

Read the following papers :—

No. 246. From Lieutenant D. McNEIL CAMPBELL, R.E., Executive Engineer in charge Godavery District, to Lieutenant-Colonel J. MULLINS, R.E., Chief Engineer for Irrigation, dated Dowlaishweram, 21st August 1876, No. 1,423.

With reference to your No. 14 GD, dated 17th March 1876, I have the honor to forward a report from the Executive Engineer in charge 1st Division on the project for a Junction Canal from Covoora to Munja together with the plans and estimates as per margin.

11 Plans.
1 Specification.
1 Calculations of Bridge.
1 Comparative Statement.
1 Abstract Estimate.
1 Statement A.
1 Do. B.
1 Report No. 259, dated 18th Aug. 1876.

2. As the report is written, and the plans and estimates revised by myself, it is needless for me to make any remarks on them, except to say that if it is thought that the information regarding drainage basins, &c., is not sufficiently accurate, I may be allowed to apply for a survey establishment, and also that should further revision be considered necessary, it may first be ascertained what sum can be given towards the project from Salt and Local Funds; for, I think, it is shown that the cost of the canal is not fairly debitable to irrigation.

From Lieutenant D. McNEIL CAMPBELL, R.E., Executive Engineer in charge Eastern Delta Division, Godavery District, to the District Engineer, Godavery, dated Dowlaishweram, 18th August 1876, No. 259.

With reference to your memorandum, No. 58, dated 10th April 1876, I have the honor to submit plans and estimates as per margin, together with the following report.

- 11 Plans.
8 Detailed Estimates.
1 Specification.
1 Calculations of Bridge.
1 Comparative Statement.
1 Abstract Estimate.
1 Statement A.
1 Do. B.

2. PARAGRAPH 1, LINE OF CHANNEL ORIGINALLY PROPOSED.—In the original project submitted with Colonel Fischer's letter, No. 3,708, dated 13th March 1874, it was proposed

to take the channel off from the Cocanada canal in the 28th mile, and from thence it was to run in the line of an existing irrigation channel for a distance of 5 miles (passing under the Karapah road at 2 $\frac{1}{2}$ mile), at this point it was taken under the Cotipilly road, and a short distance further on it was to pass over the Thooliabaga drain and from thence run in a nearly straight line to the Coringa canal just above the Munja lock.

3. PARAGRAPH 2, LINE OF CHANNEL AS NOW ESTIMATED FOR.—Though nothing is said on the subject in Colonel Mullins' memorandum, No. 14 GD, dated 17th March 1876, returning the plans and estimates for revision, I have deemed it advisable to make an alteration in the first 5 miles. I inspected the line carefully and came to the conclusion that it was a mistake to make the channel run in the line of the existing irrigation channel; for, if that were done, a new irrigation side channel must be dug outside, and it will be seen from the sections that the estimate is in no way reduced by using the old line of channel as the cutting, even taking the ground level is not sufficient for the banks, the area of existing wet cultivation on the right side of the irrigation channel is 497.82 acres which is very well supplied, and as that acreage is not likely to be increased, I see no object in digging a new channel and having to pay compensation for the land taken up. On the left side the wet cultivation is 481 acres, and this can be supplied by a sluice to be built in the 2nd mile and no new channel will be required. It will be observed that, if the line chosen by Colonel Fischer were adopted, two bridges would be required, one to carry the

Karapah road, the other to carry the Cotipilly road at the 5th mile, but the former bridge was omitted in the original estimate. I propose therefore to take the channel outside the left bank of the irrigation channel, carry it over the Bhavaram drain by an aqueduct under the Karapah road by a bridge along the east side of the Cotipilly road to a short distance beyond the village of Gorripoody, where it will join and continue along the line originally proposed. It will be observed by this that the bridge on the Cotipilly road allowed in the original project will not be required. It will also be noticed from the plan that, as all the land it is proposed to irrigate is to the east of the Cotipilly road, if the channel were carried along the west side of that road, tunnels would be required to supply the branches.

4. PARAGRAPH 3, SOIL.—The soil throughout the whole of the line is bad and ill adapted for banking; I have therefore allowed slopes of 2 to 1 from the head to 5½ mile, and 2½ to 1 from thence to Munjair; in this latter portion most of the soil is that friable brown earth called in Telugu Rova, and the rest is loose sand.

5. PARAGRAPH 4, WIDTH OF CHANNEL.—As the side slopes have been increased I have made the bottom width vary from 27 to 25 feet, so as to get a mean width of 39 feet as laid down by Colonel Mullins; but, as the channel is nearly all embanked, and as it is to be a still water one, it can be made any width without increasing the cost except for compensation.

6. PARAGRAPH 5, WIDTH AND HEIGHT OF BANKS.—I have estimated for banks 3 feet above F.S.L. and 7 feet wide at top; in the original estimate they were 9 feet wide at top, for the purpose I suppose of enabling bandies to use them as roads; but the traffic in this direction will be so trifling that I do not see the object of incurring the expense, but at the same time I must remark that I do not think there is any advantage in making them 7 feet wide; this is too narrow for bandies and wider than necessary for towing or riding, and, in my opinion, 5 feet top width would be sufficient, especially as the slopes have been increased and the saving by reducing the width by 2 feet would be considerable.

7. PARAGRAPH 6, LOCK INTO CHOLANGY CREEK.—It is proposed to lock into the Cholangy salt creek, and I now submit a plan showing the position of the lock. I have placed it near the creek end of the lock channel, in order to reduce the cost of clearing silt. It is necessary to let the lock channel join the creek some distance below the aqueduct, as during floods the current through the latter will be considerable. The lock will be a first-class one, length 150 feet, width 20 feet, and will be filled and emptied by side culverts, the shutters being worked by rack and pinion.

8. PARAGRAPH 7, LEVEL OF WATER SURFACE.—Colonel Mullins states that the water will tend to rise to a level of 5.99 or 9.99 above M.S.L.; as the level of the top of the chamber walls of Coovor lock is 11.87 + M.S.L., no raising is required.

9. PARAGRAPH 8, CATTLE CROSSINGS.—I have allowed cattle crossings at the following places:—

Bhavaram at	1½ mile.
Patharlagadda	4¼ do.
Gorripoody	5½ do.
Chalapaka at	6¾ do.
Munjair at	8¾ do.

No provision was made for cattle crossings in the original estimate.

10. PARAGRAPH 9, IRRIGATION ARRANGEMENTS.—The existing irrigation channel on the right bank of the proposed channel crosses the Bhavaram and Cholangy drainages by aqueducts, both of which are very old and quite inadequate to pass the drainage, I therefore propose to end the channel at these drainages and give a new head sluice immediately below; this will necessitate building two new sluices at the points marked A and B on the survey, the cost of both these sluices will be approximately Rupees 1,500. There is a culvert in existence in the Karapah road. A sluice will be required in the left bank of the proposed channel at the 1½ mile at point marked C, to supply the Nadakuduroo irrigation channel, a plan for this sluice is submitted, and the cost is

Rupees 720. Two similar sluices will also be required at the points marked D and C, and channels dug from them in the direction of the blue dotted lines; the cost of these sluices and channel will be approximately—

Sluice at D	Rs. 760
Channel to irrigate lands of Gurazanapilly and Cholangy	2,520
Sluice at E	760
Channel to irrigate lands of Gorripoody and Vamaveram	1,980

It is assured that 1,000 acres will be cultivated in the village of Chalapaka to irrigate these two iron trough sluices and two short channels will be sufficient, the approximate cost will be Rupees 3,400. A sluice (Rupees 720) will be required at point f to supply an existing channel which takes water to the fields of Patavala, this channel is at present useless for want of an aqueduct over the Coorada drain, which will have to be built at a cost of Rupees 1,500. It will be seen from the foregoing that the cost of irrigating the acres 7,100 of land proposed to be irrigated, vide statement A, will be Rupees 13,860.

11. PARAGRAPH 10, DRAINAGE.—It is impossible to obtain accurately the amount of information required by the Chief Engineer for Irrigation unless a survey establishment be appointed for about six months to run lines of levels in all directions over the drainage basins, and a further establishment be employed for several years in gauging height of floods, flood discharges, &c.; however, I have had as many levels as I can find plotted on the plan, and from them and other information I have been able to obtain by inquiry and from flood marks on masonry works, &c., I think the results I have found may be taken as fairly correct.

12. PARAGRAPH 11, DRAINAGE BASIN.—There are four drainages to be passed under the canal. I have divided the basins of these as nearly as I can from the levels available, and find them to be as follows:—

Bhavaram drain	5 Square miles.
Cholangy	10 do.
Thooliabaga	58 do.
Coorada	6 do.

The drainage basin of the latter is the most difficult to determine, but, as far as I could ascertain, all the drainage to the east of the Cotipilly road and the Congodoo channel flows to the east, while that on the west of the same road and channel flows into the Thooliabaga, however there is no doubt that during high floods there is no separation between the drainage basin of this drain and the Thooliabaga.

13. PARAGRAPH 12, FLOOD LEVELS, &c.—Judging from the levels, I should say that in the case of all the drainages, the drainage water above the canal may be allowed to rise to height of 8 feet + M.S.L., and this apparently would do no damage and would not submerge any roads or villages. The normal height of water below the canal as ascertained by inquiry and by marks on masonry works is in the case of the Bhavaram and Cholangy drains 4 + M.S.L., and in the case of the Thooliabaga and Coorada drains 6 + M.S.L.

14. PARAGRAPH 13, DISCHARGE.—The discharges to be provided for found by the formula $D = C \sqrt[3]{M^2}$, $C = 400$ are as follow:—

Bhavaram drain, 1,528 cubic feet a second.	
Cholangy do., 1,856 do.	
Thooliabaga do., 6,304 do.	
Coorada do., 1,320 do.	

The Thooliabaga has in addition to this to discharge the surplus from the Coorada and Mundapet canals, the former is 70,000 cubic yards per hour (allowed in project), the latter may be taken at 20,000 cubic yards per hour (half the discharge of channel); the total to be added is therefore 90,000 cubic yards per hour, or 675 cubic feet a second, making the discharge to be provided for 6,979 cubic feet a second.

15. PARAGRAPH 14, WATER PONDED.—To ascertain the water that can be stored is a matter of extreme difficulty and would require a very great number of levels, but as far as I can make out with the data available, the following are the amounts in proportion to the discharges:—

Bhavaram	...	...	...	...	...	...	...	...	...	1 st th
Cholangy	...	...	...	...	...	...	...	...	...	3 rd
Thooliabaga	...	...	...	...	...	...	...	...	...	1 st th
Cooradaa	...	...	...	...	...	...	...	...	...	3 rd

16. PARAGRAPH 15, DISCHARGE REQUIRED THROUGH MASONRY WORKS.—The tunnels under the canal will, therefore, have to discharge the following quantities:—

Bhavaram	...	...	...	...	...	1,376 cubic feet a second.
Cholangy	...	...	...	...	...	1,238 do.
Thooliabaga	...	...	...	...	...	5,731 do.
Cooradaa	...	...	...	...	...	880 do.

17. PARAGRAPH 16, HEAD AVAILABLE.—It will be seen from paragraph 12 that the head available for discharge in the case of the first two drainages is 4 feet, the velocity would then be 10 feet a second, and the waterway required is—

For Bhavaram	...	...	...	...	...	153 Square feet.
„ Cholangy	...	...	...	...	...	186 do.

In the case of the latter two drainages the head available is 2 feet, giving a velocity of 7.13 feet a second; consequently the waterway required is—

For Thooliabaga	...	...	...	...	...	887 Square feet.
„ Cooradaa	...	...	...	...	...	185 „

18. PARAGRAPH 17, BHAVARAM AQUEDUCT.—At the site where this work is to be constructed, there is an old aqueduct of two vents of 6 feet span each carrying the irrigation channel, and this is probably what is referred to in paragraph 8 of Colonel Fischer's letter, No. 3,708, dated 13th March 1874, but the work would certainly never do to carry a navigation channel, as it is only about 6 feet wide, and moreover the waterway is quite insufficient; it is therefore proposed to build a new work (the plan for which is herewith forwarded) with a waterway of about 161 square feet. The width of aqueduct has been made 30 feet, and a towing path 5 feet wide has been provided, waterwings have been allowed as laid down by the Chief Engineer for Irrigation; the other details can be seen from the plan.

19. PARAGRAPH 18, CHOLANGY AQUEDUCT.—At the site of this work there is a bridge of 3 vents 3 x 3 rise 1½ feet carrying the road; this was built about three years ago by the Salt Deputy Collector, and is a very inferior structure and the waterway is insufficient, the irrigation channel is now carried across this drain by a wooden trough. It is proposed to erect an aqueduct here with a waterway of 201.16 square feet, the general design of this work will be similar to that of the Bhavaram aqueduct except that two of the piers will be extended to carry arches over which the road will pass.

20. PARAGRAPH 19, THOOLABAGA AQUEDUCT.—A little above the site where it is proposed to build this work there is a bridge (waterway 324 square feet) across the drain, and Colonel Fischer therefore considered that 42 square feet of waterway for the aqueduct was ample, but I am informed that in the year 1874 after heavy floods the Cotipilly road for a considerable distance on either side of the bridge was breached, which proves that the waterway is insufficient. The proposed work will have a waterway of 822.24 square feet, and will be built according to the plan herewith submitted.

21. PARAGRAPH 20, COORADA AQUEDUCT.—There is at present no work where it is proposed to construct this aqueduct, the design of which is exactly similar to the proposed Bhavaram aqueduct, the waterway of this work has been made ample in order to prevent damage by water from the Thooliabaga. The total cost of the drainage works for this canal will be—

	RS.
Bhavaram aqueduct	11,920
Cholangy do.	17,890
Thooliabaga do.	28,140
Cooradaa do.	14,340

This is a very large amount, and, in my opinion, the works are a great deal larger than necessary. From the experience I have had of floods in deltas I think the discharge obtained by Major Ryves' formula using the co-efficient $C = 400$ are far too great, and I believe a co-efficient of 200 would give more correct results, that is when the drainage channel rises and runs throughout its whole course in the delta.

	RS.
22. PARAGRAPH 21, Cost.—The total cost of the works included in this project is	1,89,450
Add 25 per cent. for Establishment	47,362
Tools and Plant at 8 per cent.	15,156
Depreciation at 1 „	1,894
Capitalization of abatement of land-revenue, 169 acres, average assessment at Rupees 4	13,520
Leave and pension allowances at 10 per cent.	18,945
Total...	2,86,327

23. PARAGRAPH 22, REVENUE.—It is so very evident that this canal will give no direct profit, that it is almost useless to give any details concerning the revenue, but as far as the returns from irrigation are concerned, it is necessary first to ascertain how the proposed acreage could be irrigated without this expensive canal and what would be the cost of the arrangements which would be as follows:—

	RS.
1. Widening and improving irrigation channel from above Covoork lock to village of Gorripoody	3,000
2. Constructing aqueducts on above channel over Bhavaram and Cholangy drains	4,000
3. Constructing sluice in 4th mile of above channel on the Cotipilly road to supply branch channel to irrigate the lands of Gura-zanapilly, Cholangy and Cholangipetta	760
4. Digging above branch channel	2,520
5. Extending No. 1 channel beyond the existing culvert at 5th mile on the Cotipilly road to irrigate the lands of Gorripoody and Vamaveram	1,980
6. Extending the existing irrigation channel from above Munjair lock as far as the village of Chalapaka to irrigate the lands of that village	2,500
7. Constructing an aqueduct on this channel over the Cooradaa drain	1,500
Total ...	16,260

Without the Junction canal the cost of distribution arrangements would therefore be Rupees 2,400 more than with it; from this it is evident that it would be absurd to incur the expense of excavating this Junction canal for the sake of irrigation.

24. PARAGRAPH 23, SALT TRAFFIC.—The value of the canal in connection with the salt pans has already been shown in Proceedings of the Madras Government, No. 2,558, of 20th October 1873, and I now submit a statement B showing the revenue derived from the salt-pans from fasli 1277 to fasli 1285.

25. PARAGRAPH 24, DEBIT OF COST.—The direct returns from navigation would, in my opinion, be so trifling that they may be left out of the question; no doubt the advantage to the public would be considerable. Taking what has been written above into consideration, I quite agree with the opinion expressed by Colonel Mullins in paragraph 5 of his note, No. 143, dated 13th April 1870, that the amount of the estimate should not be added to the cost of completing the Delta canals as Agricultural Works; in fact, I consider that only the sum of Rupees 16,260 can fairly be debited to irrigation, and the remainder of the sum of Rupees 2,70,067 should be paid out of Salt and Local Funds.

No. 14 G.D.

IRRIGATION—MEMORANDUM.

WITH reference to the letter, No. 3,708, of the 13th March 1874, from the late District Engineer, Godavery, which letter was revised and retransmitted by Lieutenant-Colonel Fischer in September of the same year, the undersigned has the honor to say that Colonel Fischer not having attended to his instructions it will be necessary to revise the arrangements of the canal and the estimate, as also to obtain and furnish the information which that officer has avoided giving.

2. Proceedings of the Madras Government of the 9th May 1870, No. 1,215, contain a note reviewing the principal features of the project for this canal as submitted in October 1869, but in the project sent up in 1874, some of the arrangements approved in the earlier estimate have been altered and others that were objected to and the revision necessary pointed out have not been so revised.

3. In the review already referred to the very important subject of cross drainage was not noticed, and this omission was subsequently made good, and the principles upon which the provision for this drainage was to be made were indicated. These instructions were not properly carried out by Colonel Fischer, and the waterway allowed in the project of 1874 appears to be altogether inadequate.

4. It was further pointed out to the late District Engineer that, if the project were submitted with full information and with its real bearing on irrigation, local communications and the salt trade clearly explained, probably no difficulty in obtaining sanction would be experienced. Instead of supplying the definite information required, Colonel Fischer has devoted the greater part of his letter to an elucidation of his own views on the value of communications and to the destruction of arguments against those views which he apparently attributes to others, but which are the product of his own futile imagination.

5. It is necessary therefore to begin again and state in detail what the arrangements should be and to ask Major Beatty to have the designs and estimates revised accordingly.

1st.—The dimensions of the canal should be those proposed in 1869 and approved in the review of 1870, viz. :—

Bottom width	...	...	...	...	30 feet.
Surface do. (water)	...	...	...	...	48 "
Depth of water	...	...	...	...	6 "

6. In the project of 1874 the bottom width is 20 feet and the practical width for navigation or the width at say half depth varies according to the ground surface and depth of cutting.

Whether then there be any cutting or not the bottom width should be 30 feet; there should be no berms and the width available for navigation will then be approximately the mean width or 39 feet.

2nd.—The determination of the width of waterway at masonry works is of some importance as regards expense. On the other hand it has to be remembered that boats do not

steer to a nicety, and that when under sail they but seldom move with their centre line parallel to the axis of a canal, and that inconvenience will certainly result from making the waterways too narrow. In this view the 20 feet width allowed by Colonel Fischer for bridge and aqueducts is too small and should be increased one-half or to 30 feet.

3rd.—The proper width of tow-paths has been laid down generally in circular No. 14 and specially as regards this canal in the note of 1870. The instructions have yet to be attended to by the provision of 5 feet pathways at the aqueducts, &c.

4th.—The headway to be allowed under the Cotipilly road bridge and under the tail bay bridge of the lock should be considered. The adoption of the 11 feet minimum allowable should not be made unless circumstances render a greater headway inconvenient. At the lock the 20½ feet above sill or 12 feet above datum high water may be appropriate, but the water-levels must be clearly marked.

5th.—The level of the lock sill (lower) must be determined on the data laid down in circular No. 30, paragraph 5, and must be shown to conform thereto by the water-levels on the plan and that of the sill.

6th.—Generally slopes of 1½ to 1 have been found suitable for the delta earthworks, and if the soil through which this canal is to be cut be similar, these slopes may be retained, but it should be remembered that sometimes the soil close to the coast and that of swamps is not to be depended on at a steep slope, and, where necessary, a modification can be made, the mean width of the waterway of the canal being kept at 39 feet.

7th.—The width of the Cotipilly road bridge should be 13 feet in the clear instead of 15 feet between the girder webs.

8th.—It has not been explained why the width of the top of the canal banks has been fixed at 9 feet. It may be that these banks are intended to be used as communications, if so that width may stand; if not 7 feet so as to secure a minimum of 6 feet would appear to be sufficient.

9th.—The circumstances require all cross drainage to be passed under the canal without danger to the Cocanada and Coringa canals, the admission of drainage to the junction canal could not be allowed; moreover as the rule the water in the junction canal will be carried almost entirely above the surface of the country, and drainage could not be admitted without risk, even were the banks specially raised in proportion.

10th.—The water from Covoer lock to Munjair lock will practically find its level, and as that level is 5.99 at the Munjair lock the tendency will be to raise the proper level of 5.12 at Covoer to 5.99. Colonel Fischer states that the walls of the Covoer lock are 0.18 higher than was intended and so 5.99 — 5.12 — 0.18 will be the difference, and it may be necessary to raise the Covoer lock walls 8 or 9 inches.

Memorandum No. 650, paragraph 2. 6. The drainage has next to be considered.

(a).—It has already been pointed out that the drainage to be disposed of should be estimated by Ryves' formula with a co-efficient = 400.

(b).—It has next to be ascertained how far the several lines of drainage may be allowed to be considered together, a point the determination of which depends upon the level to which flood waters usually attain in years of extraordinary rainfall, and whether therefore that waterway at one point would be supplemented by spare waterway at another work.

(c).—The next matter to be settled is the maximum level to which water may be allowed to rise on the west side of the canal, the normal level deducted therefrom will give the head available for discharge and the consequent velocity of discharge.

(d).—It has next to be decided what proportion of the discharge from the area drained will have to be passed under the canal in a given limited time. This will depend

upon the quantity which can be ponded without submergence of roads, villages, &c., and without exceeding the fixed maximum level west of the canal.

There will probably be great difficulty in effecting a demonstration of this matter, but at any rate the arrangements to be made must be based on something better than a mere guess and must have direct reference to the area of ground which will be submerged and the consequent storage capacity, also to the level of roads and villages within that area.

The above points when determined as accurately as circumstances will permit will settle at once the total area of waterway to be provided and the areas at particular lines of drainage.

The Thooliabaga main drain, or as it is called in these papers the Mutlapalem river, carries all the distant and the larger part of the near drainage, and the correct settlement of the waterway here to be allowed is very important.

7. The area the drainage of which has to be passed under the canal is about 115 square miles, and canal surplus in considerable quantity has to be taken into account besides. In the project of 1874 the area of waterway allowed is—

For the Cholangy river	...	...	...	17 ½ Square feet.
„ Thooliabaga	...	...	...	427 „
„ Coorada drain	...	...	...	54 „
				498 ½ „

Were ahead of 4 feet allowable the velocity would be 10 feet a second, the discharge 4,985 cubic feet a second, and this latter would with $C = 400$ correspond to an area of 45 square miles drained. If one-third of the water could be ponded, the waterway would suffice for 67½ square miles. On the other hand were a head of 2 feet only available, a perhaps more likely circumstance, the velocity would be 7.13 feet a second, the discharge 3,554 feet a second, and this discharge would correspond to an area of 26½ miles drained. Allowing one-third of the drainage to be ponded, the waterway would suffice for, say, 40 square miles.

In these rough calculations the most favorable view of what the waterway is capable of doing has been taken, for it has been assumed that all the drainage may be considered as one, and that each masonry work would take in proportion to its area its full share of the discharge.

* Cocanada, Mundapeta.

The canal* surplus has, moreover, been left unconsidered. These remarks will show that a canal constructed as designed would probably have breached in many places the first time a heavy rainfall occurred and ultimately after much money had been wasted, a reasonable amount of waterway would have had to be provided.

In paragraph 8 of his letter, Colonel Fischer refers to an aqueduct of 24 square feet waterway carrying the canal over the Bhavaram and Aratlacutta drainage channel. No such

No. 3,708, 13th March 1874.

aqueduct has been provided for in the estimate, and if, as would seem, it be an existing aqueduct, it must be for a petty channel and unsuited to carry the canal. Further on in the same paragraph that officer notices that the “observed area of flood discharge through the girder bridge on this drain (Thooliabaga) a quarter of a mile above” (the canal crossing) was 324 square feet, and

* Reckoned as 427.

he considered that in allowing 420* square feet he had sufficiently provided for the increased flow that will result from the enlargement of the Thooliabaga from 42 to 75 feet. The remark as it stands is worthless for any purpose connected with the settlement of waterway under the canal.

1st.—It has not been noted to what year the flood mark or level referred, and what was the corresponding rainfall.

2nd.—It has not been shown that all the water discharged passed through the bridge.

3rd.—The disposition of the waterway has not been stated, viz., its width and depth.

4th.—The enlargement of the drain does not affect the quantity of water to be disposed of, but only the location of the discharge.

If then the waterway of the bridge be of any importance it could be so only as an evidence of the total discharge, and if it bear no evidence on this point, no use can be made directly of the fact of that area, but it together with other areas may be used in connection with known corresponding rainfall, as a basis for the deduction of areas required to dispose of drainage from other given rainfall.

8. The proposed arrangements for locking into the Cholangy river without interfering with the drainage passing under the canal should be made clear by a site plan.

9. The following remarks on details of the designs should be considered:—

Lock.—Screw gearing is inadmissible as a power for working lock culvert valves. Colonel Fischer's inattention to instructions on this point has already led to waste of money, as the

Circular 30, paragraph 7.

screw gearing used by him has had to be replaced by more suitable gear. The entrance to the upper side culverts may be made direct through the front wall.

Calingulah and Tunnel.—Cholangy river. There is nothing corresponding to a calingulah. The upstream wings are inadequate as would have been seen had the slopes been plotted. The wing section on E.F. would do at the line named, but is inadequate a little further to the right.

The following is among the information which must be noted on the revised design:—

Area of drainage.

Calculated maximum flood discharge.

Quantity to be discharged.

Area of waterway.

Maximum F.L. above canal.

Do. do. below do.

Velocity of discharge.

Actual (estimated) discharge.

Aqueduct, Thooliabaga or Mutlapalem river. Tow-paths.

Splay of wings insufficient.—In the design, which allows only 20 feet waterway across the aqueduct, the distance between the basis of the earth slopes would be only 8½ feet and the width at half depth 17½ feet. The width of the waterway of the aqueduct is to be 30 feet and the width in the channels of approach at half depth must not be less than 30 feet, and may with advantage be 34½ feet, consequently the splays should be 34½ — (17½ + 10) = 7 feet greater or 3½ feet on each side. The embankments at top should overlap the wings at least 3 feet.

Nominal width at half depth 39 feet.

Contracted at bridges and aqueducts to 30 feet, mean 34½ feet.

There should be a rough stone flooring on the upper side of lower floor 9 feet wide and 15 feet on lower side. The concrete (canal) flooring should not be carried beyond the rear face of the abutments, carrying it to the ends of the wings interfere with a proper junction between these and the earthworks. A good arrangement is to provide small buttresses inside the wings at or near the ends to secure a more perfect junction; such buttresses should be completely covered by the earthwork.

If 4.13 be the maximum flood level without a canal, the height of the side walls of the aqueduct are manifestly insufficient, and the ends of the wings must be of the same height

See line marked on the elevation.

as the canal banks, and not as in the design 18 inches lower. The side walls or the west side wall between the abutment faces must be above maximum flood level, as this may be fixed in order to secure the required discharge with a minimum of waterway. The requisite width of towpath may be obtained by carrying up the piers to carry arches at the required level, and with these the thickness of the side walls allowed in the design, dated 4th March 1874, may suffice.

The abutments are somewhat weak for the small rise of the arches, and with 30 feet width of waterway two or three buttresses between the wings will be desirable.

It is thought that inverts will be preferable to a flat flooring under the arches and that additional waterway may thus be obtained. Inverts in concrete would probably answer very well if made with the excellent hydraulic cement produced at Dowlaishweram. It is not clear from the drawing on what the cyclopean stone flooring there shown is to be laid, there being apparently an unoccupied space of 1 foot below it.

Cotipilly Road Bridge.—Beyond the general instructions already given as to waterway, headway, &c., the only remark required is upon the arrangement of the towpath walls. The normal

* $4\frac{1}{2}$ feet of the banks are 9 feet wide, but practically 3 feet may be taken as the tow line.

distance of the centre of the towpaths on the canal banks will be $24 + 4\frac{1}{2} + \text{say } 3 \text{ feet}^* = 31\frac{1}{2}$ feet from the centre line of the canal. The centre line of the towpath under the bridge will be $15 + 2\frac{1}{2} = 17\frac{1}{2}$ feet from the centre line, and the arrangements should be so made as to effect a convenient transition from the one distance to the other. As above remarked the width of canal at half depth may be reduced on approaching masonry works to $34\frac{1}{2}$ feet, and this will bring the bank towpaths $2\frac{1}{2}$ feet nearer the centre line, so that the transition near the bridge will be from $17\frac{1}{2}$ to $29\frac{1}{2}$. By modifying the ends of the towpath walls as shown in dotted line on the plan, the transition will be conveniently managed and the length of wall will remain unchanged. Only by plotting the actual requirements can such details be laid out to suit the circumstances.

Irrigation Sluice.—The design is not at all a good one. The dimensions of the tunnel are very confined. If the tunnel be made 3 feet in width, $2\frac{1}{2}$ feet to the springing and with a semi-circular arch, the vent may probably be arranged to suit the discharge required in particular cases without alteration of the rest of the design. The rear portion of the sluice will be better if built as shown in pencil; the front wings should be sloped down to 1 foot above canal water-level.

Coorada Drain, Calingulah and Tunnel.—See remarks on similar design for Cholanga river.

10. The estimate should show a total for works; then establishment and tools and plant should be provided for and a second total made; lastly, capitalization of abatement of land revenue and leave and pension allowances have to be entered with a third total. A classified abstract will be required.

11. It will be necessary to show where the land to be irrigated by this junction canal is situated, and this can be done either on a Revenue Survey map or on a tracing therefrom. It should also be stated how this land would be irrigated in the absence of the canal and what the probable cost of the distribution works would be. The area to be irrigated would seem to be uncertain. In paragraph 4 of Lieutenant-Colonel Fischer's letter, printed in Proceedings of the Madras Government, 9th May 1870, No. 1,215, 3,000 acres are mentioned: it is hardly necessary to remark that the cost of distribution in the ordinary manner would be from 6,000 to 9,000 Rupees, and that officer's calculation of returns in the same paragraph is fallacious. In the Collector's letter, printed in Proceedings of the Madras Government, 20th October 1873, No. 2,558, the estimate of the Tahsildars is given as acres 7,100, but the Collector himself prefers to reduce the area to 3,750 acres. It is necessary to settle where the land is, and how water is to be conveyed to it; what the cost would be of the distributaries if there were no junction canal, and what with it; the difference, if any, will indicate the value of the canal as an irrigation work.

12. The value of the canal in connection with the salt-pans has been indicated in Proceedings of the Madras Government, 20th October 1873, No. 2,558; any further information which may be obtainable will be of value. The cost of the lock and of the improvement of the Cholanga river should be a separate item of the estimate.

It is hoped that with the help of the foregoing instructions the project will be resubmitted in a form admitting of its sanction by Government.

(Signed) JOHN MULLINS, Lt.-Col., R.E.,

Chief Engineer for Irrigation.

17th March 1876.

Comparative Statement showing the Original and Revised Estimates for constructing a Canal from Coovor Lock to Munjair Lock in Eastern Delta, Gollatery District.

ORIGINAL ESTIMATE.										REVISED ESTIMATE.																				
Description of Work.			Amount.			Total.				Quantity or Number.			Description of Work.			Amount.			Total.				Excess.			Surplus.		Remarks.		
			RS. A. P.			RS. A. P.										RS. A. P.				RS. A. P.			RS. A. P.				B2. A. P.			
5	Constructing canal improving Cholanga river contingencies	138	41,937	2	3	18,744	10	6	2,733	3	3	1	Canal Cholanga Contingencies	..	..	..	..	..	..	..	..	..	..	..	..	..	Owing to increase of side slopes.			
1	Look at the head of Cholanga river.	1	22,000	0	0	53,420	0	0				1	Aqueduct over Bhavaram drain	..	..	..	..	..	..	..	..	..	..	..	..	..	Not allowed in original estimate.			
1	Calingnab with under tunnel for Cholanga river.	1	3,030	0	0							1	Look at the head of Cholanga river.	..	..	..	..	..	..	..	..	..	..	..	..	..	Owing to increased waterway being al- lowed.			
1	Aqueduct over Theoliabaga drain or Mutlapalem river.	1	8,900	0	0							1	Aqueduct over Cholanga river	..	..	..	..	..	..	..	..	..	..	..	..	..	Do.			
1	Bridge to Cotipilly road.	1	7,050	0	0							1	Do. over Theoliabaga drain or Mutlapalem river	..	..	..	..	..	..	..	..	..	..	..	..	..	Do.			
1	Calingnab with under tunnel for Coorada drain.	1	4,720	0	0							1	Bridge to Cotipilly road	..	..	..	..	..	..	..	..	..	..	..	..	..	Span and headway in- creased as per Chief Engineer's memoran- dum, No. 14 G.D., dated 17th Mar. 1876.			
5	Irrigation sluices	138	1,700	0	0	56,580	0	0				1	Aqueduct over Coorada drain	..	..	..	..	..	..	..	..	..	..	..	..	..	Owing to increased waterway.			
	Acres of land to be occupied by the canal		8,280	0	0							5	Cattle crossings	..	..	..	..	..	..	..	..	..	..	..	..	..	Not allowed in original estimate.			
												6	Irrigation sluices	..	..	..	..	..	..	..	..	..	..	..	..	..	Owing to improved de- sign.			
												169	Acres of land to be occupied by the canal and minor channels	..	..	..	..	..	..	..	..	..	..	..	..	..	Land compensation al- lowed for branch channel.			
												8 1/2	Miles minor channels	..	..	..	..	..	..	..	..	..	..	..	..	..	Not allowed in original project.			
														</																

No. 216 W.

No. 426-A.

Note by the Chief Engineer for Irrigation.

Cocanada and Coringa Junction Canal.

THIS Junction canal to run from the Cocanada canal above the Covoor lock to the Coringa canal above the Munjair lock was apparently first suggested by the late Major Ryves as a means of connecting the Penuguduru salt-pans with the water communications of the delta. Government in the Revenue Department concurred in the views expressed by Captain Ryves which were supported by Captain Fischer as to the value of the canal in connection with the salt trade, and as a general communication.

2. In Proceedings of Madras Government, 9th May 1870, No. 1,215, a scheme for connecting the salt-pans with the Cocanada canal and with the Coringa canal also was reviewed, the estimated cost being—

	RS.
Canal from Cocanada canal to the salt-pans	60,187
Do. from Cholangy river to Coringa canal	50,813
	<u>1,11,000</u>

This project was generally approved, but its sanction was deferred for want of funds.

3. In 1873 a project for improving the supply of water to, and the communications with the salt-pans was reviewed and not considered desirable. Its cost was Rupees 11,300, and there would have been a constantly recurring outlay. It was also noticed that if the more effective project of a Junction canal was unnecessary in the interests of irrigation, it would be desirable that it should be undertaken jointly from Local and Imperial Funds.

4. Lieutenant-Colonel Fischer, the then District Engineer, did not deal satisfactorily with the questions referred to him for investigation, and finally his scheme, which was estimated to cost Rupees

No. 14 GD, 17th March 1876.

1,20,000, was sent back for revision, with instructions, and it has now been resubmitted in a shape which will it is hoped admit of the project being carried out and of the incidence of its cost being determined.

5. The total amount of the revised estimate is—

	RS.	RS.
For works	1,89,450	
Establishment at 25 per cent.	47,362	
Tools and plant at 8 „	15,156	
	<u>2,51,968</u>	
Capitalized abatement of land-revenue	13,520	
Leave and pension allowances one-fourth of establishment	11,842	
	<u>25,362</u>	
9½th mile.		2,77,330
or at the rate of Rupees 30,390 a mile.		

6. Lieutenant Campbell shows, paragraph 10, that the cost of distribution works with the Junction canal will be about Rupees 13,860, and that without it their cost would be about Rupees 16,260, consequently the saving would be only Rupees 2,400.

7. The salt trade and the local traffic are virtually the only interests concerned therefore in the construction of this canal. That it would be a convenience as a line of communication generally is certain, though as it would connect two canals which are only 9 miles apart, and between which there is already communication on the one side by the Mundapeta canal and at the lower end by the Coringa river, it would be quite possible to over-estimate this convenience. As regards this point the Local Fund Board can, however, form its own opinion. The chief value of the canal, so far as the part connecting the Penuguduru salt-pans with Cocanada is concerned, is the influence which it might be expected to exercise upon the salt sales. The revenue derived from these salt-pans fluctuates between 4 and 5 lakhs. The cost of the work so far, viz., to 3½ miles on the Junction canal with the lock into the Cholangy river, &c., has not been distinctly shown in the estimate submitted by the District Engineer, but a sufficiently close approximation can be made.

	RS.
Compensation for land (share of Rupees 8,280)	3,065
Cotipilly road bridge	8,880
Cattle crossing, Bhavaram	110
Bhavaram aqueduct	11,920
Lock at head of Cholangy river	21,600
Widening and deepening river	19,720
Canal earthworks (share of Rupees 45,590)	17,500
Total	<u>82,795</u>

The interest on this sum at 5 per cent. is Rupees 4,140, while if, to the cost of works for connecting the salt-pans with the Cocanada canal, the other charges amounting to about 45 per cent. on works or Rupees 37,255 be added, the total outlay involved will be 1,20,050 and the interest, say, 6,000 Rupees a-year. If improved communication with the salt-pans be of any value at all, it would seem that its effect on the salt-revenue will be far in excess of the interest on the expenditure required. The above figures may need some modification for the items land compensation and canal earthworks, which have been calculated on the mileage, and the correct amounts will probably be somewhat less.

8. The canal is necessarily an expensive one, as it crosses the drainage of the country, and this drainage, owing to the level of the canal, has all to be passed under the latter. Perhaps the Bhavaram drainage might be passed partly under and partly over the canal, as the water-surface there in the latter is not much above ground level. Lieutenant

No. 259, paragraph 21.

Campbell is of opinion that the provision made for cross drainage, which in each case has been approximately determined by calculating the maximum flood discharge by Ryves' formula with a co-efficient of 400, is larger than is necessary, and he thinks a co-efficient of 200 would give more correct results. This opinion is founded on his experience, but although he is aware that definite information is much required as well as much desired for a determination of fairly accurate co-efficients for all localities or any locality for use with Ryves' and Dickens' formulæ, he has not referred to any

facts or shown on what circumstances his experience is based. He is acquainted with the Commamoor canal and the Kistna Ellore canal, both of which have been extensively breached by every heavy fall of rain, but he has drawn no deductions therefrom as to the waterways which have or have not proved adequate to discharge the drainage of given areas of country. In the Godavery Delta, moreover, the drains have for some two or three years been gauged, and though the rainfall has been very light perhaps some deductions may reasonably be made from the facts ascertained. Lieutenant Campbell has brought forward no definite information whatever, and his supposition that a co-efficient of 200 would be more correct means that the maximum quantity of drainage would amount to 1.92 inches in the 24 hours from the area of 58 square miles, which drains across this canal. All that need be said is that in the face of the recorded falls of rain so vastly in excess of this quantity, it would be very rash to accept Lieutenant Campbell's experience without some support from facts. As Lieutenant Campbell is aware cross drainage works were formerly constructed without any reference whatever to the drainage they had to deal with, and the results were not satisfactory. Since then certain arrangements have been prescribed both for cross and intra delta drainage, until it can be shown that in particular cases, or generally, a modification of these arrangements would be proper; and officers generally have been invited to aid in determining as correctly as possible the discharge from given areas small and large. Opinions based on practically nothing are useless. If Lieutenant Campbell will show what the actual discharge in any drain from any recorded rainfall has been, what the maximum recorded rainfall has been, what discharge he would deduce from the latter and what arrangements would necessarily follow, his views based upon facts, however limited, will probably be of value.

Ootacamund, (Signed) JOHN MULLINS, Lt.-Col., R.E.,
6th October 1876. *Chief Engineer for Irrigation.*
To the Secretary to Government, Public Works Department.

No. 247. ORDER THEREON, 17th October 1876, No. 2,776.

IRRIGATION, No. 31.

THE estimate for a Junction canal to unite the Cocanada and Coringa canals, and the Penuguduru salt-pans with them by a lock into the Cholangy river and the improvement of the latter, is approved, and the project will, in connection with the orders as per margin, be referred to the Revenue Department for consideration of the probable effects on the salt-revenue of that part of the scheme which will bring the salt-pans into direct communication with the Cocanada canal. The estimated cost of the whole project is for *works* Rupees 1,89,450, and that of the part from the Cocanada canal to the Cholangy river, including the improvement of the latter, Rupees 82,795.

2. Inclusive of all charges the cost of the scheme will be Rupees 2,77,330, and of that part in which the salt-revenue is more particularly interested Rupees 1,20,050, and to cover the bare interest on the latter sum an increase of revenue by salt sales of Rupees 6,000 annually will be necessary.

				RS.	
Imperial	...	...	...	2,77,330	
				1,20,050	
				1,57,280	
Deduct Irrigation distribution works				13,860	
Charges	...	...	...	6,240	
				20,100	
Balance	...			1,37,180	

3. It has been shown that the interest of irrigation in the canal is very small, and the construction of the canal from the Cholangy river to the Coringa canal will, if it is to be undertaken, have to be provided for from Local Funds. The Board of Revenue will be requested to determine, in communication with the Local Fund Board, whether the sum of about Rupees 1,37,180 required can be made available, and, if so, to settle the allotment to be proposed for 1877-78.

4. Pending the report by the Revenue Department on the financial aspect of the scheme as regards salt-revenue, provision to the extent of Rupees 40,000 will be made in the Budget of 1877-78 under Imperial against the estimate of Rupees 82,795 for the canal from the Cocanada canal to the salt-pans.

5. The District Engineer will report what part of the land compensation, and of the general provision for earthworks of the canal, appertains to the portion up to the head of the branch to the salt-pans, and consequently the totals of the estimates belonging to Imperial and Local Funds respectively.

(True Extract.)

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

To the District Engineer, Godavery.
" Chief Engineer for Irrigation.
" Revenue Department.
" Board of Revenue.
" Financial Department.
" Examiner of Public Works Accounts.

Exd. E. C. Shunker.
Spare Copies

Govt. of 1876 Madras.

PUBLIC WORKS.

To

THE DISTRICT ENGINEER,
GODAVERY,
&c., &c., &c.

Dated, October 17th.

Issued

Recd.

Encl.

G. O., 17th October 1876, No. 2,776.

OCTOBER.

Nos. 246-247.

Junction Canal to unite the Cocanada and
Coringa Canals and the Penuguduru Salt-pans
with them by a Lock into the Cholangy River.
—Passing orders on the estimate for a —.

No. 2014

FROM

THE SUPERINTENDENT OF WORKS

GODAVARI DISTRICT.

TO

THE CHIEF ENGINEER P.W. Department
FOR IRRIGATION.

Enclos.

Dowlaishweram, 31st October 1881.

SIR,

With reference to G.O. No. 2453 W. of 5th October 1881, I have the honor to observe that the work "Bridge over Kovur Manjair Junction Canal under Kotipilli Road" has been classed as Incorporated local (Canal and Ferry Fund) while the estimate of the work sanctioned in G.O. No. 2776 of 17th October 1876 has been classed as "Other incorporated local" (Canal and Ferry Fund).

I request therefore your orders as to which is to be considered the correct classification.

I have the honor to be,
your most obedient Servant

P. Walef
Supd of Works Godavari

P. W. D. No. 6466

From The Superintendent
of Works &
(M. S. Circle)

To The Chief Engineer
P. W. D.
Madras

Date 31st
Despatched 31st } Octob 31st
Received 7

No. 2014

Enclosure 1

Bridge over Korum

Munjaivir Junction

Canal. - Under

Kotipilly Road.

Reporting as regards
the classification of
the work of -

Subd. in Receipt Regd. 2014

No. 2792 W

PUBLIC WORKS DEPARTMENT.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Under date the 10th Nov. 1881.

Read the following: -

From the S. S. I. Circle H. B. No. 2014 of 31 Oct. 81.

Erratum.

In the first line
of para 4 of S. O. No.
2453 W of 5th October
1881 -

For

"Incorporated Local"

Read

"The Incorporated Local"

Cy

P. No. S. S. I. Circle (new)

"C. S. P. D."

"S. P. W. D."

"Rev. Dept."

"File Sept 1"

Sept 10 - 11 - 81

2792 W 10-11-81

Arched 11/11