(1) பக்கங்களின் எண்ணிக்கை 118

(2) புதுக்கித் திருப்பிய நாள் 3.8.88

(3) ஆதாரங்குறிப்பவர் சுருக்கொப்பம்

தமிழ்நாடு ஆவணக் காப்பகம்.

தமிழ்நாடு அரசு

P.W. துறை

அரசாணை எண்.
மு. கோப்புத் தாள் எண். 2036.W

அச்சகம்
பலவகை

நாள் : 18.3.1884

198 .

க்கவோ கண்டபடி கையாளவோ கூடாது

ன. கா-1—10,0

59

2036 W

18TH AUGUST 1884, No. 2036 W., PUBLIC WORKS.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

General.
Account.

READ—the following papers:—

From the Superintending Engineer, V Circle, dated 1st August 1884, No. 1669.
Office note from the Chief Engineer for Irrigation, dated 4th August 1884, No. 167.

ORDER—dated 18th August 1884, No. 2036 W., Public Works.

The sum of Rs. 15,953 required for "Tools and Plant" in connection with the Buckingham canal is appropriated by transfer from the Provincial reserve.

(True Extract.)

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

To the Superintending Engineer, V Circle, with two enclosures.
" Examiner, Public Works Accounts.
" Chief Engineer for Irrigation.
" Financial Department.

Exd. E. Fernandez.
Spare Copies

5/3

GENERAL.
ACCOUNT.

Govt. of {1884} Madras.

PUBLIC WORKS.

Dated August, 18*th*.

Recd. *Encl.*

G.O., 18th Aug. 1884, No. 2036 W.

AUGUST.

Buckingham Canal

Rs. 15,953 required under "Tools and Plant" for the —, appropriated by transfer from the Provincial reserve.

2036 W

Proceedings of the Madras Government, Public Works Department,
17th August 1876. *No.* 2,153.

No. 395. Read the following Proceedings of the Government of India, Public Works Department, (Account—General,) dated Simla, 8th July 1876, Nos. 595—96 A.—G.:—

Review of the Madras Provincial Budget Estimate, 1876-77.

Read the following papers:—

Letters from the Secretary to Government of Madras, Nos. 952—953, dated 10th April 1876.

	Rs.
Resolution.—The Public Works Budget Estimate for 1876-77 under Provincial has been prepared for an allotment of ... ... (1)	14,00,000
in addition to which there is a grant-in-aid to Local Funds of ... (2)	3,50,000
and a provision from Special Funds of ... ... (3)	2,68,795
as also for petty work under Civil Officers of ... ... (4)	62,000
The total of the estimate now rendered therefore amounts to ...	20,80,795
2. Of this total of Rs. 20,80,795, the grant from Provincial Services is represented by the aggregate of the two sums (1) and (2), Rs. 14,00,000 and Rs. 3,50,000, making a total of ...	17,50,000
Compared with which the grant for 1875-76 was	19,72,000
The outlay of 1874-75	24,84,572
That of 1873-74	26,66,560
And that of 1872-73	23,09,040
But the amount given to Madras for Public Works in the calculations on which the Provincial Service arrangement was based, amounted, in its original integrity, to	23,34,550
and, after taking off its proportion of the reduction made in the total grant for Provincial Services, to	22,18,960
Hence the grant for 1876-77 being only	17,50,000
it follows that the allotment has been diminished below what may be considered the normal amount by	4,68,960

3. The explanation furnished of this decrease is contained in paragraph 2 of the letter from the Secretary to the Government of Madras, No. 953, dated 10th April 1876, in which the following passage occurs:—

"Not only had this Government to provide for an anticipated excess over the Provincial grant for Public Works during the year 1875-76, but also to allot in the

Provincial Budget for 1876-77 a sum of no less than Rs. 5,23,432 to meet the balance of the cost of Public Works Establishment not provided for in any other Public Works Budget."

4. Analysing the figures, the following abstract shows the distribution of the Provincial Service grant for 1876-77, as compared with that of 1875-76, and the outlay of the two previous years:—

	Grant, 1876-77.	Grant, 1875-76.	Outlay, 1874-75.	Outlay, 1873-74.
	RS.	RS.	RS.	RS.
CIVIL BUILDINGS—				
Works	3,51,193	3,03,505	5,95,698	6,75,140
Repairs	1,32,005	1,14,405	1,53,904	1,46,710
COMMUNICATIONS—				
Works	2,09,740	1,46,500	1,66,258	1,96,140
Repairs	46,130	38,130	32,353	29,680
MISCELLANEOUS, PUBLIC IMPROVEMENTS—				
Works	...	6,460	9,771	94,040
Repairs	7,500	7,500	18,878	18,460
Total Works and Repairs	7,46,568	6,16,500	9,76,862	11,60,170
ESTABLISHMENT	5,23,432	1,55,000	2,03,070	2,51,580
TOOLS AND PLANT	80,000	28,500	55,508	4,970
SUSPENSE AND PROFIT AND LOSS	...	...	47,132	49,840
REFUND TO EXTRAORDINARY GRANT OF A PORTION OF THE OUTLAY INCURRED ON MADRAS WATER-SUPPLY PROJECT	50,000	...	...	...
	14,00,000	8,00,000	12,84,572	14,66,560
GRANT-IN-AID TO LOCAL FUNDS—				
COMMUNICATIONS Works	3,50,000	6,00,000	6,50,000	9,00,000
COMMUNICATIONS Repairs		2,40,000	2,50,000	
COMMUNICATIONS Establishment		3,00,000	3,00,000	3,00,000
	17,50,000	19,40,000	24,84,572	26,66,560
UPPER GODAVERY WORKS	...	32,000		
		19,72,000		

5. The chief point to be noticed in the distribution of the grant is the increase in the provision for Establishment from Rs. 1,55,000 in 1875-76 to Rs. 5,23,432 in 1876-77. The cause of the increase is not specifically mentioned, but it is understood to be due to the result of the arrangement for the distribution of the cost of Establishment under which Imperial and Local Funds respectively meet such portions of it as amount to 25* per cent. of their grants for Works and Repairs, and Provincial Services bear the whole of the

* Imperial Funds also bear the cost of the Conservancy Establishment, the cost of the Establishment of the Chief Engineer for Irrigation Works, and cost of surveys for Irrigation Works.

balance whatever it may be. Hence as the cost of Establishment in Madras is over 25 per cent., the result is that Provincial Services bear a disproportionate share of the cost of Establishment. The Local Fund Public Works Budget Estimate for 1876-77, not having come to hand yet, the exact proportion borne by the provision for Establishment to Works and Repairs for this year cannot be told, but in 1875-76 it was 29¼ per cent.

6. The Government of Madras draw attention to the circumstance that the charges for Establishment debitable to Provincial Services amount to as much as 65 per cent. of the cost of the works, and add "that the present cost of the Public Works Establishment as a whole has excited" its "earnest attention, and that it will at an early date form the subject of a special investigation, involving a thorough inquiry into the present system of carrying on public works."

7. The Governor-General in Council will await the receipt of a report of the result of these investigations. But it is necessary to notice that the recent reductions made in the Madras Imperial grant for Buildings and Roads as well as for Irrigation Works threw a larger share of Establishment charges on Provincial Services than has been provided for. Thus the total of the estimate for Establishment amounts to Rupees 21,76,981, which the Government of Madras say has been provided for as follows:—

	RS.
Buildings and Roads	1,91,000
Irrigation	7,73,470
Provincial	5,23,432
Special	46,039
Convict Labor Fund	8,000
Local	6,35,040
	21,76,981

But in consequence of the reduction made in the Imperial grant, the provision for Establishment debitable to Imperial Funds at the 25 per cent. rate has been passed only for—

	RS.
Buildings and Roads	1,76,750
Irrigation	6,97,719
Total ...	8,74,469
instead of Rupees 1,91,000 + 7,73,470 = ...	9,64,470
so that there is a deficiency of Rupees	90,001

to be made good. The attention of the Government of Madras is invited to this matter in view to the necessary provision of funds being made to provide for the charge. If the Government of Madras consider it necessary that Imperial Funds should bear an enhanced share of the cost of the Establishment, the Government of India will be prepared to consider any proposal that may be put forward on the subject, but there should be no delay in the matter.

8. Under Works, the following is an analysis of the provision made :—

—	No. of Works.	Amount of Estimate.	Computed Outlay to end of 1875-76.	Grant, 1876-77.
		RS.	RS.	RS.
Works in progress, the grants for which will suffice for their completion in 1876-77—				
Civil Buildings	19	5,12,845	3,86,946	1,14,897
Communications...	3	1,37,524	92,584	44,940
Works in progress, the grants for which will not suffice for their completion in 1876-77—				
Civil Buildings	6	3,01,620	1,46,169	41,812
Communications...	4	9,02,870	4,07,424	1,52,000
New works, the grants for which will suffice for their completion in 1876-77—				
Civil Buildings	7	25,535	...	25,455
Communications...	1	4,000	...	4,000
New works proposed to be undertaken for which there are no sanctioned estimates—				
Civil Buildings	2	...	...	30,000
Communications	2	...	...	8,800
Special grant for Police Buildings	...	...	...	56,544
Minor Works—				
Civil Buildings	...	...	...	82,485
				5,60,933

9. Of the provision made for Works the following items relate to outlay at Ootacamund :—

	Estimate.	Computed Outlay to end of 1875-76.	Grant, 1876-77.
	RS.	RS.	RS.
Churchyard in connection with St. Thomas' Church, Ootacamund	3,060	...	3,000
Lines for Sappers...	12,147	2,000	10,150
Council Room at Stonehouse	28,700	18,000	10,700
			23,850

10. In respect to the provision for lines for Sappers, the Government of India would be glad to know the circumstances under which the funds for the purpose are being met from Provincial Services.

11. For the East Coast Canal there are the following items —

	Estimate.	Computed Outlay to end of 1875-76.	Grant, 1876-77
	RS.	RS.	RS.
Extension of Canal from Dugarazpatam to Kistnapatam	2,87,000	3,12,694	1,00,000
Extension of Canal from Kistnapatam to Pennair...	2,74,000		
Extension of Canal from Pennair to Chippelair	...	...	

Against the last item the words "estimate awaited" are entered in the column of remarks. The Governor-General in Council would be glad to be informed of the probable amount of this estimate, and especially whether the total estimated cost of the whole work is over or under 10 lakhs.

2036 W

12. The provision for Tools and Plant has increased from Rupees 28,500 to Rupees 80,000. Of this increase, Rupees 30,000 is for an increase to the Capital of the Presidency Workshops, and Rupees 5,000 for Government House furniture. The charge for the last should, under recent orders, be placed under Civil Buildings. For building a house with out-office for the Shermidevy Range the estimated cost is set down at Rupees 6,700. It is supposed that rent is paid for the quarters. For the preservation of Terumul Naick's Palace and converting it into public offices at Madura the cost is set down at Rupees 1,28,620, whereas from the Madras Proceedings, No. 2 ,220, dated 2nd August 1875, it was understood that the cost would be only Rupees 87,000, with a small "sum for restoring and decorating those portions of the buildings which are not adjacent to the main structure."

13. It is observed that in the case of the new Potinghy Ghaut road, which is estimated to cost Rupees 1,84,500, and on which the outlay has as yet amounted to Rupees 45,520, leaving Rupees 1,38,980 as the value of the work still to be done, the grant is only Rupees 20,000.

ORDER.—Ordered, that this Resolution be communicated to the Government of Madras for information and guidance, and to the Financial Department for information.

(Signed) C. H. DICKENS, Colonel, R.A.,
Secy. to the Govt. of India.

No. 396. ORDER THEREON, 17th August 1876, No. 2,153.

ACCOUNT, No. 30.

IN these orders the allotments made by the Government of Madras for Provincial Public Works are contrasted with the assignment made for the purpose by the Government of India, and remark is made on the differences which are apparent; the allotment for the current year having, it is observed, been diminished below what may be considered the normal amount by Rupees 4,68,960. The causes of this diminution are assumed to be, an anticipated excess over the Provincial grant for Public Works during 1875-76, and the balance of the cost of Establishments not provided for in any other Public Works Budget. The true explanation of the discrepancy is given in paragraph 5 of the Proceedings of Government in the Financial Department, No. 859, dated 13th May, in which it is intimated that "there are other services of even more importance than Public Works, the requirements of which are increasing and are more imperative, *e.g.*, Education, Police, and Jails, and the increased expenditure in these directions, which cannot possibly be avoided, absolutely restricts the means at the disposal of Government for Public Works."

2. The cause of the increased charge against Provincial Funds on account of Establishments has been rightly understood by the Government of India. The operation of existing arrangements under which so unequal a weight is caused to be borne by Provincial Funds has already been represented to the Government of India in letter, No. 1,594, dated 26th June 1876, with a view to permanent remedial action being taken as well as to immediate relief being afforded in the current year to at least the extent of the deficit of Rupees 90,000 alluded to in paragraph 7.

3. The Government of India will be furnished with a copy of the Proceedings of the Madras Government, No. 1,877, dated 25th July, which explain the circumstances under which the grant for Establishments under Provincial has been overstated by about 1 lakh. One-half of this amount has, it will be seen, been added to the grant for the East Coast Canal. A distribution of the balance will be made when its amount shall have been precisely ascertained.

4. With reference to paragraph 10, it is remarked that the cost of hutting Sappers at Ootacamund has been charged to Provincial Funds under the ruling of the Government of India, No. 881-5 A.G.,* dated 19th October 1872, paragraph 3; the Sappers being employed on Provincial Public Works.

* G.O., No. 2,643, dated 9th November 1872.

5. The probable amount of the estimate for the section of the East Coast Canal from the Pennair to the Chippelair River is Rupees 2,16,000; and it is expected that the cost of the whole work connecting the Kistna system of Canals with Madras will be under 16 lakhs. A special communication on the subject of the work will shortly be made to the Government of India.

Paragraph 11.

6. The provision for Government House furniture was placed under Tools and Plant in accordance with the orders of the Government of India, No. 378-79 A.G.,† dated 22nd June 1875, paragraph 5.

† G.O., No. 2,220, dated 2nd August 1875.

Paragraph 12.

7. Rupees 41,620 were sanctioned in G.O., No. 3,313, dated 19th November 1875, for all works of restoration and decoration not included in the estimates, amounting to Rupees 87,000, for securing Tirumala Naick's Palace and fitting it up for public offices. The sum of the two amounts is Rupees 1,28,620.

8. The Government of India will be separately addressed on the result of the investigation into the cost of the Public Works establishment.

(True Extract.)

(Signed) G. W. WALKER, Major-General, R.E.,
Secretary to Government.

No. 397. DOCKET No. 2,153-A, dated 17th August 1876.

COPY of the above forwarded to the Government of India, with G.O., No. 1,877, dated 25th July.

(True Extract.)

(Signed) G. W. WALKER, Major-General, R.E.,
Secretary to Government.

Exd. W. H. French.
Spare Copies

2036W

10/6/80

4-9-81 W2605

Govt. of {1876} Madras.

PUBLIC WORKS.

To

THE SECRETARY TO THE GOVERNMENT OF INDIA.

Dated August 17th.

Issued

Recd. *Encl.*

G. O., 17th August 1876, No. 2,153-A.

AUGUST.

Nos. 395-397.

FORWARDING copy of Proceedings on the review of the Government of India of the Madras Provincial Budget Estimate for 1876-77.

2036 W

Proceedings of the Madras Government, Public Works Department,
17th March 1877. *No.* 920.

No. 444. Read the following letter from Lieutenant-Colonel J. J. McLEOD INNES, R.E., Deputy Secretary to the Government of India, Public Works Department, (Account—General,) to the Secretary to the Government of Madras, Public Works Department, dated Fort William, 20th February 1877, No. 168 A—G:—

WITH reference to paragraph 5 of the Proceedings of the Government of Madras, No. 2,153-A, dated 17th August 1876, I am directed to inquire when the report, therein promised, regarding the East Coast Canal, may be expected by the Government of India.

No. 445. ORDER THEREON, 17th March 1877, No. 920.

ACCOUNT, No. 32-D.

COMMUNICATED to the District Engineer, Nellore, who will report when the complete estimates for the work within Nellore limits may be expected. Mr. O'Shaughnessy's attention has already been called* by the Chief Engineer to the delay which has taken place in the preparation and submission of the requisite documents.

* Memorandum No. 187, dated 27th January 1877.

(True Extract.)

(Signed) W. FAREWELL, Colonel,
Acting Joint Secy. to Govt., P.W.D.
Buildings and Roads Branch.

To the District Engineer, Nellore.

Exd. S. T. Austin.
Spare Copies

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Govt. of {1877} Madras.

PUBLIC WORKS.

To

THE DISTRICT ENGINEER,
NELLORE.

Dated March 17th.

Issued

Recd. *Encl.*

G. O., 17th March 1877, No. 920.

MARCH.

Nos. 444-445.

East Coast Canal.—Letter from the Government of India requesting early submission of report regarding the —, communicated to the District Engineer, Nellore, with instructions.

2036 W

Proceedings of the Madras Government, Public Works Department,
10th April 1877. *No.* 1,238.

No. 261. Read the following endorsement of the Government of India, No. 93 C W—I :—

Despatch from the Government of India, Public Works Department, (Civil Works, Irrigation) to the Most Honorable the MARQUIS OF SALISBURY, Secretary of State for India, dated Fort William, 28th March 1877, No. 40, Public Works.

MY LORD MARQUIS.—We have received a petition from certain inhabitants of Mylapore in Madras, praying that the Adyar and Cooum Junction Canal Project may be abandoned.

2. We have no knowledge at present of the reasons which have led the Madras Government to undertake the project at the present time, but we have received a telegram from that Government to the effect that a report, with full details, is being prepared for submission to us.

3. On receipt of this report we will communicate to Her Majesty's Government our views on the matter; but, in the mean time, we are informed that a copy of the petition has been submitted to your Lordship direct by the Government of Madras.

COPY forwarded to the Government of Madras in reply to its telegram of the 15th instant.

(Signed) G. F. L. MARSHALL, Captain, R.E.,
Asst. Secy. to the Govt. of India.

No. 262. ORDER THEREON, 10th April 1877, No. 1,238.

CIVIL WORKS, No. 25-A.

RECORDED, pending receipt of the detailed surveys which have been called for from the District Engineer, Presidency.

(True Extract.)

(Signed) E. A. FOORD, Colonel, R.E.,
Secretary to Government, P.W.D.

To the District Engineer, Presidency.

Exd. T. O'Connor.
Spare Copies

17-9-91

Govt. of {1877} Madras.

PUBLIC WORKS.

To

THE DISTRICT ENGINEER,

PRESIDENCY.

Dated April 10th.

Issued

Recd. *Encl.*

G. O., 10th April 1877, No. 1,238.

APRIL.

Nos. 261-262.

Adyar and Cooum Junction Canal Project—Endorsement of the Government of India forwarding copy of Despatch to the Secretary of State on the subject of a petition from certain inhabitants of Mylapore praying for the abandonment of the —, recorded.

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2036 W

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

18th June 1877, No. 266 W.

Buildings and Roads.
Civil Works.

Read the following paper :—

No. 173. From J. O'SHAUGHNESSY, Esq., District Engineer, Nellore, to the Chief Engineer, Public Works Department, Buildings and Roads, dated Nellore, 11th June 1877, No. 842.

I HAVE the honor to submit a survey of the Buckingham Canal near Kistnapatam showing a proposed deviation from the existing line.

2. This deviation has been long proposed, and when I was in Madras in November last I consulted the Chief Engineer and the Deputy Chief Engineer for communications on the subject. I understood General Walker to say that the deviation was so obviously advisable that I might have done it on my own authority. Colonel Farewell seemed to be of opinion that the deviation was necessary also; indeed I believe that he suggested the line of the proposed deviation as the best line for the canal when he inspected the place some two years ago.

3. When His Grace the Governor visited Nellore last month he asked on looking over the plans what the object was of leading the canal off from a point so far from the direct course. I informed His Grace that, as I was not here when the work was done, I could not say exactly how it happened, but it was admittedly a mistake, and I explained the proposals for remedying it. His Grace then directed me to send up these proposals in the regular course, which I now beg to do.

4. The estimate for carrying out the proposal, so far as it relates to the canal alone, amounts to Rupees 10,700, but I have thought it advisable to provide for a boat basin and a terrace near the high road to facilitate the loading and unloading of cargo, which will cost Rs. 3,400, making the total of the estimate now submitted Rs. 14,100.

5. There were several important mistakes discovered in the alignment and estimate for this section of the canal, besides the objectionable "take off" now proposed to be remedied. The most serious being that the sole of the canal was laid down 9 inches too high; this has been remedied in construction, but as the actual rates paid for the work are much below the estimated rates, the extra cutting will not cause the total expenditure to exceed the total amount of the sanctioned estimate, otherwise it would have added over Rupees 1,000 a mile to the cost of the work, or about Rupees 25,000 to the total amount of the estimate for this section of the canal.

6. Owing to this and other charges not provided for in the original estimate, I am afraid that the cost of the alteration and addition now proposed will cause the total amount of the original estimate to be slightly exceeded; the excess will, however, be within 5 per cent. of the original estimate.

No. 174. ORDER THEREON, 18th June 1877, No. 266 W.

HIS GRACE the Governor in Council sanctions the proposed diversion of the canal at Kistnapatam.

(True Extract.)

(Signed) E. A. FOORD, Colonel, R.E.,
Secretary to Government, P.W.D.

To the District Engineer, Nellore.
" Revenue Department.

Exd. E. C. Shunker.
Spare Copies

9-9-91

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1877} Madras.

PUBLIC WORKS.

To

THE DISTRICT ENGINEER,
NELLORE.
&c., &c., &c.

Dated June 18th.

Issued

Recd. *Encl.*

G. O., 18th June 1877, No. 266 W.

JUNE.

Nos. 173-174.

East Coast Canal.—The proposed diversion of the — at Kistnapatam, sanctioned.

2036W

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

No. 845 W.

No. 187.

FROM

THE SECRETARY TO THE GOVERNMENT OF MADRAS,
Public Works Department,

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
Public Works Department.

SIR,—In answer to the Assistant Secretary's letter, No. 119-1 I, dated 14th January 1878, calling attention to your letter 119 I, of the 11th May last, I am directed to state that the report for which the Government of India telegraphed on the 26th February 1876 was understood to be required *solely* with regard to a petition from the inhabitants of Mylapore against the undertaking of the work which was already in hand and with which considerable progress had been made. A similar petition had been addressed to this Government and this Government had also addressed the Secretary of State with reference to a similar petition. Hence during the pressure of famine work the preparation of the further copies and particulars asked was overlooked, for which I am to express regret.

2. The canal was commenced in December 1876 by famine labor and is all but completed, and a report on the canal communication of the Presidency, of which this is a short link, will be very shortly submitted.

I have the honor to be,

Sir,

Your most obedient servant,

(Signed) E. A. FOORD, Colonel, R.E.,
Secretary to Government, P.W.D.

FORT ST. GEORGE,
19th February 1878.

Exd. S. T. Austin.

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7-9-91

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1878} Madras.

PUBLIC WORKS.

To

THE SECRETARY TO THE
GOVERNMENT OF INDIA.

Dated February 19th.

Issued

Recd. *Encl.*

G. O., 19th February 1878, No. 845 W.

FEBRUARY.

No. 187.

EXPRESSING regret in not furnishing certain information in connection with the Adyar Junction Canal, and intimating that a report on the canal communications of the Presidency will shortly be submitted.

10

2036 W

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

6th February 1880, No. 283 W.

General.
Establishment.

Read the following paper:—

No. 14. From Major H. M. VIBART, R.E., Acting Superintending Engineer, Third Circle, to the Chief Engineer, Public Works Department, dated Chepauk, 24th December 1879, No. 7,530.

I HAVE the honor to forward copy of a report submitted by the Executive Officer, Buckingham Canal, (drawn up after personal inspection,) on the damages sustained by the Buckingham Canal during the cyclone of 18th and 19th November 1879.

No. I.—MEMORANDUM OF OBSERVATIONS MADE ON THE DAMAGES TO BUCKINGHAM CANAL DURING THE CYCLONE OF 18TH AND 19TH NOVEMBER 1879.

1. *Madras to Ennore Section, 1 to 12 Miles.*—No damage occurred on this portion of canal, save that the flood overtopped the embankment on 7th mile west side below the lock and swept it down for about 100 yards to ordinary ground level, the revetment below that level prevented scour further down. A large drainage from the west (from the direction of Red Hill Tank) meets the embankment at this point, and as at the time the Kortalayár was in high flood and banked up the drainage, it went over the weak embankment. The entire section from Madras to the lock needs banking. East of lock through the low grounds also the Kortalayár floods poured into canal towards Madras owing to the Cooum bar being open. The lock gates could not be closed on the above account for several days. The low grounds east of lock will be embanked across shortly. On 6th December both gauges of lock read the same 6 feet 4 inches, the water level being same both sides and gates open. The highest reading of gauge during the stormy period was 8 feet 8 inches. The gauge on Ennore lake during the storm read 4·20, the zero of this gauge is 1·5 below M.S.L. The tides at the present range on this gauge from 1·0 to 2·2. The zero of lock gauges is 6·12 below M.S. level.

2. *Ennore to Pulicat Section, 12 to 26 Miles.*—On this part of the canal, which is mostly through backwater, no damage is observable. The cut on 21st mile, connecting the Chintamoney and Pulicat backwaters, widened very much. The 15th mile and part of 16th also seems shallowed by the deposit of wash down from adjacent plains probably. The Pulicat gauge highest reading was 6·4 during the stormy period *on 18th*. The zero of gauge is 0·5 below M.S.L. Present tides range from 0·9 to 1·9 on gauge.

3. *Pulicat Lake Section, 26 to 44 Miles.*—This part of the line is through the lake, through the projections of the east shore of which four cuts were made. As in May's cyclone the effect of this cyclone on the mouths of the cut has been the same, viz., banked them up right across; the second cut particularly fared badly in this way, and up to present time a gully merely has been cut through the shoal to allow boats to pass. As to the lake side embankments of these cuts, the partial repairs done them since May's cyclone has been undone. The bank of first cut particularly has been washed down badly and breached, shoaling up canal at the breaches, the piling with fencing run out at the mouths of this cut has much of it been carried away, thus exposing the entrances to the lake wash and silt. The west bank of second cut did not fare quite so badly. The third cut was quite damaged in May's cyclone, and being but of very short length and too exposed, it was left to itself; it is somewhat more shallowed now and has no bank at all on west side. The fourth cut west bank did not suffer either as badly as first cut. But, as already observed, in all these cases their mouths have shoaled up and canal shallowed here and there where breaches have occurred. The eastern or land side low banks, such as were made in the cases of all three cuts, have been damaged further since May's cyclone. The necessity of abandoning this lake line and running a new line within the eastern shore border has already been considered. Some boats were swamped on this line during the storm, all wood boats; and this day three boats of the same description swamped on this section, the wind being very high and the lake waters very rough.

4. *Lake to Dugarázpatnam Section, 44 to 69 Miles.*—The damage on this line is of a general nature, a general shallowing up; the result of the lake wash over west bank which though low has been washed lower and breached. The east bank also has been breached in places, but of no consequence. Much of this line has backwater on the east side of it also. The flood rose very high on this section, and but for the timely opening of the Royadooroovoo bar (which has not been known to open for a long time past) much loss of life and property would have resulted. In the Royadooroovoo toll office, which is built on the bank of canal, the water was 2 feet deep over floor, as seen by water line, this is 9 feet over canal present bed. The flood that affected this portion of the canal was brought down presumably by the Dugarázpatnam river, which is the southern arm of the Swarnamukhi; and by the Swarnamukhi flood also, which before it was relieved by the opening of the Pamanjee bar must have run southward.

The Dugarázpatnam gauge not having been fixed before the storm, the flood readings are not recorded, but will be taken from water-marks and referred to B. Ms. and noted.

The tide readings on Dugarázpatnam gauge now range from 1·9 to 3·15.

The southern entrance to the Dugarázpatnam lake, which yearly shallows up and hard to maintain during westerly winds, is now much shoaled up, and the lake depth generally seems to be short especially about the entrance to branch channel of bungalow.

Two bars opened out at Dugarázpatnam during the storm, but one is now open and not very wide.

5. *Dugarázpatnam to Swarnamukhi Section, 69 to 75 Miles.*—In this reach of canal there is general shallowing up, the result of the Swarnamukhi floods, here and there particularly there are very very shallow places, as short as 1 foot at low tide, and the head of cut at junction with Swarnamukhi has silted up to 1½ feet below low tide level for several hundred feet length of channel.

The destruction of trees is more visible from hence northwards.

6. *Swarnamukhi River Section, 75 to 77 Miles.*—The river course forms the canal line in this reach. This is the worst part of the canal now as respects short water depth. Since September, when this part of canal was last seen, the flood has worked a complete change of river bed, very very deep holes have been formed in places, while generally the bed has shallowed up leaving no water at low tide, and but for the Pamanjee bar being open and the tide rising 2·8 as observed this day, navigation will be quite stopped. The bar is running freely still. This is always a difficult reach to maintain, and yearly the same trouble is experienced; so the sooner the better if a diversion is made and the river bed abandoned. The Pamanjee bar which had been closed for years past was opened by the floods of this cyclone.

7. *Siddavaram Section, 77 to 90 Miles.*—This section from the combined effects of the Swarnamukhi floods at one end and the Kundalaroo floods at the other, has shallowed up generally throughout. At the Swarnamukhi junction a great shoal was thrown up across the entire head of channel for about a hundred yards length of channel, the mouth of channel having considerably widened also. A gully had been cut through this shoal by the Overseer to about a foot only below low tide level, so that boats could not pass except at high tide, in consequence of which I remained here and put a large body of coolies on to deepen cut, several boats being detained both sides. Here and there in this reach the canal has been further shallowed by breaches in banks and drainage discharge, but the breaches are of no importance. In the sandy deep cuttings particularly, the short depth of water is mostly felt.

The Kundalaroo gauge during the storm read 8·9. The high tide of last full moon read 7·0 and low tide 4·4. The present tide readings range from 6·8 to 4·5. The zero of gauge is 4·5 below M.S.L.

The Gauge Goomastah reports that for three days the Swarnamukhi floods passed into the Kundalaroo by way of canal during and after the storm, the Kundalaroo not having been in much of flood.

8. *Kundalaroo River Section, 90 to 91 Miles,* is deep throughout. At the entrance of the canal on south border the river is shoaling up very fast, and since September a new shoal has formed about mouth of canal on east side, where there was always deep water before; deepening has to be constantly done at the south entrance to keep the channel head open.

9. *General Remarks.*—The toll office shed at Royadooroovoo was much damaged and walls fell. The platforms about the mile and furlong stones, which were damaged much by May's cyclone and were restored, have been washed away very extensively and many more of these stones have been thrown down quite. The canal avenues have suffered again, but not so badly as in May's cyclone.

10. The fullest instructions in writing have been issued to the Canal Superintendent to clear the line to 3 feet below low tide so as to allow of uninterrupted navigation, but this clearing is only practicable in the short reaches, not on the miles which have shallowed generally, the deepening of which will occupy months. On the lake to Dugarázpatnam section I have ordered all the breaches on west side to be closed temporarily with small banks, so as to prevent

the tide floods from the ends of section and from the Royadooroovoo bar being locked in as much as possible, and not allowed to spread into the lake as now, by which the tidal influence on canal is barely felt as the reach of this section is very long and the tidal influence at the ends very small. It will be immensely advantageous if the Royadooroovoo bar keeps open.

15th December 1879. (Signed) S. OTTMANN, Sub-Engineer,
Executive Officer, Buckingham Canal Division.

No. II.—OBSERVATIONS ON THE DAMAGES DONE TO THE BUCKINGHAM CANAL DURING THE CYCLONE OF 19TH AND 20TH NOVEMBER 1879.

Kundalaroo to Pennér Section, 91 to 114 Miles.—On 91st mile no damage was done, as there are no banks, virtually, but merely berms, through the swamp, and over which the flood rose and fell freely. *On 92nd mile*, through swamp also, the berms did not suffer for the same reason. The Kristnapatam basin revetment walls, loose set, have been much shaken. The cyclone flood level on this mile denotes 9 feet over canal bed which was designed 4·5 below mean sea level. *In 93rd mile* no particular damage occurred, save a further wash down of banks which suffered in May's cyclone. With a good opening on this mile, for the Kristnapatam drainage, the banks will be saved in future. This mile is through backwater, and without bank east side. This mile is shallower also now by the wash into canal of banks and berms. *The 94th mile* has two breaches west side from want of drainage outlet; canal generally shallowed by wash down, being deep sand cutting. *The 95th mile* through deep sand cutting has also shallowed generally by wash, the ramps at cattle crossings breached. On this mile the flood mark seems 10 feet. *On 96th mile*, half the mile being in deep sand cutting, has shallowed as on the other miles. The rest of mile is through backwater with low berms, which did not suffer particularly, but where the Nalatoor drainage enters, and the bank was breached and washed down in May's cyclone, the damage is greater now, and all along it the canal has shallowed; a good outlet is wanted here. On east side also an old drainage outlet breached wider; the Nalatoor bar opened in the cyclone, but has now nearly closed up; this bar is over half a mile distant from canal and very rarely opens. *On 97th mile* the flood mark is 10½ feet; there is no particular damage on this mile. *On 98th mile* the flood mark is 10½ feet at the mile stone, but 11 feet where the large Ananthapuram drainage joins, and which damaged the canal and banks seriously at junction, filling up canal for some length quite, low berms washed over, general shallowing, the result of breaches and drainage junction. *On 99th mile* no particular damage, save that the cattle crossing ramps breached; at the mile stone the flood mark seems 10 feet. *On 100th mile* there are no damages particularly. The Yadooroo Ravoo (ferry), which was before shallow, has deepened very much by scour. *On 101st mile* the cattle ramps breached, but no other damage; flood mark 10 feet. *On 102nd mile* the old May's breach of drainage towards Kodoor south bar widened considerably, but of no consequence: this bar, which rarely opens, was opened during the cyclone, and now closed except at high tide; a portion of east bank also has been washed down quite; the low berms generally on this mile permitted the flood to rise and fall freely, so there was no particular damage. *In 103rd mile* the damage is very serious by the Kodoor drainage which was obstructed having broken through, tearing down banks and berms at junction and for some distance beyond also, the towpaths, berms and portions of high banks have been all swept down; the locality has the appearance of a large basin; this damage occurred close by Kodoor toll office, the chains and apparatus of toll bar having been swept away (since recovered); the canal for two furlongs length quite silted up, the flood having been arrested by the storm wave through the bar a mile beyond; the flood mark at 103rd mile stone is 10½ feet. *On 104th mile* an old bar that had not opened for ages, and was quite bunded across by the canal bank, opened out by the storm wave evidently, first carrying away east bank, when the impounded Kodoor drainage increased the damage passing out. This bar is a furlong from canal. Canal quite shallowed up at this locality particularly, and generally all along the mile: the opening in bank on east side is a furlong length. On west side also a large breach occurred by drainage from the west not having had outlet; the bar is closing, flood tides only flow over now; a permanent opening will be wanted here; at 104th mile stone the flood mark seems to be 9½ feet. *In 105th mile* except in 8th furlong, where drainage from west overtopped and breached through, no particular damage occurred; an inlet is wanted here; the flood mark at the mile stone is 10 feet. *In 106th mile* no particular damages: flood mark 10½ feet. *In 107th mile* the flood mark is 10½ feet; banks not particularly injured, but canal much shallowed by the junction of a large old drainage; an old bar opened out in this locality and now closed, over half mile distant from canal. *In 108th mile* there is no particular damage; flood mark seems 9½ feet. The Koratur bungalow has fallen in, the rear half of it; it is built of raw brick with thatched roof; is a long way from canal, and I certainly do not advocate its restoration. *In 109th mile* a very old bar opened, but now closed; a very extensive drainage enters canal here, which caused the bar to open. The flood water mark of this drainage OUTSIDE *the west bank* is distinctly seen as 10½ feet, and which height it must have reached till bar opened or probably while the sea-wave from bar kept it out. Extensive outlets and inlets are

wanted here; the drainage channel cut outside west bank here is a sham; no other damage on this mile. *In* 110*th mile* the flood mark seems 9½ feet; there is a large breach on 8th furlong at old field drainage west side, and east side consequently eroded by the impact. *The* 111*th mile* flood mark seems 9½ feet; except at north end, where banks were made across drainage, and which have been swept down, no other damage. *The* 112*th mile* crosses a great drainage in two arms, of a furlong each, which is the Gangapatam river and backwater; both arms have bars, the southern one rarely opens, but on this occasion it did. The northern arm bar is now open, but does not continue so long; on the turn of the wind to south it will close, the fishermen say; the southern arm which was bunded across quite, and weathered May's cyclone, had its banks completely swept away; they should not have been made at all; the north arm is the river proper. Two furlongs of this mile are through deep sand cutting, along which the canal is very shallow by wash-down banks and berms. *In the* 113*th mile* the flood mark is 9 feet; (there being natural outlet, not allowing drainage to pack up in this locality.) In 6th furlong the cattle ramps both sides breached; banks badly eroded behind also. On 2nd furlong also breach both sides, and canal much shallowed. A third arm of Gangapatam backwater crosses here, 2nd furlong, but was banked across; it is these banks that breached, mentioned above, and opened old bar now nearly closed; this crossing must be maintained open; the canal generally is shallow along 1st furlong, being through deep sand cutting. The 113th mile indicates 9 feet flood only, the Pennér being near; no particular damage, banks eroded behind. *The* 114*th mile, 2¼ furlong,* is Pennér south border.

2. *Pennér River Section,* $\frac{114}{2\frac{1}{4}}$ *to* $\frac{116}{6\frac{1}{2}}$ *Miles.*—The Pennér gauge read 9·3 during the cyclone. The tides since have been ranging from 7·2 to 3·4. In the southern arm the sand-spit in midstream is extending still eastward, which sends the line of navigation nearer bar. It has extended since March last over a 100 yards from my own observations. The central arm is a mere over-flood water-way. Though generally deep heretofore it has much silted up since November cyclone along north border, causing a great obstruction at the mouth of the island cut; in short there is no water over it at low tide, and the silt is so fine and semi-fluid that men cannot venture out of boat; the poling rods go down 8 to 11 feet in it, with very slight pressure. Stuff like this only a dredge could manage it will be observed. The island cut between central and northern arms has not silted very much more than in May's cyclone, but its borders have been eroded very much; there is about a foot of water, perhaps less at low tide; the southern mouth, besides the river approach to it before mentioned, is high and dry over low tide, for about a furlong. The northern arm is not as deep now as after last cyclone; the southern shore has shallowed very much, thus obstructing north mouth of island cut to some extent. The river bed, as in all these cases, alters year after year; but as I before advocated, the central arm should be closed up by training the river so as to keep the north and south arms permanently deep and bars well open; the central arm bar which opened in the cyclone has already closed up securely for the season.

3. *Pennér Pydaroo Section,* 117 *to* 124 *Miles.*—*In* 117*th mile* no particular damage; the flood mark on mile seems 10½ feet, though the gauge on southern arm Pennér indicated only 9·3 at the same time, and in the canal south of Pennér 9 feet. *In* 118*th mile* no damages particularly, flood marks 10½ feet; generally shallowed from influence of river floods at one end and Ramatheertham drainage at the other. *On* 119*th mile* flood mark 10½ feet; on 1st furlong large breach east side from drainage having no outlet, and no other damages. Canal shallowed generally for same reason as above. *On the* 120*th mile* the Ramatheertham backwater crosses for about four furlongs length; this backwater was originally bunded up, leaving two little openings for outlets and inlets. In last May's cyclone the bunds were swept away and bar opened; the banks were not reformed, but merely low, flat berms with very flat slopes outwards and two openings given for drainage on west side, the May's opening left unobstructed on east side. In the recent cyclone the flood rose and fell without injuring the low berms; the bar opened, and has since closed, the high tides only flowing over. The outlet to sea needs to be created a permanency; along the reach of this backwater the canal has shallowed very much. *The* 121*st mile* has 11 feet of flood line indicated on it. Deep sand cutting, generally shallowed by wash and influence of floods both ways. *The* 122*nd mile* is also shallowed by the same influences; is through deep cutting, banks somewhat injured. *The* 123*rd mile* runs along border of backwater with low berms generally, which have not suffered very much more since May's cyclone, the flood having risen and fallen freely; the high banks where they occur are somewhat eroded. *On the* 124*th mile, 6th furlong,* the Pydaroo crosses the canal, just at crossing has a very ugly bend, at right angle almost, which is far from convenient for its navigation. The portion from 1 to 5 furlongs is along border of backwater, not much injured since May's cyclone, by reason of the berms having then been washed down low; the canal is shallow along here also.

4. *Pydaroo River Section.*—The opening proper is a furlong, but the high flood waterway is several furlongs. The bar is now open, keeps open for a great part of the year; on the west of canal the country is a vast swamp, where the floods have time to spread. The gauge read 11·0 during the cyclone, withal. The tides range from 7·9 to 5·9. The swamp above referred to is one vast bed of oyster.

5. *Pydaroo, Chippalairoo Section,* 124 *to* $\frac{132}{4}$ *Miles.*—*The* 125*th mile* indicates 11 feet flood. This mile is along the border of same swamp as in 124th. The west bank, which was washed down to a low berm in May's cyclone, has hardly suffered, save somewhat more washed. *The* 126*th mile* is also along the border of same swamp, and its west bank or berm has the same features as on preceding mile, only washed down somewhat more. *The* 127*th mile* has a 10 feet flood mark. The Eskapally river is crossed on 6th furlong, but the flood waterway is indicated by the high ground borders at the 2½ and 6 furlongs; the low west berms have not suffered more since May's cyclone; the river-way openings has widened merely; the last two furlongs are in cutting, with banks badly eroded. The Eskapally bar is very extensively open in a north-east direction. *The* 128*th mile* has been much injured. It has a flood mark of 10½ feet. On 1st furlong both banks have been entirely swept away adjacent to bar opening (this was an old drainage crossing bunded across); the west bank on 5th and 4th furlongs also swept down, and east bank also breached opposite, the breaches are adjacent to bar, about two furlongs off; what is left of both banks on this mile are mere shells, being eroded quite behind. The 6th to 8th furlongs are scarcely injured; in deep cutting; the canal is generally shallow on the mile from the breaches, and more so at Eskapally ferry on 8th furlong. *On* 129*th mile* also the east bank is badly eroded behind from outside action and breached in several places; on 7th and 8th furlongs west bank also eroded and breached; flood mark seems 11 feet. *The* 130*th mile* breached to sea, east side, at old bar that opened in cyclone and since closed. Banks generally eroded behind, and in places washed down, with some minor breaches. *The* 131*st mile* has flood marks of 11 feet. Banks generally eroded both sides, and washed down in places. *The* 132*nd mile* has a flood mark of between 10½ and 11 feet. Banks generally injured somewhat inside, but more outside. On 1st furlong breach E. side; on 8th furlong E. berm swept down mostly; the banks on this mile are more or less low berms. *The* 133*rd mile,* the Chippalairoo south border, is at end of 5th furlong, the east bank, for the 5th furlong has more or less suffered by the action of Chippalairoo south bar, breached and swept down in places; the mouth of the canal at Chippalairoo south border is a great shoal, with a gully cut through merely to let boats pass, but there is no water at low tide; the mouth on east side has been eroded and carried away, widening the mouth therefore considerably; canal much shallowed in this mile.

6. *Chippalairoo River Section,* $\frac{132}{5}$ *to* $\frac{133}{4}$ *Miles.*—This is just such another reach as the Swarnamukhi, and quite as hard to maintain a deep channel along its bed owing to the ever shifting sands. The river on its south border swept away a furlong length of canal banks which run into high flood waterway; it also opened its old southern bar, which for years had been closed; the deep channel along bed which was staked out after monsoon floods has so materially altered by cyclone floods that it became necessary to order their removal, and the new deep channel alignment restaked; the bed on the whole is shallower than in September last, and the deep channel very tortuous. The gauge reading of Chippalairoo during cyclone was 9·80 on 18th, 10·50 on 19th and 20th, 9·50 on 21st, so that the duration of the flood period was very long hereabouts. The tide readings now range from 7·8 to 5·4. The canal here needs to be led away westward entirely, leaving river bed to itself. Bar freely open.

7. *Chippalairoo to Mannaroo,* $\frac{133}{4}$ *to* $\frac{160}{3}$ *Miles.*—*In* 134*th mile* the flood mark is 10½ feet (as on gauge). The 5th and 6th furlongs have been badly eroded behind, and parts washed down; on 7th furlong breached both sides and ran to a bar now closed; the banks on this furlong are more or less much damaged. On 8th furlong high banks, outside erosions and east bank badly washed down. This mile is exposed seaward to a very low seaboard. This mile has shallowed somewhat. *The* 135*th mile* is also exposed on the sea side in the same way. Sea bank much eroded, also land bank, by the spill of Chippalairoo high flood; a breach on east bank, and on 2nd to 4th furlongs banks much washed down; flood mark 11 feet. *The* 136*th mile* flood mark is also 11 feet; banks very badly eroded behind; breach on 1st furlong west side, and banks here and there washed down. *The* 137*th mile* has the same 11 feet flood mark; banks eroded behind. *The* 138*th mile* has also a 11 feet flood line, no particular damages inside, but eroded outside. *In* 139*th mile* also the flood mark is 11 feet. East bank breached; banks eroded behind, generally washed over. Tummalapenta is on this mile. *In* 140*th mile* flood mark not visible distinctly, low berms and banks; no material injury, save erosions behind, and breach east side. *On* 141*st mile* the flood mark is 11 feet; low berms as in above mile, and damaged as in above not materially. *From* 142*nd mile* the canal leaves the low swamp country and enters deep cutting from 7 furlongs. The first seven furlongs are in swamp with low berm banks eroded behind. On 8th furlong breach east side from drainage which must be left open. *From* 143rd *to* 145th *miles,* through deep sand cutting, there has been no damage, but canal shallow from wash; at 145th mile stone the flood mark seemed 12½ feet. *On* 146th *mile* the flood mark looks 13 feet; deep, sand cutting and canal shallow. *On* 147th *mile* the flood mark shows 12½ and 12. On 1st furlong is a great breach west side, from drainage, obstructed for miles both sides without an opening, the country about being wet land with tanks adjacent. On 3rd furlong also bank overtopped and breached west side. On 5th furlong west bank overtopped and washed down somewhat. Flood mark on drainage channel banks (*outside* west bank) is clearly seen as 14 feet. On 6th furlong also west bank overtopped and washed down somewhat. On 7th furlong breaches

at bridge, on old coast road which now forms west bank of canal here. On 8th furlong the east bank has been washed over somewhat. *The* 148*th mile* shows a flood mark of 12 feet; except on 6th furlong where west bank has badly breached and swept down, and on 7th furlong where same bank is badly eroded behind, the rest of mile has not materially suffered, the banks were washed over generally by outside drainage; drainage inlet required on west side on this mile which has shallowed. *The* 149*th mile* also shows 12 feet of flood mark; the first three furlongs have erosions behind. On 4th furlong the Ramapatam river so-called crosses, which originally had merely gullies as outlet and inlet, but in May's cyclone these openings were materially enlarged. In November cyclone they have still more enlarged, and need to be provided for permanently, as this drainage runs to the bar adjacent, which opens yearly, which is indication enough it is not to be trifled with; the 5th to 8th furlongs banks are badly eroded, especially east bank as the river runs parallel to it behind; generally the banks on this mile have suffered —this mile has shallowed. *In* 150*th mile* the flood mark ranges from 12 to 12½ feet; the 1st furlong east bank, which is exposed to the bar, has been swept down quite and breached; the west bank also somewhat damaged. The 2nd furlong east bank suffered in the same way, and there is a great breach and bank swept down. On the rest of mile, in deep cutting, no particular damage has been done, though west bank was overtopped and washed down somewhat. The Sub-Division Officer's temporary bungalow in this mile was flooded and seriously damaged, and had to be abandoned by Mr. French's family, who were occupying it at the time; the storeshed all came down; the toll office had its roof blown off; this mile has shallowed somewhat. *The* 151*st mile* shows 12½ feet flood; 1st furlong west bank overtopped and breached; 2nd furlong west bank breached; 3rd and 4th furlongs overtopped and damaged, east bank eroded; 5th furlong eroded both sides; 6th furlong east bank much damaged and west bank eroded behind. On 7th furlong the Elekarroo crosses, and has swept away both banks for a full furlong. This drainage was originally embanked with a small inlet opening. The cyclone of May made large openings both sides. November's cyclone increased the opening, and no doubt extensive outlets are required to the bar here, which is very close, the waves during high tide washing across the crossing which is very deep; there are two bars still open, but will soon shut up to all appearances. On 8th furlong banks have breached, and east bank being exposed to the bar has been badly washed behind also; this mile has shallowed. *The* 152*nd mile* indicates 12½ feet flood. On 1st furlong west bank breached several places, and east bank also badly injured from the Elekarroo floods and exposure to bar. On 2nd furlong also there is a breach on west bank. There should be no banks in these furlongs, but low berms only. On 5th to 8th furlongs also banks overtopped and somewhat damaged. *The* 153*rd to* 160*th mile* the canal runs in very deep sand cutting; and much shallowed from wash off banks and berms and erosions of borders; flood mark 12 feet; on 1st furlong of 159th there is a breach on west bank. *On* 161*st mile* the Mannairoo crosses; the 1st furlong west side has been badly breached by the river, which runs parallel behind, and canal much filled up; the 2nd furlong also from the river flood has been badly eroded behind, the banks of three furlongs have been quite swept away, being across high flood waterway; properly there should be no banks on these three furlongs.

8. *Munnair River Section,* $\frac{160}{3}$ *Mile.*—This river which was very shallow in this year has now deepened extensively, and has swept down much of its north or left border, carrying away much of head of canal on that side. The gauge having been swept away by the floods there is no record in its register of rise of flood, but the flood marks are seen all along both sides and herein recorded. The gauge has since been recovered. The tides range from 3·0 to 5·8. This river crossing is very awkward, to which is to be attributed its very serious effect on the canal, both sides for several miles, which it silts up to almost low tide level yearly; there is a good open bar throughout the year.

9. *Munnair to Palairoo Section,* $\frac{160}{4}$ *to* $\frac{169}{1}$ *Miles.*—The entire length of this section has a very low exposed seaboard and canal close to sea; the storm wave from the sea is clearly indicated by the effects on sea (east) bank of canal and washing down of sand hills along the shore; the canal is a complete wreck in this reach and several old bars have opened out, the drainages leading to which having been obstructed by banks. *On* 161*st mile* the 4th furlong east bank at river junction has been quite swept away, and canal mouth eroded and enlarged on that side; a great sand bank also formed across the mouth; west bank eroded behind; on 5th furlong both banks eroded behind, the same is the case on 6th furlong, and on 7th furlong. The 8th furlong has badly breached both sides, and more or less swept down; the flood mark seems 11½ feet. *The* 162*nd mile* has 11½ feet of flood mark; the 1st furlong west bank more or less washed down, east bank badly breached and damaged; the 2nd furlong banks badly damaged and eroded both sides; the 3rd furlong banks also are badly damaged and breached; the 4th furlong banks have been swept down and breached, the 5th furlong west bank more or less swept down, and east bank badly eroded behind, the 6th furlong west bank quite destroyed, the east badly eroded. The 7th furlong banks have been destroyed and breached, and run to bar adjacent; what is left of banks are mere shells; the 8th furlong banks are badly eroded. This mile has a very low seaboard, and may be said to be a continuous bar of the Munnairoo. *The* 163*rd mile* indicates 12 feet flood; the storeshed and overseer's shed on this

mile at Oolapalem have been quite swept away, and road from village to canal breached; the flood went over banks quite all along, on 1st and 2nd furlongs banks behind quite shelled, bar adjacent running from the Munnairoo; 3rd to 5th furlongs continuously breached both sides; continuous bar adjacent now nearly closed, sand hills swept away, canal has no water at low tide by reason of the filling caused by breaches. The high tide waves wash across canal through breaches; the 6th to 8th furlongs are through deep cutting and high banks; no damage to them inside, but quite eroded outside, the east bank particularly by the sea waves. *The* 164*th mile* shows 12 feet flood mark; this mile is through deep sand cutting, east bank eroded behind, canal shallowed. *The* 165*th mile* shows also 12 feet flood, through deep sand cutting shallowed much; on 5th furlong great breaches both sides, with open bar close by and waves at high tide washing across; canal quite filled up here; permanent outlets and inlets are required here, where in May's cyclone breaches occurred, but now materially enlarged, the banks on rest of mile are eroded on sea side only. *On* 166*th Mile.*—On 1st to 6th furlongs, through deep sand cutting, only outside erosions east side. On 7th furlong both banks for half furlong swept away, being across high flood waterway of drainage; the 8th furlong is a continuous breach, with an open bar and waves washing across; this part breached in May's cyclone, and now has extensively enlarged. This is the Palairoo spill water and must be banked out, and only an inlet will then do here; canal quite silted up along here. *The* 167*th mile* indicates 12 feet flood mark. The 1st furlong is a continuous breach with 8th furlong of adjoining mile. The 2nd furlong for half length is breached continuously with the above furlong. The 3rd furlong is badly eroded, the 4th and 5th furlongs eroded also slightly, but more outside eastward. The 6th furlong has a large breach to eastward with open bar, west bank badly eroded behind; the 7th furlong badly eroded, the 8th furlong badly breached and eroded. *The* 168*th mile* shows 12 feet flood mark; 1st furlong, both banks eroded and are mere remnants; 2nd and 3rd furlongs west bank nearly all swept down; east bank also so gone to some extent, and what is left badly eroded; the 4th furlong banks damaged and eroded; the 5th furlong breached and eroded; also 6th furlong, 7th furlong east bank swept down, west bank eroded; 8th furlong both banks eroded behind. *On the* 169*th mile* the Palairoo crosses on 2nd furlong, the 1st furlong banks destroyed and eroded, being across high flood waterway. The entire reach from Munnairoo to Palairoo has shallowed up very much, particularly at Munnairoo end for 3 miles, and at the breaches canal quite filled up to low tide level.

10. *Palairoo-Moosee River Section,* $\frac{168}{1}$ *to* $\frac{169}{2\frac{1}{2}}$ *Miles.*—The Palairoo crosses on 2nd furlong of 169th mile, and the Moosee on 1st to 3rd furlongs of 170th mile; the flood mark is 12½ feet distinct; the gauge tide readings range from 7·2 to 3·9. The Palairoo bed, which was very shallow previously, has becom e very deep. The Moosee keeps as usual very deep. Both rivers have open bars, which were continuous during cyclone, but now separate. From $\frac{168}{5}$ to $\frac{169}{\frac{1}{2}}$ is in a cut between the two rivers. This cut has quite silted up and very badly breached, at which breaches the canal bed is 15 inches over low tide. There used always to be a deep channel round the point eastward behind the bars, and this channel when I was going up was all right, and boats navigated along it owing to obstruction in the cut above described, but on my return I found the channel nowhere, the high north-east winds having caused the sea to encroach inwards, and the channel has thus been blocked; the cut is therefore only practicable at high tide; this cut gives trouble yearly from the combined action of the rivers either end, it filled up in May's cyclone and was deepened and is now much worse than before.

11. *Moosee, Gundalcamma Sections,* $\frac{169}{2\frac{1}{2}}$ *to* $\frac{186}{7}$ *Miles.*—This section also, like the Munnairoo-Palairoo Section, is a wreck from 178th mile to the end; the seaboard is low and exposed and is one continuous bar, and very extensive drainages cross, which unfortunately were banked across. The canal has consequently shallowed up much in these reaches and at the breaches quite filled up. *On* 170*th mile* the 3rd furlong banks are so badly eroded behind that mere shells of them are left, these banks are across the high flood waterway of Moosee so can never be maintained and should be levelled down. The 4th and 5th furlongs for the same reason are badly breached and eroded, 6th to 8th furlongs are badly eroded inside and outside; these also are across the high flood waterway of Moosee, the slopes also are swept away and canal widened consequently; flood mark 12½ feet. *The* 171*st mile* has 13 feet flood line seen. In deep cutting, high banks, borders eroded, west bank outside eroded; the 1st furlong east bank badly eroded outside also. *The* 172*nd mile* indicates 13 feet flood; in deep sand cutting (7 yards), shallowed borders washed down in places. *The* 173*rd mile* indicates 14 feet; in deep cutting, high banks, borders slightly washed down, with breaches at ramps; bad erosions behind west bank, the result of Moosee flood. *The* 174th *mile shows* also 14 feet; in deep cutting, borders washed down, ramps breached, west bank eroded as on preceding mile. *The* 176th *mile* shows also 14 feet; deep cutting, banks somewhat overtopped west side from outside, west bank eroded by Moosee spill water, ramps badly breached and canal filled up. *The* 176th *mile* also shows 14 feet; west bank eroded behind as in preceding mile; banks overtopped, ramps breached, and canal filled up. *The* 177th *mile* mark of flood is 13 feet, not distinct; west bank eroded behind for same reason as in above miles, banks overtopped and washed into canal, bank slopes and borders eroded. *The* 178th *mile* shows 14 feet flood mark. The 1st furlong ramp breached both sides

and filled canal, bank overtopped and washed in, west bank eroded. The 2nd to 6th furlongs are through the Thondaroo creek, its west bank has been eroded by Moosee spill floods, and the cross bank at north end badly breached and destroyed. The 7th and 8th furlongs through deep cutting are not particularly injured.

The Moosee flood spills over the entire country on its left bank from 3 to 4 miles width, extending from trunk road on west side to sand ridges of coast line on east side, and originally discharged by the Thondaroo creek into the Kottapatam swamp; the canal cut through this drainage valley, and its high banks on west side offered some obstructions, but the entire bunding up of the Thondaroo was injudicious, as objected by me all along, for this vast outlet was substituted by a petty channel on outside, which would never have done the duty; the obstruction therefore raised the flood level in canal to 14 feet in this reach, the only way I can account for this very high flood line hereabouts. This rise of flood outside swamped the adjacent villages, and it is said damaged the Allore tanks also close by, on borders of flood line. The road to Ongole was also breached badly by the unusual rise of flood, though the road generally suffers more or less in the same way in ordinary floods.

The 179*th mile* shows also 14 feet flood, which went over the approaches of temporary bridge at Kottapatam carrying them away; but withal the bridge stood firm, so I cancelled the order for dismantling it and ordered approaches to be made up again. The 1st to 3rd furlongs are in deep cutting, only west bank somewhat eroded behind, owing to exposure to swamp. The Overseer's and store sheds at Kottapatam were all knocked down and swept away, the 4th to 8th furlongs, banks overtopped more or less, and west bank badly eroded exposed to swamp. The flood mark above bridge is 14 and below it 13, the result no doubt of the obstruction, the high embankment the road offered till it breached away quite. *On* 180*th to* 183*rd mile* the canal is through swamp and banks quite exposed, the west bank more exposed has been quite eroded behind, washed over and damaged, and canal shallowed; the east bank having been originally made a low berm more or less, did not suffer much more since last May's cyclone. *The* 184*th mile* shows 12 feet flood; on this mile that vast drainage the Mudigondy crosses which has an open bar at all times. This drainage ordinarily spreads over several miles which have been banked across and drainage forced into the opening of stream proper, the consequence of which has been that the banks on this mile have more or less been swept away and deposited in canal, shallowing it much. The seaboard is very very low along here, without any sand-hills. *The* 185*th mile* flood mark seems 11 feet; this mile, like the preceding, runs across Mudigonda drainage, and its banks more or less swept down and otherwise damaged; low seaboard as in above miles with continuous bars. *The* 186*th mile* has the same features as the preceding two miles, and as badly injured; low seaboard, continuous bars, flood mark 11 feet, erosions of remnant of banks before and behind also. *The* 187*th mile* shows 12 feet flood; on 1st furlong great breaches with a bar opened out; furlongs 2nd to 5th borders swept away and canal materially widened, the result of Gundlacumma floods, banks somewhat injured and eroded behind. On 6th furlong east side breached, banks eroded inside and outside, canal borders eroded to toe of banks; on 7th furlong the banks made across Gundlacumma high flood waterway have been swept away and canal head much shallowed. The river crosses on 7th furlong.

12. *Gundlacumma River Section,* $\frac{186}{7}$ *Miles.*—The river right border seems more shallowed than before; the left border remains deep, and is gradually eroding away further left at southern side; a great shoal has been thrown up at mouth of canal obliquely, leaving however deep channel beyond; on north border the river erosion widened channel mouth materially on east side and threw up a great shoal at mouth, leaving a narrow channel on one side only. The gauge having been swept away no register was made of flood, but the flood mark clearly indicates 12 feet.

13. *Gundlacumma to Rumperoo Section,* $\frac{186}{7}$ *to* $\frac{197}{3\frac{1}{2}}$ *Miles.*—This section also for several miles has a low exposed seaboard with several old bars, all which now opened by the drainages which were obstructed breaking through the banks. The 188th mile shows 11 to 11½ flood; 1st furlong, erosions both sides, canal widened, and banks also eroded; 2nd to 7th furlongs, no particular damages save erosions of banks and borders; the 8th furlong is one enormous breach with an open bar, this opening should be a permanency, it breached in May's cyclone and has breached still more now. *The* 189*th mile* has 12 feet flood mark, 1st furlong erosions only; 2nd furlong badly breached at old obstructed drainage; 3rd furlong badly breached also and eroded, bar adjacent; the rest of mile not particularly damaged save erosions to banks, berms, &c. *The* 190*th mile* shows 12 feet flood; except 4th and 1st furlongs badly breached, the other damages are erosions merely of no consequence, bar adjacent. *The* 191*st mile* shows also 12 feet flood. On first five furlongs no particular damages; 6th furlong for half its length west side swept away, and east bank badly eroded; 7th furlong, great breach east side to bar; this opening should be kept as a large drainage has to be disposed of here; on rest of mile the low berms escaped. *The* 192*nd mile* indicates 12 feet flood. The low berms on this mile escaped, the higher banks have been eroded, inside and outside in places somewhat eroded. On 7th and 8th furlongs west bank washed down quite and east bank badly eroded. *The* 193*rd mile* shows also 12 feet flood; the 2nd and 3rd furlongs breached, on other furlongs banks washed over inward shallowing canal, and some

erosions on outside. *The* 194*th mile,* sundry breaches in several furlongs; banks also washed over depositing into canal and eroded behind. *On* 195*th mile* the flood mark is 12½ feet. On first six furlongs no serious damages, sundry breaches and erosions, and washed over in places; 7th furlong east bank breached, 8th furlong both banks swept away for 100 yards, north end being across flood waterway of Pedda Ganjam creek. This locality breached before, but has extended now, showing particular waterway required for outlet and inlet. *The* 196*th mile* has also 12 feet of flood mark. The 1st furlong is a continuous breach with last furlong of preceding mile and is bed of creek; on 2nd furlong west bank somewhat injured, east bank swept away; 3rd and 4th furlongs, bad erosions both sides more on east being exposed to swamp, and east bank also otherwise destroyed on 3rd furlong; on 5th furlong both banks breached and more or less swept away, swamp both sides; 6th to 8th furlongs, no great damage inside, outside erosions. The 197th mile, 1st furlong, not particularly injured. The Ramperoo is joined at 3½ furlongs; the 2 to 3½ furlongs' banks which were obstructed across Ramperoo flood waterway have more or less been swept away and deposited in canal which is much shallowed. This reach should have no more than low berms, over which the flood can rise and fall freely. The toll shed at Pedda Ganjam was destroyed and being rebuilt. The Ramperoo bar is permanent; always open.

14. *General Observations.* (1.)—In addition to damages to banks, &c., above recorded, I have to state that several furlong stones have been displaced and thrown down, including many that were reset since May's cyclone.

(2.) The canal tow-paths, berms, and slopes of banks have been extensively sown over with prickly-pear, which I have ordered to clear away before it takes root.

(3.) All the old bars where drainages went to sea of old and had been closed for years opened out on the occasion of this cyclone. I observed that several of these bars which were open when I passed up had all but closed up when I was returning, and it is said will all close as soon as the wind changes southward, leaving only the permanent river bars open. In those places where the canal is very close to the bars, I found difficulty in passing the reaches of canal exposed to the bars by reason of the waves washing across, driving the boat out of canal into the swamps.

(4.) That a storm wave was blown up the seaboard all along the line from the Munnair northwards to Pedda Ganjam is very evident, 1st from the erosions of the sea bank and wash *inward* of breaches; 2nd from the rise of inland drainage to unusual height, and 3rd from the testimony of all the villagers along the coast line, who state that the water was absolutely sea water at first, after which the land floods came down. It is also reported by villagers more inward, but along the swamped western borders, that but for the storm wave the land floods should never have risen upon their villages; and that the canal banks and closing of natural drainages are proving disastrous all along the seaboard villages. There should be no question about this.

(5.) The May's cyclone breaches were left unclosed at the several natural outlets; the November's cyclone has materially enlarged these breaches, indicating more waterway being needed for the drainage. The outside flood on west or land bank has been very high, due no doubt to the general breaching of tanks, and this is particularly observable along the Kundakur and Ongole Taluks limits, where the tank breaches are, I understand, very very extensive.

(6.) It has been practically demonstrated both in last May's and November's cyclone that till such time as regulating flood and drainage works and locks to shut out floods are constructed, it is best to have the canal unbanked at the confluences of all the extensive drainages. The low berms wherever made, have weathered out with very little damage indeed through both cyclones. The only fault in them is that the rear slopes are too steep, and that if made 3 or 5 to 1 will stand any flood, rising and falling freely over them.

(7.) The canal has materially shallowed on the whole, the result of the drainage being impounded by the storm wave, or otherwise a general scour might have resulted. The extensive breaches *inward* by land flood on one side and sea flood on the other have thrown the banks into the canal, and all these localities are badly filled up. The reaches most effected by general shallowing are that from Ramperoo to Gundlacumma, northern portion; that from Gundlacumma to Moosee, northern portion; that of the Moosee-Palairoo section as a whole blocked very seriously; that of the Palairoo-Munnairoo section as a whole seriously; that of the Munnairoo-Chippalairoo section northern and southern portions seriously effected by the rivers, and central portions on deep sand cuttings; that of the Chippalairoo river section as a whole; that of the Chippalairoo-Ramatheerthum section more or less, especially southern portion effected by the backwater and river floods. That of the Ramatheertham-Pennér section as a whole; that of the Pennér section through island as a whole and very badly blocked. That of the Pennér and Kundalairoo section in places only, and northern portion effected by the river.

I have no intention of closing any breach till such time as it is determined whether the canal is to be an open or closed one for present purposes.

The obstructions to navigation are being now first removed, after which the general deepening in most reaches will be undertaken so far as present grants will permit, and for the rest a special estimate will be submitted for which soundings will be taken as soon as obstructions are cleared for present emergency.

(8.) The highest level of November cyclone is on Moosee-Gundlacumma section as will be seen, the flood having risen to 14 feet owing to high floods of Moosee and Gundalcumma at ends and the impounded waters of the Mudigondy drainage centrally, which must have been greatly obstructed, till the banks gave up. The Kottapatam-Ongole road high embankment must have also helped to raise the outside flood level.

MADRAS,
25th December 1879.

(Signed) S. OTTMANN, Sub-Engineer,
In charge of Buckingham Canal Division.

No. 15. ORDER THEREON, 6th February 1880, No. 283 W.

ORDERED to be recorded.

(True Extract.)

(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Govt., P.W.D.

Exd. S. T. Austin.
Spare Copies

2036 W

17-9-11

GENERAL.
ESTABLISHMENT.

Govt. of (1880) Madras.

PUBLIC WORKS.

To

Dated February 6th.

Issued

Rec'd.

Encl.

G. O., 6th February 1880, No. 283 W.

FEBRUARY.
Nos. 14-15.

Buckingham Canal.—The Executive Officer's report on the damages sustained by the — during the cyclone of 18th and 19th November 1879, recorded.

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2036 W

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

6th February 1880, No. 284 W.

General.
Establishment.

Read the following paper :—

INSPECTION NOTES.

No. 16.

BUCKINGHAM CANAL.

Tour of Inspection lasted from 18th August to 6th September 1879, both days inclusive.

I propose to note in this memorandum the present state of the Buckingham Canal as well as the improvements which I would recommend to be carried out to render it thoroughly efficient. In the first place the surveys of the canal are far from satisfactory. They are in many respects meagre and having been done before the work was commenced or finished they are inaccurate. It is of great importance that a correct and complete survey of the whole line from Madras to the Rompairoo should be available. Careful surveys are required of the various rivers crossed by the canal with soundings, and tide registers must be kept on all the rivers and backwaters which are open to the influence of the tide. Orders have already been given on this point. Until proper information is obtained on both these points (not omitting maximum river floods) it will be impracticable to prepare in detail a scheme for the proper completion of the canal.

Surveys.

2. I will now commence at the Adyar and work up towards the north.

3. *Adyar.*—The lock on the Adyar, at the head of the southern canal, is a temporary structure, formed of stakes, sandbags, &c. It should, in the new scheme, be replaced by a permanent work, and it would be desirable to construct a dam across the Adyar.

4. On the left bank of the Adyar there should be a landing-place. The Sadras section ends at the Adyar lock and

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boats coming into the Junction Canal would, under the new rules, be called upon to pay a second toll for merely going perhaps to the Cooum.

5. *Junction Canal.*—The Junction Canal is very narrow, all the bridges have insufficient waterway and of some the headway is too small. They will certainly interfere with the traffic, should it increase. When there is a flood in one of the rivers only (as occurred lately) there is a strong current through the Junction Canal, which causes scour under the bridges. The channel is somewhat filled up, but at the bridges the canal is found to be deeper owing to this scour. Would it not be a good thing to arrange for closing the Junction Canal at pleasure? A channel should be dredged along the bed of the Cooum. The proper channel alignment would pass under Government House Bridge, then under St. Mary's Bridge, about a mile and a quarter in length.

Cooum.

6. *Junction Canal.*—The deposit in the Junction Canal is about an average of 9 inches, varying in depth from 2 feet 4 inches and 2 feet 1 inch near Ice House and Soongavaru street bridges to a few inches. There are 14 bridges across this canal. The headways of these vary greatly, and would appear to have been regulated by the road approaches; when traffic increases some will require alteration.

7. *Cooum.*—The Cooum from Marine Villa to Government House Bridge and thence on to St. Mary's requires to be deepened by 6 or 8 inches, but from St. Mary's to South Indian Railway Bridge and beyond it, the deepening required amounts to 15 or 18 inches. From the General Hospital Bridge to the Madras Rail Girder Bridge slight clearing is required. Some of the bridges, especially the South Indian Railway Bridge and the Salt Cotaur Bridge, require raising, as in their present condition they will greatly interfere with traffic.

8. *Lock at General Hospital Bridge.*—At the General Hospital Bridge it has been proposed, I understand, to build a lock. I presume this is intended to exclude some sewage from the Cooum. The lock will, I venture to think, be a considerable impediment to traffic, and the sewage cut off from the Cooum will be pent up in the canal between the Railway Station and the Shadiencoopum Lock. It would be better to get rid of this sewage by some other means and prevent it entering the canal at all.

9. *Canal between Central Station and Basin.*—Between the Central Station and the basin dredging is required, also tow-paths. A narrow strip of land is required on the west bank from People's Park and on the east along the Railway as far as the Elephant Gate Bridge. From the Elephant Gate Bridge nearly up to the bridge near the basin (close to the lime-kilns) both sides of the canal are occupied by the Salt Department; tow-paths are much required here and the Salt Department should be called upon to give up sufficient ground for this purpose.

10. *The Basin.*—The dimensions of the basin are utterly inadequate even for present requirements. When I arrived at Madras on 6th instant the bridge was *completely* blocked with a great number of large firewood boats, &c., and the basin, especially on the east side, was crammed with boats. This basin must be very largely extended, and I would advocate the formation of a basin right up to the rail bridge, a distance of about a quarter of a mile. Some land will have to be bought up on the margin.

11. *Rail Girder Bridge—from Rayapuram Station.*—The Railway Girder Bridge has fair headway; at the time I passed there was $4\frac{1}{2}$ feet of water and $10\frac{1}{2}$ feet headway, total 15 feet, occasionally the headway is only 8 or 9 feet.

12. *Canal up to Shadiencoopum Lock.*—Between the Railway Bridge and the Shadiencoopum Lock the channel is in fair order. It is silted up for about a foot or 18 inches with fine mud, which should be removed by dredging. There are two old masonry bridges with very insufficient headway on this part of the canal. They should be removed and replaced by girder bridges with ample water and headway.

13. *Shadiencoopum Lock.*—The Shadiencoopum Lock is at 7 miles 4 furlongs. The lock sills are 6·12 below M.S.L., while the chamber walls are $11\frac{1}{2}$ feet high. The flood of 1872 passed completely over the lock, being 1·86 higher than the walls or 7·24 feet above M.S.L. The cyclone flood of May 1879 was much smaller, 4·66 feet below this level.

14. *Shadiencoopum Lock to Ennore.*—The channel from Shadiencoopum Lock to Ennore in the 9th, 10th, and 11th miles passes through comparatively narrow parts of the Ennore lake. At 9th mile the Kortalayár falls into the backwater on the west side. On the east of the backwater, opposite mouth of river and for some distance north, there is a deep channel which appears to have been scoured out by the action of the Kortalayár floods. At the 11th mile a long spit runs out from west side of the backwater half way across the lake, this renders the course of the deep channel very tortuous. The lock at Shadiencoopum should be dismantled, a lock being built to replace it at Ennore (a new channel being made along the margin of the backwater) close up to the Catholic Chapel.

Lock proposed at Ennore.

The rise of the tide in the Ennore lake is not great, probably not much more than 1 foot. With the view of being able at pleasure to raise the water in canal reach between Ennore and Madras a sluice weir should be built 50 feet long, so as to take in water at high tide. The crest of the weir being laid at lake mean tide so as to take in water if required without passing it through the lock as at present.

15. *Canal beyond Ennore.*—From the 12th to 14½ the channel passes through a wide backwater with salt-pans on both sides. There are no proper tow-paths. The deep channel is very tortuous. This is a great obstruction to traffic, as the trackers have to wade; and with an adverse wind the only means of getting along is by poling. The canal should follow the east margin of the backwater and be completely enclosed, so as to be in no way affected by the floods in the Ennore lake. A lock should be built at about the 11½ miles, with a sluice weir, to give the canal the benefit of the tide at the Ennore bar. Through the 15th and 16th miles the channel is along an arm of the backwater flanked on east side by casuarinas and cultivated fields. The compensation for these fields would be rather high, but no great quantity of ground would be required. The deep channel is tortuous and there is generally speaking only 3 feet depth of water. At 17th mile the banks begin for the first half mile low, but afterwards they become high and irregular, sloping down to the water with much

prickly-pear growing on the slopes. Depth of water 3 to 4½ feet. At 19¼ mile this cutting ends where the channel enters the Chintamony backwater. At 20½ there is another cut, and at this point we find the bar of the Chintamony backwater which is high and very seldom open. This backwater at present gets the benefit of the Pulicat lake tide, but the water apparently only rises some 6 or 8 inches. I would propose that the channel should be banked across this bar opening. The cut at 20½ mile is much enlarged by action of floods. It has very high banks with the berms quite swept away and no tow-paths. It continues to the end of 21st mile, where it enters the Pulicat backwater. The east border is now planted with casuarinas till end of 22nd mile, where there are high natural sand banks close to the sea. At 25½ we reach Pulicat. I would propose to have a lock at Pulicat on the east side of the backwater, so that there would be an enclosed channel from Ennore to Pulicat 11½ to 25½. The lock would open out into the channel leading to the bar and would be provided (as all others along the line) with a sluice weir to let in sea water when tide was high.

Chintamony Backwater.

Pulicat Backwater.

16. In the 26th mile we reach Coromandel. Here there are a number of garden houses built close to the margin of the lake, so that we cannot find a suitable place for a lock at Coromandel till we reach the 27th mile stone; but this is of little consequence as from the bar channel up to this point there is very deep water.

17. *Pulicat Lake.*—From the 27th to the 44th mile the course is through the Pulicat lake. The east shore of the lake is very shallow and the towing of boats was very laborious owing to the indentations of the shore projecting far into the lake. To partially remedy this several cuts were made across these projections which considerably improved the course. The first cut is 7 or 8 miles long, beginning at 27-3 and ending at 34-7. In this cut at present the canal is confined by low flat berms which were much destroyed and breached during the late cyclone in May 1879. The depth of water varies much, from 4 to 6 feet. At the end of the cut a submerged bank extends some little way into the open lake.

18. The west bank in this portion is quite exposed to the action of the lake waves, which during heavy west and south-west gales are very high and powerful. Both banks have been seriously damaged, and at the ends where the channel enters the lake the canal is shoaled up to a serious extent. To maintain these ends open is found to be very difficult during the prevalence of the west and south-west winds over the broad surface of the Pulicat lake. A mile of the open lake has to be passed before the next cut is reached. The depth in this open part is 4 to 5 feet. The 2nd cut is nearly 3 miles in length, extending from 36th to near the 39th mile. It is very much shoaled up at both ends, the entrances have to be constantly cleared, yet there was only 3 feet water at the time that we passed. On the east side of this cut is the mainland with a fine berm, turfed slopes, &c. On the west side the canal is bordered in some places by lagoons and in others by extensive foreshores. In fact a part of it is through a neck of land. The depth in the cut varied from $4\frac{3}{4}$ to $5\frac{1}{4}$ feet. The north end of this cut runs out a long way into the lake with submerged banks. This part is much silted up, there being only 3 feet of water for nearly a mile.

19. The 3rd cut is entered at $39\frac{1}{4}$ miles. This is actually in the lake and is hardly a mile long. There was only 3 to 4 feet of water in it while the ends extend far into the lake with submerged banks. In these parts it is much shoaled, there being barely 3 feet of water. On leaving this cut about 2 miles of open lake have to be crossed with depth varying from 3 to $4\frac{1}{2}$ feet; near the 42nd mile the 4th cut is entered. I should have mentioned that on the west side of the 3rd cut there is no bank, but merely stakes with brushwood fencing to break in some measure the force of the waves. The 4th cut extends up to $44\frac{1}{4}$, where the village of Jonangipolliem is situated. On the east side there is lake water spread and low ground; on the west a low flat berm more or less destroyed, being artificial and exposed to the severe action of the lake. There was about 4 feet of water in this part. I would propose to abandon all these cuts, except No. 2 and part of No. 4, and follow the margin of the lake on the low ground, so as to form a most substantial bank on west side, and have, wherever

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practicable, a good foreshore outside the bank. No. 2 cut is a good one and I would retain the whole of it. Parts of No. 4 are also worth preserving.

20. *Canal beyond Jonangipolliem.*—From Jonangipolliem to Cusbah, a distance of $1\frac{1}{2}$ miles, there is a low flat berm on east side with tow-paths well turfed, but bank very slight. On the other side is a berm of 3 feet with bank washed away by cyclone flood; outside of this a wide expanse of lake. From Cusbah at 45-2 to Royadoravoo at 57-5 there is a fair channel, bordered on the west by a wide expanse of shallow water. (Lake.) The berms generally throughout are good, but the banks are more or less damaged and on both sides they need to be thoroughly made up.

21. *Detail observation forwarded with this report.*—I have got details of the whole canal throughout in survey form. These are being put together in a readable shape and when complete will be forwarded for reference.

22. *Royadoravoo to Dugarázpatnam.*—From Royadoravoo to entrance of Dugarázpatnam backwater, 57-5 to 65-5 the channel runs through a shallow backwater. Banks, &c., require to be made up on both sides with a few inlets for drainage.

23. *Dugarázpatnam Backwater.*—At 65-5 the present channel enters Dugarázpatnam back water, which it crosses to Dugarázpatnam. The channel across the backwater undefined and difficult. I propose to take a new cut along the west margin of the backwater so as to have the channel completely enclosed, an inlet and outlet being required to dispose of a drainage which now enters the backwater. This cut will extend for 5 miles up to Dugarázpatnam.

Sketch enclosed.

24. *Channel beyond Dugarázpatnam.*—The channel from Dugarázpatnam towards the north now in existence (69th to 73-3) is more or less in connection with the backwater, as only in parts is it provided with a bank on the east side, and those which exist are very weak and low. This it is proposed to thoroughly embank and provide a sluice weir in this bank opposite the bar at Kondoorpolliem, so that the canal may be supplied with water during the rise of the tide. At 73-3 the canal enters a cut through high ground,

banks rugged and berms damaged. At 74-3 the cut ends and we enter Pamanji backwater.

25. *Swarnamukhi River.*—At 75-4 the Swarnamukhi river joins the canal. This river originally discharged into the sea through a bar to the north, afterwards it changed its direction and discharged through a new mouth to the east. At both these places there are now bars which but seldom or ever open. Shortly after the canal was connected with the Swarnamukhi, the river instead of continuing to discharge through its original bar, possessed itself of the canal, and now discharges at intervals through the Pamanji bar and Dugarázpatnam backwater a long way to the south. From 75-4 to 77th the Swarnamukhi bed is used as the canal. The canal course through the river is difficult to maintain, and in parts the trackers have to wade in the water. At the time I passed there was a depth of 3 to $4\frac{1}{2}$ feet. Of course this part as well as the canal as far as Dugarázpatnam is occasionally subject to somewhat violent floods. At the point where the canal north of the river leaves the river bed the Swarnamukhi has two branches with a high bank between. It is proposed to bank up one of these and so force the river into one channel; close up the two cuts from the Swarnamukhi into the Pamanji; embank the south bank of the Swarnamukhi from these cuts to some high sand dunes near the sea; cut the Pamanji bar and thus force the Swarnamukhi through the above bar to the east. The canal is to be taken in a new cut from 75th to 77th miles. A lock being built on each side of the river to keep out river floods. There will thus be an enclosed reach of canal from Coromandel to Swarnamukhi supplied with sea water at Coromandel, Dugarázpatnam and Swarnamukhi. There might be five sluice weirs to supply the necessary water, placed at average distances of 12 miles apart.

Sketch enclosed.

26. At present the tidal rise in the Swarnamukhi appears to be not more than 8 or 9 inches, which water appears to be received from the Kundalairoo through the canal which is some 12 miles long.

The opening of the Pamanji bar, if it can be kept open, will greatly increase this rise.

27. *Swarnamukhi to Kundalairoo.*—The channel from the Swarnamukhi to the Kundalairoo, 77th to 89-6, is generally good, with high banks and tow-paths, but the channel is too narrow in parts and sometimes unnecessarily winding. There is not sufficient berm and if the channel is ever considerably widened (which we may look on as certain to be requisite) the widening will be expensive, as one bank will have to be removed. The channel is shallow in parts and must be deepened. With the exception of field drainage from certain wet cultivated lands there is none in this section. Before the present cut joins the Kundalairoo the canal follows the course of an old drainage and is consequently tortuous and formed with many curves.

Entrance to Kundalairoo. Sketch enclosed.

The entrance to the river was well situated for the previously intended north canal, but it does not suit the present canal as the river has to be followed for nearly a mile. The mouth of the cut cannot be maintained deep.

28. I propose to abandon about half a mile of the canal and run a new channel from the point (half a mile away from the river) straight across through low ground nearly opposite to the entrance of the north canal. The canal from the Swarnamukhi will be enclosed with a lock and sluice weir at each end. This reach will be $12\frac{1}{2}$ miles long. The Kundalairoo river is very deep; the bar always open; tide rises fully 3 feet. Large ships of 300 or 400 tons enter this estuary to refit.

29. Mouths of the present cuts have silted up 2 feet. At high tide in the river there is fully 7 feet of water, while at the mouth of the cut there is only 5 feet. Where the north canal leaves the Kundalairoo there will also be a lock. It would be as well perhaps if a "nose" was run out from extremities of canal, some little distance into the river, so as to check this shoaling.

30. *Canal north of Kundalairoo.*—About half a mile from the river we reach Kistnapatam. At 92nd the new cut joins the old channel. The new cut is deep throughout with tow-paths. There are however no banks; backwater and low ground on both sides. There is a basin at this place, but it is far too small, not

wide or long enough. The present one is also damaged at the ends from boats striking against the laterite masonry.

Through Kistnapatam backwater for about a mile the banks of the canal are destroyed, and the channel much silted up (as much as 2 to 3 feet), all this requires to be embanked.

31. From 93rd mile to 94th also the banks require raising, &c. From 94th to 95½ the channel is in deep cutting, banks high, tow-paths good, &c. From 95-4 to 97-6 the Nellatoor drainage is crossed and recrossed many times. The banks and tow-paths in this section require completion and the drainage must be provided for. It is not however a large one. It is crossed for the last time at Ananthapurum. The depth of water in the canal varies from 3 feet opposite to the Nellatoor bar, where the banks breached; to 6 and even 7 feet in other parts. From 97-6 to 100-6 the channel is in deep cutting with high banks, fairly planted with rabbit wort, tow-paths good.

Nellatoor Drainage.

32. *Kodoor Drainage.*—At 100-6 we reach the Kodoor backwater which continues till 102-4. Banks are generally wanting through this section. At 102-4 to 111 the canal again passes through a deep cutting with good banks well planted, tow-paths on both sides. A few field drainages have alone to be provided for.

33. *Gungapatam Drainage.*—At 111 the Gungapatam backwater is entered. In the next 1¼ miles this backwater is crossed twice. At 112-2 there is a bar where an inlet and outlet would be desirable. After this for the space of a mile the banks are high and good, but only partly turfed.

At 113-2 one of the old Pennér channels is crossed. This old channel might readily be banked out at the point where it leaves the river.

34. *Pennér River.*—At 115 we reach the Pennér river. In this portion the east side banks are all low, while on the west side parts are high. The channel crosses the Pennér right branch to a large island; this is passed by means of a cut a mile long which cannot be properly maintained. At low tide it has scarcely a foot of water and large sums have to be spent yearly (some 8,000 to 10,000 rupees) in maintaining it simply in its present

Sketch enclosed.

inefficient condition. In addition to this, in front of the entrance of the southern canal a long shoal has formed, which necessitates a long detour for vessels. It would be better, I think, to cross the river some 1½ or 2 miles higher up in the neighbourhood of Utakoor, where there are no islands and the river runs in one bed. There is a ferry at this village, and it is understood that the tide runs up the river several miles. Survey of the river is required with its islands and shoals, and cross sections should be taken from present crossing point up as high as Utakoor.

35. Between Utakoor and the present canal mouth the river runs in three streams, there being two islands with a shallow stream between. It might perhaps be feasible to close this centre stream, and so help to keep clear the other two and remove shoals which form in them.

36. If the river was to be crossed higher up, as proposed, the ends of the present north and south cuts would be useless, as the north and south channel would have to leave the present channel fully half-a-mile from the river and curve to the west. The new enclosed channels north and south of the Pennér might be supplied with sea water through the present mouths where sluice weirs could be built. The island cut would also be abandoned. In the cyclone flood the Pennér rose 10 feet above true bed of canal, but in 1874 the flood must have been far greater than this.

37. *Canal north of Pennér.*—The canal on the north of the river commences at 117-2. The channel has silted up 1½ to 2 feet owing to the floods of the Pennér. Up to 119-4 the banks of canal are high, but then there is a breach caused by the Ramatheertham drainage. This was banked up and an attempt made to take it into the Pydaru, but the bank across the drainage was swept away during the late cyclone. There is at present a rough bank which has been formed from recent clearings. Banking up the Ramatheertham and running it into the Pydaru I think inadmissible. It would probably not be successful and it would certainly cost a great deal of money as the ground between is high. Moreover, it would increase the difficulties of dealing with the Pydaru, which are not small as it is.

Ramatheertham Drainage.

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38. The canal at present passes too close to the Ramatheertham bar, it should cross the drainage where cutting ends at 120-1 and join cutting other side, quarter of a mile up. The channel appears to have silted to a depth of about 2 feet. Up to 121-5 canal continues through deep cutting, banks turfed and planted, but more planting required here and there.

39. *Pydaru Backwater.*—From this point the canal follows generally the bed of the Pydaru. On the east side the canal runs along border of high ground, while on the west side it is separated from the backwater by a low and weak bank. At 123-4 we find the Pydaru bar. It would be better to cross the Pydaru close to the bar, and skirt the margin of the high ground to the east. The ends of the canal proper would then be brought much closer together. In the survey the canal is shown as having a fine curve at this point, but as a matter of fact there is an abrupt turn forming about a right angle. A weir should be provided as an outlet from the Pydaru River crossing. Pydaru at this point. This will have to be large as the Pydaru appears to drain about 110 square miles of country. After crossing the Pydaru stream the canal continues (till it reaches Eskapally backwater, 126th mile,) with high ground on the east, and broad expanse of water on the west. Banks on both sides are somewhat low, being 10 feet above bed. The channel might, I think, have been taken with considerable advantage somewhat nearer the sea.

40. *Eskapally Backwater.*—Across the backwater the banks have been almost washed away by cyclone of May last and they are now but 6 inches above the water. They are chiefly composed of oyster shells. This being so, tracking (especially with a west wind) is rendered very troublesome as the shells cut the feet of the trackers. The deep stream in the backwater is at 126th mile $5\frac{1}{2}$ furlong.

41. At 127-4 we reach the Eskapally bar, the drainage here is banked across. Some parts of the canal are in deep cutting, others through low ground with banks. At 129th there is the Tullipaliem bar. In this section there is a cut on the west to take the drainage into the Chippelairoo further on. This, like all the others, is not large enough, the waterway is very insufficient.

42. *Chippelairoo River.*—It is at 130 miles $3\frac{1}{2}$ furlongs that the canal first crosses the Chippelairoo (a branch of which runs almost parallel to the coast), it then enters a cutting for three or four furlongs, emerging whence, it crosses it a second time. The drainages at both these places are banked across. The canal runs in this way close to and occasionally crossing the Chippelairoo till 132-5, where it enters the main Chippelairoo river. Banks good in parts, but sometimes weak.

43. At 132nd the branch of Chippelairoo is again banked across. Where the canal enters the river two "noses" are run out far into the river, too much across the stream. Canal line should, I think, run further inland.*

* As shown in Sketch.

Accurate survey required of this river. The crossing of the Chippelairoo is exceedingly troublesome and lengthy. In the canal some distance before it reaches the river the depth of water is 6, $6\frac{1}{2}$ and even 7 feet, while at and near the mouth it shoals to 3 or 4 feet. The distance to be passed in the river is nearly a mile. Great difficulty is experienced in entering canal on both sides owing to the shoaling up of the entrances. At the mouth of the north canal there is only 3 feet of water, and at 3rd furlong only $4\frac{1}{2}$ feet. Both banks from river to 133-7 require raising to keep out floods. It seems to me that some of the present canal should be abandoned and the canal taken inland, furthest point being about one-fourth of a mile from where it now is. In all this I speak under correction as no trustworthy surveys are available for study.

44. 134th mile passes through low land on east and paddy fields. 135th, banks good, but require raising as they are subject to Chippelairoo floods. The Chippelairoo might perhaps be banked from canal to sand ridges on the west and the local drainage let into the canal or, if necessary, across it. At high tide the depth in canal $6\frac{1}{2}$ to 7 feet.

45. 136th.—Banks, &c., good up to the village of Nadumpally.

From 137th for a distance of 5 miles the canal runs in low lying ground, situated between sand ridges parallel to one another, at a distance of a few furlongs. Drainage immaterial, but still needs some small inlets into canal. The banks are fairly

good, but want raising in parts. After this the canal enters a deep cutting which is partially filled up with drift sand, &c. At the 3rd furlong (142-4) the cutting is nearly 20 feet deep. High banks turfed and planted with rabbit wort. Tow-paths 3 feet wide, depth of channel varies from $4\frac{1}{2}$ to 6 feet.

46. *Ramapatam River.*—Up to Ramapatam river, at 148-3, high banks, partly turfed and good, tow-paths mostly completed. Drainage channels outside to divert drainage have insufficient waterway. At 147-4 the banks for a short distance are weak, having been washed away partially. At this point the depth is only $4\frac{1}{2}$ to 5 feet, whereas a furlong further each way the depth is 6 feet. Laterite is found in this cutting. The Ramapatam backwater is crossed at 148-3. This was previously banked across up to tow-path level. It is now open. Inlet and outlet required here. The Ramapatam bar is opposite 149-2 where the banks are low for a quarter of a mile and require strengthening. With this exception, past Ramapatam temporary rest-house to 150-7 the banks are good, tow-paths formed and well planted with rabbit wort, but in the channel bed we find a great quantity of muddy slush brought in by the Elikeru drainage crossed about 2 miles further on.

47. *Elikeru Drainage.*—The Elikeru was also banked across, but it was breached during the cyclone of May 1879. There are two branches of the Elikeru: one might be substantially banked while the other should be provided with outlet to discharge the whole drainage through the bar. Up to 152nd mile the ground continues low, but at that point a sand ridge running from the west joins the canal. From 152nd up to the Manneru (160 miles 2·3 furlong) it runs through this sand ridge in a deep cutting of fine sand. Rabbit wort has been planted all along, but has not thriven equally well. Tow-paths have been formed. One to two feet of sand has formed in the bed. It is, I fancy, chiefly drift from the banks. All this should be removed.

48. It would be well, I think, if palmyra trees were planted all along the banks in these sections. Two grasses grow well on the slopes of this canal, Toonga and Woolsa.

Manneru.—From 159-4 to 160-3 the Manneru runs parallel to the channel; as the channel approaches the Manneru it is found to be very much silted. The proper depth of water at high tide should be 7 feet—

Sketch enclosed.

The line of canal might be altered as shown in sketch. This can be considered when the surveys are ready.

while at 159-6 it is only 5 feet.

159-7	$4\frac{1}{2}$ "
160	4 "
160-2	4 "

and at junction $2\frac{1}{2}$ to 3 feet. On the other side of the river at entrance to canal it is $3\frac{1}{2}$ to 4 feet, and this depth is continued all the way to the Pakala backwater, 166th. In the 161st mile the banks are low. The Manneru left bank might, it is thought, be embanked with advantage from the canal up to ridge near Binganapalle to prevent the spill of the river. The Manneru drainage basin is 1,245 square miles, the river is however not much more than a furlong in width. Although the Manneru is crossed by canal at 160-$\frac{2}{3}$ the bar is found to be opposite 161-$\frac{6}{7}$ a mile and-a-half further north, the Manneru working considerably to the north. At 162-3 another drainage crosses the canal. This might be diverted to 161-$6\frac{1}{2}$ and outlet provided so as to discharge it through the bar. Banks good in parts, but washed away in places. A salt creeper grows well here, it is somewhat similar to the rabbit wort. The natives called it merely "Oopu Tega," or salt creeper. Owing to the floods of the Manneru the banks require raising to the extent of perhaps 3 feet.

49. In 163rd mile the banks, &c., are good, but more planting and turfing is required.

Pakala Drainage.—164-$4\frac{1}{2}$ there is a bar of the Pakala drainage very close to the canal. Cross banks require strengthening.

At 166th to 166-2 there is a second Pakala bar; bank here very weak and almost destroyed. There is a large swamp on the west side of the canal. The bar is very low and close to the canal, east bank of canal is much exposed and must be remade very strong.

The Paleru spill water now falls into the Pakala swamp. The Paleru should

be embanked from canal bank to Pakala tank bank, and then there will be only a small quantity of drainage to be disposed of into or through the canal.

50. In 167th mile the banks are good. The whole country above the canal on the west is occasionally flooded from the Paleru and the Manneru so that the west bank is required high and strong. It is sufficiently so nearly every where. It should be 15 feet above bed of channel. The cyclone flood which was not particularly severe rose to 10 feet. In this section "Eela," a salt shrub, grows on the berms.

51. *Paleru River.*—The river Paleru (drainage area about 767 square miles) is met at 168th mile $\frac{1}{2}$ furlong. This river a few years ago, before the canal was made, was 8 or 9 feet deep at low-tide, it now has barely 2 feet at the same period; since it was connected by the canal with the Moosee it has shoaled up from the Moosee water entering the Paleru by means of the canal, the Moosee being more frequently in flood than the Paleru.

The drainage area of the two rivers is approximately—

	SQ. M.
Moosee	1,011
Paleru	767
	1,778

52. *Cut between Paleru and Moosee.*—

Sketch enclosed.

The cut between the Paleru and Moosee cannot, I fear, be avoided. It silts up terribly and will be a constant source of trouble and expense. Depth at low tide $2\frac{1}{2}$, $2\frac{3}{4}$, and 3 feet; banks and tow-paths are good, but the slopes are affected by the floods.

53. *Moosee River.*—At 169th mile we reach the Moosee. Crossing is difficult. The Moosee has a very winding course. It would perhaps be advisable and feasible to straighten the river by a new cut as shown in sketch attached. The river crossing is about 3 furlongs in length. At the entrance of the south canal the depth at low tide is $2\frac{1}{2}$, 3, $3\frac{1}{2}$ feet. In the river there is 5 feet while at the north entrance into canal the depth is 4 feet.

54. The Moosee spills over the country and comes down on banks. The banks

are good, but the cut between the rivers is greatly silted.

55. From 170th to 175th the banks are high, good and turfed. The tow-paths are all right. The course of the Moosee for nearly 2 miles above the canal crossing is generally parallel to the north canal, no where 3 furlongs distant and at two points hardly a furlong away.

From 175th to 177th banks are good, fairly turfed, tow-paths complete; depth of water 6 feet, shallowing to 5 feet near the Thondairoo at 177·1. The west bank is exposed to great floods from the spill waters of the Moosee. At 177-$1\frac{1}{2}$ we enter the Thondairoo. On east side there is no bank, and the channel is very shallow for 5 or 6 furlongs. Our boat went aground here although drawing less than 2 feet. Depths of water 3 feet, 2 feet 3 inches, 2 feet, 1 foot 10 inches, $2\frac{1}{2}$ feet from 177-$1\frac{1}{2}$ to 177th 3 feet. From 177-3 to 177-6 3 feet and at 177-$6\frac{1}{2}$ $2\frac{1}{2}$ feet. There is a side drainage channel here, its capacity is quite inadequate.

Thondairoo Drainage.

56. The spill waters of the Moosee, I understand, stretch from the canal westward to near the trunk road, a distance of 4 miles, and cannot be relieved by so small a channel flanked by high ground.

57. The Thondairoo (Kottapatam creek) could and should have been avoided or, at any rate, the canal taken along its east border. At 178-$2\frac{1}{2}$ we reach the wooden bridge of Kottapatam. It is very shaky and unsafe. It is of insufficient span; should be removed at once and replaced by an iron girder bridge. The site of basin close to the bridge. It is proposed to have the basin enclosed with a narrow entrance at right angles to the canal. It would, I think, be preferable to have the basin simply an enlargement of canal. No fresh water is to be obtained at this important station. The water supply is distant $1\frac{1}{2}$ to 2 miles. Provision for water-supply on the spot is highly desirable. On east side of the canal there is low ground with a drainage side channel which leads north connecting the low ground with next swamp. Banks here small. The west bank is high with tow-paths. Kottapatam swamp being behind. The

Kottapatam Bridge and Basin.

rise of the tide appears to about 2 feet in this reach.

58. 179th mile.—There is no bank along east side for three-fourths of a mile, but merely an artificial tow-path 3 feet above water. East swamp behind requires inlet into canal. It was banked across, but the cyclone made several openings. Tow-paths eroded in rear. West bank high, but unfinished. Kottapatam swamp behind the floods in this, I am told, rise high.

59. 180 to 182.—East bank low, unfinished and unturfed; high ground beyond. West bank, high, but unfinished and unturfed also. Kottapatam swamps behind; also Beerangoonta salt-pans on west side, on borders of swamp.

60. *Mootoomala Creek.*—At 183-2 we reach Moodegonda or Mootoomala creek bar. The drainage area of this creek is estimated approximately at 146 square miles. In addition it receives spill water of Moosee and Kottapatam swamp; a large inlet and outlet required here. Near the Moodegonda on west side ground, for half a mile to the north, low and swampy; banks and tow-paths are good on both sides; turfed, but the turf has got covered with drift soil from inland.

61. At 184 we reach another branch of Moodegonda drainage. It is banked across. This also will require an inlet and outlet unless it is carried by a cut to the one proposed at 183-2. The banks are high, partially turfed; tow-path 3 feet above water; swamp to the west and drainage not relieved up to 185. When Moosee is in flood it spills over. In fact the Moosee requires a more extended channel. It is believed that since the construction of the canal the Moosee has improved, as the bar now keeps continually open and this was not the case before. The improvement of this river—indeed all the rivers between the Pennér and the Gundlakamma—must be taken in hand and every exertion made to improve their channels and bars.

62. *Gundlakamma River.*—The Gundlakamma river is at 187th mile. This has a drainage area of about 4,500 or 5,000 square miles. A lock will have to be built on either bank in connection with sluice weirs. The bar is always open and the floods are considerable. The river runs to the sea in only one channel.

63. I may mention here that I propose to have a lock on each side of the Manneru, one on south bank of the Paleru and one on north bank of Moosee. Two will be required on the Gundlakamma, and one where the channel enters Rompairoo. Thus, including the Adyar, I propose 18 locks. About a mile from the Gundlakamma we reach an old branch of the river which has been banked across. It is much silted and will probably shortly get silted up altogether. At present there is a drainage cut on west side of canal, connecting old channel with the river; this should be closed. A mile beyond this old channel a sluice is required to supply salt-pans.

64. From 188 to 190-6 banks, &c., are good; at this latter point we enter the Kanuparti backwater, at the mouth of which there is a long, low bar. The channel follows this creek for about a mile and, as a consequence, twists about very considerably. The channel should here be rectified. It should, I think, run from 190-4 more to left, cross the creek at 191-4 near the ferry and join the other channel at 192-1. The channel would be much improved, awkward curves got rid of and one-fourth mile in length saved.

Kanuparti Backwater.

65. In 192nd to 194th miles the banks are not quite completed or completely turfed. Side drainages are also obstructed. Sand ridges on both sides. Tow-paths complete. Depth of water in—

192nd	...	6 and 5¾ feet.
193rd	...	5½ and 5 feet.

66. *Creek at Chinna Ganjam.*—At 195th the canal crosses Chinna Ganjam creek. An inlet or outlet is proposed for this drainage 500 feet in length (proposed by Kistna Engineer).

67. *Junction with Commamoor Canal, Kistna.*—At 195-1 is the point where the Buckingham Canal will join the Commamoor Channel a short distance below the lock now in course of erection.

68. *Rompairoo.*—At 196-3½ the Buckingham Canal joins the Rompairoo; banks incomplete, but fairly good. They extend, I think, too far into the waterway of the Rompairoo. From this point up to the temporary lock into the Commamoor Canal near Feringy Dibba is about 2 miles. There is already a considerable traffic along the Rompairoo to Vetapolliem on the

sand ridge beyond Chinna Ganjam. Lock necessary where Buckingham Canal joins the Rompairoo, and it would be well to have a channel to the Chinna Ganjam salt-pans.

69. At present no attempt has been made to control the rivers crossed by the canal so as to prevent their floods entering it. These floods cause enormous quantities of silt and sand to be deposited on the bed of channel. Such attempts as have been made to deal with the minor drainages have usually been ineffectual and may be considered as a general rule failures. The channels to lead them in other directions have usually proved insufficient and the result has been that the banks raised across the drainages have been swept away causing great damage to the canal. It should not be forgotten that the damages now mentioned are those caused by a cyclone certainly, but it was as regards rainfall not a very severe storm other cyclones have been much worse so in future we may expect to experience far more serious storms and far heavier falls of rain and the damage to the canal if left as it is, will be proportionately greater. I propose to entirely exclude the larger rivers from the canal by the construction of a lock on each bank. I would arrange to keep the water in the canal up to high tide by providing at or near each lock a sluice weir of same width as canal, say 50 feet with its sill on M.S.L. At each tide sea water could be let into the canal to bring it up to high tide level and replace the water which had in the interval been expended either by lockage, leakage or evaporation. If $4\frac{1}{2}$ feet were taken as the maximum depth required at present the canal need only be excavated to $4\frac{1}{2}$ feet below ordinary high tide or say 5 feet and a foot or 18 inches of expensive deepening could be dispensed with. This would allow of boats drawing $3\frac{1}{2}$ to 4 feet passing the canal. As it is possible when the canal is extended to Calcutta (which I take for granted is a certainty in the future), a greater depth of canal will be required (perhaps up to 6 or $6\frac{1}{2}$ feet). I would build the sill of the locks $1\frac{1}{2}$ feet lower than the present proposed bed of canal, so that when it is found necessary to deepen the canal, no alteration would be required to the locks. The locks and sluice weirs must be so arranged as to completely exclude floods of river as well as to retain level in the canal at spring

tides, and with this object the locks must be provided with a double set of gates. Of course these gates will require abutments of the strongest masonry; but the heel-posts of each couple of gates must be built as close together as possible to avoid superfluous masonry; and with this object the heavy wooden levers now used for opening the gates of locks in Godávari and Kistna must be dispensed with in the Buckingham Canal locks and some other expedient adopted for opening the gates. The chamber walls between the gates need not be of masonry, and the floor between the gates need not be very massive, as a rule the difference of level between the canal and the rivers will be slight and the velocity of the water entering the lock will be small. The banks might be substantially constructed of earth with a core of puddle and revetted strongly inside. The floors might consist merely of 2 or 3 feet of concrete (hydraulic).

70. The drainages which it is settled are to be passed across the canal should be provided with inlets and outlets, water not to rise more than 2 or 3 feet above high tide. Hitherto the rivers when in flood have been allowed to wander along the canals and pass into backwaters, &c. By providing locks and making other improvements in the way of banking and training, the floods, so to speak, will become more concentrated; they will scour out deeper channels and the bars must necessarily from this action, it is thought, be improved and, as a result, the tides in some of the rivers will have a greater range than before.

71. The level of bed of each section of the canal will be arranged with reference to the tide in the rivers or estuaries at the ends of each section. In Ennore, Pulicat and Dugarázpatnam section, the rise of the tide is comparatively small. In the Pennér, Kundelairoo, Gundlakamma and Rompairoo it is high being frequently something between 3 and 4 feet. Of course I am fully aware that there are objections to locks—

1st.—Expense of construction;
2nd.—Pay of establishment to manage them;
3rd.—Delay to traffic.

The first will, I consider, be more than balanced by the lesser depth required for the canal.

Locks have the great advantage of preventing to a very large extent the deposit of mud and sand in the canal. At present although the north canal has only been open two years the deposits already in the canal amount to a very large quantity in spite of the exertions made to remove it, and the large quantity of money expended with this object.

The delay to traffic will not be very great, in fact I question whether the delay due to locks will be anything like so great as the detention caused by deposits in canal, and contrary winds in crossing lakes. Tidal observations are now being taken on all the rivers and lakes crossed by the canal. The only (at all reliable) registers kept were those for Pennér, Kundelairoo, and Rompairoo.

The disadvantages of having no locks.

1*st*.—Canal must be cut and kept deeper.

2*nd*.—Boat basins more expensive.

3*rd*.—Maintenance far more expensive owing to silting and slopes washing in.

4*th*.—Branch channels more expensive.

5*th*.—Many parts of spoil banks unnecessarily high.

72. I subjoin a few general remarks as to the action of the various tidal rivers, &c., crossed by the canal.

Rompairoo and Gundlakamma keep the sections between those rivers in good depth. Between Gundlakamma, and Moosee, Palairoo 20 miles, tidal floods supplemented by Moondegonda Creek keep this section deep, except between Moosee and Palairoo which is very much silted.

Between Palairoo and Manneru the reach is 6 miles; served by both floods, their action has shoaled up the canal particularly at Manneru.

Manneru to Chippelairoo, the reach 27 miles, neither of tidal floods is very great and the latter bar closes some months in the year. Chippelairoo to Pydaru is 10 miles. Tide floods small, latter bar not always open, but Pennér tides affect this part.

Pydaru to Pennér 6 miles, much silted up, and but for the help of the Pennér floods would be quite obstructed.

Pennér to Kundelairoo 25 miles.—Tidal range large in both rivers.

From Kundelairoo no open bar till Dugarázpatnam is reached 20 miles.

This tidal rise is not great, owing to small size of bar and large extent of backwater.

Kundelairoo floods run down to Soornamookhee 13 miles; rise in Soornamookhee about 9 inches (observed).

Dugarázpatnam flood about a foot.

Dugarázpatnam to Coromandel.—Tidal flood, no great range and that only at ends for a few miles nearest the bars.

Pulicat tide apparently rarely rises to 18 inches.

Between Pulicat and Ennore no open bar. Pulicat tide runs to Chintamony backwater for 5 or 6 miles where it is lost. Tidal rise of Ennore lake varies considerably, never much more than a foot. The bar does not keep open throughout the year; the tide is felt at Shadiencoopum 4 miles to south.

Thirteen bars were open during my inspection:—

Ennore; this has since closed.
Pulicat.
Dugarázpatnam.
Kundelairoo.
Pennér.
Pydaroo.
Chippelairoo.
Manneru.
Palairoo, } Bar common to both rivers.
Moosee, }
Moodegonda.
Gundlakamma.
Rompairoo.

73. The information available regarding tidal ranges is very defective. In most of the rivers no gauge had been up to date of my inspection set up. Gauges have now been set up in all, and I have impressed upon the Executive Officer the great importance of correct registers. Before concluding this memorandum I may perhaps be permitted to remark that the limit of draught fixed for boats ($2\frac{1}{2}$ feet) is very small, and that it would be desirable to increase this to $3\frac{3}{4}$, the same as that for Kistna and Godávari. We should, I think, aim at making the minimum depth of the canal 4 or $4\frac{1}{2}$ feet. I understand that the British India Steam Navigation Company and other merchants contemplate placing steamers on the canal, and if their draught is to be limited to $2\frac{1}{2}$ feet their speed will be interfered with, as they will have to be made with very flat bottoms.

74. Mr. Executive Engineer Ottmann accompanied me in my tour up and down the canal, and I wish to state rendered me every assistance in his power, and furnished me with a great deal of valuable information. He has also assisted me by compiling the notes which I took in survey book form during my return journey. Although not a part of the canal, I may be permitted to remark that the lunkas or berms of the Commamoor Canal are now much covered with water and nanul grass, and this greatly interferes with the tracking. I would suggest that order should be given for the formation of towing-paths along this canal and cutting down the nanul.

75. I subjoin a statement showing approximately the drainage basin of the various rivers, &c.

Adyar.
Cooum 275 square miles.
Cortelliar into Ennore lake.
Pulicat lake drainage 1,859 square miles.
Area of Pulicat lake 280 square miles.

Perhaps 60 of them are islands, leaving 220 for lake proper; much of this very shallow, but in flood time the water can spread over this.

	Square Miles.
Soornamookhee ...	1,318
Kundalairu ...	1,170
Pydaroo	108
Chippelairoo ...	370
Manneru	1,245
Paleru	768
Moosee	1,012
Moodegonda ...	147
Gundlakamma ...	4,500 to 5,000
Pennér	20,000 or more.

(Signed) H. M. VIBART, Major, R.E.,
Ag. Supg. Engineer, Third Circle.

CHEPAUK,
27th September 1879.

To the Chief Engineer, Public Works Department.

No. 17. ORDER THEREON, 6th February 1880, No. 284.W.

ORDERED to be recorded.

(True Extract.)

(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Govt., P.W.D.

Exd. E. C. Shunker.
Spare Copies

4-9-81

W.30

GENERAL.
ESTABLISHMENT.

Govt. of [1880] Madras.

PUBLIC WORKS.

To

Dated February 6th

Issued

Recd. Encl.

G. O., 6th February 1880, No. 284 W.

FEBRUARY.

Nos. 16-17.

Buckingham Canal.—Inspection notes of the Superintending Engineer, Third Circle, on the —, recorded.

29

2036W

Appendix to G.O., No. 284 W., of 6th February 1880.

OBSERVATIONS BY THE CHIEF ENGINEER ON MAJOR VIBART'S BUCKINGHAM CANAL INSPECTION NOTES DATED 27TH SEPTEMBER 1879.

Paragraph 1.—The requisite survey establishment has been sanctioned, and the Superintendent of Works, Captain Awdry, is engaged in preparing the estimate for submission to the Government of India. Tide gauges have been established in all backwaters and open estuaries, as also at intermediate points along the canal.

2. *Paragraph* 3.—For sanitary purposes it is most desirable that the level of the water in the Cooum and Adyar rivers should, as far as possible, be maintained at 3·5 feet above mean sea level, and to do this the lock here proposed would be indispensible, as with the Covelong bar open (maximum rise of tide 2·92 feet above and low water 0·70 below M.S.L.) the water would otherwise escape through the southern canal. The necessity for constructing a dam here is not sufficiently apparent to warrant the work being included in the estimate as yet.

3. *Paragraph* 4.—Under the present arrangements for taking the tolls, the proposed landing place would not help traffic, but Captain Awdry has a proposal for altering the sections so soon as the channel shall be open as far as the Cheyoor backwater, which if combined with a proper opening, headway being given to the South Indian Railway bridge, would permit and encourage traffic through the Junction Canal.

4. *Paragraph* 5.—Appended is a detailed statement of the spans and headways of the bridges, the former being generally under 20 feet each, and the latter as low as 9·22 feet at M.S.L. The headway is thus only 5·72 feet when the level of the water is 3·5 feet above M.S.L., and is therefore much too low. The expense of altering all these bridges, fourteen in number, would be prohibitory for the present, but means should be found by corbeling or otherwise to provide an 18-inch wide board for the towing coolies to pass. To prevent water escaping from the Cooum when the Adyar bar is open, a lock should be built at south end of the Junction Canal. So long as it can be managed without injury to the channel or the bridges a scour may be provided for in order to remove silt.

STATEMENT showing the clear headway and span of Bridges over the Buckingham Canal.

Mileage from Basin.	Name of Bridges.	Minimum span at M.S.L. in feet.	Maximum height above M.S.L. in feet.	Remarks.	Height available above M.S.L. for boats	
					With tops 10 feet wide.	With tops 13 feet wide.
M. F.	*Bridges north of Cochrane's Basin.*				10·72	10·72
0 4	Ráyapuram Railway bridge ..	59	10·72	Iron girder bridge	9·60	9·40
1 4½	Washermanpettah bridge ..	43	10·00	Masonry segmental arch ..	9·58	9·36
3 6	Theroovattoor bridge	43	10·00	Do. do.		

Statement showing the clear headway and span of Bridges over the Buckingham Canal—*cont.*

Milage from Basin.	Name of Bridges.	Minimum span at M.S.L. in feet.	Maximum height above M.S.L. in feet.	Remarks.	Height available above M.S.L. for boats	
					With tops 10 feet wide.	With tops 13 feet wide.
M. F.	*Bridges south of Basin.*					
0 0	Basin bridge	50·00	12·52	Masonry segmental arch ..	12·17	11·94
0 4	Salt Cotaur bridge	29·66	*8·64	Wooden bridge	8·64	8·64
0 6½	Elephant Gate bridge	49·00	10·94	Masonry segmental arch ..	10·52	10·28
0 7	Central Station Railway bridge ..	64·00	9·35	Iron girder bridge	9·35	9·35
1 4¼	General Hospital bridge	49·00	11·04	Masonry segmental arch ..	10·62	10·38
..	South Indian Railway bridge ..	13·91	7·03	Wooden bridge	7·03	7·03
1 6	Saint Mary's bridge	29·00	11·49	Do. metalled ..	11·49	11·49
2 3	Government House bridge ..	32·00	10·40	Masonry segmental arch ..	9·74	9·53
3 0	Marine Villa	19·83	10·92	Iron piles rough stone abutments.	10·92	10·92
3 2	Chepauk bridge	19 62	10·92	Masonry segmental arch ..	9·92	9·17
3 6	Pycroft's road bridge	19·62	11·29	Do. do. ..	10·29	9·54
3 7½	Soonkarammah Street bridge ..	20·17	11·52	Masonry and wooden platform.	11·52	11·52
4 2	Ice House road	19·83	11·68	Masonry segmental arch ..	10·68	9·93
4 6½	Elliott's road	20·17	11·77	Masonry semicircular arch ..	10·44	9·35
5 0	Barber's bridge	27·33	9·71	Masonry and wooden platform.	9·71	9·71
5 3½	Moondacunny Covil road bridge ..	20·00	13·22	Do. do. ..	13·22	13·22
5 5	Cutcherry road	19·58	10·42	Masonry semicircular arch ..	9·09	8·00
5 5½	Brodie's road bridge	20·17	10·89	Do. do. ..	9·68	8·77
..	Poonthotum aqueduct	20·42	10·05	Masonry wooden platform ..	10·05	10·05
6 3	Yellapatha Mauda Covil road ..	20·25	9·22	Do. do. ..	9·22	9·22
..	Soolay Cauthoy Syphon	21·83	10·00	Do. do. ..	10·00	10·00
7 1½	Greenaway's bridge	21·00	13·03	Masonry segmental arch, skew ..	12·03	11·03
8 0	Guindy bridge, span excluding tow paths.	45·00	15·42	Masonry elliptical arch ..	15·17	15·09
10 0	Lattice bridge do. do. ..	43·00	12·14	Masonry abutments and wooden structure.	12·14	12·14
42 0	Sadras bridge do. do. ..	43·75	13·83	Masonry elliptical arch ..	13·58	13·50
45 0	Ismalpett bridge do. do. ..	35·00	14·75	Masonry semicircular arch ..	14·38	14·13

* The figures in antique show the Bridges having the least headway.

5. *Paragraph* 7.—Observations concurred in.

6. *Paragraph* 8.—A flood-gate which would form no impediment to traffic would answer all purposes.

7. The sewage of all the north portion of Black Town should unquestionably be diverted from discharging into the canal by an intercepting sewer, to be constructed by the Municipality.

8. *Paragraph* 9.—Agreed.

9. *Paragraph* 10.—Approved, but the question will require further study. Some of the present lime kilns which occupy the needed ground must be removed.

10. *Paragraph* 12.—New bridges should be provided for, but the removal of the present structures is not a matter of urgency.

11. *Paragraphs* 13 *and* 14.—This lock has not sufficient height to clear it in maximum floods, and is at least half a mile too far north. It will be necessary to remove this lock and take a new isolated channel from 6 M. 6 F. through the ground to the east as far as 9 M. 3 F. where there should be a flood-gate. By these arrangements the canal will be preserved from the effects of the floods of the Kortalayár and of the Red Hill tank drainage, from both of which it now suffers greatly at times.

12. *Paragraph* 15.—From 11½ to 20½ M. should be taken in a new isolated channel east of the backwater, with flood-gates at either end. The existing deep portion of canal between 17 M. and 19 M. might be included in this new line. Owing to the oozy nature of the bottom in the existing backwater, dredging would have no permanent effect.

13. The opening into the Chintamony backwater will have in any case to be left open for the free passage of flood water. From immediately beyond this point, and to the entrance of the lake beyond the town of Pulicat, careful study is required. So far as can

be judged, however, a feasible plan would seem to consist in making an isolated channel 4½ miles in length along the west margin of the backwater, between 20½ M. and 25 M., with flood-gates at either end.

14. I do not approve of the proposal to bank across the opening at 20½ M., nor to take the canal along the east margin close up to the bar; this would certainly be dangerous for boats during flood.

15. *Paragraph* 17.—The only apparent means for ensuring a sufficiently protected line along all this portion will be to take a new isolated line, as proposed, along the depression which commences a little north of the Pulicat bar. Some palliatives are feasible, *e.g.*, altering slightly the end of the south cut in the lake so as to carry it into deep water, but there is no radical cure apparently for the admitted difficulties of the present line, which is throughout exposed to the wide expanse of water on the west.

16. The only part of the line which can be considered as adequately protected between Pulicat and Cusbah is the short portion between 35 M. 7 F. and 38 M., and this of course can be taken into the new line.

17. From a peculiarity in the conformation of the Pulicat lake, it appears that, when the waters of excessive floods begin to subside, the canal from a little north of 36 M. acts as a surplus channel. A very beneficial scour is thus found to have been set up throughout the line to its southern debouchure in the lake at 27 M. This peculiarity should be turned to use for the new isolated line by the construction of a powerful head sluice in the west bank at 36 M., and a scour produced in the channel down to the bar whenever circumstances favor. A sluice with five or six openings, 6 feet wide each, would apparently suffice.

18. Whether a flood-gate would be needed at the southern extremity near the Pulicat bar is not as yet clear.

19. *Paragraph* 22.—From Cusbah, 45 M., northwards a strong west bank, well above flood level, is essential, and the canal should be isolated up to 68 M., where a flood-gate may be placed. An interval will here have to be left for the passage of flood water, and the new cut to the west of the backwater, as suggested by Major Vibart, made up to Dugarázpatnam, 69 M. This short portion will also need to be isolated by flood-gates at either end. The proposed basin at Dugarázpatnam should, as elsewhere, consist of a simple widening of the channel.

20. *Paragraph* 24.—If on further inquiry the drainage which enters at 71 M. 5 F. cannot safely be barred from entering the canal, a flood-gate must be placed a little north. I do not consider a sluice weir, as proposed here, to be suitable. Another flood-gate will be needed a little south of the Swarnamukhi river. This reach of canal, 4 miles in length, will thus, with the embankments proposed, be thoroughly isolated in case of flood.

21. *Paragraph* 25.—The crossing of the Swarnamukhi river is a complicated matter, and calls for further examination. So far as can be judged, Major Vibart's proposed deviation from a point near the village of Govindapulli to Mullapulli, combined with training the river by means of embankments and strongly constructed cross bunds east and west, appears to hold out the best solution.

22. *Paragraph* 27.—No remark called for further than that at either extremity of these 14 miles of canal flood-gates might with advantage be placed. It does not appear essential to make so long a deviation, (1 mile in length,) as proposed here by Major Vibart. If the present end of the channel as it enters the Kundalairoo river is turned east and north for about 2 furlongs, and made to enter the backwater close to the west of the Gungapalliem village, it will answer all purposes, as the backwater is believed to remain permanently deep at this point.

23. *Paragraph* 30.—The Kistnapatam basin must be extended as proposed. A flood-gate will be required south of the basin, and as regards the canal to the north, the banks must be raised and the channel isolated.

24. *Paragraph* 31.—At Nellatoor it will be necessary to cut a fresh channel for nearly two miles (95 M. 4 F. to 97 M. 6 F.,) a little east of the present line in rather higher ground, thus leaving the present channel free for the passage of drainage.

25. *Paragraph* 32.—The whole of the drainage here must be collected and passed across the channel at one point.

26. *Paragraph* 33.—Here again, of the three openings the central one must be kept clear for the passage of the drainage, closing the others.

27. *Paragraph* 34.—The Pennér river (114 M. 3 F. to 116 M. 6 F.) crossing is probably the most difficult matter to deal with in the length of the canal. Some Rs. 11,000 were spent in taking the silt out of the cut here (115 M. 4 F. and 116 M. 3 F.) within the first year of opening the canal, and in both the cyclones of 1879 not only has the same cut again silted up to within 9 inches of L.W.L., but the several branches of the river, five in number, show such a tendency to change their course that it has become a serious matter for consideration as to how the canal can here be kept open for traffic. Even were steam-dredges available, the canal would still be closed after each ordinary fresh in the river to all but top-boats and others of very light draft taking advantage of high tide, and the stoppage would be absolute after a cyclone flood of any intensity. No mere palliatives will therefore answer here, and my conviction is that the best and. in the end, by far the most economical course will be to train the Pennér in such a way from the head of its delta that the discharge shall take place entirely through its southernmost channel, closing all the others. This can be done by training the river from a point near the village of Utakoor, about three miles west of the canal, on the left bank. At the same time, groynes should be so constructed on the right bank, a little north of Kuddipalem, that the present line of river bank and the flood embankment within it shall be preserved from invasion. The left embankment would probably extend from Utakoor to the destroyed village of Palipalem. By this means not only would a sufficiently deep channel be always preserved in the southern branch of the river, but by closing the canal ends north and south with flood-gates, these would be preserved from the silting which now causes the difficulty. I do not consider that there should be any serious difficulty in training the Pennér as proposed, but further careful study of all the features is necessary.

28. *Paragraphs* 37 *and* 38.—Banking across the Ramatheertham drainage is inadmissible ; it will be essential to cut a new line, of about six furlongs in length, to the west of the present line, so as to avoid getting dangerously close to the bar.

29. *Paragraphs* 39 *and* 40.—As with the Ramatheertham so with the Pydaru (123 M. 6 F.) and the Eskapally (126 M.) drainages, free vent must be allowed across the line of canal, but a strong west bank to keep out floods should be constructed. Whether it will be necessary eventually to isolate each of these portions with flood-gates (that at 117 M. is essential) cannot however be decided with certainty.

30. *Paragraph* 42.—The plan suggested of training the river so as to occupy and deepen out its central channel, and further to make a new cut to the west, of about two miles long, through ground 3 or 4 feet above M.S.L., seem essential. Since the cyclone of May 1879 the existing channel through the backwater has changed no less than four times.

31. Flood-gates will be required, one north of the Chippelairoo, at probably 134 M. and another at the 148 M. 2 F.

32. *Paragraph* 46.—The Ramapatam drainage, which enters at 148 M. 3 F. might have its outlet to the sea barred permanently, and the drainage thus taken into the canal utilised with a view to bringing a beneficial scour to bear on the northern portion towards the Elikeru.

33. *Paragraph* 47.—As regards this drainage it will be best to embank across the northern outlet, placing a flood-gate at 151 M. leaving the present southern opening (150 M. 6 F. to 150 M. 7 F.) free to discharge by the open bar.

34. To prevent the silting of the channel south of the Manneru, a flood-gate will be necessary at about 160 M.

35. The spill of the Manneru floods over the left bank of the river must be stopped by an embankment, but the most essential work here, and one which there should be no delay in carrying out, is the deviation of the present channel for about three furlongs in length, as suggested by Major Vibart. Without any cyclone flood in 1878 some three miles of channel here silted up to a depth of over 2 feet with ordinary

freshets, and there can be no question that flood-gates are essential at both the Manneru and Palar ends of this reach of the canal.

36. *Paragraphs* 49 *and* 50.—Agreed. It is essential that the spill of the Paleru floods over its right bank should be barred by a strong embankment from the north end of the present Pakala bank as far as the canal.

37. *Paragraph* 51.—The short portion of canal, six furlongs in length, between the Moosee and Palar rivers, having silted up in both the May and November cyclones of 1879, barring navigation, some early and effective means must be found for curing the present defects.

38. Hand-dredging alone has not sufficed to allow of a passage being opened for any but boats of very light draft at high tide within two months after the last flood, and even then cargo boats drawing over 1′ 9″ have had to unload and have the goods carried by hand three-quarters of a mile. For a short time after the November cyclone there was a passage to the east, close to the united bars of the two rivers, but this did not last long. Had powerful steam-dredges been available, and at once set to work, a passage might no doubt have been opened at an earlier date, but at the best it may be assumed that, subsequent to each of the cyclones of last year, this portion of the canal must have been closed to traffic for five or six weeks ; it is thus clear that exceptional measures are called for to prevent as far as possible the recurrence of such delays, which if allowed to continue must affect very injuriously the traffic on the canal. Were it feasible to divert one or other river, so as to discharge both streams by a single channel into the sea, the difficulty now experienced would vanish, but as this means cannot I consider be adopted, it appears that the most effective and economical plan will be to excavate a second channel parallel to, and a little west of, the present cut, six furlongs long. This channel, measuring 15 feet in breadth at bottom and carried to $2\frac{1}{2}$ feet below M.S.L., should be excavated as soon as possible. When opened to traffic the existing channel should be closed, cleared and deepened, opened for traffic, and the new subsidiary canal closed by temporary banks and prepared to receive the traffic after the next flood. By thus working alternately on two channels alongside of each other a feasible palliative for the existing difficulties will at least be provided. No west bank will be needed for the new channel, all spoil going to form a high strong bank for the existing cut so as to insure its isolation. Flood-gates at each extremity of the latter will also be needed, if not indeed for both channels.

39. *Paragraph* 57.—The preservation and management of the stretch of canal from one mile north of the Moosee bar (about 170 M.) to the Gundlakamma river depends on the treatment of the spill of the former river during flood over its left bank. Whether it be feasible to train the river by means of a left embankment, starting from a point near the village of Tirupu Nayadipalum, and thus force the whole floods through the present bar, is not clear, but the subject should receive attention.

40. For the present, immediate relief will be given by cutting away entirely the banks which were injudiciously thrown across the Tondairoo creek at 177 M. 2 F. and again at 177 M. 6 F. The effect of any further flood will be to bring a beneficial scour to bear on the whole length of the channel northward, towards the Gundlakamma.

41. Should, however, the training bank for the left bank of the Moosee river as suggested prove feasible, it would in that case probably be desirable to cut a fresh channel for the canal in the four furlongs a little to the east, so as to keep clear of the Tondairoo creek as proposed by Major Vibart. There should be a flood-gate at the end of the canal as it enters the Moosee river.

42. *Paragraphs* 57 *and* 58.—The basin at Kottapatam may, as suggested, consist of nothing more than an enlargement of the channel to the east and north of the present bridge. This latter, though shaken by the November cyclone, is now sufficiently secure to last with repairs for some years, and though boats in passing it have to lower their masts, there is no serious inconvenience, as they invariably halt at the place.

43. The road dam immediately west of the bridge must be removed (as being much too close to the canal) to a point on the Ongole road 300 yards further west ; and be

there reconstructed 100 yards in length, lowest point of invert being 1 foot above H.W.L. The materials of the present dam will nearly suffice for the new, and the same style of tail apron should be employed. The western embankment of the canal (south of the bridge) should be much strengthened, and the road well raised over the site of the present dam, so as effectually to prevent any future invasion by flood water. The laterite bridge, which with its nine elliptical arches of 18 feet span carries off all the residue of the Tondairoo drainage not vented by the canal, should be thoroughly repaired as its flooring is still sound. The unworkman-like additions made on either side of the arches to bear the parapets, and which were much injured by the November flood, must be removed and the roadway reduced to about $9\frac{1}{2}$ feet in width. The removal and reconstruction of the road dam above adverted to must be charged to the canal, but the alterations of the bridge ought to devolve on the Local Fund Board, who may also fairly undertake the construction of the proposed Moosafirkhana at Utapotu.

44. *Paragraphs* 59, 60, 61.—Northward from Kottapatnam (179 to 187 M.) the banks originally low have suffered severely during the November cyclone, first by the action of the storm wave from the east, there being no protecting "dunes" here, and second, from the land flood which supervened. But notwithstanding this destruction of the banks the channel has been, if any thing, improved owing to the fact that the surplus of the Moosee river flood vented itself through the Tondairoo creek, and finding its way into the canal scoured it throughout and cleared it of silt. Practically, therefore, little work is required in this reach. In a few places a strong, well planted, east bank will be needed to counteract the action of a storm wave; but on the west the less obstruction presented to the land flood the better, unless at some future time the expense of a sufficiently high and strong isolating west bank be considered essential. As matters stand, levelling down the bank as much as possible and bringing the tow-path into order is all that need be thought of. No vegetation seems to thrive here owing to the salt dust carried by the west winds which smothers and kills even the "woolsa" rush and the salt plant "eela," both of which thrive elsewhere. So long as the channel is not isolated no flood-gate is necessary at the Gundlakamma.

45. *Paragraph* 62.—The crossing of the Gundlakamma river calls for no special remark.

46. *Paragraph* 63.—As regards the proposals in this paragraph I have seen reason for the present at least to prefer flood-gates nearly everywhere to locks, the grounds for which will be found elsewhere.

47. *Paragraph* 64.—For five miles north of the Gundlakamma river the canal is exposed to serious wash, particularly at two places where bars opened in the November cyclone, and which must therefore be left free of any obstruction. To all appearances, however, the spill water from the Gundlakamma might, as suggested by Sub-Engineer Ottmann, be effectually checked by constructing a strong training bank along the left bank of the river, two or three miles in length, and diverting the drainage from the Kanuparti swamp. The alternative to this plan would be to construct a strong west bank all along the canal. In addition to protection on the west, a well-planted east bank is also needed at two places, but only for short lengths. Major Vibart has suggested an entirely new channel between $199\frac{1}{2}$ and $191\frac{1}{2}$ M. but as the object here must be to get sufficiently inland from the Kanuparti bar, to which the present line is dangerously near, it will suffice to make the new cut to the westward of only three furlongs in length at a distance of 200 yards from the existing channel.

48. *Paragraphs* 66, 67, 68.—Little remark called for. It may be doubted whether the position of the new lock at Feringy Dibba has been judiciously selected, and whether, looking to the great drainage which sweeps over the whole country south of Santaravoor, it would not have been safer to have given another flight to this latter lock, and dropped the canal thus direct into the Rompairoo drainage. It is now however too late to suggest any alteration of the arrangements here.

49. *Paragraph* 69.—The reasoning here employed by Major Vibart in favor of isolating the different reaches of the canal which intervene between drainages that cannot safely, particularly during flood, be barred in the passage to the sea, derives additional force from the effects of the November cyclone which followed on the

one which occurred in May and which is the subject of his report. But there is such a strong and, it must be admitted, well-founded objection to the delays inseparable from locks, added to the great expense of first construction and subsequent working, a regular establishment being necessary for each all the year round, that I have proposed for the present at least to construct flood-gates at the end of each reach. These would only be closed on extreme occasions to exclude silt and flood from the channel. They would be comparatively cheap in construction, could be made portions of locks at any future time should such be considered requisite, would in no way interfere with or delay traffic, and need only have a small establishment to look after them in the cyclone or flood period. Inlet weirs I also see no immediate necessity for, but the depth of the canal and even its section may now with advantage be much diminished to meet actual requirements. These and other subjects will however be discussed in a separate paper.

50. *Paragraph* 70.—The training of the several large drainages, and the necessity for a special study of each case, has been sufficiently pointed out in the above remarks, but here, as elsewhere, Major Vibart seems to favor the use of inlets and outlets of masonry for the disposal of minor drainages. I very much question the applicability of works of this character to the canal, as in hardly any case is there means of securing a proper outfall for the water on the down or eastern side of the channel. There may however be a few cases in which the principle might be accepted, and where this is the case the plan might be tried, adding however a capacious silt trap on the upper or west side of the canal. This should be kept always clear. It seems to me that all drainages which cannot be effectually shut out and diverted into other lines must of necessity be allowed free vent at a level across the canal, and that everything in the shape of an obstruction would be a mistake.

CHEPAUK,
10th April 1880.

R. H. SANKEY, Colonel, R.E.,
Chief Engineer.

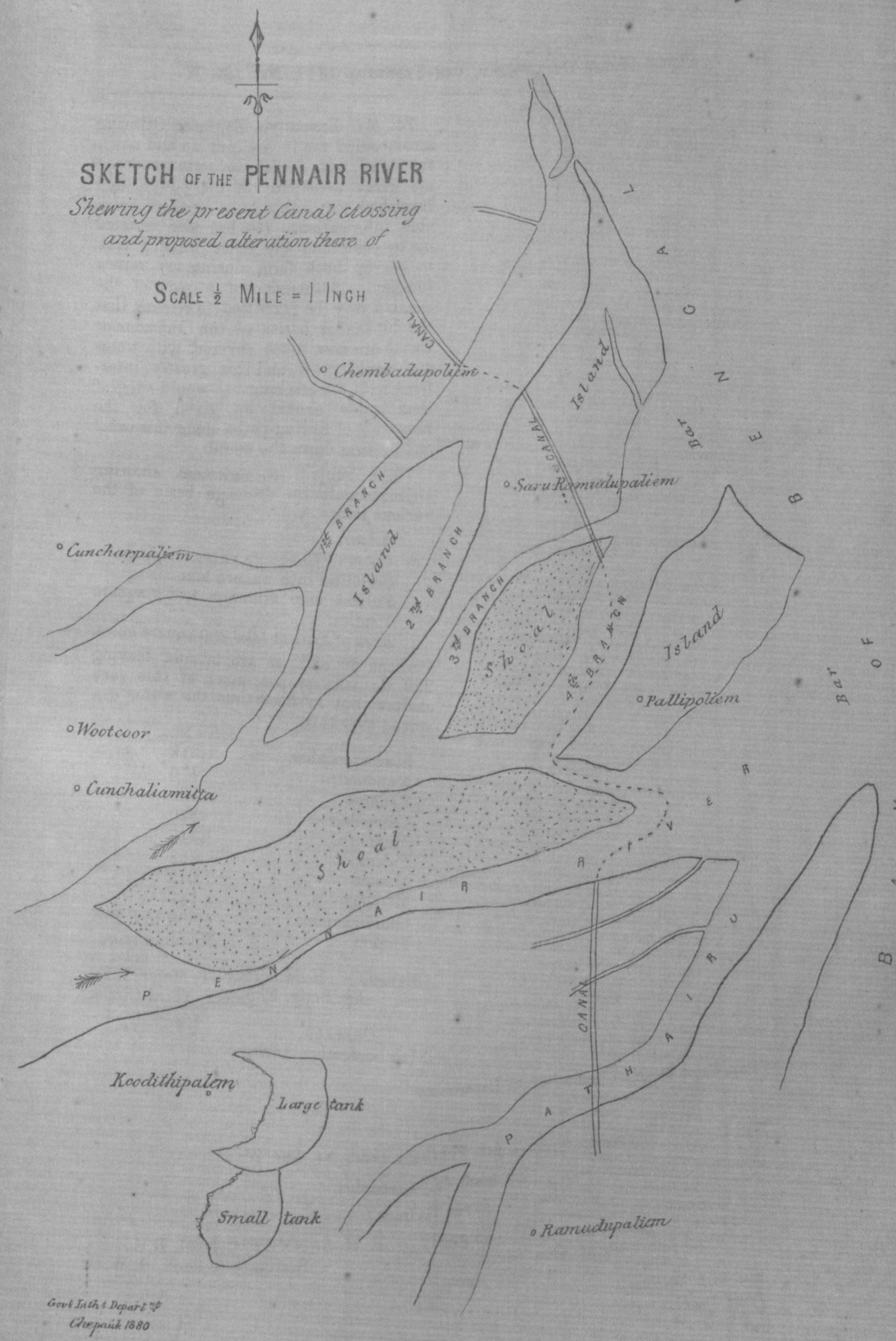
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2036W

SKETCH OF THE PENNAIR RIVER

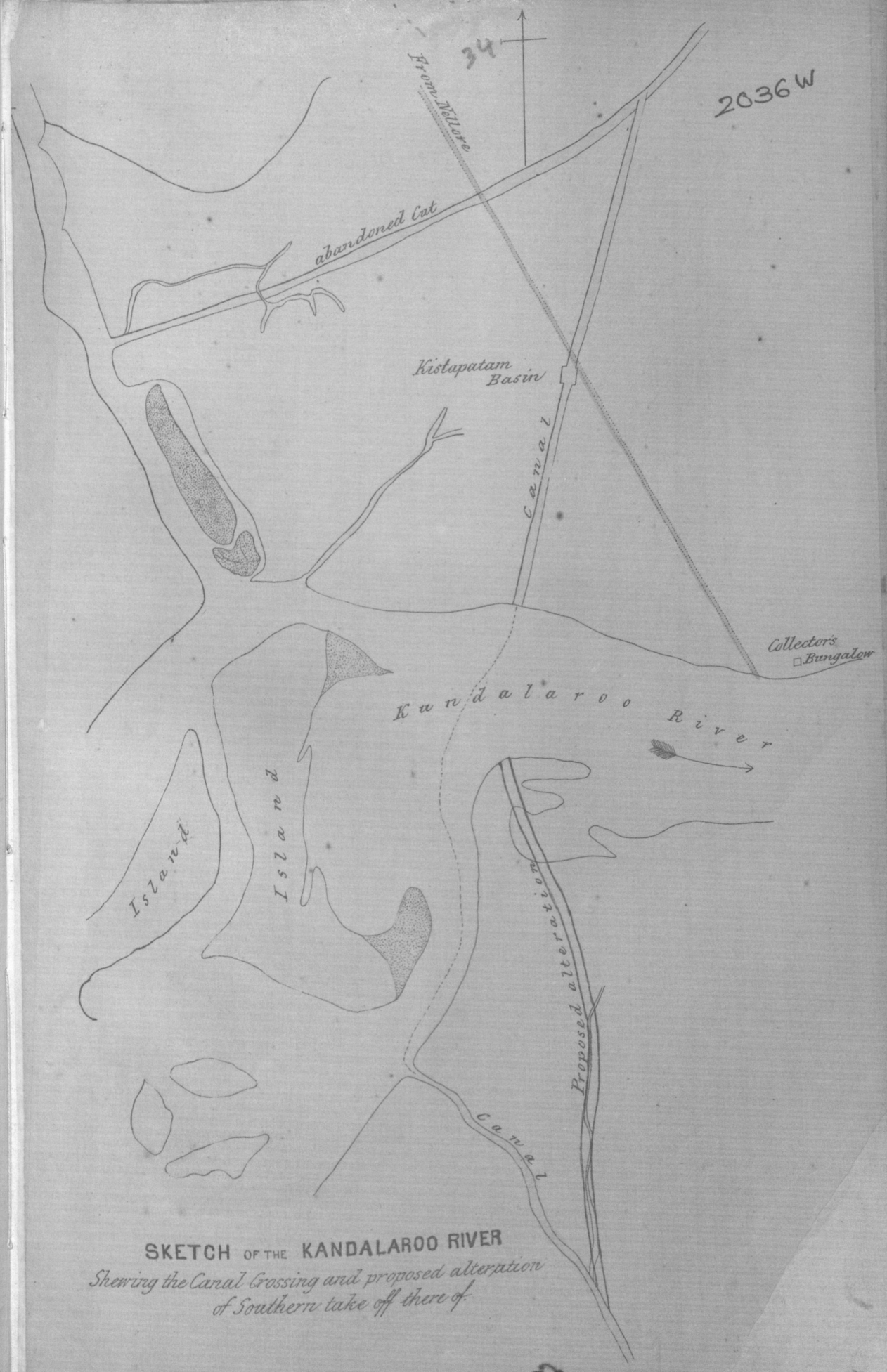
Shewing the present Canal crossing and proposed alteration there of

SCALE ½ MILE = 1 INCH



Govt Inth Depart
Chetpauk 1880

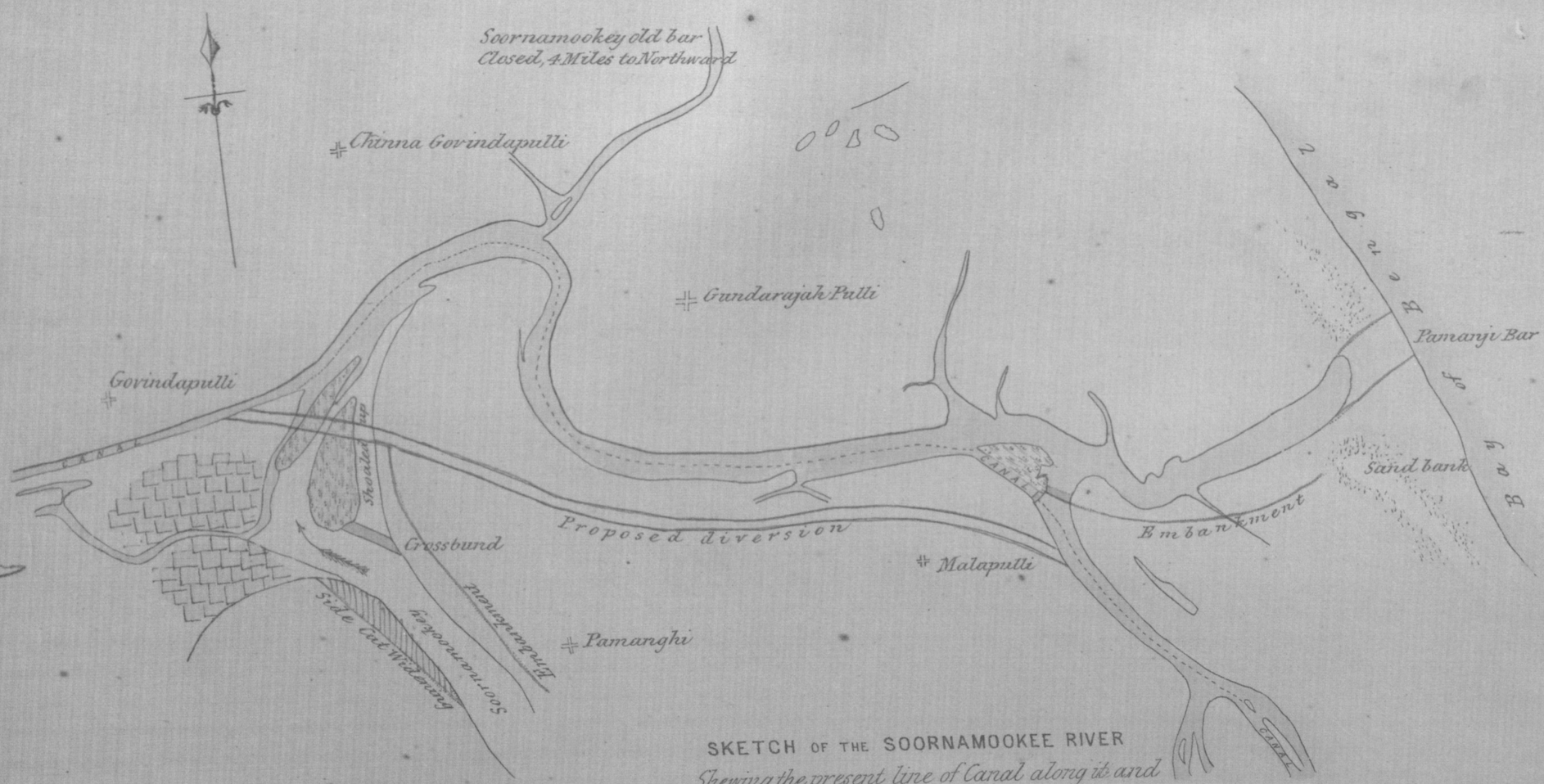
2036 W



SKETCH OF THE KANDALAROO RIVER

Shewing the Canal Crossing and proposed alteration of Southern take off there of

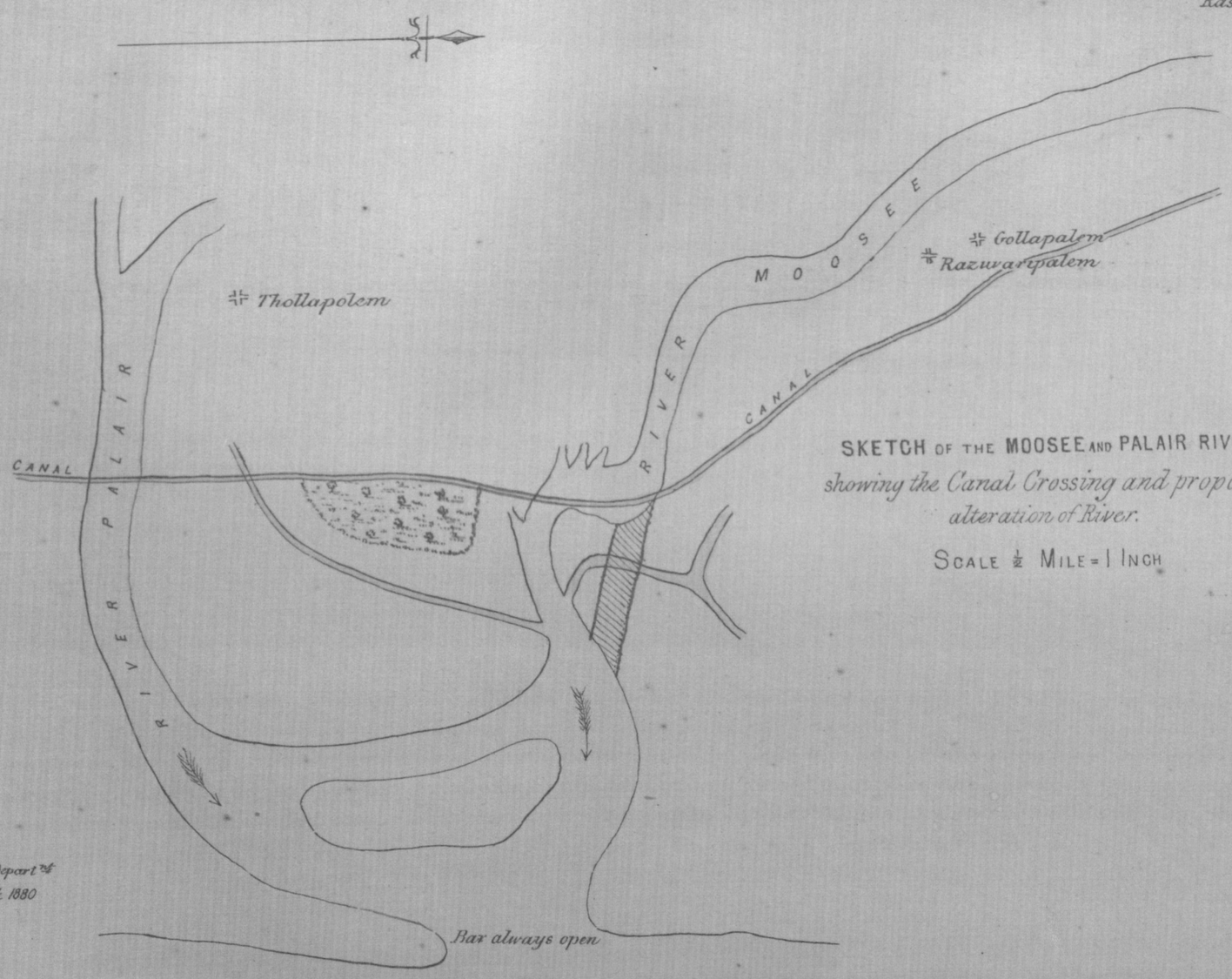
32



SKETCH OF THE SOORNAMOOKEE RIVER
Shewing the present line of Canal along its and
Proposed alteration of line

SCALE ½ MILE 1 INCH

2036 W



SKETCH OF THE MOOSEE AND PALAIR RIVER.
showing the Canal Crossing and proposed alteration of River.
SCALE ½ MILE = 1 INCH

Govt Lith: Depart: Chepauk 1880

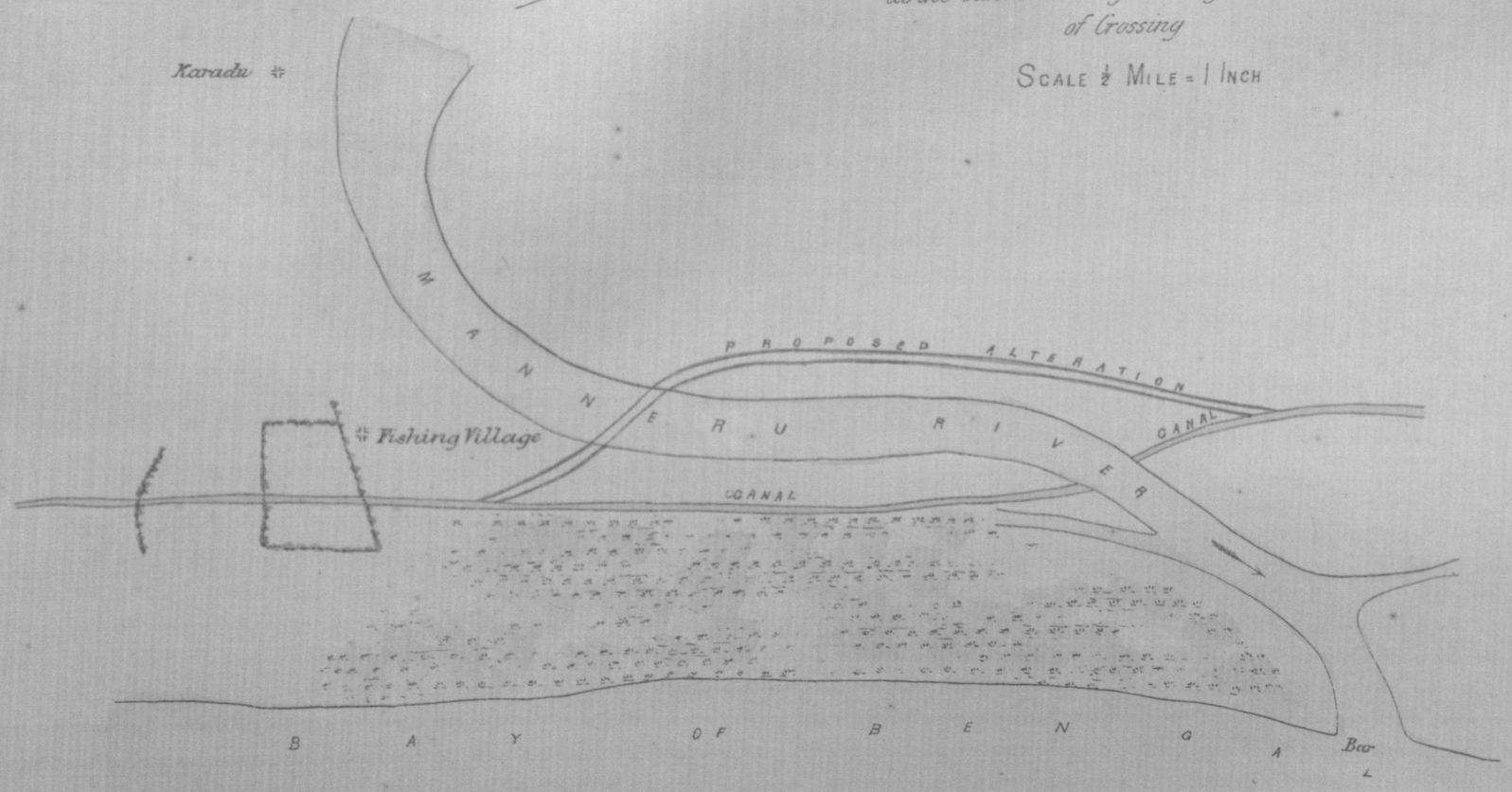
36

2036W

SKETCH OF THE MANNERU RIVER

at the Canal Crossing Shewing the alteration of Crossing

SCALE ½ MILE = 1 INCH



Govt Lith. Depart.
Chepauk 1880

37
367
2036W

SKETCH OF THE DUGERAJAPATAM BACKWATER

Shewing present line of Marygalon that proposed
by Mr. O'Shaughnessy & alteration that Should be made

SCALE ¼ MILE = 1 INCH

Proposed alteration

Proposed by Mr. O'Shaughnessy

Present line of Marygalon

Bay of Bengal

Dugerajapatnam

Bungalow

Pyrl. Sees. Office & Store
Rest house
2nd Class

36

37

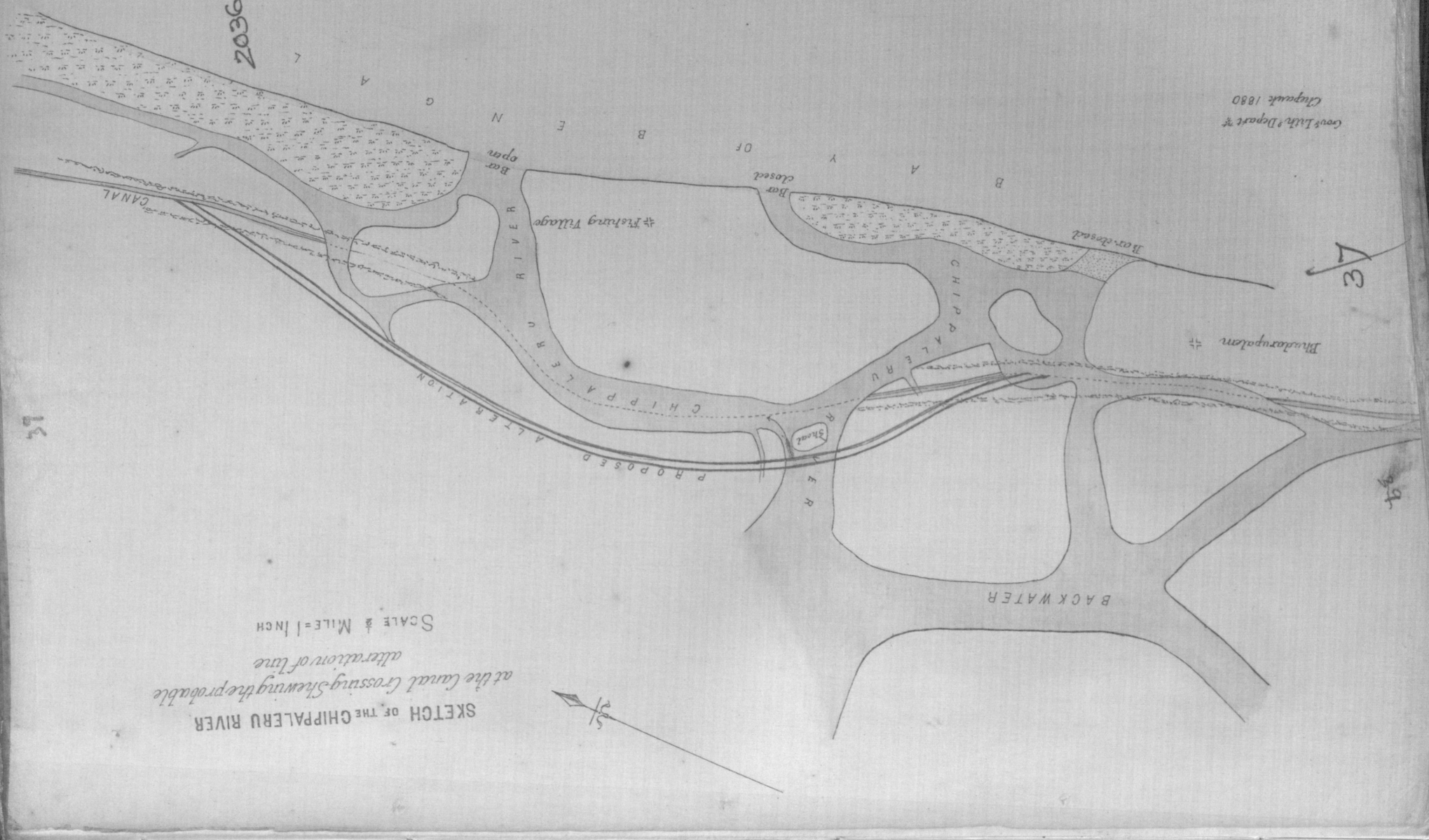
2036

2036 W

SKETCH OF THE CHIPPALERU RIVER

at the Canal Crossing Shewing the probable alteration of line

SCALE 4 MILE = 1 INCH



Govt Lith? Depart?
Chipeuk 1880

40

2036 W

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

3rd September 1880, No. 2,080 W.

Buildings and Roads.
Civil Works.

Read again the following papers:—

No. 14. G.O., P.W.D., dated 6th February 1880, No. 283 W.

No. 14-A. G.O., P.W.D., dated 6th February 1880, No. 284 W.

No. 14-B. Memo. by the Chief Engr., P.W.D., dated 6th Feb. 1880, No. 411.

Read also:—

No. 14-C. From Mr. S. OTTMANN, Sub-Engineer, Buckingham Canal, to the Chief Engineer, Public Works Department, dated Madras, 14th February 1880.

I BEG to send herewith, in part of the information you required me to compile in the memorandum you left with me (on return from your inspection of the canal in last month), the following papers:—

2 Statements of tide range for 1878 and 1879.
1 Statement of draught of boats registered on the canal.
1 Statement of toll-collections from October to January last.
1 Statement of toll-collections for two years preceding under the old rules.
1 Statement of present and proposed toll establishment for the canal.

2. With respect to the tide gauge range, as the gauges have not all been fixed to the same zero, I could not adopt one uniform unit of comparison, say to M.S.L.

3. As regards the statement of draught of boats, I have addressed the officers of Kistna and Godávari districts for information to complete the statement, for only a small percentage of those district boats have as yet been registered on this canal. The present statement comprises only the registered boats for the period named of all districts.

4. The two statements of toll-collections require no notice. The recent ruling of passing empty boats free of tolls will necessarily reduce the collections of the future.

39

5. The statement of toll establishment present and proposed needs some explanation, &c. I have classified the offices in the order of importance, creating four first class and two second class offices; of the first class offices the Madras office is provided with a superintendent on Rs. 30 it will be observed. This is done to provide for the present head clerk of that office, who will soon put in his time for pension, when the salary may be reduced to the same standard as that of the others.

The present superintendent on Rs. 100 will have to retire, as it will be a heavy charge to retain him, nor will it be equitable to the other offices to admit so great a disparity of salary.

It will be observed also from the statement that there is provision for an establishment at the basin. This I find absolutely necessary; in short there is such an establishment now—a sub-overseer of work establishment and two peons of toll establishment—doing the duty. The large and important business done at the basin and the keeping in order of boats in it, regulating loading and unloading, &c., requires a higher paid individual, and I would suggest one on Rs. 50, who should not be a native, for boatmen seem not to care for them.

In the present scale of toll establishment the division office is provided with two clerks on 30 and 20, an attender on 8, and two peons on Rs. 7. We find the number of hands far short of actual demand for the labor involved, and have had therefore to call in two clerks from the toll offices to assist, and withal it is as much as they all can do to keep apace with the toll department work, that tells very hard indeed on the division office establishment, also there being only one accountant and one assistant available. I have therefore recast the present scale of establishment by which clerks are secured. In the matter of the toll establishment of the division office, I write from the close experience of four months, and trust no reduction will be made, while, on the other hand, I would be glad to see higher salaries given, the work being really hard and which will increase year after year as the traffic increases, which certainly it must.

6. The longitudinal section is in hand.

The district maps were received only yesterday from the Revenue Survey Office. They will be put together at once and the canal map made up therefrom, as per instructions you gave me.

The other papers and statements are being compiled.

2036 W

STATEMENT showing the Range of the Rise and Fall of Tides in different parts of the Buckingham Canal during 1879.

No.	Stations.	JANUARY 1879.			FEBRUARY.			MARCH.			APRIL.		
		Maximum or high tide average during month.	Highest spring during month.	Minimum or low tide average during month.	Maximum high tide average during month.	Highest spring during month.	Minimum low tide average during month.	Maximum high tide average during month.	Highest spring during month.	Minimum or low tide average during month.	Maximum high tide average during month.	Highest spring during month.	Minimum or low tide average during month.
1	Pálár river	..	..	..	..	..	..	..	..	..	..	..	..
	Zero of the gauge 2·60 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
2	Covelong	..	..	..	..	..	..	..	..	..	..	..	..
	Zero of the gauge 2·00 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
3	Adyar river	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 4·5 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
4	Shadiencoopum lock S.G.	5′ 10″	6′ 6″	5′ 6″	..	..	..	..	..	..	5′ 10″	6′ 8″	5′ 8″
4a	Do. N.G.	5′ 9″	6′ 6″	5′ 5″	..	..	..	..	..	..	5′ 9″	6′ 8″	5′ 8″
	Zero 6·12 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
5	Ennore	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 1·5 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
6	Pulicat	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 0·50 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
7	Jonagipolium	..	..	..	..	..	..	..	..	..	..	..	..
	Zero not known.	..	..	..	..	..	..	..	..	..	..	..	..
8	Dugarázapatnam	..	..	..	..	..	..	..	..	..	..	..	..
	Zero not known.	..	..	..	..	..	..	..	..	..	..	..	..
9	Kundalaroo river	..	..	..	..	..	..	..	..	..	..	..	..
	4·5 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
10	South bank of Pennér	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·50 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
11	Pyderoo river	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·00 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
12	Chippalaroo river	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·00 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
13	Munnaroo river	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·00 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
14	Mushi river	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·00 below M.S.L.	..	..	..	..	..	..	..	..	..	..	..	..
15	Rompairu river	..	..	..	..	..	..	..	..	..	..	..	..
	Zero not known.	..	..	..	..	..	..	..	..	..	..	..	..
16	Junction canal, Peddaganjam	5′ 11″	6′ 3″	4′ 10″	5′ 10″	6′ 8″	5′ 0″	5′ 9″	6′ 6″	4′ 11″	5′ 9″	6′ 6″	4′ 11″
	Zero not known.	..	..	..	..	..	..	..	..	..	..	..	..

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Statement showing the Range of the Rise and Fall of Tides in different parts of the Buckingham Canal during 1879—*cont.*

No.	Stations.	MAY. Maximum or high tide average during month.	MAY. Minimum or low tide average during month.	MAY. Highest spring during month.	MAY. Lowest tide during month.	JUNE. Maximum or high tide average during month.	JUNE. Minimum or low tide average during month.	JUNE. Highest spring during month.	JUNE. Lowest tide during month.	JULY. Maximum or high tide average during month.	JULY. Minimum or low tide average during month.	JULY. Highest spring during month.	JULY. Lowest tide during month.	AUGUST. Maximum or high tide average during month.	AUGUST. Minimum or low tide average during month.	AUGUST. Highest spring during month.	AUGUST. Lowest tide during month.
1	Pálár river	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero of the gauge 2·50 below M.S.L.																
2	Covelong	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero of the gauge 2·00 below M.S.L.																
3	Adyar river	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 4·5 below M.S.L.																
4	Shadiencoopum lock S.G.	6′ 3″	6′ 2″	8′ 0″	5′ 6″	5′ 11 1/3″	5′ 10″	6′ 1″	5′ 10″	6′ 5″	6′ 5″	7′ 3″	5′ 10″	6′ 8″	6′ 8″	7′ 7″	6′ 1″
4a	Do. N.G.	5′ 3″	4′ 10″	7′ 10″	4′ 2″	5′ 3″	5′ 2″	5′ 5″	4′ 11″	5′ 8″	5′ 2″	6′ 10″	4′ 6″	5′ 4″	5′ 2″	6′ 7″	4′ 7″
	Zero 6·12 below M.S.L.																
5	Ennore	..	..	..	..	..	..	..	..	..	..	..	..	1·93	1·15	2·50	0·65
	Zero 1·5 below M.S.L.																
6	Pulicat	..	..	..	..	..	..	..	..	..	..	..	..	1·72	0·83	2·10	·80
	Zero 0·50 below M.S.L.																
7	Jonagipolium	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero not known																
8	Dugarázapatnam	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero not known.																
9	Kundailaroo river	..	..	..	..	6′ 5″	4′ 0″	7′ 0″	3′ 4″	6′ 8″	4′ 2″	7′ 2″	3′ 9″	6′ 6″	4′ 3″	7′ 0″	4′ 0″
	4·5 below M.S.L.																
10	South bank of Pennér	6·38	3·32	8·20	2·50	6·50	2·87	7·55	2·60	6·14	3·11	7·00	2·70	6·32	3·28	7·45	2·90
	Zero 2·50 below M.S.L.																
11	Pyderoo river	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·00 below M.S.L.																
12	Chippalaroo river	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·00 below M.S.L.																
13	Munnaroo river	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·00 below M.S.L.																
14	Múshi river	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	Zero 2·00 below M.S.L.																
15	Rompairu river	6′ 3″	3′ 8″	9′ 0″	3′ 0″	5′ 11″	3′ 6″	6′ 10″	3′ 0″	5′ 7 1/2″	3′ 5″	6′ 7″	3′ 3″	..	..	..	..
	Zero not known																
16	Junction canal, Peddaganjam	4′ 5″	3′ 2″	7′ 10″	2′ 0″	4′ 9 1/4″	2′ 11 1/2″	5′ 10″	2′ 0″	4′ 7 1/2″	2′ 5 1/2″	5′ 7″	2′ 0″	4′ 11 1/2″	3′ 2 3/4″	6′ 2″	2′ 0″
	Zero not known.																

Statement showing the Range of the Rise and Fall of Tides in different parts of the Buckingham Canal during 1879—*cont.*

No.	Stations.	SEPTEMBER. Maximum or high tide average during month.	SEPTEMBER. Minimum or low tide average during month.	SEPTEMBER. Highest spring during month.	SEPTEMBER. Lowest tide during month.	OCTOBER. Maximum or high tide average during month.	OCTOBER. Minimum or low tide average during month.	OCTOBER. Highest spring during month.	OCTOBER. Lowest tide during month.	NOVEMBER. Maximum or high tide average during month.	NOVEMBER. Minimum or low tide average during month.	NOVEMBER. Highest spring during month.	NOVEMBER. Lowest tide during month.	DECEMBER 1879. Maximum or high tide average during month.	DECEMBER 1879. Minimum or low tide average during month.	DECEMBER 1879. Highest spring during month.	DECEMBER 1879. Lowest tide during month.	Remarks.
1	Pálár river	..	..	..	..	3·72	2·49	4·40	2·12	4·45	2·21	5·90	2·00	4·14	2·01	4·75	1·90	
	Zero of the gauge 2·50 below M.S.L.																	
2	Covelong	..	..	..	.	2·69	2·53	2·87	2·36	3·52	2·95	4·92	1·70	2·89	2·35	3·35	1·65	Backwater near bar.
	Zero of the gauge 2·00 below M.S.L.																	
3	Adyar river	..	..	..	..	6·69	6·59	8·35	5·00	6·03	4·80	8·00	3·50	5·46	4·10	6·80	3·40	
	Zero 4·5 below M.S.L.																	
4	Shadiencoopum lock S.G.	6′ 5″	6′ 4″	6′ 11″	5′ 8″	7′ 3″	7′ 3″	8′ 2″	6′ 5″	7′ 4″	7′ 3″	9′ 3″	6′ 3″	..	..	..	..	
4a	Do. N.G.	5′ 9″	5′ 6 1/2″	6′ 1″	5′ 3″	6′ 4″	6′ 2″	8′ 2″	5′ 4″	5′ 11″	5′ 10″	7′ 9″	5′ 3″	6′ 3″	5′ 3″	6′ 11″	4′ 9″	
	Zero 6·12 below M.S.L.																	
5	Ennore	1·89	1·53	2·50	1·30	2·66	2·19	4·10	1·40	3·18	2·55	4·60	1·00	2·36	1·05	3·30	0·60	Lake near bar.
	Zero 1·5 below M.S.L.																	
6	Pulicat	1·26	0·80	2·10	0·60	1·98	1·36	3·30	0·70	2·94	2·27	6·40	0·90	1·99	0·97	2·50	0·40	Do.
	Zero 0·50 below M.S.L.																	
7	Jonagipolium	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	On Pulicat lake, 42nd mile.
	Zero not known.																	
8	Dugarázapatnam	..	..	..	..	..	..	..	..	2′ 11″	2′ 3″	3′ 5″	1′ 6″	2′ 10″	1′ 11′	4′ 1″	1′ 3″	Backwater near bar.
	Zero not known.																	
9	Kundailaroo river	6′ 7″	4′ 4″	7′ 2″	4′ 3″	6′ 8″	4′ 5″	8′ 5″	4′ 3″	7′ 4″	5′ 2″	8′ 9″	4′ 3″	6′ 8″	4′ 4″	7′ 3″	4′ 0″	
	4·5 below M.S.L.																	
10	South bank of Pennér	6·37	3·41	7·40	3·00	6·67	3·43	8·20	3·10	7·14	3·94	9·30	3·00	5·61	2·33	8·10	1·05	
	Zero 2·50 below M.S.L.																	
11	Pyderoo river	..	..	..	..	6·88	6·63	7·90	6·20	7·40	6·25	11·00	5·30	5·86	4·21	8·20	1·90	
	Zero 2·00 below M.S.L.																	
12	Chippalaroo river	..	..	..	..	..	..	..	..	8·32	6·61	10·50	5·00	6·19	3·96	8·90	2·20	
	Zero 2·00 below M.S.L.																	
13	Munnaroo river	..	..	..	..	5′ 8 1/2″	4′ 8″	11′ 0″	3′ 8″	6′ 7 1/2″	4′ 9″	8′ 1″	3′ 8 1/2″	5′ 9″	3′ 0 3/4	7′ 3″	2′ 3 1/2″	
	Zero 2·00 below M.S.L.																	
14	Múshi river	..	..	..	..	6·43	5·49	9·80	4·00	6·38	4·13	11·00	2·1	5·5	2·7	7·2	1·9	
	Zero 2·00 below M.S.L.																	
15	Rompairu river	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	At temporary lock, Ferringidibba.
	Zero not known.																	
16	Junction canal, Peddaganjam	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Commamur junction.
	Zero not known.																	

(Signed) S. OTTMANN,
Sub-Engineer, Buckingham Canal.

1878.

STATEMENT showing the Range of the Rise and Fall of Tides in different parts of the Buckinghan Canal during the year 1878.

Station.	JANUARY 1878.				FEBRUARY.				MARCH.				APRIL.			
	Maximum or high tide average during month.	Minimum or low tide average during month.	Highest spring during the month.	Lowest tide during month.	Maximum average during month.	Minimum average during month.	Highest spring during month.	Lowest tide during month.	Maximum average during month.	Minimum average during month.	Highest spring during month.	Lowest tide during month.	Maximum average during month.	Minimum average during month.	Highest spring during month.	Lowest tide during month.
Coromandel	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zero of the gauge not known.																
Jonagipolium	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zero of the gauge not known.																
Dugarázapatnam	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zero not known.																
Rompairu river	5′ 1½″	3′ 8″	6′ 3″	3′ 2″	5′ 1″	3′ 5″	6′ 1″	3′ 4″	5′ 1½″	3′ 2″	6′ 0″	3′ 0″	5′ 0″	3′ 1″	6′ 0″	2′ 11″
Zero not known.																

1878.

STATEMENT showing the Range of the Rise and Fall of Tides in different parts of the Buckingham Canal during the year 1878—*cont.*

Station.	MAY.				JUNE.				JULY.				AUGUST.			
	Maximum average during month.	Minimum average during month.	Highest spring during month.	Lowest tide during month.	Maximum average during month.	Minimum average during month.	Highest spring during month.	Lowest tide during month.	Maximum average during month.	Minimum average during month.	Highest spring during month.	Lowest tide during month.	Maximum average during month.	Minimum average during month.	Highest spring during month.	Lowest tide during month.
Coromandel	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zero of the gauge not known.																
Jonagipolium	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zero of the gauge not known.																
Dugarázapatnam	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Zero not known.																
Rompairu river	5′ 5″	3′ 3½″	6′ 2″	3′ 0″	5′ 7″	3′ 7⅛″	6′ 3″	3′ 3″	5′ 7″	4′ 5″	6′ 6″	3′ 6″	..	..	..	..
Zero not known.																

2036 W

1878.

STATEMENT showing the Range of the Rise and Fall of Tides in different parts of the Buckingham Canal during the year 1878—*cont.*

Station.	SEPTEMBER.			OCTOBER.			NOVEMBER.			DECEMBER 1878.			Remarks.
	Maximum month. average during	Highest month. spring during	Lowest tide during month.	Maximum month. average during	Highest month. spring during	Lowest tide during month.	Maximum month. average during	Highest month. spring during	Lowest tide during month.	Maximum month. average during	Highest month. spring during	Lowest tide during month.	
Coromandel	5·87	6·05	5·10	5·88	6·40	5·00	6·09	6·25	5·35	6·07	6·35	5·35	In lake 27th mile.
Zero of the gauge not known.													
Jonagipolium	..	..	..	4·37	4·57	3·85	4·43	4·57	3·85	4·39	4·62	3·85	In lake 42nd mile.
Zero of the gauge not known.													
Dugarázapatnam	..	..	..	1·80	2·20	1·40	1·77	1·90	1·45	1·83	2·00	1·60	In backwater 69th mile.
Zero not known.													
Rompairu river	6′ 5″	8′ 8″	4′ 10″	6′ 3″	8′ 8″	1′ 1″	0′ 9″	1′ 7″	0′ 1″	3′ 11″	6′ 8″	0′ 1″	At temporary lock. Ferringidibba.
Zero not known.	5′ 7″	6′ 5″	5′ 7″	5′ 7″	6′ 5″	5′ 7″	0′ 6½″	1′ 7″	0′ 6½″	2′ 7″	3′ 7″	2′ 7″	

(Signed) S. OTTMANN,
Sub-Engineer, Buckingham Canal.

BUCKINGHAM CANAL.

STATEMENT showing the Draught of Water of Boats Licensed for, and plying on, the Buckingham Canal from 8th October 1879 to 31st January 1880.

Sections.	Below 1½ feet.	From 1½ to 2 feet.	From 2 to 2½ feet.	Total Boats.	Remarks.
A or Sadras Section ...	87	15	...	102	Those few only of Kistna and Godávari boats licensed for the canal are included herein. The Kistna and Godávari Officers have been applied to for information in this matter.
B or Madras do. ...	29	4	8	41	
C or Pulicat do. ...	271	170	219	660	
D or Kistnapatam do. ...	3	12	3	18	
E or Ramapatam do. ...	2	18	4	24	
F or Kotapatam do. ...	18	34	10	62	
Total ...	410	253	244	907	

MADRAS,
14th February 1880.

(Signed) S. OTTMANN,
Sub-Engineer, Buckingham Canal.

STATEMENT showing Toll-collections on the Buckingham Canal from January 1877 to September 1879.

Year.	Month.	Amount.
		RS. A. P.
1877 ...	January	1,846 15 9
	February	380 5 0
	March	...
	April	...
	May	733 9 0
	June	5,651 4 0
	July	3,192 9 3
	August	1,392 8 6
	September	1,363 4 0
	October	2,555 15 0
	November	2,889 0 0
	December	3,196 8 9
1878 ...	January	3,110 13 3
	February	2,480 14 3
	March	2,223 14 9
	April	4,472 8 3
	May	7,248 7 0
	June	7,366 15 9
	July	7,704 15 0
	August	4,718 3 0
	September	2,705 8 0
	October	2,485 0 0
	November	1,418 3 0
	December	1,194 11 0
1879 ...	January	2,587 4 0
	February	2,451 8 0
	March	2,484 0 9
	April	2,519 1 6
	May	4,519 7 0
	June	5,663 13 0
	July	5,649 11 0
	August	2,826 1 0
	September	2,396 13 0
	Total ...	1,01,429 11 9

(Signed) S. OTTMANN,
Sub-Engineer, Buckingham Canal.

14th February 1880.

STATEMENT showing the Amount of Collections of License Fee and Tolls, &c., on Boats plying, from 8th October 1879 to 31st January 1880, on the Buckingham Canal.

Month.	A or Sadras Section.		B or Madras Section.		C or Pulicat Section.		D or Kistnapatam Section.		E or Ramapatam Section.		F or Kotapatam Section.		Total Collections.		Grand Total of License Fee and Tolls.
	License Fee.	Tolls, &c.	License Fee.	Tolls, &c.	License Fee.	Tolls, &c.	License Fee.	Tolls, &c.	License Fee.	Tolls, &c.	License Fee.	Tolls, &c.	Net License Fee.	Net Tolls, &c.	
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Oct. 1879 ..	512 8 0	556 4 0	282 12 0	1,393 11 0	302 7 0	686 6 0	..	525 0 0	63 0 0	281 8 0	164 0 0	213 8 0	1,324 11 0	3,685 11 0	5,010 6 0
Nov. ,, ..	190 0 0	207 4 0	429 12 0	1,880 8 0	763 0 0	614 6 0	..	404 8 0	..	546 4 0	72 0 0	329 4 0	1,454 12 0	3,982 2 0	5,436 14 0
Dec. ,, ..	64 8 0	228 4 0	171 8 0	2,922 6 0	817 8 0	544 4 0	49 8 0	459 0 0	53 0 0	490 4 0	30 0 0	120 6 0	1,186 0 0	4,764 8 0	5,950 8 0
Jan. 1880 ..	373 8 0	205 0 0	238 0 0	1,477 10 0	1,825 8 0	780 10 3	150 0 0	472 12 0	..	500 12 0	303 8 0	218 14 0	3,249 0 0	3,655 10 3	6,904 10 3
Total ..	1,140 8 0	1,196 12 0	1,122 0 0	7,674 3 0	3,708 7 0	2,625 10 3	199 8 0	1,861 4 0	474 8 0	1,818 12 0	569 8 0	882 0 0	7,214 7 0	16,087 15 3	23,302 6 3

(Signed) S. OTTMANN,
Sub-Engineer, Buckingham Canal.

MADRAS,
14th February 1880.

COMPARATIVE Statement showing the Present and Proposed Toll Establishment for the Buckingham Canal.

PRESENT ESTABLISHMENT.				PROPOSED ESTABLISHMENT.				Increase.	Decrease.
No.	Description.	Rate per Month.	Per Annum.	No.	Description.	Rate per Month.	Per Annum.		
	A OR SADRAS SECTION OFFICE.	Rs.	Rs.		A OR SADRAS SECTION OFFICE.	Rs.	Rs.	Rs.	Rs.
	Second Class.				*Second Class.*				
1	Superintendent	50	600	1	Superintendent	20	240		
1	Clerk	20	240	1	Clerk	15	180		
1	Cashier	15	180	..	....	..	..		
1	Do.	12	144	..	....	..	..		
3	Peons	7	252	2	Peons	7	168		
2	Lascars	7	168	2	Lascars	6	144		
			1,584				732	..	852
	B OR MADRAS SECTION OFFICE.				B OR MADRAS SECTION OFFICE.				
	First Class.				*First Class.*				
1	Superintendent	100	1,200	1	Superintendent	30	360		
1	Clerk	30	360	1	Clerk	15	180		
1	Do.	15	180	..	....	..	..		
3	Peons	7	252	2	Peons	7	168		
2	Lascars	7	168	2	Lascars	6	144		
			2,160				852	..	1,308
	C OR PULICAT SECTION OFFICE.				C OR PULICAT SECTION OFFICE.				
	First Class.				*First Class.*				
1	Superintendent	60	720	1	Superintendent	25	300		
1	Clerk	20	240	1	Clerk	15	180		
1	Cashier	15	180	..	....	..	..		
1	Do.	12	144	..	....	..	..		
3	Peons	7	252	2	Peons	7	168		
2	Lascars	7	168	2	Lascars	6	144		
			1,704				792	..	912
	D OR KISTNAPATAM SECTION OFFICE.				D OR KISTNAPATAM SECTION OFFICE.				
	First Class.				*First Class.*				
	As per particulars for Pulicat Section.	..	1,704		As per particulars for Pulicat Section.	..	792	..	912
	E OR RAMAPATAM SECTION OFFICE.				E OR RAMAPATAM SECTION OFFICE.				
	First Class.				*First Class.*				
	As per particulars for Pulicat Section.	..	1,704		As per particulars for Pulicat Section.	..	792	..	912
	F OR KOTTAPATAM SECTION OFFICE.				F OR KOTTAPATAM SECTION OFFICE.				
	Second Class.				*Second Class.*				
1	Superintendent	50	600	1	Superintendent	20	240		
1	Clerk	20	240	1	Clerk	15	180		
1	Cashier	15	180	..	....	..	..		
1	Do.	12	144	..	....	..	..		
1	Peons	7	252	2	Peons	7	168		
3	Peons	6	168	2	Lascars	6	144		
2	Lascars								
			1,584				732	..	852
	DIVISION OFFICE.				DIVISION OFFICE.				
1	Clerk	30	360	2	Clerks	15	360		
1	Do.	20	240	1	Clerk	12	144		
1	Attender	8	96	1	Attender	10	120		
2	Peons	7	168	2	Peons	7	168		
			864				792	..	72
	BASIN OFFICE.				BASIN OFFICE.				
	....	..	..	1	Superintendent	30	360		
				2	Lascars	6	144		
							504	504	..
							5,988	504	5,820
	Total ..	..	11,304		Total ..	..	..	..	5,316
					Net Saving by present proposal.	..	..		

BUCKINGHAM CANAL DIVISION OFFICE,
14th February 1880.

(Signed) S. OTTMANN,
Sub-Engineer, Buckingham Canal.

No. 14-D. From Captain A. AWDRY, R.E., Superintendent of Works, Buckingham Canal, to the Chief Engineer, Public Works Department, dated Pálár river, 10th May 1880, No. 462.

IN continuation of my letter, No. 127, dated 12th April 1880, I have the honor to forward a table exhibiting the quantities of silt deposited in the canal by the cyclones of May and November 1879, and the estimates for removing the same to different widths and depths prepared by Mr. (Sub-Engineer) Ottmann.

The following notes are appended for information in explanation of the computations made in calculating quantities, rates, &c., of this table.

1. There is no record of what the canal bed was before May's cyclone, and for the purpose of this table it is assumed as 4·5 feet below M.S.L. The canal division was created in November 1878. The Northern canal was opened about a year previously.

2. The depths of silt in column 2 for the two cyclones were obtained by first averaging the depths (from the soundings at every furlong) for each mile separately, and subsequently averaging that result again for the *actual* mileage of *such* silting, and not for full mileage of canal. The May's cyclone silt is computed on the 4·5 feet bed below M.S.L. for reasons given in preceding paragraph. The November's cyclone computation of silt is based on three feet bed below M.S.L., below which no work was done according to Mr. O'Shaughnessy's intention, and as means were not available for working to original datum.

3. It should be stated that the canal from Cooum to Pulicat was originally laid with a 6·12 feet datum, that is to say on the level of the Shadiencoopum lock sill.

4. In regard to length of silting, on which the computation of quantities is made, the following were adopted from actual measurement taken from section :—

For May's Cyclone.

For the 4·5 feet datum 160 miles, average depth 1·53 feet.
" 4 " " 138 " " " 1·24 "
" 3 " " 82 " " " 0·78 "

For November's Cyclone.

For the 4·5 feet datum 180 miles, average depth 1·77 feet.
" 4 " " 158 " " " 1·50 "
" 3 " " 97 " " " 1·05 "

The quantities in columns A, B, and C are based on above lengths and depths.

5. It should be stated in regard to the November cyclone that in cases were there was no silt in May (as in 66 to 69 miles for instance) the height actually deposited over the 4·5 feet M.S.L. was adopted, and where both May's and November's lines fell below the 3 feet datum, the difference between the two was taken.

6. In regard to rates of columns A, B, and C an average was adopted between those of sand and slush and between tidal and non-tidal, and which will be found somewhat in excess of the average as would be struck from "table of rates" submitted by me, for the reason that the latter are specific rates, whereas for the purposes of the present table of quantities an average rate had to be computed.

7. It may not be out of place to record here what I have already submitted before in the case of the Pennér island cut, about a mile long, which silted completely up in the first year of opening, that it cost Rs. 11,527 for earthwork alone to re-open the line (which was at Rs. 4-3-2 per cubic yard), and that in last November's cyclone it had silted up again over low tide level. The Múshi-Pálár cut silted in November's cyclone over low tide level.

8. The impracticability of maintaining a 20 feet channel only *in the old bed*, which is 30 feet and over and especially in backwaters, has been sufficiently tested to permit my submitting for consideration the advisability of retaining the original sole of 30 feet. The passage of boats under sail through a 20 feet clearing in an old 30 feet bed and backwaters has been found to cause the sides, especially in fluid mud, to run down, and fill the cut 6 inches in 24 hours. The silting does not go on of course in that proportion daily, but till the superabundant stuff of the sides settles itself, the process of filling will go on.

And in respect of depth, 3½ feet below the lowest registered tides level, seems a practical limit, for it will allow 6 inches for ordinary silting, and will still leave half a foot between boat bottom and bed.

22nd April 1880.

(Signed) S. OTTMANN,
Sub-Engineer, Buckingham Canal.

BUCKINGHAM CANAL, CENTRAL SUB-DIVISION.

TABLE exhibiting Quantities of Silt deposited in the Canal by the Cyclones of May and November 1879, and the Estimates for removing the same to different widths and depths.

	Average depth of Silt deposited on Canal bed.		A. If cleared to only 3 feet below M.S.L., with bottom width of 20 feet, slopes 4 to 1.				B. If cleared to 4 feet below M.S.L., with bottom width of 20 feet, slopes 4 to 1.				C. If cleared to original section 4½ feet below M.S.L., with bottom width of 30 feet, slopes 2½ to 1 original.			
	Feet.	Inches.	Quantity, Cubic Yards.	Average Rate.		Cost.	Quantity, Cubic Yards.	Average Rate.		Cost.	Quantity, Cubic Yards.	Average Rate.		Cost.
				Rs. A. P.		Rs. A. P.		Rs. A. P.		Rs. A. P.		Rs. A. P.		Rs. A. P.
I. As per soundings made after the cyclone of May 1879.	1	6½	4,83,863	0 2 9		83,163 15 3	12,07,873	0 3 3		2,45,349 3 0	21,48,970	0 3 6		4,70,087 0 0
II. As per soundings made after the cyclone of November 1879, computed to 3 feet below M.S.L. only.	...	11¾												

N.B.—This table refers to canal from Cooum to Peddaganjam only.

(Signed) S. OTTMANN,
Sub-Engineer, Central Sub-Division Office.

(Signed) A. AWDRY, Captain, R.E.,
Supt. of Works, Buckingham Canal.

MADRAS,
22nd April 1880.

10th May 1880.

No. 14-E. From Captain A. AWDRY, R.E., Superintendent of Works, Buckingham Canal, to the Chief Engineer, Public Works Department, dated Buckingham Canal, 15th May 1880, No. 558.

WITH reference to your No. 953 of the 24th March 1880, I have the honor to inform you that I have just received from Mr. Ottmann the survey of the canal and the longitudinal section showing the silt deposited by the cyclones of May and November in last year, the height of the floods, tides and banks, and I forward them herewith.

2. I also return as directed the enclosures to your letter under reply, and with reference to paragraph 2 have had a revised statement made out as required. I have omitted from the calculation all months when bars were closed and have added the readings to the end of April. By the end of this year I hope to have a far more extensive and valuable record of tides, and I shall before the close of the year have checked the line of levels joining the zeros of the gauges. There is a marked change in gauge readings between the canal south and north of the Pennér, for the M. S. L. used on the southern part is deHaviland's, and from the Pennér northwards M. S. L. was arrived at by tidal observations in 1876 for six months at the Pennér by Lieutenant Henderson, R.E. It is actually found in the Northern Canal that in many places the tide does not fall nearly to so low a level as the canal bed (4·50 below M. S. L.) would lead one to suppose, either therefore there must be something wrong in the levelling from the Pennér northwards for determining M. S. L., or else the canal was cut out to more than 4·50 feet below M. S. L.; fortunately the fault as regards depth of canal appears to be on the right side.

3. The average readings of high and low tides on the intermediate stations recently set up is herewith sent as requested in the latter part of your paragraph 2, but I fear that the observations have not been taken long enough to be a very sure guide.

4. With reference to draught of boats I think that in the present state of the canal it will be advisable not to alter the rules as to depth, while I should feel disposed not to interfere with boats loaded beyond the load line of $2\frac{1}{2}$ feet above keel, as if they do overload they will be liable to detention in waiting for high tides, and at present it would, I think, be injurious to growing traffic to measure boats for a greater depth than $2\frac{1}{2}$ feet and register their tonnage accordingly. I quite agree that we should endeavour to make the canal available for steam traffic, and that $4\frac{1}{2}$ feet below M. S. L. is the very least that would do for this, but $4\frac{1}{2}$ feet is a depth which it is impossible practically to work down to by manual labor, and it would require dredging to keep it clear, so that for this depth dredgers would have to be kept up for the whole length of the canal. There is so much still to be done to the canal before we could put steamers on it with any great chance of their doing well, that it will, I should consider, be best to make all gate cills at least 4·50 feet below M. S. L., and for the present endeavour to maintain a depth of 3·00 below lowest tide and make no alteration in the rules, but permit heavy boats to use the canal and take their chance of sticking until a high tide frees them. I do not read the rules as prohibiting boats of deeper draught than $2\frac{1}{2}$ feet although licenses and tolls are only taken on the capacity of the boats when drawing that depth as maximum. I have never quite understood, looking to the slight rise and fall of tides, why a certain distance below *lowest* tide was not taken as the bed of the canal; it is more easy for an inexperienced workman to know whether he has done a sufficient clearance if low water instead of mean tide is used, and if properly worked down to it will allow the whole rise of tide as a margin to assist boats sticking in getting off. Tide readings of intermediate stations will be available by the end of the year, so that the question cannot well be definitely settled until then, as I imagine that a few months gauging would not be accurate as tides vary with the seasons.

5. I have made out a revised statement of the earnings of the canal, the amounts are as follow.

	RS.
License fees for 1880	19,000
Tolls (at average since October last)	51,600
Sales, &c., say	700
Total per annum ...	71,300

In regard to this it should be noted that the figure is far lower than what may shortly be hoped for, for the rules have only been a short time in force and all the boats formerly plying on the canal have not yet been replaced on it. New boats have not yet come in in large numbers owing to the novelty of the charges and recent cyclones having given the canal an unfavorable chance to start with. Considerable traffic will probably accrue to the canal from the Kistna and Godávari canals in future years, now that the fact has been definitely made known that the Kistna and Godávari grain must be worked out of those canals before their annual closure in April, for the produce was not brought down owing to hopes on the part of the boatmen that the Kistna canals would be kept open and to the objections to the rates of tolls, &c. The more stringently it is enforced that the canals of Kistna should be closed *yearly at a certain date* the better for developing traffic before that date; if the boatmen have no hope of the canals being left open, they will probably push on their carrying operations earlier in the year.

6. In regard to charges for maintenance of the canal I do not consider that it will be necessary to reckon on so large an outlay on the Adyar to Pálár Section of the canal as on the other parts of it. Very little has been spent on clearance in this section of the canal in former years, and I think as an average Rs. 110 per mile might suffice for these 40 miles. The maintenance of the Northern and Junction canals for the present must be expected to be more costly as larger rivers are crossed and the banks are not yet thoroughly consolidated. I reckon for a few years the maintenance of the canal for these 207 miles cannot well be done under Rs. 275 per mile. This makes a total charge for maintenance of Rs. 61,325 per annum, which will, after the Northern canal banks are more consolidated and grown over, the rivers crossing it trained, cattle crossings paved, &c., be capable of considerable reduction.

In regard to charges for establishment I have entered one half of the sanctioned scale, considering that half the time of the establishment is taken up in original work and work for the Salt Department and minor works, which is certainly the case. The toll and lock establishments are now fixed at the lowest figures they can be and have been largely reduced from what they formerly were. The total charges for maintenance establishment and collection are Rs. 85,625.* Interest at 4 per cent. on the capital outlay amounts to Rs. 1,23,946 per annum, and of itself without maintenance establishment and collection charges utterly swamps the receipts, but the through traffic has not yet developed on the canal and will, I trust, in a few years increase the receipts very many fold. The canal received very great damages last year from two cyclones, one of which was exceptionally severe and they have done the development of its traffic much harm; but by clearing out the debris of the old high banks and not replacing them in situations where they are liable to be washed into and block the canal, much will be done towards reducing the possible damage from cyclones, so that traffic will not be likely in the future to be as much impeded by cyclones even if they occur as was the case in 1879.

		RS.
* Maintenance		61,325
Establishment		16,800
Collection, &c.		7,500
	Total ...	85,625

STATEMENT showing the Mean Annual Maximum and Minimum Heights of Tides for the year 1879-80.

No.	Gauge Stations.	Zero of the gauge below M.S.L.	Reduced to Heights above and below Mean Sea Level.															
			April 1879.		May.		June.		July.		August.		September.		October.			
			Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.		
1	Pálár river near Kadalur	2·50	..	..	..	..	..	..	..	..	..	..	..	..	+ 1·22	— 0·01		
2	Covelong	2·00	..	..	..	..	..	..	..	..	..	..	..	..	+ 0·69	+ 0·53		
3	Adyar river	4·50	..	..	..	..	..	..	..	..	..	..	..	..	*+ 2·19	*+ 2·09		
4	Shadiencoopum lock N.G.	6·12	— 1·00	— 1·37	— 0·87	— 1·29	*— 0·87	*— 0·95	— 0·46	— 0·95	— 0·79	— 0·95	*— 0·37	*— 0·48	+ 0·21	+ 0·05		
5	Ennore	1·50	..	..	..	..	*	*	..	..	+ 0·43	— 0·35	*+ 0·39	*+ 0·03	+ 1·16	+ 0·69		
6	Pulicat	1·50	..	..	..	..	..	..	..	..	+ 0·22	— 0·67	— 0·24	— 0·70	+ 0·48	— 0·14		
7	Dugarázpatnam ..	2·00	..	..	..	..	..	..	..	..	..	..	..	..	*	*		
8	Kundailaroo river ..	4·50	+ 1·58	— 0·84	..	..	+ 1·92	— 0·50	+ 2·16	— 0·33	+ 2·00	— 0·25	+ 2·08	— 0·17	+ 2·16	— 0·08		
9	South bank of Pennér river ..	2·50	+ 3·62	+ 0·46	+ 3·88	+ 0·82	+ 4·00	+ 0·37	+ 3·64	+ 0·61	+ 3·82	+ 0·78	+ 3·87	+ 0·91	+ 4·17	+ 0·93		
10	Pyderoo river	2·00	..	..	..	..	..	..	..	..	..	..	..	..	+ 4·88	+ 4·63		
11	Chippalaroo river	2·00	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
12	Mannér do.	2·00	..	..	..	..	..	..	..	..	..	..	..	..	+ 3·70	+ 2·66		
13	Múshi do.	2·00	..	..	..	..	..	..	..	..	..	..	..	..	+ 4·43	+ 3·49		
14	Gundlakamma do.	2·00	..	..	..	..	..	..	..	..	..	..	..	..	..	..		

* Bars closed and the heights in months so marked omitted from calculating average.

Statement showing the Mean Annual Maximum and Minimum Heights of Tides for the year 1879-80—*cont.*

No.	Gauge Stations.	Reduced to Heights above and below Mean Sea Level—*cont.*												Mean annual maximum height of tides.	Mean annual minimum height of tides.
		November.		December.		January 1880.		February.		March.		April.			
		Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.	Maximum tide average during month.	Minimum tide average during month.		
1	Pálár river near Kadalur	+ 1·95	— 0·29	+ 1·64	— 0·49	+ 0·71	— 0·58	+ 0·16	— 0·66	— 0·08	— 0·65	*— 0·86	*— 0·88	+ 0·93	— 0·45
2	Covelong	+ 1·52	+ 0·95	+ 0·89	+ 0·35	+ 0·35	+ 0·18	*+ 0·01	*— 0·09	*— 0·40	*— 0·41	— 0·13	— 0·44	+ 0·66	+ 0·31
3	Adyar river	+ 1·53	+ 0·30	+ 0·96	— 0·40	*+ 0·95	*+ 0·69	*+ 2·06	..	*+ 1·77	..	*+ 0·90	*	+ 1·24	— 0·05
4	Shadiencoopum lock N.G.	— 0·20	— 0·29	+ 0·13	— 0·87	— 0·99	— 1·40	— 0·44	— 1·62	— 0·87	— 1·78	— 0·96	— 1·63	— 0·57	— 1·09
5	Ennore	+ 1·68	+ 1·05	+ 0·86	— 0·45	+ 0·37	— 0·89	— 0·04	— 1·02	— 0·13	— 1·00	— 0·33	— 1·04	+ 0·50	— 0·38
6	Pulicat	+ 1·44	+ 0·77	+ 0·49	— 0·53	— 0·10	— 1·19	+ 0·64	— 0·38	+ 0·58	— 0·49	+ 0·41	— 0·69	+ 0·44	— 0·44
7	Dugarázpatnam ..	+ 0·92	+ 0·25	+ 0·83	— 0·08	+ 0·34	— 0·66	+ 0·17	— 0·87	+ 0·08	— 0·96	— 0·16	— 0·75	+ 0·36	— 0·51
8	Kundailaroo river ..	+ 2·83	+ 0·67	+ 2·16	— 0·17	+ 1·58	— 0·67	+ 1·33	— 0·84	+ 1·16	— 0·92	+ 1·28	— 0·92	+ 1·85	— 0·42
9	South bank of Pennér river ..	+ 4·64	+ 1·44	+ 3·11	— 0·17	+ 1·69	— 1·58	+ 1·48	— 1·77	+ 1·40	— 1·75	+ 1·30	— 1·84	+ 3·12	— 0·08
10	Pyderoo river	+ 5·40	+ 4·25	+ 3·86	+ 2·21	+ 2·08	+ 0·03	+ 1·86	— 0·32	+ 1·77	— 0·33	+ 1·56	+ 0·02	+ 3·06	+ 1·50
11	Chippalaroo river	+ 6·32	+ 4·61	+ 4·19	+ 1·96	+ 2·21	+ 0·50	+ 1·73	+ 0·32	+ 1·57	+ 0·30	+ 1 84	+ 0·77	+ 2·98	+ 1·41
12	Mannér do.	+ 4·62	+ 2·75	+ 3·75	+ 1·06	+ 3·28	+ 0·51	+ 2·98	+ 0·47	+ 2·95	+ 0·44	+ 3·01	+ 0·71	+ 3·47	+ 1·23
13	Múshi do.	+ 4 38	+ 2·13	+ 3·50	+ 0·70	+ 2·98	+ 0·02	+ 2·92	— 0·05	+ 2·89	— 0·23	+ 2·84	+ 0·55	+ 3·42	+ 0·95
14	Gundlakamma do.	+ 3·45	+ 0·99	+ 2·59	+ 0·13	+ 3·58	+ 0·68	+ 4·38	+ 1·40	+ 1·86	— 1·54	+ 2·00	— 0·49	+ 2·98	+ 0·20

* Bars closed and the heights in months so marked omitted from calculating average.

It should be noted that from the Pálár to the Pennér M.S.L. is deHaveland's M.S.L. at Fort St. George, Madras, carried along the canal by levelling. From the Pennér to the Gundlakamma M.S.L. is the mean arrived at by Lieutenant Henderson, R.E., from six months' observations of tides in the Pennér in 1875 carried along the canal by levelling. Both high and low water appear to be at a uniformly higher level in this northern section than in the southern. Possibly deHaveland's result is too high or Lieutenant Henderson's too low.

CHEPAUK,
14th May 1880.

(Signed) A. AWDRY, Captain, R.E.,
Supt. of Works, Buckingham Canal.

STATEMENT showing the Mean Maximum and Minimum Heights of Tides.

Number.	Mileage.	Gauge Stations.	Zero of the gauge below M.S.L.	Reduced to M.S.L.		Differences, Columns Nos. 5 and 6.	Remarks.
				Mean maximum height of tides.	Mean minimum height of tides.		
1	2	3	4.	5	6	7	8
1	46 1 South ..	Palar river—Kadalur ..	2·50	+0·93	−0·45	1·3	(Bar closed on 2nd April.)
2	40 VI "	Sadras	4·50	..	..	..	..
3	31 VI "	Salancooppam	2·00	−0·71	−0·79	0′·08	..
4	21 1 "	Covelong	2·00	+0·66	+0·31	0′·35	(Bar open in April.)
5	13 VII "	Sholanalloor	2·00	+0·03	−0·33	0′·36	..
6	5 VII "	Head of Sadras Canal	4·50	..	..	..	..
7	5 VI "	Adyar river	4·50	+1·24	−0·05	1′·29	(Bar closed in April.)
8	III "	Greenaway's bridge	4·50	..	..	..	..
9	1 North ..	Basin	4·50	..	..	..	..
10	VI 8						(Cooum bar closed in April.)
11	12 "	Shadiencoopum lock N.G.	6·12	−0·57	−1·09	0·52	..
12	19 "	Ennore	1·50	+0·50	−0·38	0′·88	(Bar open in April.)
13	1 "	Kalanjee	2·00	−1·35	−1·50	0·15′	..
14	25 31 "	Pulicat	1·50	+0·44	−0·44	0′·88	(Bar open in April.)
15	IV "	Thanipanthal	2·00	−0·32	−1·11	0′·79	..
16	37 43 "	Thetupett	2·00	−0·02	−0·51	0′·49	..
17	V "	Jonaghipallem	2·00	+0·45	+0·23	0′·22	..
18	59 "	Royadooruvu ..					..
19	64 "	Pumbly	2·00	..	..	..	..
20	69 "	Dugarazpatnam	1·50	+0·64	+0·45	0′·19	(Bar open in April.)
	76 "	Swarnamukhi river	2·20	+0·36	−0·51	0′·87	(Swarnamukhi river bar closed in April.)
	81		1·50	+0·62	+0·20	0′·42	
21	VI "	Konoopur	2·00	+0·59	−0·12	0′·71	..
22	89 VI "	Kundailaroo river	4·50	+1·85	−0·42	2′·27	(Bar open in April.)
23	103 1 "	Kodoor	2·00	+0·06	−0·27	0′·33	..
24	114 111 "	South Bank of Penner river.	2·50	+3·12	−0·08	3′·20	(Bar open in April.)
25	120 IV "	Ramatheertham	2·00	+1·40	−0·05	1′·45	..
26	123 VI "	Pyderoo river	2·00	+3·06	+1·50	1′·56	(Bar open in April.)

The figures in large type are the averages of several months of old gauges (only calculated when bars are open) as per separate statement.

The figures in small type are the averages for one month (April) of the new intermediate gauges.

Statement showing the Mean Maximum and Minimum Heights of Tides—*contd.*

Number.	Mileage.	Gauge Stations.	Zero of the gauge below M.S.L.	Reduced to M.S.L.		Differences, Columns Nos. 5 and 6.	Remarks.
				Mean maximum height of tides.	Mean minimum height of tides.		
1	2	3	4	5	6	7	8
27	127 V North ..	Iskapalle	2·00	+1·70	+0·56	1′·14	..
28	132 VII "	Chippalaroo river ..	2·00	+2·98	+1·41	1·57	(Bar open in April.)
29	142 1 "	Kottachuttram	2·00	+1·81	+1·34	0′·47	..
30	149 11 "	Ramapatam	2·00	+1·96	+1·67	0′·29	..
31	160 IV "	Manner river	2·00	+3·47	+1·23	2′·24	(Bar open in April.)
32	164 V "	Oottaravu Calva at Pakala ..	2·00	+2·41	+0·49	1′·92	..
33	169 IV "	Mushi river	2·00	+3·42	+0·93	2′·47	(Bar open in April.)
34	177 VI "	Thandaroo creek	2·00	+1·80	+0·44	1′·36	..
35	187 "	Gundlakamma river ..	2·00	+2·98	+0·20	2′·78	(Bar open in April.)
36	190 VII "	Kanuparthy	2·00	+0·93	−1·00	1′·93	..

The figures in large type are the averages of several months of old gauges (only calculated when bars are open) as per separate statement.

The figures in small type are the averages for one month (April) of the new intermediate gauges.

(Signed) A. AWDRY, Captain, R.E.,
Supt. of Works, Buckingham Canal.

15th May 1880.

REVISED Statement showing the Draught of Water of Boats Licensed for plying on the Buckingham Canal from 8th October 1879 to 31st March 1880.

Section.	Below 1½ feet.	From 1½ to 2 feet.	From 2 to 2½ feet.	Total Boat.	Remarks.
A or Sadras Section	87	16	..	103	
B or Madras do.	29	5	8	42	
C or Pulicat do.	285	191	265	741	
D or Kistnapatam do.	4	13	4	21	
E or Ramapatam do.	5	21	5	31	
F or Kottapatam do.	18	35	12	65	
Kistna and Godâvari boats plying on the Buckingham Canal.	..	..	1,012	1,012	These boats, though licensed for Kistna and Godâvari, are also plying on the Buckingham canal, paying tolls for all sections.
	428	281	1,306	2,015	

(Signed) A. AWDRY, Captain, R.E.,
Supt. of Works, Buckingham Canal.

BUCKINGHAM CANAL,
17th May 1880.

STATEMENT showing the Receipts and Charges of the Buckingham Canal.

RECEIPTS.		CHARGES.		
Items.	Amount.	Items.	Amount.	Remarks.
	Rs.		Rs.	
Amount of license fees for 1880-81, 9,500 tons at Rs. 2 per ton.	19,000	Maintaining the Southern canal, 40 miles, at Rs. 110 =	4,400	
Toll collections	51,600	Do. Junction and Northern canal, 207 miles, at Rs. 275 =	56,925	
Sales of canal produce ..	700		61,325	
	71,300	Present permanent establishment employed in the division, at Rs. 2,800 per mensem for 12 months.	* 16,800	* Half only entered to canal maintenance as the same establishment carries on original works, salt works, and other special works.
Difference	1,38,271	Toll establishment as per revised sanctioned scale, at Rs. 515 per mensem for 12 months.	6,180	
		Lock establishment, at Rs. 110 per mensem for 12 months.	1,320	
			85,625	
		Interest on capital for Rs. 30,98,654 at 4 per cent. per annum.	1,23,946	
Total ..	2,09,571	Total ..	2,09,571	

CHEPAUK,
17th May 1880.

(Signed) A. AWDRY, Captain, R.E.,
Supt. of Works, Buckingham Canal.

No. 14-F.

No. 102-A.

Memorandum by the Chief Engineer, Public Works Department.

LETTER No. 558, dated 15th May 1880, from the Superintendent of Works, closes a series of reports and communications on the subject of the Buckingham Canal, and it thus appears desirable to submit a selection of the correspondence with plans, &c., as per margin, for the orders of Government with such supplementary remarks as appear called for in reference to the estimate which is now being framed for submission to the Government of India.

G.O., 6th February 1880, No. 283 W.
" " " " 284 W.
Letter from Chief Engineer, No. 411, of 6th February 1880.
Appendix to G.O., of 6th February 1880, No. 284 W., with Chief Engineer's memorandum, dated 10th April 1880.
Letter No. 462, dated 10th May 1880, from Superintendent of Works, Buckingham Canal, forwarding memorandum from Sub-Engineer Ottmann.
Do. No. 558, dated 15th May 1880.

2. During the past year the canal was visited by two cyclones, one in May the other in November, and the results of these have been duly recorded in G.Os., Nos. 283 W. and 284 W., of 6th February 1880.

3. Early in January His Grace the Governor made a tour of inspection up the canal, and the undersigned who accompanied His Grace has placed on record the results of his observations in a memorandum, dated 10th April 1880, which has since then been followed up by the correspondence quoted.

4. It would be impossible to condense the details of a work of such magnitude within moderate limits, and as the time has not yet arrived for drawing up the general report of the work for submission to the Government of India, it will suffice here to discuss one or two of the leading points regarding which it is desirable to lay down directions for the guidance of the Superintendent of Works. It is proposed moreover here to deal specifically only with the 196½ miles of channel north of Madras leaving the 40 miles south to Merkanum, which exists under somewhat different and more simple conditions for consideration subsequently.

5. Between the Cooum and the Rompairu river where the canal meets the Commamur channel from Bezváda, there are not less than thirty drainages crossing the line on their way to the sea, and none of them admitting of being readily either taken into the canal, or diverted. The most important of these drainages are enumerated in paragraph 75 of Major Vibart's Inspection Report of 27th September 1879, where the catchment areas in each case are shown to vary from 147 to 20,000 square miles.

6. Throughout the whole length, but more especially towards the north, the canal is exposed to the effects of cyclone floods, which, though probably not recurring oftener than once in every seven or eight years, have nevertheless to be provided for, and fortunately the occurrence of two storms in last year, one of which (that on 18th and 19th November) was of exceptional severity, has supplied data on which it may be possible to base certain conclusions, as to the provisions required in the estimate, for securing the safety of the work.

7. The reports on the effects of these storms are as above observed recorded in detail, and the annexed longitudinal section shows in a graphic manner most of the leading facts. The marks of the flood line of November were easily distinguishable all along the banks on the occasion of His Grace's tour, and these, with the soundings taken at every furlong to ascertain the depth of silt deposited in the channel bed, have secured most valuable information for future guidance.

8. From want of precise knowledge as to the previous state of the canal bed, as also in regard to the condition of the work throughout, prior to November's flood, the section purporting to show the facts must be taken with certain reservations, though the soundings taken after each of the floods mentioned are no doubt very correct.

9. In any case it is clear that over and above the clearances effected since opening the canal in 1878, the amount of silt actually deposited in its bed, as shown in Sub-Engineer Ottmann's memorandum of 22nd April 1880, amounted to 2,148,970 cubic yards; and that to remove this quantity so as to restore the channel to its original condition would have cost Rs. 4,70,087 at present rates of working. In many places, such as in the 98th, 103rd, 107th, 112th, 128th, 134th, 143rd, 148th miles the depth of silt reached mean sea level; and in the 161st, 169th, and 178th it ranged from 1' 6" to 2' 3" above it, barring all traffic.

10. Leaving aside the fact that at present the removal of silt from the bed of the canal costs more than it probably will do with more perfect arrangements (though no very great reduction of cost can, it is feared, be looked for even with the most perfect machinery) it is clear that owing to the numerous drainages which cross the line of canal, and which cannot possibly be interfered with in their way to the sea, enormous amounts of silt are liable to be brought in and deposited with each recurring cyclone flood, and that even with the ordinary monsoon freshes silting goes on to a serious extent. As an extreme example of the amount of silt deposited even during the ordinary freshes, the fact may be mentioned that shortly after the opening of the canal in 1878, no less than Rs. 11,000 odd were expended in recovering the section of about 1 mile of canal which crosses portion of the Pennér river delta.

11. The first question that arises in reference to the work to be performed, is whether the section of the canal as originally decided on should not be reduced, so as to minimise the annual clearances, and the next whether expedients for keeping the silt out of certain reaches of the canal may not with advantage be adopted.

12. As regards the first point the Superintendent of Works argues, in paragraph 4 of his No. 558 of 15th May, that while Government should not interfere with the maximum draft for boats being left as now ruled (2½ feet), it will be "practically impossible "to effect annual clearances to a depth of 4½ feet below mean sea level. He also contends for 6 inches being left at all stages of the tide below the keel of the boats, so as to allow a little for silting that cannot at once be removed.

13. The principles on which this decision is based, although leading virtually to the abandonment of the original section of the canal and of its navigation by boats propelled by steam, seem to be sound, and the undersigned would therefore recommend—

1*st*,—that the sole be maintained throughout only 20 feet wide at 3 feet below low tide level;
2*nd*,—that the side slopes for the water section be nowhere less than 4 to 1;
3*rd*,—that tow-paths be made where practicable 3 feet above high water level.

14. The tidal action, though shown in the section by lowest and highest tide level lines, requires more study than it has been possible as yet to give to it, but it may be assumed that, had the reduced section now recommended been originally adopted, about 1 foot of excavation would have been saved throughout. At only 2 annas per cubic yard without any allowance for pumping, the saving on excavation alone would have amounted to Rs. 3,69,000.

15. As moreover argued by Captain Awdry the plan of referring all clearances in future to low water instead of to mean sea level will have the great advantage of being easily understood by the laborers.

16. In regard to the second point, viz., the expedients for keeping silt out of the channel, at least during heavy floods, it can hardly be doubted that the necessity for this would, from a mere inspection of the section, be almost a foregone conclusion.

17. The following brief table shows in a general way the financial aspect of such expedients:—

With a channel of the normal section above, viz., 20 feet breadth of sole and side slopes 4 to 1.

Assumed depths of silt to be removed ...	6″	1′ 0″	1′ 6″	2′ 0″
Corresponding quantity to be removed in cubic yards per mile	2,151	4,582	7,013	9,444
Average cost of removal at 3 annas per cubic yard ... ... Rs.	403	860	1,315	1,771
Equivalent to a capital outlay of an annual recurring charge at 5 per cent. ... Rs.	8,060	17,200	26,500	35,420

In other words, if silt to the depths shown in the first line could be excluded by certain expedients, it would be worth while incurring outlay to the amounts the capital values shown in the last line for each mile of canal.

18. To isolate each reach of the canal intervening between the drainages which must be allowed free vent to the sea, it will be necessary to establish either flood gates or locks at both ends of such reaches, and a western canal bank of such height as to be well above and exclude all cyclone floods.

19. The question of isolating by means of locks is hardly as yet in a condition to be properly discussed. These works would of course keep the water at a higher level in the different reaches than is at present possible, but their actual value in this respect cannot be determined with accuracy till at least the end of the present year, and even if shown that they would with the river bars open retain a higher level in the canal than at present seems probable, it must be borne in mind that—

1*st*,—with closed bars their value would be extremely small;
2*nd*,—their cost would be very heavy, not less than Rs. 15,000 each for those of the cheapest description having earthen slopes instead of masonry chamber walls;

3*rd*,—a heavy establishment would have to be maintained;
4*th*,—each lock would occasion delays to traffic and probably open the door to peculation from the demands of the lock establishments.

20. The time has therefore not as yet apparently arrived for their general adoption as means for isolating the several reaches, though probably for specific objects necessary for the canal in the immediate neighbourhood of Madras, as observed in memorandum of 10th April 1880.

21. A single set of lock gates might however be placed facing outwards at the end of each of the reaches which it is proposed to isolate, and as having only to be closed once and again during the actual progress of extraordinary flood to exclude silt, the establishment for working them may be small, and retained only throughout the cyclone months, say for April and May, and again from 15th October to 15th December; in fact the gates might be worked by the ordinary maintenance establishment at such exceptional times.

22. Should locks be decided on at any subsequent period, it will only be necessary to place extra gates at 120 or 150 feet in rear of each of these flood gates to make them act as such.

23. Each set of gates would cost not more than Rs. 7,000 or 7,500, and comparing this amount with the capitalized cost of silt removal (table paragraph 17) it is clear that it would pay sufficiently well to build such flood gates for reaches of canal only 2 miles* in length if they can be made to keep out even 6 inches in depth of silt.

	Rs.
Capitalized cost of clearing silt to a depth of 6 inches at Rs. 8,060 per mile for 2 miles	16,120
Cost of two flood gates	14,000
Saving ...	2,120

24. But as it will hardly ever be necessary to isolate any reach having a shorter length than 4 or 5 miles (see remarks in memorandum of 10th April) the advantage of constructing such gates must be evident, and the more so if it be considered that as a fact the May cyclone of last year brought in a depth of 1 foot 6½ inches of silt into the channel as an average (see Mr. Ottmann's memorandum of 22nd April) and the November flood added nearly a foot or more in depth.

25. In framing the detailed estimate, flood gates, with the completion of the bank on the western side of the canal to a height of at least 3 feet above the highest flood, it may therefore be assumed, will be needed.

26. The several flood gates required are specified in the memorandum of 10th April 1880 and need not be further adverted to. On precisely the same grounds, the advisability of excavating fresh portions of channel as deviations at the various points specified, in order to keep out silt, or for other reason, is advocated.

27. With reference to the action of the tides on the canal, the lines as laid down on the accompanying section, only in reality show the heights as recorded immediately within the different estuaries at the gauge stations, but do not indicate the level throughout the canal; they are therefore so far misleading. Captain Awdry's letter, however, of the 15th May shows that towards the end of the year, when the registrations at all the intermediate stations shall have been completed, accurate conclusions may be drawn.

28. From his second table giving the results already some what imperfectly obtained, the average difference of level between the mean maximum and mean minimum, as recorded at several intermediate points at distances from the open river bars, appears to be very small. At Pumbly, 64th mile, 5 miles south of Dugarázpatnam, it is only 0·19 feet, and even less (0·15 feet) at Kálaujee, 6 miles south of Pulicat.

29. These with other examples show that, although in the immediate neighbourhood of the several open bars the value of the tidal action is considerable [from particularly the Kundalairoo river (90th mile) northwards,] it apparently ceases at 7 or 8 miles distant from the several bars. South of the Kundalairoo river the action

of the tide in keeping up the level of the canal is much diminished, but as above observed the whole question in this respect is at present in rather an inchoate condition.

30. The best means for removing silt from the channel also requires more study, but so far as can at present be seen there is no very distinct prospect of sensibly diminishing the present charges, heavy as they appear to be.

31. The results of the experiments which have been ordered with the "spoon dredge" advocated by His Grace, and other expedients recommended by the undersigned, will have to be awaited.

32. Steam dredges appear at first sight to hold out decided advantages, so far as concerns speed in execution of the work, but, so long as the channel is to be maintained at only 3 feet below low tide level, their utility is not so clear.

33. Upwards of one million cubic yards of silt were deposited in the channel by the May cyclone, and to remove this quantity in two months no less than 33 steam dredges, capable of clearing 500 cubic yards per diem each, would have been needed.

34. The procuring, maintaining, and manning of such a fleet of dredges would obviously be out of the question, particularly as the work, while being performed under conditions disadvantageous to the working of such machines, is well adapted to the capacity and habits of the ordinary working population, using the most simple appliances.

35. In a few places, such as the crossing of the Gundlakamma, Mushi, Pálár, Mannér and Pennér rivers it is quite possible that steam dredges may be advantageously applied, and four or five might after further inquiry be provided for.

36. As regards the other points connected with the estimate for the training of some of the rivers crossed, especially the Pennér (see memorandum of 10th April), it would be premature to say more than has been already recorded; but that such measures will be found essential the undersigned entertains no doubt.

37. It is needless also to dwell more on subsidiary matters, which, however, will all claim attention in dealing with the detailed estimate which, it is hoped, may be ready by the end of the present year.

38. Captain Awdry in his letter under consideration shows the number of boats already using the canal and the financial condition of the work. This latter, however, is a matter with which no doubt His Grace will himself deal, and therefore calls for no remark at present from the undersigned.

29th May 1880. (Signed) R. H. SANKEY, Colonel, R.E.,
Chief Engineer, P.W.D.

No. 14-G. From the Government of India, dated 21st June 1880, No. 172 I.

No. 14-H. From Captain G. F. L. MARSHALL, R.E., Officiating Assistant Secretary to the Government of India, Public Works Department (Civil Works—Irrigation), to the Secretary to the Government of Madras, Public Works Department, dated Simla, 30th July 1879, No. 214 I.

As it is understood that the Buckingham Canal suffered some injury in the late cyclone, I am desired to request that, with the permission of His Grace the Governor, a full report may be submitted to the Government of India with as little delay as possible; reliable information as to the risks attaching to a canal in such a position being especially needed with reference to a canal project under similar circumstances elsewhere which is now under the consideration of the Government of India.

No. 14-I. To the Government of India, dated 14th August 1879, No. 2,070 W.

No. 15. ORDER THEREON, 3rd September 1880, No. 2,080 W.

ORDERED that the preceding printed collection of papers be forwarded to the Government of India for information.

(Here enter No. 2,081 W., dated 3rd September 1880.)

(True Extract.)

(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Superintendent of Works, Buckingham Canal.
" " Kistna, } for information.
" Revenue Department, "

Exd. A. F. Goodall.
Spare Copies

17-9-81

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1880} Madras.

PUBLIC WORKS.

To

THE SECRETARY TO THE
GOVERNMENT OF INDIA.

Dated September, 3rd.

Issued

Encl.

Recd.

G. O., 3rd September 1880, No. 2,081 W.

SEPTEMBER.

No. 16.

FORWARDING a collection of papers on the subject of the Buckingham Canal and on the damages sustained by it by the cyclones of May and November 1879, and stating that the complete estimates will be ready for submission by June 1881.

6508

Can 2036W (3)

This requisition for an allotment of Rs 15,953 for Tools & Plant, B. Canal, might be disposed of in connection with the demand recently made on the Finl Dept for an additional grant under Provincial

Cu
9.4.84

Await result of application to the Financial Dept

W.
11.6.84

2036 W

17-9-84

2036 W

No. 1665

SUPERINTENDING ENGINEER'S OFFICE,
5TH CIRCLE, MADRAS,
Chepauk, 15th August 1884.

From

THE SUPERINTENDING ENGINEER,
5TH CIRCLE,

To

THE Chief Engineer
for Irrigation

SIR,

I have the honor to
submit for
Estimate for Rupees 853 for
purchasing Oil Engine Plant
for the Buckingham
Canal — to request
that sanction may also
be given to the transfer
of funds from works
specified in the statement
below

Enclosures.
Abstract estimate

0-9-8-84

below.

From
Surrender of Funds from Works grants

Names of Works	Grant for 1884-85 as per G.O. No. 500 I.A. 26th May 1884	Proposed Reduction	Amount required for 1884-85
Provincial Irrigation & Navigation Works for wh. Capital & Revenue Accounts are kept.			
Capital Works.			
Buckingham Canal.			
Northern Canal.			
Section I			
Item 8. Flood gate - Sault gate of Cannore back water.	19,039	2,000	17,039
Section II			
Item 2. Diversion of Canal from Cotaumedu to Thettoo.	25,000	5,000	20,000
Section V			
Item No. 59. Flood gate - North bank of Moodyar River	18,440	3000	15,440
Item No. 75. Flood gate. South bank of Mudigoondy River	21,460	3,453	18,007
Item No. 83. Flood gate. North bank of Goouda-lacammarum	21,720	3000	18,720
Total Rupees.....	105659	16453	89206

To
Funds Required for Tools and Plant.

Item	Amt.	Remarks.
Provincial Irrigation & Navigation Works for wh. Capital and Revenue Accounts are kept.		20366
Capital		
Tools and Plant.		
Amount required for Tools and Plant Vide Statement printed in G.O. No. 500 I dated 26th May 1884.....	9600	In the last official year Rs. 12000 were allotted and Rs. 9398 adjusted in the Accounts for March 1884 for a account of 2 Engines & Pumps. The amount now required is for adjustment of a bill of Rs. 5740 and additional charges on account of the Engines
For 2 Portable Engines	6000	Estimate herewith submitted.
For Leather belting and Hammers	853	
Total requirement.	16453	

I have the honor to be
Sir
Your Most Obedt Servt
Chief Superintg Engr & Ex Officio P.W.C.

Superintg Engr
5th Circle

From

THE SUPERINTENDING ENGINEER,

5TH CIRCLE,

To

THE Chief Engineer
for Irrigation

Dated 1st
Recd. } August 1884

ENCLOSURES. 2

No. 1669

Tools and Plant for the Buckingham Canal - Submits for sanction an estimate of Rs. 853 for purchasing — and requests sanction to the transfer of funds from Works to Tool under Capital.

G.O. No 500 I. 26-5-81.

E. I. Form No. 34-F.

KEEP-WITH.

No. dated 188 .

2036W Rs. 6500

GOVT. OF MADRAS } 1884. { P. W. DEPT.

CHIEF ENGINEER FOR IRRIGATION.

Madras, 14th August, 1884. (3)

OFFICE NOTE. No. 167

Re 2036 W 18-8-84

Circulation Register.

To	From	Despatch Date.	Receipt Date.
F.W.	C.C.I.	4/8	

The Supg. Engineer 5th Circle applies for an allotment of Rs. 6853 for Tools & Plant chargeable to Capital account of the Buckingham Canal in addition to Rs. 9100 referred to in para 2 of G.O. No. 500 I dated 26th May 1884. Please let me know whether the amount required can be allotted

56

allotted from the balance
of Reserve for ~~Roads~~ Buildings
under Provincial Funds,
or an application for in-
-crease of allotment should
be made to the Financial
Department.

For C.E.I

B/F
4/8/82

Genl Secrt

Public Works Department.

2036 W

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Under date the

Read the following

Letter from S.E. V. Circle — H.E. No. 1169 d/ 1st August/82
Office Note from the Chief Engr: for Irrgn: " " 167 d/ 4th August/82

The sum of Rs 15,953

required for Tools and Plant in connection with the Buckingham Canal is appropriated by transfer from the Provincial Reserve.

15-8-82

Ex 1/8

S.E. V. Circle with 2 Encls:
Ex: P.W. accts:
Chief Engr: for Irrgn:
Fin: Dept.

57 58

17 9 91

6508
6913.

Govt. of {1884} Madras.

PUBLIC WORKS.

19/8

Dated

(59)

Read. Encl.

G.O. 18 aug 1884 No. 2036 vy

Buckingham Canal

An 15,953 required
for "Tools & Plant"
included "Tools & Plant"
for the ——
appropriated by
transfer from
the Provincial
Reserve.

60
15

Acc 19/8

Jorg/8