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PAPERS
RELATING TO
THE BUCKINGHAM CANAL.

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THE BUCKINGHAM CANAL.

*Report by Major R. R. E. DRAKE-BROCKMAN, R.E., Executive Engineer,
Buckingham Canal Division.*

THE Buckingham Canal is a salt-water canal (tidal to a great extent whenever the river bars are open), extending along the East Coast of the Madras Presidency, southwards 66 miles from Madras to Merkanam, and northwards 195 miles from Madras to Pedda Ganjam, at which place communication is made (at the end of the high level Commamur channel) with the fresh-water canal system of the delta of the Kistna, which again communicates with the canal system of the delta of the Godávári.

2. The total length of main navigable canal to Coconada and northwards thus made available is as below, *viz.* :—

	Miles.
Buckingham Canal	261
High level canals (Commamur channel) of the Kistna Delta Systems.	112
Do. do. of the Godávári „	89
TOTAL	462

this length being exclusive of any but the direct line of fresh-water canal from Pedda Ganjam to Sámalkót, *viz.*, Bezváda, Ellore, Dowlaishweram, and Coconada; though the branch canals of the Kistna and Godávári will, no doubt, acting as feeders, bring much traffic to the main line.

3. The canal runs within 3 miles of the sea-coast throughout its entire length, and in many parts is within half a mile of it.

4. The general features of many parts of the East Coast of the southern portion of India

General nature of the country in which the canal is made. are briefly as follows :—

Close to the sea there is generally a line of sand dunes, between which and, frequently, a second line of dunes, there is a hollow which may be taken as the result of the action of waves, currents and winds on the extension of the coast line eastward due to the silt, &c., brought down by each river into the sea. These hollows, frequently forming backwaters, are filled with water, and are of sufficient depth in many places for navigation, being supplied with sea water through the bars of the rivers with which they are in connection.

5. Early in this century (1801) the narrow strips of backwater found at the mouth of the

river Kortalayár suggested to Mr. Heefke to obtain from Government permission to cut a canal, about 11 miles in length, from Madras to the southern end of the Ennore backwater; this permission was granted, and Mr. Basil Cochrane was the surety to Government for the terms being complied with.

The contractor, Mr. Heefke, and Mr. Cochrane ultimately obtained the whole control of

the canal—completed the section of the canal from Madras to Ennore backwater in 1806. Some cuts were also made

near Katupulli between the backwaters so as to complete the

communication with the Pulicat lake, 27 miles distant from Madras. Mr. Cochrane became sole proprietor of the canal for a period of 45 years, dating from 1st November 1802, with permission to levy tolls on it. In 1837, he having left India, the canal got into bad order, and Government took it over, paying to him R14,061 a year, which was the average amount he had been realizing from the traffic, until 1847, when his lease expired.

6. Such was the commencement of the East Coast Canal, and from the condition of the

waterway, as shown in Appendix II of the first Report of the Madras Public Works Commissioners, there had by 1852

been great silting up of the bed. The system followed in construction was merely that of joining the backwaters in the cheapest manner possible.

7. The Shadayankupam Lock, 7 miles from Madras, was commenced in 1854, with the Shadayankupam Lock at 7 miles 3 furlongs. object of keeping the level of the water in Cochrane's Canal high during periods when the Kortalayár bar at Ennore is open. It was originally sanctioned at 16 feet wide and 105 feet long, but Captain Chambers, R.E., the then Superintendent, obtained permission during its construction to alter it to 20 feet wide and 150 feet long.

8. In the first Report of the Public Works Commissioners, compiled in 1852, Appendix II, Pulicat Lake to Dugarápatnam, 44 miles (77 miles in Commissioners' Report). paragraphs 27-28, notice is taken of improvements to the canal by extending it to Dugarápatnam, 69 miles from Madras, from the northern end of the Pulicat lake; along this line strips of backwater more or less were found, so that the cutting was not heavy and the work was in progress in 1854, and is shown by the Progress Report for 1856-57 to have been "recently extended" to Dugarápatnam. In the same year improvements were also made to Cochrane's Canal to the extent of R72,800, inclusive of the Shadayankupam lock, estimated to cost R25,000.

9. In the same Progress Report mention is made of a proposed extension of the East Dugarápatnam to Kistnapatam, 21 miles. Coast Canal from Dugarápatnam to Kistnapatam backwater in the budget of 1855-56, and the project was recommended to the Honourable Court of Directors in 1855; this estimate was framed by Captain Chambers, R.E., but was not carried out. As shown by G. O. No. 189 of the 20th January 1865, Mr. W. Fraser, C.E., was engaged about that time in a comparison between the merits of Captain Chambers's design of December 1854 and one proposed by Mr. Kennedy in November 1863, and estimated to cost R2,35,000. Government, however, were unable to provide funds for either.

10. Captain Hasted, R.E., in June 1870, submitted a revised estimate of R2,87,000 for Estimate and expenditure on the this section of the canal, which was at the time being cut, above section. following Captain Chambers's line in preference to Mr. Kennedy's; the estimate of R2,35,000 for the latter was, however, the one on which the work was executed—

The expenditure in 1867-68 was	R
Do. in 1868-69	6,248
Do. in 1869-70	64,796
Do. in 1870-71	35,154
	29,827

when work was suspended under G. O. No. 274 of 28th January 1873. Funds were provided for the remainder of the work on Colonel Hasted's estimate, and orders were given to push on the work in 1873-74 from Provincial Funds, and work to the extent of R67,000 was carried out in that year; R59,845 were expended in the year 1874-75, the section being completed in 1876-77 at a total cost of R2,85,532, thereby placing Nellore in easy communication (with a short length of road from Kistnapatam) by water with Madras. This section was reported open for traffic in May 1875, the portion up to Siddaveram having been made by Mr. Fraser, and from Siddaveram to the Kundelairu by Lieutenant C. B. Henderson, R.E.

11. The next section of the East Coast Canal undertaken was that from the Kundelairu Kistnapatam to Pennér river, 24 miles. river, close to Kistnapatam, to the Pennér river. The work was sanctioned under G. O. No. 814 of the 23rd March 1875, and the line followed is for the most part identical with that proposed by Captain Chambers nineteen years before; the estimate amounted to R2,74,000. In G. O. No. 266 W. of the 18th June 1877, certain modifications, including the Kistnapatam basin, were sanctioned, estimated by Mr. O'Shaughnessy to cause an addition of R14,100. This section was commenced by contract in 1875-76, in which year R25,000 were spent on it, R1,71,658 being spent in 1876-77. Six miles were completed by November 1876. In the year 1877-78 this section was employed as a famine work for the distressed of the Nellore District, R1,06,755 being expended, and the work completed in 1878-79 at a total cost of R3,63,536. This section was open for traffic in May 1877; having been under Lieutenant C. B. Henderson, R.E., from 1873-75, under Lieutenant Cotter, R.E., in 1876, and, lastly, under Sub-Engineer Ottmann and Supervisor Stephens.

12. G. O. No. 1302 of 24th May 1876 shows the state of the work up to that date, and Pennér to Pedda Ganjam, 82 miles. points to the anxiety of Government to complete at an early date the communication with the Godávári and Kistna systems of navigation. Lieutenant Cotter, R.E., in June 1875, had reported on the section from the Pennér to the Chippelairu, and had pointed out that the high floods of October 1874 in the Pennér had altered the features of that river since Captain Chambers had selected his line as being the most suitable one for the canal.

13. The pressure of famine being very severe in the districts to the west of Nellore, it was decided in G. O. No. 3060 of 15th November 1876 that this section of canal should be immediately proceeded with by famine labor imported from the Bellary, Kurnool, and Cuddapah Districts. Under the orders of Mr. O'Shaughnessy, the District Engineer of Nellore, Lieutenant C. B. Henderson, R.E., was directed to lay out the section of canal between the Pennér and Chippelairu, and he did so, following, where practicable, Captain Chambers's line and giving a bed width of 30 feet with side slopes of 2½ to 1.

The bed of the canal was fixed at 3½ feet below a mean of all low tides recorded for six months and 3 feet below the lowest recorded spring tides. This section was ordered to be carried out by 10,000 coolies from Bellary and Kurnool. After laying out the portion to the Chippelairu, Lieutenant C. B. Henderson, R.E., was directed to survey and lay out the section to the north of the Chippelairu for the employment of a second batch of 10,000 coolies.

14. At the same time Lieutenant C. C. Rawson, R.E., was directed to commence at Chippelairu northwards for 22 miles. Pedda Ganjam and survey and set out work for the employment of 20,000 more coolies on 42 miles.

15. The surveys and estimates were pushed on as quickly as practicable, but in this case, as in all the famine works, it was primarily necessary to employ and pay or feed the coolies, and so the work of projection and estimation had necessarily to take a secondary place; however, Lieutenant Henderson, R.E., in the Pennér to Mannairu section, and Mr. deGroussiers, an Executive Engineer of the Bengal Public Works Department, in the Mannairu to Pedda Ganjam, nevertheless pushed on the plans and estimates quickly, at the same time that they supervised the execution of the works.

16. In his original report on the Pennér to Pedda Ganjam section of the canal, Mr. O'Shaughnessy states that the line is generally the same as that selected by Captain Chambers in 1855, but that certain deviations had to be made; in the first four miles a deviation to the westward was made, as Captain Chambers's line was too near the sea; in the 7th and 8th miles a deviation was made to avoid cutting through a high ridge; in the 10th to the 14th miles a deviation was made to obtain a sufficient cutting for towpaths and embankments; in the 15th mile a deviation to avoid a deep cutting was made. Between the Chippelairu (about the 20th mile) and the 52nd mile north of the Pennér no deviation was made from Captain Chambers's line; from the 52nd to the 56th miles a trifling deviation was also made to carry the line further from the sea. A considerable deviation was made from the Moosee river near Ethamukala to the Ongole road, between the 56th and 63rd miles, to avoid a very heavy cutting through sand, and also to keep clear of some valuable land.

17. In regard to the level of the bed, Mr. O'Shaughnessy writes:—"Hitherto 4½ feet below mean tide level has been the specified depth of the canal. It was supposed that the range of tides was about 3 feet, and that a depth of 4½ feet below M. S. L. would give a minimum depth of 3 feet for navigation at low tide." * * * "It has been found, however, that the range of the tides is more than 3 feet at Kistnapatam; a gauge has registered a range of 3 feet 10 inches, and at the Mannairu, 71 miles further north of the gauge, has shown a difference of level between high and low water of spring tides of over 4 feet; if the canal was cut to 4½ feet below mean tide in those reaches, there would be only 2 feet 6 inches or 2 feet 7 inches of water at low tide, or about 6 inches less than the depth required."

18. Mr. O'Shaughnessy points out that this error has been carried through the section between Kistnapatam and the Pennér, but to the north of the latter river it has been avoided by fixing gauges at the open bars and cutting the canal out to a depth of 3 feet below the lowest readings on the gauges. The width at the bed was made 30 feet, with side slopes of 2, 2½, and 3 to 1, according to the nature of the soil.

19. Mr. O'Shaughnessy estimated that the whole excavation required for the canal from the Pennér to Pedda Ganjam would be 8,652,146 cubic yards at 1 anna 10 pies per yard, and his subsequent report shows that in actual working 7,959,708 cubic yards completed by the end of May 1878 had cost on an average 2 annas 2½ pies per yard—an excess which he had attributed to the employment of famine labor.

20. The same officer reports that including 16½ miles of the Kistnapatam to Pennér section and 16½ miles of new canal along the margin of the

Total length of canal cut in thirteen months.

gave employment to an average of 32,000 work-people daily, while the greatest number of people on the work at one time was 61,200 (or including women and children, 100,000 persons were at one time on the work during the famine); and he concludes his report by an allusion to the fact that he had asked for and obtained permission from His Grace the Duke of Buckingham to name the canal after him. It may here be observed that the portion of the canal from Madras originally (*viz* Atlas Sheet No. 78) named after the great Lord Clive. The designation subsequently applied to the work—"East Coast Canal"—so distinctly pointed to the position of the work on the Map of India that it seems doubtful whether, looking also to the fact that Government did not take the initiative in the matter, His Grace did not permit it to be called after himself rather than wound the feelings of an energetic District Engineer, during whose charge of the Nellore Division the junction with Kistna system of canals had been completed. That the work was no new design, but had been steadily prosecuted, at intervals, ever since the beginning of the century, especially in the years 1867 to 1870, and with even more vigour again in the years 1872 to 1875, will have been observed from the history as above narrated. The designation of the work as the Buckingham Canal is, however, so far the accepted one, that there is now no sufficient reason for again altering it.

Number of people employed on the work.

Named after His Grace the Duke of Buckingham at Mr. O'Shaughnessy's request.

to Ennore appears to have been

Portion previously named after Lord Clive.

East Coast Canal a more suitable name.

did not take the initiative in the matter, His Grace did not permit it to be called after himself rather than wound the feelings of an energetic District Engineer, during whose charge of the Nellore Division the junction with Kistna system of canals had been completed. That the work was no new design, but had been steadily prosecuted, at intervals, ever since the beginning of the century, especially in the years 1867 to 1870, and with even more vigour again in the years 1872 to 1875, will have been observed from the history as above narrated. The designation of the work as the Buckingham Canal is, however, so far the accepted one, that there is now no sufficient reason for again altering it.

21. Turning to the Southern Canal, Colonel Foord's memorandum, dated the 29th

Southern Canal.

November 1878, printed with G. O. No. 1102 of the 20th

May 1879, puts on record in paragraphs 26 to 47 the whole

history of the work, which is quoted below for ready reference:—

"26. The project of excavating a canal along the Eastern Coast between the Adyar and the Pálár, with the view of perfecting the long line of inland water communication north and south of Madras, was brought forward for consideration in the year 1854. Two points in connection with this project particularly claimed attention—

"(1) The possibility of keeping the canal navigable throughout the year; and

"(2) The substitution of masonry bridges in lieu of ferries, recommended by the Chief Engineer, at each of the places where the road crossed the proposed water communication.

"27. The Chief Engineer, who made a personal examination of the canal, reported that it was quite possible to keep up an unfailing supply of water, averaging 4 feet 6 inches, in seasons of the greatest drought, by artificial cuttings of the bars at Covelong and at the mouth of the Pálár. This result, however, could only be attained by a proper system of locks with a sluice or calingulah at Covelong for the admission of tidal water. Bridges were also recommended at three places. The whole cost of the work was estimated at Rs2,21,800.

"28. The length of the canal was to be 40 miles. The first section extended from the river Adyar to the town of Sadras, a distance of 35 miles. This section was commenced in May 1855 and completed in the early part of March 1857, with a surface width of 45 feet, and a depth varying from 3 feet 6 inches to 4 feet 6 inches. Boats drawing 1 foot 6 inches were, in March 1857, enabled to use this section throughout, and it was calculated that there would be sufficient water for passenger traffic, and the transport of light goods even when the Adyar, Covelong, and Yeroor bars were closed.

"29. The expenditure on the canal amounted to Rs1,75,500 against the sanctioned estimate of Rs2,21,800.

"30. The extension to the river Pálár, 5 miles south of Sadras, was estimated to cost Rs54,750. The average cost of the 40 miles of canal between the rivers Pálár and Adyar, including five large bridges, each 60 feet span, was thus Rs7,000 per mile.

"31. In March 1857 an estimate, amounting to Rs7,800, was sanctioned for completion of a cut through pure sand, close to the sea, between Sadras and the Pálár, 1½ miles in length. The object of the work was to improve the alignment.

G. O. No. 414 of 4th March 1857.

"32. In the same year a Committee was appointed to consider the question of the existing navigation, and the measures necessary for its improvement and extension. As regards the Southern Canal, the Committee recommended the establishment of landing places in different parts of Madras, with the view of bringing the Cooum into use for purposes of traffic, the connection of the canal with the Cooum at its northern end and with the Pálár at its southern end, and the construction of feeder roads. The Government recognized the importance of the proposed measures, and called for plans and estimates.

G. O. No. 166, dated 29th January 1858.

for plans and estimates.

"33. The estimate of Rs7,800, sanctioned in March 1857, for the extension of the canal from Sadras to the Pálár river, was, in December 1859, superseded in favor of an estimate of Rs21,000. This estimate provided for the alignment being taken further inland.

G. O. No. 2844, dated 7th December 1859.

further inland.

"34. In July 1861 the Government, on a representation of the Chief Engineer urging the commencement of the work, remarked that they did not see sufficient prospect of its proving so remunerative as to then justify the proposed large outlay.

G. O. No. 1273 dated 10th July 1861.

It was intimated, however, that as it was intended ultimately to connect the canal terminus at the Adyar with the Northern Canal, the scheme would be considered as a whole.

"35. The estimate of Rs2,21,800 for the Sadras Canal was subsequently reduced to Rs2,18,873, and of

this sum Rs1,01,000 were spent, when further outlay was suspended for financial reasons, leaving the canal incomplete. In April 1862 the Government sanctioned a further expenditure of Rs29,000 for deepening and widening the canal between the

Sadras river and Salancoopum. This estimate provided for deepening the southern portion of the canal to 4½ feet below mean tide, and was designed to complete the canal as allowed for by the estimate of Rs2,18,873.

"36. One of the main considerations in sanctioning the Sadras Canal was its capability of being prolonged to Cuddalore, to join there the canal from Porto Novo, which again is connected with the line of water communication between Coimbatore and the sea-coast through the district of Tanjore. This section of canal was sanctioned by the Government of India in July 1853 at an estimated cost of Rs40,000, and provided for connecting the ports of Porto Novo and Cuddalore by a cutting from the river Vellár near Porto Novo to the Paravanár or Cuddalore river. The canal was designed to give sea outlet to the traffic carried by the navigation of the Cole-roor and Vellár rivers, the former of which runs inland a distance of 150 miles through Tanjore and Trichinopoly into Coimbatore.

"37. There being through water communication along the coast from the Adyar to the Sadras, and from, Cuddalore to Porto Novo, it was proposed in March 1856 to excavate a canal through the intervening country. The project was originally framed as a prolongation of the Sadras Canal all the way to Cuddalore, a distance of 59 miles, but the southern part of the canal appearing to need more careful investigation, and arrangements having to be made with the French authorities for the passage of the canal through French territory, the Madras Government laid before the Government of India only a portion of the project, which included 34 miles of canal, estimated to cost Rs3,75,000.

"38. The canal was to be cut to a depth of 4½ feet below mean tide, and it was believed that even at the worst season there would be sufficient water in it for passenger and light cargo boats. The framer of the project provided for no locks, preferring to add them afterwards if found necessary; the bed of the canal being left to be acted upon by the flux and reflux of the tide, and to be scoured by the passage of the land drainage to the sea. The Chief Engineer, however, included two locks and falls, being of opinion that in a tract so destitute of large streams sufficient scour would not be obtained. Instead of admitting the intercepted minor drainage into the canal, the Chief Engineer proposed to lead it, wherever practicable, along the outside of the western bank by small channels until it reached a backwater or other main drainage, into which it would be made to enter at some distance from the navigation. Three bridges of masonry and three of timber were provided. The section allowed for the cutting gave a bottom width of 20 yards. This width was considered necessary in consequence of the sandy nature of the soil. Some difficulty was anticipated in keeping the canal free from sand-drifts, and it was intended to plant the top of the banks with palmyra as a protection, and the slopes with shrubs and marine creepers. In some places the banks were considered to require puddling.

"39. The Government of India took exception to the project, on the ground that it did not appear clear how its level could be steadily maintained unless there were a lock at each point where it enters and emerges from the tidal lagoons, through which it passes. To this it was replied that though locks formed no

part of the original project, yet two were included in the revised estimate drawn up in the Chief Engineer's Office; that such works would not have been thought so indispensable to maintain a sufficient depth for navigation had the fact been known that the extreme difference of level between spring and neap tides in the backwaters is under 2 feet, while the actual rise and fall is only from 6 to 9 inches; and that the depth of the bed of the canal being assumed at 4 feet 6 inches below mean tide, and the fall of tide in neaps being, as above stated, only 1 foot below this level, the minimum depth of water lasting perhaps not more than a few hours once a fortnight, would still be 3 feet 6 inches. It was added that the locks introduced into the project in the Central Office were doubtless intended for increasing the depth of water in the canal by the retention of land floods, and, though not quite sufficient in number to effect that object entirely, would still add greatly to the efficiency of the communication. The framer of the project, Lieutenant Chambers, was, however, of opinion that tidal locks in estuaries with such little rise and fall as those on the East Coast are not of unmixed good to the canals on which they are constructed. He held that in connection with weirs, their adjuncts, they offer obstruction to the free flux and reflux of the tidal wave, and diminish greatly its scouring power, and he was of opinion, therefore, that their construction need not be simultaneous with the establishment of any one section of the coast line; in fact, that the locks should not be built until experience shall have pointed out their necessity or utility, or at least not until after a few years' scour, to allow the banks, berms, and sides of the main channel and of the drainage cuts of a tidal canal to assume their normal shapes and slopes. These views were concurred in generally by the Superintending and Chief Engineers, the latter of whom remarked that the two locks added to the estimate were intended for the junction of the canal with the estuary of the Pálár on the north, and that of the Merkanam river on the south, between which points there exist no drainage outfalls which may not be regulated by simple weirs, which, being provided with ample sluices, will always admit as much tidal water as will keep the canal full when the bars are open. The Chief Engineer added that the locks would, in his opinion, be necessary to prevent or retard the subsidence of the canal surface with the evaporation of the backwaters during the hot season. When fully completed the canal would, the Chief Engineer stated, form one long backwater or lagoon, receiving all the drainage of the country it traverses, and discharging the surplus by the waste weirs, both intermediate and terminal, and that on the proper construction of these works would greatly depend the freedom of the channel from deposits.

"40. The project was brought forward to the Government of India, for an appropriation of funds in the budget of 1858-59, but no funds were granted, and the Court of Directors seemed to think that the time had not then arrived for expending the large amount of money required for the completion of the line of water communication along the East Coast of the Presidency.

"41. The coast canal in the South Arcot and Chingleput Districts was again brought forward in connection with the recent famine as suitable work on which to employ the distressed population.

"42. This section from the south bank of the Pálár to Merkanam at the southern boundary of the Chingleput District was ordered to be lock-split in G. O. No. 412 W., dated 25th January 1878. In August of the same year an estimate of Rs1,79,600 was submitted for the execution of work. The total length of this portion of

* Despatch No. 8 of 1859.

the canal is 20 miles 3 furlongs, which, added to the portion already open, will give a length of 80 miles 6 furlongs from the Adyar.

"43. On leaving the Pálár, the canal, as now aligned, skirts for a short distance a sandy ridge, and is then taken through 3 miles of wet cultivation. It afterwards follows the course of backwaters almost the whole way to the boundary of the Chingleput District. There is, however, a bit of very high ground, about 2 miles in length, between the Cheyúr and Merkanam backwaters. The cutting required here is 7 yards. The estimate, amounting to Rs. 1,79,600, for this portion of the canal received the final sanction of Government in G. O. No. 2102, dated 9th October 1878, F. R.

"44. From Merkanam to French territory estimates for the canal have been prepared. The cost of the earthwork is estimated at Rs. 28,000, and that of the masonry at Rs. 1,19,700. To this a sum of Rs. 45,800 has to be added for compensation for land, making a total of Rs. 4,93,500 for the portion of the canal which is in English territory. For a distance of 2½ miles the canal runs through French territory. This length is estimated to cost Rs. 1,70,880. The total cost of the portion of the canal between Merkanam and French territory will therefore amount to Rs. 6,64,380.

"45. The section of the canal from the Vellár river near Porto Novo to the Paravanár was estimated for in 1878. This section was originally cut in 1856, and was commenced as a famine relief work, but not completed. The excavation was not taken as far as it should have been. A depth of 4½ feet below M. S. L. and 20 feet bottom width has now been allowed, and an estimate, amounting to Rs. 85,855, sanctioned by Government in the Famine Department in G. O. No. 1518, dated 11th July 1878.

"46. In September 1878, an estimate, amounting to Rs. 31,290, was submitted for completing the canal from Vellár at Porto Novo southward to the Killiar, which communicates with the Coleroon. The canal was cut more than twenty years ago, but not apparently to the full depth of 4½ feet below M. S. L., and as it has not been repaired since the work was stopped in 1857, there is now a large quantity of silt to be removed. The length to be cleared is 3½ miles. The rest of the communication between the Vellár and Coleroon is by a natural backwater.

"47. The following statement shows the estimate sanctioned for the coast canal within Chingleput and South Arcot limits, and the budget provision made in successive years :—

Number.	Work.	Amount of estimate.	Government Order sanctioning the work.	AMOUNT APPROPRIATED IN				
				1856-57.	1857-58.	1858-59.	1877-78.	1878-79.
		R		R	R	R	R	R
1	Adyar Junction Canal.	*5,02,378	G.O. No. 2874 W., dated 13th July 1878. Government of India, 1st June 1856.	...	...	...	† 6,12,156	† 46,867
2	From Adyar to Pálár.	2,21,873	G.O. No. 321 of 10th July 1856.	1,21,873	40,931	27,396	...	...
3	From Pálár to Merkanam.	1,79,600	G.O. No. 1243, dated 25th June 1857.	...	...	...	...	\$ 12,582
4	From Merkanam to the French territory.	4,93,500	G.O. No. 2102 of 9th October 1878, F. R.	...	...	...	...	...
5	From the French territory to Cuddalore.	1,70,880	Estimates under consideration. Do. do.	...	...	...	...	...
6	From Cuddalore to Porto Novo.	40,000 85,855	G.O. No. 280 of 17th August 1853. G.O. No. 1518 of 11th July 1878, F. R.	...	...	...	...	85,855*

* 21A. The portion between the Pálár and Mudaliyarkupam (58 miles south of Madras) was opened for traffic in the latter months of 1880, and from this point down to Merkanam (66 miles south of Madras) was opened for traffic since April of the current year. Boats prior to 1880 were able only to ply between Madras and the Pálár river (46 miles south of Madras).

* This is the amount at which Mr. Fraser estimated the canal; a revised estimate is under consideration; completed as a famine relief work.

Actual outlay.		Probable normal cost.	
	R		R
1876-77	28,305	1876-77	10,982
1877-78	5,93,851	1877-78	5,15,556
	† 6,12,156		5,32,538
1878-79	† 46,867		44,097
Sanctioned as a famine relief work.			
Actual outlay.		Probable normal cost.	
	R		R
1878-79, 1st April to 30th September	\$ 12,582	1878-79, 1st April to 30th September	10,656
Ordered to be carried out as a famine relief work in G.O. No. 1720 of 9th August 1878, F. R.			
Actual outlay.		Probable normal cost.	
	R		R
1877-78	6,555	1877-78	...
1878-79, 1st April to 30th September	5,597	1878-79, 1st April to 30th September	...
	11,152		8,913

22. The portion beyond Merkanam, not included in the present estimate, for a distance of 23½ miles, as far as the northern boundary of French territory (Pondicherry), the line has been surveyed, and for the work an estimate for Rs. 64,380 has been prepared, though probably requiring to be again checked and put into shape. This line of canal, though not at present proposed for execution, would form an excellent famine work, and would, it is considered, bring a good deal of traffic to Madras.

23. For many years it had been in contemplation to cut a canal between the Cooum and Adyar rivers, in order to complete the water communication between the northern and southern canals. This work was carried out under instructions in G. O. No. 3225 of 29th November 1876, the bed of the canal being 20 feet wide and the depth 3 feet below low-water spring tides, with side slopes of 2 to 1. A headway of 9½ feet clear above M. S. L. was ordered to be allowed for all bridges, which gives 6 feet above highest water level of the canal. The bridges are without towpaths, and the span of several of them being only 20 feet is inconvenient. The provision of towpaths which must subsequently be made will further contract the already over-restricted space, while the narrowness of the span has added sensibly to the cost of the bridges, owing to the long and heavy wing-walls thereby entailed. While the head of the canal was open to the river Adyar and Cooum, this construction of the waterway was a source of weakness to the bridges owing to the scour set up in the channel; but with the construction of the double lock sanctioned for 1881-82 at the south end of the Junction Canal, and which is intended to shut off the Adyar or Cooum floods, whichever may be the highest, all danger of this kind will be at an end.

24. As a conclusion to this brief history of the Buckingham Canal it may here be noted that before the estimates were submitted in detail for the work done during the famine, and before the banks were protected by well-grown vegetation, that portion of the coast through which it runs to the north of Madras was, in the months of May and November 1879, visited by cyclones, which, though perhaps not of maximum violence, were of sufficient force to damage the works considerably, and to prove clearly the necessity for modifications of the design in many particulars.

25. The several G. O.s quoted at the head of this report under "References" show in detail the results of the cyclones alluded to, and Colonel Sankey's memoranda of the 10th April and 29th May 1880 printed therewith, give the conclusions which up to that time had been arrived at.

26. Since then certain points of detail have been discussed, and estimates for several portions of the work framed, and had orders passed on them.

27. With a large work of this character carried across the whole drainage of the country, and exposed in an exceptional manner to cyclones of the greatest severity, it would be impossible, without expanding this report to an undesirable length, to note fully in detail the effects that have been produced by these occurrences, or to set forth all the reasons for the modifications and improvements now considered essential, in order to give the desired stability to the work, and make it a safe line of internal navigation throughout the year.

28. As will have been gathered from the history of the work above narrated, the sole aim of the several projections of making the canal a safe line of internal navigation. of the several projects has been to cut a navigable canal close to the sea-coast, taking advantage of all backwaters and depressions lying to the west of the outer line of sand dunes, so as to minimise the amount of excavation, and necessarily, therefore, the expense.

29. With the one exception of the lock at Shadayankupam (specially constructed in the interests of Madras sanitation), there were practically no regulating works of any kind. The principle acted on of simply improving a line indicated as it were by nature, allowing rivers and drainages to spill across the canal uninterruptedly on their way to the sea, did not admit of any regulating works which would cause obstruction. As explained by Sir Arthur Cotton, the object to be aimed at was the construction of an "effective" work at the least possible outlay.

30. If the conditions which exist in all ordinary years were only permanent, none would be disposed to question the thorough soundness of this principle.

31. Unfortunately, however, experience has shown that the disturbing elements, chiefly cyclone floods, &c., which occur every eight or ten years, and with especial violence to the north of Madras, must be taken into account.

82. In only two or three portions of the line of channel is a beneficial scour set up by the General condition of canal after retiring land floods, and elsewhere the tendency at such times is to deposit silt, and in some places (particularly in the neighbourhood of the several river mouths and across their deltas) to very nearly, if not entirely, fill up the whole of the bed.

83. It has thus been incontestibly proved that the principle of non-regulation cannot be Hence the principle of non-regulation cannot be maintained if the very serious recurring charges, due to re-opening periodically the channel, are to be avoided, and if the requisite permanence and stability is to be given to the trade, which has not only sprung into vigorous existence throughout the whole line, but which is rapidly increasing as shown by the returns.

34. The recognition of the necessity for regulation throughout the work involves the (1) Measures necessary to be adopted adoption of means for isolating the several reaches of the canal for regulation. which intervene between the respective drainages, so as to exclude, whenever desired, all extraordinary floods, and (2) the training of all rivers and drainages as they cross the line of canal, so as to give clear and sufficiently deep crossings at such points for the passage of boats.

35. The provisions to which the adoption of these principles have necessarily led are Principles upon which the complete specified below, as being those upon which the estimate now framed has been based; and as it is to be hoped that the reasons for the provisions detailed in each case may be sufficiently obvious, it is only necessary here to advert briefly to the preference which has been given to flood-gates at the ends of the several reaches instead of regular locks.

36. Locks, no doubt, would have a specific value in retaining throughout a great portion of the year a higher water level in the several isolated reaches Reasons for and against the construction of locks as regulating works. than is possible without them. But in the first place, they are expensive works, and, considering the number necessary, would add very materially to the capital outlay.

Secondly, it is not as yet clearly proved that the actual gain in depth of water as due to their construction would exceed, on the average, 6 inches.

Thirdly, there is the expense of housing and maintaining a large number of lock establishments.

Lastly, and mainly, is the fact that locks would not only delay traffic, but might very seriously impede and drive it away by the illegal exactions which are almost certain to be made by the establishments entertained.

37. To flood-gates opening outwards at the end of each reach of canal these objections do not, as a rule, apply. They will, in fact, consist of a simple pair of gates to be closed only on the occasion of any extraordinary flood by the ordinary establishment entertained generally for the canal.

38. Their use is simply to isolate each reach on such occasions, and as it has been shown by calculation that if they only prevent the deposit of 6 inches of silt in the channel, it would be economical to place them even in such short reaches as ones of only 2 miles in length. They can also at any future time be turned into locks, if such be considered desirable, by the simple expedient of adding a pair of similar gates at the required distance (120 or 150 feet) from the first set.

General provisions under which the present estimate has been framed. 39. The general provisions under which the present estimates have been framed are as follows:—

- That the canal shall be isolated into reaches between rivers or such other large drainages as require free vent across the line of canal to the sea, each end of such reach being provided with flood-gates, and the channel embanked on both sides, where necessary, so as to keep out the highest known floods, above which level the banks will be constructed 3 feet generally, and in certain places 4 feet; that the ordinary minor land drainage shall be taken into the canal by pipes in places, or by open inlets, where such expedient is feasible, and that all excess drainage water be discharged either at ends of the "reach," or at other convenient places, by means of masonry sluiced outlets; that all river bars which it is unnecessary to keep open shall be closed, and the floods concentrated into the rivers and other major natural outlets thereby increasing the depth of the channels, and correspondingly improving the crossing of the canal. From the experience gained in two successive cyclone years, it has been distinctly demonstrated that many of the bars referred to are superfluous, and that land and river floods, if left unregulated, have
- (1) Isolation of reaches.
 - (2) Treatment of minor cross drainages.
 - (3) Unnecessary river bars to be closed.
 - (4) Results of experience of cyclones.

a tendency to spill in all directions, thus clearly showing the necessity for minimising the number of bars to those absolutely essential for the discharge of the drainage which must find its way to the sea; that by regulating river floods and preventing spill, the canal can be secured, as a rule, from nearly all injury by floods, and the number of drainage outlets reduced to a minimum; that as the nature of the country along the coast does not permit of the discharge of surplus water at all the existing crossings by means of masonry outlets, such works are, as a rule, avoided, and, as already stated, the floods are concentrated on certain selected major openings, and regulated in the manner above noticed; that the canal be given generally a bottom width of 20 feet, side slopes 4 to 1 or less, and a depth of 3 feet below lowest recorded tide in each "reach;"

(5) Detail of construction of canal. that the embankments be made up to 3 and 4 feet above the highest known flood according to circumstances; that all diversions found necessary have a similar cross section to that above specified up to the towpath, which will be 6 feet wide, the slope of the embankment being 2 to 1; that beyond the towpath shall be berms of 15 feet, excepting in cases where the ground is at or below towpath level, when the berm shall be 21 feet, the towpath being always made up to the standard 4.5 feet above M. S. L.; that all embankments much exposed to the action of floods shall be 10 feet wide at top, slopes 2 to 1 on the canal side, 3 to 1 outside, other banks being given a width of 6 feet at top, but with the same slopes; that the cutting and bank slopes shall be turfed or planted with rabbit-wort or other suitable vegetation; that rivers which, owing to the shallowness of their beds as they approach the sea, throw out spill water over the country, shall have their waters confined by flood-banks, the operations, however, of this character being restricted to such rivers only as have been proved in cyclone years to require this mode of treatment; that the crossings of certain rivers shall be improved by excavating diversion lines and by training works, and, as in the case of Pálár and Pennér rivers, by concentrating the several defluents into one main channel; that where experience has proved it to be necessary, the canal shall be removed out of the backwaters, and a new independent channel excavated, leaving the backwaters for drainage, it having been proved that the maintenance of canal in such positions is both difficult and expensive, and navigation toilsome and risky; that boat basins shall be provided at the places where experience has shown such to be necessary; that bridges shall be constructed only at such places (and these very few in number) where their necessity has been indisputably established; that certain existing bridges shall be altered so as to give the requisite headway; that necessary inspection bungalows, rest-houses, overseers' quarters, toll offices, and lines shall be provided for meeting the requirements of the canal employes and of the travelling public; that the basin at Madras shall be improved and extended to meet ascertained demands of traffic.

(6) Shallow rivers to be embanked. (7) Diversion lines to be formed. (8) Canal removed, where necessary, out of backwaters. (9) Boat basins and lay-byes to be provided. (10) New bridges constructed and existing ones altered. (11) Inspection bungalows and accommodations for toll establishments. (12) Terminal Basin at Madras to be improved.

40. The following notes on the mode of dealing with each of the reaches of the canal so as to render them complete in every way show how the provisions above laid down are to be now applied.

41. As experience has shown that this section* has not, as a rule, suffered from the effects of cyclone floods, it is not proposed to isolate the reaches, and the work is therefore of an ordinary character calling for no special remarks.

42. It is proposed to isolate this reach by "flood-gates" at the ends, with outlet at selected places, to embank out the Raperla and Oopoogoon-dur swamp drainages, which spill over the Kanuparti ridge, and to construct a flood-bank for cutting off the Gundlacamma river spill, these measures being necessary to obviate necessity for keeping an opening in the canal near the Kanuparti bar. At this latter place a diversion† of canal is proposed in order to take the channel further from sea than it is at present. From the Gundlacamma river to Pedda Ganjam there is a rising ground, on which the village of Kanuparti stands; if the low places at certain points of this ridge are banked off, and spill of river floods diverted by judiciously placed banks, the reach (closed at it will be at each end by flood-gates) should be sufficiently secure, especially as otherwise there is but little land drainage to be taken into the canal. On the east or sea-side, however, of this reach, the ground being low and exposed, the canal bank will have to be strengthened and further rendered secure by cross and training banks at all the old bars which are to be closed as being unnecessary.

Index Survey Sheet No. 3.
Pedda Ganjam to Gundlacamma River, 8 miles.
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Section V as per General Abstract.
191 to 190
† IV to III.

It may be necessary hereafter in this reach to provide for other embankments at the south end of the Kanuparti* ridge, but at present it is considered needless to provide specifically for these. The land drainage finds an outlet northwards through swamp already referred to, to the large masonry outlet at Pedda Ganjam,† which is now being built by the officers of the Western Kistna Division.

43. This reach is necessarily short, as the Mudigondi opening must be maintained. It will be isolated by flood-gates, embankments; also by a flood-bank for directing the spill of the Gundlacamma river. The eastern, or sea-side, bank of the canal in this reach has to be very strong, as the ground up to the sea-shore is very low and exposed. The western bank also requires to be strong, as being much exposed to the Mudigondi floods.

It will be well to mention here that, although the Mudigondi stream itself is insignificant when the floods are supplemented by the spill of the Gundlacamma river on one side, and those of the Moosee-Enegalaroo spill on the other, a large quantity of water is banked up and becomes dangerous to the canal. When once the proposed flood banks, however, have been carried out, it is considered that no further danger here need be apprehended.

44. This reach is a large one, but exposed only at the north end for some five miles to Mudigondi floods, and also for about three miles to the effects of storm waves from the sea side. This reach will be isolated by flood-gates, outlet sluices, embankments; also by a flood-bank for the Moosee river.

With the elevated line of coast from Kotapatam‡ to near the Moosee river there is no need for a high canal bank on that side, as also from Thondaroo to Moosee. On certain occasions the flood-waters of the Moosee and Enegalaroo have been known to extend from near the trunk road on one side up to the sand ridges of the coast line, thus forming a vast sea of water. This was, in fact, twice experienced during construction of canal in this reach, and the Thondaroo drainage is believed to have been formed by these floods. To deal effectually with this reach it is proposed to

abandon§ that portion of the line which runs through the Thondaroo drainage, which is a deep pool of fluid mud, and in which the channel as now formed cannot (as shown by experience) be maintained at the proper depth without undue expenditure.

45. The Moosee and Palaroo river reach is short and difficult, if not impossible, to maintain as now existing. This reach will be isolated by flood-gates and strong banks, but even with these this short piece of canal is so much exposed to rapid silting that it is considered highly desirable, in order to provide against all inconvenience being experienced by traffic, to have an alternative portion of canal close alongside which can be used while the main line is being cleared.

The Moosee|| river makes an awkward bend at the crossing which it is proposed to cut through, in order to rectify this objectionable feature. The banks of the Moosee river on the left side for about 4 furlongs (up to village) are also to be levelled down, so as to give the river a perfectly free spill. Experience has shown that where perfect isolation cannot be secured by means of sufficiently high banks, &c., the less the obstruction opposed to the flood the better, even at cost of having to maintain yearly the open reach of canal up to the flood-gates. In this case the latter will be placed near the village of Anantapuram.¶

46. This reach suffers severely every year, and has been much injured by the cyclones of 1879 and 1880. It will be isolated by flood-gates and by strong embankments and by flood-banks to both rivers to train the spill water. Outlets are also needed. The east or sea-side bank must be strongly constructed, as the coast line is low and exposed and the sea very close to canal. In 1879 the storm wave from the sea reached nearly to top of banks. The west bank, when once the land floods are regulated in the manner proposed, need not be very strong, as the only drainage of any importance derived from surplus is that from the Pakala** tank series. As this terminal reservoir rarely, however, gets

a full supply, no apprehension need exist respecting it. This part of canal reach is also exposed to the spill of the Palaroo†† river, which the proposed flood-bank will dispose of. At the other end, the rising ground at Singarayeeekonda acts as a sufficient protection, and there is thus only Bingini-pally‡‡ and Somarazapally§§ tank drainages to dispose of. None of these tanks are well supplied, and the special

arrangements for disposal of their surplus water, such as it is, will be readily made. In order to improve the crossing of the Munnaroo river, a diversion* of the canal, on the north side for a mile, has shown itself to be necessary. The head of old course of Munnaroo must also be closed, in order to afford proper protection to the diversion line from injury by floods.

All the old river openings and bars in this reach are to be securely closed, it being neither desirable nor necessary that they should be kept open.

47. This reach is protected nearly throughout on both sides by high sand dunes, and will not need much banking for isolation, which will be sufficiently secured by the proposed flood-gates with outlets. At the end to Munnaroo river a short diversion† of canal will be made, to ensure a better crossing

than heretofore, as in the storm of November 1880, the river became sensibly widened at the old crossing, 2 furlongs of canal being carried away. The river course will also be trained at the crossing, to ensure a permanent deep channel. At the Elekaroo‡ crossing, training banks on both sides of canal are required to keep flood-water from taking the canal bank in reverse along the swamps, as also to close the second or north Elekaroo bar, which it is not at all necessary to keep open.

48. The isolation of this reach is to be ensured by flood-gates and outlets, by training banks to shut off flood, and prevent water through the bar getting behind the banks along the swamps; also by embankments (though of this latter much will not be necessary), and again at the Chippelaroo river end by a diversion§ in the line of canal, in order to avoid the river bed, along which the navigation is now conducted at serious inconvenience and expense.

At Chenneyapallem,|| the canal cuts through rising ground which extends seaward nearly up to Ramapatam¶ bar, and thus obviates the necessity for high banks on that side. Similarly on west side, from Chenneyapallem southward up to the Chippelaroo river, the high ground extends, so that here also the canal is naturally protected and requires no high banks. The canal from Chenneyapallem to Chippelaroo runs through a depression forming a salt swamp, protected on both sides by high sand dunes. This swamp is under the influence of the Chippelaroo tides, so that by training banks from canal running east and west into the high ground this reach can be protected from all floods without the necessity for much banking.

From Chenneyapallem to Ramapatam on the west side of canal is all paddy land with tanks. Heretofore this section had but one small opening in bank for outlet of drainage. Owing to very heavy rainfall of November 1880, this drainage opening became gorged, and a large breach was the result. In the interest of the cultivators and of the canal, it seems best to make several openings for venting the surplus water in similar cases, converting these eventually into masonry works, should experience prove this to be essentially necessary. It is proposed to close permanently the Ramapatam bar, as it is not wanted. All drainage of this reach will discharge itself in both directions to the terminal outlets.

From the proposed diversion of the canal here, a short flood-bank will be carried to Chippelaroo river across the low saddle in ridge up to the rising ground, so as to prevent flood-water getting behind the bank.

49. The isolation of this reach will be effected in precisely the same way as that of the preceding reach. Old bars will be closed and training banks run across so as to divert any excess of flood or tide water to the swamps; this will obviate the necessity for any high banking for some miles. Owing to the high ground on both sides, at both Chippelaroo and Pyderoo ends, short diversions** of canal will suffice for ensuring good and safe crossings.

It is proposed to close entirely the opening at Eskapally†† and force all drainage by the Pyderoo.

From the Pyderoo to Eskapally, being a very exposed and rather difficult reach for navigation, it is intended to isolate the channel for the entire distance from Pyderoo to the Chippelaroo river.

From Eskapally northwards to the Chippelaroo there is very little land drainage to contend with, and no special work is proposed.

50. This reach will be isolated on the same principles as the others. At the Pyderoo end there will be a *diversion** which will place the canal beyond influence of the swamps. At Ramatheertham,† where there is an old bar very close to canal, a *diversion*‡ of the channel will be made so as to retire the line sufficiently. A strong bank on the sea-side will also be added to give the desired security. Except at Ramatheertham there is no land drainage of importance to contend with, while that of Ramatheertham is so insignificant that it may be taken safely into the canal.

The reach is generally through deep cutting; being thus protected from floods very little embanking will suffice.

The flood-gate for south end of this reach will not be constructed at present, in view to the following observations on the subject of dealing with the delta of the Pennér river.

51. Extensive works are proposed for this section, experience having shown it to be essential to train the river to one channel, viz., the southern defluent which is widest, deepest, and otherwise best suited for the object in view.

Owing to the effects of the two storms of 1879 in silting up the canal channel across the delta, operations with this view have already been undertaken in anticipation by carrying a substantial training embankment from Ootocuru § along north bank of the river crossing north branch with a strong bund, and proceeding eastward, skirting the island between the central and southern branches. After this the embankment crosses the central branch and will run on to the island between the central and southern branches where a village was washed away some years ago. The river will also be trained by groynes, &c., to prevent erosion along its new left border and with a view to clear away the shoals and islands in southern channel.

¶ 116 left bank.
|| 114 right bank.

A new *diversion* || cut is moreover proposed in a direct line from end to end of present channel on all this portion which will be strongly banked on the east side where it will cross northern arm as a protection here against any unusual sea wave during storms. The diversion line will be taken to the west of the island cut, and the flood-gate will be at its northern end. The top of the embankments will be at a level of 4 feet above highest known floods, and 6 feet wide at top with slopes 2 to 1, except at crossing of rivers, where the top will be made 10 feet wide, with side slopes either 4 or 6 to 1 as may be required by the soil; also where necessary protected by piling, planting, &c.

52. This short reach is unavoidable, though experience may possibly show that the Gungapatam ¶ opening will admit of being closed up, and this reach made continuous with the next up to Kódúr.** This is, however, a detail of no particular significance. The present crossing looks formidable now, as no less than three bars are open, but as it is only an old estuary hitherto kept up by Pennér spill water during flood, the operations now in hand for training this through one channel should effectually dispose of any difficulty here. Just now the Pennér discharges much of its flood-water through the Gungapatam bar, but the training banks proposed for this portion will effectually prevent this in future. Should further experience prove the necessity for maintaining any opening between the Pennér river and Kódúr, it is not improbable that the position of Korattúr†† about midway, where there is a bar channel, now used for carrying away the flood from Pennér Delta cultivation, may be found best, but this, like a few other minor details, may with advantage be left open for the present. In the estimate however, provision is made for making the Gungapatam river discharge opening on the information previously obtained, and this may stand as a provisional arrangement.

Any alteration of the design here will not in any material way affect the estimate. The reach will have flood-gates at both ends, and an outlet which may conveniently be placed in the bed of the so-called "Old Pennér." The embankments will be strengthened, particularly the eastern one, as the coast line is here low, and the channel rather exposed from that side. South bar will be closed.

53. This reach will have flood-gates at both ends with "outlets;" except for 2 miles at north end, the coast line is very high, consequently no banks are wanted on that side. None are, moreover, required on the west side, so far as rising ground in the neighbourhood of Kódúr extends; but beyond it northward to the Gungapatam river the country is low and all

Pyderoo River to the Pennér River,
7 miles.

* $\frac{129}{V}$ to $\frac{122}{VI}$.
† $\frac{120}{I}$ to $\frac{119}{III}$.

under wet cultivation, and here protection is essential. A number of old river bars must be closed in this reach, which are not wanted, in addition to the Gungapatam drainage bar. Training banks in the neighbourhood of the bars are to be provided with a view to keep flood-water from getting behind the banks along the swampy hollows. A *diversion** of canal will also be made at south end of this reach, so as to secure a good crossing for the Kódúr river, and confine this drainage in a distinct channel capable of carrying of a maximum flood.

Further experience of the full effects of the works undertaken with the object of training the Pennér river into one channel may as above show the desirability of amalgamating the two reaches mentioned in this and preceding paragraph with, in addition to the end outlets, two others at intermediate points to discharge surplus drainage.

54. The isolation of this short reach is unavoidable, as the Nalatur† drainage brings in a large volume of water, which must be provided for. At the north end there will be a *diversion*‡ in continuation of that of preceding reach to avoid the drainage which comes from south and enters on the west of the channel. Similarly, at the south end a *diversion* § is proposed to provide separately for the drainage, which now crosses the canal in several places and runs through the canal doing mischief. At the south end a strong bank will be required on the east side to prevent the flood and tide water from entering swamp and getting behind the bank. On the east side but slight banking will be required, as the ground along the coast line is here high. The west side bank, on the contrary, requires to be strong in order to effectually keep out land-floods.

55. This reach, which is unavoidably short, is to be isolated by flood-gates and outlets at both ends. For three miles from north end the cutting is deep through sufficiently high ground, and will not require much banking. After this up to the Kundaleroo || river, the line is through swamp and backwater, where, to a great extent, heavy banking is required on both sides. A *diversion* ¶ along Kistnapatam backwater is also to be made, as this will be cheaper than to embank both sides through the portion of exposed backwater.

The left border of Kundaleroo river will likewise be embanked at all the low places up to the Mootocoor** high ground, so as to keep that river spill from getting behind canal along the Kistnapatam swamp on the west side of canal.

This part of reach from the Kundaleroo river to the Kistnapatam†† high grounds is exposed to floods and the swamps on both sides, and will need strong banking.

56. This is a well-protected reach, situated in a hollow between high sand ridges. Flood-gates will isolate it, and an outlet will be constructed for the discharge of the small field drainage. Banks not wanted, but it will be essential to fill in certain gaps in saddle of the ridges, as during the floods of November 1880 these low portions were overtopped by the flood-water, seriously damaging the canal. The side field drains can be disposed of by pottery-pipes across the berms, simple cuts in bank being sufficient to pass the drainage. Originally it was intended to sluice all these openings, but after isolating the reach it is thought that no such measures will be necessary.

A short *diversion* ‡ cut, 6½ furlongs long, at the Kundaleroo river end, will be made to give the canal a conveniently placed mouth in deep water. At some places in this reach the cuttings are very deep and sandy, and in such places the canal slopes will be altered to 4 to 1, and the banks thrown back.

57. This reach requires extensive works for its isolation. First, a *diversion* §§ of canal will be made at Soornamooke end, which will have the effect of keeping the canal away from the river, and of training the river to its old bar. Second, a *diversion* ||| will be formed from above the Tupuli drainage along Kódúrpallem ¶¶ and Dugarápatnam, so as to remove the line from the backwater. The only land drainage that has to be disposed of in this portion is that of Tupuli, and this can be readily received into the canal by proper inlet arrangements. The reach will have flood-gates and outlets as usual with all isolated portions.

Kódúr River to Nalatur River, 6 miles.

† $\frac{95}{V}$.
‡ $\frac{101}{IV}$ to $\frac{101}{I}$.
§ $\frac{97}{VII}$ to $\frac{97}{II}$.

Nalatur River to Kundaleroo River,
5½ miles.

|| $\frac{96}{IV}$.
¶ $\frac{93}{IV}$ to 92.

** 93 M.

†† 93 M.

Index Survey Sheet No. 4.
Kundaleroo to Soornamooke River,
14 miles.

Section III as per General Abstract.
‡ $\frac{89}{VII}$ to $\frac{89}{I}$.

Soornamooke River to Dugará-
patnam River, 8½ miles.

§ $\frac{77}{II}$ to $\frac{75}{II}$.
|| $\frac{72}{II}$ to $\frac{67}{II}$.
¶ $\frac{70}{VI}$.

The Soornamooke diversion works are explained in the annexed estimate, which is among those already sanctioned by Madras Government.

As regards the other diversion, it will suffice to observe that it is essential in order to avoid the backwater. This line will run at the back of Kódúrpallicm, which, being purely a fishing village, would otherwise be inconvenienced by having the canal between it and the sea. The cutting will here be deep, but this is unavoidable.

58. Dugarápatnam to Coromandel is the longest isolated reach which it has been found

Section II, as per General Abstract.
Dugarápatnam River to Coromandel, 41 miles.

* 67 to 65
I to V
+ 69 M.
† 43 to 27.

possible to make in the entire canal. It starts with a diversion * at the north end to avoid the backwaters of Dugarápatnam.† At south end there will also be a long diversion ‡ of 17 miles to avoid the Pulicat lake along and indeed almost through which the existing line is carried, and which experience has shown is dangerously exposed. There will be flood-gates to isolate it with four outlets, one at

each end, and two placed intermediately on the east side; the coast line is high, but there is a great width of land here between the canal and the sea; large provisions for drainage have to be made. On the west side the bank will be made up to full height for 22 miles to keep out the lake floods. With the two diversions and the lake side bank this reach is necessarily a costly one, but under all the circumstances the improvements here proposed will be found well to repay the outlay. On east side a low bank will suffice.

§ 38 M.

It may here be mentioned that in the lake diversions the present so-called "Tettupet"§ cut will be included and utilized.

59. Virtually this reach will be but 1½ miles in the land, the rest being along open lake and across the Pulicat river. A short reach here is unavoidable, in order to avoid the backwater along Pulicat, which

Index Survey Sheet No. 3.
Section I as per General Abstract.
Coromandel to Arani River, 3 miles.

is much exposed during high wind and proves troublesome to the boatmen, and in which also, as in all backwaters, it has been found both difficult and costly to maintain a channel efficiently to the needful minimum

|| 25 to 24.
VI
¶ 25 M.

depth. The diversion || here proposed will run from Pulicat river, along west border, along Pulicat¶ and Edamany. The northern arm of Arani river by which spill water now enters the channel will be embanked across on both sides of

canal line, and there will be a subsidiary bund higher up the arm so as to render the crossing safe. This arm is virtually the spill of the lake at the back of Pulicat and forms a swamp. By shutting up this opening, the flood-water will concentrate in the main arm of the Arani river and keep the crossing deep, which is the point to be aimed at. The Pulicat backwater is shallowing up very fast, and it is therefore very desirable to have a distinct channel for navigation. The reach will have flood-gates, but outlets are not required. Two boat basins formed by simply widening the channel will be formed at Pulicat. The basin for the fishing village will be small and sufficient for immediate wants, the other is needed for traffic and boat building, a large number of boat owners and builders being residents at Pulicat.

60. Arani river to Ennore will be a comparatively costly reach, as it will consist of a new ** canal throughout for nearly the whole distance placed beyond reach of backwater along the east border. The expense here is chiefly enhanced by the compensation which will have to be paid for land and plantations. Parts of the existing canal along Chintamony †† and Kálánji ‡‡ will be utilized, their western side being

†† 20 to 11
II
‡‡ 18 to 14
IV

strongly embanked. As the ground along the coast is here high, there will be no need for a high bank along the new line; the reach will be isolated by flood-gates, and have outlets for land drainage. Across Chintamony backwater on 21st mile the crossing on west side will be embanked so as to keep out the land floods. The old bar being closed, no bank will be required on the east side for the present, though possibly hereafter some special work with this object may be needed.

61. The work proposed in this reach with a view to the proper isolation of the channel from the backwater is a diversion §§ extending from Ennore to the lock at Shadayankupam|||, and embankments from the latter place to Madras, with a drainage channel along the low swampy ground on the east side. This will provide for the Madras drainage being led to a point north of lock, where it will join diversion line, and be furnished with a surplus self-acting sluice on west side. The existing

Index Survey Sheet No. 3.
Ennore Backwater to Cooum River, 11 miles.

§§ 11 to 7
IV
||| 7 to 11
II

Trivettore surplus sluice will be altered, so as to make the shutters more effective. The Ennore* end of the diversion channel will have a flood-gate.

It is not practicable to carry this head of diversion more to the north, and a stretch of about a mile of open lake will therefore have to be crossed. In order, moreover, to obtain a direct crossing, the shoal now forming across lake, from west border and extending towards bar, will be cut through.

With a flood-gate at Ennore end, and strong high banks from that place to Madras, there will be no need to make any alterations to the existing Shadayankupam lock.

A flood-gate is not requisite at the point where the canal enters the Cooum river at Madras, as the bar of this river is invariably cut through so soon as the water level rises to 3.5 feet above mean sea level.

At the Madras (better known as "Cochrane's") Basin an extensive wharf will be constructed to supersede the present basin, the walls of which have sunk, and the form found inconvenient. The improvement of basin here provided for will be limited to the east side for the present. The form of wharf will consist of a widening of canal by 60 feet for 1,800 feet in length, 50 feet being allowed for canal. The wharf will be formed by a concrete wall to M. S. L., above which there will be steps of laterite. The basin grounds will be enclosed in with palisading, and the ground adjoining entirely cleared of native huts, provision being made for compensating the owners. The existing lime kilns, with the exception of one or two, will not be touched. To afford the requisite facilities for traffic, roads will be run from the wharf wall directly across to existing line of road.

The only improvement to be made on the west side is the construction of a short branch channel to join the basin at the Government lime kilns. This will allow of the shell boats unloading there instead of at the former shell platforms which have been now surrendered.

The Government grounds on which the lime kilns are placed will also be fenced off from the canal. The Trivettore and Washermanpett bridges, as they obstruct navigation, will be altered by removing the arches and substituting iron girders to give the requisite headway.

These bridges, as also all the others up to the Cooum, save the railway and salt bridges, will have towpaths constructed under the arches. The South Indian Railway bridge, which is now a temporary structure for running trains to the Harbour Works, will, if eventually made permanent (a point still open for consideration), need to be much enlarged, but no provision for the work is necessary in this estimate. The Timber Salt Depot bridge will be altered, as the centre span is quite obstructed.

At the Shadayankupam lock an embankment will be made eastwards to Trivettore, so as to afford means of access across the swamp and fields to the toll and lock establishments.

62. The only work required in this reach will be deepening and forming the channel which along all this portion is carried through the river bed without any special arrangements as far as the north end of the next reach known as the Junction Canal.

Cooum River, 1 mile.

63. This reach, better known as the Junction Canal, will be closed at the Adyar† end by a lock which is so arranged with double sets of gates facing in opposite directions as to afford means for keeping out floods whether coming from the Cooum or the Adyar river ends.

Index Survey Sheet No. 3.
The Junction and Southern Canal.
† Zero of mileage as per map.

As it is essential for the health and comfort of Madras so to work its two rivers (the Cooum and Adyar) that there shall always, if possible, be water in their beds from 2 to 3.5 feet above M. S. L., so as to keep all offensive mud banks covered with water, it would be useless to attempt to do what is necessary by flood-gates alone. The lock at Shadayankupam and the other to be constructed permanently at south end of the Junction Canal are both indispensable with this object. The inconveniently low headway and small waterway of the bridges may at some future time (should a large traffic spring up) necessitate the alteration of all the bridges, by raising them and substituting iron girders for the existing arches. The cost of altering the fourteen bridges involved will not be serious, but under existing circumstances no such change is urgently required, and no provision for the work has therefore been made in this estimate. Some other improvements may also in future be desirable, but towpaths only are immediately necessary at present, and an item for this is inserted. The Adyar river, the bed of which above and below the point of crossing of the line of canal has been very much encroached upon by the silting up of the river margins and the formation of numerous large islands therein, requires to be considerably improved. It is proposed to effect this by a system of groyning

and the construction of flood-banks to confine the floods within fixed limits, and thereby increasing the scour, establish a deep and permanent waterway for the river for some distance upwards from its mouth. The amount required for carrying out these improvements has been provided for in item No. 68 A of the general abstract of the estimate for Southern Canal.

64. This reach will be isolated by a lock at the north with gates facing towards the river and flood-gates at south end. The lock is essential for keeping up the requisite water level in the Adyar, Junction Canal, and Cooum river (see previous remarks). In this reach there will be a *diversion* * from Solanganallur along east border to take the channel out of the backwater, and obtain a good crossing at the Covelong opening. The west bank will be made strong. The coast line on the east being well raised, no high bankage taken in and disposed of.

65. This reach is at present in every way unsatisfactory, running as it does through Covelong to Kokkelamoodoo, 16 miles. swamp and backwater, and becoming quite a sea during high floods, rendering the navigation very troublesome.

A *diversion* † will be made for its entire length along the east border. Flood-gates will also be employed for closing both ends. Outlets at both ends will, moreover, be constructed for relieving the land drainage which, however, will not be much. The west bank will be made strong, but as the ground along the coast is high, the east bank of the canal need not be high.

The Kokkelamoodoo bar does not generally open, but as there will be no other relief to drainage in this portion of the canal, it is considered essential that this opening shall be maintained.

66. A short *diversion* ‡ line in continuation of the preceding one is required at the north end of this reach to join on to the existing canal. There will be flood-gates and outlets at both ends of this reach. Training banks running from canal eastward will also be constructed with a view to keep the flood from getting behind banks throughout the swampy and low grounds.

A drainage near the Sadras bar will be strongly banked on the sea side and the drainage taken into the channel; so also with the next drainage at Sembadakupam, § which will be banked across on east side and drainage similarly disposed of. An old outlet to the south will now be restored, and will no doubt be kept open by the above two drainages, discharging through the flood-gate and outlet. The direction of this old cut will be altered with reference to the Pálár river crossing. Here, contrary to the case of the Pennér river, the southern channel of the Pálár will be closed, and northern one only maintained, as the present choked up condition of the bed of the former and the more free and open passage down the latter favor this arrangement, which in other respects accords with the local features.

A *diversion* || cut will also be made through the islands to the south, near the end of which the flood-gate will be placed. The estimate, it will be observed, provides for the flood-gates for right bank of Pálár at the end of extension canal. No large drainages cross the extension canal.

67. Having thus, as far as possible, detailed the method of treatment proposed for the improvement of each reach of the canal from its most northern limit ¶ from Madras to the Pálár river at 47 miles south of Madras, and to a point whence the extension canal into the Merkanam backwater is continued, a summary of the headings of the estimate for each section of the proposed work, and the amounts of estimates, will now be given. From the Statement A it will be seen

that the total outlay on the canal contemplated, as well as that already incurred, amounts to Rs 63,87,100. It is believed that this sum will be found sufficient for all requirements, and that it is even quite possible savings may be effected by the substitution of artificial stone composed of Portland cement concrete in the quoins and floors of the flood-gates for cut granite, and either of indigenous teak, or by employing Jarrah wood from Australia in the flood-gates, instead of the more expensive Burma teak.

68. The distribution of the whole outlay—past, present and future—will be seen from Appendix B, and divides itself naturally into three distinct periods, viz.:—

Total outlay on the work. Appendix B.	R
(1) Outlay from the commencement of the work to the last famine	5,49,078
(2) Outlay during the famine, i.e., from October 1876 to 31st March 1879.	21,93,854
(3) Subsequent outlay, viz.:—	R
(a) From April 1879 to 31st March 1882	3,44,253
(b) Probable in current year	1,54,300
(c) From end of the current official year	31,45,615
	36,44,168
	TOTAL . 63,87,100

The figures given under (1), (2), and (3) (a) have been supplied by the Examiner, Public Works Accounts, and have been finally accepted as correct by the Accountant-General.

69. The soil all along the canal is pretty constant in its character, a surface layer of sand, and light loam with denser clayey strata underlying it. No borings were found necessary, and in the construction of the foundations of the flood-gates grilles of timber with sheeting piles have been provided for with a view to distribute the superincumbent pressure over the subsoil.

70. The data upon which the rates have been based are those obtained from the actual construction of works along the canal in the neighbourhood, and sufficient margin has been allowed to accommodate them to such moderate increment of charge as unforeseen circumstances may entail.

71. The traffic on the canal has shown a tendency to increase in the successive years, during which registers have been systematically maintained. Appendix C gives the abstract of the traffic inwards to and outwards from the terminal station at Madras for the successive

half-years from 1st July 1878 to 30th June 1882. In the year 1879 the tonnage arriving at the Madras Basin amounted to 185,491 tons, and the departures amounted to 49,133 tons during that period. For 1881 the figures were 241,207 and 208,630 tons respectively.

The first half of the current year shows a considerable falling off owing to the long-continued drought during that period having so far reduced the depth of water in the backwaters through which the canal passes as to close them for over two months against any but the smallest description of boats.

Of the commodities carried over the canal, the largest and most important is salt; after which come firewood, food-grains, and shells (for burning lime) in order of their importance. The import of these articles into Madras amounted in 1881 to 85,301, 5,46,54 22,020, and 21,971 tons respectively. Numbers of boats with passengers and goods now find their way from Cocatons respectively. Nada and Dowlaishweram, as also other intermediate places to Madras; and it can scarcely be doubted that on the execution of the completion works of the Godáviri and Kistna Delta schemes lately sanctioned by the Government of India, adding greatly to the existing irrigated area, the traffic in grain, &c., must greatly increase; and in the event of famine occurring, the value of such through communication with the Northern Delta Works would be of incalculable benefit. Further impetus may also be ere long looked forward to owing to proposed reductions of tolls and simplification of license fees. The mode of travelling by boats is decidedly popular with the natives, and efforts of this character cannot fail to produce beneficial results.

With the opening, moreover, of the Singareni coal-fields in the Nizam's Dominions, about 80 miles north-west of Bezvada, a traffic in carrying coal down for the use of the Madras and South Indian Railways may not improbably spring up. The fact of the canal as a high-way will be thus still further established, as through no other route could these coal-fields be tapped so economically as by means of the canal.

In the Proceedings, Madras Government, No. 450, dated 21st November 1868, reports on the traffic on the Godáviri, Kistna and East Coast Canals gave full details regarding the working of the boats plying on those canals. The conditions then obtaining have not in any great degree altered, and the rates charged for goods have not materially decreased. These Proceedings were communicated to the Government of India in G. O. No. 3652 of 21st November 1868. The suggestions then made by Colonel Anderson, the Chief Engineer for Irrigation, that a scheme of a coast canal be taken up in earnest, met with the approval of the Madras Government, and is now an accomplished fact.

72. In Appendix D is shown the number, tonnage, and description of boats which ply on the canal. Amongst the class that are built specially for cargo, the largest number are of 20 tons burden, whilst the tonnage of the class which carries 28 and 29 tons respectively gives the largest aggregate results. The whole of the cargo boats work out to an average of 16½ tons, which is a convenient size both for being handled with ease and of a draught better suited to the varying depths of water in the several reaches of the present canal. The largest boats are used for conveying firewood from the plantations within 45 miles north of Madras, as they afford stowage to compensate for the light nature of the freight carried by them. Of covered cargo and passenger boats, the most numerous are those of 4 and 5 tons respectively, commonly called "top" boats, and the total number of these works out to an average capacity of 6 tons for each. The deck and dinghy boats are the description used most generally in the Northern Circars, and which, plying on the Godavari and Kistna Canals, have taken out licenses for the Buckingham Canal as well.

Appendix E contains the text of the rules for navigation now in force on the canal, which were approved and sanctioned by the Madras Government in their Proceedings, No. 1801-A. W. of 8th July 1879. These rules differ in several respects from those obtaining on the Kistna and Godavari Canals. There is no apparent reason why this difference should exist; the Madras Government have therefore ordered a Committee to convene and take into consideration the advisability of establishing an uniform set of rules for the whole of the coast canal license system, and abolishing most of the tolls. This, however, will not do away altogether with the toll establishments now maintained, as particulars of traffic will have still to be recorded for each section of the canal as is done at present. As there will be no money collections this work can in future be carried out by a clerk and one peon on R15 and R6 per mensem.

73. The fluctuations of the tides were registered at thirty-eight stations along the canal during the years 1879, 1880, 1881, and 1882, but these were necessarily of only value during the period when the several bars were open along the coast. The recorded readings during the times when the rivers were in flood, and again when some of the bars were open, whilst others were closed, gave very conflicting results, and have proved of doubtful value in determining the nature of the works to be carried out for the improvement of the canal. The M. S. L. was the datum to which it was at first proposed to refer all bed levels of different sections of the canal, and the cills of the masonry works along them. The M. S. L. in use in this Presidency was, till recently, that established by the late Colonel De Havilland, of the Madras Engineers, and referred to a bench-mark stone placed by him some forty years ago on a marble slab in the Fort wall near the north gate at Madras. The tidal observations carried out in the Great Trigonometrical Survey of India have, however, proved De Havilland's bench-mark to be very nearly 1 foot below its true value.

In a canal running along the coast line, however, and only here and there connected with the sea, as is the case with the Buckingham Canal, it has appeared necessary to work between two limiting levels, viz., that of the highest storm wave level as yet recorded for the determination of the heights to which the bank of the canal should be raised, and the lowest recorded tide level for the depth to which the bed of each reach should be excavated. The former level was deduced from the cyclone of November 1880, when the canal suffered severe damages from the irruption of the sea; and the latter levels, owing to the peculiar circumstances of each reach of the canal, were taken from the tide gauge readings. To simplify the calculations of quantities in the estimates, average lowest recorded tide levels were struck for each reach, and the longitudinal and cross sections drawn out accordingly, a slightly give-and-take arrangement being thus followed. Below this average L. R. tide level the canal bed has been calculated to 3 feet, and it is at this depth that it should always be maintained.

74. Of those sections of the canal where connection with the sea is liable to be temporarily suspended by the closure of the bars, the most notable are the reaches between Madras and Kundelairu, 90th mile N.). In this length exist large bars at Ennore (11th mile), Pulicat (26th mile), Dugarápatnam (69th mile), and Kottapatam (80th mile). The opening of these bars, however, is due chiefly to the fact that large back-waters within the coast line receive upland drainage until they accumulate to a level at which they overtop and clear away the bars formed by the surf. As there are no defined channels out to sea through these bars, it has been found impossible to keep them open when, with the setting in of the south-west monsoon, the wind

and littoral current turn northwards up the Bay of Bengal. With the closure of the river bars, and the setting in of the hot weather, evaporation over the areas of back-water goes on apace without any compensating indraught from the ocean, or supplies from local drainage; and the water level in long sections of the canal gradually diminishes, as was evidenced more particularly in the present than in probably any other year.

75. These back-waters may, therefore, be looked upon as huge evaporating basins during a time of the year when the canal is cut off from all its sources of supply, and as such should be avoided.

The reclamation of the back-waters in the interests of the canal, then, is a subject of vital importance, but in doing so the fact must not be overlooked, that a certain storage area is necessary to receive water at high tides from the sea in order to maintain the scouring action on the bars during the ebb. But on the other hand, as in the case of the Pulicat lake, where the area to be covered amounts to 178 square miles, and of which one half at least is covered by high tides during the time the Pulicat bar is open to a depth of something under 2½ feet of water, the width of the bars during this period being under 100 yards, it may be taken for granted that from the month of March, when the bars begin to show signs of closing, down to September, when the lowest tidal variation is reached, the indraught through the bars is not commensurate with loss by evaporation from the surface of the backwaters, and that, owing to their great area, the accession of tidal water does not influence the remoter parts before the ebb sets in. There are thus large areas of these back-waters which after a certain time of the year draw upon the canal for their supply to keep pace with the evaporation from their surfaces, and the water level must necessarily diminish until the bars open again by the influence of the sea, or by the receipt of upland drainage waters.

76. The reclamation by embankments of all backwaters is therefore necessary within certain limits, say, to lands not covered at high tides to a greater depth than 2 feet. Were this done, the drainage falling into the backwaters could be pounded up within those embankments, and, as it is presumed that the water will be charged with much silt from the uplands, they may be allowed to deposit the little held in suspension, and then be allowed to flow off through regulating weirs at ebb-tides to increase the action on the bars. By shutters opening towards the backwaters, no salt water need be allowed on to the lands thus reclaimed, which would increase enormously in value owing to their proximity to the canal, and eventually, by their sale, recompense all expenditure incurred on them.

77. As it is on all accounts desirable, therefore, in the interests of the canal, to permanently establish a series of open bars along the coast, and as the only way this desideratum can be attained is by the concentrated outflow through a defined channel at frequent periods, both as regards all upland waters and of all the tidal outflow during an ebb tide, and as this can only be effected by extensive reclamation of tracts of backwater which have up to the present served no other purpose than to dissipate rather than conserve the energy of tidal action, the regulation of the canal in the manner now proposed must lead to the conversion of hitherto useless, if not unhealthy, swamps into valuable cultivated areas.

These areas thus reclaimed may, if desired, be taken over by the Forest Conservancy Department for the growth of timber and fuel trees. The practicability of this has already been sufficiently demonstrated at various points along the course of the canal, and testimony is borne to the utility of the scheme in Proceedings of the Board of Revenue, No. 859, dated 25th June 1880, where the inward traffic in firewood in the Nellore District (through which the canal runs for 150 miles of its course) is ascribed to the "facilities afforded by the improvement of the Buckingham Canal" during the year 1878-79. From the information furnished by the Collector of South Arcot District again, it would appear that large tracts of waste land remain to be planted up with casuarina and other fuel trees, which he is confident will be taken up by private enterprise as the benefits afforded by the canal as a cheap means of carriage come to be realized. The effect of opening up the canal to Merkanam and southwards, as contemplated, will be to raise the local price of fuel by at least 25 or 30 per cent., and thus improve the condition of the villagers along the coast. It would be desirable if the whole of the works now estimated for could be completed within the next six years, which would necessitate an average allotment of 5 lakhs of rupees per annum distributed as follows:—

3 lakhs in 1886-87.	6 lakhs in 1886-87.
5 do. in 1887-88.	6 do. in 1887-88.
5 do. in 1888-89.	6 do. in 1888-89.

The average amount allotted for new works on the canal during the last two official years has been R1,35,000 only.

R. R. E. DRAKE-BROCKMAN, Major, R.E.,
Executive Engineer, Buckingham Canal Division.

APPENDIX A.

Summary of Estimates for improving the several reaches of the Buckingham Canal as sanctioned in detail from time to time by the Madras Government.

Number on Index Map and General Abstract Estimate.	Sheet Number of Index Map.	Description of Work.	Position.	Reference to Report.	Amount of Estimate as sanctioned in detail by the Madras Government.	Total for each Section.
		NORTHERN CANAL.			R	R
		<i>Section I.—From St. Mary's Bridge at Madras to Pulicat.</i>				
1	2	Improvements and alterations to Salt Kotar Bridge.	1st mile	Paragraph 61	13,000	
2	...	Improvements to the basin at Madras.	2nd "	Do. 61	95,685	
3	...	Improvements to canal from basin to Shadayankupam Lock.	2nd to 7th mile	Do. 61	19,775	
4	...	Improvements and alterations to Washermanpett Bridge.	3rd mile	Do. 61	7,090	
5	...	Do. do. to Trivettur Bridge.	5th mile	Do. 61	7,090	
6	...	Toll Office and establishment sheds at Shadayankupam Lock.	7th mile 3rd furlong.	Do. 39 (11).	759	
7	...	Diversion to canal from Shadayankupam Lock to Ennore.	7th mile 3rd furlong to 11th mile.	Do. 61	42,250	
8	...	Flood-gate south bank of Ennore Backwater.	11th mile	Do. 61	19,380	
9	...	Do. north bank of do.	12th "	Do. 60	19,380	
10	...	Second-class Rest-house at Ennore.	13th "	Do. 39 (11).	5,715	
11	...	Diversion and improvements to canal from Ennore to Pulicat.	12th to 25th mile 6th furlong.	Paragraphs 59 and 60.	1,43,360	
12	2	Siding basins at Pulidivakkam, Kattupally, Kalanjee, and Karangalee.	15th, 17th, 19th and 22nd miles.	Paragraphs 59 and 39 (9).	4,640	
13	...	Flood-gates south bank of Arni River.	23rd mile 6th furlong.	Paragraph 60	16,650	
14	...	Do. north bank of do.	24th mile	Do. 59	16,650	
15	...	Two siding basins at Pulicat	25th "	Paragraphs 59 and 39 (9).	2,685	
16	...	Flood-gate at the Pulicat lake end.	25th mile 6th furlong.	Paragraph 59	16,650	
		Add Items of General Abstract Estimate, Nos. 65, 68 and 78.			4,30,759 3,653	
		<i>Section II.—From Pulicat to Dugarázpatnam.</i>				4,34,413
1	...	First-class Rest-house at Coromandel	27th mile	Paragraph 39 (11).	3,160	
2	...	Diversion to canal from Coromandel to Tettupett.	26th to 28th mile.	Do. 58	99,000	
3	...	Flood-gate at Coromandel end	26th mile	Do. 58	16,650	
4	...	Siding basin at Coromandel	27th "	Do. 39 (9)	510	
5	...	Outlet at do.	27th "	Do. 58	3,950	
6	2	Improvements to canal, 36 miles 2 furlongs to 38 miles.	36th to 38th mile.	Do. 58	7,350	
7	...	Siding basin at Tettupet	38th mile	Do. 39 (9)	635	
8	...	Diversion to canal from Tettupet to Jonaghipolliem, 38 miles to 43 miles 5 furlongs.	38th to 43rd mile.	Do. 58	70,000	
9	...	Two siding basins at Chemigaripolliem and Jonaghipolliem.	42nd and 44th mile.	Do. 39 (9)	1,055	
10	...	Second-class Rest-house at Jonaghipolliem.	44th mile	Do. 39 (11).	5,715	
11	...	Improvements to canal, 44 miles to 65 miles 5 furlongs.	44th to 65th mile.	Do. 58	1,35,765	
12	...	One siding basin at Cusbah	46th mile	Do. 39 (9)	395	
13	...	Toll Office and Establishment sheds at Royadoruvu.	59th "	Do. 39 (11).	868	
14	...	Second-class Rest-house at Royadoruvu.	59th "	Do. 39 (11).	5,715	
15	...	Two siding basins at Royadoruvu and Pambali.	58th and 64th miles.	Do. 39 (9)	1,320	
16	...	Diversion to canal, 65 miles 5 furlongs to 67 miles 2 furlongs.	65th to 67th mile.	Do. 58	20,430	
17	...	Outlet at 67 miles 2 furlongs	67th mile 2nd furlong.	Do. 58	3,660	
18	...	Flood-gate south bank of Dugarázpatnam river.	Do. Do.	Do. 58	19,030	
		Add Items of General Abstract Estimate, Nos. 65, 68, 69 and 73.			3,95,208 2,63,590	8,58,798

Summary of Estimates for improving reaches of Buckingham Canal, &c.—contd.

Number on Index Map and General Abstract Estimate.	Sheet Number of Index Map.	Description of Work.	Position.	Reference to Report.	Amount of Estimate as sanctioned in detail by the Madras Government.	Total for each Section.
		NORTHERN CANAL—contd.			R	R
		<i>Section III.—From Dugarázpatnam to Kistnapatnam.</i>				
1	...	Diversion to canal, 67 miles 2 furlongs to 72 miles 2 furlongs.	67th to 72nd mile.	Paragraph 57	55,570	
2	...	Flood-gate north bank of Dugarázpatnam river.	67th mile 3rd furlong.	Do. 57	19,030	
3	...	Outlet at 67 miles 3 furlongs.	Do. Do.	Do. 57	3,660	
4	...	Second-class Rest-house at Dugarázpatnam.	69th mile	Do. 39 (11).	5,715	
5	...	Stores and office at Dugarázpatnam	69th "	Do. 39 (9).	2,340	
6	...	Siding basin at do.	69th "	Do. 39 (9).	1,090	
7	...	Do. at Thupili	72nd mile	Do. 57	590	
8	...	Outlet at 71 miles 6 furlongs	71st mile 6th furlong.	Do. 57	3,660	
9	...	Improvements to canal, 72 miles 2 furlongs to 75 miles 3 furlongs.	72nd to 75th mile.	Do. 57	17,200	
10	...	Soornamookkee diversion and flood-banks.	76th to 77th "	Do. 57	36,700	
11	...	Outlet at 76 miles 5 furlongs	76th mile 5th furlong.	Do. 57	3,450	
12	...	Flood-gate south bank of Soornamookkee river.	77th mile	Do. 57	20,880	
13	...	Do. north bank of do.	77th " 1st furlong.	Do. 56	20,880	
14	...	Improvements to canal, 77 miles 1 furlong to 89 miles 1 furlong.	77th to 89th mile.	Do. 56	24,200	
15	...	Second-class Rest-house at Siddavaram.	79th mile	Do. 39 (11).	5,715	
16	...	Two siding basins at Siddavaram and Kanooopur.	79th and 81st mile.	Do. 39 (9).	1,270	
17	...	Diversion to canal, 89 miles 1 furlong to 89 miles 7 furlongs.	89th mile	Do. 56	8,400	
18	...	Outlet at 89 miles 6 furlongs	89th mile 6th furlong.	Do. 56	3,450	
19	...	Flood-gate south bank of Kundaleru river.	90th mile	Do. 56	18,040	
		Add Items of General Abstract Estimate Nos. 65, 68 and 73.			2,51,840 2,88,409	5,40,249
		<i>Section IV.—From Kistnapatnam to Pennér River.</i>				
1	2	Flood-gate north bank of Kundaleru river.	91st mile	Paragraph 55	18,380	
2	...	Improvements to canal, 90 miles 6 furlongs to 92 miles.	90th to 92nd mile.	Do. 55	6,100	
3	...	Outlet at 90 miles 6 furlongs	90th mile 6th furlong.	Do. 55	3,450	
4	...	Siding basin at 91 miles	91st mile	Do. 39 (9).	1,480	
5	...	Bridge at Kistnapatnam road crossing	91st "	Do. 39 (10).	10,250	
6	...	First class Rest-house at Kistnapatnam.	93rd mile	Do. 39 (11).	6,690	
7	...	Diversion to canal, 92 miles to 93 miles 4 furlongs.	92nd to 93rd mile.	Do. 55	13,680	
8	...	Siding basin at Kistnapatnam	93rd mile	Do. 39 (9).	655	
9	...	Improvements to canal, 93 miles 4 furlongs to 95 miles 6 furlongs.	93rd to 95th mile.	Do. 55	7,030	
10	...	Outlet at 95 miles 4 furlongs	95th mile 4th furlong.	Do. 55	3,485	
11	...	Flood-gate south bank of Nalatur river.	Do. do.	Do. 55	18,550	
12	...	Improvements to canal, 95 miles 6 furlongs to 97 miles 2 furlongs.	95th to 97th mile.	Do. 54	11,930	
13	...	Flood-gate north bank of Nalatur river.	95th mile 6th furlong.	Do. 54	18,550	
14	...	Outlet at 95 miles 6 furlongs	Do. Do.	Do. 54	3,485	
15	...	Diversion to canal, 97 miles 2 furlongs to 97 miles 7 furlongs, and new cut to drainage channel.	97th mile	Do. 54	6,340	
16	...	Improvements to canal, 97 miles 7 furlongs to 101 miles 1 furlong.	97th to 101st mile.	Do. 54	4,350	
17	...	Diversion to canal, 101 miles 1 furlong to 101 miles 6 furlongs, and cutting drainage channel.	101st mile to 6th furlong.	Do. 54	7,300	
18	...	Outlet at 101 miles 3 furlongs	101st mile 3rd furlong.	Do. 54	3,590	
19	...	Flood-gate south bank of Kódúr river.	Do. do.	Do. 55	15,540	

Summary of Estimates for improving reaches of Buckingham Canal, &c.—contd.

Number on Index Map and General Abstract Estimate.	Sheet Number of Index Map.	Description of Work.	Position.	Reference to Report.	Amount of Estimate as sanctioned in detail by the Madras Government.	Total for each Section.
NORTHERN CANAL—contd.						
Section IV.—From Kistnapatam to Pennér River—contd.						
20	...	Flood-gate north bank of Kodur river.	101st mile 4th furlong.	Paragraph 53	15,540	K
21	...	Outlet at 101 miles 4 furlongs	Do. do.	*Do. 53	3,590	
22	...	Improvements to canal, 101 miles 6 furlongs to 111 miles 3 furlongs and 5 furlongs.	101st to 111th mile	Do. 53	29,950	
23	...	Toll Office and Establishment sheds at Kodur.	103rd mile	Do. 39 (11)	1,400	K
24	...	Outlet at 107 miles 3 furlongs	107th mile 3rd furlong.	Do. 53	3,590	
25	...	Do. at 108 miles 5 furlongs	108th mile 5th furlong.	Do. 53	3,510	
26	...	Siding basin at Mypaud	110th mile	Do. 39 (9)	1,075	K
27	...	Store and office at do.	110th "	Do. 39 (11)	2,340	
28	...	Outlet at 111 miles 3 furlongs	111th mile 3rd furlong.	Do. 53	3,510	
29	...	Flood-gate south bank of Gungapattam river.	111th mile 4th furlong.	Do. 53	20,500	K
30	...	Improvements to canal, 111 miles 5 furlongs to 114 miles 2 furlongs.	111th to 114th mile	Do. 52	12,980	
31	...	Flood-gate north bank of Gungapattam river.	111th mile 5th furlong.	Do. 52	20,500	
32	...	Outlet at 113 miles 2 furlongs	113th mile 2nd furlong.	Do. 52	3,510	K
33	...	Flood-gate south bank of Pennér river.	114th mile	Do. 52	20,500	
Add Items of General Abstract Estimate, Nos. 65, 68 and 73.					3,03,270	
					3,09,498	6,12,768
Section V.—From Pennér River to tail of Commamur Canal in Kistna District.						
1	...	Pennér diversion	114th to 117th mile	Paragraph 51	69,300	K
2	...	Flood-gate north bank of Pennér river.	114th mile 4th furlong.	Do. 51	20,500	
3	...	Training and cross bank of Pennér river.	Do. do.	Do. 51	68,690	
4	...	Second-class Rest-house at Pennér island.	115th mile	Do. 39 (11)	5,715	K
5	...	Outlet at 116 miles 7 furlongs	116th mile 7th furlong.	Do. 51	3,510	
6	...	Improvements to canal, 116 miles 7 furlongs to 119 miles 3 furlongs.	116th to 119th mile	Do. 50	11,145	
7	...	Ramatheertham diversion, 119 miles 3 furlongs to 120 miles 1 furlong.	119th to 120th mile	Do. 50	8,230	K
8	...	Siding basin at Ramatheertham	120th mile	Do. 39 (9)	1,310	
9	...	Outlet at 120 miles	120th "	Do. 50	3,250	
10	...	Improvements to canal, 120 miles 1 furlong to 122 miles 6½ furlongs.	120th to 122nd mile	Do. 50	20,000	K
11	...	Diversion to canal, 122 miles 6½ furlongs to 123 miles 5 furlongs.	122nd to 123rd mile	Do. 50	14,030	
12	...	Two outlets at 123 miles 5 furlongs and 123 miles 6 furlongs.	123rd mile 5th and 6th furlong.	Do. 50	6,500	
13	...	Flood-gate south bank of Pyderu river.	123rd mile 5th furlong.	Do. 50	19,060	K
14	...	Diversion to canal, 123 miles 6 furlongs to 126 miles 7 furlongs.	123rd mile to 126th mile.	Do. 49	45,900	
15	...	Flood-gate north bank of Pyderu river.	123rd mile 6th furlong.	Do. 49	19,060	
16	...	Improvements to canal, 126 miles 7 furlongs to 131 miles 7 furlongs.	126th to 131st mile	Do. 49	25,900	K
17	...	Siding basin at Iskapalle	128th mile	Do. 39 (9)	1,160	
18	...	Flood-gate south bank of Iskapalle river.	128th "	Do. 49	19,080	
19	...	Flood-gate north bank of Iskapalle river.	128th "	Do. 49	19,080	K
20	...	Diversion to canal, 131 miles 7 furlongs to 132 miles 5 furlongs.	131st to 132nd mile	Do. 49	9,364	
21	...	Outlet at 132 miles 5 furlongs	132nd mile 5th furlong.	Do. 49	3,045	
22	...	Flood-gate south bank of Chippaleru river.	Do. do.	Do. 49	18,100	K
23	...	Diversion to canal, 132 miles 5 furlongs to 134 miles 3 furlongs.	132nd to 134th mile	Do. 48	18,680	
24	...	Flood-gate north bank of Chippaleru river.	132nd mile 6th furlong.	Do. 48	18,100	

Summary of Estimates for improving reaches of Buckingham Canal, &c.—contd.

Number on Index Map and General Abstract Estimate.	Sheet Number of Index Map.	Description of Work.	Position.	Reference to Report.	Amount of Estimate as sanctioned in detail by the Madras Government.	Total for each Section.
NORTHERN CANAL—contd.						
<i>Section V.—From Pennér River to tail of Commamur Canal in Kistna District—contd.</i>						
25	...	Two outlets at 132 miles 6 furlongs	132nd mile 6th furlong.	Paragraph 48	6,090	R
26	...	Improvements to canal, 134 miles 3 furlongs to 150 miles 5 furlongs.	134th to 150th mile	Do. 48	33,100	
27	...	Siding basin at Tumulapenta	139th mile 2nd furlong.	Do. 39 (9)	900	R
28	...	Second-class Rest-house at Tumulapenta.	Do. do.	Do. 39 (11)	5,715	
29	...	Siding basin at Chenugari-polliem	145th mile	Do. 39 (9)	3,180	R
30	...	First-class inspection bungalow at Ramapatam.	149th mile 2nd furlong.	Do. 39 (11)	8,004	
31	...	Office and store at Ramapatam	Do. do.	Do. 39	2,340	R
32	...	Toll Office, &c., at do.	Do. do.	Do. 39	1,300	
33	...	Siding basin at do.	Do. do.	Do. 39 (9)	2,590	R
34	...	Two outlets at 150 miles 5 furlongs	150th mile 5th furlong.	Do. 48	5,640	
35	...	Flood-gate south bank of Elekeru river.	Do. do.	Do. 48	13,720	R
36	...	Improvements to canal, 151 miles to 159 miles 7 furlongs.	151st to 159th mile	Do. 47	21,530	
37	...	Flood-gate north bank of Elekeru river.	151st mile	Do. 47	13,720	R
38	...	Outlet at 151 miles	151st "	Do. 47	2,820	
39	...	Two siding basins at Chackicherla and Karedu.	154th and 159th miles.	Do. 39 (9)	1,310	R
40	...	Manneru southern diversion	159th to 160th mile	Do. 47	2,987	
41	...	Outlet at 159 miles 7 furlongs	159th mile 7th furlong.	Do. 47	2,990	R
42	...	Flood-gate south bank of Manneru river.	160th mile	Do. 47	20,240	
43	...	Manneru right flood bank	160th "	Do. 46	2,118	R
44	...	Do. left do.	160th "	Do. 46	6,525	
45	...	Do. north diversion	160th mile to 160th mile 6th furlong.	Do. 46	6,250	R
46	...	Flood-gate north bank of Manneru river.	160th mile	Do. 46	20,240	
47	...	Outlet at 160 miles	160th "	Do. 46	2,990	R
48	...	Improvements to canal, 160 miles 6 furlongs to 168 miles 2 furlongs.	160th to 168th mile	Do. 45	31,660	
49	...	Second-class Rest-house at Oollapoliem.	163rd mile	Do. 39 (11)	5,715	R
50	...	Siding basin at Oollapoliem	163rd "	Do. 39 (9)	1,115	
51	...	Outlet at 164 miles 5 furlongs	164th mile 5th furlong.	Do. 45	3,055	R
52	...	Siding basin at Pakala	166th mile	Do. 39 (9)	615	
53	...	Outlet at 168 miles	168th "	Do. 45	3,055	R
54	...	Flood-gate south bank at Paleru river.	168th "	Do. 45	18,440	
55	...	Paleru right flood bank	167th to 168th mile	Do. 46	6,130	R
56	...	Duplicate cut and improvements to canal, 168 miles 2 furlongs to 169 miles 3 furlongs.	168th to 169th mile	Do. 45	14,100	
57	...	Flood-gate north bank of Paleru river.	168th mile 2nd furlong.	Do. 45	18,440	R
58	...	Flood-gate south bank of Moosee river.	169th mile 3rd furlong.	Do. 45	18,840	
59	...	Flood-gate north bank of Moosee river.	Do. do.	Do. 45	18,440	R
60	...	Outlet at 169 miles 3 furlongs	Do. do.	Do. 45	3,055	
61	...	Moosee left flood bank and Enagalur diversion to Moosee.	172nd mile	Do. 45	14,960	R
62	...	Improvements to canal, 169 miles 3 furlongs to 177 miles.	169th to 177th mile	Do. 44	15,800	
63	...	Siding basin at Manneru	172nd mile	Do. 39 (9)	2,135	R
64	...	Bridge at Ethamukkala	173rd "	Do. 39 (10)	10,250	
65	...	Siding basin at do.	173rd "	Do. 39 (9)	2,410	R
66	...	Thunderu diversion, 177 miles to 177 miles 7 furlongs.	177th "	Do. 44	11,150	
67	...	Improvements to canal, 177 miles 7 furlongs to 183 miles 1 furlong.	178th to 183rd mile	Paragraphs 43 and 44.	23,900	R
68	...	First-class inspection bungalow at Kothapatam.	179th mile	Paragraph 39 (11)	6,680	
69	...	Stores and office at Kothapatam	179th "	Do. 39 (11)	2,340	R
70	...	Bridge at do.	179th "	Do. 39 (10)	10,250	
71	...	Basin at do. both sides	179th "	Do. 39 (9)	8,180	R
72	...	Road dam at do.	179th "	Do. 39 (10)	8,600	

Summary of Estimates for improving reaches of Buckingham Canal, &c.—contd.

Number on Index Map and General Abstract Estimate.	Sheet Number of Index Map.	Description of Work.	Position.	Reference to Report.	Amount of Estimate as sanctioned in detail by the Madras Government.	Total for each Section.
NORTHERN CANAL—conold.						R
<i>Section V.—From Pennér River to tail of Commamur Canal in Kistna District—conold.</i>						R
73	...	Siding basin at Mottumala	183rd mile	Paragraph 39 (9)	505	
74	...	Outlet at 183 miles 2 furlongs	183rd mile 2nd furlong.	Do. 44	3,170	
75	...	Flood-gate south bank of Mudigoudi river.	183rd mile 2nd furlong.	Do. 44	21,460	
76	...	Improvements to canal, 183 miles 3 furlongs to 186 miles 6 furlongs.	183rd to 186th mile.	Do. 43	41,220	
77	...	Flood-gate north bank of Mudigoudi river.	183rd mile 3rd furlong.	Do. 43	21,460	
78	...	Siding basin at Patapadu	185th mile	Do. 39 (9)	515	
79	...	Gundlacamma right flood-bank	186th mile 6th furlong.	Do. 43	3,400	
80	...	Flood-gate south bank of Gundlacamma river.	186th mile 6th furlong.	Do. 43	21,720	
81	...	Improvements to canal, 187 miles to 190 miles 3½ furlongs.	187th to 190th mile	Do. 43	13,380	
82	...	Gundlacamma left flood-bank	187th mile	Do. 43	11,850	
83	...	Flood-gate north of bank of do.	187th "	Do. 42	21,720	
84	...	Siding basin at Devarampadu	188th "	Do. 39 (9)	590	
85	...	Diversion at Kanoo-parthi, 190 miles 3½ furlongs to 191 miles 4 furlongs.	190th to 191st mile	Do. 42	11,630	
86	...	Second-class Rest-house at Kanoo-parthi.	191st mile	Do. 39 (11)	5,715	
87	...	Siding basin at Kanoo-parthi	Do. do.	Do. 39 (9)	1,115	
88	...	Two outlets at 191 miles	Do. do.	Do. 42	6,780	
89	...	Flood-bank at Kanoo-parthi	191st to 192nd mile	Do. 42	1,970	
90	...	Improvements to canal, 191 miles 4 furlongs to 194 miles 7½ furlongs.	191st to 194th mile.	Do. 42	24,800	
91	...	Toll Office and Establishment sheds at Pedda Ganjam.	195th mile	Do. 39 (11)	2,004	
92	...	Siding basin at Pedda Ganjam	Do. do.	Do. 39 (9)	430	
93	...	Flood-gate at do.	196th mile	Do. 42	18,300	
94	...	Improvements to canal, 194 miles 7½ furlongs to 196 miles 3 furlongs.	194th to 196th mile	Do. 42	3,100	
Add Items of General Abstract Estimate, Nos. 65, 68, 69 and 73.					11,25,667 13,25,229	24,50,896
<i>Section VI.—Junction Canal from Buckingham Canal to Commamur Canal, Kistna District.</i>						
1	...	Drainage cut	195th mile	Paragraph 41	3,830	
2	...	Under tunnel	Do. do.	Do. 41	14,000	
3	...	Inlet and outlet at the crossing of the Pedda Ganjam Creek.	Do. do.	Do. 41	2,770	
Add Item of General Abstract Estimate, No. 73.					20,600 20,674	41,274
Tools and Plant and Machinery (General Abstract Estimate, Item No. 71).					...	47,38,397 56,103
Total, Northern Canal					...	47,94,500
SOUTHERN CANAL.						
<i>Section I.—From St. Mary's Bridge at Madras to Sadras Canal Lock.</i>						
1	...	Lock at Adyar river left bank	...	Paragraph 63	51,280	
Add Items of General Abstract Estimate, Nos. 65, 68-A 69-A, and 73.					6,51,957	7,03,237
<i>Section II.—From Sadras Canal Lock to Pálar River.</i>						
1	...	Improvements to canal from Adyar river to 8 miles 4 furlongs.	0 to 8th mile	Paragraph 64	50,700	

Summary of Estimates for improving reaches of Buckingham Canal, &c.—conold.

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SOUTHERN CANAL—conold.						R
<i>Section II.—From Sadras Canal Lock to Pálar River—conold.</i>						R
2	...	Lock at Adyar river right bank	1st mile	Paragraph 64	42,750	
3	...	Two siding basins at Guindy Bridge and at lattice girder bridge, &c.	1st and 3rd miles	Do. 89 (9)	4,045	
4	...	Toll Office and Establishment sheds at Palavakkam.	5th mile	Do. 39 (11)	925	
5	...	Siding basin at Neelankarai	5th "	Do. 39 (9)	1,250	
6	...	Diversion to canal, 8 miles 4 furlongs to 15 miles 1 furlong.	8th to 15th mile	Do. 64	55,200	
7	...	Two siding basins at Vanienchavady, 12 miles and 13 miles.	12th to 13th "	Do. 39 (9)	1,800	
8	...	Flood-gate north bank of Covelong Backwater.	15th mile 1st furlong.	Do. 64	14,800	
9	...	Diversion to canal, 15 miles 2 furlongs to 31 miles 2 furlongs.	15th to 31st mile	Do. 65	1,69,300	
10	...	Flood-gate south of Covelong Backwater.	15th mile to 2nd furlong.	Do. 65	14,800	
11	...	Second-class Rest-house at Covelong	16th mile 3rd furlong.	Do. 39 (11)	5,715	
12	...	Six siding basins at 16 miles 3 furlongs, 18 miles, 20 miles 4 furlongs, 23 miles 4 furlongs, 28 miles 4 furlongs, and 30 miles 1 furlong.	16th mile 3rd furlong, 18th mile, 20th mile 4th furlong, 23rd mile 4th furlong, 28th mile 4th furlong, and 30th mile 1st furlong.	Do. 39 (9)	9,625	
13	...	Flood-gate north of Edayur Backwater.	31st mile 2nd furlong.	Do. 65	14,800	
14	...	Diversion to canal, 31 miles 4 furlongs to 32 miles 3 furlongs.	31st to 32nd mile	Do. 66	7,430	
15	...	Flood-gate south bank of Edayur Backwater.	31st mile 4th furlong.	Do. 66	14,800	
16	...	Siding basin at Konatur, 32 miles 2 furlongs.	32nd mile 2nd furlong.	Do. 39 (9)	1,695	
17	...	Improvements to canal, 32 miles 3 furlongs to 36 miles 3 furlongs.	32nd to 36th mile	Do. 66	14,875	
18	...	Siding basin at Sadras	35th mile	Do. 39 (9)	2,610	
19	...	Flood-gate north of Pudupatnam drain near Sadras.	36th mile 3rd furlong.	Do. 66	15,130	
20	...	Improvements to canal, diversion and flood bank to Pálar River.	36th to 41st mile	Do. 66	92,280	
21	...	Flood-gate south bank of Pudupatnam drain.	36th mile 5th furlong.	Do. 66	15,130	
22	...	Siding basin at Pudupatnam	37th mile	Do. 39 (9)	3,375	
23	...	Flood-gate left bank, Pálar River	39th "	Do. 66	18,950	
23-A	...	Five outlet sluices	13th, 18th, 30th, 33rd and 38th miles.	Do. 66	14,700	
Add Items of General Abstract Estimate, Nos. 65, 68, 68-A and 73.					5,86,745 78,608	6,65,353
<i>Section III.—From Pálar River to Merkanam.</i>						
1	...	Flood-gate, Pálar River right bank	40th mile	Paragraph 66	18,620	
2	...	Second-class Rest-house at Panayur.	54th "	Do. 39 (11)	5,715	
3	...	Toll Office and Establishment sheds at Alambarai.	58th "	Do. 39 (11)	640	
4	...	Store and Office at Alambarai	58th "	Do. 39 (11)	2,340	
Add Items of General Abstract Estimate, Nos. 65, 68 and 73.					27,315 1,86,450	2,13,765 10,245
Tools and Plant and Machinery, Item No. 71.					...	15,92,600
Total, Southern Canal					...	63,87,100
Grand Total, Northern and Southern Canals.					...	63,87,100

CHAPARK,
December 1882.R. R. E. DRAKE-BROCKMAN, Major, R.E.,
Executive Engineer, Buckingham Canal.

APPENDIX B.

Statement showing the Expenditure incurred up to 31st March 1882 and to be incurred on different Sections of the Buckingham Canal.

No.	Sections of Canal.	Expenditure up to the commencement of famine.	EXPENDITURE DURING FAMINE.			Expenditure subsequent to famine up to 31st March 1882.	Total of columns 3, 6 and 7.	Further Expenditure to be incurred including the probable outlay in 1882-83.	Total of columns 3 and 9.
			Total famine expenditure.	Deduct excess over normal rates debited to famine.	Net ordinary expenditure.				
1	2	3	4	5	6	7	8	9	10
	<i>Southern Canal.</i>	R	R	R	R	R	R	R	R
1	From St. Mary's Bridge at Madras to Junction Canal Lock	16,002	7,12,497	1,29,395	5,83,102	48,053	6,47,157	56,080	7,03,237
2	From Sadras Canal Lock to Pálár River	48,836	39,719	15,591	24,128	361	73,325	5,92,028	6,65,353
3	From Pálár River to Merkanam	...	32,633	15,016	17,617	1,65,793	1,83,410	30,355	2,13,765
		64,838	7,84,849	1,60,002	6,24,847	2,14,207	9,03,892	6,78,463	15,82,355
	<i>Northern Canal.</i>								
1	From St. Mary's Bridge at Madras to Pulicat	...	...	...	...	1,452	1,452	4,32,960	4,34,412
2	From Pulicat to Dugarápatnam	1,800	3,10,685	69,185	2,41,500	7,673	2,50,973	4,07,825	6,58,798
3	From Dugarápatnam to Kistnapatam	2,85,782	...	...	...	...	2,85,782	2,54,467	5,40,249
4	From Kistnapatam to Pennér River	1,96,658	85,239	6,341	78,898	32,434	3,07,990	3,04,778	6,12,768
5	From Pennér River to tail of Commamur Canal	...	17,39,875	4,94,500	12,45,375	71,047	13,16,422	11,34,474	24,50,896
6	Junction Canal from Buckingham Canal to Commamur Canal	...	4,281	1,047	3,234	17,440	20,674	20,600	41,274
		4,84,240	21,40,080	5,71,073	15,69,007	1,30,046	21,83,293	25,55,104	47,38,397
	Total	5,49,078	29,24,929	7,31,075	21,93,854	3,44,253	30,87,185	32,33,567	63,20,752
	Tools and Plant and Machinery provided for in the General Abstract Estimate	...	...	...	...	...	...	...	66,348
	GRAND TOTAL	...	...	...	...	...	...	...	63,87,100

R. R. E. DRAKE-BROCKMAN, Major, R.E.,
Executive Engineer, Buckingham Canal.

APPENDIX C.

Statement showing the Arrivals at, and Departures from, the Madras Basin of Boats, with their Tonnage, for the period 1st July 1878 to 30th June 1882.

DIRECTIONS.	HALF-YEAR ENDING 31st DECEMBER 1878.		HALF-YEAR ENDING 30th JUNE 1879.		HALF-YEAR ENDING 31st DECEMBER 1879.		HALF-YEAR ENDING 30th JUNE 1880.		HALF-YEAR ENDING 31st DECEMBER 1880.		HALF-YEAR ENDING 30th JUNE 1881.		HALF-YEAR ENDING 31st DECEMBER 1881.		HALF-YEAR ENDING 30th JUNE 1882.	
	Number of Boats.	Tons.	Number of Boats.	Tons.	Number of Boats.	Tons.	Number of Boats.	Tons.	Number of Boats.	Tons.	Number of Boats.	Tons.	Number of Boats.	Tons.	Number of Boats.	Tons.
Inwards from A Section	3,199	19,880	2,681	14,946	4,019	25,494	1,467	9,330	3,762	26,440	3,390	26,638	3,842	21,841	3,100	15,968
Do. from C do.	6,561	81,836	7,125	78,645	5,396	66,406	5,653	70,208	7,657	116,755	5,333	95,975	6,856	96,753	5,070	59,341
Total	9,760	101,716	9,806	93,591	9,415	91,900	7,120	79,538	11,419	143,195	9,223	122,613	10,698	118,594	8,170	75,309
Outwards into A Section	1,438	7,863	1,629	9,059	730	3,954	277	2,405	2,208	17,037	3,975	26,247	3,828	21,561	3,153	16,639
Do. into C do.	959	6,754	1,121	11,463	2,036	24,657	5,591	67,679	7,701	117,591	5,763	62,357	6,913	98,474	5,072	58,018
Total	2,397	14,617	2,750	20,522	2,766	28,611	5,868	70,084	9,909	134,628	9,738	88,604	10,746	120,035	8,225	74,657
GRAND TOTAL	12,157	116,333	12,556	114,113	12,181	120,511	12,988	149,622	21,328	277,823	18,961	211,217	21,444	238,629	16,395	149,966

CHEPAUK,
15th September 1882.R. R. E. DRAKE-BROCKMAN, Major, R.E.,
Executive Engineer, Buckingham Canal.

APPENDIX D.

Statement showing the Number, Tonnage, and Description of Boats licensed for each Section of the Buckingham Canal for the year 1881.

PARTICULARS.	UNCOVERED CARGO BOATS.																																	Total.
	1 Ton.	2 Tons.	3 Tons.	4 Tons.	5 Tons.	6 Tons.	7 Tons.	8 Tons.	9 Tons.	10 Tons.	11 Tons.	12 Tons.	13 Tons.	14 Tons.	15 Tons.	16 Tons.	17 Tons.	18 Tons.	19 Tons.	20 Tons.	21 Tons.	22 Tons.	23 Tons.	24 Tons.	25 Tons.	26 Tons.	27 Tons.	28 Tons.	29 Tons.	30 Tons.	31 Tons.	32 Tons.	33 Tons.	
Government Boats	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Private Boats	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Boats compounded for the whole canal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
A or Sadras Section	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
B or Madras do.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
C or Palitot do.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
D or Kistnapatnam Section	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
E or Ramapatnam do.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
F or Kottapatnam do.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total number of Boats	4	6	8	29	18	11	13	15	6	9	7	7	8	10	4	17	14	15	10	21	14	13	13	12	17	9	13	16	16	11	6	4	1	573
Total Tonnage	4	13	24	116	90	66	91	120	54	90	77	84	104	140	60	272	238	270	190	420	294	286	299	288	425	234	351	448	484	330	249	128	85	9,852

PARTICULARS.	COVERED CARGO, PASSENGERS AND RADANI BOATS.																			Total.
	1 Ton.	2 Tons.	3 Tons.	4 Tons.	5 Tons.	6 Tons.	7 Tons.	8 Tons.	9 Tons.	10 Tons.	11 Tons.	12 Tons.	13 Tons.	14 Tons.	15 Tons.	16 Tons.	17 Tons.	18 Tons.	19 Tons.	
Government Boats	...	...	1	3	1	4	3	3	3	...	...	...	1	...	2	...	...	...	...	17
Private Boats	...	...	1	1	1	3	1	...	...	...	...	1	...	1	1	1	...	...	...	8
Boats compounded for the whole year	...	...	1	3	1	9	3	5	8	2	3	1	1	1	...	...	...	...	...	36
A or Badras Section	...	7	27	43	19	4	...	...	...	...	...	...	1	...	1	1	...	...	...	160
B or Madras do.	3	1	4	2	2	...	1	1	...	...	...	...	...	5	2	1	...	...	...	261
C or Ponnich do.	4	24	18	52	55	35	19	18	16	15	6	10	9	...	...	...	1	...	...	15
D or Kintanapatam Section	...	...	1	5	...	...	4	...	2	...	1	1	...	...	...	...	...	...	...	24
E or Ramapatam do.	...	...	1	1	5	6	6	5	3	1	...	...	1	...	...	...	...	...	...	19
F or Kottapatam do.	...	...	...	1	5	1	5	4	...	...	...	...	...	...	...	...	...	...	...	...
Total number of Boats	7	33	53	106	94	61	41	35	27	30	13	14	13	7	6	3	1	...	1	633
Total Tonnage	7	66	156	424	470	366	287	230	243	206	132	168	160	98	90	48	17	...	10	3,240

Statement showing the Number, Tonnage, and Description of Boats licensed for each Section of the Buckingham Canal for the year 1881—continued.

Statement showing the Number, Tonnage, & Value of Boats.		Deck and Dinghy Boats.																	TOTAL.
PARTICULARS.	1 Ton.	2 Tons.	3 Tons.	4 Tons.	5 Tons.	6 Tons.	7 Tons.	8 Tons.	9 Tons.	10 Tons.	11 Tons.	12 Tons.	13 Tons.	14 Tons.	15 Tons.	16 Tons.	17 Tons.	18 Tons.	TOTAL.
Government Boats	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
Private Boats	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Boats compounded for the whole year	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
A or Madras Section	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...
B or Madras do.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
C or Palicat do.	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...
D or Kistnapatam Section	...	...	...	...	...	...	...	2	...	2	...	...	2	2	2	...	1	...	...
E or Bampatam do.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
F or Kottapattam do.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total number of Boats	...	...	...	...	...	...	...	4	1	6	...	3	3	2	4	1	3	3	29
Total Tonnage	...	...	...	...	...	...	...	32	9	60	...	36	30	28	60	16	51	36	537

PARTICULARS.	FISHING BOATS.						TOTAL.	VARIOUS OTHER BOATS.				TOTAL.	Total number of all kinds of boats.	Total Tonnage of Boats.
	1 Ton.	2 Tons.	3 Tons.	4 Tons.	5 Tons.	6 Tons.		1 Ton.	2 Tons.	3 Tons.	4 Tons.			
Government Boats	...	...	...	...	...	...	...	...	...	...	...	...	17	114
Private Boats	...	...	...	...	...	...	...	...	...	...	...	...	8	84
Boats compounded for the whole year	...	...	...	...	...	...	...	...	...	...	...	...	43	318
A or Sadras Section	...	...	...	...	...	...	...	...	...	...	...	...	125	437
B or Madras do.	...	...	...	...	...	...	...	...	...	...	...	...	44	237
C or Pulicat do.	...	...	...	...	...	...	...	...	...	...	...	...	11	7,516
D or Kistnapatam Section	...	...	...	...	...	...	...	...	...	...	...	...	1	36
E or Ramapatam do.	...	...	...	...	...	...	...	...	...	...	...	...	39	291
F or Kottapatam do.	...	...	...	...	...	...	...	...	...	...	...	...	48	453
Total number of Boats	108	42	3	1	...	1	155	21	10	...	1	33	1,128	...
Total Tonnage	108	84	9	4	...	6	211	21	20	...	4	45	...	10,215

CHEPAUK,
15th September 1882.

R. R. E. DRAKE-BROCKMAN, *Major, R.E.,*
Executive Engineer, Buckingham Canal.

APPENDIX E.

THE BUCKINGHAM CANAL.

Ootacamund, September 22, 1879.

The following Revised Rules for the regulation of the navigation of the Buckingham Canal, passed by the Madras Government with such alterations as appeared necessary, are, under the provisions of Section 23 of Act I of 1870, hereby published for general information :—

- I.—The Buckingham Canal includes the following lines of navigation, extending from south of the Pálar river in the District of Chingleput to the junction of the tidal and fresh-water canals in the Kistna District near Pedda Ganjam, together passing over a continuous distance of about 256 miles, viz.:—
- 1st.—The Sadras Canal extending from 12 miles south of the right bank of the Pálar river to Palavakkam, distance about 50 miles.
 - 2nd.—The Madras Canal extending from Palavakkam to the Shadayankuppam Lock, distance about 16 miles.
 - 3rd.—The Pulicat Canal extending from the Shadayankuppam Lock to near Raidurravoo, distance about 48 miles.
 - 4th.—The Kistnapatam Canal extending from near Raidurravoo to near Kodoor, distance about 48 miles.
 - 5th.—The Ramapatam Canal extending from near Kodoor to Ramapatam, distance about 48 miles.
 - 6th.—The Kottapatam Canal extending from Ramapatam to the junction with the Commamur fresh-water canal in the Kistna District, distance about 46 miles.
- II.—These lines of navigation include also such portions of all navigable estuaries, backwaters, rivers, and channels, whether salt or fresh, connected with each such line as have been artificially formed, deepened, or protected; except all those minor channels which have been excavated as feeders to the main line of canal for purposes connected with the Salt and Wood Departments; they shall be each and severally distinct lines of navigation as defined in Section 1 of Act I of 1870 (The Canals and Ferries Act), the provisions of which shall apply to each of these distinct lines of navigation separately, and they shall be denominated sections of the Buckingham Canal as follows :—
- 1st.—A or the Sadras Section.
 - 2nd.—B or the Madras Section.
 - 3rd.—C or the Pulicat Section.
 - 4th.—D or the Kistnapatam Section.
 - 5th.—E or the Ramapatam Section.
 - 6th.—F or the Kottapatam Section.
- III.—From and after the 8th day of October 1879, no vessel, but those hereinafter excepted, shall be allowed on, or to use any of the abovementioned distinct lines of navigation without—
- (1st) The payment of an annual license fee at the rates specified in the Schedule A annexed for the use of any one of the abovementioned distinct lines of navigation.
- Exception (1).—*Vessels possessing licenses for the navigation of the canals of the Godáviri or Kistna District will not be required to pay a license fee for the use of any section of the Buckingham Canal.
- Exception (2).—*The Pulicat fishermen (with boats under 2 tons each) should be free to fish in the backwater without the obligation to take out a license.
- (2nd) The payment of a toll at the rates specified in the Schedule B annexed for passing from any one to any other of the abovementioned distinct lines of navigation for which the owner does not hold a license.
- Exception (1).—*Boats leaving their section will not be liable to toll when returning empty within two months.
- Exception (2).—*Boats licensed for the Kistna and Godáviri plying through the length of the canal to Madras will pay 4 annas per ton on the outward journey, but on returning full or empty, they will

pass free at any toll-bar at which they had paid toll within one month.

*Exception (3).—*Boat-owners have the option of compounding for a year's tolls at Rs 10 per ton.

*Exception (4).—*Boats licensed for the whole canal will not pay tolls.

*Exception (5).—*Boats returning into their own sections with a cargo after an absence from it of ten clear days, or if returning empty after an absence from it of two months, must pay tolls.

IV.—The Executive Engineer of the Canal will issue licenses (in the Form C annexed) personally or by Agents authorized by him in writing for the purpose, at such times and places as he may notify in the *Port St. George Gazette* and in the official Gazette of the district in which the line of navigation, for which licenses are to be issued, is situated. The vessels to be licensed must be brought at the time specified in the notification to the places where licenses are to be issued to be measured and registered and to have the necessary distinguishing marks put on them.

V.—These marks will show by letter the section of the canal to which the vessel belongs and which it is licensed to navigate. They will show the registered number of the vessel and the tonnage, or the number of passengers the vessel is licensed to carry. They shall be put on under the direction of the Executive Engineer at the cost of the owner of the vessel, who will be held responsible that they are not defaced or obliterated, and that they are renewed from time to time as required. Yachts, pleasure-boats, and other vessels not intended to ply for hire, may be marked as the owner desires, provided the figures are clearly legible.

VI.—Applications for licenses shall be made in the Form D annexed, at any time before the 8th October for the current calendar year, and in the months of October, November or December for the ensuing calendar year. Printed forms of applications for licenses will be issued by the Executive Engineer of the Canal at his Office in Madras and by the Toll Superintendents of the Canal at the Toll Offices at Palavakkam, Shadayankuppam Lock, Raidurravoo, Kodoor, Ramapatam, and Pedda Ganjam.

VII.—The maximum dimensions of vessels brought on the canal hereafter will be limited to 90 feet in length, 13 feet beam, and 2½ feet in draught; vessels of greater length and beam that may be now on the canal will be allowed to remain upon it at the owner's risk until they are worn out or renewed, but the draught of water will be limited in all cases to 2½ feet, which draught will be marked by a painted band or water-line round the outside of the hull, provided that the painted band or water-line thus arrived at shall not allow less free-board than 12 inches; or, in other words, be less than 12 inches below the lowest point in the gunwale; and no vessel shall be laden so as entirely to submerge this painted band. The height of fixed fittings, such as the roofs of boats, mast partners, funnel shockers, &c., shall be limited to 6½ feet above the deep load-line.

The height of piled cargo, such as firewood, cotton, leaves, &c., will be limited to the same dimensions and in a similar manner.

VIII.—The gross tonnage of all vessels will be obtained by the following rule :—

$$\frac{L \times B \times D}{50}$$

L being equal to the length of the vessel, measured at half the midship depth, from the afterpart of the stem to the forepart of the stern post.

B is equal to the sum of five widths taken from the inner side of the planking to one side of the rib on the other side, at equal distances of one-sixth of the above length, divided by 6.

D is the midship depth taken from the upper surface of the limber strake (the bottom plank next the keelson, or the centre bottom plank when there is no keelson) to the under surface of the deck planking in decked vessels, or to the top of the upper strake or gunwale in open vessels.

The net or registered tonnage will be for—

Steamers, the gross tonnage less one-third; and for

Other vessels, the gross tonnage less 15 per cent.;

but the carrying capacity of any vessel to the load-line painted round the hull as laid down in Rule VII will be actually tested by weight on the owner of the vessel or his Agent bringing it

to the Basin at Madras and making written application to the Executive Engineer to have it so tested, and the result arrived at by such testing shall be the registered tonnage of the vessel and be painted on it and adopted as the registered tonnage of the vessel, with effect retrospective to the commencement of the license under which the vessel is plying, *i.e.*, all excess license fees and tolls collected from the commencement of the calendar year for which the vessel is licensed will be refunded, and *vice versa*. In the case of a vessel being tested which is found to have had its tonnage correctly or under-estimated by the method of measurement in this rule, the boat owner or his agent who applies for the testing will pay a fee for testing of eight annas per ton of the tonnage arrived at by the testing. The cost of testing shall be borne by the Government when it is carried out on the order of the officer in charge of the canal, and in such case its effect shall not be retrospective.

IX.—Vessels adopted to carry passengers, *i.e.*, having a covered space for their protection, may be registered as passenger vessels, and will then be licensed to carry one passenger for every 5 square feet of deck surface under cover to be measured as follows:—Length, from stem to stern at the deck level; breadth, the sum of five widths taken at equal distances of one-sixth the length and divided by 6; then length and breadth divided by 5 will give the number of passengers a vessel will be licensed to carry, including 40lb. of luggage for each passenger. When passenger vessels carry cargo as well as passengers, the quantity of cargo allowable will be the registered tonnage less 400lb. for each passenger on board.

First-class passenger vessels (such as budgerows) plying for hire and not carrying cargo will be licensed at the commencement of the year at the option of the owners, either like other vessels by a license fee of R2 per ton for one section and tolls at 4 annas per ton, or by a license fee at R4 per ton for the *whole* Buckingham Canal for the year. In the calculation of the tonnage of such boats the free-board will be taken as at 18 inches and the load-line marked accordingly, the tonnage being determined by testing. The minimum fee for licensing a budgerow for the whole canal shall be R15.

Vessels, the private property of individuals, making use of the canals, but not carrying passengers or goods or plying for hire, will be licensed for a calendar year for the *whole* Buckingham Canal on payment of a fee of R15.

X.—Rafts will be permitted to navigate the several sections of the Buckingham Canal on payment when entering each such section of the toll prescribed in Schedule B annexed; no raft exceeding 90' x 13' x 2" will be allowed on the canal.

XI.—If a vessel after the issue of a license be enlarged, it shall not again use the canal until it has been re-measured and re-licensed. The new license will be granted on surrender of the old license and on payment of the prescribed fee per ton on the difference between the old and new tonnage.

XII.—No person who has taken out a license for the navigation of any section of the canal shall have claim to compensation on account of any impediment to navigation that may occur from any cause whatever.

XIII.—Sea-going vessels brought into rivers and backwaters for shelter, for repair, or for any other purpose except to ply for hire, must anchor or lay up outside the fairway of canal traffic which will be defined by the Canal Officers; such vessels will not be allowed to enter on the main line of the canal for the purpose of proceeding from one river or backwater to another river or backwater or for any other purpose except in accordance with the rules prescribed for the use of the canal.

XIV.—The Executive Engineer in charge of the canal for the time being is authorized to enforce these rules, to collect tolls and license fees, to remove obstructions to navigation, and to direct prosecutions under the provisions of Sections 7, 8, 9, 10, 12, and 25 of Act No. I of 1870.

BYE-LAWS.

I.—No vessel shall moor on the towing path side of the canal when there is only one towing path, nor on the windward side when there are two towing paths, except when actually loading or unloading, or with the special permission of the Canal Officers.

II.—No cargo shall be loaded or unloaded, and no passengers shall be shipped or landed at any lock or masonry work other than the quays or wharfs specially provided for the purpose.

III.—No vessel shall be repaired or fitted on the main line of the canal without the written permission of the Executive Engineer or other officer authorised to give such permission on the Executive Engineer's behalf.

IV.—No vessels shall be moored in a lock channel defined as such by notice-boards erected for the purpose by the Canal Officers.

V.—Vessels when moored in main line of the canal shall be made fast stem and stern to the banks in single tier, and there must be a person always in charge of each vessel; vessels when thus moored must, between sunset and sunrise, show a clear bright light not less than 4 feet above the water-level and visible all round the vessel.

VI.—When vessels, other than steamers, going under sail in opposite directions, meet, the vessel going with the wind shall give way, while the vessel going against the wind shall hold on its course.

VII.—Vessels not under sail shall give way to vessels under sail, and steamers shall in all cases give way to other vessels.

VIII.—When vessels not under sail, including steamers, meet, those going north should keep to the east, and those going south should keep to the west.

IX.—When a vessel passes another vessel going in the same direction, it should keep to the leeward of vessels under sail, and on the opposite side of the towing line of vessels not under sail.

X.—Vessels when not moored must, between sunset and sunrise, carry lights as follows:—

Steamers, three lights—

1st.—A clear white light not less than 9 feet above water and in the centre line of the vessel.

2nd.—A bull's-eye bright red light on the port (left) side.

3rd.—A bull's-eye bright green light on the star-board (right) side.

The bull's-eye lights to be not less than 8 inches diameter and not less than 4 feet above water.

Vessels other than steamers must carry a clear white light at the fore end not less than 4 feet above water.

Passenger-boats must, in addition to the above lights, carry a light in each cabin or compartment for passengers.

XI.—The maximum speed of steamers will be limited to 10 miles an hour by day and to 5 miles an hour by night, reduced to 4 miles an hour when within half a mile of a lock, or vessels ahead coming in an opposite direction. The steam whistle shall be blown when speed is reduced on the abovementioned occasions and when nearing a vessel going ahead in the same direction, or when approaching any sharp bend in the canal. Steamers passing through portions of the canal under repair or through portions of the canal that cannot stand a high speed shall reduce speed at those places to the limit fixed by the Canal Officers on notice-boards erected for this purpose.

XII.—Every vessel shall have its license always on board, and it shall be produced for examination by the Executive Engineer or by any officer authorised by the Executive Engineer to demand an inspection of it.

XIII.—Every vessel plying for hire is liable to be inspected at any time or place by the Executive Engineer or by officers authorised by him to inspect vessels, and the Executive Engineer may withdraw the license of any vessel found to be from any cause unfit for use, and to withhold the license until the vessel is made serviceable.

XIV.—The Executive Engineer may suspend the license of any vessel for any period not exceeding three months, or levy a fine not exceeding 5 rupees in each case, for any infringement of these rules or bye-laws.

THE BUCKINGHAM CANAL, MADRAS.

SCHEDULE A.

LICENSE FEES.

Description of Vessel.	Rate per ton of Re- gistered Tonnage per annum.
	R. a. p.
For every ship, steamer, boat, barge, or vessel of any description, except those specified in the latter part of Rule IX (for the licenses for the whole canal), propelled in any manner and use for any purpose except fishing or pleasure	2 0 0
For every fishing or pleasure boat	0 4 0

Fractions of tons will be counted as one ton, and the minimum charge for any vessel will be one rupee.

Licenses will be issued on payment of the above fees for the use of any distinct line of navigation included in the Buckingham Canal.

A license will not be granted to the same vessel for the use of more than one line of navigation on the canal, except in the instances of the two classes of vessels specified in the latter part of Rule IX.

Vessels licensed in any month of one year must pay the annual fee for the whole of that year.

Licensed vessels will have to pay no other dues of any sort for the use throughout the year of the section of the canal for which the license is granted.

The fee for a duplicate license will be two rupees.

THE BUCKINGHAM CANAL, MADRAS.

SCHEDULE B.

SCHEDULE OF TOLLS.

Tolls.

Description of Vessel.	Rate per ton of Registered Tonnage.
	R. a. p.
For every ship, steamer, barge, boat, or vessel of any description and propelled in any manner entering any of the distinct lines of navigation or sections of the canal other than the section in which it is licensed, and which it can use free of tolls	0 4 0
	R. a. p.
For every raft of floating timber, bamboos, or other floating substance	0 1 0

THE BUCKINGHAM CANAL, MADRAS.

FORM C.

License No.

of 1879.

This vessel is licensed to use the
calendar year 1879 free of further charge.

section of the Buckingham Canal during the

Registered No.

Name of owner.

Residence of owner.

Class of vessel (a).

Extreme length.

Do. breadth.

Do. depth.

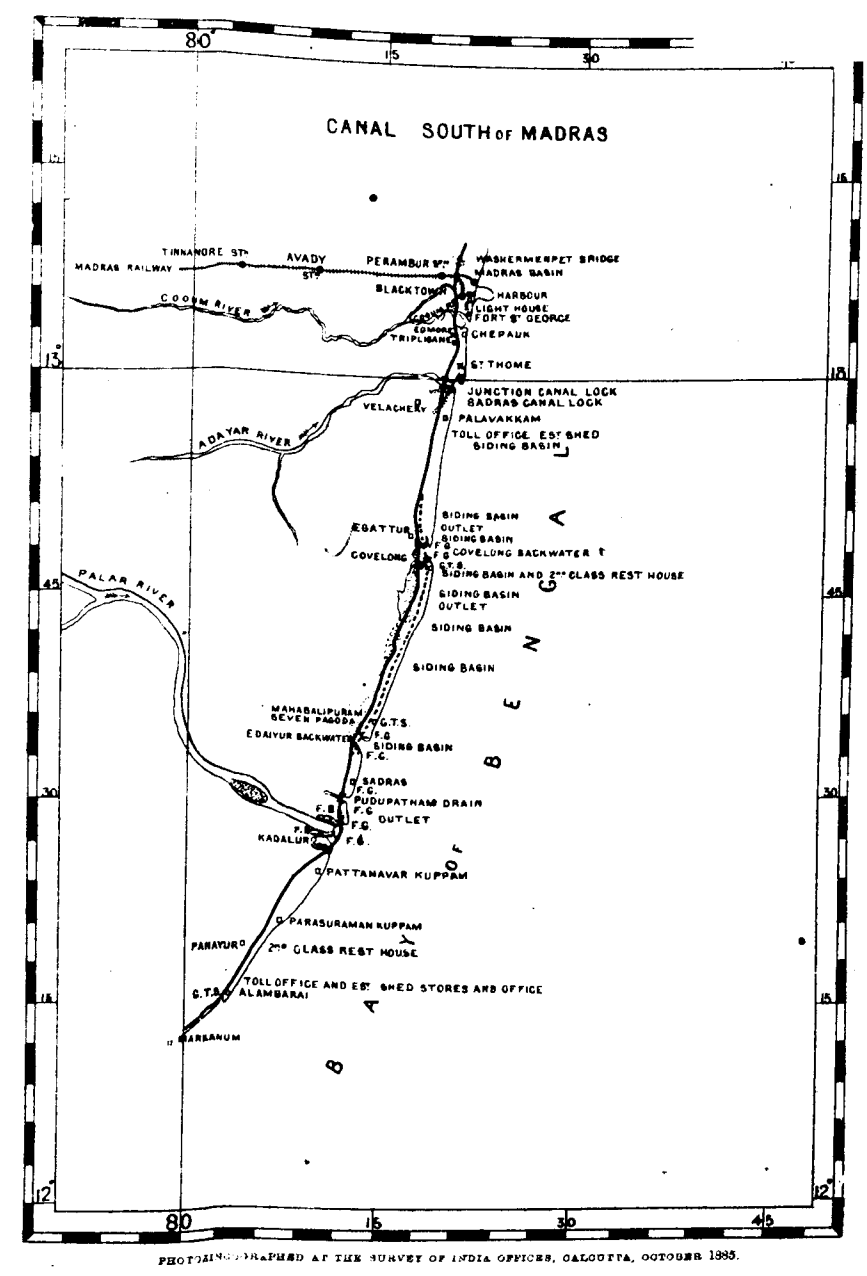
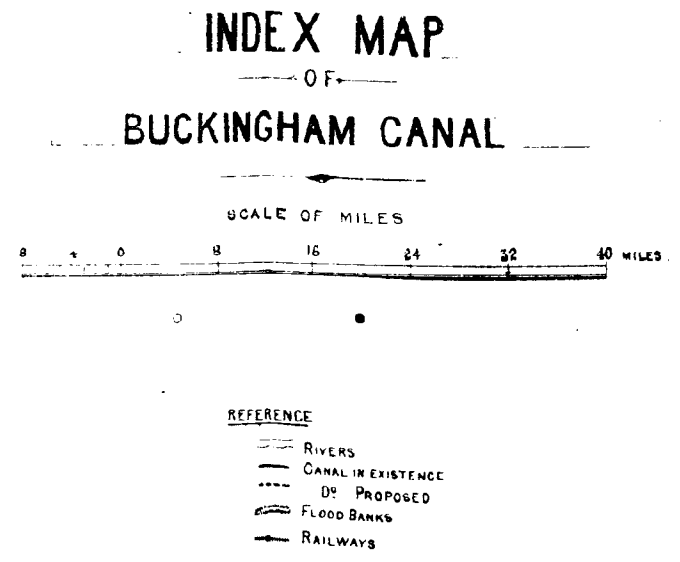
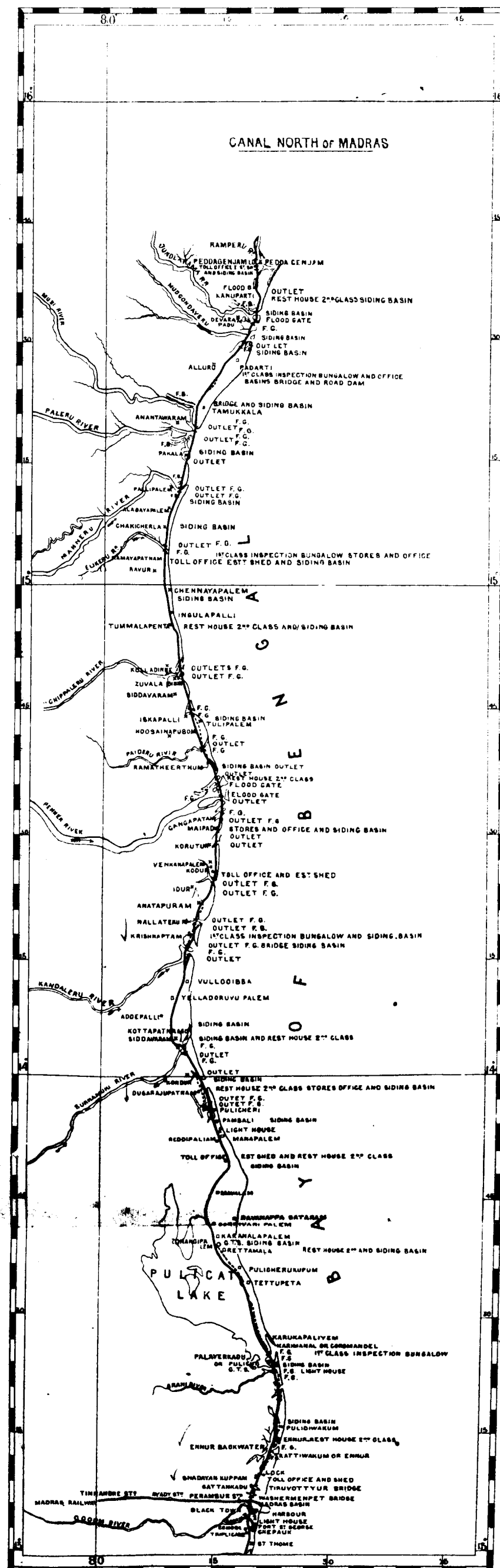
Draught of water.

Licensed to carry

Do. do

tons cargo.

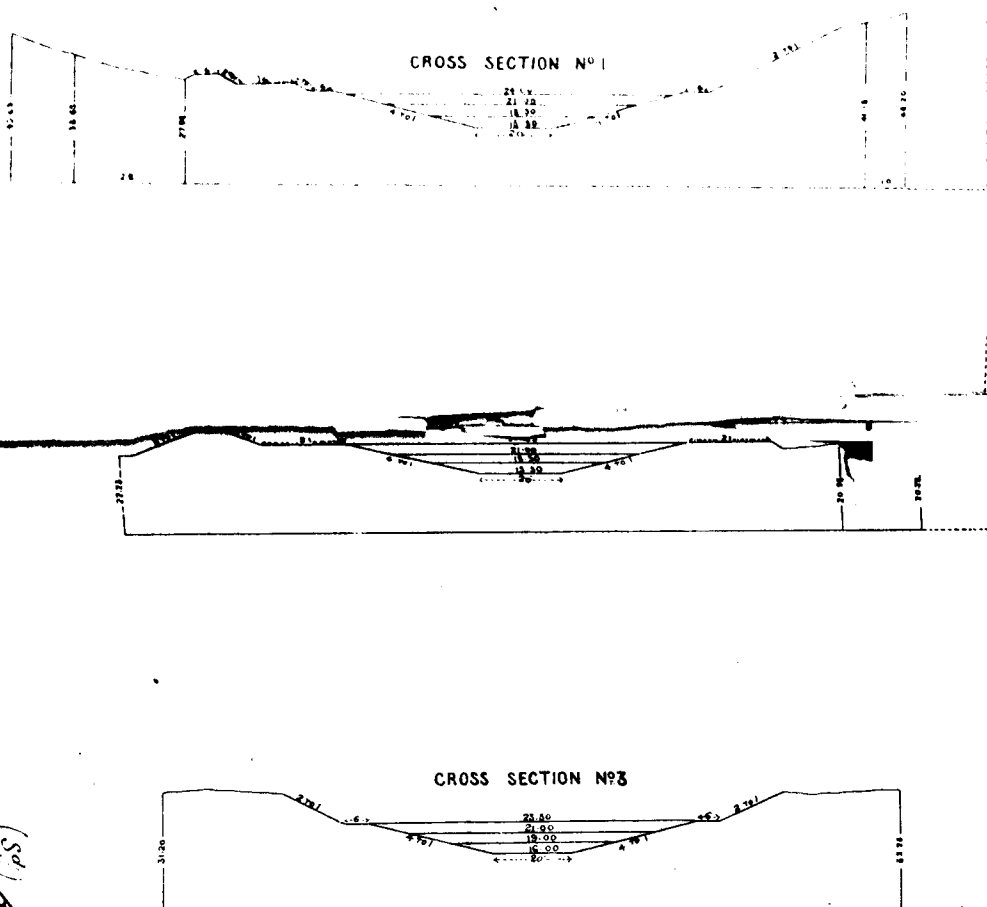
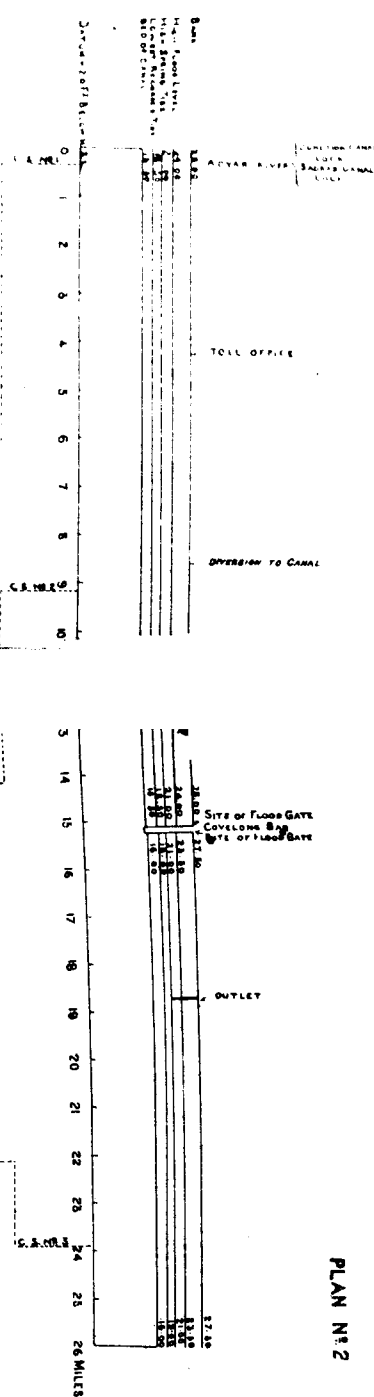
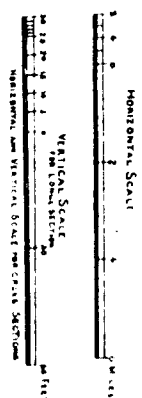
passengers.



PHOTOGRAPHED AT THE SURVEY OF INDIA OFFICE, CALCUTTA, OCTOBER 1935.

(Sd) *A. R. S. R.* CAPTAIN R.E.
ASST CHIEF ENGINEER FOR IRRIGATION

LONGITUDINAL AND CROSS SECTIONS
OF
BUCKINGHAM CANAL
SOUTH OF MADRAS
FROM ADYAR RIVER DOWN TO THE 26TH MILE



(Sd) A. S. B. B. B.
AST CHIEF ENGR FOR IRRIGATION
PROVIDED AS THE SURVEY OF INDIA OFFICE, CALCUTTA, OCTOBER 1890.

REFERENCE

DATUM - 20 FEET BELOW MEAN SEA LEVEL

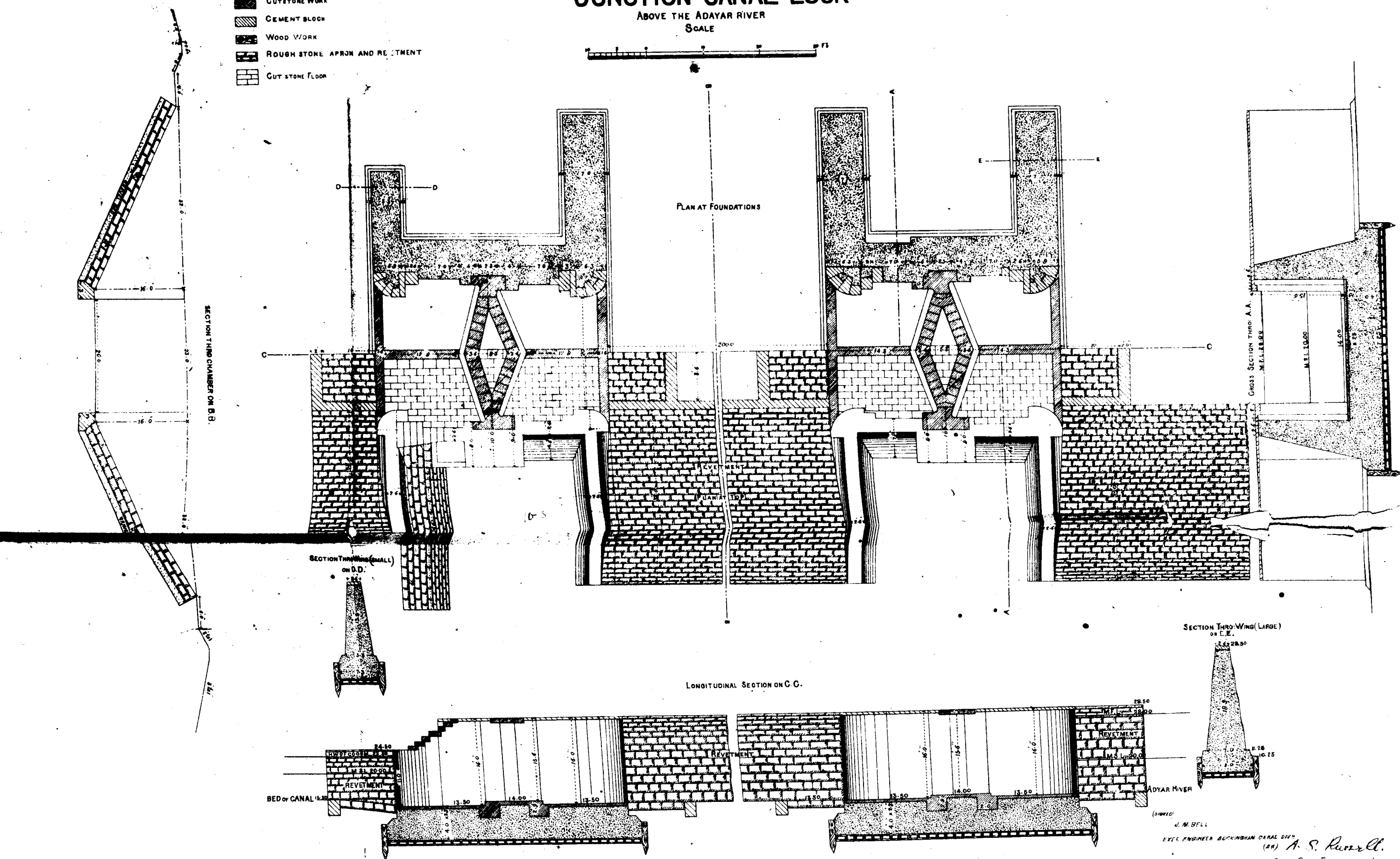
SURFACE SOIL AND SUB SOIL. SAND

ESTIMATE AMOUNT OF RE 48250

COST OF WORK AT 42-00

YEAR BETWEEN IT WAS COMPLETED 1954

- | | |
|---|--------------------------------|
|  | CONCRETE IN SURRLI MORTAR |
|  | GUTSTONE WORK |
|  | CEMENT BLOCK |
|  | WOOD WORK |
|  | ROUGH STONE APRON AND RETIMENT |
|  | GUT STONE FLOOR |

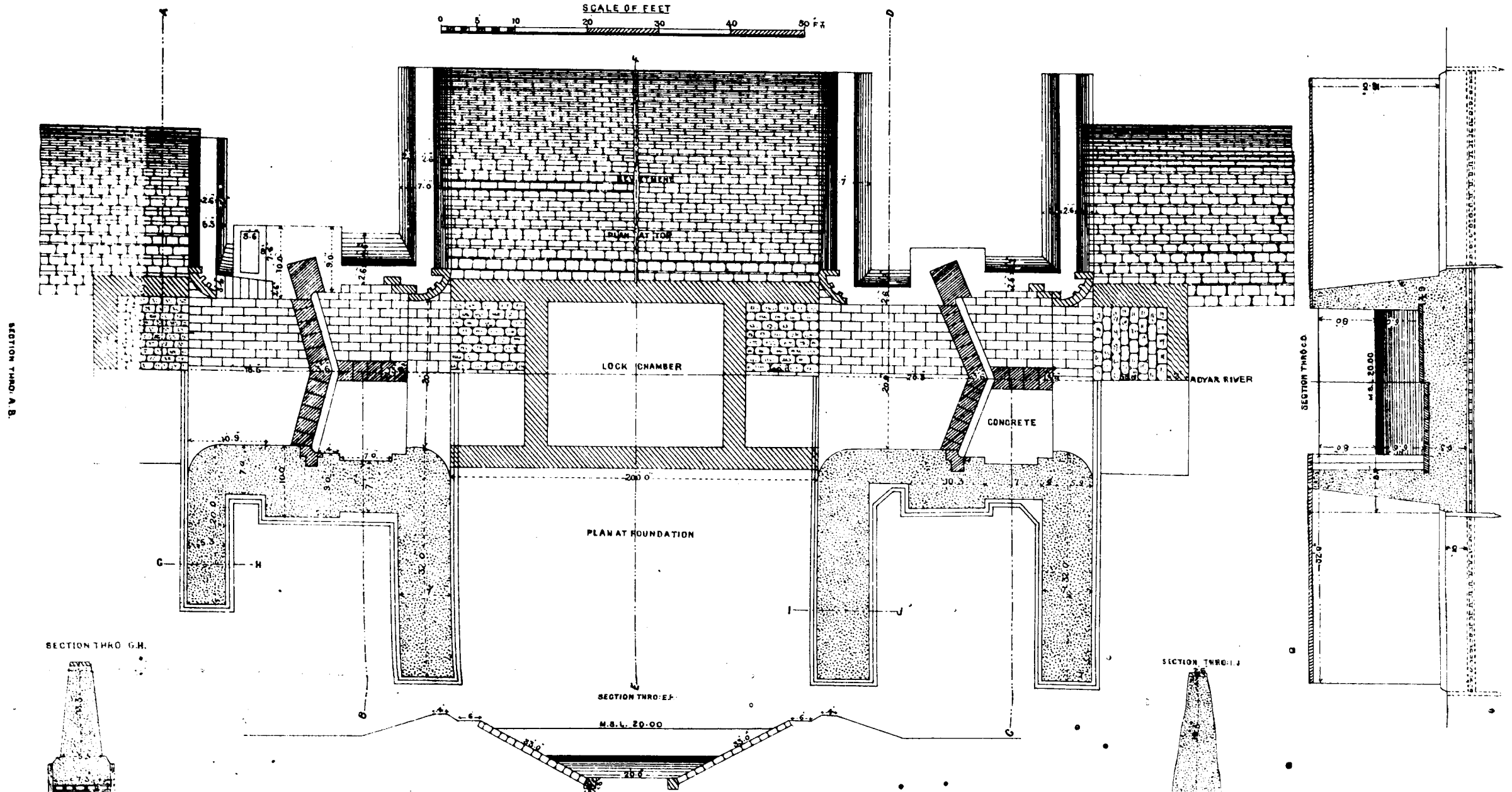


PHOTOZINCGRAPHED AT THE SURVEY OF INDIA OFFICES, CALCUTTA, OCTOBER 1986

BUCKINGHAM CANAL
PLAN
OF
SADRAS CANAL LOCK
BELOW THE ADYAR RIVER

PLAN N°4

SCALE OF FEET
0 10 20 30 40 50 FT

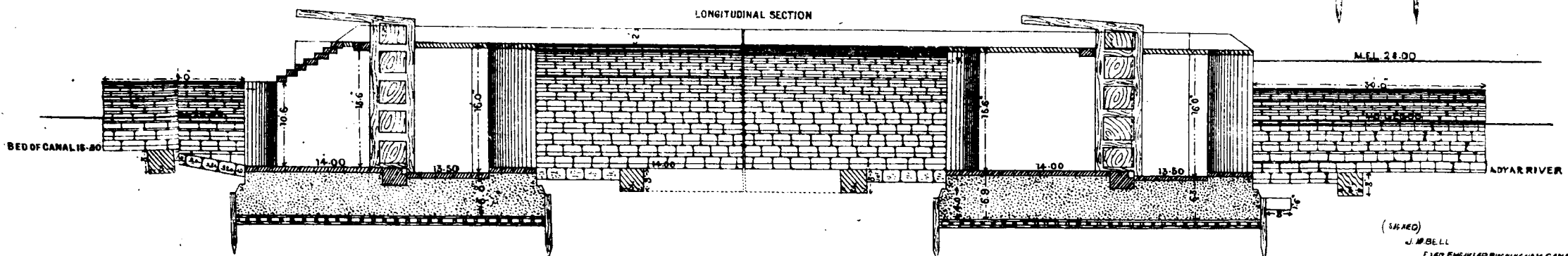


SECTION THRU G.H.

SECTION THRU E.F.

SECTION THRU J.I.

LONGITUDINAL SECTION



REFERENCE

DATUM - 20 FT. BELOW MEAN SEA LEVEL
SURFACE AND SUB SOIL - SAND
ESTIMATE AMOUNT OF RS 42,750
COST OF WORK RS 41,618
YEAR IN WHICH IT WAS COMPLETED 1885

- CONCRETE IN SURKI MORTAR
- CEMENT BLOCK
- CUT STONE WORK
- ROUGH STONE APRON
- WOOD WORK
- ROUGH STONE REVETMENT
- CUT STONE FLOOR

(IN AID)
J. M. BELL
FIELD ENGINEER BUCKINGHAM CANAL DIV.

(Sd) A. S. Russell.
ASSIST. CHIEF ENGINEER FOR IRRIGATION

PHOTOGRAPHED AT THE SURVEY OF INDIA OFFICE, CALCUTTA, OCTOBER 1885

BUCKINGHAM CANAL

DESIGN

FOR AN

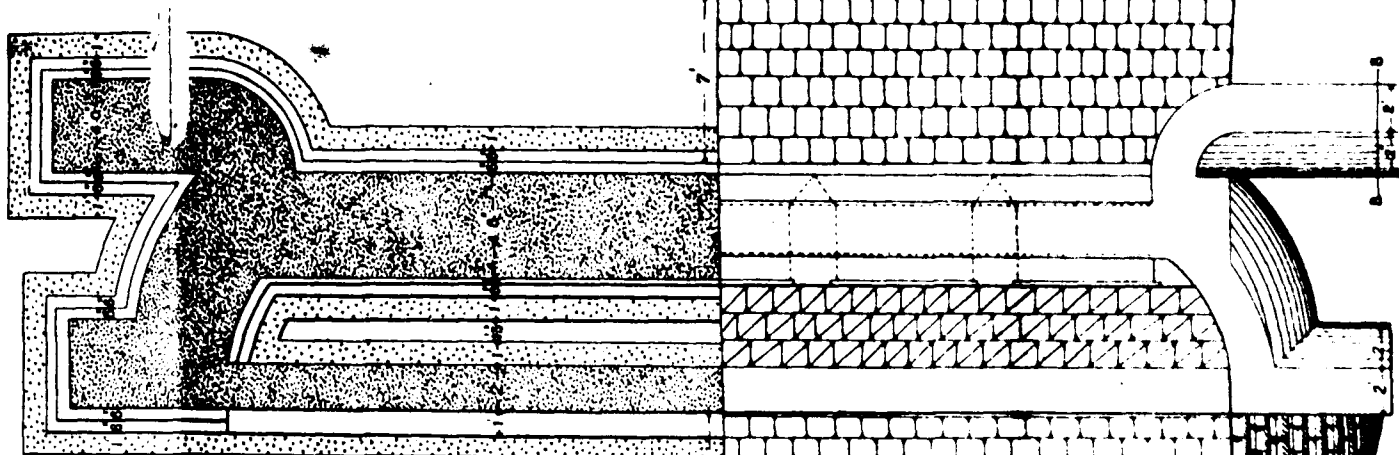
OUTLET SLUICE

PLAN No 5

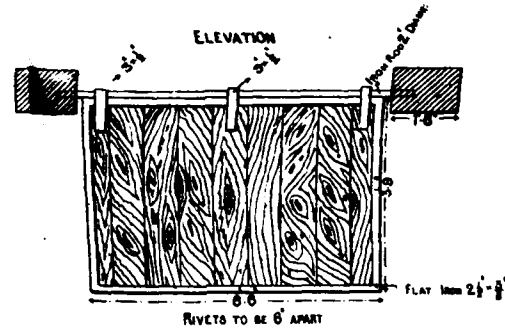
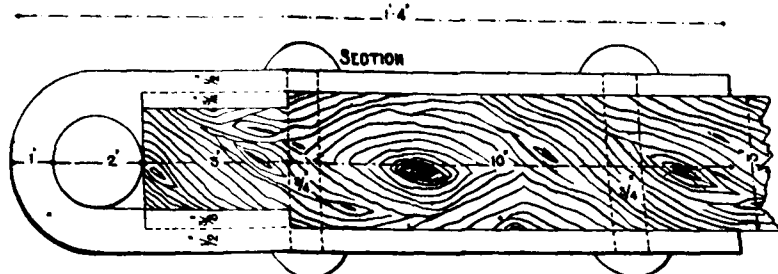
SCALE 1" = 20'

PLAN AT FOUNDATIONS

PLAN AT TOP
25.0'

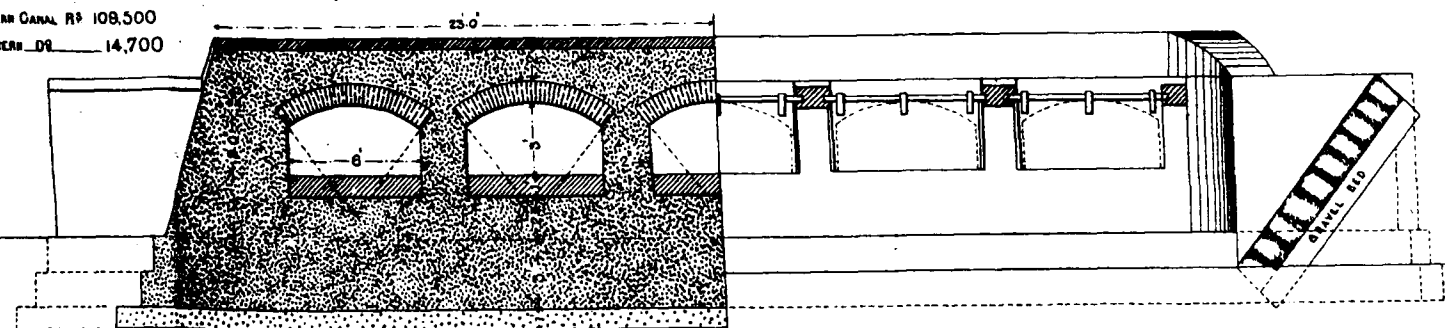


ENLARGED DRAWING OF SELF ACTING SHUTTER



HALF LONGITUDINAL SECTION

HALF REAR ELEVATION



REFERENCE

DATUM 20' BELOW MEAN SEA LEVEL
SURFACE AND SUB SOIL - SAND

CONCRETE IN MORTAR

DR IN SOONKI MORTAR

DR IN CHUNAM

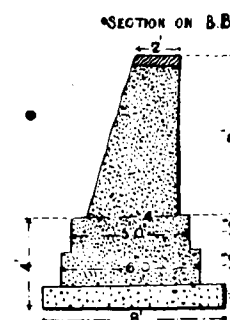
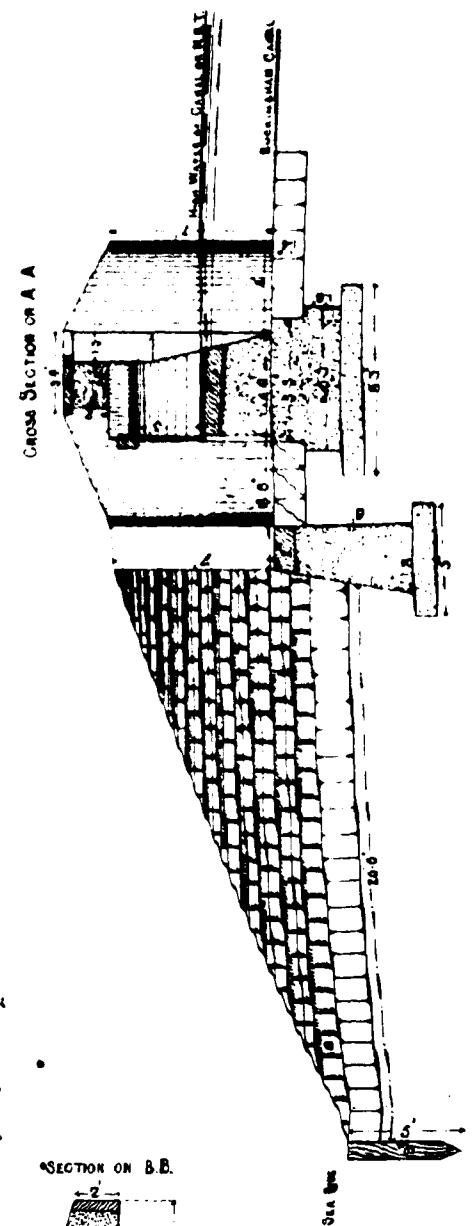
CUT-GRANITE IN SOONKI MORTAR

ROUGH-STONE REVETMENT

DR IN CHUNAM

DR APRON

AMOUNT OF ESTIMATE WILL VARY
D² D² FOR 35 OUTLETS NORTHERN CANAL R² 108,500
D² D² SOUTHERN D² 14,700



SIGNED J.N. BELL
EXEC ENGR BUCKINGHAM CANAL DYE

(S^d) A.S. Russell.

ASST CHIEF ENGR FOR IRRIGATION

PHOTOGRAPHED AT THE SURVEY OF INDIA OFFICE, CALCUTTA, SEPTEMBER 1950

BUCKINGHAM CANAL

DESIGN

FOR

FLOOD GATES

OF

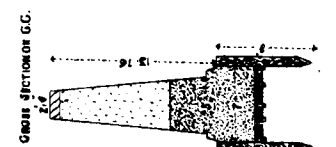
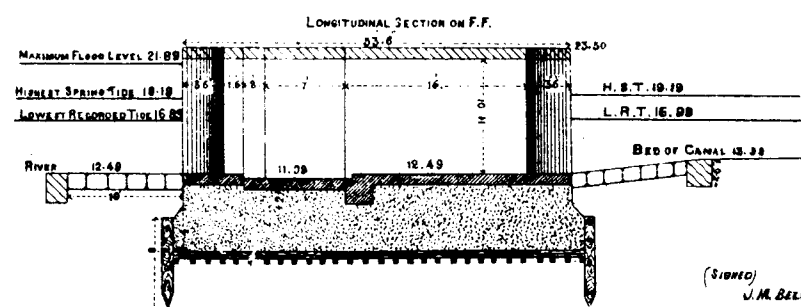
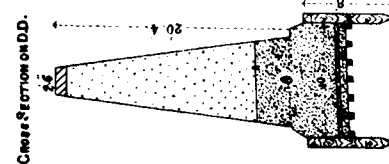
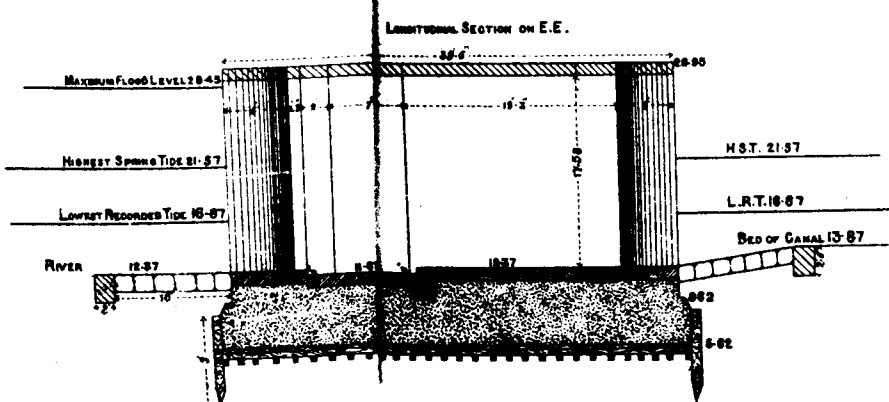
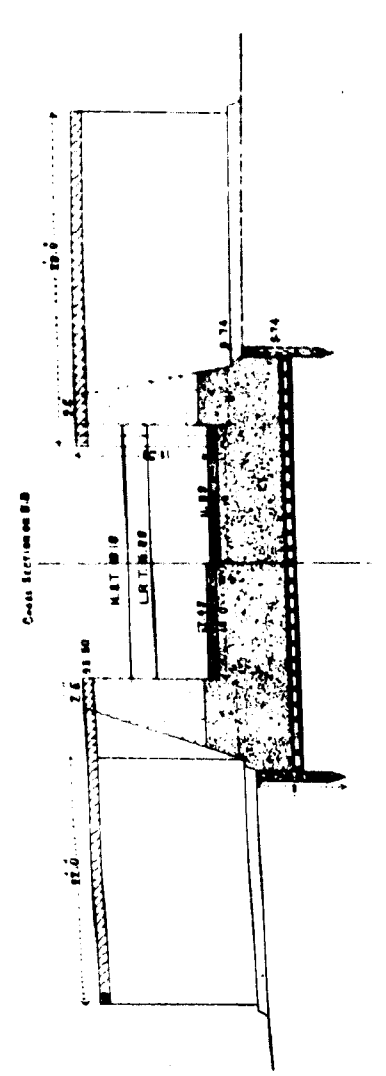
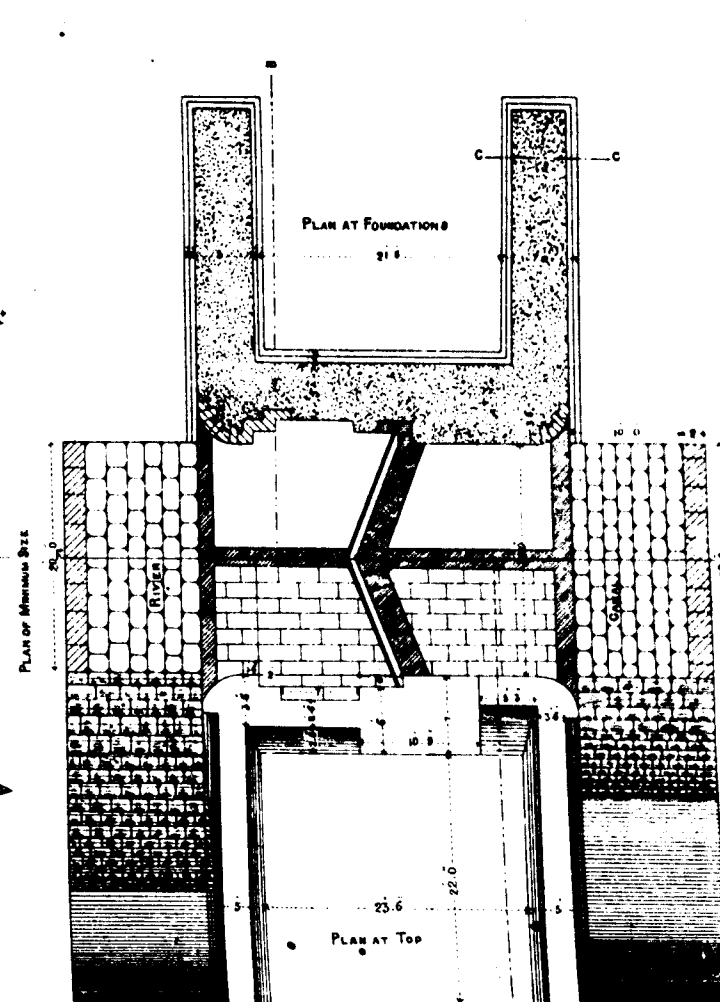
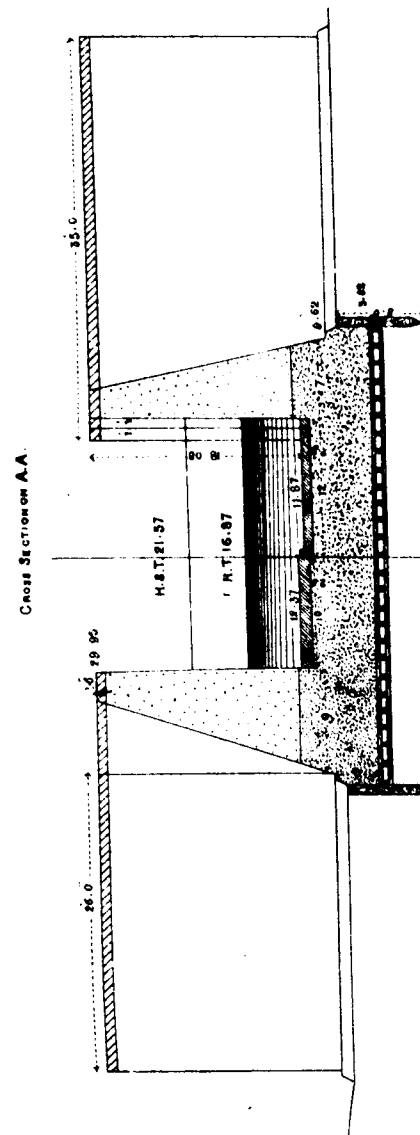
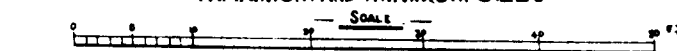
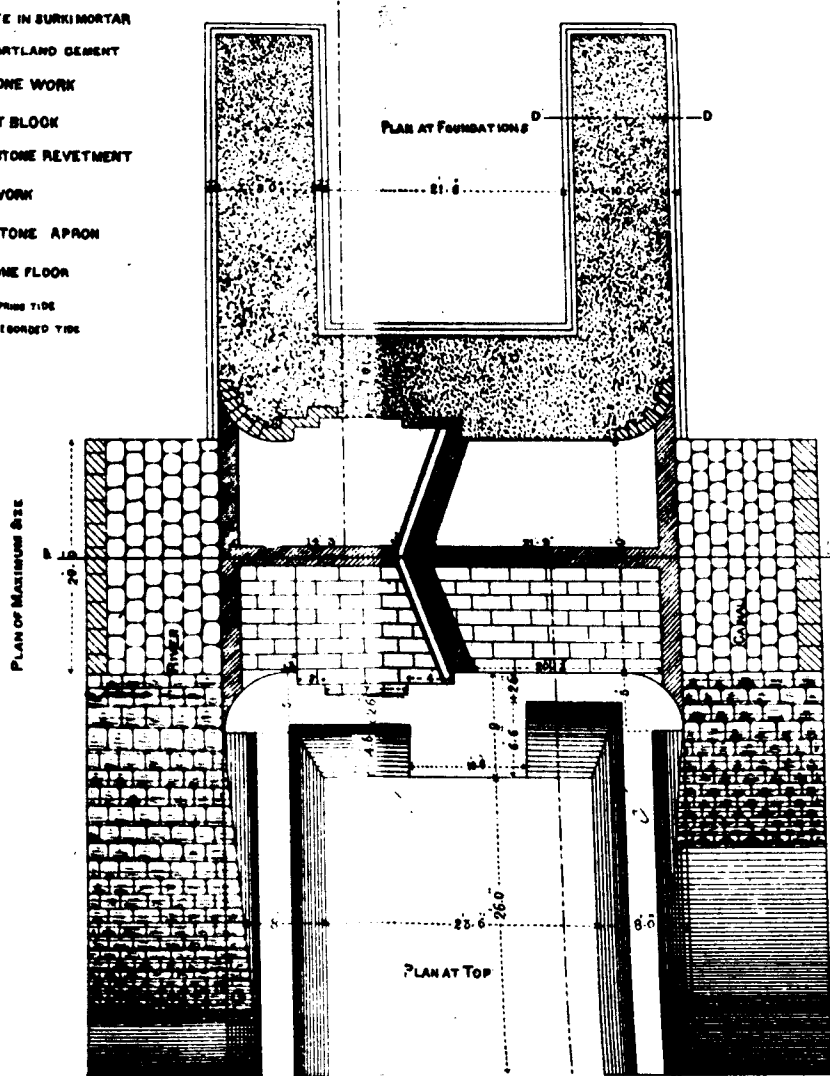
MAXIMUM AND MINIMUM SIZES

PLAN 116

REFERENCE

DATUM - 10' BELOW MEAN SEA LEVEL
SURFACE AND SUB SOIL SAND

- CONCRETE IN SURKIMORTAR
- DR IN PORTLAND CEMENT
- CUT STONE WORK
- CEMENT BLOCK
- ROUGH STONE REVETMENT
- WOOD WORK
- ROUGH STONE APRON
- CUT STONE FLOOR
- H.S.T. - HIGHEST SPRING TIDE
- L.R.T. - LOWEST RECORDED TIDE



(SIGNED)
J.M. BELL
ESQ. ENGINEER, BUCKINGHAM CANAL DIV.
(SE) A.B. Russell
ASST. CHIEF ENGINEER FOR IRRIGATION

PHOTODUPLICATIONS AT THE SURVEY OF INDIA OFFICE, CALCUTTA, OCTOBER 1945

Fee paid.
 License issued by _____ on the _____ day of _____ 1879.
 Executive Engineer.
 (a) Here enter steamer, budgerow, cargo-boat, passenger-boat, fishing-boat, or pleasure-boat as the case may be.

THE BUCKINGHAM CANAL, MADRAS.

FORM D.

APPLICATION FOR LICENSE.

I (or we) the undersigned (1) _____ residing at (2) _____
 in the _____ district of (3) _____ hereby apply for license to
 place (4) _____ on the (5) _____ section of the Buckingham Canal during
 the year 1879.

Date

Signature.

- (1) Here enter name or names of owners.
- (2) Place of residence.
- (3) Name of district in which residing.
- (4) Description of boat and purpose for which it is to be used, such as passenger-boat, cargo-boat, budgerow, &c.
- (5) Section of the canal for which a license is required, *i.e.*, the
 - A or Sadras Section.
 - B or Madras Section.
 - C or Pulicat Section.
 - D or Kistnapatam Section.
 - E or Ramapatam Section.
 - F or Kottapatam Section.

R. H. SANKEY, Colonel, R.E.,

Secretary to Government, P. W. Dept.

Note by the Chief Engineer, Public Works Department.

The history, constructive details, financial position, &c., of this work have been dealt with at such length in the accompanying Report that little more than a brief *résumé* of the points will suffice in submitting the project for the consideration of Government.

2. The work now known as the Buckingham Canal, extending along the coast 66 miles south and 195 miles north of Madras (where it unites with the Kistna and Godavari Canal Systems), had its commencement as early as 1801.

3. Mr. Heefke, with Mr. Basil Cochrane as security, obtained the first concession for excavating 11 miles of channel (which was then known as Lord Clive's Canal) between Madras and Ennore, but Mr. Cochrane, obtaining subsequently entire control, finished this portion in 1806, and afterwards extended the communication to Pulicat 25 miles. This gentleman remained sole proprietor of the work for 45 years, when his rights were bought out by Government. Throughout this period the work was generally known as "Cochrane's Canal," a term which, in spite of the lapse of time and two consequent changes of title, first, to "East Coast Canal," and then later on, to the Buckingham Canal, still adheres to the first portion.

To maintain a sufficient height of water in the canal, which otherwise, when the Ennore bar was open, would have reduced the height of water in the Cooum river at Madras, the Shadayankupam lock was built in 1854 at $7\frac{1}{2}$ miles north of Madras; and subsequently, the channel was extended as far as Dugarápatnam, 69 miles north. About the same time the canal was pushed south from Madras 40 miles to the Pálár river.

The ultimate objects in view at this period were to reach Kistnapatam backwater, 21 miles north of Dugarápatnam, thus affording a terminus for Nellore; and as regards the

southern branch of the canal, to make for Merkanam, and ultimately the French territory (Pondicherry).

That much wider views of the ultimate extension of the work obtained is clear from all the reports of the time, but want of funds and difficulties connected with the disposal of the cross drainage (every river along the coast passing the channel on its way to the sea) interfered with the actual progress of the work.

Captain Chambers, Mr. Kennedy, Mr. Fraser and other able officers designed extensions of the work north and south, and it was probably as much due to the fact that these designs were in readiness as to anything else that on the occurrence of the late severe famine the further prosecution of the work was resolved on.

Under the orders of His Grace the Duke of Buckingham large gangs of work-people from the famine-stricken districts of Bellary, Kurnool, and Cuddapah were marched down to the coast, and worked along the whole line, partly in improving the then existing channel, partly in excavating the new canal extending from Dugarápatnam to Pedda Ganjam, the junction of the Kistna System (a length of 126 miles in all), was put in hand to the north, and a further length from the Pálar river south. At one time it is reported that no less than 100,000 men, women, and children were so employed.

The whole line in its present length may thus be said to have reached a certain stage of completion with the termination of the famine.

The circumstances which have directly led to the necessity for the present large completion estimate may now be briefly noticed.

From the shallowness of the several backwaters along the coast, out of the connection of which no doubt arose the original conception of the canal, flat-bottomed boats, with only trifling draft, were at first used; owing to this the several connecting cuts or channels were given very little depth, say 12, or at most 15 inches.

In many places the backwaters were necessarily much deeper than this, and so also the canals in places, but these were at least the ruling depths.

This view of the requirements and capacity of the work is clearly shown by the trifling outlay which, down to 1856, had taken place in its construction, which did not exceed R1,400 per mile.

Some of the highest engineering authorities of the time considered that for the development of an inland coast trade it would not only suffice thus, as it were, to "scratch" out a shallow channel, but that it would be quite a mistake to attempt anything more.

This view in itself was by no means illogical, as, in addition to providing for the small class of boats there in use, it certainly met in a way the difficulties arising out of silt-bearing floods which, in crossing the line of canal all along the coast, would always tend to fill up the channel.

To re-excavate, even along a considerable length, a channel to only 12 or 15 inches might be periodically faced, and few or no works of flood protection would be essential.

This view, like all others, dependent on arguments derived from small beginnings, had of necessity to yield as traffic increased, and a larger class of boats began to be built and used on the canal.

It thus came to be recognized that if the work was to meet in any adequate way the strain thrown upon it, a depth of not less than 3 feet everywhere at low water must be secured; and although, as will be observed from an examination of the present Report, this has led to greatly enhanced outlay, the conclusions on which it is based appear to be irresistible.

Whereas merely clearing a shallow trough through backwaters might have well suited the requirements of the small flat-bottomed skiffs at first used, it has year by year become more clear that if a canal with sole 3 feet below low water were to be maintained, the first necessity would be to exclude the land floods which usually accompany cyclones on the coast, and which in many places have been shown to rise to no less than 10 or 11 feet above mean sea level.

Such floods, owing to the flatness of the littoral tract, take some time to vent themselves, and after two or three days they have, in many places, been shown not only to bring in silt sufficient to fill up the canal, but even to raise the bed above mean sea level. The enormous recurring outlay required by the re-excavation of the silt thus poured into the unprotected channel has proved that it would in the end be far cheaper to isolate and protect from flood invasion all the several reaches of the canal between the different drainages as they cross the line.

The necessity of constructing high isolating side embankments, flood gates, and the training of the several rivers near the coast have, thus one and all, followed as a matter of necessity.

The trifling outlay which, as before shown, was found to suffice with shallow boats and a

small trade has thus gradually progressed from a capital outlay of R1,400 per mile in 1856 to nearly—

R	3,500	per mile at end of 1875-76,
"	8,500	" " of 1877-78,
"	12,000	" " of 1881-82.

[This omits the excess over normal rates due to famine, which amounted in the aggregate to R7,31,075.]

As shown by the completion estimates herewith sent up, amounting with all past outlay to R63,87,100, the ultimate cost for a fully completed first-class canal, 261 miles in length, will be a little under R24,500 per mile.

The returns show that all classes of boats employed on the canal have increased in a very marked manner, notwithstanding what is now admitted to have been a vexatious and deterrent method of levying license fees and tolls.

In 1879 there were in all 723 boats with a gross burden of 6,287 tons. By 1882 these had increased to 1,055 boats aggregating 10,551 tons.

In 1875 the receipts from tolls, &c., were R51,113, and the total collections had increased to—

R	1,09,808	in 1880,
"	1,16,527	in 1881,
"	1,00,037	in 1882.

The falling off in the last year was due to certain changes in regard to the tolls not necessary to particularize.

As further illustrating the vitality of the trade which in the present imperfect condition of the work exists, it may be mentioned that no less than 241,207 tons passed through the locks north and south of Madras during 1881.

It is now fully recognized that the system on which the tolls have been levied acts as a direct impediment to trade, and on the report of a Committee which has lately taken the whole subject into consideration, Government has decided on modifications which, though reducing the actual receipts for the present, will, it is certain, have a very beneficial effect in stimulating traffic.

Sufficient, it is hoped, has been adduced to show the growing commercial value of a work which, while being admirably adapted to all the physical conditions of the coast, suits in every way the native habits as a mode of conveyance for passengers and goods, opens a field of new and diverse employment to the inhabitants of the littoral tract, and affords a high way of limitless capacity at a cost of certainly not over one quarter of that of a railway.

Among other benefits indirectly touched on in the Report is the value which may yet attach to the large tracts of land which hitherto from having been open to invasion of tidal water will eventually be reclaimed by the works, and may, like others of a similar character, be turned to the best account as casuarina plantations, the success of which as an industry is now so well established along the older portions of the canal.

As a means of bringing the coal from the Singareni field in Hyderabad at a price which will admit of successful competition with patent fuel and English coal at Madras, the Railway authorities have lately expressed themselves to be very sanguine.

But the main advantage and importance of the work is its probable use during the prevalence of famine. As linking the great delta systems of the Godáviri and Kistna with Madras and the country to the south, and thus affording a means, whether the sea-board be closed or not, of depositing grain at any point along the whole line ready for transport into the interior, its value must be held to be incalculable. It is on these grounds that the claims of this work to be classed as "Protective" have been urged on the attention of the Government of India, and, it is hoped, that this view may be fully maintained and recognized.

As shown in Appendix B to the Report, the actual capital amount expended on the work from its commencement down to 31st March 1882 has been R80,87,185.

As the outlay in the current year will be nearly R1,36,000, the capital outlay for the completion of the work during 1883-84 and subsequent years will amount to R31,63,915.

From experience of past working, it is thought that, with temporary increase to the present permanent staff, the expenditure in subsequent years might fairly be raised to three lakhs per annum on original works over and above the amounts needed for repairs and maintenance.

The annual outlay under the latter head, which has for the period, April 1879 to March 1883, on an average amounted to R99,000, will necessarily, as the works now estimated for advance towards completion, diminish sensibly till, as anticipated by the present Executive Engineer, the whole maintenance of the 261 miles of canal will not exceed R40,000 per



annum (exclusive of establishment), a charge which will be fully covered by the revenue derived from tolls and license fees.

To provide, then, the requisite ways and means for completion of the work, yearly contributions of one lakh from Provincial (which also bears the full maintenance charges) and two lakhs from Imperial under Protective would, it is thought, best meet the requirements of the case, and would, under all the circumstances of the case, appear to provide in a fair and equitable manner for the incidence of the charges.

(Signed) R. H. SANKEY, COLL., R.E.,
Chief Engineer, Public Works Department.

8th March 1883.

From MAJOR J. PENNYCUICK, R.E., Under Secretary to the Government of Madras, Public Works Department, to the Secretary to the Government of India, Public Works Department,—No. 812 W, dated 14th March 1883.

I am desired to submit, for the information and sanction of His Excellency the Governor General in Council, the plans and estimates, as per accompanying list, for the completion of the Buckingham Canal.

2. Full and complete information regarding the details of this important work having been afforded in the report on the estimate and the appended Note by the Chief Engineer, it will suffice here to remark that although commenced very early in the present century, the work languished from lack of means for its prosecution till the late famine, when it was vigorously prosecuted for relief purposes.

3. Though then left in a very incomplete state, the value of the canal as a communication connecting Madras with the Godavari and Kistna Delta Systems to the north, and with Merkanam to the south, has now been fully established, and its importance as a Protective Work during famine placed beyond doubt.

4. The work was classed under this latter head in G. O., 9th July 1881, No. 1697 W, Appendix D, and subsequently in the communications as per margin.
1. Letter to Government of India, No. 1697 W, dated 9th July 1881.
 2. Letter from Government of India, No. 681 G, dated 5th May 1881, para. 7.
 3. Letter from Government of India, No. 1250 G, dated 23rd September 1881, para. 9.
 4. Docket to Government of India, No. 2022 W, dated 23rd November 1881.
 5. Letter from Government of India, No. 473A—G, dated 22nd December 1881.
 6. Letter to Government of India, No. 88W, dated 11th January 1882.
 7. Letter to Government of India, No. 348 W, dated 7th February 1882.
 - Telegram from Government of India, dated Calcutta, 13th February 1882.
 8. Letter from Government of India, No. 33A—I, dated 14th February 1882.
 9. Docket to Government of India, No. 1307 W, dated 25th May 1882.
 10. Letter from Government of India, No. 107A—I, dated 14th July 1882.

7. It is, of course, to be understood that Provincial has to meet not only all repair and maintenance charges without assistance for the work, but has also to pay for the needful establishment, the special grants for which heretofore made from Protective ceasing in future if the above arrangement be acceded to.

Telegram from Works, Simla, to Works, Madras,—dated 19th July 1883.

Buckingham Canal estimate. Tables I and II, vide Circular VI of 18th March 1882, urgently required, please submit. Leave and pension allowances to be calculated at 12 per cent. on gross establishment charge.

From the Government of India, P. W. Dept., to Secretary to the Government of Madras, P. W. Dept.,—No. 267I., dated 24th July 1883.

I am directed to acknowledge the receipt of your letter No. 842 W., dated 14th March 1883, submitting plans and estimates for the Buckingham Canal, and soliciting an Imperial grant-in-aid from Famine Insurance Funds to the extent of Rs2,00,000 per annum during 1883-84 and the nine subsequent years. Your succeeding reminder No. 480 L., dated 16th June 1883, has also been received.

2. In reply, I am to state that His Excellency the Governor General in Council is pleased to assign Rs1,33,000 from "F—Famine Relief and Insurance, 34—Protective Works, Irrigation" for expenditure on original works connected with the canal during the current year, and to enquire whether the Government of Madras can engage to spend yearly Rs1,50,000 on it from Provincial funds. In that case the Government of India will be prepared to give grants-in-aid from the Famine Relief and Insurance grant as funds may be available. Such grants to be spent solely on original works and to equal, if possible, the amount expended from Provincial funds. All charges for Establishment and Tools and Plant must be met from Provincial funds.

3. The original plans received with your letter under reply are herewith returned.

Proceedings of the Government of Madras, Public Works Department, No. 626I, dated 9th August 1883.

Note by COLONEL J. O. HASTED, R. E., Acting Chief Engineer for Irrigation, Madras,—dated 30th July 1883.

The accompanying tables Nos. I and II showing the summary of the direct and indirect charges to Capital Account of the Buckingham Canal, prepared in this Office, are submitted to Government with reference to the telegram, dated 19th instant, received from the Government of India.

2. The completion estimates of the canal submitted with R. M. G. No. 841 W., dated 14th March 1883, did not include Rs5,04,091, the old outlay prior to 1862-63, as the final Capital Account has but recently been prepared by the Examiner of Public Works Accounts. The total estimate for works has therefore been increased from Rs63,20,752 to Rs68,24,843.

3. The works will, it is expected, be completed by the end of 1893-94, assuming that the annual expenditure on works from 1884-85 to 1892-93 will be Rs3,00,000.

4. No provision was made in the completion estimates for Establishment charges, and the amount provided for Tools and Plant charges did not include the whole of the past charges.

5. The Establishment charges have now been estimated at Rs16,29,395, as shown below:—

Actual charges booked to the end of 1882-83	R 9,56,094
Establishment charge at 23 per cent on Rs29,27,397, the unspent balance of the estimate for works on 1st April 1883, exclusive of land compensation	6,73,301
	<u>16,29,395</u>

6. The estimate of Tools and Plant charges amounts to Rs1,57,762, as shown below:—

(1).—Actual charges booked to the end of 1882-83	R 94,330
(2).—Tools and Plant charges at 1½ per cent. on Rs29,27,397, the unspent balance of estimate for works	43,911
(3).—Special Tools and Plant	19,471
TOTAL	<u>1,57,762</u>

Rupees 3,054 of item (1) and the whole of items (2) and (3) appertain to the works now in progress. The total of these items exceeds the amount provided in the completion estimates for tools and plant by Rs88, which has been added in order to make the total estimate of direct charges a round sum, viz., Rs6,12,000.

7. As the abatement of land revenue lost has not yet been fully ascertained, its capitalization has been estimated in this Office at 25 times the annual assessment, which is assumed at 1/10 of the amount of land compensation. The total amount paid for land to the end of March 1882, so far as can be ascertained from the records available, is Rs3,03,201, of which Rs2,93,229

is included in the old outlay, leaving R9,972 as a charge against the current estimate of R65,367 for B land. The total estimate for B land is R3,58,596, and the capitalization of land revenue abated is R1,48,245.*

$$\frac{3,58,596}{20} \times 25.$$

8. As R12,000 have been provided this year for payment in England on account of pumps and machinery required for unwatering foundations of masonry works, the loss by exchange has been estimated at R2,000, taking 1s. 8d. per rupee as the rate of exchange

9. The estimate of charges for leave and pension allowances amounts to R2,16,243, as shown below :—

	R
Charges booked to end of 1882-83	1,35,447
12 per cent. on the estimate of Establishment charges from 1883 to 1884 to 1893 to 1894, in accordance with the telegram from the Government of India, dated 20th July 1883	80,796
TOTAL	2,16,243

† *Vide* Government of India Resolution No. 385 A.—G., dated 1st December 1883.

These charges were hitherto calculated at 14½ per cent. on Establishment charges or ½ of salaries, assuming that salaries amount to 85 per cent. of the Establishment charges.

Read the following :—

Telegram from the Government of India, dated 19th July 1883.

Note by the Acting Chief Engineer for Irrigation, dated 30th July 1883.

Order thereon by the Government of Madras.

The Tables I and II showing the summary of direct and indirect charges to Capital Account of the Buckingham Canal, as prepared by the Acting Chief Engineer for Irrigation, are approved, and will be submitted in manuscript to the Government of India with a copy of these Proceedings in reply to their telegram dated 19th July 1883.

Endorsed by the Government of Madras, P. W. Dept.,—No. 626 I., dated 9th August 1883.

Forwarded accordingly.

BUCKINGHAM CANAL.

No. I.

Summary of the estimated direct charges to Capital Account.

Year.	Works.	Establishment.	Tools and Plant.	Total.	Remarks.
1	2	3	4	5	6
	R	R	R	R	
Outlay to end of 1882-83	38,42,061	9,56,094	94,380	48,92,535	
Grant for 1883-84	1,57,832	36,301	14,367	2,08,500	
Estimate for 1884-85	3,00,000	67,620	6,410	3,74,030	
" 1885-86	3,00,000	67,620	6,410	3,74,030	
" 1886-87	3,00,000	67,620	6,410	3,74,030	
" 1887-88	3,00,000	67,620	6,410	3,74,030	
" 1888-89	3,00,000	67,620	6,410	3,74,030	
" 1889-90	3,00,000	67,620	6,410	3,74,030	
" 1890-91	3,00,000	67,620	6,410	3,74,030	
" 1891-92	3,00,000	67,620	6,410	3,74,030	
" 1892-93	3,00,000	67,620	6,410	3,74,030	
" 1893-94	1,24,960	28,420	1,864	1,55,244	
TOTAL	68,24,843	16,29,395	1,57,763	86,12,000	

N.B.—1. The amounts in column 2 include land compensation R6,000 a year from 1884-85 to 1893-94 and R1,396 for 1893-94.
2. The amounts in column 4 include special tools and plant.
R12,000 for 1883-84, R2,000 each year from 1884-85 to 1896-87, and R1,471 for 1887-88.

No. II.

Summary of the estimated indirect charges to Capital Account (excluding interest).

Year.	Capitalisation of land revenue abated.	Loss by exchange on payments in England.	Charges for leave and pension allowances.	TOTAL.
1	2	3	4	5
	R	R	R	R
Charges to end of 1882-83	3,79,001	...	1,35,447	5,14,448
" during 1883-84	7,500	2,000	4,356	6,356
" " 1884-85	7,500	...	8,114	15,614
" " 1885-86	7,500	...	8,115	15,615
" " 1886-87	7,500	...	8,114	15,614
" " 1887-88	7,500	...	8,115	15,615
" " 1888-89	7,500	...	8,114	15,614
" " 1889-90	7,500	...	8,115	15,615
" " 1890-91	7,500	...	8,114	15,614
" " 1891-92	7,500	...	8,115	15,615
" " 1892-93	7,500	...	8,114	15,614
" " 1893-94	1,744	...	3,410	5,154
TOTAL	4,48,245	2,000	2,16,243	6,66,488

J. O. HASTED, Colonel, R.E.,
Acting Chief Engineer for Irrigation.

From A. S. RUSSELL, Esq., Under-Secretary to the Government of Madras, P. W. Dept., Irrigation Branch, to Secretary to the Government of India, P. W. Dept.,—No. 650 I., dated 16th August 1883.

In acknowledging the receipt of your letter No. 267 I., dated 24th July 1883, I am directed to express the satisfaction of this Government that their representation for a grant-in-aid from F—Famine Relief and Insurance Funds for the Buckingham Canal has been duly recognized by the Government of India, and to inform you that Provincial funds can be provided to meet the expenditure on the canal to the extent of R1,50,000 yearly.

From the Government of India, to Her Majesty's Secretary of State for India,—No. 50 P. W., dated 25th September 1883.

We have the honor to forward, for your Lordship's approval and sanction, estimates received from the Government of Madras, of the probable cost of completing the Buckingham Canal, amounting after modifications to R92,91,954, of which R86,12,000 represent the direct and R6,79,954 the indirect charges.

2. These estimates provide for the completion of the Buckingham Canal between the tail of the Commamur Canal of the Kistna Delta system, and a point 66 miles south of Madras, from which it is hoped that, at some future date, it will be extended for 23½ miles to Pondicherry. The canal is intended solely for navigation.

3. Of the total estimate for works, amounting to R68,24,843, R38,42,051 have been expended up to the close of 1882-83, leaving only R29,82,792 for future expenditure.

4. Even in its present unfinished condition the canal is popular with the natives, the number of boats plying on it having increased from 723 to 1,055, or 44·5 per cent., and their gross tonnage from 6,287 to 10,551 tons, or 67·8 per cent., in the three years from 1879 to 1882. During 1881, 241,207 tons of goods passed through the locks, north and south of Madras, and during the six years 1875 to 1881, the receipts from tolls increased from R51,113 to R1,16,527.

5. When the coal-fields in Hyderabad are opened up, the completion of the canal will afford 307 miles of cheap water communication, out of 387 miles which intervene between the town of Madras and the nearest coal-field.

6. The completion of the canal will also place the town of Madras in direct water communication with every part of the fertile and well irrigated deltas of the Kistna and Godavari rivers. The canal will thus prove a very useful line of communication in time of famine.

7. The project is not likely to prove directly very remunerative. It will probably do a little more than pay its working expenses. But considering the administrative advantages which will undoubtedly arise from the completion of the canal, we have no hesitation in recommending it to Her Majesty's Government for sanction as a Provincial Ordinary Irrigation

and Navigation Work under H—Expenditure on Public Works not classed as Productive. The Government of India intends to give grants-in aid towards the completion of the work from the Famine Protective grant when funds are available: such grants to be, if possible, equal to the amount expended from Provincial funds.

8. For further details in connection with the scheme, we beg to refer your Lordship to the Proceedings of the Madras Government which accompany this Despatch.

Documents accompanying.

- 1.—Letter from the Government of Madras, No. 842W., dated 14th March 1883, and enclosures.
- 2.—Summary of the estimated direct and indirect charges to Capital Account (Statements Nos. I and II).

BUCKINGHAM CANAL.

No. I.

Summary of the estimated direct charges to Capital Account.

Year.	Works.	Establishment.	Tools and Plant.	Total.	Remarks.
1	2	3	4	5	6
	R	R	R	R	
Outlay to end of 1882-83	38,42,051	9,56,094	94,380	48,92,525	<i>N.B.—1. The amounts in column 2 include land compensation Rs. (Rs.) a year from 1884-85 to 1892-93 and Rs. 1,395 for 1893-94.</i> <i>2. The amounts in column 4 include special Rs. 12,000 for 1883-84, Rs. 2,000 each year from 1884-85 to 1896-87 and Rs. 1,471 for 1887-88.</i>
Grant for 1883-84	1,57,832	36,301	14,367	2,08,500	
Estimate for 1884-85	3,00,000	67,620	6,410	3,74,030	
" 1885-86	3,00,000	67,620	6,410	3,74,030	
" 1886-87	3,00,000	67,620	6,410	3,74,030	
" 1887-88	3,00,000	67,620	6,410	3,74,030	
" 1888-89	3,00,000	67,620	5,881	3,73,501	
" 1889-90	3,00,000	67,620	4,410	3,72,030	
" 1890-91	3,00,000	67,620	4,410	3,72,030	
" 1891-92	3,00,000	67,620	4,410	3,72,030	
" 1892-93	3,00,000	67,620	4,410	3,72,030	
" 1893-94	1,24,960	28,420	1,654	1,55,234	
TOTAL	68,24,843	16,29,395	1,57,792	86,12,000	

No. II.

Summary of the estimated indirect charges to Capital Account.

Year.	Capitalisation of land revenue abated.	Loss by exchange on payments in England.	Charges for leave and pension allowances.	Total.
1	2	3	4	5
	R	R	R	R
Charges to end of 1882-83	3,79,001	...	1,35,447	5,14,448
" during 1883-84	7,500	...	5,062	7,062
" " 1884-85	7,500	2,000	9,467	16,967
" " 1885-86	7,500	...	9,467	16,967
" " 1886-87	7,500	...	9,467	16,967
" " 1887-88	7,500	...	9,467	16,967
" " 1888-89	7,500	...	9,467	16,967
" " 1889-90	7,500	...	9,467	16,967
" " 1890-91	7,500	...	9,467	16,967
" " 1891-92	7,500	...	9,467	16,967
" " 1892-93	7,500	...	9,467	16,967
" " 1893-94	7,500	...	9,467	16,967
TOTAL	4,49,245	2,000	2,29,709	6,79,954

*From Her Majesty's Secretary of State for India, to the Government of India,—
No. 72 P. W., dated 6th December 1883.*

Your Public Works letter No. 50 of 25th September last, forwarding estimates for the completion of the Buckingham Canal, has received my consideration in Council.

2. The outlay, direct and indirect, now proposed for completing the work will bring the total expenditure up to Rs. 92,91,954, of which the sum of Rs. 54,06,973 had been already expended up to the end of 1882-83, leaving Rs. 38,84,981 for future expenditure, of which Rs. 37,19,475 would consist of direct and Rs. 1,65,506 of indirect charges.

3. The development of the Buckingham Canal from its first conception, when it was simply a series of shallow channels connecting the various backwaters and drainage streams along the coast of Madras, to the present scheme for its completion as a first-rate canal with regulating works and protective embankments, is clearly described in the reports of Colonel Sankey and Major Drake-Brockman, the Executive Engineer in charge.

4. The mileage cost, which only amounted to Rs. 1,400 in 1866, and was sufficient for the accommodation of shallow boats which carried a small traffic, gradually increased with the increase of requirements to Rs. 3,500 in 1875-76, to Rs. 8,500 in 1877-78, and to Rs. 12,000 in 1881-82, and the estimates now submitted would swell the direct mileage outlay to Rs. 32,996.

5. You are of opinion that the advantages of the work, as affording communication in times of famine between Madras and the rich deltas of the Kistna and Godáveri, as well as a means of conveying to Madras the products of the coal-fields in Hyderabad when opened up, together with the increase of traffic and the popularity of the canal with the natives, afford sufficient grounds to justify the additional outlay of capital now proposed, in order to make it complete and more suitable for its enlarged operations. You do not, however, consider that the work will be productive to the extent that would justify its being classed as Productive, and you are even doubtful whether, for some time to come, it will do more than cover the working expenses.

6. It is stated in the letter from the Government of Madras, dated the 14th March, that not more than three lakhs can be satisfactorily expended annually, and it is proposed that this should be provided in the proportion of two-thirds from the Famine Insurance Fund and one-third from Provincial funds. Your Government are of opinion, however, that the grants-in-aid from the Famine funds should, when available, be equal in amount to that expended from Provincial funds.

7. The expenditure would thus be spread over a period of ten years from the present time, and I am disposed to agree with your Excellency that, if applied in such a manner as to produce commensurate results, the revised estimate for the improvement and completion of the undertaking may be accepted, and I accordingly sanction it.

