Archives I—10,006—16-8-77.

(1) Number of pages 38

(2) Date of repair Nov 88

(3) Initials of the Referencer

TAMIL NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

P.W.D. DEPARTMENT

G.O. No. / B.P. No.	3417-W.	Press. / Mis.

Dated 15.12.1987 197 .

Not to be folded or roughly handled

3417/1

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

General.
Establishment.

READ—the following letter from H. S. TAYLOR, Esq., Executive Engineer, Periyár Division, to the Superintending Engineer, VI Circle, dated Thekady, 1st December 1887, No. 495 P.F. :—

In G.O., No. 2314 W., dated 29th August 1887, the appointment of one lascar only, under each subordinate, is sanctioned, under Establishment.

2. Under the peculiar circumstances of their position, I beg to represent that one lascar is hardly enough.

3. They have to pay away large sums of money three times in the month, and they keep a certain amount constantly in their cash chests.

4. They also have to send away frequently down into the valley, long distances, for various articles and with money.

5. These necessities, as well as the daily attendance of one lascar required during execution of work, call, I think, for the attachment of at least two lascars to the establishment of each subordinate.

No. 412 P.R.

Submitted to the Chief Engineer, Public Works Department, for orders.

2. I am of opinion that the peculiar circumstances of the case justify the employment of a second lascar to each subordinate, and the statement of establishment attached to my report of 1882 shows that the credit to Provincial Funds on this account is likely to considerably exceed the actual cost of establishment employed.

3. Under the circumstances, I recommend the appointment of a second lascar on Rs. 9 per month to the upper subordinates employed on the project (two in number) for the remainder of the official year.

CHINNAMANUR, 6th December 1887.

(Signed) J. PENNYQUICK, Lieut.-Col., R.E., Superintending Engineer, VI Circle.

ORDER—dated 15th December 1887, No. 3417 W., Public Works.

Under the circumstances explained, two additional lascars, on Rs. 9 each per mensem, are sanctioned for employment under the upper subordinates attached to the Periyár Project division.

2. This sanction has been registered as Provincial, No. 49 W. of 1887-88, and classified as Establishment, Temporary. It will lapse at the end of the official year.

(True Extract.)

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

To the Superintending Engineer, VI Circle.
„ Examiner, Public Works Accounts.
„ Chief Engineer for Irrigation.

Exd. A. Aubert.
Spare Copies

GENERAL.
ESTABLISHMENT.

Govt. of {1887} Madras.

PUBLIC WORKS.

Dated December, 15*th*.

Recd. *Encl.*

G.O., 15th Dec. 1887, No. 3417 W.

DECEMBER.

Lascars

Two additional —, for employment under the upper subordinates attached to the Periyár Project division, sanctioned.

3417/7

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Civil Works.
Irrigation.

READ again—

Proceedings of the Madras Government, Public Works Department, dated 13th August 1887, No. 498 I.

Read—the following letter from Major A. G. BEGBIE, R.E., Officiating Deputy Secretary to the Government of India, Public Works Department (Account—Irrigation), to the Secretary to the Government of Madras, Public Works Department, dated Simla, 1st August 1887, No. 68 A.I.:—

In continuation of my letter, No. 83 A.I., dated 19th November last, I am directed to inform you that the Government of India has been pleased to allot a sum of Rs. 1,50,000 under "48. Irrigation—Capital Expenditure not charged against Revenue" for outlay in the current year on acquiring land and commencing work on the Periyár project. The grant now given is below the amount that was requested in your letter, No. 690 I., dated 14th October 1886, but it is possible the Government of Madras may be able to supplement the allotment by re-appropriation from the grants for existing works. Judging from the actual * transactions of the past three years, the grant as now increased should be amply sufficient for all requirements.

2. I am to add that the Government of India will, if possible, allot Rs. 5,00,000 for the work for 1888-89, and in framing the forecast of probable expenditure during the next five years on Productive Public Works, called for in another letter, that amount should be provided for the Periyár project.

* 48. Irrigation.

Capital Expenditure not charged against Revenue.

	Budget grant. Rs.	Actuals. Rs.
1884-85	19,84,000	16,10,444
1885-86	18,20,000	14,94,677
1886-87 (approximate).	15,00,000	9,00,556

Order—dated 13th August 1887, No. 498 I., Public Works.

Communicated to the Superintending Engineer, VI Circle, who will suggest as soon as possible the arrangements necessary for the commencement of the Periyár project.

(True Extract.)

(Signed) H. R. MEAD, Colonel, R.E.,
Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

READ also—

No. 88 C.

Note on proposed programme of work in connection with the Periyár Project for the season 1887-88.

In the printed statement, printed with G.O., No. 354 I., of 8th June 1887, the expenditure on works during the first year is entered at Rs. 4,00,000; this was intended to include Rs. 2,40,000 as the cost of the machinery to be ordered from England and Rs. 1,60,000 for local expenditure, made up roughly as follows:—

	Rs.
Construction of road and foot-paths	40,000
Buildings and lines	1,00,000
Preliminary expenditure	20,000

2. This estimate was based on the supposition that sanction to begin work would be notified before the beginning of the official year so that arrangements for the organisation both of labour and establishment could be made at leisure during April, May and June, and work commenced vigorously as soon as the state of the climate admitted.

3. This of course cannot be done this year, as it will be practically impossible to begin work before the beginning of September, and it is possible that not much can be done till a month later.

4. The sanction to begin work was quite unexpected, and for the first month or two the supply of labour will be small, though our former experience shows that, as the news of the commencement of operations spreads, labourers will come in until we have as many as we want.

5. Taking all the circumstances into consideration, I do not think we can reckon with certainty on being able to spend usefully a larger sum than Rs. 50,000 * during the present season, and this sum I would propose to distribute as follows:—

* Exclusive of establishment charges.

	Rs.
On road and foot-paths	25,000
On lines and buildings	20,000
On preliminary expenditure	5,000

6. It is quite possible that more can be spent, as the labour will probably come in freely during December, January and February, but it will be better to begin gradually than to attempt to do too much at first and possibly to waste time and money by working with an imperfect organisation.

7. Practically the effect of beginning in this manner in the middle of a season instead of at the beginning will be to throw everything back half a season, and the work will occupy five full seasons and two halves and be completed (assuming that we follow the programme laid down in my original report, and adopted in the forecast printed with G.O., No. 354 I. of 8th June 1887) by October of the seventh season (October 1893) instead of occupying six full seasons and being completed in February of the sixth season.

8. It happens that the working season is divided into two parts very similar in character, each beginning with a very rainy month (July and November) and followed by three months of increasing dryness. Practically therefore all the statements and estimates of progress contained in my original report may hold good, the dates being simply shifted four months back.

9. With regard to the establishment required for the present season's work, it would seem desirable that the operations should be in charge of the officer who is to be selected for the permanent charge of the work on the hills; I understand that it is proposed to select Mr. H. S. Taylor for this duty, and this selection would be in accordance with my own wishes. Whoever the officer is, I would recommend that he should be directed to join as soon as possible and place himself under my orders.

10. In addition to the officer, two upper subordinates will be required, who should, if possible, be military men, and in any case Europeans.

11. The office establishment required would be—

	One clerk on Rs. 40 for Executive Engineer.
Later on an additional clerk on Rs. 30 and a draftsman may probably be required, but they are not necessary at present.	One clerk on Rs. 80 for Superintending Engineer.
	Two clerks on Rs. 25 for subordinates.
	Two peons on Rs. 10 for Executive Engineer.
	Four lascars on Rs. 9 for do.
	Two lascars on Rs. 9 for subordinates.

A medical subordinate would also be required.

12. The Examiner of Public Works Accounts would be best able to judge whether the work should be considered as an independent division as regards accounts or as a sub-division of Madura; at first sight the latter appears the better course, but it must be remembered that Madura is already burdened with the accounts of the Vaigai bridge and of a Tank Maintenance party, both of which are, as regards executive work, independent charges, and if a third independent sub-division were added, it would probably be necessary to provide an additional accountant for that division. As, in any case, the Periyár works next year must form at least two independent divisions, it will probably be better to start one of them at once; in that case, besides the accountant an additional clerk on Rs. 30 will be required for accounts work.

13. It is hoped that both officers and subordinates will be granted the additional allowances specified in paragraph 245 of my report and detailed in statement No. III attached thereto.

14. I presume that Government desire me for the present to superintend these works in addition to the ordinary work of the circle; if so, I must ask to be allowed to delegate a certain amount of the routine work of my office to the Executive Engineer in charge of the head-quarter division (Trichinopoly). This work is very heavy, and, as during the next month or two I shall have to be a good deal out of doors at a place more than 180 miles from my head-quarters, the more of it I can get rid of the better. It is not necessary to specify precisely what work I should propose thus to delegate; the Government may be assured that it will be only what can be delegated without injury to the public service.

15. The above remarks have reference only to the work to be done locally during the current season, but the whole of the machinery should, if possible, be ordered so as to arrive in Madras not later than the end of July 1888, and, if this is to be paid for during this year, an additional grant of Rs. 2,40,000 will be required.

16. In connection with this subject I wish to draw particular attention to paragraph 246 of my report and to paragraph 11 of Colonel Hastel's note, No. 44 I., printed with G.O., No. 355 I., of 27th April 1883. It is of the utmost importance that the machinery should be selected and ordered after personal discussion with the manufacturers, and I have no hesitation in saying that, if it be ordered in the ordinary way by indent through the India Office, delays and misunderstandings will be likely to arise which may seriously affect the economical and efficient execution of the work.

17. I have been studying this subject for years, and can assert confidently that there are numerous points of detail, trivial in appearance but important in reality, which it would be almost impossible to specify in an indent, and that the cost of my deputation to England for a few months would be repaid over and over again by the superior efficiency of plant selected after personal consultation between the India Office officials, the makers, and myself, as compared with that selected by the former on written indents.

18. Four or five months would do all that was necessary, and it would be easy for me to start Mr. Taylor at work this year and return in time for the serious work of next season.

PULIANGUDI,
8th August 1887.

(Signed) J. PENNYQUICK, Lieut.-Col., R.E.,
Superintending Engineer, VI Circle.

No. 25 E.W.

Note by the Chief Engineer for Irrigation.

In forwarding the enclosed note by Colonel Pennycuick on the arrangements he considers advisable for the commencement of the Periyár project, for which the Government of India, in their letter, No. 68 A.I., dated 1st August 1887, have allotted Rs. 1,50,000, I request that an Executive Engineer and two selected European upper subordinates may be, as soon as practicable, appointed to the work and be ordered to join without delay.

2. With regard to office establishment, I consider it advisable that the Periyár project should be an independent division from the commencement of the work and not a sub-division of Madura. The Madura office has as much as it can well carry on, and it should not be burdened with the accounts of the Periyár project, and it will also be better for the Periyár work to start from the beginning as a separate division.

3. The office should be a third-class divisional office, consisting of —

	Rs.
1 Accountant, 5th grade	57½
1 Clerk, 3rd class, 3rd grade	55
1 Do. 4th „ 2nd „	35
2 Clerks, 4th „ 3rd „	50
1 Draftsman, 2nd class	42½
1 Do. 3rd „	25
1 Messenger	7
1 Do.	6
Petty—	
4 Lascars (each)	6

For the two upper subordinates there should be two clerks on Rs. 20 each, and two lascars on the ordinary pay of Rs. 6 per month.

4. It is, I consider, necessary that a selected medical subordinate should be attached to the work, and he should join the party as soon as possible.

5. It is supposed that all officers, subordinates and office establishment, including lascars, &c., will be granted the additional allowances named in paragraph 245 of Colonel Pennycuick's report on the project when employed on the head works, these allowances to cease when they are in the plains. I request that early orders regarding these allowances may be passed, and also that Colonel Pennycuick may be authorised to entertain the office establishment asked for.

6. With regard to obtaining the machinery required for the work, I consider it absolutely necessary that an officer acquainted with the work to be done should proceed to England, and order the greater portion of it after personal discussion with the manufacturers, and Colonel Pennycuick, who has for years studied the subject, should be deputed to go to England for a few months on this duty, and I request early orders sanctioning this arrangement.

7. Some of the machinery can be ordered at once in the ordinary manner by special indent on the Secretary of State. Colonel Pennycuick has been requested to submit an indent as soon as practicable for this, and it is proposed that, as soon as received, it be sent home, so that a portion of the grant allotted this official year for the work may be utilised in the purchase of this machinery; the special machinery to be selected by Colonel Pennycuick, in consultation with the India Office officials and manufacturers, will be purchased from the grant for the next official year.

8. With the establishment proposed, Colonel Pennycuick, it is thought, might continue in charge of the VI Circle for a few months, being relieved of this charge at the end of December or early in January, as there is much to be done in preliminary work, construction of roads, paths, &c., and in building lines for the coolies, &c.

9. Until the machinery is procured and shelter for the establishment and coolies is built, not much work can be done. Colonel Pennycuick should proceed home about the end of January, but before doing so will set the Executive Engineer and his establishment at work and lay out what they are to do. He will be able to return by the end of June, when the first burst of the south-west monsoon is over, and be ready to superintend the work as soon as weather will permit, arranging for the carriage of the machinery, and it is hoped that most of it will be in place and ready for work in December, a portion of it perhaps in August.

10. The Government of India proposes to allot Rs. 1,50,000 for the work this official year, and the following distribution is proposed and approved of :—

	Rs.
Works—	
Construction of road and foot-paths	25,000
Buildings and lines	20,000
Preliminary expenses	5,000
Establishment and tools and plant	12,650
Total ...	62,650

The remainder of the grant, Rs. 87,350, it is proposed to spend in the purchase of the ordinary machinery that can be procured by special indent on the Secretary of State.

Chepâk, (Signed) H. R. MEAD, Colonel, R.E.,
13th August 1887. Chief Engineer for Irrigation.

To the Chief Engineer, Public Works Department.

Order—dated 29th August 1887, No. 2314 W., Public Works.

In the foregoing papers, the Superintending Engineer, VI Circle, and the Chief Engineer for Irrigation submit proposals for commencing work on the Periyár project, for outlay on which the Government of India have allotted Rs. 1,50,000 during the current official year.

2. Mr. H. S. Taylor, Executive Engineer, and two military upper subordinates have already been posted to the work and directed to report themselves to Lieutenant-Colonel Pennycuick without delay.

3. The project will now be organised as a temporary third-class division, and the Superintending Engineer will proceed to appoint the office and petty establishment mentioned in paragraph 3 of the Chief Engineer's note. The Examiner, Public Works Accounts, will arrange for the requisite temporary accounts establishment.

4. The Surgeon-General will be requested, in the Public Department, to post a selected medical subordinate to the work.

5. The Government of India will be addressed with respect to granting the staff employed on the project the extra allowances detailed in paragraph 245 of Lieutenant-Colonel Pennycuick's report of 1882.

6. The Government fully concur in the remarks of the Superintending Engineer and the Chief Engineer for Irrigation as to the desirableness of Lieutenant-Colonel Pennycuick proceeding to England to select, in communication with the Store Department and the manufacturers, the more important part of the machinery required, and the Secretary of State will be requested to sanction his deputation in accordance with the rules laid down in section 17 of the Civil Leave Code.

7. An emergent indent on the Home Government, for such of the machinery as can be procured in the ordinary course, should be submitted without delay.

8. The arrangement proposed in paragraph 14 of the Superintending Engineer's note with respect to the routine work of his office is sanctioned.

9. The distribution of the current year's grant, proposed in paragraph 10 of the Chief Engineer's note, is approved.

(Here enter No. 2315 W., dated 29th August 1887).

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Chief Engineer for Irrigation.
" Superintending Engineer, VI Circle.
" Examiner, Public Works Accounts.
" Public Department.
" Political Department.
" Revenue Department.

Encl. J. Moses.
Spare Copies

341/5

CIVIL WORKS.
IRRIGATION.

Govt. of {1887} Madras.

PUBLIC WORKS.

Dated August, 29th.

Read. *Encl.*

G.O., 29th Aug. 1887, No. 2314 W.

AUGUST. 341 to 346

Periyar Project

Orders on proposals of the Superintending Engineer, VI Circle, for commencing work on the —.

341/2

Appendix to G O., No. 355 I., dated 27th April 1883.

From Major J. PENNYCUICK, R.E., Superintending Engineer, on Special Duty, to the Chief Engineer for Irrigation, dated Bangalore, 14th September 1882, No. 92.

I have the honor to forward, herewith, the plans and detailed estimates for the Periyár Project, as shown in the enclosed list.

2. The report, classified abstract estimate, tables, financial and other statements are being printed, but the delay in printing has been so great that I do not consider it advisable to remain here until they are completed, and am therefore about to return to Bellary, having given instructions for the printed papers to be sent to me there for transmission to Government.

3. In forwarding them explanation will be given upon all points which may require it; the plans and estimates are only forwarded now, in order to avoid the inconvenience of carrying them with me to Bellary.

4. Certain duplicate plans, plans no longer required, and papers received from your office in connection with the work are being returned with a separate letter. The plans and estimates accompanying this letter are all that are required for consideration of the project.

5. I leave for Bellary on the 15th instant.

List of Plans and Estimates.

	Plans. Nos.	Estimates Nos.
General	1 & 2	...
Head Works in Periyár Valley	1 to 18	1 to 10
Regulating Works in Sourcolly Valley ...	1 to 11	1 to 5
Distribution Works in Vaigai Valley ...	1 to 79	1 to 69

From Major J. PENNYCUICK, R.E., Superintending Engineer, to the Chief Engineer for Irrigation, dated Bellary, 6th November 1882, No. 1434.

I have the honor to report that I have at length received a specimen copy of my report on the Periyár Project, and have requested the Manager of the Caxton Press at Bangalore (where the papers have been printed) to send the remaining copies, ninety-nine in number, direct to your office.

One Errata.

2. The delay in printing has been very annoying, and was of course increased by my having to leave Bangalore before the work was completed, so that the proofs had to be sent here for examination and returned for correction.

3. A few errata are found still to exist, and, to avoid further delay, I enclose a list of these, which I request may be printed as a separate slip at the Government Press and attached to the report.

4. I have endeavoured to make the report complete in itself, requiring no reference to any other document except Major Oakes' memorandum on the works in the plains of Madura, and Mr. Clogstoun's report on the revenue returns; the former of these is reprinted in full as an appendix to the report; the latter is also named as an appendix, but is not actually printed with the other papers, as copies can, presumably, be obtained from the Government Office, and it seemed undesirable to occupy time in reprinting it. A copy is, however, enclosed herewith.

5. For the designs and estimates for the head works I am entirely responsible; Mr. Smith's plans have been used for topographical features, but none of them are sent up, fresh plans having been prepared for all works in the Periyár Valley, and the levels having been re-arranged to a datum more suitable to the present project than that of Mr. Smith's surveys, which was originally selected with reference to site No. 1.

6. It will be observed that large allowances have been made, both in the rates and in the estimates for the head works, on account of "Sundries" and "Contingencies;" I hope that a good deal of these will not be required, but looking to the novel nature of the work, and the peculiar conditions under which it has to be executed, I do not consider it would be wise to reduce the estimates by their omission or reduction.

7. It is probable that the principle on which the section of the main dam is designed, as explained in Appendix 1, will be the subject of some discussion, and there need be no delay in the sanction of the estimates on this account, as the total quantity of material involved is only 24,000 cubic feet, which, at the rates entered in the estimate, would cost Rs. 4,800, but in reality the *extra* cost, if this extra quantity be required, will not be nearly so much. There is surplus stone to a considerably greater amount than that in question, and the cost of plant and labor will be no more for 6,030 cubic feet per day than for 6,000; the extra expense will really be only that of the lime and sand or, say, Rs. 2,000 in all. The questions for discussion will of course be settled long before the main dam comes to be built, which cannot, under any circumstances, be for another two years.

8. I have made no alteration whatever in Mr. Smith's designs or quantities for the works below the ghát, but the estimates have been re-written in accordance with existing rates as regards form and classification, and a few errors in calculation corrected.

9. The classified abstract is in accordance, as regards general arrangement, with the specimen given in G.O., No. 377 L., of 8th May 1882 (the Ilumbikulyn Project), but the actual form used is one received from the Examiner's Office.

10. In paragraph 30, Appendix I of the Code, it is stated that under main head (3) all works falling under sub-heads other than L. Earthwork are to be classed under sub-head C. Works, but the reason given for this is that under other sub-heads the expenditure would be so small as not to justify their separate entry. This reason does not apply here, as the expenditure under these sub-heads amounts to more than 50 per cent. of the total, exclusive of land, and it would render the classification altogether meaningless to lump together this proportion of the total under a sub-head to which no part of it belongs.

11. The whole of the works under main head (3) have therefore been classed under their proper sub-heads, and this renders it inconvenient to prepare the general abstract precisely in the form prescribed by your memorandum, No. 14 M.D., of 31st July 1882; the form has therefore been slightly modified.

12. Separate estimates have been prepared for all individual works, and (except for the head works in the Periyár Valley) these estimates have been kept separate from the tables of quantities, as it may possibly be considered necessary to submit the former, but not the latter, to Government.

13. No definite decision having yet been arrived at as to the amount to be paid to the Travancore Government, Rs. 8,00,000 has been entered on this account; if this sum is deviated from by any considerable amount, it may be necessary to alter the Financial Statements 1 and 2, but this can easily be done in your office.

14. Duplicate plans of the works in the Periyár Valley have been prepared. No duplicates have been taken of the plans for the works in the Vaigai and Soorcolly Valleys, but I cannot help thinking that such duplicates must exist somewhere, or rather that those forwarded to me and sent up with my letter mentioned below (paragraph 20) are really duplicates, and that the originals are in your office.

15. The duplicate plans of the head works, Mr. Smith's original plans, and all other papers connected with the project received from your office, except such as are required to accompany the report, have been returned separately.

16. You will see that the Financial Statement No. 3 is not in the form prescribed by G.O., No. 514 L., of 4th July 1882, which had not been received when the papers were sent to the press, but in that used in G.O., No. 377 L., of 8th May 1882; forwarded to me for guidance with your No. 14 M.D. of 31st July.

17. A copy of the latter form has been sent to the Collector for countersignature, but has not yet been returned; it is, however, believed that you have discussed the matter personally with him. The alteration from this form to the later one used in G.O., No. 514 L., can be made in your office, the only difference being that columns 3, 4, and 5 of the earlier form are included in column 3 of the later, and columns 8, 9 and 10 of the earlier in column 6 of the later.

18. It is very desirable that experiments should be undertaken at once as to the quality, strength, &c., of the lime to be used; it was proposed to undertake these some time ago, but there was a difficulty in getting any one to take charge of them. I would suggest the immediate employment of an experienced subordinate under the general supervision of the Executive Engineer, Madura, the expenditure being charged hereafter adjusted against the provision in the estimate for "preliminary expenditure," in fixing the amount of which regard was had to the necessity of these experiments; Rs. 500 will probably cover the cost, and if desired, I will draft the necessary instructions for the conduct of the experiments.

19. I shall take it as a favor if Government will allow me a few copies of the report for personal disposal.

20. The plans, detailed estimates, and other papers not requiring to be printed were forwarded from Bangalore with my letter, No. 92, of 14th September 1882.

ERRATA.

Contents—

Page I, last line but three, *for* "vent," *read* "wrest."
Page II, line 7, *for* "Turbines," *read* "Turbine."
" " 8, *for* "culvet," *read* "culvert."
" " 13, *for* "Fraction," *read* "Traction."

Report—

Paragraph 5, line 2, *insert* "4,32,170"
" " 8, " "7,92,047."
" " 7, " "3,85,394"
" " 8, " "1,18,110."
" " 9, " "1,20,626." and "1,27,901."
" 20, 3rd, line 2, *for* "pouring," *read* "passing."
" " " 3, *for* "anicut," *read* "anicuts."
" 25, line 4, *for* "masonary," *read* "masonry."
" 34, line 5, *for* "equillibrium," *read* "equilibrium."
" 112, last line, *after* "paragraph," *add* "221."
" 173, lines 4 and 6, for "*n*" read "*h*."

Tables—

No. V, last column, *for* "maximum," *read* "minimum."
" VI, column headed "Third Season," *for* "2·759" *read* "2,759."

The second entries in this column and the corresponding ones under "Fourth Season" refer to the flood of 17th to 19th November 1869, and not to that of 7th to 8th November as entered.

No. VII, last column but two—

January: *for* "·26," *read* "5·26."
February: *for* "·77," *read* "2·77."

Appendix I, page 5, line 2, *for* "$\sqrt{\frac{e}{p}}$", *read* "$\sqrt{\frac{x}{p}}$"

No. 3-A.

LEFT BANK SIPHON.

QUANTITIES.

Number.	Length.	Breadth.	Height or Thickness.	Content or Weight.	
	FEET.	FEET.	FEET.	C. FEET.	
...	80	12	26/2	12,080	Upper cutting.
...	160	20	35/2	52,800	Lower do.
				64,500	Total removing rock.
			INCH.		
...	188	28	1/8	26,320	Main pipe.
...	10	Diameter	1/4	785	Cover at upper end.
...	4	20	1/6	580	Regulating valve.
...	18	Diameter	1/4	1,323	Bottom of flask at lower end.
...	4½	41	1/8	923	Side of do. do.
				29,981	
				7,480	Add for rivets, covering plates and contingencies.
				35,414	Total pounds.
				16·71	Tons of sheet iron.

Number.	Length.	Breadth.	Height or Thickness.	Content or Weight.	
	FEET.	FEET.	FEET.	C. FEET.	
2	2	Diameter	...	...	Iron ball floats with chain.
		INCHES.			
...	188	6	Diameter	...	Cast-iron flanged pipe.
2	...	...	...	...	Stop-valves at ends of pipe.
2	...	2	Diameter	...	Stop-cock in main and cast-iron pipe.
1	...	...	...	...	Five horse-power turbine fixed in cast-iron pipe.
½	...	...	...	...	Air pump to exhaust 60 cubic feet per minute.
12	7	1	1½	} 224	Blocks for supporting main pipe.
	6	1	1		
24	1½	1	1	36	Pair of wedges.
				279	Total cubic feet of timber.
					Lifting Trestles.
4	18	½	1	24	Upper cross bars.
...	32	½	1	16	Upper frame.
...	48	½	1	24	Lower frame.
				64	Total cubic feet of timber.
				R. FEET.	
8	25	...	...	200	Legs.
16	10	...	...	160	Braces.
				360	Running feet of bamboo.
	INCHES.				
4	9	Diameter	...	...	Wheels.
4	35	¼"	Diameter	...	Chain.
8	...	12"	do.	...	Pulleys.
2	...	...	...	...	Water tanks to hold 100 gallons each.
2	...	...	...	...	Counterbalance weights, each 2½ tons, or 40 cubic feet of stone.

ESTIMATE.

Number of Units.	Description of Work.	Rate.	Unit.	Amount.	Total.
		RS.		RS.	RS.
645·00	Removing rock	8	100 C. ft.	5,160	
1671	Sheet iron	350	Ton.	5,849	
188	Cast-iron flanged pipe	3	Foot.	564	
2	Iron ball floats	20	Each.	40	
2	Stop-valves	40	...	08	
2	Stop-cocks	15	...	30	
1	Five horse-power turbine	...	...	800	
½	Air pump	600	...	300	
270	Timber	3	Cubic ft.	810	
	Erection and fitting	...	...	3,500	17,133
	Trestles.				
64	Timber	3	C. ft.	192	
360	Bamboos	1·40	Foot.	9	
4	Wheels	25	Each.	100	
140	Chain	¾	R. ft.	105	
8	Pulleys	25	Each.	200	
2	Water tanks	30	...	60	
2	Counterbalance weights	10	...	20	
				686	
	For each trestle	...	...	...	2,744
	For four trestles	...	...	...	2,000
	Labor for shifting	...	...	...	2,000
	Additional cost of temporary dam	...	...	...	3,123
	Contingencies	...	...	...	27,000
	Total ...	...	...	...	

No. 6-A.

RIGHT BANK SIPHON.

QUANTITIES.

Number.	Length.	Breadth.	Height or Thickness.	Content or Weight.	
	FEET.	FEET.	FEET.	C. FEET.	
...	140	12	26/3	21,000	Upper cutting.
...	85	13	23	28,560	Lower do.
...	40	13	21	10,080	Turbine supply channel.
...	80	23	5/2	1,660	Weir.
...	8	8	31	1,044	Penstock cutting.
...	24	18	30	10,800	Turbine vault.
...	210	13	30/2	47,250	Do. tail race.
				121,384	Total removing rock.
			INCHES.	lbs.	
...	188	20	¼	15,900	Main pipe.
...	2	Diameter	1	883	Curve at upper end.
...	10	...	½	265	Bottom of back of lower end
...	31½	31½	½	551	Side of do.
...	4	21	½	420	Regulating valve.
				20,041	
				5,235	Add for rivets, covering plates and contingencies.
				26,175	Total pounds.
				11·69	Tons of sheet iron.
2	2	Diameter	...	...	Iron ball floats with chain.
		INCHES.			
...	188	6	Diameter	...	Cast-iron flanged pipe.
2	...	...	...	...	Stop-valves at ends of cast-iron pipe.
2	...	2	Diameter	...	Stop-cocks in main and cast-iron pipe.
1	...	...	...	...	Five horse-power turbine fixed in cast-iron pipe.
½	...	...	...	...	Air pump to exhaust 60 cubic feet per *minute*.
	FEET.	FEET.	FEET.	C. FEET.	
12	5	¾	1½	} 180½	Blocks for supporting main pipe.
½	7	¾	1		
24	1½	1	1	36	Pair of wedges.
				166½	Total cubic feet timber.
					Lifting Trestles.
4	18	½	1	24	Upper iron bars.
...	32	½	1	16	Upper frame.
...	48	½	1	24	Lower do.
				64	Total cubic feet timber.
				R. FEET.	
8	25	...	...	200	Legs.
16	10	...	...	160	Braces.
				360	Running feet of timber.
	INCHES.				
4	9	Diameter	...	...	Wheels.
	FEET.	INCH.			
4	35	¼	Diameter	140	Running feet of chain.
8	...	9	Do.	...	Pulleys.
2	...	...	...	...	Water tanks to hold 80 gallons each.
2	...	...	...	...	Counterbalance weights, each 2 tons or 32 cubic feet of stone.

ESTIMATE.

Number of Units.	Description of Work.	Rate.	Unit.	Amount.	Total.
		Rs.		Rs.	Rs
1212·84	Removing rock	8	100 C. ft.	9,702	
11·69	Sheet iron	350	Ton.	4,092	
2	Iron ball floats	20	Each.	40	
188	Cast-iron flanged pipe	3	Foot.	564	
2	Stop-valves	40	Each.	80	
2	Stop-cocks	15	...	30	
1	Five horse-power turbine	...	...	800	
½	Air pump complete	600	...	300	
166⅔	Cubic feet of timber	3	C. ft.	500	
...	Erection and fitting	...	...	2,500	
					18,609
	Trestles.				
64	Timber	3	C. ft.	192	
360	Bamboos	1/40	Foot.	9	
4	Wheels	25	Each.	100	
140	Chain	½	Foot.	70	
8	Pulleys	20	Each.	160	
2	Water tanks	25	...	50	
2	Counterbalance weights	8	...	16	
	Total for one trestle ...	...	...	597	
	Total for four trestles ...	...	...	...	2,388
	Labor for shifting ...	...	...	...	1,000
	Contingencies ...	...	...	...	2,003
	Total ...	...	...	...	24,000

NOTE.

Since submitting my report on the Periyár Project, I have learnt that Colonel Prowdow, R.E., Inspector-General of Irrigation, objects to the method therein proposed of passing the water of the river round the bank of the dam during construction, and considers that the culverts provided for that purpose would be a source of risk.

2. This method was proposed after careful consideration of every possible alternative (including that about to be discussed in this note), and I am convinced that no risk whatever is to be apprehended from its adoption, and that no other plan combines in the same degree the required elements of security, efficiency, and economy.

3. In gross, what we either practically enclose from the power of absolute control over the water-levels during the construction of the work (excepting quite abnormal floods), and that of emptying the lake after completion, or of discharging a portion of its contents into the river below, a power which, under certain circumstances, may be of great value.

4. In case, however, Colonel Prowdow's objections should be insuperable, the best alternative remains to be considered.

5. The simplest and cheapest is simply to allow the water to go freely over the dam, but I do not recommend its adoption; the perpetual trouble of getting up frames in water, the annoyance to the workmen of moving about in it, and, above all, the impossibility of testing leakage whose water is constantly running down the rear slope, are all evils for avoiding which a considerable expense may well be incurred.

6. It is true that many dams have been constructed in this manner, but they were all over streams which were either dry for part of the year, or which were mere rivulets in comparison with the Periyár, and I do not know of any case in which the water of a considerable stream has been allowed to pass during construction over a dam of any height.

7. If the ordinary stream cannot be passed by a culvert under the dam, it must be passed by a siphon above it, and the question is what the dimensions of this siphon should be. No arrangement can be considered satisfactory in which the passing of water over the substance of the dam is an ordinary as distinguished from an exceptional occurrence.

8. The scheme submitted by me provides for passing the whole stream under the dam except during about eight or ten days of the whole period (900 working days) occupied in its construction, but it is not necessary to keep to so small a number as this, if doing so involves any considerable expense.

9. I consider that, in order to ensure safety, thorough inspection, and careful workmanship, it is necessary that the siphon should be able to pass the whole discharge of the stream during at least five days out of six; and, in order to do this, there being but little margin between the water-level and the top of the work, the records show that the discharging power must be about 1,800 cubic feet per second, the maximum effective head being 25 feet.

10. A single pipe with an area of 72 square feet or a diameter of 9·58 feet would provide for this, but as it is necessary to make separate provision for the supply of water to the driving machinery, two pipes must be provided.

11. In order to get during the early part of the work (when it is most wanted) the full effect of the atmospheric pressure, the temporary dam must be made 55 feet high instead of 30 feet as originally proposed.

12. The arrangements recommended are shown on drawing No. 10-A, and their cost in the Estimates Nos. 3-A and 6-A submitted herewith. There is a pipe on the left bank, 8·91 feet in diameter, and one on the right for the supply of the driving machinery, 6·32 feet in diameter.

13. The effective head in a siphon is the difference between the water surfaces above and below, or 33 feet *minus* the maximum height of the diameter of the pipe above the upper surface, whichever may be the least.

14. In this case the latter is 26 feet, but during the early part of the work the former is on the left bank 25 feet, as the water will be headed up in the discharge cutting to about 10 feet, and on the right bank 8 feet, as the weir which regulates the level in the penstock cutting is at 25 feet, and there will be about 2 feet going over this when the water above is up to the crest of the temporary dam.

15. The areas of the pipes are 62·36 and 31·82 square feet respectively, and if the velocity in feet per second be taken at 4½ times the square root of the head, the discharges will be 1,403 and 540 cubic feet per second, rather more than the required amount.

16. The discharging power of the right bank pipe will increase as the main dam rises, until the latter reaches 50 feet, when the full head of 25 feet will be available for both pipes, and the total discharge will be 2,119 cubic feet per second.

17. The pipes will be made of ½-inch iron sheets with double rivetted butt joints. The diameters are those corresponding to circumferences of 7 and 5 sheets of 4 feet each, which is the greatest breadth usually made. The materials will be sent out ready prepared, and put together *in situ*; ample allowance is made in the estimate for the cost of erection.

18. The maximum pressure, either internal or external, to which the pipes can be subjected is that of about 25 feet of water or, say 11 pounds on the square inch, so that the greatest strain on the material is $8 \times 11 \times 8{\cdot}91 \times 6 = 4{,}504$ pounds on the square inch for the left bank pipe, and $8 \times 11 \times 6{\cdot}36 \times 6 = 3{,}375$ pounds on the square inch for the right bank, which is very moderate for good double rivetted joints.

19. When the discharge of the river is low, the water-level above the temporary dam would fall below the 25 feet necessary for the supply of the turbines, as for instance in February, when it averages only 352 cubic feet per second and the level would fall to about 11 feet; to prevent this a cover is provided at 4 feet from the upper mouth of the pipe of diameter slightly larger than the latter and fixed to it by iron bars. A valve consisting of a length of plain pipe 4 feet long and just large enough to slide easily over the main pipe is attached to floats by chains of such a length that when the water sinks to near the desired minimum level the valve descends and closes the space between the covering plate and the main pipe, thereby shutting off the water from the latter. This valve is obviously in equilibrium throughout, and may be made to slide quite loosely over the main pipe, as there is no necessity for anything like an absolute closure of the latter.

20. In order to prevent the entrance of air at the discharging mouth of the siphon, the latter is surrounded by a tank whose diameter is about one and-a-half that of the main pipe, and its upper rim 6 inches above the mouth of the latter; this is a simpler and cheaper arrangement than turning up the pipes at their mouths. These tanks are not necessary during the early part of the work, when both siphons will discharge into water standing above the level of their mouths.

21. It will be seen from the plan that the left bank siphon rests on the ground at 35 feet above the river-bed and communicates with the latter by cuttings; until the main dam reaches this level the work can proceed without interruption, and no moving of the siphon is required. After the 35-feet level the latter has to be moved from time to time as the space under it has to be filled in, and this will be done in the following manner.

22. The pipe being emptied will be raised by the trestles, shown on the drawings, to a height sufficient to allow of the completion of the work under it, the water-supply of the river (over and above what the other siphon can take) being absorbed by the margin between the water-level and the crest of the work.

23. This margin varies in depth, under normal circumstances, from 10 to 15 feet, and in content from 150 millions to 4,000 millions of cubic feet. The total time occupied in raising, completing the work below, lowering and filling the pipe again is calculated at ten hours as a maximum, a period for which the minimum margin of 150 millions of cubic feet would absorb a discharge of 4,200 cubic feet per second. Of course, if the river was in high fresh at the time, the available margin would be reduced, and the risk of submersion increased, but this is a risk which must be faced so far as it cannot be avoided by judicious timing of the various operations.

24. To allow of the easy raising and lowering of the pipes, they are attached to counterbalances, composed of blocks of concrete of weight slightly less than their own. To each counterbalance is fixed a small water tank, which when filled causes the counterbalance to descend, and when emptied causes it to rise.

25. The tanks will be filled at leisure when the siphon is at work, and when the latter is emptied it will rise at once; the work below being completed, the water will be allowed to run out of the tanks and the pipe will descend into position again.

26. The siphon will be raised and lowered in one vertical plane until its lower limb is clear of the ground level, after which it will be moved longitudinally up the bank from time to time so as to keep this lower limb just clear of the ground, and reduce as much as possible the height of the trestles, which will be necessary to support the rear portion of the pipe as the thickness of the dam diminishes.

27. The right bank siphon does not require to be removed until the work reaches the 45 feet-level, and here the conditions are somewhat different from those on the left bank. The supply of power to the whole of the machinery depends upon this pipe, and consequently it cannot be raised during working hours. That is to say, that the space underneath its original position cannot be filled in until it is lowered again, and it cannot therefore be raised and lowered in one vertical plane, but must have a certain amount of longitudinal traverse. This is provided for by the return cuttings shown on the plan which allows the pipe to be traversed to any position between the limits c d and e f. Of course, when once the lower limb is clear of the ground, this pipe, like the other, will be moved longitudinally up the bank.

28. It is necessary that the pipes should be emptied before being moved, because their weight when full would be too great to be conveniently dealt with, even if horizontal traversing only were to be adopted (as would be possible, though the arrangements would be far less convenient than those proposed); and the following arrangements are provided to allow of this being easily and rapidly done.

29. A small cock is fixed in the highest part of the main pipe, by the opening of which cock, air is admitted to the pipe and the water at once driven out.

30. Alongside of the main pipe runs an ordinary cast-iron pipe 6 inches in diameter; this pipe is never emptied (the weight of water contained in it being trifling), being furnished with a stop-cock at each end, which is closed before the pipe leaves the water on lifting.

31. The object of this tube is twofold; first, to provide a convenient source of power (by means of a small turbine fixed in its length) for working the air pump, by which the main pipe has to be exhausted; and, second, to supply water to the tank at the lower end of the latter during the process of exhaustion.

32. This latter is required because without it, it would be necessary to provide an air-tight valve for closing the lower mouth of the siphon during the process, and the cost of this valve and the apparatus for opening and closing it would probably exceed that of the small pipe and its appurtenances, and be far less practically convenient. Indeed, I have failed in designing any arrangement of this kind, which I consider thoroughly satisfactory.

33. The siphon having been lowered empty into position, the air pump will be set up in a position where it can be conveniently worked by a strap from the small turbine and connected by a flexible pipe to the cock in the main pipe, the air from which will be thoroughly exhausted.

34. It has been said that the small pipe is never intended to be emptied, but if by any accident the water should be allowed to run out it can be re-filled by the air pump in a few minutes, a cock similar to that on the main pipe being provided for the purpose.

35. The small turbines cost but little, and it will be a great convenience to have a source of power which can be immediately and rapidly applied to the working of the air pump. Indeed, it will probably be often found convenient to have on the work itself a source from which power may be taken for pumping, working a hoist, or other contingent work.

36. The turbine will supply from three to six horse-power, according to the water-levels; the smaller of these powers will suffice to exhaust at the rate of 60 cubic feet per minute, so that the exhaustion of the larger pipe will take about 3½ hours, and of the smaller about half that time.

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37. The estimates have been made on liberal terms, for the rates of Rs. 350 per ton material and Rs. 200 per ton for workmanship are certainly in excess of what will be found actually necessary.

38. It will be seen that the actual cost is Rs. 51,000 against Rs. 39,000 provided in the estimates for the culverts; the difference of Rs. 12,000, is so small in comparison with the total of the estimate, that it does not seem necessary to alter the Financial Statements.

39. Three alternative arrangements have been considered, but it is unnecessary to discuss them here, as they are all clearly inferior to that now proposed.

40. There is, however, an alternative mode of constructing the pipes, which I think is worthy of consideration, that is, to make them of wooden planks, say 2 inches thick, bound round with iron or steal wire or wire rope. The timber at Rs. 3 per cubic foot would cost Rs. 14 and Rs. 10 per running foot for the two sizes of pipes and the binding Rs. 15 and 9 respectively, to which might be added Rs. 5 and Rs. 3 for painting, tarring, and caulking, making the total cost Rs. 32 and 22 per foot against Rs. 44 and 31, which is the estimated cost of the iron pipes. I see no reason why wooden pipes should not be made perfectly water-tight under such small pressures as we are dealing with, and they would be more easy to make up and keep in repair than the iron ones.

CHEPAUK,
31st March 1883.

(Signed) J. PENNYCUICK, Major, R.E.

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Irrigation.

READ—the following papers :—

Letter from Major J. PENNYCUICK, R.E., Superintending Engineer, on Special Duty, dated 14th September 1882, No. 92.

Letter from Major J. PENNYCUICK, R.E., Superintending Engineer, on Special Duty, dated 6th November 1882, No. 1434.

Office Note from Deputy Chief Engineer, Public Works Department, dated 31st March 1883.

G.O., No. 1193, dated 30th April 1875.

G.O., No. 115, dated 10th March 1877.

G.O., No. 159 W., dated 20th January 1881.

No. 44 I.

Note by the Acting Chief Engineer for Irrigation.

In G.O., No. 1164 W., 8th May 1882, Major J. Pennycuick, R.E., was appointed to revise the designs and estimates for the Periyár Project, and with the above letters that officer has submitted his report with complete estimates. These estimates have since been discussed, and Major Pennycuick has forwarded the notes above referred to in consequence, with alternative estimates for part of the works. The forecast statements have received the approval of the Revenue authorities, and have been revised in accordance with the latest instructions, and the estimates are therefore now submitted in a complete form to be forwarded to the Government of India.

2. In his report, paragraphs 9 to 28, Major Pennycuick has given "a history of the Present Project," which explains all that has been done in past years. It is sufficient here to say that the project, as now submitted, agrees generally with that submitted in 1872, after careful and prolonged investigations, by Mr. R. Smith, and approved by Colonel Oakes and Colonel Mullins, with the exception that the dam which it was originally proposed to construct of earth by the silting process is now intended to be constructed of concrete throughout. The main features of the projects are the same, a dam across the Periyar on the Travancore side of the Western Ghats, a tunnel through the water-shed ridge, a series of regulating sluices for passing the water diverted from Travancore into the Madura District round the mouths of the Suruculy river, and distributary works; the two last named having been very carefully worked out originally, have not now been revised, but the estimates for the dam and head works have, after a careful study of the subject for years, been most thoroughly worked out by Major Pennycuick.

3. The supply is derived from the Periyár draining 300 square miles of the Western Ghâts, and is beyond question. Tables VII and VIII attached to the report give an estimate of the amount of water available, which, not taking into account rainfall on the tract to be irrigated, shows an ample supply for 150,000 acres. It has been suggested that to fill the dry bed of a river in the eastern plains will require a vast quantity of water, but it must be remembered that when the works are completed, the bed of the river will never be altogether dry, and it will be observed that to fill it up after each hot season 500 millions of cubic feet have been allowed.

4. The land commanded by the channels is about 200,000 acres, of which it is proposed to irrigate 101,000 acres with first crop and 35,813 acres second crop. An elaborate report on the subject of revenue to be expected was made * by Mr. Clogstoun, then Deputy Director of Revenue Settlement, now Accountant-General, on which the forecast of revenue has been based, and which has received the approval of the present Collector. Attached to the forecast statements is a note explaining briefly how the figures are obtained.

* (Public Works Department) G.O., No. 115, 10th March 1877.

5. The original project was to cost Rs. 53,99,700 direct charges without any payment to the Travancore Government for the use of the water, and the estimated return was Rs. 6,24,600. The estimates now submitted are as follows:—

Direct Charges.

	Rs.
Works	52,00,000
Establishment	9,25,000
Tools and Plant	60,000
	61,85,000
Indirect Charges	2,56,463
	64,41,463

The works are expected to be completed in six years, and the irrigation fully developed in ten years after their completion. The gross revenue will then be Rs. 7,00,000, the working expenses and collection charges Rs. 1,25,400, and the net revenue will therefore be—

Including Enhanced Land Revenue	...	Rs. 5,74,600, or 9·29 per cent. on direct charges.
Excluding Enhanced Land Revenue	...	„ 5,31,912, or 8·92 on direct and indirect charges.

Under Works a sum of eight lakhs is allowed as compensation to the Travancore Government. The subject is not yet settled, but negotiations are so far advanced that it seems certain this provision will be more than sufficient. The latest offer † made to the Travancore Government is six lakhs of rupees, the cession of certain small tracts of country, and Rs. 50 per acre for every acre occupied above 8,000.

† G.O., No. 233 (Political), 21st March 1883.

6. The works estimated for are so peculiar in character, and, being situated as they are in an almost uninhabited jungle on hills which are for a part of the year very unhealthy, require a method of construction so unusual, that it is necessary here to make some remarks on the designs submitted.

The dam, which is 155 feet in height above the deep bed of the river with a parapet of 5 feet, the level of the escape weirs being 144 feet and the probable actual maximum water-level being 153·16, is intended to be made entirely of concrete. The large dams which have been constructed in the south of France, with which the proposed dam may be compared, were made of rubble masonry, and there are no examples of any large concrete dam, but it is considered that concrete will prove in all respects a more suitable material than rubble masonry. Made of good materials, the rock on the spot and hydraulic mortar, and well rammed, it will bear the same crushing weight, and will be perfectly solid, and the construction will be simpler.

7. As regards the section of the dam, Major Pennycuick has submitted a note which is attached to his report, in which he enters very fully into the calculations on which it is designed. In this note he gives his reasons for differing from the "old method" of calculating pressures, and also from the French authority, M. Bouvier, who has lately investigated the subject, and prepared designs for dams of about the same size. The subject is one which requires special study, and it is suggested that Mr. Molesworth, whom we have for years looked to as the highest authority on the subject, should be invited to discuss Major Pennycuick's note before the section is definitely decided on. Major Pennycuick's calculations are believed to be sound, and his section to be perfectly safe, but as he has propounded a new theory, it is advisable that his calculations should be discussed by known experts. On the proposed section which is submitted the line of rear slope as calculated by M. Bouvier's method is also shown. M. Bouvier's calculations would require somewhat more material, but the excess is so small that the estimate will in all probability suffice, whatever section is determined on.

8. The escape dam is designed on the same principles as the main dam, and the arrangements for the water cushion are considered satisfactory. There will be two escapes with an aggregate length of 920, and their effect in an extraordinary flood is shown in Table IV attached to the report.

9. There has been some discussion since the report was written on the subject of the escape culverts proposed by Major Pennycuick. He proposed two culverts, one on either bank of the river, to dispose of the water during the construction of the dam, that on the right bank supplying the turbine which is to drive the manufacturing machinery. These culverts were to be closed by an equilibrium self-acting shutter very ingeniously contrived, but it was considered that in a work of these dimensions any under passage would be objectionable, and doubtful whether any self-acting machinery, such as that proposed, would prove satisfactory. Major Pennycuick has therefore designed an alternative arrangement whereby the flood-water, except in high floods, may be passed over the dam by means of siphons, one of which will feed the turbine. These designs have been very carefully worked out, and it has been considered whether the siphon tubes, instead of passing over the dam itself, could not be laid on the slope of the bank on either side; the difficulty of raising them in this position has been considered a sufficient obstacle to such an arrangement, and the proposed arrangement, which is no doubt feasible, seems the most satisfactory. The cost of the siphons would be only Rs. 12,000 more than of the escape culverts, and it has not therefore been considered necessary to alter the forecast statements. It would, of course, be possible to allow all surplus to pass freely over the dam during construction, but this, though it might safely be done, would be a hindrance to the work, and in any case it is advisable to have a siphon to supply the turbine, as it must evidently be economical to utilize the water power available. The only question seems to be whether smaller discharging power might not be sufficient, more flood-water being allowed to pass over the dam and less expensive siphons being provided. It has not, however, been considered advisable to reduce the amount of the estimate.

10. The equilibrium sluice proposed to be constructed at the entrance to the tunnel, by which the supply to Madura is to be regulated, is open to some of the objections raised to those proposed for the escape culverts. The principle on which the sluice is constructed is substantially the same as that on which equilibrium valve sluices were proposed by Mr. F. Stoney, two of which were purchased by the Madras Government. In Mr. Stoney's sluice the water was admitted to both sides of the shutter; in Major Pennycuick's it is admitted within the shutter and presses outwards on both faces, so that in both cases there is no pressure due to the head of water to deal with. The principle is believed to be correct. Major Pennycuick has further introduced in the shutters hollow water-tight cylinders of such size that the weight of the shutter becomes of little account and the power required to lift it is very small. It is proposed that the shutters should, by an ingenious arrangement, be raised by buoys floating on the surface of the water in rear, and should thus be self-

regulating. It is to this arrangement that exception is taken. The regulating gear is subject to rust and at the mercy of such things as logs of wood which might be sucked through the sluice. It is thought that it will be found necessary to raise the shutter by means of a screw or by chains, and it is recommended that this point should be considered in carrying out the works. It will probably be necessary also to provide grooves into which shutters could be inserted in case of its being necessary to raise the shutter for the purpose of repairing it at a time when water was not required, or could not be passed through the tunnel. The provision made in the estimate will allow for the necessary alterations in these particulars being attended to.

11. In carrying out the works, machinery has been provided for, the details of which have been very carefully worked by Major Pennycuick, and are shown in the drawings. In this situation there is no doubt but that it will be economical to employ machinery to a great extent, labor being expensive, though in some cases, as for instance in ramming the concrete in the dam, it may prove, should labor be attracted to the work, better to ram by hand. The mortar-mixers and concrete-mixers should certainly be worked by machinery, but the particular form of machine to be used may be left to be decided when the work is commenced. Improvements in machinery are being made so constantly that machines now considered the best type may, in a year or two, be superseded. The drills for rock boring are no exception to this rule. The rates entered in the estimates based on careful inquiry, in some cases in communication with manufacturers, and providing amply for carriage, will suffice. The arrangements proposed for working the machinery may be accepted subject to such alterations as further experience may show to be necessary. The wire tramway up the ghât and the traction engines above and below are also approved. Should it be decided that the works are to be commenced at once, it is recommended that Major Pennycuick, who is now proceeding to England on furlough, should be entrusted with the duty of selecting the machinery required within the sums allotted. That officer's long acquaintance with the project and assiduous study of the details of the works point to him as the best selection that can be made for starting the work.

12. The rates to be allowed for work have been the subject of careful inquiry. When the original project was prepared, this subject received the attention of Mr. R. Smith, Major Pennycuick and Colonel Mullins, and it was the opinion of the latter officer that the rates proposed were too low. The use of machinery will have a considerable effect on the rates; and the opening out of the work spot will make it easier to obtain labor than it hitherto has been, but the rates as now worked out are in excess of those originally allowed, and it is believed will prove ample. The principal item in the work is concrete, and this is now estimated at Rs. 20 per 100 cubic feet, the prevailing rates in the Madura District being Rs. 15 to 17. The data for rates of work are given in an appendix to the report.

13. It has been stated that the works as proposed in the Madura District are as originally estimated after having been most carefully worked out by Mr. R. Smith. After much consideration it was decided that the water now thrown into the Sooroolyaur and Vaigai should be passed round the existing anicuts and not over them. It is to be noticed that all these anicuts supply Government land exclusively, and that therefore there is no reason to anticipate difficulty from interference with the existing supply. The additional water sent down the river will of course benefit existing cultivation, but as the anicuts supply but a very few tanks and the surplus all falls back into the river, there can be but little waste of the water. The designs of some of the works may need modification to some extent, but generally they are approved and may be accepted.

OOTACAMUND, 11th April 1883.

(Signed) J. O. HASTED, Colonel, R.E., Ag. Chief Engineer for Irrigation.

To the Joint Secretary to Government, Public Works Department, Irrigation Branch.

NOTE.

The ultimate area of irrigation and the estimate of revenue have been arrived at as follows:—

	Number of Taram.	Estimated yield per Acre, Madura Measures.	Irrigable Area, Acres.	Rate per Acre.	Revenue.
				Rs.	Rs.
Government Land	1	1,000	16,031	5½	1,39,063½
Do.	2	900	29,522	7½	2,21,415
Do.	3	800	21,905	6½	1,42,382½
Do.	4	700	5,849	5½	32,169½
Do.	5	620	2,643	5	13,215
Total ...	...	...	76,350	...	5,48,846½
Tank beds	...	...	9,126	8	73,008
Usual Wet Inams	...	...	4,356	Free.	
Inams, dry	...	...	3,400	6	20,400
Zemindari and Inam Land	...	...	15,240	6	91,260
Total ...	...	...	108,512	...	7,34,073½
Deduct Revenue due to old Irrigation, average of ten years' collections ...	...	...	...	...	1,52,598
Net Total ...	...	...	...	...	5,81,475½
Deduct Area and Revenue of land irrigated by Korumbors, which it is not advantageous to bring under the project	...	...	7,338	...	22,849½
Net Total ...	...	...	101,074	...	5,58,626
Or, say ...	...	...	101,000	...	...
Second Crop ...	...	...	...	...	1,41,374
Total ...	...	...	101,000	...	7,00,000

The above estimate is based on Mr. Clogstoun's report printed with G.O., Revenue Department, No. 730, of 17th February 1877, except that, in the case of second-crop cultivation, the assessment has been reduced from Rs. 2,15,648 to Rs. 1,41,374. The Collector of the Madura District has approved the estimate of revenue, and has countersigned the forecast statement as prepared by Major Pennycuick.

Mr. Clogstoun's report shows that the irrigable area of first crop is 96,085 acres, which includes only 1,000 acres under the first group instead of 5,886 acres, as pointed out in paragraph 33 of his letter, he having assumed that the water required for 5,886 acres of old cultivation would be the same as that required for 1,000 acres of new cultivation. The ultimate area of irrigation is therefore 101,000 acres. The amount of direct and indirect revenue have not been separately estimated, as the rates of assessment proposed are consolidated. The consolidated assessment has been separated into land and irrigation revenue, the former being calculated at the average rate of dry land assessment according to Rule IV, paragraph 7, of G.O., Revenue Department, No. 769, of 9th July 1880.

The extent of unoccupied lands which will be brought under irrigation is 35,998 acres, as shown below:—

Dry lands	20,613
Wet, do.	6,186
Tank beds	9,199
Total ...	35,998

Appendix to Table No. III.

Statement showing the Estimated Charges on Revenue Account in the Public Works and Civil Departments.

Years.	Maintenance Charges in the Public Works Department.	Collection Charges in the Civil Department at 7·2 per Cent. on Revenue.	Total.
	Rs.	Rs.	Rs.
Seventh	15,000	5,040	20,040
Eighth	30,000	10,080	40,080
Ninth	45,000	15,120	60,120
Tenth	60,000	20,160	80,160
Eleventh	75,000	25,200	1,00,200
Twelfth	75,000	30,240	1,05,240
Thirteenth	75,000	35,280	1,10,280
Fourteenth	75,000	40,320	1,15,320
Fifteenth	75,000	45,360	1,20,360
Sixteenth	75,000	50,400	1,25,400

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Chief Engineer for Irrigation.

List of Plans connected with the Periyár Project to be forwarded to the Government of India.

1. Sketch map showing the sites proposed for the head works, the valleys of the Sooroollyaur and the Vaigai, and the alignment of the distribution channels in the plain of Madura.
2. Sketch map showing the arrangements for the distribution of the Periyár water in the plains of Madura.
3. Plan of lake and ground in its immediate neighbourhood with contours at 50 feet vertical intervals.
4. Plan of ground in the neighbourhood of dam and escape.
5. Longitudinal section along crest of dam and escape.
6. Transverse sections of dams.
7. Arrangements of main work shed.
8. Enlarged half plan of gearing of main work shed.
9. Details of measurers and elevator.
10. Plans showing arrangement of wire tramway at various periods.
11. Framing and concrete distributing apparatus.
12. Escape culvert, gates and lifting gear.
13. Details of gates of escape culvert.
14. Plan and sections of right bank escape.
15. Supply culvert for turbine, gates, &c.
16. Plan and longitudinal section of southern water-shed cutting with part of trace of road from water-shed to site of dam.
17. Plan and section of water-shed tunnel.
18. Details of water-shed tunnel.
19. Plan showing portion of trace of road from water-shed to site of dam.
20. Plan showing portion of trace of road from water-shed to site of dam.
21. Escape syphons.
22. Survey and longitudinal section of the Sooroollyaur from near the foot of the Chinnamullay hill to the Vaigai.
23. Survey of the Sooroollyaur Sheet No. 2.
24. Do. do. „ 3.
25. Do. do. „ 4.
26. Do. do. „ 5.
27. Do. do. „ 6.
28. Plan, sections and elevation of the regulating sluice proposed for construction on the left bank of the Sooroollyaur adjacent to the Katahar weir.

29. Plan, sections and elevation of the regulating sluice proposed for construction on the right bank of the Sooroollyaur immediately above the Cotamuth weir.
30. Plan, sections and elevation of the regulating sluice proposed for construction on the left bank of the Sooroollyaur above the Soliamputty weir.
31. Plan, sections and elevation of the regulating sluice proposed for construction on the right bank of the Sooroollyaur immediately above the Gullianoor weir.
32. Plan, sections and elevation of the fall proposed for construction adjacent to the Paliamparava weir.
33. Plan of the Paranay anicut showing the positions of the proposed head and under-sluices.
34. Survey, longitudinal and transverse sections of the northern main channel.
35. Northern main channel, longitudinal and transverse sections of the line recommended for adoption.
36. Do. do. do. do.
37. Do. do. do. do.
38. Do. do. do. do.
39. Do. do. do. do.
40. Do. do. do. do.
41. Do. do. do. do.
42. Do. do. do. do.
43. Do. do. do. do.
44. Do. do. do. do.
45. Do. do. do. do.
46. Do. do. do. do.
47. Do. do. do. do.
48. General plan of head sluices for distribution channels taking off from 188 to 288 cubic feet per second.
49. Do. do. do. from 42 to 94 cubic feet per second.
50. General plan of the regulators proposed for construction at the head of the subsidiary branch channels.
51. General plan of sluices proposed for construction at the heads of minor distribution channels.
52. General plan of irrigation sluices for areas from 200 to 300 acres.
53. Do. do. do. „ 100 to 200 acres.
54. Do. do. do. „ 50 to 100 acres.
55. Do. do. for plots not exceeding 50 acres.
56. General plan for falls of 6 feet in the main distribution channel.
57. General plan for overfalls in branch channels with crest up to 10 feet in length.
58. Plan and sections of the aqueduct proposed for construction in the third mile.
59. Plan, sections and elevation of the surplus sluice proposed for construction in the embankment of the Ramarajapuram tank in sixth mile.
60. Plan, sections and elevation of the surplus sluice proposed for construction in the embankment of the Natchicullam tank in seventh mile.
61. Plan of proposed shutter and raising and holding gear for sluices Nos. 54 and 55.
62. General plan of inlet weirs to admit the drainage from catchment basins not exceeding six square miles.
63. General plan of outlets for catchment basins not exceeding six square miles.
64. General plan of the occupation bridges proposed for construction in the third reach of the northern main channel.
65. Plan, sections and elevation of the bridge proposed for construction in the 21st mile.
66. Plan, sections and elevation of the bridge proposed for construction in the 29th mile.

Order—dated 27th April 1883, No. 355 I., Public Works.

The revised estimates for the Periyár Project as follows:—

Direct Charges.

	Rs.	Rs.
Works	52,00,000	
Establishment	9,25,000	
Tools and Plant	60,000	
		61,85,000
Indirect Charges.		
Capitalization of Land Revenue ...	85,413	
Loss by Exchange	40,000	
Leave and Pension Allowances ...	1,31,050	
		2,56,463
Total ...		64,41,463

will be submitted to the Government of India for the sanction of the Secretary of State.

2. It has been shown that the returns anticipated are—

Including Enhanced Land Revenue, 9·29 per cent. on direct charges;
Excluding Enhanced Land Revenue, 8·92 per cent. on direct and indirect charges;

the project has therefore every claim to be considered a Productive Public Work, and the immense importance of providing a continuous supply of water to the Madura District stamps it as of the utmost value as a Famine Protective Work.

3. The question of compensation to the Travancore Government is believed to be in a fair way of settlement, and the provision in the estimates under this head is believed to be ample.

4. The Government of India will be requested to invite the remarks of Mr. G. L. Molesworth, C.I.E., on the separate note by Major Pennycuick on the mode of calculating pressures in masonry dams.

5. The Government desire to acknowledge the complete way in which the project has been worked up, after years of study and attention to the subject by Major Pennycuick, and feel confident that the work cannot be entrusted for execution to a more competent officer.

(Here enter No. 356 I., dated 27th April 1883.)

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

To the Superintending Engineer, Sixth Circle.
„ the Chief Engineer for Irrigation.
„ the Examiner, Public Works Accounts.
„ Major J. Pennycuick, R.E.
„ the Revenue Department.
„ the Board of Revenue.
„ the Political Department.

ENDORSEMENT—dated 27th April 1883, No. 356 I., Public Works.

Copy of the above forwarded to the Government of India.

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

Exd. A. F. Goodall and C. Howarth.
Spare Copies

3412/16

IRRIGATION.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated April, 27th.

Read. *Encl.*

G.O., 27th April 1883, No. 356 I.

APRIL.

Periyar Project

FORWARDING to the Government of India copy of Proceedings regarding the revised estimates, &c., of the —.

No 495 P.P. Office of the Asst Engr Periar Division Thekady 1st December 1887.

From.

M. J. Taylor Esquire Executive Engineer Periar Division.

To.

The Supdg Engineer I/ Circle.

Sir,

In S.C. No 2314 W dated 29th August 1887 the appointment of one Lascar only under each Subordinate, is sanctioned, under establishment.

2. Under the peculiar circumstances of their position, I beg to represent that one Lascar is hardly enough.

3. They have to pay away large sums of money, three times in the month, and they keep a certain amount constantly in their each-chests.

4. They also have to send away frequently, down into the valley, Long

long distance, for carriage articles and with money.

5. These necessitates, as will as the daily attendance of the Lascar, required during execution of work, call, I think, for the attachment of at least two Lascars to the establishment of each Subordinate.

I have &c

Sd/ H. D. Taylor
Exec: Engr, Periar Dn

No 412 P.d

Submitted to the Chief Engineer, S. W. D. for orders.

2. I am of opinion that the peculiar circumstances of the case justify the employment of a second Lascar to each Subordinate, and the Statement of establishment attached to my report of 1862 shows that the credit to Provincial Funds on this account is likely to considerably exceed the actual cost of establishment employed

3. Under the circumstances, I recommend the appointment of a second Lascar on Rs 9 per month to the Upper Subordinate employed on the project (two in number) for the remainder of the official year.

Sd/ [illegible]
Superintending Engineer

Chintamanis
6: December 1875

Supt Engineer bi Circle

3412/19

Go. 2310 dt/29-8-87
- 3563 - 27-9-87

under the circumstances explained, two additional Lascard on Rs 9 each per mensem, are sanctioned for employment under the upper Subordinates attached to the Periar Project division.

This sanction has been registered as Provincial No 49 of 1887-88 and classified as Establishment Temporary. It will expire at the end of the official year.

Under
10-12-87

for
17/12/87

S.E. VI circle
Exc. P.W. Reds
Ch. Engr for Insp.

Sir,

The Supt Engineer
1 circle

Do the Chief Engineer
P.W.D.

Ref: 3412. P.K

Dated 1: December 87

Submits for orders with recommendation copy of letter from the Supt Engineer Periar Ry, applying for an additional Vacancy to each subordinate employed in the Division

with order

Circ. 18-12-87

STATE OF ILLINOIS
DEPARTMENT OF
PUBLIC WORKS