3509 C 11. 10. 86.
1190 R. 14. 12. 85
1498. P. 6. 74
1275. 14. 4. 77.

November
No. 2952 dy 10. [illegible]

B/

Communicated
to the Chief Engineer
for Irrigation and
the Consg. Engineer
for Railways.

Ch. Engr for Irrign √
Ch. [illegible]
Consg. Engr for Rys √ with 20 copies
Exr. P.W. Accts √ with three copies

Despd 10-11-86.

8/11/86

Jou
8/11/86.

Govt. of {1886} Madras.

FINANCIAL.

8. S.C

4 pm Post Office 12

Issued

Recd. 6.11.86 Encl.

G.O., 28th Oct. 1886, No. 1417 L.F.

November
No. 2952 dy 10. [illegible]

OCTOBER.

Puckle's Channel.

Directing that the cost of maintaining — in Tinnevelly be distributed among the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works in the proportion pointed out.

2 Copies both ordy

with order

P. & D.

Proc: of the Govt: and Govt.

Read the following:-

28TH OCTOBER 1886, No. 1417 L.F., FINANCIAL.

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following papers :—

From S. H. WYNNE, Esq., President, District Board, Tinnevelly, to the Chief Secretary to Government, dated Tinnevelly, 4th August 1886, No. 48.

I have the honor to submit the following subject for the orders of Government.

To the north of road No. III, Palamcottah to Tuticorin, there is a drainage channel known as the Puckle's channel. It runs parallel to the road and the Tuticorin fresh-water channel from the third milestone from Tuticorin eastwards. The work was originally constructed in connection with the Srívaikuntham anicut project—*vide* paragraphs 31 and 50 of Mr. Rundall's report, embodied in G.O., No. 1498, dated 8th June 1874. At present, however, the channel does not appear to be of any material use to that system. It is practically a protective work to keep out the storm water from inundating the town of Tuticorin in general, the railway station there, the above said road of the Local Fund department, the fresh-water canal supplying the town of Tuticorin, and the wet lands of Korampallam tank, as well as the salt pans of Levingepuram.

2. In November 1884, breaches occurred in Puckle's channel, for the closing of which and for strengthening its right bank, the Imperial Public Works Department framed an estimate for Rs. 370. These repairs were considered necessary for the safety of the fresh-water channel. The Superintending Engineer differed from this opinion, and expressed that the South Indian Railway Company may fairly be called upon to repair and keep the banks in order, probably on the understanding that the natural drain was interfered with by the railway compound.

3. The work was not undertaken by any department until October 1885, when, on the recommendation of the Sub-Collector, the district board undertook the work on the consideration that the several agencies referred to in paragraph 2 *supra* should contribute their share towards the cost, and set the work on foot according to the estimate prepared by the Public Works Department. It was found that the estimate was insufficient, and a revised estimate for Rs. 1,060 was sanctioned by the board, and fund allotted. The work is now almost completed.

4. The different departments concerned were requested to contribute their quota, and their replies, disowning any interest in the work, are herewith submitted for the perusal of Government.

5. The damage that may at any time be caused by floods to the Local Fund road must be trifling, whereas the damage to other interest, and specially to the wet lands under Korampallam tank, would be very heavy. Under no circumstances therefore will the board undertake any further repair unless the cost is chiefly borne by the other agencies, and they would not have undertaken the work now done, had they supposed there would have been any attempt on the part of others to deny their obvious liability.

6. The board therefore request that Government will be pleased to issue orders for a fair contribution from those concerned.

7. A plan of the locality, with the Local Fund Engineer's letter explaining it, and other papers are herewith forwarded. A list is enclosed.

Referred to the Public

(

MADRAS,
23*rd August* 1886.

Note by the Officiati

It is considered that this departm
Puckle's channel, and that there is no
it in order should be met from Public

2. It is also considered that the i
is but slight, and that the chief concer
South Indian Railway.

3. A reasonable distribution of th
the district board should bear one-fift
the railway and the municipality.

CHEPÂK, (Signe
5*th October* 1886.

To the Officiating Joint Secretary to Gover
Public Works Department, I

N

Transferred to the Financial Depa
in that department, No. 521, of the 2

(

CHEPÂK,
11*th October* 1886.

To the Financial Department, with paper

ORDER—dated 28th October 1886, No.

The Government observe that t
Railway Company, the District Board,
interested in a greater or less degree i
that the cost should be distributed as f

Tuticorin Municipality ..	
South Indian Railway Company	
District Board	
Department of Public Works	

(Tr

To the President, District Board, Tinnevell
„ Chairman, Municipal Council, Tutic
through th
„ Public Works Department.
„ Joint Secretary to Government, Pul

„ „ „ to Government, Pul

Exd. T. O'Connor.

No. 521.

Works Department for remarks.

By Order.)

(Signed) E. S. LAFFAN,
Under Secy. to Govt.

No. 138-I.

g Chief Engineer for Irrigation.

nent has no interest in the maintenance of the
reason why any portion of the cost of keeping
Works funds.

nterest of the Local Fund Board in the matter
n rests with the Tuticorin Municipality and the

e cost of maintenance would appear to be that
h, the remainder being divided equally between

ed) J. PENNYCUICK, Lt.-Col., R.E.,
Offg. Chief Engineer for Irrigation.

nment,
rrigation Branch.

No. 3509-C.

rtment, with reference to endorsement (returned)
rd August last.

By Order.)

(Signed) R. DAVIDSON,
Under Secy. to Govt., P.W.D.,
Irrigation Branch.

in original.

1417 L.F., Financial.

he Tuticorin Municipality, the South Indian
and the Department of Public Works are all
n the maintenance of the channel, and consider
ollows :—

..	..	..	..	..	..
..	..	..	..	..	..
..	..	..	..	..	..
..	..	..	..	..	..

ue Extract.)

H. E. STOKES,
Ag. Chief Secretary.

y, with enclosures.
orin,
e Collector.

lic Works Department,
Railway Branch.
lic Works Department,
Irrigation Branch.

Order No. R. 6th November 1886.

Communicated to the Consulting Engineer for Railways for information.

[True Extract]

W. Cooke Major R.E.

Undersecy: to Govt. P.W.D.

Ry: Branch.

Govt. of {1886} Madras.

FINANCIAL.

Issued

Recd. Encl.

G.O., 28th Oct. 1886, No. 1417 L.F.

B No 29528 dy 10-11-86.

OCTOBER.

Puckle's Channel.

Directing that the cost of maintaining — in Tinnevelly be distributed among the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works in the proportion pointed out.

No Copy for Ry

" Exec. Engr. Ry: Branch:

Enc: of the Hindoo Regt.

Read the following:-

28TH OCTOBER 1886, No. 1417 L.F., FINANCIAL.

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following papers:—

From S. H. WYNNE, Esq., President, District Board, Tinnevelly, to the Chief Secretary to Government, dated Tinnevelly, 4th August 1886, No. 48.

I have the honor to submit the following subject for the orders of Government.

To the north of road No. III, Palamcottah to Tuticorin, there is a drainage channel known as the Puckle's channel. It runs parallel to the road and the Tuticorin fresh-water channel from the third milestone from Tuticorin eastwards. The work was originally constructed in connection with the Srivaikuntham anicut project—*vide* paragraphs 31 and 50 of Mr. Rundall's report, embodied in G.O., No. 1498, dated 8th June 1874. At present, however, the channel does not appear to be of any material use to that system. It is practically a protective work to keep out the storm water from inundating the town of Tuticorin in general, the railway station there, the above said road of the Local Fund department, the fresh-water canal supplying the town of Tuticorin, and the wet lands of Korampallam tank, as well as the salt pans of Levingepuram.

2. In November 1884, breaches occurred in Puckle's channel, for the closing of which and for strengthening its right bank, the Imperial Public Works Department framed an estimate for Rs. 370. These repairs were considered necessary for the safety of the fresh-water channel. The Superintending Engineer differed from this opinion, and expressed that the South Indian Railway Company may fairly be called upon to repair and keep the banks in order, probably on the understanding that the natural drain was interfered with by the railway compound.

3. The work was not undertaken by any department until October 1885, when, on the recommendation of the Sub-Collector, the district board undertook the work on the consideration that the several agencies referred to in paragraph 2 *supra* should contribute their share towards the cost, and set the work on foot according to the estimate prepared by the Public Works Department. It was found that the estimate was insufficient, and a revised estimate for Rs. 1,060 was sanctioned by the board, and fund allotted. The work is now almost completed.

4. The different departments concerned were requested to contribute their quota, and their replies, disowning any interest in the work, are herewith submitted for the perusal of Government.

5. The damage that may at any time be caused by floods to the Local Fund road must be trifling, whereas the damage to other interest, and specially to the wet lands under Korampallam tank, would be very heavy. Under no circumstances therefore will the board undertake any further repair unless the cost is chiefly borne by the other agencies, and they would not have undertaken the work now done, had they supposed there would have been any attempt on the part of others to deny their obvious liability.

6. The board therefore request that Government will be pleased to issue orders for a fair contribution from those concerned.

7. A plan of the locality, with the Local Fund Engineer's letter explaining it, and other papers are herewith forwarded. A list is enclosed.

No. 521.

Referred to the Public Works Department for remarks.

(By Order.)

MADRAS, (Signed) E. S. LAFFAN,
23rd August 1886. *Under Secy. to Govt.*

No. 138-I.

Note by the Officiating Chief Engineer for Irrigation.

It is considered that this department has no interest in the maintenance of the Puckle's channel, and that there is no reason why any portion of the cost of keeping it in order should be met from Public Works funds.

2. It is also considered that the interest of the Local Fund Board in the matter is but slight, and that the chief concern rests with the Tuticorin Municipality and the South Indian Railway.

3. A reasonable distribution of the cost of maintenance would appear to be that the district board should bear one-fifth, the remainder being divided equally between the railway and the municipality.

CHEPÂK, (Signed) J. PENNYCUICK, Lt.-Col., R.E.,
5th October 1886. *Offg. Chief Engineer for Irrigation.*

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

No. 3509-C.

Transferred to the Financial Department, with reference to endorsement (returned) in that department, No. 521, of the 23rd August last.

(By Order.)

CHEPÂK, (Signed) R. DAVIDSON,
11*th October* 1886. *Under Secy. to Govt., P.W.D., Irrigation Branch.*

To the Financial Department, with papers in original.

ORDER—dated 28th October 1886, No. 1417 L.F., Financial.

The Government observe that the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works are all interested in a greater or less degree in the maintenance of the channel, and consider that the cost should be distributed as follows:—

Tuticorin Municipality	
South Indian Railway Company	
District Board	
Department of Public Works	

(True Extract.)

H. E. STOKES,
Ag. Chief Secretary.

To the President, District Board, Tinnevelly, with enclosures.
„ Chairman, Municipal Council, Tuticorin, through the Collector.
„ Public Works Department.
„ Joint Secretary to Government, Public Works Department, Railway Branch.
„ „ „ to Government, Public Works Department, Irrigation Branch.

Exd. T. O'Connor.

Order &c. R, 6th November 1886.

Communicated to the Consulting Engineer for Rail-ways for information.

True Extract

Undersecy: to Govt. P.W.D.

By: Branch.

Govt. of {1886} Madras.

FINANCIAL.

Issued

Recd. *Encl.*

G.O., 28th Oct. 1886, No. 1417 L.F.

13 Rec. 29529/10-11-86

OCTOBER.

Puckle's Channel.

Directing that the cost of maintaining — in Tinnevelly be distributed among the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works in the proportion pointed out.

Secy: to Govt. for Rlys:

Examiner Accts: Rly: Accts:

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following papers :—

From S. H. WYNNE, Esq., President, District Board, Tinnevelly, to the Chief Secretary to Government, dated Tinnevelly, 4th August 1886, No. 48.

I have the honor to submit the following subject for the orders of Government.

To the north of road No. III, Palamcottah to Tuticorin, there is a drainage channel known as the Puckle's channel. It runs parallel to the road and the Tuticorin fresh-water channel from the third milestone from Tuticorin eastwards. The work was originally constructed in connection with the Srívaikuntham anicut project—*vide* paragraphs 31 and 50 of Mr. Rundall's report, embodied in G.O., No. 1498, dated 8th June 1874. At present, however, the channel does not appear to be of any material use to that system. It is practically a protective work to keep out the storm water from inundating the town of Tuticorin in general, the railway station there, the above said road of the Local Fund department, the fresh-water canal supplying the town of Tuticorin, and the wet lands of Korampallam tank, as well as the salt pans of Levingepuram.

2. In November 1884, breaches occurred in Puckle's channel, for the closing of which and for strengthening its right bank, the Imperial Public Works Department framed an estimate for Rs. 370. These repairs were considered necessary for the safety of the fresh-water channel. The Superintending Engineer differed from this opinion, and expressed that the South Indian Railway Company may fairly be called upon to repair and keep the banks in order, probably on the understanding that the natural drain was interfered with by the railway compound.

3. The work was not undertaken by any department until October 1885, when, on the recommendation of the Sub-Collector, the district board undertook the work on the consideration that the several agencies referred to in paragraph 2 *supra* should contribute their share towards the cost, and set the work on foot according to the estimate prepared by the Public Works Department. It was found that the estimate was insufficient, and a revised estimate for Rs. 1,060 was sanctioned by the board, and fund allotted. The work is now almost completed.

4. The different departments concerned were requested to contribute their quota, and their replies, disowning any interest in the work, are herewith submitted for the perusal of Government.

5. The damage that may at any time be caused by floods to the Local Fund road must be trifling, whereas the damage to other interest, and specially to the wet lands under Korampallam tank, would be very heavy. Under no circumstances therefore will the board undertake any further repair unless the cost is chiefly borne by the other agencies, and they would not have undertaken the work now done, had they supposed there would have been any attempt on the part of others to deny their obvious liability.

6. The board therefore request that Government will be pleased to issue orders for a fair contribution from those concerned.

7. A plan of the locality, with the Local Fund Engineer's letter explaining it, and other papers are herewith forwarded. A list is enclosed.

No. 521.

Referred to the Public Works Department for remarks.

(By Order.)

(Signed) E. S. LAFFAN,
Under Secy. to Govt.

MADRAS,
23rd August 1886.

No. 138-I.

Note by the Officiating Chief Engineer for Irrigation.

It is considered that this department has no interest in the maintenance of the Puckle's channel, and that there is no reason why any portion of the cost of keeping it in order should be met from Public Works funds.

2. It is also considered that the interest of the Local Fund Board in the matter is but slight, and that the chief concern rests with the Tuticorin Municipality and the South Indian Railway.

3. A reasonable distribution of the cost of maintenance would appear to be that the district board should bear one-fifth, the remainder being divided equally between the railway and the municipality.

(Signed) J. PENNYCUICK, Lt.-Col., R.E.,
Offg. Chief Engineer for Irrigation.

CHEPÂK,
5th October 1886.

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

No. 3509-C.

Transferred to the Financial Department, with reference to endorsement (returned) in that department, No. 521, of the 23rd August last.

(By Order.)

(Signed) R. DAVIDSON,
Under Secy. to Govt., P.W.D.,
Irrigation Branch.

CHEPÂK,
11*th October* 1886.

To the Financial Department, with papers in original.

ORDER—dated 28th October 1886, No. 1417 L.F., Financial.

The Government observe that the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works are all interested in a greater or less degree in the maintenance of the channel, and consider that the cost should be distributed as follows:—

Tuticorin Municipality	..
South Indian Railway Company	..
District Board	..
Department of Public Works	..

(True Extract.)

H. E. STOKES,
Ag. Chief Secretary.

To the President, District Board, Tinnevelly, with enclosures.
" Chairman, Municipal Council, Tuticorin,
through the Collector.
" Public Works Department.
" Joint Secretary to Government, Public Works Department,
Railway Branch.
" " " to Government, Public Works Department,
Irrigation Branch.

Exd. T. O'Connor.

B
No. R. 6th Dec 1886.
Sent to the Consulting Engineer for Railways for information.
Sec to G.

C 02 646/66

Govt. of {1886} Madras.

FINANCIAL.

Issued

Recd. *Encl.*

G.O., 28th Oct. 1886, No. 1417 L.F.

B
No. 2952 dy 10-11-86

OCTOBER.

Puckle's Channel.

Directing that the cost of maintaining — in Tinnevelly be distributed among the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works in the proportion pointed out.

Copy sent for Rys:
Ex. Pub. Wks. Dept:

Proceedings of the Madras Government, Public Works Department, 8th June 1874.

Read the following papers:—

No. 292-A.

No. 121. *Note by the Chief Engineer for Irrigation.*

STREEVIGOONTUM ANICUT PROJECT.—With a letter No. 24, of the 20th January 1873, the District Engineer submitted revised estimates, amounting to Rupees 9,57,200, in supersession of the estimates which were in G. O., No. 1,520, of the 21st June 1872, approved in place of those originally sanctioned. The amount of these latter, and of what may be termed the first revision, was identical, though as shown in the Government Order just quoted the alterations in the works were by no means inconsiderable.

2. Very shortly afterwards supplemental estimates, amounting to Rupees 74,070, were submitted for certain works reported to be necessary, and Rupees 43,700 in addition were reported to be required for office and work establishments, making altogether an addition of Rupees 1,17,770 to the then sanctioned amount. Upon this revised estimates for the whole project were ordered to be prepared, and those sent up in January 1873 were the result of this order.

G. O., 10th August 1872, No. 1,896.

3. On some points, such as the proposed raising of the anicut, the amount of storage available, etc., the information was insufficient to allow of the modified arrangements being submitted to Government, and accordingly the District Engineer's attention was requested to the subject of the water-supply, etc., and a further report was called for. As a result the estimates have been modified, and, as submitted with the District Engineer's No. 143, of the 13th December 1873, their amount is Rupees 9,71,470.

Memorandum No. 188, 25th March 1873.

4. Mr. Rundall explains the amount of the present estimates to be made up as follows:—

	RS.
Original Works	8,11,680
Extra Works	1,17,790
Petty Establishment	42,000
	9,71,470

But to this must be added the cost of the engineering establishment* employed up to November 1872 on this project 59,150

Making the total... 10,30,620

* *Vide* Statement.

5. The variations from the original arrangements of the works up to 1872 are explained in detail in the papers printed in Proceedings, Madras Government, of the 21st June 1872, No. 1,520. The District Engineer has not forwarded a comparative statement for the last revision, but he shows that the comparative

statement, dated 15th January 1873, gives the cost of works included in the first revision as... 7,94,590

To which have to be added certain works mentioned in paragraph 35 of his letter, No. 143, of the 13th December 1873... 17,090

Making up the total, of "Original Works" above given, of 8,11,680

It is to be noticed also that Mr. Rundall does not appear to have anywhere taken account of the charge to be made to the project for capitalization of the abatement of assessment of lands taken up for the works, though a statement showing the particulars, as also the land compensation, was forwarded with the late Superintending Engineer's letter, No 3,250, of the 16th October 1872. From this it will be seen that the land compensation is estimated to amount to ... ... Rs. 32,739

And the capitalized assessment *16,191

48,930

* Corrected from 16,181 to

† District Engineer's No. 24, paragraph 33.

It is however stated† that the whole of the provision for land compensation will be required, viz., ... 40,000

And maintaining the proportion for capitalized assessment this will be about 20,000

60,000

Difference... 20,000

so that the total of the direct charge on account of the project will amount to Rupees 10,30,620 + 20,000 = 10,50,620.

6. In paragraph 24 of the memorandum on the estimates, printed in Proceedings, Madras Government, of the 26th October 1868, No. 3,365, it was stated that to these estimates, amounting to Rupees 8,31,600, probably not less than 10 per cent. would have to be added on account of extra establishments, and 30,000 Rupees for drainage channels, and that they would amount then to about 9,77,696 Rupees. The present estimates therefore are Rupees 73,000 in round numbers in excess of what the project was originally expected to cost. In paragraph 3 of the District Engineer's No. 24 of the 20th January 1873, it is remarked that the estimates include an expenditure of Rupees 36,974 incurred in making good damage caused by the flood of November 1869. How this was distributed is not shown in the comparative statement or referred to in the remarks, but the facts were reported at the time, and will be found in the order as per margin. Rupees 5,000, Item No. 60, are also shown in the comparative statement as damage to materials, and were the amount paid to the Contractor Ragavacharry; capitalized assessment, Rupees 20,000, also was not in 1868 commonly included in estimates; of the increase nearly 62,000 Rupees therefore are due to

No. 1,424, dated 8th June 1870.

G. O., No. , dated

causes which could not have been provided for. The present estimates also contain a large item, Rupees 82,800, No. 3 in the list of extra works, for the revetment of the north tanks, a safe-guard which was not supposed to be necessary when the estimates of 1868 were prepared. A comparison between the works provided for in the estimates of 1868 and those either carried out or now proposed is not easy. A great many changes have been introduced, and of these a large number received the approval of Government in the Order No. 1,520, of the 21st June 1872, on the first revision of the estimates. The remarks now to be offered will be confined to the extra works, or those which have not already been fully considered and disposed of in previous papers.

7. *Item No.* 1, *Rupees* 4,400.—*Raising the Anicut.*—It is proposed to raise the anicut 18 inches in order to admit of a full supply being passed into the main channels on the two sides of the river when the water is flush with the crest. This alteration was advocated in the District Engineer's letter of the 20th January 1873, No. 24, paragraph 39, but the information therein given, and in Lieutenant Shepherd's report,* did not appear to be conclusive, and as in several respects the latter officer's deductions seemed to be incorrect, further details were called† for and paragraphs 4 to 13 of the District Engineer's letter, No. 143, of the 13th December 1873, deal with this question. It is stated that the calculations of water-supply available, which were made by Colonel Horsely, probably some time before the year 1855, have to a considerable extent been vitiated by the improvements subsequently carried out in the irrigation under the upper anicuts across the river, and that the extent of these improvements may be in some degree estimated by the increase of revenue amounting, it is said, to three lakhs of rupees, therefrom resulting; that as a consequence the minimum discharge of the river at the Streevigoontum anicut, which is the lowest of seven, has been reduced from 198 to 90 cubic feet per second. The information given is not as conclusive as might have been desired, owing in part to Lieutenant Shepherd's calculations having been made on data which were, from the varying state of the anicut then under construction, known only to him, and put into a shape which did not admit of the results being converted into actual quantities of water available on the average of the years over which observations extended. The data possessed by this office do not admit of the deficiencies in the information supplied by the local officers being made good, but it may be noticed that Mr. Rundall states that with the anicut at the sanctioned height of 6 feet, a full supply will not enter the channels until 1·20 millions of cubic yards an hour are passing over the weir to waste, and no doubt if any of that water were really required for irrigation the loss would be undesirable. As far, however, as can be judged from the data available, it is by no means certain or even probable that the height of the anicut as sanctioned will be found insufficient. What has been termed by the District Engineer a full supply in the channels is really the maximum supply they are to carry, and it was not contemplated that this would be conveyed for more than a short time. This is indeed evident from the circumstance that this

* No. 22, 15th January 1873, paragraphs 4 and 5.

† Memorandum, No. 188, 25th March 1873.

No. 143, paragraph 12.

maximum supply is at the rate of 6·35 cubic yards per acre per hour for the north channel, and 5·66 cubic yards an acre for the south channel. It appears to me that the estimate of water-supply required is somewhat excessive. Lieutenant Shepherd allows—

for the Kar crop $2\frac{1}{4}$ cubic yards per acre per hour for 90 days.
for the Peshanum do. do. do. for 150 days.

This not only provides for a full supply of water during a longer period than such is usually needed, for even were the crops on the ground so long a full supply is not required for the whole time, but no account whatever is taken of the rain-fall which will be stored in the tanks. And, moreover, it is by him supposed that the whole area will be double cropped, and this can hardly be anticipated as probable, though in Tinnevelly it would appear that lands are re-cropped to a greater extent than elsewhere.

The allowance for the—

Kar crop may be taken at 2 cubic yards for 80 days.
Peshanum do. do. do. for 105 do.

over the whole area. The quantity of water required will then be—

North Channel 20,600 acres—$20{,}000 \times 185 \times 24 \times 2 = 177{\cdot}60$ millions of cubic yards.
South Channel 13,500 acres—$13{,}500 \times 185 \times 24 \times 2 = 119{\cdot}88$ do. do.

Total... 297·48

With the water flush with the crest of the anicut with a height of 6 feet, it has been ascertained that the depth in the north channel will be a little under 5 feet, and that the discharge may be taken at 690 cubic feet a second.

Similarly the depth in the south channel will be just under 4 feet, and the discharge about 462 cubic feet a second.

In paragraph 5 of Lieutenant Shepherd's report it is shown that a full* supply may probably be depended upon for $24\frac{1}{2} + 39\frac{1}{2} = 64$ days in the season. Consequently the supply the channels will carry with the water flush with the crest of the weir will be available for at least that time, and $64 \times 24 \times 153{,}600 = 235{\cdot}929$ millions cubic yards.

* *i.e.*, Water for a maximum supply—

	C. FT.
North Channel	953
South do.	573

690 + 462 = 1152 cubic feet.
384
153600 cubic yards.

It is further assumed by that officer that for the rest of the season an average of 26,000 cubic yards an hour will be available, and his season being 240 days, against the 185 here supposed to be necessary, the supply may be the more safely be supposed to be reliable for the shorter period, and the quantity will be $121 \times 24 \times 26{,}000 = 75{\cdot}504$ do. do.

Total... 311·433 do. do.

As this calculation shows an excess of 14 millions of cubic yards, and as the additional supply derivable when the river may be above the crest of the anicut has

Proceedings of the Madras Government, Public Works Department,
8th June 1874.

been left out of the account altogether, I think it may at least be assumed that it is worthwhile to ascertain practically whether a 6-feet anicut will or will not suffice. It will cost a little, but only a little, more to take off and reset the coping should raising be ultimately deemed necessary, than it would to raise the crest at once. It may be that the character or duration of the freshes may be so far unsuitable as to make it insufficient that an ample quantity should be conveyed during the season, and this can be determined only by actual experience, or by a calculation of the kind referred to in the memorandum* on this subject. The District Engineer has accordingly been informed that for the present it has been recommended that the anicut should remain at the sanctioned height of 6 feet, at which it should be completed.

* No. 188, 25th March 1873.

8. *Item* 2.—*Platform Bridge for working the under-sluice shutters, Rs.* 3,550.—It is more than doubtful whether the proposed arrangement would answer its purpose. I do not think baulk or needle shutters could be worked from a platform. This item will therefore be omitted.

9. *Item* 3.—*Revetments to Northern Tanks, Rupees* 82,800.—In connection with this part of the estimates it will be advisable to consider what amount of storage capacity has been provided to supply the irrigation between the freshes in the Tambrapoorny. Originally it was proposed that the tanks on the north side should hold 15 millions of cubic yards, or 750 cubic yards per acre; and on the south side 20 millions, or nearly 1,500 cubic yards per acre. Then Lieutenant Shepherd, on a consideration of the circumstances of the water-supply, suggested alterations of the northern tanks to raise their capacity to 42 millions of cubic yards, and similarly the capacity of the southern tanks, was to have been raised from 20 to 28 millions; these modifications were approved in the Government Order as per margin on the first revision of the estimates, and, so far as the work then provided for was concerned, carried out. It was noticed, however, by the Acting Chief Engineer for Irrigation that the estimated cost of these tanks was likely to be exceeded: first, because the height of the banks left a margin of 3 feet only above the highest water mark; and, secondly, because a stone revetment would probably be found necessary for the large tank of Chinnasawmy Naicken or Korumpullum. For reasons connected with the discharge of surplus at the Upar Oday dam, the full level of this tank has been reduced from 20·90 to 19·40; and, with the exception of the Korkei and Arumugamungalum tanks on the north, and the Kadamba tank on the south, these reservoirs have been contoured and their contents ascertained. The District Engineer has not stated what storage has been lost by the reduction of the level of the Chinnasawmy Naicken tank, but as the area of the tank as shown on the map is about $2\frac{1}{2}$ square miles, the reduction is probably not in excess of 4 or $4\frac{1}{2}$ millions of cubic yards, and Lieutenant Shepherd's estimate of capacity must have been much too high.

No. 1,520, 21st June 1872.

Note, paragraphs 4 and 7.

The following is the acreage under each tank, etc.—

Names of Tanks.	Acres of irrigation.	Lieutenant Shepherd's estimate of capacity.		Revised capacity.		Remarks.
		Total.	Per Acre.	Total.	Per Acre.	
		Millions of C. yds.	C. yds.	Millions of C. yds.	C. yds.	
North Side.						
Paykolum	3,150	3·500	1,111	3·604	1,144	
Marathony	1,000	0·500	500	0·583	583	
Pottakolum	2,000	3·500	1,750	2·316	1,158	
Chinnasawmy Naicken ...	8,100	30·000	3,703	15·194	1,876	
Arumugamungalum ...	2,000	4·500	2,250	4·500	2,250	
Palayacoyal	3,750	Put down as under channel.	3,750	0·865	497	Approximate.
Korkei				1·000		do.
	20,000	42·000	2,100	28·062	1,403	
South Side.						
Auvudiar	200	1·500	7,500	0 996	4,980	
Autur	2,000	1·000	500	2·094	1,047	
Seenimavady	250	0·500	2,000	0·699	2,800	
Ammenpuram	3,750	3·000	800	2·892	1,176	
Kanam				0·819		
Nullur	2,200	3·000	1,364	0·398	318	
Keeranullur				0 301		
Tuluken	800	0·750	937	0·757	946	
Kadamba	3,550	16·000	4,507	15·000	4,225	Approximate.
Ellapanaicken	750	2·250	3,000	1·662	2,216	
	13,500	28·000	2,074	25·618	1,398	

It would have been well had the differences which these statements exhibit been noticed by the District Engineer, but it may be remarked that on the north side the Paykolum and Marathony tanks are virtually one, and that they will get their supply maintained whenever there is water in the river as the main channel runs into them. Also the Palayacoyal and Korkei tanks are commanded by larger reservoirs, so that their duty will be almost nominal. It may be further observed that had the Chinnasawmy Naicken tank been actually made of the capacity calculated by Lieutenant Shepherd, it would have held much more water than is needed. On the south side all the tanks whose storage capacity is small are commanded by the Kadamba tank, and there should consequently be no difficulty in making the excessive contents of that work make up for deficiencies elsewhere. Indeed, it seems probable that ultimately some of the smaller tanks will be found unnecessary, and, if so, their beds may be cultivated. On the whole, then, I think that the arrangements will answer sufficiently well, but they cannot be demonstrated to be altogether suitable in the absence of such a calculation as was called for in paragraph 3 of this Office Memorandum, No. 188 of the 25th March 1873, and for this data are not available. Returning now to the question of the revetments there is, I think, no room for doubt that this protection is needed to a part of the bunds of the Pottakolum, and to a greater length of the Chinnasawmy Naicken tank, but I am disposed to consider that a reduction may be made if those portions of the bund which are not exposed to the prevailing winds are covered with nanul grass. While, therefore, recommending that the estimate be

Proceedings of the Madras Government, Public Works Department,
8th June 1874.

allowed to stand at the amount above named, the District Engineer should give this subject his further careful consideration, with a view to the omission of the revetment wherever it can safely be superseded by the cheaper material. The revised sections of the bund are suitable, and it will be seen that, with the reduced water level in the larger tank,

Chinnasawmy Naicken.

it has been deemed necessary to raise the bund 1 foot, so as to leave a margin of 3½ feet above the calculated maximum water level.

10. *Upar Oday Dam.*—This surplus work has not been included in the list of extra works, but the difference, Rupees 6,400, between it and the former estimate has been included in what the District Engineer terms original works. The revised plan is a return to the general arrangement of the original

Rupees 8,11,680, paragraphs 4 and 5 above.

design. This latter consisted of a body wall 4½ feet high with a flush, or unobstructed, crest and a number of sluice vents 4 feet wide, the estimated cost was Rupees 36,640. Then it was proposed to raise by calingulah posts the level at which water was to be retained to 3 feet above the crest, and the revised estimate amounted to Rupees 35,500. The removal of the shutters in time on the occurrence of freshes appearing doubtful, Mr. Rundall wished to substitute shutters worked from a bridgeway, and the estimate for this arrangement amounted to Rupees 32,700 + 17,450 or together Rupees 50,150. Either of these revisions would have necessitated the maintenance of a considerable establishment, and as, in a case of this kind where a large drainage, 120 square miles, has to be dealt with, it is much the better plan to have a self-acting escape, it was intimated to the District Engineer that this kind of work was considered preferable, and the result is the present design which, except in some minor details, differs from the original only in the height of the crest, which is 6 feet instead of 4½ feet above the first apron, the level of which latter has not been altered. The maximum flood discharge from the drainage basin may be taken at

$$D = 562{\cdot}5\ M^{\frac{3}{5}}.$$

13,685 cubic feet a second, and, leaving out of account the sluice vents which might not be opened when most required, the depth passing over the crest 600 feet in length will be 43 inches, the top of the bund being 5½ feet above the crest. The margin is enough but none too much, and it is evident that had it been necessary to retain water at 1½ feet higher level, a considerable additional outlay on the tank would have been necessary. With the 24 sluice vents open 2½ feet on the crest will be the maximum W.L. The only modifications considered desirable are

* 1 foot.

the raising* of the wings to the level of the top of the bund as sketched on the plan, and the keeping of tops of the sluice shutters flush with the crest of the dam.

11. Items 4 and 5 are—

Pitching to North Channel	Rs. 4,440
Do. to South do.	,, 1,100

The heads of both the main channels are in very sandy soil, and at the north channel the District Engineer has proposed to carry the pitching for a length

No. 24, paragraph 42.

of 1,000 feet. Major Oakes wished to alter this to 300 feet, but it has been

explained that here there is a considerable bend, and Mr. Rundall has suggested that this work should be carried out tentatively for a length of 600 feet, and accordingly the estimate may be reduced from 4,440 to Rupees 2,660.

12. *Items* 6, 7, *and* 8 are for screw gearing for sluices, and require no special notice.

13. *Items* 9 *and* 10 are small works for passing small drainages, and they were reported to have been completed prior to January 1873.

District Engineer's No. 24, 20th January 1873, paragraph 47.

14. *Item* 11, *Rupees* 3,200, is for an accommodation bridge over the south channel for the large village of Alwar Tinnevelly. The circumstances were inquired into some time ago, and the necessity for it admitted. The mean width of the channel is 45 feet, so that three spans of 12 feet each are not suitable. The width, 18 feet, of roadway seems unnecessarily great; 13 feet, that of a bridge for a 2nd class district road, will probably suffice. The design should be altered to three spans of 15 feet, or two of 22½ feet, and with the diminished width of roadway the amount of the estimate will be about correct, as the rise 4½ feet of arch allowed for the 12 feet arches will be enough for either of the other spans, and the level of the roadway will be about the same.

15. *Item* 12, *Rupees* 2,500, *for a bridge on the Cotton Road over the Tuticorin Drain.*—The necessity for the work is explained by the alterations noticed in the District Engineer's letter as per margin, and it has been already completed on sanction given by the late Superintending Engineer under the circumstances noticed, and the total cost of the revised arrangements has been less than the estimated amount of those before sanctioned.

District Engineer's No. 24, 20th January 1873, paragraphs 31 and 50.

16. *Item* 13, *Rupees* 3,500—*Raising bund of Perungolum Surplus Channel.*—This provides for remedying an omission from former estimates. The north main channel crosses the surplus from the Perungolum tank, and the water is received into the channel, part being carried along the latter, and excess discharged into the Arumugamungalum tank. The banks of the surplus channel are at present below full supply level in the main channel, and it is therefore necessary to raise them. It is necessary to remark that the relative levels of the water and banks are not marked on the longitudinal and cross sections, and that the margin of the latter above the former appears to be insufficient. The sections do not scale accurately, and exactly what this margin is cannot be ascertained, but it would seem to be 18 inches. Another foot may be provided by side ridging at a small cost.

District Engineer's No. 143, paragraph 29.

17. *Items* 14, 15 *and* 16 are Inlets,..... Rupees 1,440
Dam near Kulpadagai head sluice, ,, 240
Dam in Poriur channel, ... ,, 540
and provide for petty works found necessary during the progress of the work.

18. An additional estimate, Rupees 860, termed *repairing the Ammenpuram and Kanam tanks*, but which should be called "*improving*" them, is requisite in consequence of the amalgamation of these small works. It was pointed out, in connection with the remarks on the proposed arrangements, that the difference in the level of the bunds appeared to have been overlooked, and the District Engineer has now provided what is needful.

Memorandum No. 188, paragraph 7.

District Engineer's No. 24, paragraph 14.

District Engineer's No. 143, paras. 26 and 37.

19. *Yeral Syphon Sluice or Under Tunnel.*—This work is for passing the drainage of five square miles under the north main channel, and the original design provided one vent of 4×5 feet. It was next proposed to substitute three vents of 4 feet with a water-way of 56 square feet, and at the time this was reported the foundations had been laid. This waterway being considered insufficient, and the level of the floor admitting of a much more capacious work, the design was altered to one span of 12 feet and 9 feet high to the soffit of the arch, thus giving 92 square feet, and the under tunnel has been so constructed. The present estimate amounts to Rupees 8,840, of which Rupees 8,050 were sanctioned in the first revision of the estimates, and Rupees 750 are included in the item Rupees 8,11,680, paragraphs 4 and 5 above. No provision was however made for carrying off the water through the under tunnel, and in the list of extra works Rupees 3,800 are entered for cutting an outfall channel with a bottom width of 30 feet. A part of this work has been carried out. The water will run into the Korkei tank, which is reported to have an escape adequate to the discharge of the surplus if necessary.

District Engineer's No. 24, paragraph 25.

District Engineer's No. 143, paragraph 35.

District Engineer's No. 143, paragraph 37.

20. As the District Engineer has not submitted a complete abstract of the revised estimates the following list of works is subjoined to show clearly how the total amount recommended for sanction is made up:—

Items.	Description.	Amount.	Items.	N.B.—The items in this list are taken from the Comparative Statement, dated 15th January 1873, the District Engineer's letter No. 143, 13th December 1873, paragraph 35, and the list of extra works therewith forwarded.
		RS.	RS.	
1.	Streevigoontum Anicut ...	1,71,000		
	Rough stone	3,000		
	Two groynes	1,540		
			1,75,540	*Vide* paragraph 36 of District Engineer's No. 24, 20th January 1873. The whole item has been put down to the anicut.
2.	South channel head sluice ...	11,796		
	Screw gearing for do. ...	754		
			12,550	
3.	South main channel	63,956		
	Stone pitching do.	1,100		
			65,056	
4.	Colasagarampatam road bridge...	4,085	4,085	
5.	Tricalore syphon sluice ...	1,830	1,830	
6.	Tricalore bridge	6,042	6,042	

Items.	Description.	Amount.	Items.	N.B.—The items in this list are taken from the Comparative Statement, dated 15th January 1873, the District Engineer's letter, No. 143, 13th December 1873, paragraph 35, and the list of extra works therewith forwarded.
		Rs.	Rs.	
7.	Kadamba head sluice	3,115	3,115	
8.	Autur head sluice	1,696		
	Screw gearing for do.	250		
	Autur channel	16,870		
	Drop in do.	1,084		
	Do. in do.	940		
			20,840	
9.	Trichendoor road tunnel ...	1,140	1,140	
10.	Yeral road tunnel	1,140	1,140	
11.	Aqueduct across old Autur channel	3,690	3,690	
12.	Sathuvoycal calingulah ...	1,559		
	Rough stone pitching	1,210		
			2,769	
13.	Poriur head sluice	3,070		
	Screw gearing for do.	720		
			3,790	
14.	Poriur channel	7,277		
	Do. do. bridge	3,260		
	Dam in channel	540		
			11,077	
15.	Improving Ammenpuram and Kanam tanks	860		
	Ammenpuram channel	937		
	Kanam do.	3,162		
			4,959	
16.	Tuluken channel head sluice and drop	906		
	Tuluken channel	2,560		
	Do. do. drop	555		
	Do. tank	2,590		
	Do. do. calingulah ...	920		
			7,531	
17.	Kanam channel	35,450		
	Do. drop	1,350		
			36,800	
18.	Ellapanaicken tank	8,411		
	Do. calingulah ...	1,745		
			10,156	
19.	Auvudiar tank	6,903		
	Do. do. calingulah ...	1,846		
			8,749	
20.	Ammenpuram syphon sluice ...	964	964	
21.	Palipat do. ...	746	746	
22.	Alwar Tinnevelly bridge ...	3,200	3,200	
23.	North channel head sluice ...	17,930		
	Screw gearing do. ...	1,486		
			19,416	
24.	North channel	95,791		
	Stone pitching do.	2,660		
	Dam in do.	871		
			99,322	
25.	Kulapadagai head sluice ...	1,921		
	Screw gearing for do. ...	250		
			2,171	

Proceedings of the Madras Government, Public Works Department, 8th June 1874.

Items.	Description.	Amount.	Items.	N. B.—The items in this list are taken from the Comparative Statement, dated 15th January 1873, the District Engineer's letter, No. 143, 13th December 1873, paragraph 35, and the list of extra works therewith forwarded.
		Rs.	Rs.	
26.	Savaramungalum bridge ...	4,257	4,257	
27.	Mungalakurichy bridge ...	4,945	4,945	
28.	Korkei head sluice	1,290		
	Screw gearing do.	250		
			1,540	
29.	Yeral under tunnel 8,500+340	8,840		
	Do outfall channel	3,800		
			12,640	
30.	Yeral bridge and calingulah ...	4,692	4,692	
31.	Causeway	3,780	3,780	
32.	Siruthundu bridge	3,550	3,550	
33.	Double dam	7,160	7,160	
34.	Palayacoyal road bridge ...	3,503	3,503	
35.	Marathony tank	478		
	Do. calingulah	2,885		
			3,363	
36.	Pottakolum tank	11,998		
	Do. calingulah	5,934		
	Do. revetment, etc.	12,800		
			30,732	Revetment taken out of estimate for northern tanks.
37.	Chinnasawmy Naicken tank ...	33,614		
	Do. escape weir called Upar Oday dam 32,700+6,400 ...	39,100		
	Revetment, etc., to tank ...	70,000		
			1,42,744	Do. do. do.
38.	Upar Oday embankment ...	26,830	26,830	
39.	Tuticorin channel	14,112	14,112	
40.	Distribution sluices	18,600		
	Do. channels	29,000		
			47,600	
41.	Bridge on cotton road	2,500	2,500	
42.	Perungolum surplus channel embankment	3,500	3,500	
43.	Dam near Kulpadagai head sluice	240	240	
44.	Pudugudy bungalow	3,888	3,888	
45.	Land compensation	40,000	40,000	
46.	Capitalized assessment on land taken up	20,000	20,000	
47.	Damage to materials	5,000	5,000	
48.	Inlets	1,440	1,440	
49.	Sundries, including tools and plant—			
	Contractor 31,621			
	Departmentally ... * 8,156			
		39,777	39,777	* Rupees 40,937, Item No. 61 of comparative statement, 15th January 1873, less contractor 31,621.
				Vide statement of details. Store shed 52; Overseer's Bungalow... 1,107 } 1,159; Uneven item 1
50.	Temporary sheds 3,700+1,159	4,859	4,859	
51.	Petty establishment	42,000		
	Engineering do.	59,150		
			1,01,150	
			10,40,480	

The difference between the total and that mentioned in paragraph 5 above is thus explained :—

		Rs.
Total in paragraph 5...		10,50,620
Deduct error in the excess amount required for Yeral syphon sluice, this excess being 8,840 — 8,500 = ...	340	
and not 8,840 — 8,090	750	
	410	
Item for raising anicut	4,400	
Under sluice platform bridge	3,550	
Reduction of stone pitching, north channel	1,780	
		10,140
Revised Total ...		10,40,480

The District Engineer should now prepare an abstract exhibiting the works in their proper order thus :—

(1.)—The anicut and all its works.

(2.)—The south channel and all its works. Each branch of the south channel with all the works, tanks, etc, thereto appertaining in their regular order.

(3.)—The north channel and all its works. Each branch of the north channel and all the works, tanks, etc., belonging to it and them, in their regular order.

and then a classified abstract dividing the works into the heads required to be shown in the Budget and accounts.

Much more time than should have been necessary has had to be devoted to the examination of these estimates, owing to the absence of any abstract estimate, to connected works not being placed together, and to unconnected works being amalgamated. Thus the item, rough stone 3,000 Rupees, is stated to belong principally to the anicut, and to a small extent to the escape (Upar Oday dam) of a tank a great many miles off; and again the revetments of two tanks are put into one estimate without the cost of each being shown separately, although other items for each have to be added to the shares in the revetment estimate. The Account Department cannot possibly deal with items thus jumbled up together.

21. With regard to the returns to be expected from this project, the latest information available is contained in the Collector's report to the Board of Revenue, dated 31st May 1872, No. 224, in which the additional revenue is estimated at 1,60,000 Rupees, or over 15 per cent. Government have called for detailed Revenue Statements in the form in which those for the Godavery Delta have been prepared, and when these are received and the standard revenue, with which that obtained after the construction of the anicut or opening of the main channels for irrigation, is to be compared shall have been determined, a more definite idea of the effect of the works will be obtainable.

Vide paragraph 14 of Lieutenant Shepherd's report, No. 22, dated 15th January 1873.

22. With these remarks this latest revision of the estimates is submitted for sanction.

OOTACAMUND, *25th April* 1874.

(Signed) J. MULLINS, Lieut.-Colonel, R.E.,
Chief Engineer for Irrigation.

No. 121A. From J. W. RUNDALL, Esq., District Engineer, Tinnevelly, to Lieutenant-Colonel J. MULLINS, R.E., Chief Engineer for Irrigation, dated Palamcottah, 13th December 1873, No. 143.

I HAVE the honour, with reference to your memorandum No. 188 of the 25th March last, to re-transmit the papers connected with the Streevigoontum Anicut Project revised estimate, and to supply such additional information as it is possible for me to afford with reference to your remarks in the memorandum under reply.

Two Lists, one of plans and estimates of first revision and one of other documents, all sent by banghy.

2. I send also all the plans and sections connected with the first revision forwarded to Major Oakes by the Superintending Engineer, late 8th Division.

3. The sections have been re-drawn and reduced to the mean sea level. The masonry works and other details have been shown as constructed, and I trust you will now find them sufficiently clear.

4. The first point to be noticed is the question of the supply of water reaching the anicut.

5. Lieutenant Shepherd's observations were based on a register of the height of water in the river, and he, knowing the height of anicut from time to time, deduced the information recorded in the tables already sent to you. I have no means of reducing his figures to cubic yards per hour, for with anicut incomplete, and with under sluices sometimes open, sometimes partly closed with turf, etc., Lieutenant Shepherd's calculations are necessarily only approximations.

6. I think there is one fallacy in them, viz., that he has assumed that whenever there is a discharge of 210,000 cubic yards per hour, it will all go down the channels, whereas with an anicut 6 feet high, and the head sluices as constructed, not more than 158,000 cubic yards per hour can enter the channels when the water is level with the crest.

7. From June of this year we have kept registers of the water in the river at anicut, of the height on rear floor of each head sluice, and of the number of vents of the anicut under sluices open, and have calculated out as nearly as possible the quantity of water reaching the anicut.

8. I forward diagrams showing the result *up* to the full discharge of the channels, beyond this it is not necessary to go; the diagrams of height of water in river sent to you every month will give you any other information you may need.

9. I should, however, state that the south-west monsoon supply in June and July of this year has been far above the average. The opinion of the ryots was that they had not had such a season for twenty years.

10. In this year, therefore, there were forty days between 1st June and 31st October where the river supply was equal to or above the full supply of the two channels.

11. If the anicut is only 6 feet high, we should lose during every one of these forty days up to 52,000 cubic yards per hour. Of course we might not want it if the tanks were already full, but I think it is highly necessary to have the power of passing into the channels the maximum they will carry whenever it may be available. Raising the anicut to 7 feet 6 inches will alone give us this power in the case of the north channel.

12. The calculations by which this is arrived at are appended ; with the anicut only 6 feet high 1,200,000 cubic yards per hour must be passing to waste over the anicut before the full supply can be passed into the channels.

13. The full supply can be passed into the south main channel with 7·1 foot on the upper floor of sluice. The calculations suppose both channels clear of silt, which is only likely to be the case at the commencement of a season. I should here note that the calculations given by Major Prendergast in the printed report do not apply now, the north head sluice having been built with six instead of four vents. The necessity for taking as much as possible of the flood waters was not, I think, realized by that officer when preparing the project, as the minimum discharge of the river was estimated on Colonel Horsley's data to be so much more than we have found it. For thirty-one days consecutively in September and October the discharge was below 30,000 cubic yards per hour, the minimum being 12,000, so that the statement in paragraph 3 of Major Prendergast's memorandum is clearly wrong, the minimum discharge being 90 cubic feet per second instead of 198.

14. With regard to the question of storage in the tanks, it was originally proposed (see Major Prendergast's report) that the north tanks should contain 15,000,000 and the south tanks 20,000,000 cubic yards. During the execution of the work the tank banks were raised and alterations introduced, by which Lieutenant Shepherd calculated the storage would be increased to 42,000,000 cubic yards on the north and 28,000,000 on the south. As, however, these were only approximations, and as it seemed advisable that the storage should be accurately known, I wished before re-submitting the papers to have the tanks contoured and their capacities properly determined. The list which accompanies this shows the capacities of the tanks at the maximum level at which it is proposed to maintain them. Only three tanks could not be contoured on account of water in them, viz., the Korkei and Arumugamungalum on the north and the Kadamba on the south side. I believe, however, the capacities given to be very close approximations.

15. The result is that the storage is not as much as Lieutenant Shepherd estimated it to be, on the north side it is 28,000,000 on the south 25,600,000 cubic yards. The greatest difference between the actual and estimated capacities is in the Chinnasawmy Naicken (or Korumpullum) tank, which is shown to be 15,200,000 cubic yards against 30,000,000 estimated by Lieutenant Shepherd. This partly arises from my having reduced the proposed maximum level of this tank from +20·90 to +19·40. The reasons for this change will be explained when noticing the Upar Oday dam.

16. For the Kar or south-west monsoon crop we shall have to depend entirely on the river, and cannot calculate on receiving water from the rainfall. I forward a statement showing the rain registered at Ottapedaram and Tuticorin during the last ten years. The rainfall at Ottapedaram may be assumed to that of the Upar Oday basin, that at Tuticorin may be assumed to be the amount of rainfall which would assist in raising the crops. From this statement it will appear that it is only in the north-east monsoon that the tanks will receive any supply, and that principally on the north side. The Kadamba is the only tank on the south side which can receive much rain water. The other tanks are bounded by the sand hills, called the Teri, off which the rainfall comes only slowly

Proceedings of the Madras Government, Public Works Department,
8th June 1874.

and in the shape of springs, which are already used for garden cultivation.

17. On the north side it is proposed to cultivate 20,000 acres, and assuming for the Kar crop 50 cubic yards per diem to be required for 90 days $\frac{90,000,000}{28,000,000}=32$ times, the tanks will have to be filled to bring the crop to maturity or for the Peshanum crop of 150 days $\frac{150,000,000}{28,000,000}=5{\cdot}3$ times.

18. It will be some time before the 20,000 acres extent of cultivation are reached, but we must now arrange for the total area.

19. Similarly, on the south side, with 13,500 acres the tanks will have to be filled 2·4 times for the Kar and nearly four times for the Peshanum crop.

20. It does not seem to me possible to state positively that a certain supply of water will be available in the river for a certain number of days. Situated as the Streevigoontum Anicut is, the last on a river which has already seven anicuts across it, and on every feeder of which there are numerous anicuts, the flood water is really what we have to depend on; and, as originally designed, the height of anicut and the dimensions of the channels and sluices are not proportioned one to another.

21. As the cost of raising the anicut will be so small, about Rupees 4,000, and the extra afflux and velocity over it will in no way endanger the stability of the work, I trust there may be no hesitation in sanctioning it.

22. With regard to the remarks in paragraph 4 of your memorandum under reply, I would beg to state that the 13,000 acres of old irrigation was not cultivated entirely from independent sources of supply. On the north side the cultivation was supplied by the Kulpadagai and Korkei channels, on the south by the Tentraperi and Autur channels, all of which are merged into the north and south main canals respectively. The independent supply was uncertain and precarious, being the surplus from the Marudur, Melakal, and Kilakal.

23. With regard to your paragraph 5, I would beg to point out that the northern tanks are really divided into three, with calingulahs between each. The old Paycolum and Marathony tanks form one, the Pottacolum the second, and the Chinnasawmy Naicken (or Korumpullum, for I regret to say it is called by both names) the third. I have, bearing in mind your instructions with regard to the Upar Oday dam, reduced the maximum level of the latter tank by 1½ feet. I think it is very advisable to do this as the material of the bund is very inferior, and the tank very considerable in area and capacity, even allowing the water not to stand as high as was proposed by Lieutenant Shepherd.

24. With regard to your paragraph 6, I have the honour to enclose the statements showing the details of petty establishment as charged month by month to the anicut estimate. In G. O., No. 3,906, of the 15th December 1868, sanction was accorded to the entertainment of a first class Range Office for the project, and this was kept up till the 1st December 1872, when Lieutenant Shepherd became 2nd Range Officer on the general district establishments. It was of course necessary to maintain Maistries to supervise the work under execution, whether by the contractor or departmentally; and the Superintending Engineer was authorized by the Chief Engineer for Irrigation to do so.—*Vide* Colonel Anderson's Memorandum, No. 105, of the 30th November 1868. I have already, in my previous letter of the 18th January 1873, stated that I consider this establishment was on too extravagant a scale, and I reduced it after my arrival.

25. The other statements you require are also forwarded, viz., one showing the cost of engineering establishment, and one the various items charged off to sundries. There are some items of the latter on which recoveries can be made, and these will be made as soon as possible.

26. With regard to your paragraph 7, I have the honour to state that though the general level of the Ammenpuram bund is high, both it and the Kanam bunds require raising in some places. I have had the levels taken and the longitudinal section of both bunds is included in the book of sections now forwarded. The work required is only Rupees 860, for which sum an estimate is likewise submitted.

27. As requested, general maps, one for the south side and one for the north side, have been prepared; in these all the works as carried out are shown, also the old and proposed irrigation. The part colored yellow indicates rather the position than the precise area of the new cultivation. In some places a much larger proportion of the ground can be cultivated than in others.

28. The estimate for Yeral syphon sluice has been prepared as directed by you, and the work has been completed accordingly.

29. The circumstances of the Perungolum surplus channel will, I think, be understood from the map and sections now forwarded. The Perungolum is the last of the series of tanks under the Marudur. Kilakal and its surplus formerly found its way into the Arumugamungalum tank, but is now intercepted by the northern main channel. The work called the "bridge and calingulah" being intended to pass both the regular supply, and as much of this surplus as may be necessary, to the Arumugamungalum tank. The Perungolum surplus channel had a small embankment on both sides for part of its length and for part on the south side only. This bank was very low, and would not admit of the water being kept at the intended level in the main channel. The raising of the bank should have been included in the original estimate, but was strangely overlooked both in it and in the first revision. The Perungolum surplus may amount to as much as 100,000 cubic yards per hour, in which case the north channel head sluice will have to be partially closed, and the water passed on both through the bridge and calingulah and down the channel to the Paycolum and other tanks. The longitudinal section of the proposed embankment has been re-drawn and embodied in the general book of sections. The anicut referred to by you in your memorandum under reply is a dam across the channel near its head for diverting water to the Nunjei on either side. The new road from Streevigoontum to Yeral will pass over the south bank of this surplus channel. The extra earth to form the bank to a proper width for a road has been provided for in the road estimate.

30. With regard to the Upar Oday dam, I quite think the flush calingulah as ordered by you is the best arrangement. The screw shutters were proposed by me in lieu of the dam stones and planks proposed by Lieutenant Shepherd, and included by him in his first revised estimate. Bearing in mind the soil of which the bund is composed, and the considerable capacity of the tank, I think it would not be advisable to fix the level of a flush escape higher than + 19·40. The bunds are already + 23·90 and the revetment estimate provides for raising them to +24·90, with this height the water might be allowed to rise to +21·40. Two feet passing over the weir with the under sluices open would discharge 11,259 cubic feet per second, or 1,400,000 cubic yards per hour, a discharging capacity sufficient in any

case, taking the catchment basin of the Upar Oday at 120 square miles; but ample, I believe, when it is remembered that the tank itself will act as a regulator. The work has during the past season been built to a height of 4 feet above the floor of vents, leaving 20 feet to be added, or such a height as you may determine upon.

31. The estimate now sent provides for carrying out the work with crest at +19·40, and amounts to Rupees 39,100. This is in excess of the revised estimate. The excess is due, firstly, to increase in the rate for cut stone, which we have everywhere found the most difficult part of the work to get executed; secondly, to my having allowed for plastering the wings with Portland cement, which is necessary owing to salt having already attacked the brick-work. The previous estimate did not allow for the iron bars to vents, nor for shutters for them, screw shutters having been provided in a separate estimate of Rupees 17,450, which will not now be required.

32. Lieutenant Shepherd omitted the second drop in the Autur channel, and showed the amount of the estimate as saving. This drop is, in my opinion, necessary, and I forward plan and estimate, amounting to Rupees 970, for it. Without it the fall would be too heavy in the sandy channel below the first drop, between it and the Sathuvoycal channel.

33. The estimate for the syphon sluice at Yeral amounts to Rupees 8,840; the increase is due to there having been no proper allowance in the previous estimate for making up the banks over the sluice for the centerings and for baling.

34. I must also ask you to increase the sum for field channels to Rs. 29,000. These channels have now been marked out and the levels taken. We had previously calculated on the ground being of a tolerably uniform slope, but find that in many places heavy embankments have to be made, and that on an average the cost will be about Rupees 1,000 per mile, including drops and sluices. The length of channels altogether will be 29 miles.

35. In Lieutenant Shepherd's comparative statement, forwarded with my letter of the 18th January, Rupees 7,94,590 is given as the total of the old estimates; to this must now be added the increased amounts noted above, viz.:—

		Rs.
2nd Drop, Autur channel		940
Increase on Yeral syphon sluice		750
Do.	Upar Oday dam	6,400
Do.	small channels	9,000
	Total...	17,090

This will make the total of the works originally included in the first revision Rupees 8,11,680, or less than the original estimate by Rupees 19,920.

36. Four of the extra estimates prepared by Lieutenant Shepherd have been revised by me, viz.:—

I.—Raising the anicut increased to Rupees 4,400. This is due to the rate for brick-work having been altered to Rupees 4-8-0.

II.—Perungolum surplus embankment Rupees 3,500 instead of Rupees 3,100. The increase here is chiefly due to the extra provision for protecting the village of Siruthundu.

III.—Dam in Poriur channel, Rupees 540. In this I have lowered the floor as Lieutenant Shepherd allowed a fall of a foot in the surface in the lower part of the channel, even when the Ammenpuram tank was

full, the fall would be greater with the tank empty, and would probably cut up the channel.

IV.—I have also revised the estimate for the tank revetments, first, because I think that in Lieutenant Shepherd's estimate the 2 to 1 slope was commenced at an unnecessarily low level, and that a saving in quantity could be effected; and, secondly, because I do not think the work can now be done at the rates allowed. It could have been done for Lieutenant Shepherd's rate had the work been carried out simultaneously with the bunds. Both the Nallamally and Puthukottei Hills, from which stone and gravel will have to be brought, are situated above the tank, and thus stone for the greater part of the work will have to be carried round it when there is water in the tanks. At the return of the bank, where the water will be shallow, I have allowed only gravel or small stone pitching. The estimate now amounts to Rupees 82,800 against Rupees 75,900.

37. I have also added two more estimates, one for the Ammenpuram and Kanam tanks already alluded to, and one for deepening out the tail race from the Yeral syphon sluice to the Korkei tank. The old channel was quite insufficient to pass the water off. In your memorandum under reply you say Major Ryves' formula would allow for a drainage of 8 inches in 24 hours through the syphon sluice, but supposing this rainfall to occur, it would hardly run off paddy land all at once, the field banks would assist in retaining it. As the ground above the syphon sluice is flat, the water would stand back for a considerable distance. It is proposed to make the channel from the syphon sluice 30 feet at bottom with slopes 2 to 1 with 9 inches fall per mile, to carry after unusual, but not extraordinary, rains $3\frac{1}{2}$ feet. The water level in the channel would in this case be 1·64 above the rear cistern wall, and in front the water would stand $1{\cdot}64' + 1{\cdot}25' = 2{\cdot}89'$ above the upper cistern wall, that is about 2 feet over the Nunjei. This would only be for a short time. In order to render the syphon sluice effective this year it was necessary to clear the old channel partially; this has been done by digging the channel for the first half a mile to half width. It will be seen that the water from the syphon sluice is picked up by the Korkei tank, the calingulah of this tank is capable of discharging the surplus should much water come down when the tank is full.

38. The estimate amounts to Rupees 3,800, and should have been included in the original estimate.

39. The total of the extra estimates thus comes to Rupees 1,17,790.

40. In all the extra estimates forwarded provision has been made for the petty establishment required, but to cover past expenditure the whole sum required will be about Rupees 42,000, the total expense of the project may therefore be considered to be—

	Rs.
Original works	8,11,680
Extra works	1,17,790
Establishment, Petty	42,000
	9,71,470

41. This is Rupees 14,000 more than Lieutenant Shepherd's total, but the corrections made are all necessary, and such as my present experience of the works leads me to believe to be essential.

Proceedings of the Madras Government, Public Works Department,
8th June 1874.

42. I should mention that the following extra works sanctioned by the Superintending Engineer, late 8th Division, from anticipated savings, have been completed:—

	Rs.
Screw gearing for north and south Head Sluices	2,240
Do Poriur Head Sluice	720
Syphon Sluice at Palipat	746
Do Ammenpuram	964
Bridge on Cotton Road	2,500
	7,170

43. A portion of the work on the Perungolum surplus embankment of syphon sluice tail race have also been carried out, as the water could not have been let down the north channel without the work being done.

44. I shall feel obliged if you will let me have the books of sections back to have tracings made from it for my Office. The sections I have now are all drawn to the previous datum (head sluice floor), and I am unwilling to detain these papers any longer while copies are being made.

45. I regret the time which has elapsed in answering your Memorandum; it was only in November that the tank contours were completed by Lieutenant Boddy, R.E., without which information the papers could not be sent to you.

From J. W. RUNDALL, Esq., District Engineer, Tinnevelly, to Lieutenant-Colonel J. MULLINS, R.E., Chief Engineer for Irrigation, dated Palamcottah, 20th January 1873, No. 24.

1. Comparative Statement, one in number.
2. Statements showing the state of the river, six in number.
3. Estimates for extra work to be done to the Anicut, seventeen in number with a list.
4. Plans for do. do., seventeen in number (sent separately).
5. Do. referred to Comparative Statement, one in number.
6. Estimates to do. do., two in number.
7. Report of Lieutenant Shepherd, R.E., one in number.

I HAVE the honour to forward herewith, as desired in G. O., No 1,896, of the 10th August, revised estimates for the Streevigoontum Anicut Project. All those items for which separate estimates have been submitted to you are now included, and some further works necessary for the proper development of the scheme have been now added.

2. The estimates are accompanied by a report from Lieutenant Shepherd, R.E., explaining in detail the reasons for the most important modification now proposed, viz., the raising of the anicut.

3. The total of the estimates as now completed is Rupees 9,57,200, including Rupees 40,000 for extra Petty Establishment, and Rupees 36,974 for damage by the flood of November 1869, both of which items should not be included in comparing the present with the original estimate of 1868.

4. The estimates as now submitted do not furnish a basis for comparison with that originally sanctioned, as they form a revision of the estimate prepared in March 1871 by Lieutenant Shepherd, R.E., and sanction to which was accorded in G. O. of the 21st June 1872.

5. The deviations proposed from the estimates as then sanctioned are few; there would be a net saving of Rupees 37,010 (see comparative statement) on this estimate if carried out without further additions, but from the re-commencement of the works in September 1871, after Ragavacharry's contract was cancelled, it was evident that a very considerable saving would result in consequence of the reduction of rates.

6. From this saving certain of the works entered as additional works were from time to time sanctioned by the Superintending Engineer, late 8th Division, and have been completed. These are Items Nos. VI., VII., X., XI., XIV., the total cost of which is Rupees 7,170.

7. I will first notice the items of the estimate of March 1871, which require explanation, and in doing so will reply to Major Oakes' Note of 20th May 1872, No. 74, as the reply thereto furnished by me in July 1872 has never, I find, been communicated to you. The numbers refer to those in the comparative statement.

8. *Item No.* 1.—*The Anicut.*—An increase of Rupees 4,300 is shown on this item ; one cause for this is an increase in the rate for brick-work, which is due to Contractor Ragavacharry having been paid Rupees 5 for brick in common, and Rupees 5-8-0 for brick in hydraulic mortar, together with an extra allowance for firewood. Brick-work in common mortar can now be done by us at Rupees 4, and that rate is entered in the estimate for raising the anicut forwarded herewith. Besides the above reason, the stone ordered to be packed in rear of the under sluices and sanctioned in G. O., No. 198, dated 18th January 1870, was inadvertently omitted when the estimate of March 1871 was prepared. An increase to the rate of cut-stone for the coping has likewise been entered, Rupee 1 for cubic foot is not sufficient to provide a well cut granite coping. There is also an increase to the cost of earthwork owing principally to the anicut having been so long in hand, and the river having filled up previous year's work. It was not possible to alter the rear wings of the anicut as proposed by Major Oakes, as they were half finished in 1870.

9. *Item No.* 3.—*South Head Sluice.*—On this there is a saving, as in G. O., No. 449, dated 14th March 1872, Revenue Department, the construction of a bridge over the anicut was negatived, and as the estimate provided for raising the side walls and wings of this sluice, which is unnecessary except the bridge is built, a saving of Rupees 2,874 has been effected with reference to Major Oakes' remark regarding the level of the platform for working the shutters of this sluice, the estimates now sent provide for raising the platform.

10. *Item No.* 6.—*Tricalore Syphon Sluices.*—Of these two syphon sluices for passing irrigation water, one only has been constructed, and arrangements have been made by which the whole of the land intended to be cultivated by the two syphons is supplied from the one. The second is therefore not required. The syphon already built has cost more than the estimate ; this is due to the fact that the work was commenced by Ragavacharry, but only a few foundation cubes put in. On resuming the work baling and excavation were heavy.

11. *Item No.* 8 was completed in 1870 ; the alterations suggested by Major Oakes cannot be carried out.

12. *Item No.* 10.—*Autur Branch Channel.*—The question of this channel and the drop in it are intimately connected ; several letters have passed regarding the latter. The earthwork of the channel had been carried out for a distance of 21,500 feet when the flood of 1869 broke in and obliterated about 1½ miles of the channel, necessitating a revision of its arrangements, the estimate for which was included in the flood-damage estimate. In the estimate of March 1871 provision was made for two drops, but as Lieutenant Shepherd, R.E., found that the Sathuvoycal channel (into which the Autur channel is dropped) had silted by the action of the flood about 3 feet, he raised the general level of the Sathuvoycal calingulah (Item No. 15), and by placing one drop at 17,500 feet from head, and allowing the water a slightly increased surface fall in the lower part of the channel, rendered the construction of a second drop unnecessary. I wished to lengthen the crest of this weir, and raise its level in order to reduce the velocity over (or rather through) the originally designed work, but as Major Oakes in his letter No. 135, dated 2nd August 1872, overruled my proposal, the work has been built on the level and with the length of crest ordered by him.

13. *Item No.* 15.—*Sathuvoycal Calingulah.*—The level of this work was altered as stated above, but this necessitated a greater depth of foundations than allowed for in the estimate, hence the slight increase of Rupees 145 shown.

14. *Item No.* 20.—*Ammenpuram Calingulah.*—The foundations of this work were put in by Ragavacharry, but as the Kanam tank immediately below it is very small, it is not necessary that it should be separated from the Ammenpuram tank by constructing a calingulah between them, and the unexpended balance of this estimate is therefore shown as a saving The two tanks

Proceedings of the Madras Government, Public Works Department,
8th June 1874.

become practically one, but there is not likely to be any disputes between the villagers, as the anicut will give them a far more abundant supply of water than ever they had before.

15. *Items Nos.* 22 *and* 23—*Tuluken Head Sluice and Channel.*—Major Oakes notices that the head sluice should consist of two vents of 4 feet each ; it is true that by a mistake in the original estimate the head sluice and channel are not proportioned one to another, but the mistake consists in the channel having been made too large and not in the sluice being too small. The area of land which will be cultivated under the Tuluken tank and channel is under 1,000 acres, and for the supply of this the head sluice as constructed is amply sufficient. The saving on the Tuluken head sluice is due chiefly to reduction in rates, and partly to the fact that rock being met with there was less depth of foundation required.

16. *Item No.* 24.—*Tuluken Drop.*—This work is, as supposed by Major Oakes in his Note, founded on kunkur rock, and was built before the receipt of his remarks. The saving shown is due to a reduction of rates.

17. *Item No.* 25.—*Tuluken Tank.*—The capacity of this tank was not, as supposed by Major Oakes, reduced, as the bund was raised 3 feet above the level allowed in the estimate of 1868 ; the waterspread was however reduced, and the area which would have been submerged is thus available for cultivation from the Kanam tank.

18. *Item Nos.* 27 *and* 28.—*Kanam Channel and Drop.*—The crest of the drop has been built on the level given by Major Oakes in his Note.

19. *Item Nos.* 31 *and* 32.—*Auvudiar Head Sluice and Drop and Auvudiar Channel.*—It was found unnecessary to provide a sluice and channel of the dimensions originally allowed for ; they have, therefore, been made of the dimensions of the ordinary supply sluice and distribution channel, and paid for from the lump sum allowed for such works.

20. *Items Nos.* 33 *and* 34.—*Auvudiar Tank and Calingulah* require no special notice. This tank is chiefly intended for the water-supply of the large town of Trichendoor hitherto most badly supplied.

21. *Item No.* 35.—*North Head Sluice.*—The saving shown here is due to the same cause as that on the south head sluice, viz., the non-construction of bridge over the anicut.

22. *Item No.* 36.—*North Channel.*—This has been completed. As observed by Major Oakes in his Note, the water will probably be delivered at the Paycolum tank at a somewhat higher level than shown in the section accompanying the estimate of March 1871. The bunds of the channel have however been made of a sufficient height, viz., about 10 feet above bed of channel.

23. *Item No.* 37.—*Dam in North Channel.*—Properly speaking an inlet ; a new channel is proposed above the north channel which will pick up the drainage which this inlet was intended to pass into the north channel ; this work need not therefore be built.

24. *Item No.* 38.—*Kulpadagai Head Sluice.*—This work was finished before the receipt of Major Oakes' Note, and the alteration in the thickness of the wings cannot therefor be carried out.

25. *Item No.* 42.—*Yeral Syphon Sluice.*—The foundations of this work have been completed, and it has been built up to floor level. Unfortunately the foundations were dug out by Ragavacharry in accordance with the provisions of the estimate of March 1871, hence it was not possible to raise the general level of the work. Regarding this work, I would beg to refer you to Major Oakes' letter of the 4th July 1872, replying to a proposition made by Lieutenant Shepherd, R.E., to omit the cut-stone lining. The cut-stone in the floor has been put down, but I would again venture to suggest that the cut-stone lining to piers and cistern may be omitted. The area to be drained is about five square miles of Nunjei, and supposing 1½ inches to run off this area per diem, the velocity through the work would be 4 feet per second. The above quantity would not be a constant discharge, and I think the brick-work would safely stand this, and an occasional higher velocity. The stone for this work has to be carted across a considerable distance of sand. Stone work is therefore both difficult and expensive to execute, hence the high rate of Rupees 20 per cubic yard, which it is found necessary to enter for this work in the estimate now submitted. I should mention that the quality of the bricks at Yeral is very good.

26. *Item No.* 46.—*Double Dam at Arumugamungalum.*—The saving on this is due to a partial substitution of rough stone for brick-in-chunam, which was sanctioned by the Superintending Engineer, late 8th Division.

27. *Item No.* 50.—*Pudukulum Tank.*—The increase shown on this work is due to the fact that the return of the bund had to be taken through the Teri sand, as a great loss of water would have occurred unless the sand had been removed and the bund formed on a water-tight substratum of clay.

28. *Item No.* 52.—*Chinnasawmy Naicken Tank.*—Major Oakes' remarks on this will be noticed further on when explaining the necessity for the additional works. The saving shown is due to a more favourable line for the return of the bund having been found by which its length was considerably shortened.

29. *Item No.* 53.—*Upar Oday Dam.*—This work will be discussed further on. The saving of Rupees 2,800 shown is due partly to reduction of rates, and partly to the substitution, in the body of the work, of rough stone for brick-in-chunam, sanctioned by the Superintending Engineer, late 8th Division.

30. *Item No.* 54.—*Upar Oday Embankment.*—These bunds have been taken along the northern channel of the Upar Oday instead of along the southern (see map in the project book). The advantages of this are that the banks pass through land much less valuable than if carried to the south; that the field channels from the tanks are less interfered with; and the distance to the sea being shorter, the outfall is *pro tanto* the better. The quantity of earthwork is however about the same, and the saving shown is almost entirely caused by reduction of rates.

31. *Item No.* 55.—*Tuticorin Channel.*—This channel was carried to the natural outfall north of Tuticorin instead of the south, the length and other dimensions were the same, and the general level of the ground was similar to that of the line originally selected, hence the saving is due almost entirely to reduction of rates. This channel is for the diversion of drainage only; the water-supply of Tuticorin has been provided for by a small field channel and sluice included under Items Nos. 56 and 63.

32. *Item No.* 56.—*Small Sluices.*—Previous to the receipt of Major Oakes' Note a revised plan of sluice fitted with screw shutters was sanctioned by the Superintending Engineer; thirty sluices will still be required, and the average cost, including shutters, is about Rupees 600.

33. *Item No.* 59.—*Compensation for land.*—The sum of Rupees 40,000 here provided has not been fully paid away yet, but the Collector considers the whole sum will be required.

34. *Item No.* 60.—*Damage to Materials.*—This sum was paid to Contractor Ragavacharry.

35. *Item No* 61.—*Tools and Sundries.*—This shows the expenditure to date; no new tools will be required.

36. *Item No.* 62.—*Rough Stone.*—The principal work on this item has been carried out in adding three yards of rough stone in rear of the retaining wall below the anicut apron. The addition of this stone was stated to be unnecessary by Major Oakes in his Note of the 23rd July 1872, No. 128, on the ground that there was already 33 feet in width of rough stone below the anicut, and that this was sufficient; no doubt amply sufficient, had the retaining wall been placed at about two-thirds of the total length from the cut-stone apron. I think however (and you will, I believe, agree with me) that the masonry retaining wall if not backed by a small amount off rough stone might be damaged or destroyed by the action of the river, especially by any laterial scour from water discharged through the anicut under sluices. Similarly a small quantity of rough stone has for this reason been added beyond the retaining wall of the Upar Oday Dam.

37. *Item No.* 63.—*Small Channels.*—The reason for the lump sum estimate being doubled is that now that nearly all the distribution channels on the south side, and some of those on the north have been marked out and cut, it is evident that the original provision was quite insufficient. The sum of Rupees 20,000 now entered will cover the cost of small masonry works, such as aqueduct and drops, which may be found necessary.

38. I will now notice in order the additional works for which detailed estimates and plans are furnished; the numbers quoted refer to those in the list of these works which accompanies this.

39. *Item No. I.—Raising the Anicut.*—Lieutenant Shepherd, R.E., in his report notices at length the reasons which have led him to the conclusion that it is necessary to raise the anicut 1½ feet. At the time of the preparation of the estimate of 1868, the only data of the water-supply available were those recorded by Colonel Horsley. The observations now recorded prove that the discharge of the river was either over-calculated by that gentleman, or that subsequent improvements in the upper anicuts and channels have reduced the quantity of water available at Streevigoontum. It might have been predicted from the character of the river, and of all the irrigation channels under it, that the combination of tanks with the channels is a necessity, and, if necessary with the upper channels, still more so with the channels from the anicut at Streevigoontum, the last on the river. As, therefore, there is not as much water in the ordinary state of the river as was supposed, full advantage must be taken of all freshes by running into the tanks the full supply of the channels. The revision of this project, which has been carried out by increasing the capacity of the north tanks during the progress of the work, and by bringing the Kadamba tank into the main system, is similar to that which it was found necessary to carry out to the Pennair anicut channels in Nellore. The capacity for storage has on the whole been double. The original storage was 35 (20 north + 15 south side) million cubic yards and is now 70 (42 north + 28 south side) million cubic yards. Lieutenant Shepherd, R.E., shows how the proposed arrangements will suffice for the areas on each side which are commanded and cultivable, but in doing so he does not take into account the rainfall and drainage caught by the tanks. This would be but small during the Kar (or south-west monsoon) crop, but would be considerable during the Peshanum (or north-east monsoon) crop. The height to which it is necessary to raise the anicut has been determined with reference to the head required to discharge the maximum supply of each channel through the sluices; this is shown by Lieutenant Shepherd to be 6′ + 1½′ = 7½′ above sluice floor on the north side, and 4½′ + 2¾′ = 7¼′ on the south side. I trust that, under the explanations given, that sanction may be granted for the raising of the anicut.

40. *Item No. II.—Bridge to work Under Sluice Needles.*—This has been provided in accordance with your own suggestion when visiting the works in 1869. The piers are slight, but there is no danger in this river from either floating timber or from boats.

41. *Item No. III.—Revetment to North Tanks.*—I regret that the explanation originally furnished by me when sending on the estimate for this, reviewed by Major Oakes in his Note of the 23rd July 1872, was not communicated when the estimate was forwarded to that officer. The weak point of the whole project seems to me to be the material of which the north tank banks is composed. Every care has, I think, been taken by Lieutenant Shepherd to reject sand, and to use the best soil obtainable, but bad is the best, considering the heavy wind from the west which prevails in this district from June to the end of September, and that these tank banks run in a N. N. easterly direction, I believe the banks will be a constant source of anxiety and trouble unless protected. There is, of course, the question as to whether the necessary protection could not be obtained by nanul planting, and Mr. Puckle, the Collector, who has advocated planting in discussing the question with me points to the nanul on several of the old tank banks as instances of its efficiency. But the slope of these old banks is 3 to 1 or even more (and the tanks shallow), and where this is the case sufficient depth of nanul can be obtained to break the waves. I do not think this can be done on the steeper slope of the new bunds; and even if done the nanul will require more attention and expenditure in maintenance than the rough stone revetment proposed. The estimate as now sent up has been revised, and the cost of the gravel backing included. It will be necessary to revet the tanks only for the length provided in the estimate, for other portions are either shallow or already protected by nanul or other plants. Major Oakes in his Note on the estimate of March 1871 (under No. 52) noticed that no protection had been provided for the interior slope of these tank banks, and had the above explanations been before him, together with explanations as to the necessity for the departure from the original estimate by increasing the capacity of storage and raising the tank banks, he would doubtless have looked more favourably on the estimates for revetments. The raising of the tank banks is a necessity from the fact that the number of days on which a full supply is obtainable is less than originally calculated, and the revetment of the banks is a necessity from the bad soil of which they are composed and

their unfavourable aspect as regards the heavy winds. Believing the revetments essential to the success of the scheme, I regret the fact was not earlier foreseen and explained.

42. *Item No. IV.—Stone pitching in the North Channel.*—This is provided in accordance with your suggestion when visiting the works. In his Note of the 31st July, paragraph 8, Major Oakes suggests that this revetment be carried out for a length of only 300 feet. At this point, however, there is a sharp curve, and the pitching is necessary for some distance beyond it. The estimate provides for 1,000 feet; the work might be carried out tentatively, 600 feet being done the first year and added to if found necessary.

43. *Item No. V.—Extending the rough stone pitching in South Channel.*—There is now considerable action beyond the curve at 950 feet, and the soil being sandy it is desirable to lengthen the pitching.

44. *Item No. VI.—Screw gearing for the North and South Head Sluices.*—This was sanctioned by the Superintending Engineer and has been completed. The necessity hardly needs explanation, as nothing can be more crude than the needles originally proposed, and it is next to impossible to record accurately the volume discharged where needles are used. Estimates have been framed for fitting all sluices from the main canals with screw gearing, as in Item No. VII.

45. *Item No. VIII.—Screw gearing and shutters for the Upar Oday Dam.*—The necessity is great for having better arrangements for regulation than those sanctioned for this important work, viz., dam stones with either loose shutters or a turf bank. The crest of this dam has been fixed at 3 feet below the full supply level of the north tanks. Supposing heavy rain to fall throughout the catchment basin of the Upar Oday, which, though stated by Major Prendergast, R.E.,* to be 342 square miles, is in reality (found by measurement on the Ordnance Map) only 120; it would sometimes be impossible to remove the planks quick enough or to breach a well consolidated turf bund, and breaches would certainly occur; on the other hand invaluable water might be lost from the length of time which would be occupied in closing a weir 600 feet long with either turf sods or plank shutters. If the latter were used they would constantly be washed away and lost. It would, I think, be impossible to work the weir satisfactorily unless provided with means for speedily opening or closing the shutters. The original dam stones stopped $\frac{3}{16}$ths of the water-way, the piers and cast-iron standards now estimated for reduce the effective water-way to 460 feet. A depth of 3 feet of water discharging over this length is in round numbers 1,050,000 cubic yards per hour; the sluices will give an additional discharge of 360,000, or a total discharge of 1,410,000 cubic yards per hour. This would permit of $3\frac{1}{4}$ inches being run off the whole catchment basin in 24 hours, an amply sufficient provision. The cost of these shutters has been obtained from data supplied by the General Superintendent of Public Works Stores, they appear to be much more expensive than the cost of similar shutters at Dowlaishweram.

* Report accompanying original estimate, *vide* Project Book

46. *Item No. IX.—Screw shutters for the Autur, Kulpadagai, and Korkei Head Sluices.*—This is simply a modification of the general plan of screw shutters to suit those sluices constructed sometime ago.

47. *Items Nos. X. and XI.—Syphon Sluices at Palipat and Ammenpuram.*—These are small syphon sluices required for the drainage of less than half a square mile in each case, which could not be drained into the channels. These were sanctioned by the Superintending Engineer and have been completed. No. XI. is part of an arrangement with the Collector, and its construction saved the necessity of purchasing land valued at Rupees 20,000, which would otherwise have been submerged by the extended water-spread of the Ammenpuram tank.

48. *Item No. XII.—Bridge near Alwar Tinnevelly.*—You may remember that when down here there was a discussion as to whether this bridge should be built to the east or west of the town. Its necessity was admitted, and it will now be placed to the west, where the villagers propose to construct a road across the Nunjei.

49. *Item No. XIII.—Raising the bund of the Perungolum Surplus Channel.*—The necessity for this has only recently been recognised. Unless the old bank be raised and strengthened, as now proposed, the Nunjei lands of Perungolum will be submerged when the northern channel is running full.

Proceedings of the Madras Government, Public Works Department,
8th June 1874.

50. *Item No. XIV.—Skew Bridge on the Cotton Road over Tuticorin Drain.*—This work was rendered necessary as the road dam on the old drainage channel, now converted into our catchment drain, was on too high a level, *vide* explanations under Item No. 55; the work was sanctioned by the Superintending Engineer from the savings on that item, and has been completed.

51. *Items Nos. XV., XVI., XVII.*, are small works now found to be necessary.

52. There seems to be only one important engineering detail to which it is necessary to allude. In paragraph 27 of Colonel Anderson's memorandum, No. 549, of the 28th September 1868, that gentleman states that further provision for local drainage would probably be required. I will therefore explain how the drainage of each is provided for. On the south side local drainage coming into the south main channel will be passed on into the Kadamba tank. The calingulah of this tank is ample, and the water passing over it is discharged down existing channels, which do not require improvement, into a back-water between the villages of Autur and Arumuganery. Any drainage finding its way into the Ammenpuram tank and Kanam channel is discharged over the Ellapanicken calingulah. There is only a small area of about half a square mile which cannot be thus drained, and for this a syphon sluice has been provided, *vide* Item No. X. of the additional works. Local drainage below the Ammenpuram tank and Kanam channel is discharged in two places by natural channels, near Trichendoor and Arumuganery. On the north side the drainage crosses the channels and tanks at only three points. At Yeral a syphon sluice (No. 42) has been provided, the water passing under which is picked up by the Korkei tank. At Arumugamungalum the drainage passing the double dam passes over the Arumugamangalum tank calingulah and thence to the sea. The Upar Oday is the third point; the dam and embankments already referred to pass this into tide-water. The drainage from the north is caught and diverted by the Tuticorin drainage channel and carried out to the north of that town. Below the north tanks and parallel to the north embankment of the Upar Oday, a small drain eight yards wide has been cut to pass the local drainage to tide-water. The southern channel of the Upar Oday will become the main drain for the cultivation under the other tanks.

53. In his paragraph 12, Lieutenant Shepherd, R.E., shows that the total amount of the estimates as now submitted is Rupees 9,57,200, adding the cost of Engineering establishment, the total cost to the State would thus amount to not less than $10\frac{1}{4}$ lakhs.

54. With regard to the sum of Rupees 40,000 entered for office and petty establishment, it should be borne in mind that Colonel Anderson struck out from the original estimate (see paragraph 29 of his Note of the 28th September 1868) the sum of Rupees 26,458 provided for office and petty establishment, remarking that a special establishment would be required. The extra cost of the petty establishment above the sum originally estimated is due partly to the longer time the works have been in hand, owing to the stoppage of work by Contractor Ragavacharry and his subsequent imprisonment, and partly to what I consider the somewhat extravagant scale on which the establishments were originally kept up.

55. With reference to the financial prospect of the scheme, having regard to what is now apparent, viz., that it cannot be completed for the sum originally estimated, I would refer you to the last paragraph of Lieutenant Shepherd's letter. Mr. Puckle estimates the increase of revenue at Rupees 1,60,000, hence the net returns will vary from 12 to 14 per cent. The south channel has already done good service in twice saving the cultivation under the Kadamba tank, and this year the Arumugamungalum and other tanks received water before the north-east monsoon filled the rain fed tanks. The return to Government in such cases is only indirect.

56. In these estimates it has been supposed that we shall have to pay Ragavacharry only the sums due on the bills prepared by Lieutenant Shepherd, R.E.; should the Government lawyers consider that we are likely to have to pay any further sums, it would be well to add sufficient to cover this. You will of course have information on this point and be able to add anything if necessary.

57. With these explanations, I trust you may be able to recommend all the estimates for sanction.

From Lieutenant F. A. SHEPHERD, R.E., Officer in charge of No. 2 Range, Tinnevelly, to J. W. RUNDALL, Esq., District Engineer, Tinnevelly, dated Puthugudy, 15th January 1873, No. 22.

With reference to your docket No. 870, dated 3rd October 1872, enclosing G. O., No. 1,896, dated 20th August 1872, I have the honour to forward plans and estimates, etc., as per margin, connected with the revised estimate for the Streevigoontum Anicut Project.

1 Comparative Statement.
6 Tables showing the mean state of the Tambrapoorny River from 1868 to 1872.
1 List of extra works required.
18 Tracings and Plans.
20 Estimates (Detailed and Abstract).
11 Specifications attached thereto.

2. The comparative statement shows the difference between the revised and sanctioned estimates, and explanations of the causes of difference are given in the column of remarks. It is therefore only necessary for me to state here that the net saving of Rupees 37,000 is chiefly due to the general fall in the rates which took place throughout the district after the conviction of Mr. Colquhoun; and that Rupees 10,000 have been added to the estimate for field channels to cover the cost of excavating one channel to its full extent from each sluice. The original estimate only provided for completing these channels up to the point at which they might branch off to supply different villages. Further experience has, however, proved that it is not desirable to throw so much work on the villagers themselves, and that the gain to the revenue on account of the increased rapidity with which the land will be taken up for cultivation, if these field channels be excavated by Government, will amply compensate for the additional outlay. Where the works are nearly completed, and the differences between the revised and sanctioned estimates are in the rates only, I have not thought it necessary to give details in the comparative statement.

3. A list of extra works required is forwarded separately. The specifications which accompany the estimate fully explain the necessity for each work.

It will be observed that all the sluices, with the exception of some of minor importance in the various calingulahs, have been provided with shutters worked by screws (*vide* Estimates Nos. 6, 7, 8, and 9).

Estimates Nos. 10, 11, and 15 provide for additional drainage works that have been found necessary.

Nos. 4, 5, 12, 13, 14, 16, and 17 require no further explanation. In order to explain the necessity for Nos. 1, 2, and 3 I must refer to the original report on this project printed with G. O., No. 3,365, dated 26th October 1868, paragraph 3.

4. The calculations of the supply of water available were based on the records of the Office of this division, which showed that for six months in the year the discharge of the river at Streevigoontum is not less than 79,200 cubic yards per hour; and that during the cultivating season the minimum discharge is 7⅓ cubic yards per second, or 26,400 cubic yards per hour.

Five years careful observations of the river have convinced me that a supply of 79,200 cubic yards per hour cannot be depended on for three months in the year, and that during the cultivating season, with the exception of sixty-four days, it is not safe to calculate on more than an average discharge of 26,000 cubic yards per hour. I have only on one occasion observed a flow of less than 8,000 cubic yards per hour during the cultivating season; but after a fresh has begun to subside, the discharge of the river generally falls very rapidly to 15,000 cubic yards per hour. The anicut was thrown completely across the river in July 1870, since which time the vents in the anicut have afforded facilities for gauging the quantity of water with great accuracy.

A table showing the number of days on which a full supply for both the channels can safely be depended on is forwarded. This table is the result of my observations of the river for the last five years. It was prepared at the beginning of October, and the record for the last north-east monsoon has not been included. This monsoon has been unusually abundant, and the quantity of water in the river was about double the average. It was, therefore, considered safe to omit these results in calculating the average discharge. I may here mention that it appears to me probable that the data originally assumed were based on accurate observations, and that the discrepancy now pointed out is due to the fact that, after the date of the first series of observations, improvements were made by Colonel Horsley, R.E., in the cultivation under the upper anicuts to such an extent as to increase the revenue by three lakhs of rupees. There is however, as far as I am aware, nothing to show the exact date of the first series of observations; but they must have been taken before 1855, when the project was originally sanctioned.

Vide Mr. Puckle's letter to the Board of Revenue printed with Government Order, No. 365, of the 4th February 1869, paragraph 3.

5. Assuming, then, that a full supply for the channel may be depended on for 24½ days for the Kar crop and for 39½ days for the Peshanum crop, and that during the remainder of the cultivating season there will be an average discharge of 26,000 cubic yards per hour, the quantity of land that may be brought under cultivation would be as follows:—

1. The constant stream of 26,000 cubic yards per hour, which will be maintained by the tanks when the supply from the river falls below that quantity, will, at 2 cubic yards per hour per acre, be sufficient for 13,000 acres for either the Kar or Peshanum crop.
2. The channels when running full discharge together 210,000 cubic yards per hour (in round number). Deducting 26,000 cubic yards per hour we have 184,000 cubic yards per hour available for storage during 24½ days for the Kar crop and 39½ days for the Peshanum crop.

$$24\tfrac{1}{2} \times 24 \times 184{,}000 = 108{,}192{,}000 \text{ cubic yards.}$$

Allowing for evaporation it may be assumed that 2¼ cubic yards per hour per acre for ninety days will be sufficient allowance for the Kar crop.

Hence—

$$\frac{108{,}192{,}000}{24 \times 2\tfrac{1}{4} \times 90} = 22{,}300$$

nearly the number of acres that may be cultivated from the tanks.

Therefore the total number of acres for which water will be available during the Kar crop is 13,000 + 22,300 = 35,300 acres.

In the same way for the Peshanum crop, the number of acres that may be cultivated from tanks is

$$\frac{\text{Days. } 39\tfrac{1}{2} \times \text{Hours. } 24 \times \text{C. Yds. } 184{,}000}{\text{Days. } 150 \times \text{C. Yds. } 2\tfrac{1}{4} \times \text{Hours. } 24} = \frac{174{,}432{,}000}{8{,}100}$$

= 21,500 acres nearly. Hence the total number of acres for which water will be available for the Peshanum is 34,500.

6. It has been shown in previous reports that the quantity of land actually cultivated before the anicut works were commenced was in round numbers—

	Acres.
On the North Bank	5,000
Do. South do.	8,000
	13,000

Hence, it will be observed that the average supply of 26,000 cubic yards per hour has been assumed to be only sufficient to provide an unfailing supply for the existing cultivation.

Nearly all the field channels have been cut on the south side of the river, and I am therefore in a position to state that new land to the extent of 5,500 acres may be brought under cultivation on that side. I have no reason for doubting that 15,000 acres of new land can be brought under cultivation on the north bank in accordance with the original estimate, (*vide* Colonel Anderson's Memorandum, No. 549, of the 28th September 1868, paragraph 16.)

The revised estimate now submitted provides, therefore, for the cultivation of 20,000 acres (old and new) on the north bank of the river and for 13,500 acres on the south bank. Total 33,500 acres. This quantity is approximately the same as that provided for in the original estimate.

7. The original estimate provided for a storage of 15,000,000 cubic yards on the north side of the river, and 20,000,000 cubic yards on the south side of the river.

By raising the bunds of the northern tanks from 1 foot to 7 feet the storage capacity has been increased to 42,000,000 cubic yards, and by improvements on the south side from 20,000,000 to 28,000,000. The storage capacity of the tanks on each side is therefore nearly proportional to the quantity of land to be cultivated on each side.

For the Kar crop it will be necessary that the tanks should be filled about one and a half times and for the Peshanum crop about two and a half times.

8. The following is a statement of the approximate storage capacities of each tank, and the quantity of land directly under the influence of each tank or channel.

It will be observed, however, that due provision has been made in the estimate for passing on the water without delay from the upper to the lower tanks throughout the project, so that the lands under the lower tanks are not merely dependent on the storage capacity of those tanks.

	Capacity in cubic yards.	Acres of cultivation.
North Side.		
Chinnasawmy Naicken tank	30,000,000	8,100
Pottakolum	3,500,000	2,000
Maruthunykulam	500,000	1,000
Paykolum	3,500,000	3,150
Arumugamungalumkolum	4,500,000	2,000
North channel	.....	3,750
Total...	42,000,000	20,000
South Side.		
Kadamba tank and south channel	16,000,000	3,550
Ammenpuram tank and Kanam channel	3,000,000	3,750
Ellapanaicken tank	2,250,000	750
Auvudiar tank	1,500,000	200
Tuluken tank	750,000	800
Nullur Arumuganery, etc, tanks	3,000,000	2,200
Seenimavady tank	500,000	250
Autur tank	1,000,000	2,000
Total...	28,000,000	13,500

9. If the above data be accepted as correct it will be evident that the enlargement of the northern tanks (and the consequent necessity for a rough stone revetment) was absolutely required to ensure the success of the project. It is further evident that the anicut should be raised one and a half feet in order that the channels may receive a full supply whenever there is sufficient water available in the river.

The north channel has a fall of $1\frac{1}{2}$ per mile with a maximum depth of water of 6 feet width of channel, at bottom 36 feet, slopes 2 to 1. The maximum discharge is in round numbers 130,000 cubic yards per hour.

The north head sluice has six vents of 4 feet. Hence the head necessary to effect the maximum discharge is one and a half feet nearly.

The south channel is of the same dimensions and slope as the north channel, but the maximum depth is $4\frac{1}{2}$ feet. Hence the discharge will be in round numbers 80,000 cubic yards per hour.

The south head sluice has three vents of 4 feet. Therefore the head required to effect the maximum discharge is $2\frac{1}{4}$ feet nearly.

Proceedings of the Madras Government, Public Works Department, 8th June 1874.

From this it follows that the height of the anicut should not be less than $6' + 1\frac{1}{2}' = 7\frac{1}{2}'$. The piers of the bridge over the anicut should be raised to the same extent. An estimate for this is forwarded; but the cost may be met from the balance of the ryots'* contribution,

* G O., No. 449, dated 14th March 1872.

and is therefore not included in the total of the revised estimate.

10. It may be observed that it would not have been necessary to raise the anicut if the waterway of the north head sluice had been made originally 48 feet instead of 24 feet, and that of the south head sluice 45 feet instead of 12 feet.

This increase in the dimensions of the head sluices would however have involved an additional cost of not less than Rupees 20,000. The estimate for raising the anicut is only Rupees 4,100.

11. The cultivation under this project will continue to receive a considerable supply from the Marudur anicut, and the tanks will be fed to a certain extent by the local rainfall, averaging 22 inches per annum. The catchment basin of the northern tanks is about 170 miles, including that of the Upar Oday. The catchment basin of the tanks on the south side is under twenty square miles.

The supply which will be derived from these sources, though considerable, has been omitted in the above calculations of the quantity of water available for the cultivation.

12. A sum of Rupees 40,000 has been included in the revised estimate for the cost of petty establishment both office and executive. Of this sum Rupees 38,878 have already been paid up to December from the estimate for this project, and the remainder will be required for disbursement during the current official year. The estimates now submitted for the extra works include due provision for the petty establishment required after 1st April next.

The sum of Rupees 40,000 cannot be considered as an excess above the sanctioned estimate of Rupees 8,31,600, but should be treated as a separate item, in the same way as the permanent establishment, (*vide* Memorandums of Chief Engineers for Irrigation, No. 549, dated 28th September 1868, paragraph 30, and No. 171, dated 3rd April 1869, paragraph 7.)

The revised estimate also includes a sum of Rupees 36,974, which was expended in repairing the damages caused by the flood of 1869, (*vide* G. O., No. 1,424, dated 8th June 1870,) but this amount can scarcely be considered as a fair charge against the estimate.

The total estimate for which sanction is solicited is Rupees 9,57,200 as follows :—

Originally sanctioned works, including the damage by the flood ...	7,94,590
Petty Establishment	40,000
Extra works	1,22,610
Total ...	9,57,200

Excluding the petty establishment, and the cost of repairing the damages caused by the floods, the total will be Rupees 8,80,226, which is less than 6 per cent. in excess of the originally sanctioned estimate. I trust that this result will, on the whole, be considered not unsatisfactory.

13. The works that have been sanctioned up to date are now very far advanced. With the following exceptions they are all either fully completed, or are in working order :—

(1.) Syphon Sluice at Yeral, built up to floor level.

(2.) Upar Oday Dam, body not yet built.

(3.) About two-thirds of the number of small sluices required on the north bank of the river have not yet been built.

(4.) The field channels on the north side of the river, and a few miles of those on the south side, have not yet been cut.

(5.) The Upar Oday embankment is about seven-eighths finished.

14. The following extract from the Collector Mr. Puckle's report to the Board of Revenue, (No. 224, dated 31st May 1872,) will explain the financial prospects of the project :—"I have recently been over every village under the anicut in company with Lieutenant Shepherd, the Execu-

tive Engineer in charge of the work, and have arranged with him for the distribution of water from every sluice and channel * * *. It is certain that the additional revenue will be at least 1,60,000 Rupees."

No. 188.

MEMORANDUM.

The undersigned has the honour to acknowledge the receipt of the letter No. 24, of the 20th January last, from the District Engineer, Tinnevelly, forwarding a revised estimate for the Streevigoontum Anicut Works, and to request that the following observations may receive early consideration.

2. In his letter No. 116, of the 3rd July 1872, Major Oakes asked that the plans and estimates of the first revision might be returned when the second revision was submitted. This has not been done, and the Chief Engineer is often unable to understand the explanations given in the letter of the District Engineer, and the report of the Executive Engineer.

1 G. O., No. 1,818, 28th July 1870.
1 Plan of Syphon Sluice at Yeral.
1 Sheet Longitudinal Section of Bund of Perungolum Surplus Channel.
1 Sheet Cross Sections of do. do.

3. The information given does not enable Lieutenant Shepherd's calculations of water-supply to be checked. A number of statements of number of days on which there will be a full supply and a half supply have been submitted; but what is really required is a statement of the quantities of water in each month reaching the anicut, showing also what becomes of it, or of that portion not in excess of the capacities of the channels; what quantity will be available at the commencement of the season of cultivation in the tanks, with the receipts and expenditure of water up to the close of the season. The Sungum Project in Nellore is a very similar scheme, and the papers connected with it showing how the calculations of water available and required were made are herewith forwarded; no correct deductions can be made from statements which do not profess to deal except in a rough way with half and whole day supplies. There are registers of the river in this office, but in the absence of information as to the state of the anicut in each month no calculations can be made here. Lieutenant Shepherd has made careful observations for five years; there must be therefore particulars of the discharge of the river for a period on which a tolerably reliable average for each month may be founded. When it has been shown for how many days in each month the water will stand at and below the crest of the anicut, with the supply which will be drawn off by the north and south channels respectively, and, next, on how many days the water will be above the crown, with the corresponding supply in the channels, the total river supply with the anicut at its present level will be known. It may, as has been done elsewhere, be assumed that it will suffice if the total supply required by the lands under irrigation in any ten days be provided during that period, that is that a short supply for a part of this limited period will do no harm if compensated for in the remainder of that period. Also that two cubic yards an acre an hour will be enough for the field channels, and that, on the average, the Kar crop will want water for about 75 to 80 days, and the Peshanum for 105 to 110 days. The Kistna experiments at Chebrole show that the quantity of artificial supply required is much less than has generally been assumed to be the case. It will not do to ignore either the rainfall supply of the tanks, or that which the fields obtain directly, and the average rainfall of this part of Tinnevelly should be taken into account in estimating the state of the supply in the tanks in any month, though it will be best to assume that only a fourth or a fifth at most of the drainage due to rainfall will be utilized, while where the catchment basin is sandy a considerable further reduction may be proper.

G. O., No. 1,818, dated 28th July 1870.

1870 and 1871.

4. To the Chief Engineer it would seem that the conclusion arrived at in the 6th paragraph of Lieutenant Shepherd's letter, No. 22, viz., that an average supply of 26,000 cubic yards an hour will suffice only for an unfailing supply to the 13,000 acres of land irrigated before the

Proceedings of the Madras Government, Public Works Department,
8th June 1874.

anicut was constructed, is very strong evidence that this officer's deductions are not to be relied on. That area was before cultivated from independent sources of supply, and the water thus obtained must be an important element in the calculations. Until much more detailed and reliable information is obtained and put into a shape which will admit of its being thoroughly understood, it is impracticable to say either what amount of storage is needed, or whether the present level of the anicut is adapted to the requirements of the cultivation.

5. With regard to the proposal to unite all the northern tanks and, as the undersigned supposes, to have one waterspread from end to end, it must not be forgotten how serious a matter a breach under such circumstances would be, and it may therefore be desirable to connect them only by sluices or weirs, so that their whole contents may not be lost should an accident occur at any point in a length of many miles of bund.

6. In paragraph 4 of his No. 116, of the 3rd July, Major Oakes requested that a statement showing the details of the petty and office establishments provided for in the revised estimate might be forwarded, and this should be done; in addition to this there should be a further statement showing the cost of the engineering staff up to date, and in the future up to the completion of the work. It should at the same time be explained how the provision for sundries has been disposed of, as it would seem that the greater part, if not all, of the petty establishments employed on the works themselves should have been met from this source. The authority for the entertainment of the petty establishment with dates should be noted.

7. In connection with Item 20 of the revised estimate, it may be remarked that the original longitudinal section shows a difference of level of 2½ feet between the Ammenpuram and Kanam tanks, but no item for raising the bund of the latter can be traced.

8. The remark against Item 37, in the Comparative Statement, appears to show that the whole of the amount of the estimate ought not to have been entered as a decrease, seeing that other work was substituted.

9. A general map of the project as carried out should be preferred. Without this it will hardly be practicable to make the alterations which have been made intelligible to the Government of India. Longitudinal sections showing the channels as executed, with all the masonry works duly noted, are also required, and the longitudinal scale of these should be such as to allow of all requisite information as to levels being clearly entered upon them.

10. In a letter, No. 57, dated 21st March 1873, the District Engineer asks for early orders regarding the following works which it is desirable to go on with at once:—

1. The Yeral Syphon Sluice.
2. The embankment of Perungolum Surplus Channel.
3. The raising of the Upar Oday Dam to crest level.

As regards the first, which is referred to in paragraph 25 of the District Engineer's letter of the 20th January, No. 24, it must be remarked that 1½ inches per diem cannot be taken as the maximum rainfall drainage. The case is altogether different to that of drains not crossing a canal or other work. In the latter it is allowable to take time for relieving the lands of flood waters, but where an opening is made under a canal for the passage of drainage, it should either be of ample capacity, or it may in some cases be considered advisable to allow a breach in extraordinary seasons rather than incur the expense of providing sufficient waterway. Here Major Ryves' formula would allow for a drainage of 8 inches in the 24 hours, and in such a flood the water would rise considerably above the level of the top of the banks, before the head would be sufficient for the discharge. As the floor has been placed at so low a level, it will be as well to utilize the space available, and, instead of three vents of 4 feet, one vent of 12 feet with abutments 5 feet high and versed sine of 4 feet should be substituted, and the waterway will then be about 92 instead of 56 square feet; the abutments may be made 4 feet thick with two or three offsets at the base on the outside, and the work on this arrangement may be gone on with while, as the bricks are reported to be good, the cut stone facing to the abutments may be omitted and plastering substituted for the surface. A revised estimate for the work as thus altered should be sent in; the crown of the arches will be 6 inches below bed level, and can be covered with that thickness of concrete.

2nd work.—The circumstances of this are not understood; no water lines or levels are shown on the sections, and no work of any kind is shown on the original longitudinal section of the north channel. A sketch survey, with the levels marked, should be sent in in elucidation of the arrangements. Judging from the rough general plan forwarded with the original project, the north hannel crosses the surplus close to the river, and the anicut marked on the longitudinal section would be in the right bank of that channel, but, if so, the section is anything but clear. The sections are returned herewith.

Upar Oday Dam.—Paragraph 45 of the District Engineer's letter refers to this. In it in speaking of the sanctioned work it is said that the dam stones stopped $\frac{3}{16}$ths of the waterway, but in the design shown in the Irrigation Series No. 4, there are no dam stones, but, on the contrary, a flush crest with twenty vents of 4 feet in it. The undersigned thinks that a flush escape, self-acting, is the proper description of work as, independently of the cost of the shutters and gearing, a considerable establishment would have to be maintained to work these latter. Until it has been finally determined what extent of storage is required on the north side of the river, it is not practicable to determine the exact height of the crest of this work, but the District Engineer is authorized to raise it to such a level as may be necessary to retain water for the requirements of next season's cultivation, and it is presumed that by so doing no reduction of height is likely to be hereafter necessary.

(Signed) J. MULLINS, Lieut.-Colonel, R.E.,
Chief Engineer for Irrigation.

25th March 1873.
To the District Engineer, Tinnevelly.

No. 122. ORDER THEREON, 8th June 1874, No. 1,498.

IRRIGATION, No. 11.

ORDERED that the Government of India be requested to sanction the revised estimates for the Streevigoontum Anicut Project, amounting to Rupees 10,40,480, which sum includes all direct charges on account of this system of irrigation.

2. The remarks of the Chief Engineer for Irrigation should receive the attention of the District Engineer, Tinnevelly, who will be careful that the Chief Engineer's and Controller's Offices are furnished with general and classified abstracts of these revised estimates at an early date.

(Here enter No. 1,499, dated 8th June 1874.)

(True Extract.)

(Signed) J. MULLINS, Lieut.-Colonel, R.E.,
Joint Secretary to Government.

To the Chief Engineer for Irrigation.
,, District Engineer, Tinnevelly.
,, Officiating Controller of Public Works Accounts.
,, Revenue Department.

Exd. S. T. Austin.

Spare Copies

3/9/86

Govt. of {1874} Madras.

PUBLIC WORKS.

To

THE CHIEF ENGINEER FOR IRRIGATION.

&c., &c., &c.

Dated June 8th.

Recd. *Encl.*

G. O., 8th June 1874, No. 1,498.

JUNE

Nos. 121-122

Streevigoontum Anicut.—The Government of India requested to sanction the revised estimates for the Anicut Project, amounting to Rupees 10,40,480. The District Engineer, Tinnevelly, requested to furnish the Offices of the Chief Engineer for Irrigation and the Controller of Public Works Accounts with general and classified abstracts of the revised estimates at an early date.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Railway.

Read the following papers :—

From the Consulting Engineer for Railways, No. 372. dated Madras, 11th December 1885,

REPORT from the Acting Chief Engineer, South Indian Railway, to the Acting Agent, dated Trichinopoly, 5th January 1885, No. 1-85 C/14.

The following is a condensed report on the dam age to the railway caused by the extraordinary floods of the 18th and 19th ultimo, as far as I have seen them. I trust this information may be in time for you to embody it in your next rep ort to the Directors.

(1) *Chingleput.*—In portions of the 34th, 35th, and 36th miles the embankment was much eroded on the east side by the waves formed in the C hingleput tank by the violent wind. The tank was at a very high level, and the bank was only saved from being breached through by the wind subsiding. The slope of the embankm ent is pitched for about two-thirds of its height north of the Chingleput fort, but the water ro se above this level. South of the station the embankment was unprotected.

(2) *Pálár.*—The flood in the Pálár was very gr at, the water rising to the bottom of the girders. It overflowed to the south, and caused the f ollowing damage to the line :—

42/7½ 60 feet breach at back of north abutment o f 10-feet bridge.

43/6 breach of 30 feet back of north abutment, and 35 feet back of south abutment of 10-feet girder bridge.

44/7½ to 44/15 total wash away of ballast, and p artial wash away of embankment.

44/15 to 44/19½ (north abutment of 6-25 feet bri dge) a total breach. From south abutment of same bridge to 44/19, a total breach and permanen t-way turned over in the cess.

44/19 to 45/2 embankment partially eroded from ¾ to ¼ and rails overturned.

45/7½ to north abutment of 4-20 feet, and 1-25 feet bridge. Ballast and top of embankment gone, rails washed for portions of the distance o ff the bank.

45/7¾ to 45/9 embankment breached.

45/9 to 45/11½ embankment partially breached. lge to 45/12 embankment breached.

From the back of south abutment of 20-feet bri hed in places) ; permanent-way washed off

45/12 to 46/0 bank partially gone (wholly brea at 46/2. The masonry works received no embankment for part of the length.

46/0 to 46/2 ballast only gone. Flood ceased damage.

(3) *Karanguli.*—The Karanguli tank discharge d over its calingula to the depth of 8 feet 9 inches. The volume of water completely submer ged the 11-40 feet bridge over the Kullar. The whole of the girders were washed off the piers, nd pier No. 8 was overturned near the level of the river bed. The east parapets of the remaini ng piers with a few stones from the 2nd or 3rd courses below fell with the girders. The gird ers of spans 1, 8, 9, 10 and 11 have held together, and are deposited not far from the bridge . The girders of 5 more spans are in the river bed, 4 pairs about 5 chains, and another about 15 chains from the bridge. One girder has not been found ; remaining ½ span is further down the river. Two of the spans are but little damaged, the remainder will require extensive repai rs. The damage to the embankment is as follows :—

48/18⅔ partial breach.

48/19½ to 49/0½ a total breach of 300 feet. Th ere is a gap of 300 feet south of the bridge partially breached ; the flood on either side of the br idge was at rail level.

The damage in this mile is not what
one of 96 feet at the back of the north ab

The only damage in this mile is an e

At 66/4½ to 66/5½ the ballast and em
feet breach; 66/6½ a breach of 24 feet; 66
off; a shallow breach of 80 feet at 66/7½;

Sarum River.—The Sarum tank ha
railway embankment has been damaged i
68/17 to 69/0 ballast and bank on ea
69/0 on either side of 4-feet bridge li
69/0¼ to 69/3 a wash over, part of bal
From 69/3 to 69/8½ (north abutment
69/8½ water 1 foot 5 inches below r
curtain walls in spans 2 and 3 has been wa
69/11½ to 69/12½ embankment gone f
69/13 to 69/14 a breach of 69 feet an
69/14¾ the north abutment of 4 feet
fallen over without a fracture in the bricky
120 feet.
69/15 to 69/15½ a breach of 120 feet;

77th

Several tanks in the neighbourhood
following places:—
76/15½ to 76/16½ a wash over, ballast
partially breached; 77/0¼ to 77/2¼ line wa
77/3 breach at 10-feet bridge of 168 feet;
ment here is low, and the damage is not se
rails are washed off the centre line; there a
is the worst; 78/0 to 78/1 ballast washed o

Thondiar and Gingee rivers.—These rive
from one river to the other; the line has m
83/15½ breach of 28 feet back of 6-feet
84/4½ to 84/6, Thondiar river, at th
of embankment for 320 feet, and a portion
the south abutment there is a breach of 143
84/7¼ a small breach of 15 feet; 84/15½
6-feet bridge to 85/1 a gap of 240 feet; 85/3
bridge at 85/5½ is overturned, and the girde
From the back of the south abutment of the
feet in length; and from 86/1 to 86/2½ a
swept off the line. The flood-level at Ginge
rails. No damage has been done to the bri
86/3⅓ to 86/4¼ partial breach; the girders of
18 inches south by the rails giving, in the 40
of the bridge; the ballast walls are da
wash away of ballast on east side only; 85/7
abutment of 4-feet bridge 50-feet breach a
washed away; the eastern portion of the 2-
86/13⅓ the embankment is washed away
wash away of ballast from water topping
From 83/15½ to 86/15 the level of flood has

Vikravandi river.—The flood in this rive
of 3 out of 5 spans of the bridge, the damage
ment is either damaged or destroyed in the f
92/0 breach of 30 feet; 92/2 the emb
abutment of the Vikravandi bridge once stoo
piers Nos. 1 and 2 with the girders have bee
and west of this bridge there is now a gre
mark is 1 foot 7 inches below rail level in t
rail level, so that the girders were completel

64th Mile.

it was in the flood of November. The only breach is
utment of the 4-25 feet bridge at 63/14.

65th Mile.

rosion at back of south abutment of bridge at 64/11.

67th Mile.

bankment washed over, and partially eroded with a 6-
/6½ to 66/7¾ ballast and top of embankment washed
66/10 to 66/11 the ballast and top of bank washed off.
s badly breached, and is completely emptied. The
the following places:—
t side washed.
e breached, 72 feet on north, 60 feet on south side.
last and embankment on east side eroded.
f Sarum bridge) ballast and part of embankment gone.
ils at the bridge; the flooring between the masonry
shed out, in span No. 1 partially.
or greater portion.
l another of 50 feet.
culvert has got undermined from the back, and has
vork, at the back of this abutment there is a breach of

the water topped rails as far as 69/16.

and 78th Miles.

have breached, causing damage to the line at the

and bank on east side eroded; 76/16½ to 77/0¼ line
shed over, and east side of bank eroded; 77/2¼ to
77/3 to 77/8 bank partially breached; the embank-
rious; 77/13 to 78/0 line is very much damaged; the
re several through breaches, one of 100 feet at 77/13½
er; water ceased to top rails at 78/1.

rs came down in great flood; the flood water extended
et with serious damage
bridge.
e back of north abutment there is a clean sweep
of the north-east wing has fallen. At the back of
feet.
to 85/0¼ line is partially breached; 85/0¼ back of
to 85/7½ line is completely washed away; the 6-feet
rs are washed down stream, and stranded in the field.
Gingee bridge to 85/14½ there is a large breach of 220
still more serious one of 400 feet, the rails broken and
bridge was on the upstream side 2 feet 6 inches below
lge beyond the destruction of the pitching on slopes.
the 10-feet bridge at 86/3½ have been dragged about
0 feet gap, and the strain on them in the breach south
naged; 86/4¼ to 86/7½ rails topped by flood; a
½ to 86/8¼ line partially breached; 86/8½ to back of
nd a deep scour-hole; 86/8½ to 86/11 line partially
feet covered culvert has been destroyed; 86/11 to
to 4 feet below rail level; 86/13¾ to 86/14¼ a slight
rails; the water ceased to flow over rails at 86/15.
been in close proximity to rails.

r has been tremendous, and, in addition to the fall
to earthwork has been very great. The embank-
following places:—
ankment has gone at the back of where the north
d; of the 5 30-feet spans, the north abutment and
n overturned; nothing is to be seen of them. East
at expanse of water and of great depth. The flood
he embankment in the bridge; it was probably at
y submerged. From 92/5½ to 92/10 the line has

been completely wiped out to below ground level; th
to the aloe fence; 92/10 to 93/0 the ballast and gr
washed away; 93/8 the 4 feet rail girder has been
brickwork is without a crack; at 93/9 there is a thro
93/6 to 93/11, and the ballast and embankment are
that at 93/9 and 93/8; 93/14 erosion at back of 2
there are two breaches, one of 30 feet and one of 20

96th and 97th Miles.

The water stood very high in these miles; at
95/16 and 96/0 it flowed over rails, there is but slig
of 50 feet at south abutment of 4-feet culvert at
bursting of tanks.

Pombay river.—The flood in this river has be
suffered. At 97/2 to 3 the embankment has partly
large gap of 168 feet. At both these places there w
diversion between 97/9 and 97/11 has been breache
180 feet, and a deep scour-hole at 97/11; a small
breaches of November in the railway embankment
at 3 feet 6 inches below the proper rail level.

101st and 102n

Slopes of embankment between 100/3 and 6 an

Mullatar.—This river has burst both its north
in the flood of November, but the gaps have been w
railway embankment has been damaged in the follo
102/15 erosion at back of south-west wing of 2-
102/16 to 103/0 a clean sweep of 210 feet from
the rails broken off and in the scour-hole east of
bursting of the north bank of the Mullatar.
103/9 a breach of 156 feet at back of south abu

Ponniár.—The flood through the Ponniár bridg
the river bund, as far as can be seen, is not dama
bridge there was a heavy rush of water from a brea
it began to top rails just south of the 10 feet bric
104/9½. From the north abutment of 4-25 feet
washed off the bank on to the cess; the south gir
rails, and the south-west cap is cracked; there
pitching being rather small at this place. The flow
was 3 feet 3 inches. In the causeway south of th
water went over line from 96 feet north of 2 feet
culvert at 106/1; 106/6 partial erosion behind south
north-west wing of bridge.

Old Mullatar.—A very great body of water h
railway embankment has been heavily breached.
bank in this case; 107/11-12 a breach of 160 feet
abutment of 20 feet bridge (old Mullatar); the gi
weight of the hanging rails, there is now at this br
west slope eroded, 108/6½ a breach of 126 feet; 10
of 20 feet, on the south side one of 212 feet. The
east parapet of north abutment of bridge forced o
caused by the overflow of the old Mullatar.
109/1 scour into embankment north of 6-feet

111th M

110/9½ to 110/15 water topped rails, the balla

Settiapatti tank, Panruti.—This tank has brea
flowing out of the breaches went over the line fro
113/9 to 114/1 ballast and portion of embankment
with a deep scour-hole, 114/1 to 114/15 a wash aw
of ballast, and partial breach of embankment.
Through breaches of 20 feet on either side of
at 115/0.

Gadilam.—This river came down in tremend
volume of water from the Ponniár, a short distar
the railway between 122/5 and 128/5, and the wh

rails and sleepers have been overturned on
ater portion of the embankment has been
undermined, and is inclined upstream; the
gh breach. The water went over line from
considerably washed; the worst damage is
5-feet bridge; and between 93/15 and 16
feet.

Miles.

95/11 it was 3 inches below rails, and from
t damage, the worst being a shallow breach
96/2¼. The damage here is caused by the

n very high, and the 98th mile has again
gone for 120 feet. At 97/4 to 5 there is a
re breaches in the floods of November. The
l. South of 97/9 there is a clean sweep of
ap of 40 feet in each of these places; the
had not been filled up; the flood here stood

Miles.

l 101/12-14 slightly slipped in places.

nd south embankments; they were breached
idened out extensively in the last flood; the
ving places:—
25 feet bridge.
bank of south abutment of 2-25 feet bridge;
line. This damage has been caused by the

tment of Mullatar (3-40 feet).

re reached to 5 feet 10 inches below rail level;
ed. Over the causeway at the north of the
ch in the south embankment of the Mullatar;
lge at 104/6, and ceased to flow over rails at
bridge in bottom to 104/7¾ the rails were
lers were shifted slightly from strain of the
was a small through breach of 15 feet, the
of water over rails, as far as I could ascertain,
e Ponniár there was no damage to line; the
ulvert at 105/10 to 100 feet north of 2 feet
-west wing of bridge; 106/11 the same behind

as come down this old water-course, and the
At 107/3 breach of 24 feet; water did not top
107/12 to 13 a breach at the back of south
rders were shifted ¾ inch to the south by the
idge a river bed 500 feet wide; 107/13 to 14
8/8 20 feet bridge, on the north side a breach
rails were torn and twisted in this gap. The
ut by strain on rails. This damage has been

girder.

Mile.

st only is washed.

ched and completely emptied itself; the water
113/8½ to 115/2 with the following damage:
gone; a through breach of 50 feet at 113/14
ay of ballast; 114/15 to 115/0½ a wash away

3-feet culvert, and of 20 feet at 4-feet culvert

ous flood; it is said to have received a large
ce to the east of Tirukoilúr. The damage to
arf line is very great.

From 122/5 to 122/11 the ballast is was
through for 30 feet at 3 feet culvert at 122/
At 122/12½ there is a gap of 96 feet;
122/14 to 123/3 bank is partially gone;
has been swept away, and the rails turned o
is a small breach; at 123/7½ there is a gap o
the water ceased to top rails at 123/14½.
inches below rails, equal to 19 feet 9 inches
of water left the river in the low ground 10
practically no bank to the river at this point
water has caused damage to the line as follo
124/7½ to 124/12½ line partially washed
125/0 a gap of 210 feet; the tempora
standing; 125/4 a serious breach of 300 feet
125/5¾ 30 feet breach; 125/13½ to 125/
and a clean breach of 260 feet with a very d
16 a breach of 40 feet and another of 105 feet
girder bridge swept away; a breach of the
below surface of ground; 126/3½ a partial
washed away the bulk of embankment betwee
of 150 feet scoured out to 20 feet below rails
gone, including the breach at 127/4; 127/5 to
6 feet; 127/7 at back of north abutment o
temporary opening of 30 feet put in behind
feet gap.

The wings of the north abutment have cr
has moved another inch; the 30 feet openin
127/8 to 127/13 line partially washed away
over ballast and top of embankment gone.

Paravanar.—The flood in this river was
foot; the water just topped rails in the Parav
Between 134/10 and 134/15 there are t
From 135/5 to 137/1¼ there is almost continu
ballast and a good portion of the embankmen
much off the centre line.

14

140/17½ a deep breach of 75 feet in lengt

15

Line breached at 149/16 to 17, and 4 fee

251*st*, 2*nd*

Between 250/7 and 252/7 the embankmen
lineal feet.

264

The line was breached slightly north of 2

268

Slight damage was done to line between 2
This completes the list of breaches on the
Arkónam Branch.—The Arkónam branch
following places:—

From the backing up of the Pálár, the lin
breach of 40 feet; from 44/9 to 44/14 there wa
breached through for 40 feet between 44/10 and
to 15¾ ballast washed off and embankment par
small portion of embankment; 45/2 to 3½ the
At 45/10 to 11 there was a partial breac
tank supplied from the Madugu.

Pondicherry Branch.—The Pondicherry
girders of 6 out of 7 spans of the Gingee bridg
those of span No. 1; these are also damaged;
tilted out of plumb; the top booms are bent la
The girders of spans Nos. 2 and 3 are not
girders of span 4 are in the river below the bri

ed away, 122/11 to 12 line partially breached; wash
11.
22/12½ to 122/14 the ballast only is washed away.
123/3 to 123/13 a great portion of the embankment
ver on the cess for the whole length; at 123/5 there
f 130 feet scoured out to 16 feet below ground level;
In the Gadilam bridge the water rose to 1 foot 3
f water on the gauge board. An enormous volume
chains to the west of the bridge, and there is now
, and a comparatively small fresh would spill; this
ws:—
away.
ry bridge put in after the November flood is left
with a deep scour-hole.
14½ south abutment of 10 feet girder bridge gone,
eep scour-hole for 80 feet of the length; 125/15 to
; 126/2¼ to 126/2¾ a partial breach; 126/3¼ 10 feet
mbankment of 130 feet with a scour-hole 19 feet
cour of a few feet; 126/3¾ to 126/7 line partially
n 4 and 5 telegraph posts; 127/0 to 127/½ a breach
127/4 a breach of 54 feet; 127/1 to 5 line partially
6 bank partially washed away about an average of
70 feet bridge, a breach of 150 feet; at back of
the south abutment after the November flood a 70

cked away from the abutment; the south abutment
g has stood, there being a slight settlement only;
to about 6 feet below rails; 128/0 to 128/5 a wash

very high; it exceeded the flood of November by a
anar.
wo breaches measuring together about 1,300 feet.
ous damage to the line of considerable extent; the
t has been washed away; the rails were not shifted

1*st Mile.*

h at back of south abutment of 30 feet bridge.

)*th Mile.*

culvert washed away.

and 3rd Miles.

t was breached in 22 places aggregating 1,700

th Mile.

34th mile.

h Mile.

67/11 and 12.
main line.
was damaged in the 45th and 46th miles at the

was washed over; at 44/8 to 9 there was a slight
a heavy and continuous wash over; the line was
11, and for 200 feet between 44/11 and 12; 44/14½
ially gone; 45/0 to 45/1 ballast washed away with
same damage.
, wash over of line from the spill of water of a

branch has suffered severely in the loss of the
e. The only girders remaining on the bridge are
he free ends have been moved; the girders are
erally (in the direction of this river).
to be seen; they are buried under the sand. The
lge, the cross girders being uppermost. Of span

No. 5 all that can be seen above the water is the torn
the river, the bulk of the ironwork must be buried in
much in the same position as those of span No. 4. Of
in the river; the abutment ends are still on the brick
wreck.

Many parts of the girders can be used again, but
it will be advisable to order at once from England gir
the broken girders cut up and made into as many spa
in stock. The brickwork of the piers has got scoured
and the pier caps of those piers on which the free end
points damaged.

From the junction at Villupuram to 114/14½ bu
a small breach of 15 feet at 109/17, and a wash over

From 114/14½ to west abutment of bridge, the w
abutment the embankment is washed away, except a
the water level at 115/2, as far as I could judge from
above rails.

South of the bridge, the rails are overturned, bu
the ballast being washed away in the centre; the floo
115/13; between this and 15/½ there is no damage; t
go beyond this point; the report shall be given at a
up to Villenur, but the loss is principally ballast a
feet bridge has been destroyed.

Erode Branch.—From west points, Trichinopoly
away from under the pot sleepers, and the bank slig
253/4½ ballast washed away. 253/8·9 ballast washed
completely breached, with the exception of a short le

Negapatam Branch.—On this branch the lin
embankment. The following damage was caused to

Between 236/13 and 236/17 there was a was
breaches, one of 30 feet, one of 35 feet, and another

Between 236/17 and 237/0 there was a total was
a scour-hole of 15 feet below ground level.

This completes the list of damages on the bran

From W. H. SPALDING, Esq., Acting Ch
Acting Agent, Negapatam, dated Trichino

In continuation of my report * of 5th January

* No. 1-85—15.

a further report giving you more particulars of the
to be taken to prevent a recurrence of the disasters.

The flood of 19th December 1884, except in th
of November 7th that, with the exception of these n
of the later flood.

30*th mile, Singaperumálkoil Station.*—To the
embankment is wanting in water-way, and the re
compound gets flooded from the escape water from
floods of November and December the tanks were
made in the bunds. Additional water-way is requ
66 chains by an addition of an 8 feet span to the e

Chingleput Tank.—Between 33 miles 20 cha
boundary of the Chingleput tank and, with the excep
70 chains, where the fort intervenes, the railway
heavily revetted for two-thirds of its height betwee
was in addition protected by a fine growth of alo
the tank water was protected by aloes only.

The level of the water rose above the top of
soon decayed. At the same time a strong north-
their action eroded the embankment at the followi

33 miles 32 to 43 chains—slopes eroded
33 miles 51 to 55 chains—the same.
33 miles 58 chains and 33 miles 62 chain

South of the six 25 feet bridge at 33 miles 7
of centre line for 240 feet in length.

bracings. As there is very little water in
the sand. The girders of span No. 6 are
f span No. 7 the girders are not altogether
kwork, but they are overturned and are a

as the spans are so much damaged, I think
rders for 6, if not the 7 spans, and to have
ans as the material is available, to be kept
in their faces by the fall of the girders,
s rested have been forced off, and the pier

very little damage was done to the line,
f ballast at 112/3 to 4 being all.
ater topped the line, and from 115/3 to the
little earth between and around the wings;
a mark on the platelayer's hut, was 2 feet

the embankment has not suffered much,
d level appears to have been at rail level at
he wash over then begins again. I did not
later date. The line has been washed over
nd the top of embankment. At 117/1 a 12-

fort station (252·7) to 252·9 ballast washed
tly scoured on down stream side; 253/5 to
away for 40 feet; 253/10 to 253/12 the bank
ngth opposite 253/11.

was topped by the Coryaur bursting its
the railway:—
n away of ballast and three small through
of 25 feet in length.
h away of the embankment for 200 feet, with

hes.

---

ief Engineer, South Indian Railway, to the
poly, 20th March 1885, No. 3-85—C-150.

1885, giving you a condensed account of the
ods of December 1884, with the details of the
mage done to the line, I now beg to submit
ause of the breaches with the proposed action

64 to 67 miles so exceeded in magnitude that
iles, it will be sufficient to deal with the effects

north of the Singaperumálkoil station the
sult is that with a heavy rainfall the station
the Sengunam and Tricachoor tanks. In the
prevented from bursting by small cuts being
red, and it is proposed to give this at 29 miles
xisting 6 feet girder.
ins and 36 miles the line forms the western
tion of between 34 miles 40 chains and 35 miles
mbankment forms the bund. The slope was
33 miles 60 chains and 34 miles 40 chains and
s. The remaining length of bank washed by

the pitching and submerged the aloes. These
ast wind raised waves of considerable size, and
ng places:—
o within 4 feet of the centre line.

—slopes washed for 35 and 20 feet respectively.
5 chains the bank was cut into to within 3 feet

Between 34 miles 11 chains and 34 to the centre line.

From 34 miles 24 chains to 36 cha approach to the Chingleput station goods washed away and the second lay-bye attack taken away up to centre line. Between 35

The remedy, as far as the line is conce level and to extend it for the whole length should be requested to add a sluice at a low be given to the tank if considered necessary

The tank stood in great danger of bein of the high wind that the railway embankn was given by cutting the bund adjoining th of danger to the railway from the water current also partially undermined the wing taken by the Public Works Department to

Pálár.—The flood in the Pálár was drained by its tributary, the Cheyár; this r

The drainage area affected by this hea miles, the whole drainage area of the Pálár area of heavy rainfall to be about correct, or other) subjected to a still greater flood. on the up-stream side was 211·53 feet, whic pier points the afflux must have reached, if

The formation of the country at the c under the trial of a still greater flood, the and take up one further south. The deep b level of the ground at 44 miles 70 chains (45 miles 30 chains it is still lower, being ground that so much damage was done, e chains, and it is here the work for providing at the present bridge; this quantity is a economical, way to provide for it is to low way by protecting it with heavy stone; a lo surface of the ground and keep rails sufficie

* Tracing No. 46-85.

The girders of the Pálár bridge have level, but the margin of safety is too little. run the risk of their being swept off th flood. I recommend that the bridge be raise

Karunguli.—The disaster at this brid calingula of the Karunguli tank; this caling the depth of 8 feet 9 inches above the crest as far as I can ascertain from marks, was 40 feet span, offered too great a resistance to east pier parapets giving way, the whole of t was also overthrown near the level of the riv the river) were presumably in spans Nos. 8 a together by the permanent way, and from th this pier for a longer time than the ends, means a strain was brought on the mason broken off, and, although the pier and girde weakened and unable to resist the pressure of

I have already reported on the state of t you that the missing girder has been found to be searched for; they are probably in som

At this bridge it will be necessary to ad calingula I calculate was 65,000 cubic feet p from the cut made in the south end of the ta By carrying the rails on the bottom flange o increased head-way of 2 feet 4 inches is ob The addition of 4 spans will be sufficient to a 2 spans for the local drainage. The availabl depth of 12 feet.

miles 13 chains the embankment was washed away up

ins much damage was done. The earthwork of the hed was considerably eroded, that of the east lay-bye ed; the main line embankment clear of the siding was miles 53 and 56 chains the same damage was done. rned, is to carry the pitching up the slope to formation liable to the wash. The Public Works Department er level than the crest of the calingula, that relief may before the water level reaches the calingula crest. r breached, and it is principally due to the subsidence ent was saved from breaching. An additional relief e south end of the calingula, but this became a source utting into the embankment on the rear slope; th wall of the calingula. Steps ought, therefore, to b top this outlet.

hiefly caused by the excessive rainfall over the area ver takes its rise in the Javadi hills.

vy rainfall I estimate to have been about 2,000 square basin down to our line being 6,000. Presuming the t is more than probable the line will be (at some time The flood level taken at the south end of the bridge h is equal to 3·5 feet below girder bed level. At the not quite, very nearly to girder bed.

rossing of the Pálár valley is such that it is possible, river might change its course from its present bed ed of the channel in the river is 194·34, while the he river being 42 miles 65 chains) is 191·40, and at 90·54. It was in the embankment crossing this low xtending from 44 miles 37 chains up to 46 miles 12¾ for the escape of flood water should be given and not unknown one, and the only, as well as the most r the level of rails and to turn the line into a cause- wering of 3 feet will bring formation nearly to the ntly high to prevent their being flooded in ordinary years; the bridges will still have head-way enough left to take all but exceptional rainfall. A section* of the proposed lowering of the rails accompanies this report.

proved on this occasion to be at a sufficiently high To leave them at their present level would be to piers as at the Gingee in the event of a greater d three feet.

ge was caused by the heavy discharge over the ala, which has a total length of 730 feet, discharged to The level to which the flood rose at the railway, 210·15 up to rails; the plate girders, which were of the current, which in this river is very swift, and the he girders were swept off into the river. Pier No. 8 er bed. The girders which (from their position in nd 9, were the only ones that were found connected is I am led to believe that the girders held on to which were resting on the adjoining piers; by this ry which started the joint at which the pier was s may not have fallen together, the masonry was the flood. The quality of the masonry was good. he iron work. I have now, in addition, to inform and that a few cross girders are now all that have e pool and will come to light in the dry season. d additional water-way. The discharge from the er second, and a further quantity not known came nk. My proposal is to keep the present rail level. f the main girders, instead of on the top flange, an tained. The bridge to be lengthened by 6 spans. ccommodate the calingula discharge; the remaining e water-way will then be 680 feet by an average

Proceedings of the Madras Government, Public Works Department, 14th April 1877. No. 1,275.

Read the following:—

No. 169—W.

No. 330. *Note by the Chief Engineer for Irrigation.*

THE Officiating District Engineer, Tinnevelly, forwards, with his letter marginally noted, an estimate in connection with the Tuticorin supply channel situated in the Ottapidaram Taluq, Tinnevelly Range.

No. 195, dated 5th March 1877.

2. The nature of the work proposed for execution and the heads of account to which it is chargeable are as follow:—

STRIVEYCOONTUM ANICUT SYSTEM.

REVENUE.

Extensions and Improvements.

(3) Distributaries.

L. Earthwork.

	RS.
Completing the north or left bank of the Tuticorin supply channel ...	990
Total ...	990

3. The following particulars of this channel are recorded:—

Ayacut area...	Not stated.
Assessment	do.
Average revenue	411 Rupees.
Highest do.	530 „
Expenditure during the previous four years	Not stated.

The channel is that which supplies the town of Tuticorin from the Korumpullum tank and the estimates provides for a north embankment where the channel is single banked. The improvement is one of the works referred to in paragraph 46 of the notes of inspection printed in Proceedings of Madras Government of the 31st March 1875, No. 848. The work will be chargeable to Revenue Extensions and Improvements and is recommended for sanction. It is to be noticed that a longitudinal section showing bed and intended normal water-level in the channel should have been submitted. The arrangements must depend a good deal upon the level at which water is to be maintained at Meylur.

(Signed) G. T. WALCH,

Ag. Dy. Chief Engineer for Irrigation,

for Chief Engineer for Irrigation.

31st March 1877.

To the Secretary to Government, Public Works Department.

No. 331. ORDER THEREON, 14th April 1877, No. 1,275.

IRRIGATION, No. 22.

Account.

THE following estimate from the Tinnevelly Range forwarded by the District Engineer, Tinnevelly, is sanctioned.

Proceedings of the Madras Government, Public Works Department,
14th April 1877. *No.* 1,275.

TUTICORIN SUPPLY CHANNEL.

Irrigation.

Group or Project.—Striveycoontum Anicut System.
Fund—Revenue.
Class—Extensions and Improvements.
Name of Tank, Canal or Channel.—Tuticorin supply channel.
Particulars of Work.—Construction of north bank where necessary.
Amount.—Rupees 990.
To be carried out by the Public Works Department Officer in charge, Tinnevelly Range.
Total, Rupees 990.

There being no Budget provision under this class for this system, the District Engineer will have to suggest a transfer.

2. This sanction has been registered as No. 5—I. of 1877-78.

(True Extract.)

(Signed) JOHN MULLINS, Lieut.-Colonel, R.E.,
Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

To the District Engineer, Tinnevelly.
„ Collector of do.
„ Examiner of Public Works Accounts.
„ Chief Engineer for Irrigation.
„ Revenue Department.

Exd. E. C. Shunker.
Spare Copies

CHIEF ENGINEER
7 MAY
1877
FOR INFORMATION

1877 1149/1

Govt. of {1877} Madras.

PUBLIC WORKS.

To

THE DISTRICT ENGINEER,
TINNEVELLY,
&c., &c., &c.

Dated April 14th.

Issued

Recd. *Encl.*

G. O., 14th April 1877, No. 1,275.

APRIL.

Nos. 330-331.

Tuticorin Supply Channel, Tinnevelly District.—The estimate of Rupees 990 for completing north bank of—, sanctioned.

49 *miles* 56 *chains.*—The south abutment of the 10 feet girder bridge at this mileage has developed extensive cracks since the traffic has been resumed and will have to be rebuilt. The bridge was not floored; and the scour has reached the foundation, which was on clay.

64*th mile.*—The damage to the line in this mile was much more serious in the flood of November 7th than in that of December 19th; in the former flood there were breaches between 63 miles 40 chains and 63 miles 60 chains, aggregating 282 feet, while in the latter there was one breach only of 96 feet at the back of the abutment of the four 20 feet bridge at 63 miles 56 chains. The Adyalam nullah which this bridge spans received the surplus of 4 groups of tanks and of 2 isolated ones.

The following is a statement giving the list of tanks breached in the two floods:—

1. Attivakkam tangal		Breached in November and not repaired.
2. Odakkayyapakkum		
3. Velangadu		
4. Kolliyakunnam		
5. Pallambarayampettu		
	CUBIC FEET.	
6. Attivakkam tank	4,560,000	Breached in November and repaired; not breached again.
7. Kattugudalur tank	72,000,000	
8. Uttamanallur tank	3,440,000	
9. Sittapuram sitteri	1,700,000	Slightly breached in November.
10. do. tangal	760,000	
11. Adayalam	12,000,000	
12. Nemam	5,160,000	Slightly breached in November, but seriously breached in December.
13. Sittapuram tank	2,900,000	
14. Perumperkandigai	28,000,000	
15. Timmapuram	24,080,000	Breached in November; were repaired and breached again.
16. Kadamalaputtur	7,170,000	
17. Allanur	...	Breached in December only.
18. Siyyalam	...	

Our bridges are large enough to take the drainage from this basin, but have not been calculated to pass the accumulated water of so many tanks suddenly sent down on the line from the breaching of bunds.

We have not adopted the principle of giving extra water-way to provide against the bursting of tanks directly affecting the line; but, as here we are dealing with a chain of tanks surplussing into one channel, it will be advisable to enlarge our water-way. A small addition to the bridge would be of little use, and I recommend that the four 20 feet be doubled and the 10 feet bridge at 63 miles 45 chains be converted into one of 25 feet span.

65*th mile.*—We have here a precisely similar case. In the flood of December the damage was confined to the erosion of the earthwork behind the south abutment of the three 25 feet bridge at 64-11. In November the breaches were very extensive as reported in my No. 11-84—C-93. In that month five tanks (three of which were of considerable size) breached. The largest containing 45,000,000 cubic feet with another of 10,000,000 cubic feet and one smaller were not repaired before the second rains came. The following statement gives the number and names of tanks that gave way in the two storms:—

	CUBIC FEET.	
1. Oratti large tank	45,000,000	Breached in November.
2. Nedungal	10,310,000	
3. Kunankaranai	..	
4. Anangal	3,400,000	Breached in November; were repaired and breached again in December.
5. Kullatur	22,200,000	
6. Kilattivakkam	...	Breached in December.

I recommend in this case also that greater water-way be given by an enlargement of the three 25 feet bridge at 64 miles 44 chains by the addition of three 25 feet spans.

67*th mile.*—In this mile also the damage to the line by the flood of November was greater than that caused by the flood of December. In the former six tanks breached; of these five were restored and breached again in the latter flood, another being added to the list, but the largest tank (Olakur) was not repaired.

The following statement gives the names:—

	CUBIC FEET.	
1. Olakur	.....	Breached in November.
2. Tinnalur	12,000,000	Breached in November and repaired and breached in December.
3. Kongaraimampattai	24,100,000	
4. Murungai	3,600,000	
5. Allur	2,900,000	
6. Karsangal	.....	
7. Vinnampoondy	.....	Breached in December.

The wash over the line was chiefly caused by the bursting of tanks (1, 4, 5, and 6 on list in November) (in December 4, 5, and 6) immediately affecting the railway, and I do not consider we should enlarge our water-ways.

69th and 70th mile.—The damage in these miles happened in December. It extended from 68 miles 68 chains to 69 miles 29 chains and was caused by the breaching of the large Saram tank, the terminal tank of the basin.

The line runs through the east end of this tank, but the spread of water is to the west of the line. The bund was very extensively breached and the tank was completely drained. In this basin 29 tanks above the terminal tank and two below it breached.

The largest are—

	CUBIC FEET.
1. Thathavaram	60,000,000
2. Athanoor and Kodiam	17,000,000
3. Byraveram	45,000,000
4. Melapaukam	26,000,000

The ordinary capacity of Saram tank is 126,000,000 cubic feet, but before it burst it must have contained much more than this. This large body of water suddenly let loose swamped the line.

The extent of the breaches have been given in my report * of 5th January 1885. I do not propose to enlarge our present water-way.

* No. 1-85—15.

77th and 78th miles.—The line was washed over and breached in these miles by the bursting of the bulk of the tanks in two basins, the terminal tank of one basin being the large Ceddingal tank to the west of Tindivanam station, containing an ordinary capacity of 116,000,000 cubic feet, and that of the other, Suyanoor, situated about half mile to the west of the line. Above Ceddingal tank 12 tanks gave way; above Suyanoor 7 tanks. The flow of water over rail level extended from 76 miles 74 chains to 78 miles 5 chains. The line was here again damaged by the bursting of tanks in its immediate vicinity. I do not propose to add to existing water-way.

Tondayar and Gingee Rivers.—These rivers having joined up in the flood the breaches may be considered together. An immense number of tanks have burst in the areas drained by these rivers; in the Tondayar basin 41 tanks and in the Gingee basin 81 are reported to have gone in the Tindivanam taluk alone. In addition to these, some tanks have given way in the Tiruvanámalai and Wandiwash taluks; in the former 8 have burst; for the latter taluk I have not yet obtained particulars.

In the following statement I give the terminal tanks of the groups with the number breached in each group:—

Tondayar.

Terminal Tanks.	No. of tanks breached.
1. Malacoolakoor	9
2. Arookavur	4
3. Vilokam	10
4. Devanur	2
5. Agalur	2
6. Chendur	8
7. Other tanks	6
Total ...	41 tanks.

Gingee.

1. Malayanur	28
2. Kannalam and Annamangalam	17
3. Sathiamangalam	2
4. Sellaparattai	4
5. Kalava	3
6. Vadavanoor	3
7. Jambothi	5
8. Savur	6
9. Kattayanur	4
10. Sithamoor	4
11. Other tanks	13
Total ...	89 tanks.

Very serious damage was caused to the earthwork of the railway embankment, some of the gaps being of great extent. The only accident to the masonry works is the fall of a portion of the north-east wing of the Tondayar bridge, the overthrow of a 6 feet bridge at 85 miles 34

chains, and a partial destruction of the 2 feet covered culvert at 86 miles 50 chains. The Tondayar overflowed its south bank. My previous report gives particulars of the places in which the railway embankment was topped and cut through. The Tondayar water ought, if possible, to be kept to its course, or, if that is not possible, it should have some means of relief between the Tondayar and Gingee bridges in aid of the former.

The Tondayar should be enlarged; its present size is two 100-feet spans. I propose to double it. To effect the relief of the water, that must, I believe, in high floods, spill over the south bank, however much the Tondayar may be enlarged, either a large opening must be given at 85 miles 34 chains, or the rail must run down to near the ground level so that flood water may flow over the line with as little damage as possible. There is one obstacle to the lowering of the line, and that is the interference with a tank bund; the tank is, however, a small one, and it would probably pay to buy up the right of this tank if it is used for irrigation purposes. I attach a section * showing the lowering of the line as proposed.

* Tracing No. 47-85.

The addition to the Tondayar of two 100-feet spans and the free vent that would be given to flood water by lowering the line between the Tondayar and Gingee bridges should afford sufficient relief, and I consider the Gingee bridge should be left as it is for the present. If the tank prevents our lowering the line, a flood opening of at least 300 feet should be given at 85 miles 34 chains and a large addition made to the Gingee bridge. The level of the flood at the Tondayar I found, from a mark a little to the north of the bridge, to be one foot below rails equal to 276·29 feet; between the rivers it stood for some distance at rail level. At the Gingee the flood level on the north side of the bridge was 15 inches below rails; on the south side 2 feet 6 inches.

The levels refer to the up-stream side. I could find no marks on the down-stream side to show the fall through the bridges.

Vikravándi River.—The breached tanks in the area drained by this river reached the high number of 83, and from a reference to the map† accompanying this report it will be seen that all the principal tanks have burst and nearly a half of the total.

† Tracing No. 42-85.

The damage to the line was very serious, Nos. 1, 2, and 3 out of the five 30-feet spans forming the bridge over the Vikravándi river fell; the bed was scoured out to a great depth, twenty-six feet of water being sounded at what was the position of No. 2 pier. The piers were formed of two 8-feet wells up to within 1½ feet of river bed. At this level the piers were arched over, and the superstructure measuring 17 feet from pier point to pier point with a width of 5 feet was built. The abutment was founded in the same manner. North of the bridge at 92 miles 9 chains the flood level was 1 foot 7 inches below rail level equal to 239·96 feet. At 92 miles 20 chains it was at rail level, and at the bridge it was probably a little above the level of the top of the cross girders. But little damage was done to the earthwork at the bridge; there was a breach of about 50 feet in continuation of the fallen north abutment.

The flood swept over the rails between 92 miles 20 chains and 93 miles; for 450 yards of this length the embankment was completely wiped out down to below ground level; for the remaining portion the ballast or great portion of the bank went. Water continued at rail level up to 93 miles 50 chains; the 4 feet bridge at 93 miles 33 chains was undermined and overthrown bodily without developing a crack in the brickwork, the embankment being more or less damaged for 35 chains.

The flood stood at a high level up to 96 miles 30 chains, varying from 3 inches to 1 foot 9 inches below rails. The line, however, received but little injury. The line is immediately affected between 92 miles 20 chains and 96 miles 30 chains by the tanks in the group of which the large tank of Papanat is the terminal one. This group consists of 24 tanks; of these 13 including all the largest gave way, and it is by the water from these that all the damage in the 94th, 97th, and 98th miles and in great portion between 92 miles 20 chains and 93 chains was caused. The Vikravándi bridge will have to be enlarged considerably. My proposal is to add one span of 120 feet and to make this the centre of the bridge and to have three 30-feet spans on either side of it. This adds 150 feet to the length of the existing bridge. The level of rails to be raised four feet. The 120-feet span would be of the Whipple-Murphy type of girders; it is advisable to keep them well above flood.

Below is given a statement of the breached tanks:—

Terminal tanks.	No. breached.
1. Maroor	7
2. Thalavanur	7
3. Esalam	36
4. Thenpare	15
5. Assoor	2
6. Papanat and Sathanur	13
7. Other tanks	3
Total ...	83 tanks.

The bursting of tanks in group No. 6 directly affected the line; these are—

1. Papanat and Sathanur.
2. Kattiampoondy.
3. Poonjoonam
4. Poondy.
5. Thumbur (3 tanks).
6. Karanai
7. Venganthoor (2 tanks).
8. Ayooragaram.
9. Orathur (2 tanks).

Pombay River.—There was great damage to the line in the 98th mile from the Pombay river bursting its south embankment; in the flood of November the bank was burst through in 12 places aggregating 440 lineal feet; up to the time of the water finding relief through these gaps the bridges in the bank were running with an 8 feet head. To restore traffic a diversion of the line was made, and the largest gap at 97 miles 45 chains was not filled in. In the flood of December the volume of water that came down was greater; the breaches in the river bank were much extended, and the diversion in the line of this gap being at a low level was soon topped. A large breach was made in it, and the water, having freer vent, did not rise to a higher level than 3 feet 6 inches below rails, the old breaches, about 97 miles 10 chains and 97 miles 20 chains, opened out again; the former partially, the latter entirely, and was widened to 168 feet. The Pombay channel is an off-take from the Ponniár at the Tirukoilúr anicut and joins the Pombay river about eight miles to the west of our line, so that at the crossing of the railway it is more a natural drainage channel than an artificial one. The bridge under the public road is insufficient in water-way, and in the case of a high flood the south embankment must go, and the natural course for the flood water is to the south-east, bring directe dagainst our bank especially about 97 miles 45 chains.

The bridge under the railway, three 30-feet spans, is insufficient, but with the road bridge to our west it will be of no use our enlarging the railway bridge over the river.

In addition to the spill from the river, the line in the 98th mile was immediately affected by the bursting of the Thiroovamathur and Muttampoliem tanks. The proper position for additional water-way is at a place where it would be useful either for discharging water from the river or from the tanks to the west of the line; the floods have well defined this position as 97 miles 45 chains; here the new bridge should be given; one of 8·40-feet spans is proposed.

Ponniár and Gadilam.—The influence of Ponniár water having been felt as far south as Cuddalore, I have coupled these rivers together. The principal source of the enormous damage received by the line between 122 miles 40 chains and 128 miles 20 chains was from a portion of the Ponniár flood water taking to its old course, the South Malatar, in the neighbourhood of Tirukoilúr and joining up with the Gadilam. It will, therefore, be necessary to consider these two rivers in connection with one another.

The effects of the December flood so far exceeded those of November that in this report an account only of the later flood is given.

The breaches commenced at 102 miles 73 chains, and they will be mentioned in their consecutive order.

The breach at 102 miles 76 chains was partly caused by the breaching of tanks to the north of the Alangal channel and the over-flowing of this channel, but the greater body of flood water was from the North Malatar bursting its bank. A clean sweep of the railway for 210 feet was made.

The Alangal channel is an off-take from the Ponniár; it has a head sluice, but by the bank on both sides of the sluice having been cut off, the channel was flooded. The North Malatar, which is a much larger channel, takes off from the Ponniár lower down; it is not provided with a head sluice. The east embankment of the Ponniár extends from the railway only up to the branching off of this channel, so that there was nothing to hinder an excessive quantity of water being thrown into it—far more than it could take; the result was that its embankments were burst on the south side also, and in addition to the breach in the embankment of 156 feet at the back of the south abutment of the Malatar bridge, at 103 miles 41 chains (three 40-feet spans) the line was swept over between 104 miles 27 and 43 chains. But little damage was done here, the line having been constructed to pass the flood over it. A small breach of 15 feet occurred where the pitching was rather small, and the rails and sleepers were floated off on to the aloe fence, the depth of water over rails at the four 25-feet bridge in the hollow being 3 feet 3 inches.

The Ponniár proper between 104 miles 70 chains and 105 miles 16 chains received no damage.

The river bunds, as far as I can ascertain, have not been injured. The flood level in the river was 5·10 feet below rails, equal 244·01 feet, from a mark on the up-stream side near the south abutment. There was no mark to be found of the level the water stood at on the down-stream side. The reduced level of the girder seating is 247·81 feet, giving 3·80 feet clear between girders and top of flood.

In girders of the Whipple-Murphy type this is not too much. As long as the Ponniár is left as it is with liberty to spill all over the country, the bridge need not be altered, but in the event of the Ponniár being taken in hand by the Public Works Department and embanked with head sluices provided for the channels, our bridge would have to be both lengthened and raised.

South of the Ponniár the line of rails has been kept for some distance level with the ground and heavily paved with boulders. A considerable body of water derived from the bursting of the Accadavally tank and the surplussing of several others, besides local rainfall, passed over the line between 105 miles 37 chains and 106 miles 5 chains, the greatest depth being 3¼ feet, but no damage was received beyond the washing out of the smaller stone ballast.

The next breach was at 107 miles 60 chains, the South Malatar, once one of the main courses of the Ponniár river. An embankment, known as the Korayar embankment, was thrown across this course by the Public Works Department at its junction with what is now the Ponniár proper for the protection of the numerous spring wells which are opened out in this old course for the cultivation of land lying to the south. This embankment, partially breached in the November flood, was wholly destroyed in December. A large body of water took its old course and heavily breached the line in two places, one on either side of the 20 feet bridge at 107 miles 59 chains. There is now at this bridge a dry sandy river bed 500 feet wide.

108 *miles* 26 *chains.*—There were breaches aggregating 222 feet at the 20 feet bridge, caused by the water spilling over from the South Malatar. At about half a mile to the west of the line there is a hollow by which water must have at one time flooded the lands. The land having been brought under cultivation, the hollow had been blocked up by a bund which has been swept away during the recent floods.

111*th mile.*—The submerging of the line between 110 miles 43 chains and 69 chains was due to the heavy surplussing of tanks to the west of the line added to by the local rainfall. The water was ponded back to some extent by the insufficiency of water-way under the Panruti station road approach. The culvert under this approach is one of 2 vents of 3 feet each; it is proposed to enlarge this to a bridge of 3·8 feet openings. Water stood high on the east side of the line also from the breaching of the Poongoonam tank and the over-flowing of the Wallajah channel.

113 *to* 115 *miles.*—The line was damaged here in both floods but rather more extensively in December than in November; the water was over rails from 113 miles 39 chains to 115 miles 9 chains, but the line being in low embankment, the injury was principally confined to the washing away of the ballast. There were a few small breaches. The direct cause of this injury to the line was the Settipattadai (Tiruvádi) tank, which breached in November, was restored, was again breached in December and completely emptied. Above this tank 3 others (1) Maligamedu, (2) Poongoonam, and (3) Sattiarchavady burst, and their contents passed over the line through the Sittipattadai tank. In addition to the contents of these tanks, flood water from the South Malatar, which crosses the line at 107 miles 60 chains and 108 miles 26 chains, came down to the railway. All traces of this old river bed are lost after the crossing of the Wallajah channel (an off-take from the Ponniár for the Settipattadai tank) and although a portion of the water that breached our line at these mileages found its way direct to the Ponniár, yet a considerable quantity must have followed the course of the Wallajah channel through the tank across the railway and so into the Gadilam.

Gadilam.—The injury to the railway within the limits of this river was very serious, for the line was attacked at so many places. As long as the present state of affairs with regard to the Ponniár is allowed to remain, the danger to the line through the Gadilam is likely to be an increasing one. Old courses have been opened up afresh, and the volume of water which would be thrown into the Gadilam from the Ponniár in similar floods is likely to increase from the widening out and deepening of what has now been commenced in these old river beds. The present course of the South Malatar has its head at the Tirukoilúr anicut on the Ponniár, and surplus water over what is used for irrigation purposes finds its way to 107 miles 60 chains and into the Gadilam by another old course, also called the Malatar.

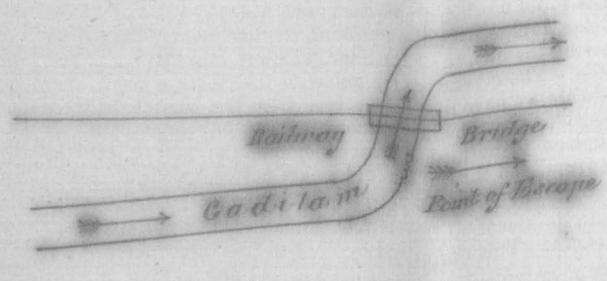
The old course of the South Malatar branched off the Ponniár about 5 miles east of the anicut, and from this 4 miles further down the Korayar took off leading into the Ponniár.

The beds of these rivers had become so much higher than that of the main river that it was only in high floods that any water was received by them. Such freshes caused great destruction to the spring wells formed in their beds, and to prevent this and also as a protection to the road bridge and the railway then sanctioned, the Government about ten years ago resolved to confine the Ponniár to one, its present course, by the construction of an embankment across the head of the South Malatar. This has proved insufficient. In the flood of November the embankment was breached for about 150 yards. In December it was completely destroyed. A portion of the water that thus escaped returned to the Ponniár by the Korayar. Another portion went along the South Malatar, crossing the line (as previously stated) at 107 miles 60 chains and 108 miles 26 chains, but the major quantity found its way into the Gadilam by the Malatar. The bridge of six arches over this river carrying the road between Panruti and Ulandarpett, which in ordinary floods had but little water through it, was completely wrecked. Before December the highest recorded flood level at the anicut was 5·77 above crest. In the December flood it rose to 10 feet although the anicut is now 400 feet longer and in spite of a breach on the north side. The water rose over the parapets and the wings of the head-works, and what escaped by this means into the Ragaven channel helped to swell the Gadilam. Thus in several ways the Ponniár helped to raise the Gadilam, which was already charged with its own flood. The level of flood at the railway bridge was 2 feet 3 inches below rails (my report of

January stated 1 foot 3 inches in error), equal to 19 feet 9 inches on the gauge-board. To the north of the bridge it burst over the line from 122 miles 23 chains to 123 miles 66 chains, causing the damage previously reported.

The three anicuts in the river were more or less damaged; at the third or Trivandipuram anicut the flood water escaping from the river swept along the valley under the Capper Hills, in which the main irrigation channel runs, burst the lower and larger portion of the Kondangi or Mount Capper Tank. This water assisted in the destruction of the line at Tirupápuliyúr and in the neighbourhood of Cuddalore Old Town, but the damage received was mainly owing to the immense body of water that left the river just above the railway bridge. The line for over a mile before reaching the bridge runs nearly parallel to and not far from the river. At the bridge the river makes a sudden bend, which was taken advantage of to give a square crossing for the railway. After passing the bridge the river takes another bend and resumes again a direction parallel to the line.

The point of escape of the water is at the bend,



where the natural bank of the river is low. In the flood of November the depth of water flowing over at this low place was 8 feet; in December much more. These two floods have opened out considerably this depression, and a flood nothing extraordinary in its proportions would now find its way by this course down to Tirupápuliyúr and on to the 70 feet bridge north of Old Town station. The breaches and loss of masonry works, which were entirely owing to the spill of the Gadilam at the low point above described, were detailed in my report of January 5th. I need not here recapitulate them.

As long as the Ponniár is left in its present state, the line is in a defenceless position; the points most liable to attack have been perhaps shown by the late floods, but of this we cannot be certain, and the water that may have to be contended with is an unknown quantity likely, now that old beds have been re-opened, to be an increasing one. The remedy is to be found in keeping the Ponniár within bounds by its being effectually embanked from Tirukoilur anicut or as much further west as is found necessary down to the line. This work should be strongly brought before the notice of Government, not only on account of the railway in which it has such an interest, but for the sake of the ryots whose lands for hundreds of acres must have become a waste from the deposit of sand.

As the embanking of the river is an undertaking that must take time to carry out, I propose only to adopt such measures as would render floods of a like description as harmless as possible and at the same time be not money thrown away. This work will be confined to the lowering of the line where possible between 122 miles 30 chains and 127 miles and the enlargement of the 70 feet bridge at 127 miles 30 chains. The brickwork of this bridge having received such damage during the recent floods as will necessitate its partial reconstruction, it would be well to build an entirely new bridge with a larger water-way. I propose a span of 150 feet as we have a set of girders of this size in the country. The channel spanned by the 70 feet bridge is the one that takes the surplus from the Mount Capper Tank, and it is the final opening to receive the spills from the Gadilam.

The breaches on either side of the bridge were very extensive and the scour very deep. On all accounts an addition of water-way is advisable. The tracing * accompanying this report will show the proposal for lowering the line. A portion of this scheme, viz., between 123 miles and the Gadilam bridge, has been already carried out; the major part of the embankment having been carried away by the flood, the balance of earthwork was removed and the rails laid at the level of 147 feet.

* No. 48-85.

Between the Gadilam bridge and Tirupápuliyúr (Cuddalore New Town) station the lowering has been practically carried out. The line was temporarily diverted and lowered to within one foot of the level shown on tracing, and the embankment has been in great part removed for filling up other breaches.

The line in the 103rd, 108th, 109th, 111th, 114th, and 115th miles will be left as it is. The level of rails cannot be lowered and, as there is no limit to the volume of water the North and South Malatars may bring down as matters now stand, and it will be better to run the risk of breaches than to spend money in building bridges that may not be effective and which, if the Ponniár is embanked, will be of no use.

Paravanar.—The flood in this valley was caused by the breaching of the Walajah and Perumal tanks, both of very large size, the latter being about 7 miles long.

The Walajah Tank has a supply channel from the Sethiathope anicut on the Vellar. Its surplus falls into the Perumal tank and is one of its sources of supply. The Perumal tank surplusses into the Paravanar.

In the November flood one sheet of water extended from the Sethiathope anicut to the Walajah tank for upwards of a mile in width. The tank burst, its water fell into the Perumal tank, and this in turn was breached extensively. This flood rose high against the banks in the Paravanar valley south of Alapákam station, being only 3 inches below rails. No damage was done. The current was sluggish, and there was little or no head through the Paravanar bridge. North of Alapákam station at the three 30-feet bridge the flood was 18 inches below rails, but there was a head of 18 inches. The bank not being of good material, the water found its way through the earthwork at 134 miles 55 chains and caused a breach of 100 feet. This relieved the flood and prevented it from rising higher. In the interval between the floods both these large tanks were repaired. They again filled and were again breached. This time the level of flood rose over the bank south of the station and damaged it extensively between 135 miles 23 chains and 137 miles 5 chains. The breach at 134 miles 55 chains re-opened, was widened out, and a fresh breach occurred north of the three 30-feet bridge 134 miles 69 chains, the line being damaged for 1,300 feet. The Paravanar, after passing the line, turns north to Cuddalore, and between it and the sea there is a line of low sand hills. These pond up the water, so that there is not a very free exit for such a flood. As the damage we have received has been from the bursting of these two large tanks, it is a question for consideration whether we should enlarge our water-ways. If done at all, a very large addition will have to be made. I am of opinion the tanks should be made safe by sufficient escape being given, and then, if our bridges are not of sufficient area to pass the maximum discharge of the calingulas, we should provide what is necessary for that only.

140 *miles* 79 *chains.*—At the south abutment of the 30 feet bridge at this mileage there was a rather deep breach 75 feet in length. This was caused by flood in the Paravanar.

149 *miles* 78 *chains.*—The 4 feet open top culvert at this mileage was undermined, and the abutments have fallen over. The whole of the country was more or less flooded, and this small work suffered. It will be rebuilt as an 8 feet span.

251*st*, 252*nd*, *and* 253*rd miles.*—The damage to earthwork in these miles was very great, the breaches aggregating 1,700 lineal feet. The line in these miles crosses the Korayar Valley. The river itself is spanned by a bridge of five 30-feet spans on skew (28 feet 6 inches on square) at 251 miles 30 chains, and in addition to this there is a flood opening of four 20-feet spans at 251 miles 70 chains. Very heavy local rain-fall in the basin drained by this river caused the breaching of numerous tanks to the south of the line. I have a list containing the names of 53 tanks which are said to have gone in the Trichinopoly taluk alone, but a considerable number must have burst in Pudukóta territory. I have not yet been able to prepare a plan showing their position or to get all information about the damaged tanks. This shall follow.

About ¾ mile to the south of the line the trunk road to Madura crosses the Korayar by a bridge of five 30-feet skew arches, 26 feet on square. Between this and the line the east side of the river is embanked. Again south of the public road to a rocky hill about ¼ mile distant, the same side of the river is embanked. The west river bank is open. The road bridge was insufficient to pass the flood-water and the road was topped. The embankment was burst through south of the road bridge; the public road was breached, and by this breach flood water got in at the back of the river embankment, and it was this that damaged the line to the east of the Korayar bridge between 250 miles 28 chains and 251 miles 28 chains. To prevent this it will be necessary that the river embankment be strengthened, and I do not recommend any additional water-way in this portion of the railway bank. To the west of the Korayar the stretch of low ground forming the valley of the river is interrupted close to the line by a small isolated rocky hill; by this the flood water from the river is divided, a portion going by the river, the remainder to the four 20-feet bridge at 251 miles 60 chains. The damage to earthwork was so great and the interruption to traffic so serious, extending for fifteen days, that it is advisable to do something to minimize, if not to entirely prevent, the damage, and I recommend that additional water-way be given to the bridge over the Korayar and to the four 20-feet bridge; to the former an addition of three spans, the latter to be doubled.

265*th mile.*—In my report * of January 5th I stated the line was slightly breached north of 264 miles. This was an error. A breach did not take place, but the embankment was threatened from the overflow of Kulleyearanputti tank. The 12 feet girder opening at this place has been more than once severely tested, and the level of water has risen above bottom of girders. It is advisable to increase the size of the bridge by giving it an extra span.

* No. 1-85 15.

268*th mile.*—A short length of ballast was washed away at 267 miles 53 chains at the entrance to the cutting. In the small embankment to the south of the cutting there is only an 18 inches opening which is insufficient in water-way. I propose to increase this to an 8 feet span.

Arkónam Branch.—In the flood of December 1884 this branch was washed over and in places breached between 44 miles 36 chains and 45 miles 11 chains and between 45 miles 46 chains and 45 miles 50 chains. The damage between 44 miles 36 chains and 45 miles 11 chains was caused by the backing up of the flood in the Pálár. There is a natural hollow between these mileages which the spill from the Pálár must follow. Forty-four miles 61 chains, where there is now a 6 feet bridge, is the point against which the greatest rush is, and here I recommend a flood opening be given of four 25-feet spans. The wash over and the partial breach of the line at 45 miles 46 to 50 chains was caused by the Siveram tank spilling round the west end of the bund. The calingula is at the opposite end of the tank, but relief is obtained when the water level has risen to a certain height by means of this spill. We have only a 3 feet opening under the line to take this water, and we must always be liable to damage. Water-way should be given and, as the embankment is low, a 25 feet span will not be too much.

At 68 miles 67 chains the upstream portion of a 3 feet covered culvert was undermined and fell in, but no breach in the bank occurred. I propose, as the culvert has to be reconstructed, to replace it by an 8 feet girder.

Pondicherry Branch.—The damage to this branch happened in the December flood and was confined, with the exception of two very insignificant breaches,—one at 109 miles 77 chains and another at 112 miles 13 chains,—to the portion of line between 114 miles 63 chains and 117 miles 73 chains affected by the flood in the Gingee. I have previously reported the damage to the Gingee bridge and to the earthwork up to 115 miles 66 chains. From this on to 117 miles 73 chains the line was almost continuously topped, but no great destruction of earthwork took place, the injury being principally damage to the top of embankment, as will be seen from the following notes :—

115 miles 66 chains to 116 miles 2 chains—A wash over all ballast and portion of embankment gone.
116 miles 2 chains to 116 miles 7 chains—Water at rail level. No damage.
116 miles 7 chains to 116 miles 25 chains—A wash over ballast and portion of embankment carried away.
116 miles 25 chains to 116 miles 34 chains—Water just over rails, but no damage caused.
116 miles 34 chains to 116 miles 39 chains—A wash over and partial breach.
116 miles 39 chains to 116 miles 70 chains—No damage. Flood up to rail level, but not over.
116 miles 70 chains to 117 miles 7 chains—Embankment much washed away, especially in the neighhourhood of the 12 feet girder bridge at 117 miles 2 chains. The east abutment of this bridge was undermined and overturned. The north parapet of the west abutment was cracked, but abutment otherwise sound. The bridge was floored, but the abutment got attacked at the back.
117 miles 7 chains to 117 miles 52 chains—a wash over for whole length. No great damage, confined to washing away of ballast and a little of the top of the bank.
117 miles 63 chains to 72 chains—a wash over and a breach of 120 feet. From this point the Gingee flood ceased to top rails, and the only other injuries to the line into Pondicherry were three small breaches in very low embankment :
One of 10 feet at 118 miles 38 chains ;
One of 20 feet at 118 miles 42 chains ; and
One of 10 feet at 118 miles 61 chains, on the east side of a small culvert.

The Gingee is joined after the crossing of the main line, by the Tondayar, the Vikravándi, and the Pombay rivers, all of which were in excessive flood. The surplussing of the Whisteri also poured a large volume of water into the river. The highest flood level to be found is to the west of the bridge. This was 2 feet above rails (79·56 feet) to the east of the bridge at 115 miles 60 chains it was at rail level (77·56 feet) ; it was probably not more than a foot over rails on the bridge except at the piers. In my report on the damage to the brickwork of this bridge I have given particulars of the fall of the girders, and, as this report is getting a very long one, I will not here repeat. The level of this flood was extraordinary. It was 6·81 feet higher than that of the highest we have record of, but it will be necessary to place our girders beyond danger, and I propose to raise the girder bed level 7 feet running down 1 in 200 on each side to our present rail level.

Erode Branch.—The line was injured here by the same flood that crossed the line in the 251st, 252nd, and 253rd miles main line, but was added to by flood in the Ariyavur and breaches in the Wiacondan channel. The Korayar, after passing the main line, joins the Ariyavur to the south of the Wiacondan channel, and the flood water of both rivers passes over the channel by means of the Puttur weir ; from that point they take the name of Kudamurutti, which crosses the Erode branch by a bridge of seven 30-feet spans. For the protection of Trichinopoly the east side of the river is embanked. This bank was breached and was the cause of the damage to the line at the fort station and in its immediate neighbourhood. Between the fort station and the embankment of the Kudamurutti there are two bridges one of two 20-feet girders and another of two 15-feet girders—but these were not sufficient, and the water rose 18 inches over rail level at the station and topped rails as far as 252 miles 36 chains. To the west

of the Kudamurutti the line was breached from the inability of the Kudamurtti bridge to pass the flood water. The line here follows very closely the Cauvery embankment, in which there is a bridge over the Kudamurutti of six 30-feet arches, two of which have fallen. This bridge, having less water-way than the railway bridge, kept back the water to some extent, but the latter also was insufficient and the line was topped at 253 miles 18 chains, where the level of rail is 3 feet lower than at the bridge. The damage to the line extended up to 253 miles 48 chains, the bank being almost entirely washed away between 253 miles 40 chains and 48 chains. The quantity of water passing over the Puttur weir was 50,000 cubic feet per second. The interruption to traffic on the branch was of no long duration, from evening of December 18th to morning of December 23rd, when the traffic was resumed. The Public Works Department propose to lower the south embankment of the Cauvery to the west of the road bridge down to level of road for a length of 300 feet. This would suit the Railway Company well, for the additional water-way I consider should be given can be provided opposite this outlet into the Cauvery. The discharge from Kudamurutti bridge is about 23,000 cubic feet per second, so that, to pass the water that was discharged over the Puttur weir alone, we should have to more than double the bridge. I propose to run rail level from the west end of the Kudamurutti bridge to opposite the position the Public Works Department propose to cut down the Cauvery bund, and then to give a bridge of 300 lineal feet of water-way.

Negapatam Branch.—The breaches in the line in the 237th mile were caused by the Korayar bursting its southern bank. The damage began at 236 miles 51 chains and ended at 237 miles. It consisted of a small wash away of ballast between 236 miles 51 chains and 53 chains. A wash away of ballast from 236 miles 70 chains and 237 miles with three small breaches of 30, 35, and 25 feet in length and one large one of 200 feet in length scoured out to 15 feet below ground level. The railway crosses the Pamanar at 236 miles 36 chains and the Korayar at 237 miles 8 chains by bridges each of five 30-feet girder openings. Between these bridges there are only the usual culverts for irrigation purposes so that the flood bursting into this pocket between the two rivers had no outlet. The waterway provided over the two rivers is ample as regards length, but they are low in headway. The flood water reached 8 inches up the plate girders. Since the Negapatam branch was constructed, the embankments of these rivers have been improved and they take higher floods than they did at that time. The level of rails should be raised over the Pamanar and Korayar and between the bridges, but unfortunately we are tied down to our present level by the Nidamangalam station which commences at the east abutment of the Korayar, and it would be of little use starting the raising from the west side of this river.

This completes my report on the floods of November 7th and December, 9th, 1884. It is accompanied by tracings Nos. 41-85 and 42-85 showing the drainage areas of the rivers (Adyalam, Nedungal, Konkara Odai, Suram, Ceddingal, Sunganoor, Tondayar, Gingee, Vikravandi, Pambay, Ponniar Valley) and tanks that were breached. Tracing No. 40-85 illustrates the spill of the Ponniar. Tracing No. 43-85 shows the position of the Wallaja and Perumal tanks, with regard to the line. Tracings Nos 46-85, 47-85 and 48-85 give my proposals for lowering the line in the Pálár valley, between the rivers Tondayar and Gingee and in the neighbourhood of the Gadilam.

Since writing the portion of the report referring to the floods in the Tondayar and Gingee, I have had inquiries made concerning the tanks that would have to be cut through in order to lower the line between these bridges, and I find the tank is of more importance than I thought it was, and that even if allowed to interfere with it, the compensation that would have to be paid would be very heavy. The proposal to lower the line must be abandoned and the alternative of a flood opening with an enlargement of the Gingee bridge will have to be adopted.

As requested in your letter No. 263 of 3rd February 1885, I attach to this report a condensed statement of all the breaches of which there is any record in my office. Particulars of any damage that occurred to the line between Erode and Negapatam prior to this portion coming under the charge of the Chief Engineer must be recorded in your office. I have no information regarding the Arkónam branch previous to the year 1876.

STATEMENT OF DAMAGE THROUGH FLOODS TO THE SOUTH INDIAN RAILWAY FROM 1876 TO 1884.

Beach Extension, Madras.

17 *July* 1879.—Ballast washed away in places between Fort and Beach stations and particularly in neighbourhood of Popham's Broadway.

4*th October* 1879.—Ballast washed away near Beach station.

8*th October* 1879.—About 300 cubic yards of ballast washed away from under sleepers in different places on the Beach extension between Fort and Beach.

23*rd October* 1879.—Ballast and portion of bank washed away in three places at Beach station, each about four yards in length.

29th November 1880.—Portion of embankment washed away near Medical College and ballast from under sleepers washed through north of level-crossing gate, Thieving bazaar road, for about 50 feet in length.

12th November 1881.—Ballast washed away from under sleepers at three different places between Evening bazaar and Popham's Broadway level-crossing gates for about 80 feet in length.

29th November 1882.—Ballast from under sleepers washed away at three different places between Evening bazaar and Popham's Broadway level-crossing gates for about 100 feet in length.

Cause.—Heavy rains and drainage not passing off quickly.

Remedy.—A 6-feet rail girder constructed between the Evening bazaar and Popham's Broadway.

2nd Mile.

18th May 1877.—The sides of embankment through the Spur tank (1 mile 37 chains) slipped for several chains in length; centre line undamaged but threatening to give way if storm continued.

Cause.—Heavy rain on the 17th and 18th May 1877, when 19 inches of rain fell.

Remedy.—None appears to have been applied. Mr. Fox in his report (No. 977 of 5th June 1877) on extra waterway stated that the reduced flood level in the Spur tank was 146·42; the discharge through the 10 feet opening at 1 mile 36 chains was moderate and there was no necessity for increased waterway.

3rd Mile.

18th May 1877.—Earth scoured by the action of the water in the river Kuam (2 miles 76 chains) from the rear of the west wing wall of south abutment, considerably endangering the safety of the line.

Cause.—Heavy rain caused floods in the river Kuam.

Remedy.—Pitching slopes of embankment from 2 miles 73 chains to 75 chains and from 2 miles 77½ chains to 3 miles 4 chains taken 25 feet up the slopes and upstream side of bridge.

4th Mile.

There was no breach on this mile on the 18th May 1877, but the reduced level in the Nungumbakam tank (3 miles 10 chains) was 153·32; the formation level is 153·22 at the south end of the tank. The discharge through the 20 feet opening at 3 miles 9·50 chains was great.

Remedy.—The earthwork was raised two feet from 3 miles 20 chains to 4 miles 60 chains; a 6-feet rail girder provided at 3 miles 36 chains and the three 2-feet spans at 3 miles 59 chains converted into a 10-feet opening, two piers being taken out and masonry of abutments raised two feet.

5th Mile.

18th May 1877.—The embankment for about 28 chains from 4 miles 1 chain to 4 miles 29 chains undermined by the water, causing the rails and sleepers to fall over on the west side.

Cause.—The Mambalam tank breached and the water accumulated on the right of the line. The water was hemmed in by the Bangalore road on the north end and by the rising ground at 4 miles 43 chains on the south, and there was only one 4-feet culvert at the road (3 miles 73½ chains), a 15-inch culvert at 4 miles 3 chains and a 4-feet rail opening at 4 miles 21 chains to let the flood water escape.

Remedy.—The earthwork was raised 2 feet up to 4 miles 60 chains and a 15-feet girder provided at 4 miles 10 chains.

9th Mile.

18th May 1877.—A breach of about 30 feet in length at 8 miles 25 chains.

Cause.—Heavy rain and by the action of the water which in flowing down the side ditch found its way over the line.

Remedy.—A 4-feet rail girder provided at 8 miles 24 chains.

The rush of water through the 10 feet girder at 8 miles 78 chains was very great; a deep hole was scoured out on the down stream side to below level of foundations.

Remedy.—An additional 15 feet girder was added to the 10 feet girder at 8 miles 78 chains.

13th Mile.

18th May 1877.—Embankment immediately to the north (12 miles 22 chains) of the north points of the Pallávaram station washed away for a length of 30 feet. A breach occurred at the same place on the 22nd May 1877.

Cause.—By the rush of water from the Pallaváram hills and no waterway to pass off drainage quickly.

Remedy.—A 6-feet rail girder at 12 miles 20 chains.

22nd Mile.

18th May 1877.—Breach in line at 21 miles 20 chains; rails topped and several small breaches, while half of the bank was in other parts washed nearly half through.

Cause.—The flood water was dammed back by the insufficiency of waterway from 20 miles 50 chains to this point and by not being able to get back between the bank and the bund of the Urapakkam tank.

Remedy.—Nothing done.

98th Mile.

22nd November 1880.—The following breaches occurred on this mileage:—

$\frac{97}{3}$ 30 feet wide.
$\frac{97}{5}$ 63 feet wide.
$\frac{97}{7}$ 63 feet wide.
$\frac{97}{8}$ 75 feet wide.
$\frac{97}{10}$ 40 feet wide.
$\frac{97}{13}$ 15 feet wide.
$\frac{97}{14}$ 30 feet wide.

Cause.—The maximum flood level appears to have been at formation level and damage was caused by the breaching of the Pambay river and several large tanks to the west.

Remedy.—The bridges at the following mileages were protected:—

Apron and pitching slopes of 25 feet girder bridge at 97-6; pitching slopes of 10 feet girder at 97-9 and pitching slopes of 10 feet girder at 97-13.

This mile has been again very badly breached in the floods of November and December 1884; a bridge of eight 40-feet spans is proposed at 97-9.

103rd Mile.

3rd November 1877.—At two 25-feet girder at 102 miles 72 chains the west side of embankment was scoured away at the back of both abutments for about 33 feet in length and for half way through in breadth. At the two 25-feet girder bridge at 102 miles 67 chains the embankment was breached through behind each abutment on the north for about 33 feet and on the south for 20 feet in length. From 102½ to 103½ the water stood 2 feet higher on the west than on the east side of the embankment, which was more or less scoured into and damaged at intervals along this portion.

Cause.—Overflowing of North Malatar (Pillur).

104th Mile.

25th September 1877, *3rd November* 1877.—At the three 40-feet girder bridge over the North Malatar (Pillur channel) at 103 miles 40 chains about 33 feet length of embankment at back of north abutment was half cut through. From the bank of the south abutment the railway embankment was washed away for a distance of about 200 feet. The water in the channel rose to 2 inches above the lower flanges of the girders and was 12 feet deep.

25th September 1877.—At 4-feet culvert at 103 miles 56 chains water rose above coping and line breached at three places behind.

Cause.—High flood in Pillur channel.

105th Mile.

3rd November 1877.—At the four 25-feet girder bridge at 104 miles 40 chains the flood rose over the tops of girders and washed away the embankment 132 feet to the north and 330 feet to the south of the bridge. To the south the scour cut out a hole 10 or 12 feet deep.

Cause.—The overflow of the North Malatar (Pillur channel).

PONNIAR BRIDGE.

25th September 1877, *3rd November* 1877.—The south approach to the Ponniár bridge was badly breached and the south approach was also breached outside the river bank by flood water that escaped from an open cut in the river embankment (right bank).

106th Mile.

25th September 1877, *3rd November* 1877.—Water rose to 2 feet 6 inches above rail, completely carrying away ballast and shifting rails out of position from 105 miles 50 chains to 106 miles 20 chains.

Cause of damages on the 103*rd*, 104*th*, 105*th and* 106*th miles.* The high flood in Ponniár and in channel leading from the Ponniár.

Remedy.—Rough-stone pitching and flooring bridges at 102 miles 42 chains, 102 miles 72 chains and 102 miles 76 chains. Groynes and rough-stone pitching 103 miles, 103 miles 5 chains, 103 miles 10 chains. Rough-stone pitching and flooring bridge at 103 miles 10 chains. Groynes and rough-stone pitching 103 miles 15 chains, 103 miles 30 chains, 103 miles 41 chains. Rough-stone pitching 104 miles, 105 miles and 106 miles, a causeway being formed in a portion of the 105th and 106th miles.

153*rd Mile.*

12*th July* 1882.—Forty feet girder bridge at 152-13 swept away and a breach of 50 yards in the embankment.

Cause.—Excessive floods in Coleroon.

Remedy.—Substitution of two 100-feet girder bridge for the 40 feet bridge.

168*th Mile.*

30*th November* 1880.—North abutment of 10 feet girder at 167—11-12 sunk about 5 inches and leaning forward supported by girders. Water to within 1 foot 7 inches of rail level.

169*th Mile.*

29*th November* 1880.—Both abutments of 6 feet rail girder at 168-1 and 2 carried away. Banks at both ends carried away, leaving a gap of 60 feet.

Cause of damage on 168*th and* 169*th mile.*—Breaching of several important channels. The line of railway is at right angles to the drainage of the country and consequently bore the full brunt of the large body of water making its way towards the sea.

Remedy.—Substitution of a 25-feet opening for the one of 10 feet at 167-12. Substitution of four 25 feet openings for the one of 6 feet at 168-1.

186*th Mile.*

27*th November* 1880.—About 100 lineal feet of the embankment at 185-6 and 7 partially carried away.

Cause.—By an overflow from the river Cauvery which here crossed the public road and rose just over the railway embankment alongside.

Remedy.—Nothing done.

200*th Mile.*

21*st November* 1880.—Ballast washed out for about 20 yards at 199—15-16.

Cause.—Heavy rains.

Remedy.—Nothing done.

210*th and* 211*th Miles.*

12*th July* 1882.—Embankment cut into in several places between 209-10 and 210-10 by wash of flood water and rendered unsafe for trains.

Cause.—Excessive floods.

Remedy.—Four 25-feet girders constructed at 209-10.

215*th Mile.*

21*st November* 1880.—South abutment of 25-feet girder bridge at 214-2 destroyed and 80 feet bank breached.

21*st November* 1880.—South abutment of 30 feet girder bridge at 214-6 came forward and separated from east wing-wall; the west wing-wall and 40 feet of bank washed away.

Cause.—The Vennár river topped its banks at several places above the railway. Large breaches ensued in the river banks and a great volume of water at once escaped across country pouring down on to the railway embankment.

Remedy.—Restoration of bridges and addition of floors and curtain walls.

231*st Mile.*

21*st November* 1880.—Total collapse of three 12-feet arch bridge at 230-11.

Cause.—Bursting of several tanks above the line.

Remedy.—New bridge of two 25-feet opening in lieu of three 12-feet arches, the new bridge being built 100 feet west of original bridge.

232*nd Mile.*

8*th December* 1877.—One of the piers of three 12-feet arches at 231-15½ washed out. The greater part of the arches on each side of the pier fell with it.

Cause.—Breaching of several tanks to the south of line.

Remedy.—A new bridge of same span with curtain walls and floor.

235*th Mile.*

4*th December* 1880.—Eastern abutment of four 30-feet bridge at 234-4 cracked from being undermined.

Cause.—Heavy floods.

Remedy.—The abutment was reconstructed.

237*th Mile.*

18*th December* 1877.—Edge of bank, north side, at 236-16½, washed away for a length of 30 feet back to line of north rail.

Cause.—Heavy rain on the night of 18th December 1877.

Remedy.—Nothing done.

267*th Mile.*

4*th October* 1877.—Groynes and nanal grass washed away and slopes of embankment cut into at 266-6.

Cause.—Heavy fresh in Mahmundi nulla which runs close and parallel to line.

Remedy.—A series of heavy stone groynes were thrown out and a straight cut was made across the bend of the river so as to relieve the rush of water alongside the railway.

279*th and* 280*th Miles.*

7*th December* 1877.—The north approach to five 20-feet bridge at 279-12 breached through for a length of about 50 feet; the water topped the line at 279-5, 278—13-14 and 278—9-10 and scoured out the ballast for some length in the shallow cutting at 278-5.

Cause.—The bridge crossed a nulla a little below a sharp bend in the channel, and a very heavy fresh topped the north bank of the nulla, sweeping away the bund and so permitted a great body of water to rush parallel to the railway.

Remedy.—The embankment was raised from 278-1 to 279-8. An 8-feet rail girder provided at 278-11 and the embankment at five 20-feet bridge at 279-12 protected.

282*nd Mile.*

31*st October* 1877.—A small breach of 50 feet at 281-15. Damage was done on this mile on 21st October 1877. Ballast washed away from under sleepers for two rails length at 281-15 and for one rail length at 282-3.

Cause.—Insufficient drainage under line.

Remedy.—The embankment was raised from 281-15 to 282-6 and a 20 feet span constructed at 281-16.

285*th Mile.*

25*th September* 1876.—Bank at 284-2 washed three-quarters through for a chain.

Cause.—Heavy rains.

Remedy.—Catch-water drain cut.

23*rd October* 1877.—The embankment at 284-2 was washed away and about four chains of rails and sleepers hanging. Between 284-2 and 284-14 the line was scoured into at points.

Cause.—The Taikmallai stream overflowed and rushed with great force against the railway bank.

Remedy.—The foot of the embankment has been secured by a parallel wall of stone laid in chunam between 284-4 and 284-16; wall averages some four feet and is brought up above flood level, rubble groynes bring thrown out at every two chains. The slope of embankment pitched. Catch-water channel cut and side ditches widened to lessen the velocity of current.

288*th Mile.*

2*nd October* 1878.—Ballast washed away for one chain and the bank deeply rutted at 288-0.

Cause.—Heavy rain.

Remedy.—Nothing done.

289*th Mile.*

31*st October* 1877.—At 288-2 to 288-3 ballast washed away for about three chains and line breached in shallow bank for half a chain.

Cause.—Owing to the surplus flood which shot past the 20 feet girder bridge at 288-5 and a great deal of water passing along the 289th mile.

Remedy.—Earthwork raised between 288-8 and 288-14; two 25-feet girder bridge constructed at 288-3 and an 8 feet rail girder at 290-7.

291*st Mile.*

22*nd October* 1878.—Ballast washed out for three chains at 290-7 and bank very severely cut.

Cause.—Heavy rain.

Remedy.—An 8 feet rail girder provided at 290-7.

292*nd Mile.*

2*nd October* 1878.—Ballast washed out for one chain at 291-7 and bank badly cut up.

Cause.—Heavy rain.

Remedy.—Nothing done.

299*th Mile.*

24*th October* 1877.—At 298-5 the bank was breached in low bank for about four chains.

Cause.—Insufficiency of waterway.

Remedy.—Earthwork raised between 298-4 and 298-9 and a 25-feet girder bridge provided at 298-4.

300*th Mile.*

8*th December* 1877.—The railway embankment in rear of the south abutment of two 30-feet girder bridge at 299-11 breached; rails and sleepers hanging for about 40 yards.

Cause.—The water in channel at 299-11 being deflected when in high flood by a natural groyne formed of clumps of bamboo in its channel above the railway line, left its usual bed and dashed into the railway embankment.

Remedy.—Extra waterway provided in the 301st mile.

301*st Mile.*

8*th December* 1877.—The water from the channel at 299-11 tore along parallel to the east (left) side of the line and coming to a lower part of the railway embankment topped it, more or less, at intervals from 300-2 to 300-9 and caused the following damage:—

$\frac{300}{2}$ a breach of 30 feet long.

$\frac{300}{3}$ do. of 170 feet long.

$\frac{300}{7}$ do. of 20 feet long.

$\frac{300}{9}$ do. of 250 feet long.

Remedy.—Two 25-feet girder bridge added at 300-3 and one 25-feet girder bridge at 300-14.

303*rd Mile.*

8*th December* 1877.—Pier No. 5 of the Mooloopady bridge at 302-6 washed out and the bank behind south abutment scoured into for about 50 feet.

Cause.—Heavy floods in the Mooloopady stream. The flood is said to have risen to within 5 feet 6 inches of rail level on the upper side with a fall through the bridge of 2 feet. It is alleged that the excessive flood here and at 279-11 was greatly augmented by the breaching of several tanks.

Remedy.—The pier was rebuilt.

304*th Mile.*

7*th December* 1877.—At 303-4 the embankment behind the south abutment of 6 feet arch bridge was deeply scoured into and the outer half of the north-west wing cracked away from the bridge.

Cause.—Excessive floods causing heavy under-scour, there having been a fall of some 3 feet between the level of the water on the upper and lower sides of the bridge.

12*th September* 1878.—Slip of earth from bank at back of wing-wall and south abutment of 6 feet arch bridge at 303-4.

Remedy.—A 25 feet girder bridge at 303-4.

305*th Mile.*

6*th October* 1876.—Three chains of ballast in cutting entirely washed away and two chains partially so at 304-10.

Cause.—Flood in nulla on the east side of the line.

Remedy.—Nothing done.

30*th November* 1880.—Earthwork and ballast washed away from under rails for a length of 48 feet at 304-3.

Cause.—Insufficiency of waterway of 2 feet culvert at 304-3.

Remedy.—Substitution of a 6 feet opening for the 2 feet culvert at 304-3.

306*th Mile.*

7*th December* 1877.—Breach of about 24 feet long at 305-7.

Cause.—Discharge from a tank immediately to the east.

Remedy.—Nothing done.

317*th Mile.*

19*th September* 1877.—Ballast washed away in places between 316-13 and 316-15.

Cause.—Heavy rainfall.

Remedy.—A 6 feet rail girder at 316-13.

320*th and* 321*st Mile.*

25*th July* 1879.—Bank washed away from east to west for a length of 6 feet immediately adjoining the north abutment of the 10 feet girder bridge at 319—7-8.

Cause.—Bund of Ammayanáyakanúr tank breaching and bringing down water in large quantities through the bridge.

Remedy.—One 25-feet girder substituted for one 2-feet culvert at 320-9 chains. Bridge of one 8-feet rail girder substituted for one 2-feet open top culvert at 320 miles 42 chains, and pitching the following bridges:—one 12-feet girder at 318 miles 28 chains, one 10-feet girder at 318 miles 54 chains, one 10-feet girder at 319 miles 4 chains, one 10-feet girder at 319 miles 34 chains, one 25-feet girder at 320 miles 18 chains.

19*th September* 1877.—Line breached for one chain at 319-14 and for 1½ chains at 320-4.

27*th September* 1877.—Three chains of embankment partially washed away between 319—13-14 and 320-4.

Cause.—Heavy rainfall discharged from the Siramallai hills with great rapidity and waterway proving insufficient to pass it off quickly enough.

Remedy.—Extra waterway provided; one 10-feet girder at 318-12, one 10-feet girder at 319-1, one 10-feet girder at 319—7-8 and one 25-feet girder at 320-3, and other protection as detailed in breach at 319—7-8 in July 1879.

22*nd October* 1884.—Ballast between 319-13 to 319-15 completely washed away in about seven places, each to the length of a rail. A part of the earthwork was scoured out to centre of track averaging from 18 inches to 2 feet deep.

Cause.—Bund of Ammayanáyakanúr tank bursting.

Remedy.—Nothing proposed to be done.

325*th Mile.*

During the floods of 1877 a great deal of water accumulated along the 325th mile and it was found necessary to provide extra waterway.

One 12-feet girder at 324-5 taken out and a 25 feet girder substituted; a 12 feet girder added to existing 12 feet girder at 324-14 to 15.

326*th Mile.*

13*th September* 1877.—A small breach at 325-17.

Cause.—Insufficiency of waterway at 3 feet culvert at 325-17.

Remedy.—An 8-feet rail girder at 325-17.

328*th Mile.*

31*st October* 1877.—A breach in line at 327-4 to 327-5.

Cause.—By water topping the line where it crossed a slight ridge dividing one embankment and hollow from another.

Remedy.—Embankment raised from 327-3 to 327-14 and 6 feet girder added to existing single 6 feet rail girder at 327-2.

The ballast was washed away for a chain in length and slopes of bank slipped at 327—4-5 on 25th July 1879 before the protective works above referred to were open for traffic.

341*st Mile.*

7th December 1877.—At 340-6 the double 20-feet girder was breached behind No. 2 (east) abutment for about 2 chains and for 4 chains at 340-8 to 340-9. At the latter points the water topped the bank, while at the former it rose to within 18 inches of rail level.

Cause.—Excessive flood caused by breaching of a chain of some seven tanks lying to the north of line.

Remedy.—The waterway was considered sufficient for the usual and ordinary drainage flowing to the point, but, as a precaution, flooring and retaining walls were added to the two 20-feet girder bridge at 340-6.

353*rd Mile.*

20*th September* 1877.—Line breached in six places for a total length of 75 feet.

Cause.—Insufficiency of waterway at 352-17.

Remedy.—One 20-feet girder provided at 352-17.

356*th Mile.*

11*th November* 1883.—Breaches to line in several places between 355-9 to 355-11.

Cause.—Breaching of tank to the west.

Remedy.—No extra waterway was considered necessary.

362*nd Mile.*

17*th October* 1884.—Second pier of the six 30-feet bridge at 361-14 washed away; also part of flank walls and pitching of north abutment. The bridge was floored throughout with large boulders with an up and down stream toe all dry, but this flooring was swept away in spans 1, 2 and 3.

Cause.—Bursting of tanks causing heavy floods in the Sheveray Cottai river.

Remedy.—The pier is to be rebuilt and the bridge flooring, where destroyed, built in masonry.

374*th and* 375*th Miles.*

7th December 1877.—Line partially washed through end of south-west wing of Virudupati bridge at 373-10 and earth washed from back of wings of 20 feet arch bridge at 374-11.

Cause.—Rush of high flood in the Virudupati river.

Remedy.—A 70-feet girder bridge provided at 374-10; at the 20 feet arch bridge at 374-11 pitching and protective walls. The whole bridge is floored.

380*th Mile.*

7th December 1877.—Embankment breached for 100 lineal feet at 379-7 and ballast washed from east side of sleepers between 379-5 and 379-9.

Cause.—Breaching of tanks to the west of the line and insufficiency of 6 feet bridge at 379-1 to pass off water.

Remedy.—Curtain walls and flooring to 20 feet bridge at 378-8; curtain walls and flooring to two 20-feet bridge at 378-15; 6 feet rail girder at 379-1 converted into a 25-feet girder. Protective wall to east wing of 15 feet bridge at 380-8.

384*th Mile.*

7th December 1877.—Line breached between 383-1 and 383-3 for 324 feet; depth 14 feet; at 383-4 slope washed away for 40 feet. Line partly breached through at north-west and south-west wings of 5-70 feet bridge at 383-5.

Cause.—Great flood in the Gunnecherry river; five arches of public road bridge destroyed and road more or less breached for 50 chains. Breaches at 383-1 and 383-4 caused by breaches occurring in the public road to the west of the line. Waterway of five 70 feet bridge at 383-5 insufficient. Pier No. 3 of this bridge settled 1½ inches.

Remedy.—Flooring and curtain walls to 6 feet rail girder at 382-11. Pitching wings, flooring and causeway to 6 feet arch under road approach at 382-16. Groynes at 383-11 to 383-12. Addittion of two 70-feet spans to five 70-feet girder bridge at 383-5.

385*th Mile.*

16*th November* 1882.—Slight wash away of ballast on both sides of 3 feet culvert at 384-9.

Cause.—Heavy rain.

Remedy.—Three feet culvert enlarged to double 6 feet bridge on skew.

386*th Mile.*

16*th March* 1877.—Flooding of line and breaching of ballast for a length of 12 feet at 385-3.

Cause.—Heavy fall of rain between 384-17 and 385-3.

Remedy.—Nothing done.

388*th Mile.*

15*th October* 1883.—Breach about 1½ feet deep below sleepers and about 5 feet wide between 387-9 and 387-10.

Cause.—Heavy rain.

Remedy.—Nothing done.

393*rd Mile.*

7th December 1877.—Earth washed from behind wings of 12 feet bridge at 392-14.

Cause.—Insufficiency of waterway at 392-14.

Remedy.—One 25-feet girder added to 12 feet span at 392-14. Pitching slopes of three 20-feet girder bridge at 393-14 and groynes for protection of side cuttings at 393—10-11.

19*th October* 1881.—Line breached at 392-14, 14 feet wide and 5 feet below rails.

Cause.—Heavy rain.

Remedy.—Pitching slopes of embankment.

6*th October* 1884.—Line breached at 392-14 for 21 feet in length and at 392-17, 12 feet in length.

Cause.—Heavy rain.

Remedy.—It is proposed to revet the embankment.

399*th Mile.*

11*th November* 1883.—Line breached for about 50 feet in length at 398-14. Earthwork on the eastern side of level-crossing within the gate washed away.

Cause.—Heavy rain.

Remedy.—Nothing done.

403*rd Mile.*

16*th and* 31*st March* 1877.—The 6 feet rail girder at 402 miles 41 chains accommodates the feeder of a small tank to the west of the line and the channel is bunded on the north side. On the 16th March, the rainfall being too heavy to be passed by the bridge, the bund was breached and the water flowed north to Koilpati station. The fall of rain on the 31st March being very heavy (1·80 in rather under two hours), the water took the same course as on the 16th March, but this time, in consequence of the rush of water being greater, the line was topped between 402 miles 27 chains and 402 miles 32 chains where the breach in the ballast occurred; the line runs along the surface of the ground.

Remedy.—The 6 feet rail girder was enlarged to a 15 feet.

408*th Mile.*

2*nd December* 1880.—A breach of 6 feet in width in bank at 407-9.

Cause.—Heavy rainfall.

Remedy.—Nothing done.

409*th Mile.*

8*th September* 1876.—Water found its way through cracks of ground and embankment breached 7 feet wide at 408-3.

Cause.—Heavy storm of rain between 404 and 412 miles and insufficiency of culvert at 408-3.

Remedy.—Three feet culvert enlarged to one 8 feet girder.

411*th Mile.*

7th December 1877.—Ballast washed from east ends of sleepers from water going over rails at 410-12 and 410-14.

Cause.—Insufficiency of waterway of 12 feet bridge at 410-10.

Remedy.—A 15 feet girder added to the existing 12 feet girder at 410-10 and one 8-feet rail girder added to 6 feet girder at 410-16. Embankment raised from 410-10½ to 410-16.

412*th Mile.*

7th December 1877.—Ballast washed from east ends of sleepers from water going over rails 411-1 to 411-3.

Cause.—Insufficiency of waterway of double 3-feet culvert at 411-7.

Remedy.—Two 3-feet culvert at 411-7 converted into a double 8-feet rail girder and embankment raised from 410-17 to 412-5½.

7th December 1877.—Ballast washed from east ends of sleepers from water going over rails 411-11 to 411-12¾.

Cause.—Insufficiency of double 3-feet culvert at 411-11.

Remedy.—Two 3-feet culvert at 411-11 converted into an 8-feet rail girder. Embankment raised from 410-17 to 412-5½.

413*th Mile.*

7th December 1877.—Embankment breached for 15 feet. Line in very low embankment 412-4¾ to 412-5.

Cause.—Three 12-feet bridge at 412-7 was insufficient to pass water.

Remedy.—One 2-feet culvert at 412 miles converted into an 8-feet rail girder adding two 12 feet spans to three 12-feet girders at 412-7.

Embankment raised from 412-5½ to 413-5½.

414*th Mile.*

7th December 1877.—Ballast washed from below east ends of sleepers 413-1 to 413-2 from water going over rails. Line cuts through what was once the bund of a small tank; a protection bund required to the west of line to divert water to bridge.

Remedy.—Bank raised from 413-10 to 413-13, conversion of 12 feet span at 412-16 into a 20 feet girder. Constructing groynes at 412-14 and 412-16 and old groynes faced with stone.

431*st Mile.*

To prevent rush of water between 430-14 and 431-8 and to guard against the line being breached, it was found necessary to add two 25-feet girders to the 15 feet girder at 430-14.

433*rd Mile.*

13*th October* 1877.—Line breached for 24 feet at 432—14¾. Line in low bank.

Cause.—Insufficiency of waterway through two 6-feet rail girder at 432-13.

Remedy.—One 8-feet rail girder added to two 6-feet rail girder at 432-13.

434*th Mile.*

7th December 1877.—A small breach occurred owing to the water ponding against the railway bank at 433-2 to 433-4.

Remedy.—Nothing done.

444*th Mile.*

7th December 1877.—Rails between 443-3 and 443-6 flooded and covered with sand.

Cause.—Water draining from Mailore village on to the line. Continuous rain fell for 36 hours.

Remedy.—Nothing done.

Arkonam Branch.

68*th Mile.*

24*th November* 1882.—Line washed off for three chains at A 67-1.

29*th November* 1882.—Embankment and ballast washed away for a length of eight chains at A 67-2.

Cause.—Heavy rain.

Remedy.—Four 25-feet girders constructed at A 66 miles 74 chains and one 20-feet girder at A 67 miles 14 chains.

Pondicherry Branch.

104*th Mile.*

28*th November* 1880.—Bank breached for a length of 30 feet at P 104-7 to P 104-8. The temporary bridge put in breach was washed out on the 30th November and traffic was not resumed till 2nd December 1880.

Cause.—The water which caused the breach seems to have come from percolation through the bund of the Vallavanur tank.

Remedy.—Nothing done.

108*th Mile.*

19*th October* 1883.—Tank water got through a crack in the bank diagonally and scoured it out badly 6 feet below top of bank at P 108-8. Top of bank, ballast, and permanent-way showed no sign of sinkage.

Remedy.—Nothing done.

Erode Branch.

284*th Mile.*

10*th July* 1882.—Bank washed away for a length of 70 feet and a breadth of 2 feet at E 283-15. The brick stile at this mileage was overthrown.

Cause.—Overflow from the Cauvery river.

Remedy.—Nothing done.

Erode Station.

14*th May* 1880.—Ballast washed away in seven places at No. 1 points and crossings, Erode station.

Cause.—Heavy fall of rain.

Remedy.—Nothing done.

Tinnevelly Branch.

427*th Mile.*

28*th October* 1876.—The 12 feet bridge at T 426-9 being insufficient to pass the water, it was ponded back on the north side of the line; the water rose 4 feet against embankment and forced its way through at T 426—9-10; the width averaged 15 feet. Bridge at T 426—8-9 floored and no damage done to it.

Cause.—Heavy rain.

Remedy.—A 12 feet span added to 12 feet at 426-9.

431*st and* 432*nd Miles.*

10*th August* 1883.—Line breached from T 430-16½ to T 431-0 for 216 feet. Ballast washed off to bottom of sleepers from T 431 to T 431-8 for 206 feet.

Cause.—Water accumulated on the north side of the line from T 429-7 to T 430-15; ran through all the bridges, but could not pass off quickly enough.

Remedy.—The cutting at T 431-5 widened out to line of fence.

440*th Mile.*

Owing to the cutting being flooded, it was decided to enlarge the 2 feet culvert at 439-9 to an 8 feet girder.

444*th Mile.*

3*rd December* 1880.—The embankment breached 12 feet wide and 6 feet deep at north end of 12 feet bridge at 443-11.

Cause.—Owing to a flood in the Támbraparni river, the Tinnevelly channel which leads from the river overflowed and burst its bank to the west of line. The water flowed through five breaches in the bank of the channel, and the single 12 feet bridge at this mileage being insufficient to take the water, it rose against the railway embankment.

Remedy.—Bridge floored.

Tinnevelly Station.

18*th December* 1877.—About 50 cubic yards earthwork washed from south end of embankment. Ballast washed from under sleepers of main line and sidings at south end of yard for an average of 66 feet. Passenger approach breached for 15 feet and damaged for 35 feet. Goods approach road damaged for 150 feet.

Cause.—Continuous rain for 36 hours caused great flood in Támbraparni river; depth of water 29 feet, highest on record since Palamcottah bridge was built; level of flood 0·47 feet below rail level.

Remedy.—Nothing done.

Salt Branch, Tuticorin.

6*th December* 1877.—The following damage occurred:—

1 mile 33	chains to 1 mile 42	chains;	bank entirely washed away.
1 mile 42	chains to 1 mile 45	chains;	bank one quarter washed away.
1 mile 45	chains to 1 mile 46½	chains;	bank three-fourths washed away.
1 mile 46½	chains to 1 mile 50	chains;	bank one quarter washed away.
1 mile 50	chains to 1 mile 54	chains;	bank one-half washed away.
1 mile 54	chains to 1 mile 60	chains;	bank entirely washed away.
1 mile 60	chains to 1 mile 67	chains;	bank one-half washed away.
1 mile 67	chains to 1 mile 70	chains;	bank entirely washed away.
1 mile 70	chains to 2 miles 2	chains;	about 18 inches washed away.

Cause.—Heavy rainfall all over the district; the Korampallam tank, five miles off Tuticorin, on the Palamcottah road, burst and this brought down in great flood a nulla which runs into the sea to the east of Sevendakulam salt pan.

Remedy.—Embankment in places was revetted.

10*th November* 1881.—Breach through embankment for 63 feet in length at 1 mile 22 chains and for 170 feet at 1 mile 65 chains.

Cause.—Heavy rains.

Remedy.—None applied.

8*th November* 1883.—Water from platform at Levingepuram and Sevendakulum depôts rushed on to line and caused breaches; rails in some places covered with sand for about 1 foot; 440 cubic yards earthwork washed out.

(Signed) W. H. SPALDING,
Acting Chief Engineer.

Note by the Acting Agent on the remedial and defensive measures proposed by the Acting Chief Engineer in his report of date, 20th March 1885, on flood damages sustained by the South Indian Railway in November and December 1884.

Chingleput tank.—I agree with Mr. Spalding that the protection required within the influence of the wash of this tank from about 33¼ miles to 36 miles is an effective rough stone revetment, and the carrying of this and the existing revetment up the slopes to formation level, and then in the more exposed places horizontally across the top of the embankment. The ballast should all be formed of stone of a size not liable to be disturbed by any "wash" or "send" from the waves of the tank under a strong easterly wind.

2. Fortunately for the railway and the country lying under this tank, the period of the rains and floods was not attended by a long continuance of high easterly winds, otherwise nothing could have saved the tank bund and railway embankment from being washed away, while the vast body of water suddenly discharging from the tank would have swept across the country in a most disastrous and destructive manner.

3. *The Pálár.*—The proposals to meet the danger here are to raise the girders of the Pálár bridge and to lower the embankment nearly to ground level in the hollow crossed immediately to the south of the river, so as to permit extraordinary floods to pass over the railway instead of being ponded back until they overflow and sweep away the embankment. I think these proposals the best that can be made. The raising of the girders will place them out of the danger they are in at present of being carried away in the event of large quantities of debris, such as trees, straw-stacks, roofs of houses, being accumulated against them, as it is supposed was the case when the 150 feet girders of the Gingee river bridge on the Pondicherry branch were swept into the bed of the river; and the lowering of the embankment to nearly ground level on the 47th mile will give an outlet of about one mile in width for extraordinary floods to flow away from west to east over the railway.

4. I think, however, that it would be well to raise the Pálár bridge girders not less than 5 feet above their present level. The highest flood during last year's floods is stated to have been 3·5 feet below girder bed level, but the flood drained off only about one-third of the whole drainage area of the river, and it is possible that a much larger proportion of the area may at times be discharging so that the water may get ponded up against the railway embankment and bridge to a greater height than last recorded. Mr. Spalding's proposed lift of 3 feet would raise the girders to 6·5 feet above this, but the afflux at the pier points surged the water through up to about girder level at the piers, and I think it would be prudent to raise the girders 5 feet, making them 8·5 feet above last year's maximum floods, or 220·00 above railway datum. The highest ground immediately to the south of the bridge—between it and the drainage hollow on the 46th mile—is about 214·00 above datum. Raising girders 5 feet would place them at 220·00, or 6 feet above highest ground level. Supposing some future flood to pond up 2 feet against the railway embankment before it escaped laterally to the drainage hollow further south, this would leave the girders 4 feet above flood level [*i.e.*, girder beds 220·00—216·00 (= flood water ponded up 2 feet against railway embankment) = 4 feet], and this would certainly not be too much to keep bridge and its approaches above such an inundation as would, under the circumstances, be overwhelming the country.

5. *Palár Valley South of the River Pálár.*—I concur with the Acting Chief Engineer in his proposals for the treatment of this hollow extending from about 44⅓ to 46¼ miles, namely, that rail level shall be lowered so as to allow the ordinary drainage of the country to cross under, while extraordinary floods shall pass over the railway as in the Ponniár valley.

6. *Karunguli.*—Since the Acting Chief Engineer wrote his report,* a further examination of the country at Karunguli has shown that, in addition to the discharge from the large calingula of the Madurantakam tank and

* No. 3-85—C-150, dated 20th March 1885.

the escape at the south end of the tank, there are two surplus weirs in the bund of the supply channel leading from the Madurantakam to the Karunguli tank. One of these weirs is 274 feet, and the other 41 feet long, and the possible maximum discharge is with a depth of 4 feet 6 inches over their crests.

7. Taking the depth of water discharging over the big calingula (725 feet long) at 9 feet and over the two smaller ones (274 + 41) at 4 feet 6 inches, I estimate the discharge at 76,000 cubic feet per second, say 80,000 cubic feet to allow for local drainage and contingencies. To let this discharge cross the railway freely, I would double the existing water-way, making it 22 instead of, as at present, 11 spans of 40 feet (880 instead of 440 lineal feet). The piers can, in my opinion, be quite safely raised 4 feet instead of the 2 feet 4 inches proposed by the Acting Chief Engineer, and this would give a still greater margin above any probable flood.

8. The existing formation level is 208·65 above datum, and girder bed level 205·74. To raise the latter 2 feet 4 inches would therefore be to bring it up to 208·07, or ·58 below the present formation. The extra 1 foot 8 inches (2 feet 4 inches + 1 foot 8 inches = 4 feet) would raise girder bed level to 209·73, or 1·08 feet above present formation level.

9. At 56 miles 14 chains a 3 feet culvert proved insufficient, the water rising to under-side of rails and standing 8 feet above the level of the water on the down-stream side. The span of this culvert should be increased.

10. On the 77th and 78th miles I think it would be well to record the dimensions of, and discharges from, the calingulas of the two tanks named Ceddingal and Suyanur, and the water-way provided under the railway to pass these discharges.

11. *Tondayar and Gingee Rivers.*—These rivers are not bunded in, and when they rise above the natural surface of the country, forming the sides of their channels, the surplus water flows across country. It is, therefore, important to permit the water in each river to flow away in its channel bed, as unimpeded as possible, to prevent ponding up and consequent overflow of the river banks.

12. The Tondayar railway bridge of two 100-feet spans to some extent obstructs the natural cross sectional flow of the river, and the bridge should be doubled as recommended by the Acting Chief Engineer. Even with this addition to the water-way of the Tondayar, there is the certainty of its overflowing its banks in times of excessive floods and forming by junction with its neighbour, the River Gingee, a continuous sheet of water above and to the west of the railway embankment. I estimate that the provision of a flood opening of 300 feet on the 86th mile and an addition of 7 spans to the south end of the existing eleven 30-feet spans of the Gingee bridge would tentatively meet the requirements of the case.

13. *Pombay River, 98th mile.*—The embankment on the 98th mile has on more than one occasion been seriously damaged by floods due to breaching of tanks. No addition to the railway water-way was decided on prior to the late floods, owing to the difficulty in arriving at any approximation to the amount of relief required. The embankment was strengthened by putting in better soil, and the approaches to existing water-ways were strongly defended by rough stone revetting. An opportunity was then awaited to observe the measure of increased water-way required to pass off the drainage during heavy floods swollen by breaching tanks. The opportunity came in November and December last, when the Consulting Engineer to Government and the Engineering Department were able to ascertain, with very approximate accuracy, the flood discharge across the line of railway on this 98th mile. The Acting Chief Engineer, in his report under review, proposes a flood opening of 8·40 feet girder spans, which he has since had reason to alter to 10·30 feet spans (giving 300 instead of 320 lineal feet) to fit in better with his stock of girder material. I consider that this additional waterway will meet the requirements of the locality.

14. Ordinarily the breaching of tanks is not provided for, because in many cases this would involve a, so to speak, impossible expenditure; but in cases like the present, where the ponding back of the water, from whatever source accumulating against the railway embankment, submerges a large area of country to the great inconvenience and pecuniary loss of the inhabitants, and the danger of the public travelling by railway, and where some reasonable limit to the extra water-way required can be seen, it has been usual to provide that water-way.

15. *Ponniár and Gadilam River Valleys.*—The Acting Chief Engineer remarks that the line on the 103, 108, 109, 111, 114, and 115 miles will be left as it is, because, if the Ponniár is not embanked and kept within limits, instead of being allowed to devastate the country as at present, there is no known limit—short of the whole river—to the volume of water that may be concentrated on these portions of the railway, while, if the Ponniár is bunded up, any works provided now may then prove to be unnecessary. As, however, the work of embanking the Ponniár, even if decided on now, would be a work of time, and as at the best the embankments cannot be a perfect security against the river occasionally breaching them, owing to the sandy and friable nature of the adjacent soil from which they must be formed, I think it would be well to make some extra provision on the 103rd mile, where the embankment is high, and consequently, when breached, difficult to repair quickly.

16. In the hollow where the late damage was greatest at 103 miles, there are two bridges each of two 25-feet girder spans situated about 130 yards apart. I think it is a question for consideration whether extra water-way should be given at one of these bridges. The line cannot conveniently be lowered here so as to let floods pass over it as on the south side of the Ponniár river.

17. I think the treatment of the line between Panruti and Cuddalore proposed by the Acting Chief Engineer the best that under the circumstances can be undertaken, namely, to lower the railway embankments (1) on the 134th mile immediately west of the Gadilam Railway bridge, (2) on the 125th mile between the Gadilam bridge and Cuddalore New Town station, and (3) between the Old and New Town stations. The line in all cases to be lowered as much as possible while adhering to the ruling gradient of 1 in 200, and making free provision for the passage under the railway of ordinary drainage and irrigation channels, the lowering being to permit the water to flow over the railway in times of extraordinary flood and so to be got rid of as soon as possible, instead of being ponded up against the railway embankments.

It is probable that, as estimated when settling the water-ways for the railway, the Gadilam bridge is able to discharge the flood water of the Gadilam proper, but the Gadilam in times of extraordinary flood is swollen, as it was in December last, by large contributions from the Ponniár. The Acting Chief Engineer states that the flood in the Gadilam rose in December last to within 2 feet 3 inches of rail level at the railway bridge. Seeing that, when this maximum was attained, a large body of water from the river must have been surplussing eastward across country towards the New and Old Town Cuddalore stations, it seems evident that if this surplussing is stopped—as, to save the country, it must be stopped, by embanking the east side of the Gadilam river from the railway bridge across to the Capper Hills,—the railway bridge will prove insufficient to pass the volume of water which will then be thrown against it; and, seeing that it is unlikely that the river Ponniár can soon, if ever, be so securely embanked as to guard against its waters ever again overdrawing into the Gadilam, it will be expedient to increase the water-way of the Gadilam railway bridge. Although the railway embankment immediately to the west of the bridge has been lowered so as to let water in times of excessive floods escape over the railway, it is not, of course, intended that this outlet should be more than a safety valve, the real point of relief should, as far as possible, be along the regular course of the river at the railway bridge, and this is the more necessary that any ponding up of the river at the railway bridge will endanger the embankment which must be thrown up from the bridge to the Capper Hills, to confine the river to its present course instead of allowing it to sweep across and overwhelm the country. It will be for the Engineering Department to submit proposals for an increase to the Gadilam Railway bridge, but, on the face of it, it seems to me doubtful if anything short of an increase of 50 per cent. will be of any value; that is, the present 1,000 lineal feet (10—100 feet girder spans) increased by 500 lineal feet (five 100 feet spans), making in all 1,500 lineal feet of water-way.

18. In reporting on the waterways when the line was laid out, and from time to time afterwards, it was pointed out by the Chief Engineer that the Ponniár and Gaddilam Valleys would be the cause of anxiety and watchfulness; that while on the one hand—towards the north—the Ponniár would give trouble by surplussing into the irrigation channels and flowing across country, on the other hand—to the south—it would not only do this, but, by overdrawing into the Gadilam, would dangerously increase the probably already full channel volume of water in that river.

19. A reference to the following papers will show that the dangers to be apprehended from floods in the Ponniár Valley were fully seen and discussed while the railway was under consideration and construction:—

G.O., No. 2224, of 8th September 1873.
G.O., No. 23 R., of 8th January 1877.

In these and other communications the dangers to be apprehended from excessive floods in this valley were fully realized and pointed out.

20. The late floods have signally borne out and verified the conclusions formed during these earlier investigations. In my opinion our best course now is an extension of the mode of treatment then adopted, namely, where practicable, to lower the railway on or near to the natural surface of the country so as to let excessive floods flow away over the rails. These excessive floods are, as a rule, infrequent and do not last long, and the interruptions to traffic would not therefore be serious, while the damage to the railway would be slight and easily repaired.

21. *Paravanar.*—The two 150-feet span girder bridge across the Paravanar should be raised to 3 or 4 feet above flood level. In the December floods the lower parts of the cross girders were submerged, and although this may occur only at long intervals of time, and although the velocity of the current through the bridge was not great, it will be well to lift the girders out of reach of the water and of drift, such as trees, straw, thatch, &c., likely to be carried down in times of heavy floods.

22. It would also, in my opinion, be well to give extra water-way at 134 miles 50 chains, at the same time raising the embankment from the Paravanar along past the Alapákam station to this point.

23. 140 *miles* 79 *chains, Thirty feet Girder over East Coast Canal.*—It would be well to raise girder seat level here to formation level so as to keep the girders above flood level and give a freer discharge to the water.

24. I concur generally with the Acting Chief Engineer in his remaining proposals.

25. The bridge of four 50-feet spans over the Showeriamangalam Nulla on the 432nd mile (between Maniyáchi and Tuticorin) has on several occasions been rather severely tried, and the girders ought to be raised to clear flood level better than at present.

Trichinopoly,
14th July 1885.

(Signed) D. LOGAN,
Acting Agent.

No. 608-A.

To the Consulting Engineer for Railways, Ootacamund.

From G. B. BRUCE, Esq., to H. W. NOTMAN, Esq., dated 2, Westminster Chambers, London, S.W., 17th February 1885.

South Indian Railway.

We have gone very carefully through the report of the Acting Chief Engineer in reference to the effects of the floods which occurred in Madras during the last south-west monsoon.

The damage done to the railway was, in the main, caused by the failure of the bunds of the rivers and tanks, over which bunds this company had and has no control. Had these remained sound, the railway would not, in most cases, have been damaged. It is a question for consideration how far the authorities responsible for the maintenance of the bunds are liable for the damage done to the railway through their neglect.

Though it may be difficult to guard against all exceptional floods, we think it ought to be done, and the railway put into such a position that the traffic may be maintained without interruption during the monsoon.

We append the following notes on the detailed statements of damage done at various points on the line with suggestions as to what we propose should be done. We do this for the consideration of the Chief Engineer, who, being on the spot, must be the ultimate judge.

Miles 34, 35, 36.

Chingleput Tank.—The embankment here should be pitched sufficiently high to avoid the wash from the water.

Miles 42 *to* 46.

Pálár.—As the water here rose to the bottom of the girders, it is very desirable that the girders should be raised, or the next flood may carry them off the piers.

Between 44 and 46 miles in the valley of the Thundalum a great deal of damage was done to the embankment, and we gather from the report that the water rose above the level of the rails. We would suggest that this bank should be lifted and more water-way provided, or, if preferred and circumstances admit of it, that the embankment be removed entirely and the rails laid near the surface of the ground, the ballast being protected as in some other places by pitching.

Mile 50.

Karunguli Bridge.—Here the bridge of eleven 40 feet-girders was completely submerged and the girders washed off the piers. In replacing girders on these piers, they should certainly in our judgment be placed so high that the water cannot reach them.

Mile 64.

Here a gap of 96 feet was made at the abutment of a bridge of four 25-feet openings. We think more water-way should be allowed.

Mile 67.

The same remark applies to the 67th mile.

Miles 68 *to* 70.

Here the water topped the bank which we think should be raised and more water-way provided.

Miles 77 *and* 78.

The water here topped the rails. The water-way should be increased and the line lifted.

Miles 83 *to* 86.

Thondayar and Gingee Rivers.—Here the damage has been serious, though it has not affected the masonry much or damaged the girders of the river bridges. The water was above the bottom of the girders, and here also we think the level of the line should be lifted to prevent this in future, and more water-way introduced.

Miles 92 *to* 94.

Vikravándi River.—Three out of the five girders of the bridge fell. The girders were completely submerged. The rail level should, we think, be lifted and more water-way allowed.

Mile 97.

Pombay River.—From the description of the damage done to the embankment here, we think that more water-way is required.

Mile 103.

Malatar River.—The damage done to the embankments here, as in most other cases, has been caused by the bursting of bunds not under the control of the Railway Company. In this case it was the bank of the Malatar that gave way. It is possible that this breach in the river bank saved the bridge itself from destruction.

Mile 105.

Ponniár River.—The low ground between this river and the Malatar, as well as on the south side of the Ponniár, has the rails laid on the natural surface and protected by pitching. This has been little damaged and suggests the consideration of the question whether this style of construction might not be extended in some cases instead of providing an increase in the water-way by means of bridges.

The only remark we would make on this section is that it is worthy of consideration whether the water-way provided for the rivers themselves is sufficient and whether the approaches to these bridges should not have more openings.

Mile 107.

Old Malatar.—To make the line safe here in future more water-way should be provided.

Miles 113 *to* 115.

Settiaputti Tank, Panruti.—Here we think more water-way should be provided and the line raised.

Miles 122 *to* 128.

Gadilam River.—For six miles great damage was done here. The water rose above the level of the underside of the girders of this bridge. We recommend that these girders be raised to avoid that in future. As to the embankment over this long sketch of low land, it should either be lowered and the ballast pitched to allow of an excessive flood flowing over the rails without doing damage, or the water-way should be very materially increased.

Miles 134 *to* 137.

River Paravanar.—The water here rose over the level of rails at the bridge of two 150-feet girders. These we think should be lifted and that generally more water-way should be provided throughout this valley.

Other Breaches, Main Line.—There were also breaches made in the line in the following miles —141st, 150th, 251st, 252nd, 253rd, 264th, and 268th, —which we need not refer to in detail, but would only observe that it would not be wise simply to restore the line to its original position in the hope that so heavy a flood will not occur for many years. The additional floods we think should be provided for.

These complete the damage done to the main line.

Arkónam Branch.—There were some breaches on the Arkónam Branch which will also require to be guarded against in future.

Pondicherry Branch.—One of the most serious accidents occurred on the Pondicherry branch, where the girders of Gingee river being seven 150-feet spans, were carried by the flood off the piers and landed in the stream. The water appears to have been 2 feet above the level of the rails, and considerably more than that above the underside of the girders. We recommend that the new girders should be placed at such a height that the water of a similar flood would pass under them perfectly clear.

It is matter for congratulation that the masonry of the line has been so little damaged by the tremendous floods which have occurred and speaks well for the character of the work and the precautions taken by the Engineers in guarding against the effect of scour in the rivers and streams. It is the earthwork almost entirely that has suffered.

From W. S. BETTS, Esq., Agent, South Indian Railway, to the Consulting Engineer for Railways, dated Trichinopoly, 21st November 1885, No. 1001 :—

For your information I forward herewith a copy of the views of this Company's Consulting Engineers upon the reports and papers relating to reconstructive and protective measures due to experience during the floods of November and December 1884.

2. I have been requested by the Managing Director to place these views in the possession of the Engineering Department for guidance.

—

Enclosures.

From Messrs. C. D. FOX and G. B. BRUCE, to H. W. NOTMAN Esq. dated Westminster, S.W., 7th October 1885.

In reference to your letter of the 4th September, we have carefully examined the proposed enlargements and alterations designed to repair the damage done by the floods.

2. With regard to the Karunguli bridge, we approve of the addition of 9 spans of 40 feet each, but we doubt whether it will be sufficient to raise the level of the underside of the girders only 2·30 feet.

3. We would suggest the reconsideration of this by the Chief Engineer.

4. The other proposals for providing increased water-way do not seem to call for special remark. They are very much in the line of the observations in our report of the 17th of February 1885, and appear to be calculated to provide for the safety of the railway in future in those parts.

5. The other proposals are as follows:—

Restoration of the Gingee bridge.

Lowering gradient in the 125th and 126th miles and protecting the same by pitching.

Protective works on divisions 2 and 3, referred to in Agent's letter No. 557. We recommend the approval of these various estimates.

—

From the same, dated Westminster, S.W., 7th October 1885.

We are in receipt of your letter of the 7th September forwarding estimate, amounting to Rs. 70,871, for restoration of the railway and the construction of a 150 feet girder bridge over the Oopanar—all in the 128th mile.

2. We have gone carefully through the estimate and find it such as may be approved. We also approve of the introduction of a span of 150 feet instead of the 70 feet span which was partially destroyed by the floods.

3. We return the estimate herewith.

—

From the same, dated 2, Westminster Chambers, Victoria Street, S.W., 23rd October 1885.

We have deferred until now answering your letter of the 16th April, which gave cover to (1) copy of the Acting Chief Engineer's report upon the fall of a pier of the Shevaracottai bridge, and (2) copy of the Acting Chief Engineer's report on the damages to the line by the floods of December last, because we wished, before advising the Board regarding the measures proposed by Mr. Spalding, to have Mr. Logan's promised criticism thereof. This reached us with your letter of the 2nd instant, and we now beg to offer our remarks upon such of the points as appear to us to call for comment.

2. With regard to the Shevaracottai bridge, we think that the increased depth which has been given to the reconstructed pier should make it safe in the future, always provided that the curtain walls which support the flooring of the bridge are carried down to a sufficient depth upon wells or otherwise.

3. Turning to the reports upon the floods of December last, we observe that the measures proposed to be adopted for the safety of the railway embankment in the neighbourhood of the Chingleput tank agree with those recommended in our letter of the 17th February last.

4. We observe that Mr. Spalding proposes to raise the girders of the Pálár bridge 3 feet and that Mr. Logan thinks they should be raised 5 feet. We have already, in our letter of the 17th February last, expressed an opinion that the girders should be raised; and if there is any doubt as to the sufficiency of the height proposed by Mr. Spalding, it will be better to increase the lift to 5 feet.

5. In our letter of 7th instant, we expressed a doubt whether the raising of the girders at Karunguli by 2·3 feet would give them sufficient clearance above flood-level, and we concur with

STATEMENT A.

SOUTH INDIAN RAILWAY.

Statement giving particulars of damage to the line caused by the floods of November and December 1884.

Floods of November 7.							Floods of December 18 and 19.																			
			Length of breaches.							Length of breaches.				Masonry works injured or destroyed.		Masonry restored.		Masonry to be added.		Masonry abandoned.		Girders to be raised.				
From	To	Description of damage.	Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.	From	To	Description of damage.	Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.	Number of spans.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Protective works to be added, if any.	Lowering of line.	Remarks.
M. T.P.	M. T.P.	....	YDS.	YDS.	FEET.	FEET.	M. T.P.	M. T.P.		YDS.	YDS.	FEET.	FEET.		FEET.		FEET.		FEET.		FEET.		FEET.			
..	..	....	..	..	..	..	30th mile.		None	..	..	..	..	..	..	..	..	1	20	1	6	..	..	..	..	The 6 feet opening at 29th mile 16th telegraph post proved insufficient and the Singaperumálkoil station compound was partially flooded. This bridge is to be converted into a span of 20 feet.
..	..	....	..	..	..	..	33 8	33 10¾	Slopes eroded to within 4 feet of centre line.	242	..	8·1	9·81	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	33 12¾	33 13¾		88	..	9·4	9·92	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	33 14¾	33 15¾	The slopes washed for 35 and 20 feet, respectively.	88	..	9·8	10·70	..	..	..	..	..	..	..	..	..	..	..	..	Chingleput tank. No breaches occurred but the embankment was damaged as given in column 5 by the action of the waves in tank. The embankment is to be strongly pitched up to formation level and formation paved with heavy boulders.
..	..	....	..	..	..	..	33 18¾	..	South of the 6·25 feet bridge the embankment was cut into to within 3 feet of centre line.	80	..	12·0	12·28	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	34 2¾	34 3¼	Embankment washed away up to centre line.	44	..	1·9	2·01	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	34 6	34 8	Earthwork of road approach to goods shed, Chingleput station, considerably eroded; that of east lay-bye washed away; the second lay-bye attacked; main line embankment clear of siding taken away up to centre line.	176	..	0·8	5·41	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	35 13½	35 14½	Embankment of main line taken away up to centre line.	110	..	4·6	5·08	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	42 7½	..	Breached at back of north abutment of 10 feet bridge.	20	20	10·0	12·99	..	..	..	..	..	..	..	..	..	..	Flank walls, flooring and pitching slopes with heavy boulders to be added.	..	These bridges span irrigation channels which have no regulating works at their heads and are open to river floods.
..	..	....	..	..	..	..	43 6	..	Breach on each side of 10 feet bridge	21¾	21¾	6·8	7·34	..	..	..	..	..	..	..	..	18	120	The same ..	..	Do. do.
..	..	....	..	..	..	..	42 11¼	..	Rough-stone flooring in spans 15 to 18 much damaged.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Pálár girders to be raised 4 feet, spans 14 to 18 to be floored and remaining piers to be protected with boulders.
..	..	....	..	..	..	..	44 7½	44 15	Total wash away of ballast and partial wash away of embankment	660	..	3·1	4·73	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	44 15	44 19	From 15th post to north abutment of 6·25 feet bridge (44th mile 17½ telegraph post) a total breach of line; from south abutment to 19th post the same.	352	290	6·1	11·92	..	..	..	..	..	..	..	..	..	..	..	..	Line will be lowered between 44th mile 9¼ telegraph post and 46th mile 3¼ telegraph post 3 feet.	Line in these miles damaged by overflow of Pálár river. No injury to any masonry works. Length of through breaches not recorded.
..	..	....	..	..	..	..	44 19	45 2	Embankment from 25 to 75 per cent. washed away.	264	..	4·0	4·29	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	45 7½	45 9	Bank partially and wholly breached.	132	110	6·2	9·56	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	45 9	45 12	Bank more or less breached; a through breach at back of 20 feet bridge at 45th mile 11½ telegraph post.	264	44	5·8	7·14	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	45 12	46 0	Bank partially washed away (wholly breached in places).	704	...	4·3	4·91	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	46 0	46 2	Ballast only washed away; flood ceased to top line at 46th mile 2nd telegraph post.	176	..	4·8	4·89	..	..	..	..	..	..	..	..	..	..	..	..	Karanguli river.
..	..	....	..	..	..	..	48 18¾	..	Embankment partially breached..	..	..	4·0	5·49	..	..	..	..	..	..	..	..	..	..	..	..	The bridge is to be doubled and girder bed level raised 4 feet.
..	..	....	..	..	..	..	48 19½	49 2½	A total breach of embankment ..	264	264	..	..	..	..	..	..	11	40	..	..	11	40	..	..	
..	..	....	..	..	..	..	..	..	On the south side of the bridge there is a partial breach of 100 yards. The whole of the plate girders of the eleven 40 feet bridge were swept off into the river and most of them much injured. The east pier parapets were carried away and pier No. 8 was overturned at river bed level.	100	..	9·8	11·65	11	40	One pier restored.	11	40	..	..	..	..	..	..	

Statement giving particulars of damage to the line caused by the floods of November and December 1884—*cont.*

Floods of November 7.							Floods of December 18 and 19.								Masonry works injured or destroyed.		Masonry restored.		Masonry to be added.		Masonry abandoned.		Girders to be raised.		Protective works to be added, if any.	Lowering of line.	Remarks.
			Length of breaches.							Length of breaches.																	
From	To	Description of damage.	Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.	From	To	Description of damage.	Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.		Number of spans.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.			
M. T.P.	M. T.P.		YDS.	YDS.	FEET.	FEET.	M. T.P.	M. T.P.		YDS.	YDS.	FEET.	FEET.			FEET.			FEET.		FEET.		FEET.			
..	..	....	..	..	..	..	49 13	..	The south abutment of 10 feet bridge settled and cracked.	..	..	..	..		1	10	1	10	..	..	..	..	..	..	Flank walls, pitching and flooring added.	..	The single 10 feet bridge at 63rd mile 10¾ telegraph post is to be made into a 25-feet span.
63 10	63 12	Embankment breached and coping of the south-west wing of the three 25 feet bridge at 64 mile 11½ telegraph post carried away.	50	50	2·6	14·05	..	..	....	..	..	..	..		..	..	..	..	1	25	1	10	..	..	..	..	
63 14	63 15	Do. do. ..	44	44	7·0	7·62	63 14	..	Breach at back of north abutment of 4·20 feet bridge.	32	32	5·10	5·11		..	..	..	..	4	20	..	..	..	..	..	..	
64 10	64 11	Do. do. ..	100¾	100¾	8·3	9·51	64 11	..	Erosion of bank at back of south abutment of 3·25 feet bridge at 64th mile 11½ telegraph post.	..	..	10·9	10·94		..	..	..	..	3	25	..	..	..	..	..	..	
64 12	64 13	Line partially and wholly breached for 32 yards; of this length, 11 yards wholly breached, and the north-west wing coping of 2·25 feet bridge at 66th mile 14th telegraph post washed off.	32	11	5·4	6·64	[66 4½	66 5½	The ballast and embankment washed over and partially eroded, a small through breach.	88	2	1·8	2·81		..	..	..	..	..	..	..	..	..	..	..	..	
64 14	..	Line partially and wholly breached for 69⅔ yards, the length of through breach being 21½ yards.	69⅔	21½	5·4	..	66 6½	66 7¾	A through breach of 8 yards at 66th mile 6½ telegraph post; a shallow breach of 26⅔ yards at 66th mile 7½ telegraph post; for the rest of this length ballast and top of bank washed.	110	34⅔	3·9	4·21		..	..	..	..	..	..	..	..	..	..	..	..	
66 4	66 12	Water flowed over line more or less damaging embankment and causing a small throug breach at 66th mile 6½ telegraph post.	704	..	3·10	4·81	66 10	66 11	Ballast and top of bank washed off.	88	..	3·1	3·47		..	..	..	..	..	..	..	..	..	..	..	..	The flooring between curtain walls of span No. 1 of 3·25 feet bridge at 69th mile 8½ telegraph post partially washed out; that of spans 2 and 3 wholly gone.
..	..	....	..	..	..	..	68 17	69 8½	Ballast and bank on east side eroded up to 69th mile; then a breach of 44 yards at 4 feet bridge from 69th mile ½ telegraph post to 69th mile 8½ telegraph post; ballast and embankment partially eroded on east side.	1,012	44	5·0	7·98		3	25	..	..	..	..	1	8	1	4	..	..	Flank walls, pitching and apron added.	..	The north abutment of 4 feet culvert was undermined from the rear. It has been reconstructed as an 8-feet rail girder.
..	..	....	..	..	..	..	69 11½	69 15½	A great portion of the embankment washed away for this length; there were through breaches between 69th mile 13th telegraph post and 69th mile 14th telegraph post of 49 yards, and at back of north abutment of 4 feet open top culvert at 69th mile 14¾ telegraph post; one of 40 yards between 69th mile 15th telegraph post and 69th mile 15½ telegraph post; another of 40 yards.	352	129	4·3	5·44		..	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	76 15½	77 5	The line which is on a low bank was washed over between these mileages; there was a breach of 56 yards at the 10 feet bridge at 77th mile 3rd telegraph post; the rest of the damage consisted of wash away of ballast and erosion of bank.	750	56	5·2	6·24		..	..	..	..	..	..	..	..	..	..	..	..	The lengths of the small through breaches were not taken.
..	..	....	..	..	..	..	77 13	78 1	The embankment was very much damaged; there were several through breaches; one of 33 yards at 77th mile 13½ telegraph post was the worst.	600	33	3·7	4·47		..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	83 15½	..	Breach of 9½ yards at back of 6 feet bridge.	9½	9½	7·32	..		..	..	..	..	..	..	..	..	..	..	..	..	Tondayar river.
..	..	....	..	..	..	..	84 4¼	84 6	On either side of the Tondayar there was a clean sweep made of the embankment. On the north side the breach was 107 yards and on the south side 48 yards long. The north-east wing wall of Tondayar bridge fell.	155	155	7·8	8·61		2	100	..	..	2	100	..	..	..	..	..	..	

Statement giving particulars of damage to the line caused by the floods of November and December 1884—*cont.*

Floods of November 7.							Floods of December 18 and 19.																			
			Length of breaches.							Length of breaches.				Masonry works injured or destroyed.		Masonry restored.		Masonry to be added.		Masonry abandoned.		Girders to be raised.		Protective works to be added, if any.	Lowering of line.	Remarks.
From	To	Description of damage.	Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.	From	To	Description of damage.	Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.	Number of spans.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.			
M. P.T.	M. P.T.		YDS.	YDS.	FT.	FEET.	M. T.P.	M. T.P.		YDS.	YDS.	FEET.	FEET.		FEET.		FEET.		FEET.		FEET.		FEET.			
..	..	....	..	..	..	..			Great damage done to line from flood in Gadilam river at the following places:—															..	Line will be lowered between 122nd mile 2½ telegraph post and 123rd mile 14¾th telegraph post nearly to the surface of the ground; the new formation on the level portion will be 5·06 feet below the present formation.	The line between 123rd mile and 123rd mile 14¾th telegraph post was lowered at the time of the restoration of the permanent-way.
..	..	....	..	..	..	..	122 5	122 11	Line washed over ballast only gone.	600	..	4·0	4·43	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	122 11	122 12	Embankment partially washed away. A through breach of 10 yards south of 3 feet culvert at 122nd mile 11th telegraph post.	100	10	4·6	4·95	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	122 12½	..	A gap of 32 yards in embankment.	32	32	4·1	..	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	122 12½	122 14	Ballast only washed away ..	150	..	4·8	5·53	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	122 14	123 3	Embankment partially gone ..	700	..	6·0	7·13	..	..	..	..	..	..	..	..	..	..	..		
123 7	..	A breach in embankment ..	15	15	7·5	..	123 3	123 13	Greater portion of embankment swept away. Permanent-way turned completely over on cess. At 123rd mile 5th telegraph post there was a small breach of a few feet, and at 123rd mile 7½ telegraph post there was a breach of 43 yards with a scour hole 16 feet below level of ground.	1,000	43	6·5	8·76	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	124 7½	124 12½	Line partially washed away ..	500	..	4·1	5·79	..	..	..	..	..	..	..	..	..	..	..	Line will be lowered between 124th mile 8⅜ telegraph post and 125th mile 5½ telegraph post to the surface of the ground; the new formation of the level portion will be 8·87 feet below present formation.	This work has been carried out; the lowering of the line does away with the necessity for reconstructing the 10 feet bridge at 125th mile. A level-crossing has now been provided.
125 0	..	A breach of 32 yards and the 10 feet bridge over the public road destroyed.	32	32	10·4	..	125 0	..	A gap of 70 yards	70	70	10·4	..	1	10	..	..	..	..	1	10	..	..	..		
..	..	....	..	..	..	..	125 4	..	A very serious breach of 100 yards with a very deep scour hole.	100	100	7·1	..	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	125 5½	..	A small breach of 10 yards ..	10	10	4·7	..	..	..	..	..	..	..	..	..	..	..	..		
125 4	..	A serious breach of 64 yards and scoured out deeply.	64	64	7·1	..	..	..	....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Flank walls and apron added.	Line will be lowered between 125th mile 11th telegraph post and 127th mile 0¾th telegraph post to nearly the surface of the ground, sufficient headway being left for the irrigation channels.	A portion of this work is in hand; the two bridges of 10 feet span have been reconstructed to suit the altered formation.
125 5½	..	A small breach of 3 yards ..	3	3	4·7	..	125 13½	125 14½	South abutment of 10 feet bridge destroyed. A clean breach of 87 yards with a deep scour hole for 27 yards of this length.	100	87	8·9	9·36	1	10	1	10	..	..	..	..	..	..	..		
125 10¾	..	A partial breach of 3 yards ..	3	..	9·4	..	..	..	....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
125 12	..	A breach of 17 yards and scoured deeply.	17	17	9·4	..	125 15	125 16	Two breaches aggregating 48 yards.	48	48	7·3	8·61	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	126 2¼	126 2¾	Embankment partially breached..	50	..	6·3	6·36	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	126 3¼	..	Ten feet bridge swept away and a large breach of 43 yards with a scour hole of 19 feet below surface of ground equal to 28 feet below rail level.	43	43	6·5	..	1	10	1	10	..	..	..	..	..	..	Flank walls and apron added.		
..	..	....	..	..	..	..	..	..	A partial scour for a few feet ..	..	..	6·05	..	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	126 3½	..	Line partially washed away; the bulk of the embankment between 4th and 5th telegraph posts.	325	..	6·3	7·85	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	126 3¾	126 7	A through breach of 50 yards scoured out to 20 feet below rails.	50	50	5·0	..	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	127 0½	..	Line washed away for an average of 4 feet of height of embankment with a through breach 18 yards at 127th mile 4th telegraph post.	400	18	3·6	5·82	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	127 1	127 5	Line partially washed away for an average of about 6 feet of the height of embankment.	100	..	4·0	6·56	..	..	..	..	..	..	..	..	..	..	..		The line will be permanently diverted to the west, the 70 feet bridge abandoned and a new bridge of 150 feet span constructed.
..	..	....	..	..	..	..	127 5	127 6	A breach of 50 yards at back of north abutment of 70 feet bridge and for 23 yards at back of temporary opening put in behind south abutment after November flood; wings of north abutment undermined and cracked.	73	73	6·6	6·	1	70	..	..	1	150	1	70	..	..	..		
127 7	..	A breach of 14 yards behind north abutment of 70 feet bridge and one of 34 behind south abutment; the latter was scoured to a depth of about 26 feet and the wings of this abutment were carried away with the wells they stood on.	48	48	6·6	..	127 7	..																		

Statement giving particulars of damage to the line caused by the floods of November and December 1884—*cont.*

Floods of November 7.							Floods of December 18 and 19.								Masonry works injured or destroyed.		Masonry restored.		Masonry to be added.		Masonry abandoned.		Girders to be raised.		Protective works to be added, if any.	Lowering of line.	Remarks.
From	To	Description of damage.	Length of breaches.				From	To	Description of damage.	Length of breaches.																		
			Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.				Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.		Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.			
M. T.P.	M. T.P.		YDS.	YDS.	FEET.	FEET.	M. T.P.	M. T.P.		YDS.	YDS.	FEET.	FEET.		FEET.		FEET.		FEET.		FEET.		FEET.				
..	..	....	..	..	..	..	127 8	127 13	Line partially washed away to about 6 feet below rails.	500	..	5·6	7·05	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	128 0	128 5	A wash over ballast and top of embankment gone.	500	..	4·6	5·14	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
128 1	128 2½	Line washed over and partially breached.	150	..	4·36	5·14	..	..	....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
134 12	..	Breach of embankment ..	60	60	8·58	..	134 10	134 15	Line extensively breached in two places; length of breaches aggregating—	433	433	9·77	13·83	..	..	..	..	8	40	..	..	..	2	150	..	..	..	
134 15	..	The embankment at north-west wing of 3·30 feet bridge was eroded.	..	..	10·37	..	135 5	137 1¼	Almost continuous damage to the line of considerable extent; the ballast and a large portion of the bank washed away, but, as there was but little current, the rails were but slightly shifted off the central line.	3,085	..	8·28	12·8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	140 17½	..	A deep breach at back of south abutment of 30 feet bridge.	25	25	6·49	..	..	..	1	8	..	..	1	4	..	..	Floor, flank walls, apron and pitching added.	..	The water at the Paravanar rose to rail level, but the current was very slight. It is proposed to raise the girders of this bridge and the embankment across the valley 2 feet.
..	..	....	..	..	..	..	149 16	..	Four feet culvert undermined and fallen in.	..	..	4·35	..	1	4	..	..	4	30	..	..	..	..	Corayár bridge to be floored and flank walls and pitching added. To the 4·20 feet bridge apron, flank walls and pitching have been added.	..	This open top culvert has been rebuilt as an 8-feet rail girder. The damage was caused by extreme flood in the Corayár. The Corayár bridge of 5·30 feet spans at 251st mile 5th telegraph post to be enlarged by the addition of 4·30 feet spans, and the 4·20 feet bridge at 251st mile 13th telegraph post by the addition of 4·20 feet spans.
..	..	....	..	..	..	..	250 7	252 7	The embankment was breached in 22 places, aggregating—	567	567	8·51	11·83	..	..	..	..	4	20									
..	..	....	..	..	..	..	264 1	..	Line threatened by overflow of Kulliyeramputti tank; 1·12 feet bridge at 264th mile 1st telegraph post insufficient.	..	..	4·35	..	..	..	..	..	1	12	..	..	..	..	..	..	Bridge is proposed to be doubled.	
..	..	....	..	..	..	..	267 12	..	Wash over of ballast	..	..	2·25	..	..	..	..	..	1	8	1	1½	..	..	..	..	The 18-inch drain at 267th mile 12th telegraph post is insufficient; it is to be converted into an 8-feet opening.	
		ARKONAM BRANCH.																										
..	..	....	..	..	..	..	A. 44 8	44 14	A continuous wash over of the line; between 44th mile 8th and 9th telegraph posts there was a slight breach of 13 yards; between 44th mile 9th telegraph post and 44th mile 14th telegraph post there was considerable damage; there were through breaches of 80 yards.	600	93	3·37	4·66	..	..	..	..	4	25	1	6	..	..	..	..	The 1·6 feet bridge at 44th mile 12th telegraph post is to be pulled down and a 4·25 feet bridge substituted.	
..	..	....	..	..	..	..	A. 44 14½	44 15¾	Ballast washed off and embankment partially gone.	125	..	3·82	3·97	..	..	..	..	..	..	..	..	..	..	..	..	A bridge of 1·25 feet span is to be constructed to take spill of Sivaram tank.	
..	..	....	..	..	..	..	A. 45 0	45 1	Ballast washed away with small portion of embankment.	100	..	1·96	2·04	..	..	..	..	1	25	..	..	..	..	..	..	The 3 feet culvert has been pulled down and an 8-feet rail girder substituted.	
..	..	....	..	..	..	..	A. 45 2	45 3½	The same	150	..	1·84	1·96	..	..	..	..	..	..	..	..	..	..	..	..		
..	..	....	..	..	..	..	A. 45 10	45 11	There was a partial breach; the line was washed over for this length.	100	..	2·07	2·52	..	..	..	..	1	8	1	3	..	..	..	..		
..	..	....	..	..	..	..	A. 68 15	..	Portion of 3 feet covered culvert destroyed.	..	..	..	..	1	3	..	..	..	..	..	..	..	..	..	..		
		PONDICHERRY BRANCH.																										
..	..	....	..	..	..	..	P. 109 17	..	A small breach	5	5	2·28	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	P. 112 3 & 4	..	A wash over of ballast ..	100	100	0·36	0·53	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	P. 114 14½	115 4	The embankment was topped by flood in the Gingee, and from 115th mile 3rd telegraph post to west abutment of Gingee bridge the embankment was washed away.	600	50	2·36	8·08	..	..	..	..	..	..	..	..	7	150	..	..	The 1st span girders although moved out of position remained on the piers and have since been lifted up; they have received no damage; the level of rails is to be raised 7 feet.
..	..	....	..	..	..	..	P. 115 4	115 6	Girders of 2nd, 3rd, 4th, 5th, 6th and 7th spans of Gingee bridge swept off piers into river and completely wrecked. South parapets of piers also fell and flooring in 5th & 6th spans a good deal injured.	..	..	..	..	7	150	..	..	..	..	..	..	..	..	..	..		

Statement giving particulars of damage to the line caused by the floods of November and December 1884—*cont.*

Floods of November 7.							Floods of December 18 and 19.																				
			Length of breaches.							Length of breaches.				Masonry works injured or destroyed.		Masonry restored.		Masonry to be added.		Masonry abandoned.		Girders to be raised.		Protective works to be added if any.	Lowering of line.	Remarks.
From	To	Description of damage.	Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.	From	To	Description of damage.	Length of line damaged.	Length of through breaches.	Average height of bank.	Maximum height of bank.	Number of spans.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number.	Width of opening.	Number	Width of opening.			
M. T.P.	M. T.P.	....	YDS.	YDS.	FEET.	FEET.	M. T.P.	M. T.P.		YDS.	YDS.	FEET.	FEET.		FEET.		FEET.		FEET.		FEET.		FEET.			
..	..	....	..	..	..	..	P. 115 6	117 6	The line was almost continuously topped, but no great destruction of earthwork took place, the injury to line being principally damage to the top of the embankment. The worst damage was between 116th mile 15½ telegraph post and 117th mile 1½ telegraph post; the embankment was here much washed away and the east abutment of 1·12 feet bridge at 117th mile 0½ telegraph post was undermined. At 117th mile 15th telegraph post there was a through breach of 40 yards.	3,720	40	3·0	5·1	..	..	..	..	..	..	..	..	..	..	Flank walls, apron and pitching added.	..	The east abutment of the 12 feet girder bridge at 117th mile 0½ telegraph post was undermined from the rear. The north parapet of west abutment cracked, otherwise abutment uninjured. The bridge has been restored.
										..	..	..	..	1	12	1	12	..	..	..	..	..	..		..	
..	..	....	..	..	..	..	P. 118 8	..	A small breach	3	3	5·61	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	P. 118 9½	..	Do.	7	7	2·77	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	P. 118 13½	..	Do.	3	3	4·95	..	..	..	..	..	..	..	..	..	..	..	..	..	
									ERODE BRANCH.																	
..	..	....	..	..	..	..	E. 252 0	252 9	Flood rose to 18 inches over rails at the Trichinopoly Fort station and topped line as far as 252nd mile 9th telegraph post, the damage being a wash away of ballast.	792	..	7·01	8·05	..	..	..	..	..	..	..	..	..	..	..	..	..	The flooring of the Kudumuriti bridge was slightly injured. This bridge was insufficient to carry off the flood, and a new bridge of 8·40 feet span is proposed to be given where the line was breached at a point which will be opposite the proposed lowering of the Cauvery bund by the Public Works Department. Rail level will be raised 3 feet.
..	..	....	..	..	..	..	E. 253 4½	253 12	Line topped between these posts and embankment almost entirely washed away between 253rd mile 10th telegraph post and 253rd mile 12th telegraph post.	660	176	6·55	7·81	..	..	..	..	8	40	..	..	..	..	..	..	..	
									NEGAPATAM BRANCH.																	The damage here was caused by the Corayár bursting its southern bank.
..	..	....	..	..	..	..	N. 236 13	236 17	A wash away of ballast and three small breaches aggregating 30 yards.	352	30	7·51	7·97	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	....	..	..	..	..	N. 236 17	237 10	There was a total wash away of embankment for 67 yards with a scour hole 15 feet below ground level.	67	67	8·19	9·91	..	..	..	..	..	..	..	..	..	..	..	..	..	
									MAIN LINE.																	No. 2 pier has been rebuilt.
..	..	....	..	..	..	..	October 1884. 361 14	..	On the 16th October a heavy flood in the Shevaracottai destroyed the greater portion of the dry-stone flooring and undermined pier No. 2, which fell.	..	..	..	..	6	30	One pier.	..	..	..	..	..	..	..	..	New flank walls built to No. 1 abutment; curtain walls in masonry taken down to hard and floor constructed in masonry.	..	

Statement of catchment areas of the principal streams and rivers with computed discharges and existing waterways—cont.

1	2		3	4			5	6				7		8
Railway mileage.	Tanks breached.			Computed discharges.				Existing waterways.				Waterways that would be necessary to meet Dickens' formula (column 4 *b*).		
From	To	Number breached in November.	Number breached in December, including those unemployed while repaired and breached again.	Catchment area.	Discharge by (Ryves') formula. $D = 676\frac{1}{4}\sqrt[3]{M^2}$.	Discharge by (Dickens') formula. $D = 825\sqrt[4]{M^3}$.	Area of waterway required by column 4 (*b*) where V = 8.	Number.	Span.	Mean depth.	Square feet available.	Number.	Span.	Mean depth.	Square feet required.	Remarks.
M. T.P.	M. T.P.			Sq. M.	*a*	*b*			Ft.	Ft. In.			Ft.	Ft. In.		
84 15½	85 7½	..	..	..	..	..	..	1	6	5 0	30	1	6	..	..	Gingee river.
											3,712				6,937	
											165				165	
85 13	85 14½	..	..	287	28,687	57,337	7,167	11	30	11 3	3,877	21	30	11 0	7,095	
								2	15	5 6		2	15	5 6		
86 1	86 2½	..	89	..	..	..	..	..	..	..	..	..	..	..	..	
86 3½	86 4½															
86 4½	86 8½															
86 8½	86 8½															
86 8½	86 13½															
86 13½	86 14½															
86 14½	86 15½															
92 0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
92 2	92 2½	..	83	165	20,304	37,950	4,744	6	30	7 0	975	6	30	6 6	1,800	Vikravándi river.
92 4½	92 5½							1	10	8 0	70	1	10	7 0	70	
								1	25	8 0	200	5	25	8 0	1,000	
											1,245				1,920	
														16 0	4,790	
97 2	97 12¾	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
97 2	97 3															
97 4	97 5															
97 9	..															
								3	30	8 0	720	..	..	..	966	Pámbaiyár river.
								1	25	6 0	150					
								1	6	6 0	36					
								1	10	6 0	60					
											966					
												10	30	7 0	2,100	
															3,066	
251 7	251 15	..	..	210	23,847	45,500	5,687	5	30	7 0	1,050	20	30	7 0	4,200	
								4	20	8 0	640	9	20	8 0	1,440	
											1,690				5,640	
								7	30	16 0	3,360	7	30	16 0	3,360	Koryar river.
												15	40	13 0	7,800	
E. 253 0½	,,	..	..	512	43,200	88,794	11,099								11,160	

Note by the Consulting Engineer for Railways, dated Madras, 5th December 1885.

The papers now submitted to Government have reference to the damage sustained by the South Indian Railway owing to floods that occurred in November and December 1884, when the large rivers Pálár, Gingee, Ponniár, Gadilam, Paravanar and Korayar burst their banks and overspread the valleys where crossed by the railway.

2. The worst of the damage occurred between the 33rd and the 137th miles. The girders of the eleven 40-feet spans in the Karunguli valley, (50th mile) were submerged and swept away. Three out of five spans of the Vikravandi bridge (93rd mile) were destroyed. Six out of seven of the 150-feet spans of the Gingee bridge, on Pondicherry branch, were swept away and entirely wrecked. About 5 miles of railway embankment between the 64th and 137th miles with seven minor masonry works were destroyed.

In the neighbourhood of Trichinopoly the Korayar river severely damaged the line, the breaches aggregating 1,700 feet, and being of great depth.

3. Full details of the damage to the line and of the remedial measures proposed will be found in the annexed statement A.

Statement B shows the rainfall registered at the several gauge stations situated in the catchment basins of the large rivers which cross the South Indian Railway within the limits of the floods.

Statement C shows the catchment areas of the principal streams and rivers with their computed discharges and the waterways hitherto provided on the South Indian Railway for each of them. It further shows what additional waterway would be necessary to provide for a discharge computed by Dickens' formula.

4. The report by Mr. Spalding, the Acting Chief Engineer, dated 20th March 1885, enters very fully into the details of damage done to the line, and describes the measures he would propose to prevent a recurrence of such disaster.

The "Note" by Mr. Logan, the Acting Agent, on the remedial and defensive measures proposed in the report above mentioned, gives that officer's views at some length.

The views of the Railway Company's Consulting Engineers on Mr. Spalding's proposals will be found embodied mainly in the two letters dated, respectively, 17th February 1885 and the 23rd October 1885, submitted herewith.

With Mr. Spalding's report will be found an interesting and useful statement of damages sustained through floods by the South Indian Railway from 1876 to 1884.

5. Before proceeding to review the proposals *seriatim*, it will be well to state the general principles upon which it has been arranged to base them.

6. As is well known, the portion of line lately damaged crosses the main drainages where they have assumed a deltaic character, where the deep beds of the rivers are at a higher level than portions of the valleys to which their wanderings are restricted by nature, and where, therefore, unregulated by embankments, the flood waters, escaping from the river courses, find their way to the sea along the low country on either side. To estimate the flood discharge which may so escape is impossible; to provide waterway even for floods already experienced, is equally so from a financial point of view. It has therefore been decided in such cases to follow the plan already adopted as an experiment in the vicinity of the Ponniár river, where the formation level of the line was kept as low as the necessity for draining the ballast would permit, and laterite rubble was substituted for ordinary ballast, the embankment, everywhere low, being pitched with similar material. Floods have passed over the line thus treated without disturbing the permanent-way, and it is proposed to deal in a similar manner with the rest of the line, where subject to flood waters the volume of which cannot be estimated. The girders of the large bridges over the main river courses will be raised beyond the reach of the highest possible flood, and they will be approached on either side with the ruling gradient of the line, such approaches being strongly pitched with stone.

7. In the smaller valleys where the floods have arisen through the breaching of tanks, it has been decided that adequate waterway for the recent floods should be provided in those cases where the discharge could be gauged, and where life and property were clearly endangered by the railway embankments themselves.

8. In the case of all bridges and culverts, large or small, so situated as to be liable to a considerable "head" upon them owing to breached tanks or river floods, it has been decided to add stone pitching and aprons to enable them to discharge with a considerable head upon them, in order that, if the embankments fail, the masonry works at least may remain. That this is practicable was shown recently in the 98th mile, where a number of masonry works discharged with a head of 8 feet for some hours and all stood well.

9. As regards the larger streams it must, of course, be acknowledged that, besides the admitted imperfections of formulæ like those known as "Ryves'" and "Dickens'," we have in the present instance to deal with breached tanks which render all comparisons of rainfall with flood discharge inapplicable; but, the recent floods having led to a review of the waterways provided in the line, it seems desirable that, at least where the conditions appear approximately the same, the waterways in future should bear some fixed relation to their respective catchment areas, and it is with this view that statement C has been prepared. In this statement it has been assumed that the flood-level in future will be 3 feet below girder bed level, and that the works will be strengthened, by aprons and protective works if necessary, to discharge on rare occasions with safety under a "head" not exceeding one foot, giving, with the velocity of approach, a mean velocity assumed at 8 feet per second. Dickens' formula has been adopted.

10. It may, of course, be reasonably questioned whether Dickens' formula does not provide for a discharge which will probably occur so seldom that the insurance against risk is unduly excessive. Ryves' formula gives lower results, which therefore may be looked for more frequently than those provided for by Dickens, while, with the varying conditions met with on the South Indian Railway, either may in places be the more suitable. It is, as in all cases of insurance, difficult to decide what sum of money to be paid for protection is warranted by the risk.

11. An opinion has been expressed that it is undesirable, if not impossible, to protect the line against breaching tanks. It appears to me, however, as reasonable in the case of the South Indian Railway to accept the conditions under which the line has to be made and maintained in respect of tanks breaching, and to insure, when financially advisable, against it, as it is to insure against accidents by heavy outlay on the "absolute block" system, or against fire by an insurance fund.

The loss through breaks in the line is enormous, estimated in this instance at—

	Rs.
Restoration of banks	90,000
Do. of bridges	1,68,000
Loss of traffic	1,50,000
Total ...	4,08,000

Risk to life and property is also involved; while, on the other hand, the floods of last year have shown that, under circumstances unexampled in the memory of man, complete protection is often possible, though the point at which protection becomes financially expedient is one on which opinions will differ.

Statement B accompanying these papers shows the extent of the rainfall which led to such unparalleled disasters; it does not appear to have been such as to render improbable a repetition of the adverse conditions with which the South Indian Railway has to cope.

12. In my opinion, looking to the facts that as traffic increases and land becomes more valuable the loss to the Company due to breaks in the line will also increase and claims to compensation for injured property become more frequent, the results, as worked out by Dickens' formula, would not lead to an expenditure on waterways disproportionate to the risk. It can, moreover, scarcely be doubted that whatever course the Railway Company may adopt now, the day is not far distant when public opinion will compel the proprietors of the line to provide completely for the highest flood known.

13. The following remarks are offered on the Acting Chief Engineer's proposals:—

In the 34th mile, the protection proposed by the Acting Chief Engineer for the line where it occupies the bund of the Chingleput tank will probably suffice, except in the event of a cyclonic storm, when a breach near the east end of the tank bund would probably be inevitable. It would, however, be well to invite the attention of the Chief Engineer for Irrigation to the suggestion of the Company's officers.

14. In the 43rd mile, the proposal of Mr. Logan to raise the girders of the Pálár bridge 5 feet, instead of 3 as suggested by Mr. Spalding, is approved; the cost of the additional raising will be insignificant as compared with the risk avoided. The proposal to lower the line in the valley of this river to ground level is, in my opinion, sound in principle; as it cannot be carried out this year, it is proposed to leave the exact level to which the line may be safely lowered, having regard to local drainage, to be settled hereafter. The Consulting Engineers to the Company approve of Mr. Logan's proposals.

15. In the 50th mile, it has been found difficult to arrive at the maximum "head" attained on the Karunguli bridge during the recent floods. On the assumption that the "head" on the bridge was at least equal to the margin of safety considered necessary in future, Mr. Spalding proposed to retain rail-level on the bridge, the same as before, viz., at recent flood level, obtaining additional headway beneath his main girders by carrying the cross girders on the lower instead of the upper flanges and increasing the waterway of the bridge.

In the absence of really reliable information as to the "head" attained by the flood, and looking to the extreme risk of a breach in a tank where the water rose, and can rise in future, almost to the level of the top of the bund, the additional raising proposed by Mr. Logan seems justifiable; its cost will be small, as a diversion must again be made next year to permit of the construction of the additional openings. The new piers will all be founded on rock and be of inconsiderable height. The Consulting Engineers to the Company approve of Mr. Logan's proposal to raise the girders 4 feet instead of 2′ 3″ but demur to the additional waterway. (*Since withdrawn, see Board's letter, dated 13th November* 1885). In my opinion the expenditure proposed by Mr. Logan is justified by the risk.

Liberal waterway here is all the more essential to save in future the pier that fell recently (the highest in the bridge) from the impact on its side of river spill water, accumulated on the embankment south of the bridge, and escaping thence into the river course with high velocity and transversely to the main current. Any such action with the revised design will, in future, fall upon piers of less height with smaller surface exposed to it, the depth of water that can be thus accumulated also being much less.

16. For the 64th mile Mr. Spalding's proposal to at least double the number of spans at 63-17 is reasonable, but for the 65th mile it seems difficult to justify the provision of a larger waterway for a catchment basin of 23 square miles than for one of 33 square miles, there being nothing either in character or form of the basin, or information recorded regarding tanks to suggest different treatment.

The computed discharge in the statement herewith submitted suggests the additions of five spans of 20 feet at 63-17 and of 3 spans of 25 feet at 64-11¼, and this I would recommend.

17. In the 67th mile, the statement suggests more liberal waterway; an addition of four spans of 15 feet would seem appropriate.

18. In the 70th mile, the Acting Chief Engineer's proposal to increase the waterway from three to five 25-feet spans is approved.

19. In the 77th and 78th miles, the present waterway would seem sufficient in ordinary seasons.

20. In the 78th and 79th miles, the present waterway is clearly insufficient. The catchment area being 11 square miles, six spans of 20 feet instead of one would seem advisable. The remarks by the Consulting Engineers to the Company appear to endorse this view.

21. In considering what waterway it will be advisable to provide in future for the main line between the 84th and 99th miles, wherein are situated the four considerable streams known as the Tondayár, Gingee, Vikravándi and Pombay rivers, it is natural to note the extent of the flood at the Gingee bridge on the Pondicherry branch, which has to pass the united discharge of these four rivers, and, in addition, the off-flow from a catchment basin estimated at 160 square miles lying to the east of the main line. From the statement it appears that, for the four rivers combined, an aggregate waterway of 18,300 square feet would meet the requirements arrived at by Dickens' formula and that it should be approximately thus distributed :—

	SQ. FEET.
Tondayár	3,500
Gingee	7,200
Vikaravándi	4,600
Pombay, &c. (98th mile)	3,000
Total ...	18,300

Unfortunately the flood in the Gingee river (where it crosses the Pondicherry branch), of which those four rivers are affluents, affords no trustworthy figures by which to check these proposed waterways. It has been suggested that the height to which the flood rose at this bridge was due to the obstruction offered by casuarina plantations to a more rapid escape of the flood-waters into the sea; if this be true, the maximum discharge through the bridge may have been reached long before the flood attained its full height there, the "head" on, and velocity through the bridge decreasing in proportion to the rise of the flood below it.

22. It appears from the maps and from inquiry that the rainfall from some part of the Gingee catchment basin (estimated at 287 square miles) finds its way into the Tondayár drainage, and during the recent floods, owing to the inadequacy of the waterway at the latter, the flood waters held up by the railway embankments flowed back into the Gingee drainage parallel to and near the line. To prevent this in future, it is proposed to give the Tondayár two additional spans of 100 feet, considerably in excess of the waterway proportional to its catchment basin proper. If this be done an addition of ten spans of 30 feet to the existing Gingee bridge (eleven 30-feet) would afford the waterway proportioned to the results of the formula.

23. Mr. Spalding proposes a further addition of ten spans of 30 feet between the Tondayár and Gingee bridges; this proposal is approved by Mr. Logan and by the Consulting Engineers to the Company who further recommend the raising of the girders of the Tondayár bridge. Having in view the low banks of the Gingee river and the rock obstruction in its bed, I am not inclined to object to the proposal if on further consideration the Company's officers press for the additional waterway.

24. In the Vikravándi bridge, looking to the increased waterway afforded by the centre span, where the rocky bed is over 20 feet below girder bed-level, the proposal of one central span of 120 feet flanked on either side by three 30-feet spans, may be accepted, but it would seem advisable to add three 25-feet spans at 92-4.

25. In the 98th mile (the Pombay river) the proposed waterway was based on observation at the time of the floods and is calculated as sufficient to pass the flood of last year with the assumed velocity.

26. In the Gingee bridge, Pondicherry branch, it is proposed to raise the girders clear of the floods of last year, with a good margin, and to force the flood in future, as recently, through the bridge as it stands.

These two latter proposals meet with the approval of both Mr. Logan and the Consulting Engineers to the Company.

27. In the valley through which run the Ponniár and Gadilam, it is absolutely impossible to find data on which to estimate the required waterway at any given point, and the provision on the railway must follow the regulation of the rivers by the Irrigation Department. The existing bridges were designed to meet a discharge

based on that of the rivers where they leave their respective catchment basins and assume a deltaic character.

28. The results of the recent floods point to the inadequacy, under present conditions, of the existing bridge where it spans the Gadilam, and, looking to the extreme improbability of the Government being in a position, for many years to come, to materially alter these conditions, it seems incumbent on the Railway Company, in the interests of life and property, to enlarge their Gadilam bridge, and, having done so, to trust to the lowering of their line throughout the valley to meet such floods as those of last year.

29. The Consulting Engineers to the Company do not approve of Mr. Logan's proposal to double or even to increase the waterway of the Gadilam. They were not, however, aware probably of the fact that in the November floods the spill from the Ponniár into the Gadilam was inconsiderable and that the Government, in the Public Works Department, have already constructed an embankment with a view to force the flood water that escaped over the right bank of the Gadilam above the railway bridge through the latter. The line on either side of the railway bridge has, it is true, been lowered, but looking to the dangerous proximity of the river to the line, north of the bridge, no encouragement should be offered to the floods to top the line at this point. In extraordinary floods, with the rivers unregulated, this may be inevitable and the line has been lowered to lessen the evil results of such an occurrence, but the bridge should be so designed as to offer no obstruction whatever to the floods from its own catchment basin. In my opinion the waterway at present given is not sufficient for this purpose, and I should prefer additional waterway as proposed by Mr. Logan to the raising of the girders suggested by the Consulting Engineers to the Company.

30. It is proposed to substitute, for the present 70-feet span close to the Cuddalore Old Town station in the 128th mile, one of 150 feet; here, again, no figures can be adduced in support. Should the Ponniár river, as is possible, pour an increased proportion of its flood into the Gadilam, this river will breach its banks and the outlet across the line must be at the site of the proposed 150-feet span. If the enlargement of the Gadilam bridge and of this waterway succeed in reducing the "head" on the lowered portion of the line between them, by rapidly filling the lower reaches of the river, they will have attained their object and will have minimised the cost to the Company and the loss to the villagers in a flood like that of 1884.

31. In the Paravanar valley, it is extremely difficult to arrive at data on which to calculate the requirements of the railway; the catchment basin has been connected with those of the Vellaur and of the Coleroon rivers, and, were this artificial system safe from breaches, it might be possible to approximate to the waterway needed. As it is, taking as a guide the floods of 1884, it has been established that the Paravanar bridge and its approaches must be raised to be safe in such a flood, and that the insufficiency of the existing waterway elsewhere in this valley, under these same conditions, can be rectified at no very considerable cost. It is proposed, therefore, to raise the girders and approaches of the Paravanar bridge (two spans of 150 feet) and to add waterway in the 135th mile, but to what extent has not yet been decided. eight spans of 40 feet have been proposed.

32. The only other part of the main line that was seriously damaged in these floods was in the neighbourhood of Trichinopoly in the 251st, the 252nd, and the 253rd miles. Here the Acting Chief Engineer proposes to add 3 spans of 30 feet to the Korayar bridge and 4 spans of 20 feet to the four 20-feet bridge close by, giving 2,960 square feet in all. Dickens' formula would require nearly double this waterway. The same river crosses the Erode branch west of Trichinopoly, its discharge being in the meanwhile largely augmented. The Acting Chief Engineer proposes to give additional waterway here to the extent of 300 lineal feet. In this case also Dickens' formula would require nearly double the amount. Mr. Logan should, I think, be invited to reconsider the proposals already made.

33. I concur with Mr. Logan in his proposals to raise the girder seats of the single 30-feet span at 140·79 and of the four 50-feet spans in the 432nd mile.

34. I take this opportunity of urging very strongly the provision of good legible gauges on the upper and lower side of every large bridge. During the floods the staff can hardly be expected to spend time needed elsewhere, for protecting the line, in procuring the requisites for accurately measuring the "head" of water on a bridge; and, as a fact, recent investigations have been seriously hampered by the absence of any such record. The documents now submitted show conclusively the tentative character of the line in respect of its waterways, and if it is ever to be otherwise, the behaviour of the bridges under floods must be accurately recorded.

35. The submission of these papers for the consideration of Government offers me the first available opportunity of bringing specially to their notice the meritorious services rendered by the Railway staff in all departments on the occasion of these floods. In my Administration Report for the year I wrote as follows:—

"Having, as briefly as possible, recounted the results of a series of floods among the most disastrous on record, it is with no small satisfaction that it can be added, that at such a season of the year, in spite of frequent rain and slowly abating flood waters, the line was reopened for traffic, by a staff barely sufficient for the upkeep of the open line and already suffering from the trying exposure entailed by the earlier floods, on the 2nd February, that is, within six weeks from the date of the disaster.

"The result attained was far beyond the anticipation of those most competent to judge. With the Kumbakónam festival (once in twelve years) almost due, and the certain prospect of increased traffic in ground-nuts and other products, owing to the complete destruction of roads and bridges in the neighbourhood, every day was of consequence, and the financial gain to the Company resulting from the wisely-directed energy of the staff in all departments was considerable."

To this I would only add an expression of my hope that the Government will see fit to record their appreciation of such successful exertions in their behalf.

(Signed) C. J. SMITH, Colonel, R.E.,
Consulting Engineer for Railways.

Submitted for the consideration of Government.

Order—dated 14th December 1885, No. 1189 R., Public Works.

The papers embodied in these proceedings cannot fail to prove an interesting contribution to the history, and a valuable guide to the future treatment of the South Indian Railway.

2. The attention of the Agent will be specially drawn to paragraphs 16, 20, 22, 23, 24, 28, 29, 32, 34 of the Consulting Engineer's note and to the views of that officer as expressed in paragraph 11, in which the Government concur.

3. Paragraph 13 will be referred, for consideration and disposal, to the Chief Engineer for Irrigation.

4. His Excellency the Governor in Council is glad of the opportunity afforded by these proceedings to place on record his high appreciation of the excellent services rendered by the staff of the South Indian Railway on the occasion of the floods in November and December 1884.

5. He has no doubt that but for the commendable energy displayed by, and complete co-operation secured between, the several departments, the inconvenience both to trade and the travelling public as well as the financial loss to the Company would have been much greater than they were.

6. His Excellency desires that the Agent will convey to Mr. Logan and individually to all members of the staff concerned his hearty approbation of the energy which characterised the restoration of the line.

7. A copy of these proceedings will be forwarded for the information of the Government of India.

(Here enter No. 1190 R., dated 14th December 1885.)

(True Extract.)

(Signed) C. J. SMITH, Colonel, R.E.,
Joint Secy. to Govt., P.W.D.,
Railway Branch.

To the Consulting Engineer for Railways.
" Examiner, Guaranteed Railway Accounts.
" Chief Engineer for Irrigation.
" Public Department.
" Revenue "

Endorsement—dated 14th December 1885, No. 1190 R., Public Works.

Forwarded accordingly.

Colonel, R.E.,
Joint Secy. to Govt., P.W.D.,
Railway Branch.

Exd. E. Fernandez.
Spare Copies

RAILWAY.

Govt. of {1885} Madras.

PUBLIC WORKS.

Dated December, 14th.

Read. *Encl.*

G.O., 14th Dec. 1885, No. 1190 R.

DECEMBER.

South Indian Railway

Forwarding copy of proceedings on reports and correspondence relating to the damages sustained by the — owing to floods of November and December 1884.

E. I. Form No. 22.

PUBLIC WORKS DEPARTMENT.

~~PROCEEDINGS OF THE MADRAS GOVERNMENT.~~

~~Under date the~~

READ the following :—

X Note by the Offg Chief Engineer for Irrigation } (HE No 138. I dated 5 October 1886

Transferred to the Financial Department with reference to endorsement in that department No 521 of the 23 August last.

Returned

X C. No 7835 - stating that 1/5 the cost of keeping Buckle's Channel in order should be met by the District Board and the remainder in equal proportion by the South Indian Ry. and the Tuticorin Municipality with whom the chief concern rests -

To The Fin. Dept. with papers in orig. 11/10/86

28TH OCTOBER 1886, No. 1417 L.F., FINANCIAL.

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following papers :—

From S. H. WYNNE, Esq., President, District Board, Tinnevelly, to the Chief Secretary to Government, dated Tinnevelly, 4th August 1886, No. 48.

I have the honor to submit the following subject for the orders of Government.

To the north of road No. III, Palamcottah to Tuticorin, there is a drainage channel known as the Puckle's channel. It runs parallel to the road and the Tuticorin fresh-water channel from the third milestone from Tuticorin eastwards. The work was originally constructed in connection with the Srívaikuntham anicut project—*vide* paragraphs 31 and 50 of Mr. Rundall's report, embodied in G.O., No. 1498, dated 8th June 1874. At present, however, the channel does not appear to be of any material use to that system. It is practically a protective work to keep out the storm water from inundating the town of Tuticorin in general, the railway station there, the above said road of the Local Fund department, the fresh-water canal supplying the town of Tuticorin, and the wet lands of Korampallam tank, as well as the salt pans of Levingepuram.

2. In November 1884, breaches occurred in Puckle's channel, for the closing of which and for strengthening its right bank, the Imperial Public Works Department framed an estimate for Rs. 370. These repairs were considered necessary for the safety of the fresh-water channel. The Superintending Engineer differed from this opinion, and expressed that the South Indian Railway Company may fairly be called upon to repair and keep the banks in order, probably on the understanding that the natural drain was interfered with by the railway compound.

3. The work was not undertaken by any department until October 1885, when, on the recommendation of the Sub-Collector, the district board undertook the work on the consideration that the several agencies referred to in paragraph 2 *supra* should contribute their share towards the cost, and set the work on foot according to the estimate prepared by the Public Works Department. It was found that the estimate was insufficient, and a revised estimate for Rs. 1,060 was sanctioned by the board, and fund allotted. The work is now almost completed.

4. The different departments concerned were requested to contribute their quota, and their replies, disowning any interest in the work, are herewith submitted for the perusal of Government.

5. The damage that may at any time be caused by floods to the Local Fund road must be trifling, whereas the damage to other interest, and specially to the wet lands under Korampallam tank, would be very heavy. Under no circumstances therefore will the board undertake any further repair unless the cost is chiefly borne by the other agencies, and they would not have undertaken the work now done, had they supposed there would have been any attempt on the part of others to deny their obvious liability.

6. The board therefore request that Government will be pleased to issue orders for a fair contribution from those concerned.

7. A plan of the locality, with the Local Fund Engineer's letter explaining it, and other papers are herewith forwarded. A list is enclosed.

No. 2952 dated 10th Oct 1886

Communicated to the Chief Engineer for Irrigation & the Consg. Engr for Railways.

(Sd) J. O. H.

Govt. of {1886} Madras.

FINANCIAL.

Issued

Encl.

Read.

G.O., 28th Oct. 1886, No. 1417 L.F.

No. 2952 dated 10th Oct 1886

OCTOBER.

Puckle's Channel.

Directing that the cost of maintaining — in Tinnevelly be distributed among the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works in the proportion pointed out.

Ch. Engr for Irrign
Consg. Engr for Rys
Exr. P. W. Accts.

With order

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following papers :—

From S. H. WYNNE, Esq., President, District Board, Tinnevelly, to the Chief Secretary to Government, dated Tinnevelly, 4th August 1886, No. 48.

I have the honor to submit the following subject for the orders of Government.

To the north of road No. III, Palamcottah to Tuticorin, there is a drainage channel known as the Puckle's channel. It runs parallel to the road and the Tuticorin fresh-water channel from the third milestone from Tuticorin eastwards. The work was originally constructed in connection with the Srívaikuntham anicut project—*vide* paragraphs 31 and 50 of Mr. Rundall's report, embodied in G.O., No. 1498, dated 8th June 1874. At present, however, the channel does not appear to be of any material use to that system. It is practically a protective work to keep out the storm water from inundating the town of Tuticorin in general, the railway station there, the above said road of the Local Fund department, the fresh-water canal supplying the town of Tuticorin, and the wet lands of Korampallam tank, as well as the salt pans of Levingepuram.

2. In November 1884, breaches occurred in Puckle's channel, for the closing of which and for strengthening its right bank, the Imperial Public Works Department framed an estimate for Rs. 370. These repairs were considered necessary for the safety of the fresh-water channel. The Superintending Engineer differed from this opinion, and expressed that the South Indian Railway Company may fairly be called upon to repair and keep the banks in order, probably on the understanding that the natural drain was interfered with by the railway compound.

3. The work was not undertaken by any department until October 1885, when, on the recommendation of the Sub-Collector, the district board undertook the work on the consideration that the several agencies referred to in paragraph 2 *supra* should contribute their share towards the cost, and set the work on foot according to the estimate prepared by the Public Works Department. It was found that the estimate was insufficient, and a revised estimate for Rs. 1,060 was sanctioned by the board, and fund allotted. The work is now almost completed.

4. The different departments concerned were requested to contribute their quota, and their replies, disowning any interest in the work, are herewith submitted for the perusal of Government.

5. The damage that may at any time be caused by floods to the Local Fund road must be trifling, whereas the damage to other interest, and specially to the wet lands under Korampallam tank, would be very heavy. Under no circumstances therefore will the board undertake any further repair unless the cost is chiefly borne by the other agencies, and they would not have undertaken the work now done, had they supposed there would have been any attempt on the part of others to deny their obvious liability.

6. The board therefore request that Government will be pleased to issue orders for a fair contribution from those concerned.

7. A plan of the locality, with the Local Fund Engineer's letter explaining it, and other papers are herewith forwarded. A list is enclosed.

No. 521.

Referred to the Public Works Department for remarks.

(By Order.)

(Signed) E. S. LAFFAN,
Under Secy. to Govt.

MADRAS,
23*rd August* 1886.

No. 138-I.

Note by the Officiating Chief Engineer for Irrigation.

It is considered that this department has no interest in the maintenance of the Puckle's channel, and that there is no reason why any portion of the cost of keeping it in order should be met from Public Works funds.

2. It is also considered that the interest of the Local Fund Board in the matter is but slight, and that the chief concern rests with the Tuticorin Municipality and the South Indian Railway.

3. A reasonable distribution of the cost of maintenance would appear to be that the district board should bear one-fifth, the remainder being divided equally between the railway and the municipality.

CHEPÂK,
5*th October* 1886. (Signed) J. PENNYCUICK, Lt.-Col., R.E.,
Offg. Chief Engineer for Irrigation.

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

No. 3509-C.

Transferred to the Financial Department, with reference to endorsement (returned) in that department, No. 521, of the 23rd August last.

(By Order.)

CHEPÂK,
11*th October* 1886. (Signed) R. DAVIDSON,
Under Secy. to Govt., P.W.D.,
Irrigation Branch.

To the Financial Department, with papers in original.

ORDER—dated 28th October 1886, No. 1417 L.F., Financial.

The Government observe that the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works are all interested in a greater or less degree in the maintenance of the channel, and consider that the cost should be distributed as follows:—

Tuticorin Municipality	$\frac{1}{5}$
South Indian Railway Company	$\frac{1}{5}$
District Board	$\frac{1}{5}$
Department of Public Works	$\frac{1}{5}$

(True Extract.)

H. E. STOKES,
Ag. Chief Secretary,

To the President, District Board, Tinnevelly, with enclosures.
„ Chairman, Municipal Council, Tuticorin,
through the Collector.
„ Public Works Department.
„ Joint Secretary to Government, Public Works Department,
Railway Branch.
„ „ „ to Government, Public Works Department,
Irrigation Branch.

Exd. T. O'Connor.

Govt. of {1886} Madras.

FINANCIAL.

Issued

Recd. *Encl.*

G.O., 28th Oct. 1886, No. 1417 L.F.

OCTOBER.

Puckle's Channel.

Directing that the cost of maintaining — in Tinnevelly be distributed among the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works in the proportion pointed out.

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following papers :—

From S. H. WYNNE, Esq., President, District Board, Tinnevelly, to the Chief Secretary to Government, dated Tinnevelly, 4th August 1886, No. 48.

I have the honor to submit the following subject for the orders of Government.

To the north of road No. III, Palamcottah to Tuticorin, there is a drainage channel known as the Puckle's channel. It runs parallel to the road and the Tuticorin fresh-water channel from the third milestone from Tuticorin eastwards. The work was originally constructed in connection with the Srívaikuntham anicut project—*vide* paragraphs 31 and 50 of Mr. Rundall's report, embodied in G.O., No. 1498, dated 8th June 1874. At present, however, the channel does not appear to be of any material use to that system. It is practically a protective work to keep out the storm water from inundating the town of Tuticorin in general, the railway station there, the above said road of the Local Fund department, the fresh-water canal supplying the town of Tuticorin, and the wet lands of Korampallam tank, as well as the salt pans of Levingepuram.

2. In November 1884, breaches occurred in Puckle's channel, for the closing of which and for strengthening its right bank, the Imperial Public Works Department framed an estimate for Rs. 370. These repairs were considered necessary for the safety of the fresh-water channel. The Superintending Engineer differed from this opinion, and expressed that the South Indian Railway Company may fairly be called upon to repair and keep the banks in order, probably on the understanding that the natural drain was interfered with by the railway compound.

3. The work was not undertaken by any department until October 1885, when, on the recommendation of the Sub-Collector, the district board undertook the work on the consideration that the several agencies referred to in paragraph 2 *supra* should contribute their share towards the cost, and set the work on foot according to the estimate prepared by the Public Works Department. It was found that the estimate was insufficient, and a revised estimate for Rs. 1,060 was sanctioned by the board, and fund allotted. The work is now almost completed.

4. The different departments concerned were requested to contribute their quota, and their replies, disowning any interest in the work, are herewith submitted for the perusal of Government.

5. The damage that may at any time be caused by floods to the Local Fund road must be trifling, whereas the damage to other interest, and specially to the wet lands under Korampallam tank, would be very heavy. Under no circumstances therefore will the board undertake any further repair unless the cost is chiefly borne by the other agencies, and they would not have undertaken the work now done, had they supposed there would have been any attempt on the part of others to deny their obvious liability.

6. The board therefore request that Government will be pleased to issue orders for a fair contribution from those concerned.

7. A plan of the locality, with the Local Fund Engineer's letter explaining it, and other papers are herewith forwarded. A list is enclosed.

No. 521.

Referred to the Public Works Department for remarks.

(By Order.)

MADRAS,
23*rd August* 1886.

(Signed) E. S. LAFFAN,
Under Secy. to Govt.

No. 138-I.

Note by the Officiating Chief Engineer for Irrigation.

It is considered that this department has no interest in the maintenance of the Puckle's channel, and that there is no reason why any portion of the cost of keeping it in order should be met from Public Works funds.

2. It is also considered that the interest of the Local Fund Board in the matter is but slight, and that the chief concern rests with the Tuticorin Municipality and the South Indian Railway.

3. A reasonable distribution of the cost of maintenance would appear to be that the district board should bear one-fifth, the remainder being divided equally between the railway and the municipality.

CHEPÂK,
5*th October* 1886.

(Signed) J. PENNYCUICK, Lt.-Col., R.E.,
Offg. Chief Engineer for Irrigation.

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

No. 3509-C.

Transferred to the Financial Department, with reference to endorsement (returned) in that department, No. 521, of the 23rd August last.

(By Order.)

CHEPÂK,
11*th October* 1886.

(Signed) R. DAVIDSON,
Under Secy. to Govt., P.W.D., Irrigation Branch.

To the Financial Department, with papers in original.

ORDER—dated 28th October 1886, No. 1417 L.F., Financial.

The Government observe that the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works are all interested in a greater or less degree in the maintenance of the channel, and consider that the cost should be distributed as follows:—

Tuticorin Municipality	$\frac{1}{3}$
South Indian Railway Company	$\frac{1}{3}$
District Board	$\frac{1}{5}$
Department of Public Works	$\frac{1}{15}$

(True Extract.)

for Ag. Chief Secretary,

To the President, District Board, Tinnevelly, with enclosures.
„ Chairman, Municipal Council, Tuticorin, through the Collector.
„ Public Works Department.
„ Joint Secretary to Government, Public Works Department, Railway Branch.
„ „ „ to Government, Public Works Department, Irrigation Branch.

Exd. T. O'Connor.

Order ck. R 6th Nov/86.

Communicated to the Consulting Engineer for Railways for information.

Railways

D/R R

Govt. of {1886} Madras.

FINANCIAL.

Issued

Recd. Encl.

G.O., 28th Oct. 1886, No. 1417 L.F.

Comment S.E.R.

OCTOBER.

To
The Consulting Engr for Rys.
" Chief Engr S.I. Ry. Co.
" Secy Local Fund Audit Dept.

Puckle's Channel.

Directing that the cost of maintaining — in Tinnevelly be distributed among the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works in the proportion pointed out.

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following papers :—

From S. H. WYNNE, Esq., President, District Board, Tinnevelly, to the Chief Secretary to Government, dated Tinnevelly, 4th August 1886, No. 48.

I have the honor to submit the following subject for the orders of Government.

To the north of road No. III, Palamcottah to Tuticorin, there is a drainage channel known as the Puckle's channel. It runs parallel to the road and the Tuticorin fresh-water channel from the third milestone from Tuticorin eastwards. The work was originally constructed in connection with the Srívaikuntham anicut project—*vide* paragraphs 31 and 50 of Mr. Rundall's report, embodied in G.O., No. 1498, dated 8th June 1874. At present, however, the channel does not appear to be of any material use to that system. It is practically a protective work to keep out the storm water from inundating the town of Tuticorin in general, the railway station there, the above said road of the Local Fund department, the fresh-water canal supplying the town of Tuticorin, and the wet lands of Korampallam tank, as well as the salt pans of Levingepuram.

2. In November 1884, breaches occurred in Puckle's channel, for the closing of which and for strengthening its right bank, the Imperial Public Works Department framed an estimate for Rs. 370. These repairs were considered necessary for the safety of the fresh-water channel. The Superintending Engineer differed from this opinion, and expressed that the South Indian Railway Company may fairly be called upon to repair and keep the banks in order, probably on the understanding that the natural drain was interfered with by the railway compound.

3. The work was not undertaken by any department until October 1885, when, on the recommendation of the Sub-Collector, the district board undertook the work on the consideration that the several agencies referred to in paragraph 2 *supra* should contribute their share towards the cost, and set the work on foot according to the estimate prepared by the Public Works Department. It was found that the estimate was insufficient, and a revised estimate for Rs. 1,060 was sanctioned by the board, and fund allotted. The work is now almost completed.

4. The different departments concerned were requested to contribute their quota, and their replies, disowning any interest in the work, are herewith submitted for the perusal of Government.

5. The damage that may at any time be caused by floods to the Local Fund road must be trifling, whereas the damage to other interest, and specially to the wet lands under Korampallam tank, would be very heavy. Under no circumstances therefore will the board undertake any further repair unless the cost is chiefly borne by the other agencies, and they would not have undertaken the work now done, had they supposed there would have been any attempt on the part of others to deny their obvious liability.

6. The board therefore request that Government will be pleased to issue orders for a fair contribution from those concerned.

7. A plan of the locality, with the Local Fund Engineer's letter explaining it, and other papers are herewith forwarded. A list is enclosed.

No. 521.

Referred to the Public Works Department for remarks.

(By Order.)

(Signed) E. S. LAFFAN,
Under Secy. to Govt.

MADRAS,
23*rd August* 1886.

No. 138-I.

Note by the Officiating Chief Engineer for Irrigation.

It is considered that this department has no interest in the maintenance of the Puckle's channel, and that there is no reason why any portion of the cost of keeping it in order should be met from Public Works funds.

2. It is also considered that the interest of the Local Fund Board in the matter is but slight, and that the chief concern rests with the Tuticorin Municipality and the South Indian Railway.

3. A reasonable distribution of the cost of maintenance would appear to be that the district board should bear one-fifth, the remainder being divided equally between the railway and the municipality.

(Signed) J. PENNYCUICK, Lt.-Col., R.E.,
Offg. Chief Engineer for Irrigation.

CHEPÂK,
5*th October* 1886.

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

No. 3509-C.

Transferred to the Financial Department, with reference to endorsement (returned) in that department, No. 521, of the 23rd August last.

(By Order.)

(Signed) R. DAVIDSON,
Under Secy. to Govt., P.W.D., Irrigation Branch.

CHEPÂK,
11*th October* 1886.

To the Financial Department, with papers in original.

ORDER—dated 28th October 1886, No. 1417 L.F., Financial.

The Government observe that the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works are all interested in a greater or less degree in the maintenance of the channel, and consider that the cost should be distributed as follows:—

Tuticorin Municipality	$\frac{1}{3}$
South Indian Railway Company	$\frac{1}{3}$
District Board	$\frac{1}{6}$
Department of Public Works	$\frac{1}{6}$

(True Extract.)

for Ag. Chief Secretary,

To the President, District Board, Tinnevelly, with enclosures.
" Chairman, Municipal Council, Tuticorin,
through the Collector.
" Public Works Department.
" Joint Secretary to Government, Public Works Department,
Railway Branch.
" " " to Government, Public Works Department,
Irrigation Branch.

Exd. T. O'Connor.

Govt. of {1886} Madras.

FINANCIAL.

Issued

Recd. *Encl.*

G.O., 28th Oct. 1886, No. 1417 L.F.

OCTOBER.

Puckle's Channel.

Directing that the cost of maintaining — in Tinnevelly be distributed among the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works in the proportion pointed out.

GOVERNMENT OF MADRAS.

FINANCIAL DEPARTMENT.

READ—the following papers :—

From S. H. WYNNE, Esq., President, District Board, Tinnevelly, to the Chief Secretary to Government, dated Tinnevelly, 4th August 1886, No. 48.

I have the honor to submit the following subject for the orders of Government.

To the north of road No. III, Palamcottah to Tuticorin, there is a drainage channel known as the Puckle's channel. It runs parallel to the road and the Tuticorin fresh-water channel from the third milestone from Tuticorin eastwards. The work was originally constructed in connection with the Srívaikuntham anicut project—*vide* paragraphs 31 and 50 of Mr. Rundall's report, embodied in G.O., No. 1498, dated 8th June 1874. At present, however, the channel does not appear to be of any material use to that system. It is practically a protective work to keep out the storm water from inundating the town of Tuticorin in general, the railway station there, the above said road of the Local Fund department, the fresh-water canal supplying the town of Tuticorin, and the wet lands of Korampallam tank, as well as the salt pans of Levingepuram.

2. In November 1884, breaches occurred in Puckle's channel, for the closing of which and for strengthening its right bank, the Imperial Public Works Department framed an estimate for Rs. 370. These repairs were considered necessary for the safety of the fresh-water channel. The Superintending Engineer differed from this opinion, and expressed that the South Indian Railway Company may fairly be called upon to repair and keep the banks in order, probably on the understanding that the natural drain was interfered with by the railway compound.

3. The work was not undertaken by any department until October 1885, when, on the recommendation of the Sub-Collector, the district board undertook the work on the consideration that the several agencies referred to in paragraph 2 *supra* should contribute their share towards the cost, and set the work on foot according to the estimate prepared by the Public Works Department. It was found that the estimate was insufficient, and a revised estimate for Rs. 1,060 was sanctioned by the board, and fund allotted. The work is now almost completed.

4. The different departments concerned were requested to contribute their quota, and their replies, disowning any interest in the work, are herewith submitted for the perusal of Government.

5. The damage that may at any time be caused by floods to the Local Fund road must be trifling, whereas the damage to other interest, and specially to the wet lands under Korampallam tank, would be very heavy. Under no circumstances therefore will the board undertake any further repair unless the cost is chiefly borne by the other agencies, and they would not have undertaken the work now done, had they supposed there would have been any attempt on the part of others to deny their obvious liability.

6. The board therefore request that Government will be pleased to issue orders for a fair contribution from those concerned.

7. A plan of the locality, with the Local Fund Engineer's letter explaining it, and other papers are herewith forwarded. A list is enclosed.

No. 521.

Referred to the Public Works Department for remarks.

(By Order.)

(Signed) E. S. LAFFAN,
Under Secy. to Govt.

MADRAS,
23rd August 1886.

No. 138-I.

Note by the Officiating Chief Engineer for Irrigation.

It is considered that this department has no interest in the maintenance of the Puckle's channel, and that there is no reason why any portion of the cost of keeping it in order should be met from Public Works funds.

2. It is also considered that the interest of the Local Fund Board in the matter is but slight, and that the chief concern rests with the Tuticorin Municipality and the South Indian Railway.

3. A reasonable distribution of the cost of maintenance would appear to be that the district board should bear one-fifth, the remainder being divided equally between the railway and the municipality.

(Signed) J. PENNYCUICK, Lt.-Col., R.E.,
Offg. Chief Engineer for Irrigation.

CHEPÂK,
5th October 1886.

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

No. 3509-C.

Transferred to the Financial Department, with reference to endorsement (returned) in that department, No. 521, of the 23rd August last.

(By Order.)

(Signed) R. DAVIDSON,
Under Secy. to Govt., P.W.D., Irrigation Branch.

CHEPÂK,
11*th October* 1886.

To the Financial Department, with papers in original.

ORDER—dated 28th October 1886, No. 1417 L.F., Financial.

The Government observe that the Tuticorin Municipality, the South Indian Railway Company, the District Board, and the Department of Public Works are all interested in a greater or less degree in the maintenance of the channel, and consider that the cost should be distributed as follows:—

Tuticorin Municipality	1/3
South Indian Railway Company	1/3
District Board	1/6
Department of Public Works	1/6

(True Extract.)

for Ag. Chief Secretary,

To the President, District Board, Tinnevelly, with enclosures.
„ Chairman, Municipal Council, Tuticorin,
through the Collector.
„ Public Works Department.
„ Joint Secretary to Government, Public Works Department,
Railway Branch.
„ „ „ to Government, Public Works Department,
Irrigation Branch.

Exd. T. O'Connor.

8/1 copies