...	6"	90	90	4500	
September	...	4500	275	4500	5"	817	6"	90	907	3668	
October	...	3668	1165	4500	1"	163	5"	75	238	4500	
November	...	4500	1123	4500	...	...	4"	60	60	4500	
December	...	4500	223	4500	7"	1143	4"	60	1203	3520	
1941											
January	...	3520	...	3520	4"	653	4"	50	703	2817	3rd and perennial crop: 16,000 acres.
February	...	2817	...	2817	10"	653	4"	47	700	2117	
March	...	2117	...	2117	10"	653	7"	64	717	1400	*9.18" of rainfall.
April	...	1400	...	1400	10"	653	9"	70	723	677	
May	...	677	53	730	*	...	10"	47	47	683	
June	...	683	5784	4500	...	...	7"	105	105	4500	
July	...	4500	4238	4500	...	...	6"	90	90	4500	

APPENDIX IV—Contd.

STATEMENT IX—Contd.

Working Tables for Malampuzha Reservoir for the years 1923-47—Capacity of Reservoir: 4500 M. Cft.

	1	2	3	4	5	6	7	8	9	10	11
August	...	4500	3284	4500	...	...	6"	90	90	4500	drawn from surplus.
September	...	4500	2087	4500	...	...	6"	90	90	4500	
October	...	4500	1356	4500	...	...	5"	75	75	4500	
November	...	4500	572	4500	3"	490	4"	60	550	4500	
December	...	4500	...	4500	3"	490	4"	60	550	3950	
1942											
January	...	3950	...	3950	4"	653	4"	55	708	3242	3rd & perennial crop : 20,000 acres.
February	...	3242	...	3242	10" for 20,000 acres.	817	4"	47	864	2378	
March	...	2378	...	2378	10"	817	7"	75	892	1486	*7.03" of rainfall.
April	...	1486	...	1486	10"	...	9"	71	888	598	
May	...	598	593	1191	*	...	10"	92	92	1099	
June	...	1099	7098	4500	...	...	7"	105	105	4500	*drawn from surplus.
July	...	4500	7501	4500	...	...	6"	90	90	4500	
August	...	4500	3305	4500	...	...	6"	90	90	4500	
September	...	4500	3305	4500	4"	653	6"	88	741*	4500	
October	...	4500	1017	4500	...	...	5"	75	75	4500	
November	...	4500	720	4500	6"	980	4"	60	1040	3460	
December	...	4500	...	4500	...	163	4"	55	218	3878	
December	...	3460	636	4096	...	...	...	...	...	...	
1943											
January	...	3878	1547	4500	...	...	4"	60	60	4500	* Perennial and 3rd crop : 30,000 acres.
February	...	4500	...	4500	10"* for 30,000 acres.	1225	4"	60	1285	3215	
March	...	3215	...	3215	10"	1225	7"	90	1315	1900	18.36" of rain.
April	...	1900	...	1900	10"	1225	9"	82	1307	593	
May	...	593	3284	3877	...	...	10"	130	130	3747	
June	...	3747	8104	4500	...	...	7"	105	105	4500	
July	...	4500	8179	4500	...	...	6"	90	90	4500	
August	...	4500	2924	4500	3"	490	6"	90	580	4500	
September	...	4500	1801	4500	...	...	6"	90	90	4500	
October	...	4500	1568	4500	...	...	5"	75	75	4500	
November	...	4500	1165	4500	4"	653	4"	60	713*	4500	*drawn from surplus.
December	...	4500	...	4500	8"	1307	4"	60	1367	3133	
1944											
January	...	3133	...	3133	4"	653	4"	47	700	2433	Perennial and 3rd crop : 14,000 acres.
February	...	2433	...	2433	10"	572	4"	39	611	1822	
March	...	1822	...	1822	10"	572	7"	58	630	1192	8.58" of rain.
April	...	1192	...	1192	10"	572	9"	57	629	563	
May	...	563	742	1305	...	...	10"	84	84	1221	
June	...	1221	3687	4500	...	...	7"	105	105	4500	
July	...	4500	5149	4500	...	...	6"	90	90	4500	
August	...	4500	1250	4500	...	...	6"	90	90	4500	
September	...	4500	1165	4500	...	...	6"	90	90	4500	
October	...	4500	763	4500	...	...	5"	75	75	4500	
November	...	4500	593	4500	2"	327	4"	60	387**	4500	**Drawn from surplus.
December	...	4500	...	4500	6"	980	4"	60	1040	3360	
1945											
January	...	3360	...	3360	4"	653	4"	48	701	2659	3rd & perennial crop : 14,000 acres.
February	...	2659	...	2659	10"	572	4"	42	614	2045	
March	...	2045	...	2045	10"	572	7"	66	638	1407	
April	...	1407	...	1407	10"	572	9"	73	645	762	
May	...	762	64	826	2" for 26,000 acres. 6" for 14,000 acres.	555	10"	58	613	213	

APPENDIX IV—Contd.

STATEMENT IX—Contd.

Working Tables for Malampuzha Reservoir - Capacity of Reservoir 4,500 M. Cft. for the years 1923-47.

Month and year.	Balance in reservoir in C.ft.	Inflow.	Total storage.	Draw for irrigation.		Evaporation and absorption losses.		Total of (6) & (8).	Balance in reservoir.	Remarks.
				In inches.	Quantity inclusive of 12 1/4 % transmission losses.	In inches.	Quantity.			
1	2	3	4	5	6	7	8	9	10	11
1945										
June	213	2023	2236	...	...	7"	79	79	2157	*Losses drawn from surplus.
July	2157	4153	4500	...	...	6"	90	90	4500*	
August	4500	1621	4500	...	...	6"	90	90	4500	
September	4500	911	4500	3"	490	6"	90	580	4500*	
October	4500	2087	4500	1"	163	5"	75	238	4500*	
November	4500	1017	4500	...	...	4"	60	60	4500	
December	4500	...	4500	8"	1307	4"	60	1367	3133	
1946										
January	3133	...	3133	4"	653	4"	43	696	2437	Perennial and 3rd crop : 14,000 acres.
February	2437	...	2437	10"	572	4"	37	609	1828	
March	1828	106	1934	9"	514	7"	64	578	1356	
April	1356	106	1462	8"	457	9"	70	527	935	
May	935	445	1380	6 7/8"	661	10"	70	731	649	
				14,000 & 3 1/2" 26,000						
June	649	2109	2758	...	...	7"	82	82	2676	*Losses drawn from surplus.
July	2676	5374	4500	...	...	6"	90	90	4500*	
August	4500	8158	4500	...	...	6"	90	90	4500*	
September	4500	3642	4500	1"	163	6"	90	253	4500*	
October	4500	1157	4500	1"	163	5"	75	238	4500*	
November	4500	924	4500	...	...	4"	60	60	4500*	
December	4500	1324	4500	...	...	4"	60	60	4500*	
1947										
January	4500	159	4500	4"	653	4"	60	713	3787	Third and perennial crop : 23,000 acres
February	3787	67	3854	10 7/23000	938	4"	55	993	2861	
March	2861	58	2919	9 7/23000	845	7"	75	920	1999	
April	1999	58	2057	7 7/23000	657	9"	85	742	1315	
May	1315	43	1358	5 7/23000 2 7/17000	608	10"	72	680	678	

STATEMENT X.

Malampuzha Discharges at Gauge site from June to September 1946—Monthwar statement.

Month.	Discharge.	Remarks.
June	2035 Million C.ft.	
July	3823 "	
August	7583 "	
September	2694 "	

APPENDIX IV—Contd.

STATEMENT XI.

Gauged discharge and Rainfall for 1916-18 and 1919-20.

Month	1916-17		1917-18		1919-20	
	Gauged discharge in Million C.ft.	Rainfall in Palghat Town.	Gauged discharge in Million C.ft.	Rainfall in Palghat Town.	Gauged discharge in Million C.ft.	Rainfall in Palghat Town.
June	2264.24	6.14"	956.91	17.33	428.53	13.12
July	3203.36	14.78"	1200.78	12.09	2350.62	14.36
August	4010.69	15.27"	1004.29	9.09	2701.19	15.37
September	2350.34	8.30"	1913.05	18.77	2313.69	7.07
October	1450.22	4.18"	1358.33	7.32	1253.30	9.96
November	1091.49	5.96"	715.24	Not available	1011.83	4.61
December	559.96	0.03"	...	...	...	...
	14930.30	54.66"	7148.60	64.60	10059.16	64.49

STATEMENT XII.

Comparative statement of Actual discharges in the Malampuzha River with that calculated at 80% of Sappal Rainfall. Catchment - 57 sq. miles.

Month & Year	Total Rainfall for the month	Actual observed discharge.	80% of Sappal precipitation.	Remarks.
June 1946	41.6"	2035 Mill. C.ft.	4407 Mill. C.ft.	
July "	30.4"	3823 "	3220 "	
August "	46.6"	7583 "	4937 "	
September "	16.8"	2694 "	1780 "	

STATEMENT XIII.

Monthwar statement of Surplus water discharged over Spillway between the years 1916-18 and 1919-20.

Years	1916-17	1917-18	1919-20
June	...	...	...
July	998 M. C.ft.	...	...
August	3920 "	...	979 M. C.ft.
September	2260 "	790 M. C.ft.	2223 "
October	1048 "	1283 "	1178 "
November	1031 "	328 "	625 "
Total	9257 M. C.ft.	2401 M. C.ft.	5005 M. C.ft.

STATEMENT XIII (Contd.)

Monthwar statement of Surplus water discharged over Spillway between the years 1923-45.

Years.	1923-24	1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34
June	...	596	...	...	...	...	...	...	...	...	287
July	3674	9479	3400	3135	206	...	1840	1335	543	3608	2792
August	4570	3087	2813	3448	1817	3946	1647	503	5165	2876	810
September	282	1940	1361	1499	1224	...	631	2749	546	1817	2717
October	742	290	950	900	361	...	730	2764	1112	1535	2256
November	...	999	...	...	558	...	...	1067	491	1635	...
Total	9268	16391	8524	8982	4166	3946	4848	8418	7857	11471	8862

Years.	1934-35	1935-36	1936-37	1937-38	1938-39	1939-40	1940-41	1941-42	1942-43	1943-44	1944-45
June	...	...	...	...	129	...	1171	1862	3592	7246	303
July	1636	288	2542	2987	8671	3168	6468	4148	7411	8089	5059
August	2114	1554	2749	1636	2421	3406	4571	3194	3215	2344	1160
September	...	...	1558	152	1384	223	...	1997	276	1711	1075
October	...	683	1112	2266	1446	2584	95	1281	645	1493	688
November	...	279	164	...	...	713	1063	22	...	452	206
Total	3750	2804	8125	7041	14051	10094	13368	12504	15139	21335	8491

APPENDIX IV --Contd.

STATEMENT XIV.

Table showing Sappal Rainfall, Run-off, extent of third and Perennial crop, and surplus discharges between years 1923-45.

Year.	Sappal Rainfall (Jan. to Decr.)	Run-off in M'C.ft. (May to Apr.)	Total of 3rd & perennial crop extents.	Surplus discharge in Mill. C.ft.	Remarks.
1923-24	147.10 inches	14,905 M. C.ft.	9,000 acres.	9,268 M. C.ft.	
1924-25	208.50 "	22,722 "	14,000 "	16,391 "	
1925-26	143.96 "	14,734 "	14,000 "	8,524 "	
1926-27	134.62 "	14,251 "	10,000 "	8,982 "	
1927-28	93.90 "	9,725 "	12,000 "	4,166 "	
1928-29	92.20 "	9,767 "	5,000 "	3,946 "	
1929-30	103.20 "	10,932 "	8,000 "	4,848 "	
1930-31	128.70 "	13,634 "	14,000 "	8,418 "	
1931-32	123.60 "	16,611 "	22,000 "	7,857 "	
1932-33	153.90 "	16,261 "	14,000 "	11,471 "	
1933-34	134.80 "	14,227 "	14,000 "	8,862 "	
1934-35	90.90 "	9,873 "	5,000 "	3,750 "	
1935-36	79.70 "	8,412 "	14,000 "	2,804 "	
1936-37	134.74 "	14,285 "	14,000 "	8,125 "	
1937-38	128.70 "	13,141 "	14,000 "	7,041 "	
1938-39	187.24 "	20,086 "	7,000 "	14,051 "	
1939-40	148.25 "	15,780 "	14,000 "	10,094 "	
1940-41	182.00 "	18,975 "	16,000 "	13,368 "	
1941-42	176.70 "	16,969 "	20,000 "	12,504 "	
1942-43	197.90 "	23,243 "	30,000 "	15,139 "	
1943-44	277.50 "	28,347 "	14,000 "	21,335 "	
1944-45	138.50 "	13,348 "	14,000 "	8,491 "	
1945-46	117.50 "	11,876 "	...	...	

APPENDIX V

Copy of letter No. 419/1579 (1) dated 9th January 1947 from the Dy. Director, Mineral Development, Geological Survey of India, Calcutta to the Chief Engineer for Irrigation, Madras.—

I have the honour to forward herewith a copy of the report entitled, "Note on a dam site across the Malam-puzha near Palghat, Malabar district," by Dr. M. S. Krishnan, Superintending Geologist, Geological Survey of India, for your information.

Acknowledgment is requested.

Encl. as above.

NOTE ON A DAM SITE ACROSS THE MALAMPUZHA, NEAR PALGHAT, MALABAR DISTRICT

By

Dr. M. S. Krishnan,

Superintending Geologist, Geological Survey of India.

It is proposed to construct a dam across the Malampuzha, a comparatively small river rising in the hills north of Palghat and joining the Bharathapuzha which flows westward through the Palghat gap and along whose valley the South Indian Railway runs here. The site is about 4 miles N.E. by E. of Olavakkot railway station (sheet 58B/9—10° 48' : 76° 38' 30") where the river cuts across the Kazhukothi malai ridge (2324 and Δ 1013) which sinks down in altitude in an E.S.E. direction. The exact position of the site has the co-ordinates (10° 49' 44" : 76° 40' 55)

The dam will have roughly this shape in plan consisting of three straight sections. It will rise about 110 ft., above the bed of the river which is 280 ft., above M.S.L.

The western section of the dam will cross the river roughly in a W 35° N-E. 35° S. direction. making a small angle with the direction of the strike of the rocks. The middle section runs practically along the strike, while the eastern section is short and has a NW-SE direction.

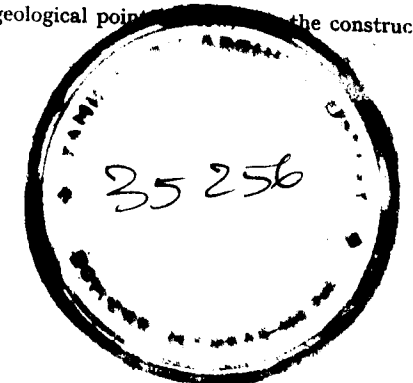
The rock forming the hills and all the neighbourhood of the site is a light grey banded biotite-gneiss, with streaks of biotite running along the direction of the banding. The strike of the gneissic banding is on an average WNW-ESE and the dip practically vertical. It is a thoroughly granitised compact rock almost free from joints. Thin veins of pegmatite traverse the rock, generally parallel to the banding and occasionally across it. The gneiss is composed of dominant quartz and feldspar and subordinate biotite. Though few bands are fairly rich in biotite, this mineral is not so abundant as to cause any marked weakness. Along the whole alignment of the dam the rock is exceptionally fresh. Only about 1000 ft. of the river valley is covered with alluvium, the maximum thickness of this being 25 ft. in the terrace which forms the right (western) side of the river valley. Rocks are exposed in the river bed itself, striking at an angle of about 30° to the dam alignment. Even underneath the alluvial terrace, the zone of weathering appears to be only a foot or two thick for I was informed that at the bottom of the alluvium hard rock is met with, without the intervention of an appreciable thickness of rubble or soft rock.

I also examined the cores from a drill hole put down in the middle of the alluvial terrace (distance 2300 ft. on the section from the western end of the dam line). All the cores were of the same rock as is exposed at the surface—fresh biotite gneiss—except for occasional thin veins of pegmatite 1 to 3 or 4 inches thick. Unrecovered parts of the core do not seem to indicate the presence of any soft rock.

The country rock is therefore quite sound in my opinion. The absence of any major joints or shear zones along the dam alignment and in the neighbourhood is a very favourable feature. I have not come across any features of weakness which would need the adoption of precautionary measures.

There is a small patch of alluvium in the eastern section but it is neither extensive nor deep. The greater part of the middle and eastern sections of the dam exposes good and practically fresh gneiss at the surface. The engineers will in due course have tests made on the rock taken from different parts of the alignment.

I consider the site described above satisfactory from a geological point of view for the construction of dam.

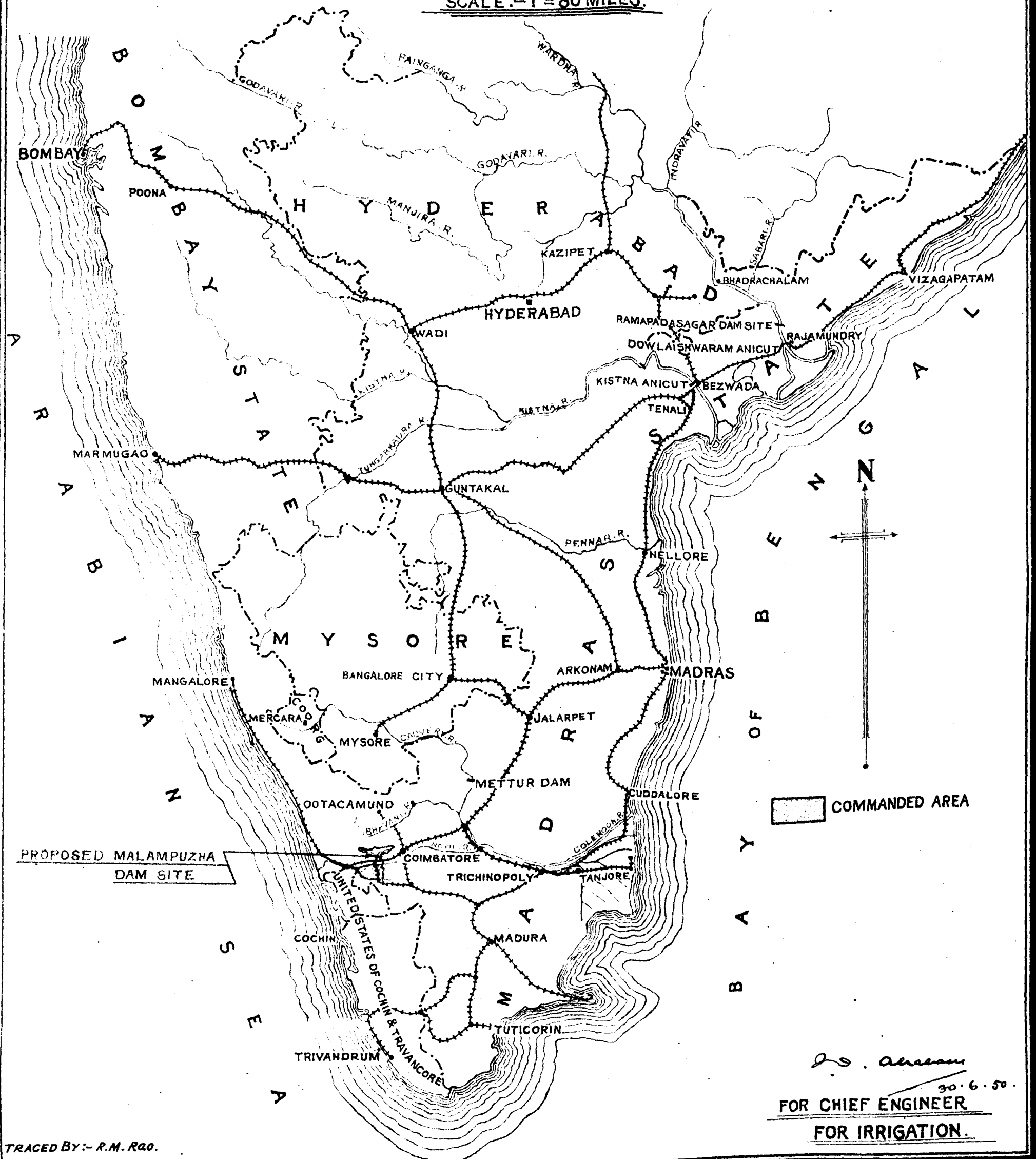


MADRAS STATE

PLATE No 1

SHOWING LOCATION OF MALAMPUZHA PROJECT

SCALE: - 1" = 80 MILES.

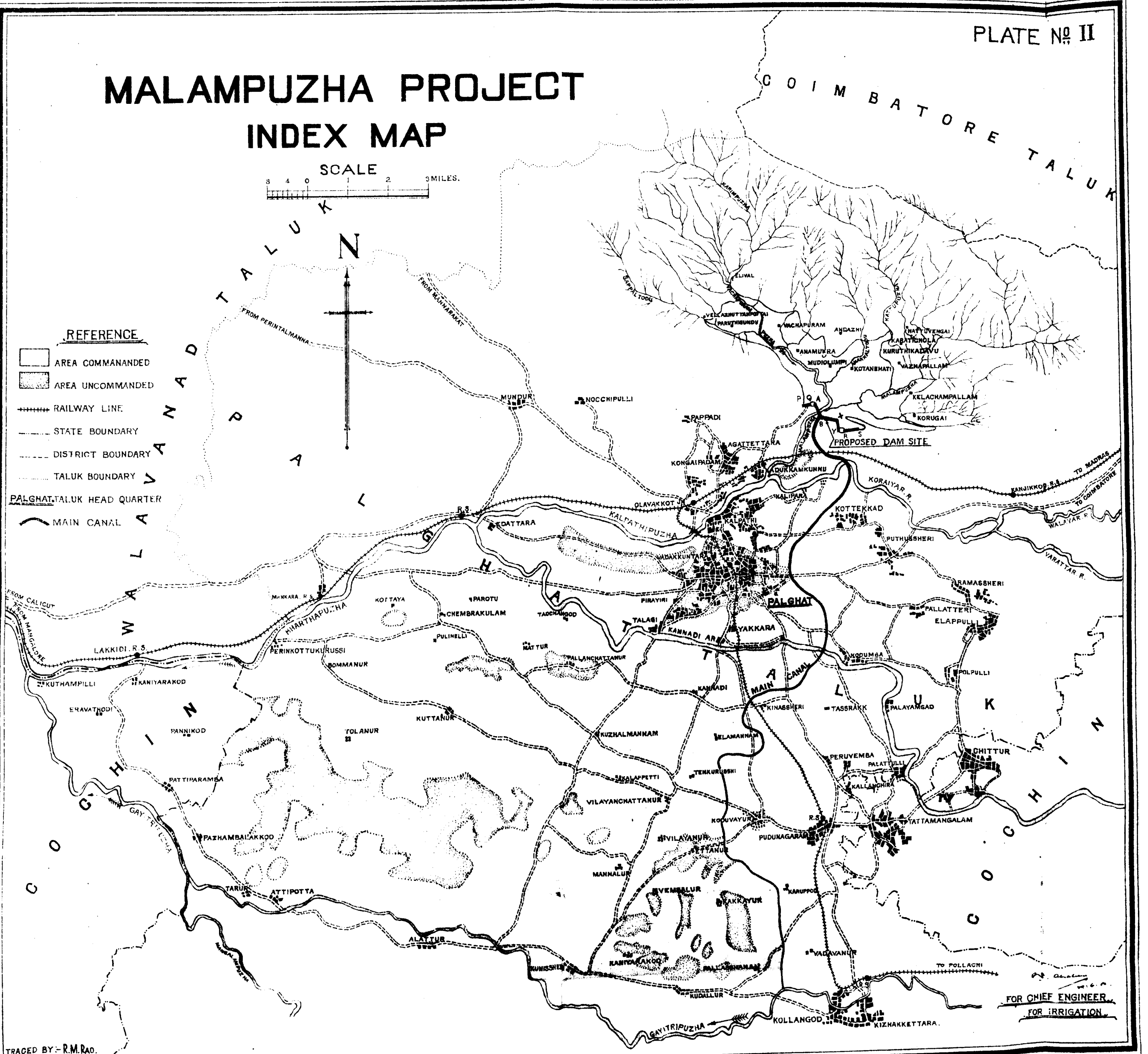


TRACED BY: - R.M. Rao.

MALAMPUZHA PROJECT INDEX MAP

SCALE
0 1 2 3 MILES.

- REFERENCE**
- AREA COMMANDED
 - AREA UNCOMMANDED
 - RAILWAY LINE
 - STATE BOUNDARY
 - DISTRICT BOUNDARY
 - TALUK BOUNDARY
 - PALGHAT TALUK HEAD QUARTER
 - MAIN CANAL



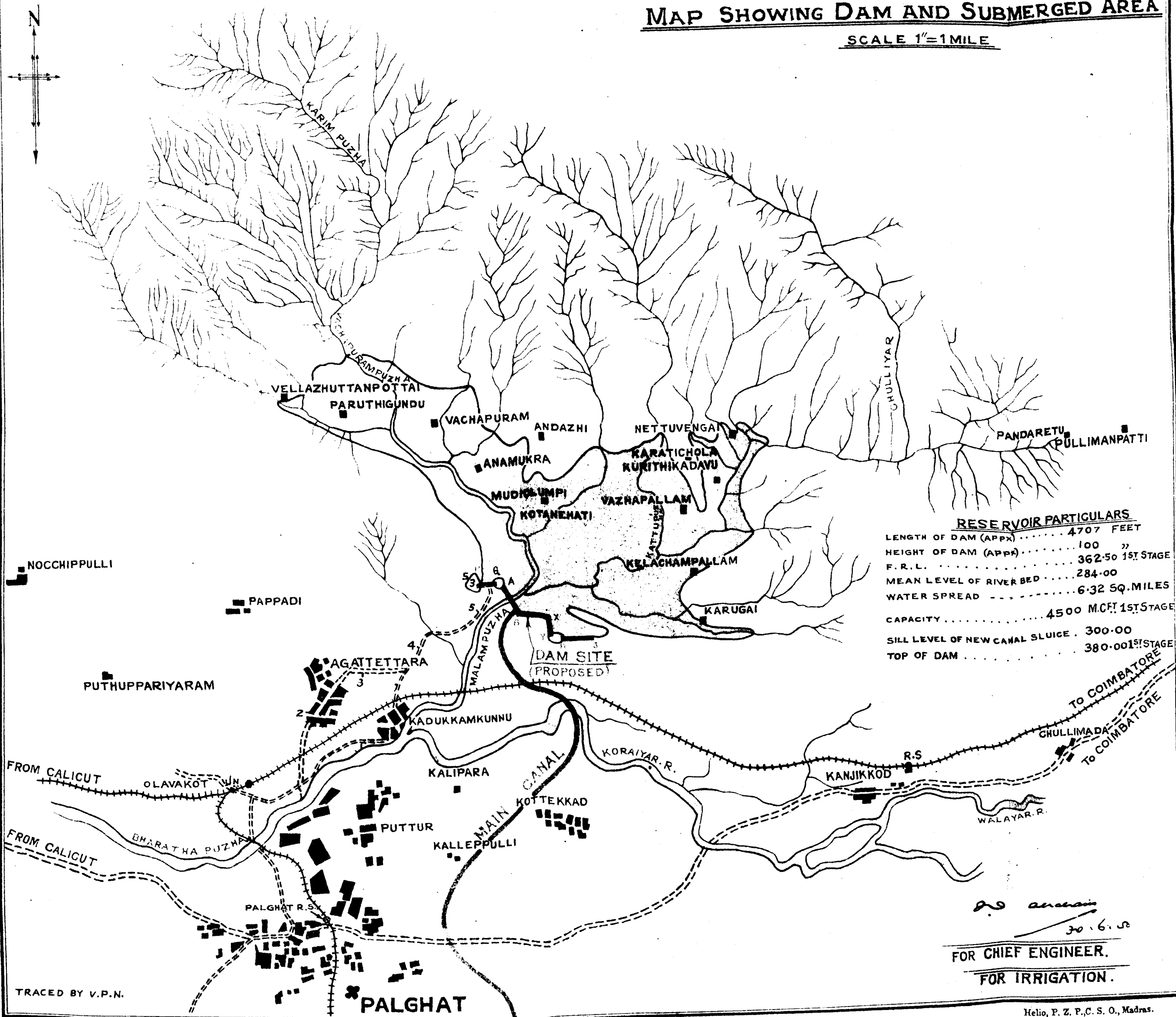
TRACED BY:- R.M. RAO.

FOR CHIEF ENGINEER
FOR IRRIGATION.

MALAMPUZHA PROJECT

MAP SHOWING DAM AND SUBMERGED AREA

SCALE 1"=1 MILE



TRACED BY V.P.N.

Reproduced From Indentor's Original

Helio, P. Z. P., C. S. O., Madras.

LEFT-SIDE SLUICE
PIERS 70x100

FOREST BOUNDARY STONE 1939
TOP LEVEL +385.23

B.M. TARMARK ON ROCK +422.71

VERT. 316.9

312.7

312.6

312.5

312.4

312.3

312.2

312.1

312.0

311.9

311.8

311.7

311.6

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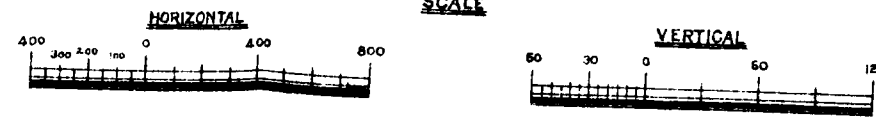
**SITE SURVEY
OF
THE PROPOSED DAM
ACROSS MALAMPUZHA RIVER**

TRACED BY:- V.P.N

MELBO, P. 2 P. C. S. O., MADRAS.

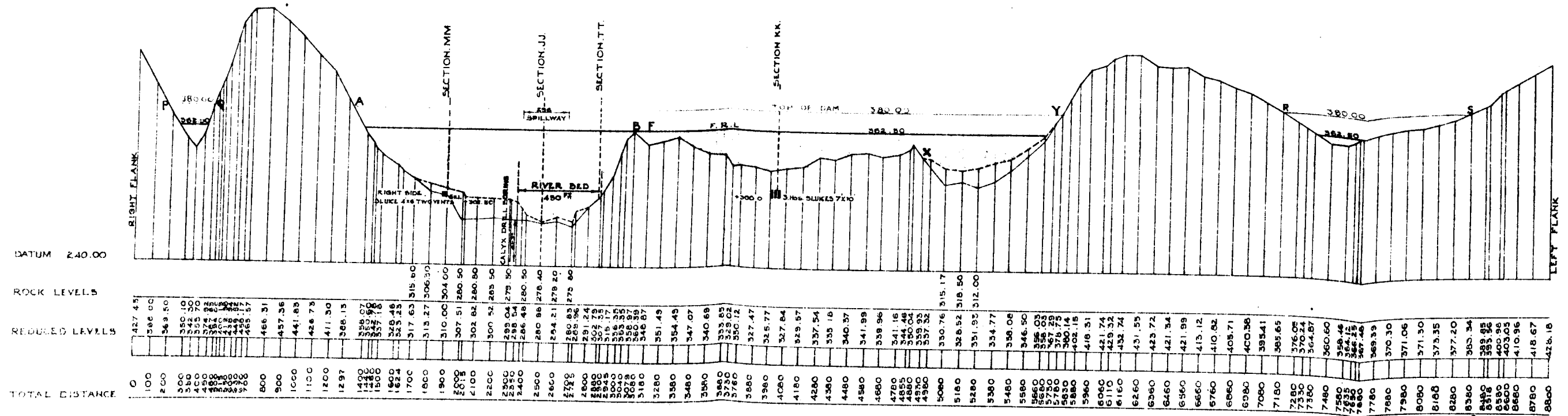
MALAMPUZHA PROJECT

SECTION OF THE MALAMPUZHA RIVER WITH PROPOSED DAM BASED ON OLD L.S.



RIGHT FLANK OF DAM

LEFT FLANK OF DAM



FOR CHIEF ENGINEER
FOR IRRIGATION