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Government of Madras.

Public works **DEPARTMENT.**

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374-79

Dated 19. 12 1862.

Not to be folded or roughly handled

10.1.44

Proceedings of the Madras Government, Public Works Department, 19th December 1862.

Read the following papers :—

No. 374. From Lieutenant-Colonel F. H. RUNDALL, R. E., Consulting Engineer for Irrigation and Canal Company, to Colonel W. I. BIRDWOOD, R. E., Secretary to Government, Public Works Department, dated 20th October 1862, No. 74.

SIR,

1. With the accompanying letter,* the Agent forwards for the sanction of Government Plans and Estimates, amounting to Rupees 1,35,400, for works required in the 2nd Section of the Canal, or from the 92nd to the 103rd mile, or from the village of Jotoor to the town of Nundial.

* No. 133 of 22nd August 1862.

2. The Canal takes off from the river Caulee at Jotoor, opposite to the spot which had been reached in the preceding section.

3. The river is crossed by an Anicut 346 feet in length, furnished with a set of six under-sluices, while the Canal is protected with a head sluice and lock.

4. The capacity of the sluice is sufficient for a discharge of 1,00,000 cubic yards per hour, and the lock is so adapted, as to maintain navigation during the highest floods of the Caulee.

5. The Canal has a fall of six inches per mile, and obtains a command of the large tank at Nundial, and of the land irrigated therefrom.

6. The supplying channel of that tank is not crossed on this portion of the Canal, but will be provided for in the next.

7. For the drainages which are however intercepted, culverts and calingulahs are provided so that no existing irrigation is interfered with, except that below the tank at Byop Goodoor, regarding which the District Engineer has suggested an alteration, and also a patch of 119 Acres near the village of Aiwarikodar. The area at Bundi Atmacoor is reported by the Tahsíldár as lying east of, and therefore above the level of the Canal, while for that at Aiwarikodar, the Chief Engineer states a culvert shall be provided passing the supply channel under the Canal.

8. In this length of the Canal 12,000 Acres of dry land will be brought under irrigation. The minor sluices will be estimated for separately, as the scheme of distribution has not been yet decided on.

9. Colonel Ludlow informs me that while on his tour, he saw the sites of the intended works across the Caulee, and is of opinion that it would be desirable to add an apron to the Anicut, as the rock on which the overfall will be received, is not compact, but of a very friable nature, ill calculated of itself to sustain the shock which will be brought upon it.

10. I have therefore added an apron to the work, the additional cost of which will amount to Rupees 3,782-10-0.

11. The rates entered in this portion of the project, Colonel Ludlow is of opinion, should be sufficient, as no rock cutting is met with.

12. Two bridges and three ferries are allowed for preserving the communication across the Canal, and are considered by the District Engineer as sufficient, so far as the Canal itself is concerned, but that as the Caulee below Jotoor is to be used as a surplus channel, down which a large body of water will be poured, and be productive of serious inconvenience to the inhabitants of three villages on its banks, he considers that additional ferries should be provided for them, but the Chief Engineer explains, that even with the quantity discharged, there will not be water enough to float a boat, as the river has a fall of seven feet per mile, and that when the Caulee is filled by local rains, no water from the Canal will be passed down.

From Acting District Engineer, dated 18th July 1862, No. 200.
Do. Agent, dated 21st August 1862, No. 124.
Do. do. dated 21st " " " 125.
Do. do. dated 27th " " " 167.
Do Acting District Engineer, dated 8th September 1862, No. 312.

† Also forwarded, to be returned.

13. The usual report from the District Engineer accompanies these papers, but from his having therein entered on other points than those enjoined in G. O. of 26th March 1861, No. 610, and animadverted on the mode in which the Company's Engineers carry on their operations, it has provoked an angry correspondence† between himself and the Chief Engineer, any notice of which, though it is much to be regretted, the Government will probably consider unnecessary.

14. With the additional work to the Anicut at Jotoor, the sum requiring sanction will be Rupees 1,35,400.

No. 375. From Lieutenant-Colonel S. O. E. LUDLOW, R. E., late Officiating Consulting Engineer for Irrigation and Canal Company, to Colonel W. I. BIRDWOOD, R. E., Secretary to Government, Public Works Department, dated Chepauk, 29th October 1862, No. 76:—

SIR,

1. In accordance with the instructions conveyed in the Proceedings* of Government dated 24th July 1862, having examined all the works executed and in progress on the Irrigation Company's Canal, between the Sunkasala Anicut and the Metacondal cutting, and made as full an inspection as circumstances would admit, of the course fixed upon or designed for the channel between Metacondal and the site of the lowest Pennair Anicut at Somaishweram, I have the honor to submit the following report for the information of Government.

* No. 1,772.

2. The works executed and in progress are situated on the portion of the line between the head at Sunkasala and the Metacondal cut, a distance of 72 miles, beyond which no ground has been broken, the largest quantity being towards the upper part of the Canal.

3. Between the Metacondal cutting and a point a little above the junction of the Kundaur and Vykaloor streams, as far as the 148th mile, the course of the Canal has been definitively settled. The estimates for the works as far as Nundyal (the 103rd mile of the Canal) have been received, and after examination have been laid before Government. The estimates down to the junction of the two above mentioned streams are in a forward state and will, I understand, be soon submitted.

4. Between the junction of the Kundaur and Vykaloor and Cuddapah the course which the Canal will take, though not finally settled may be said to be nearly so.

5. Between Cuddapah and the Somaishweram Anicut the course of the Canal is yet under consideration and examination, and some time will yet I think elapse before the exact mode in which this part of the scheme is to be carried out is finally decided, and the estimates for the works be ready.

6. The estimates for the Somaishweram Anicut and the Canal through the Nellore District are already before Government.

7. I shall now proceed to remark upon the different works executed and in progress and on the course of the Canal from the Sunkasala Anicut downwards.

8. The Sunkasala Anicut (across the Toombuddra 17½ miles above Kurnool) and its head works comprise—

The two branches of the Anicut.

The embankment across the intervening island and those on the north and south sides of the river above the Anicut, for the protection of the lands above from floods. A set of under or scouring sluices at the south extremity of the south branch of the Anicut.

The head sluices of the Canal, Office buildings and Stores.

9. *Anicut.*—No material alteration in plan has been made in carrying out the north branch of the work. In the south branch a deviation has been made from the line originally proposed in order to accommodate the work to the form of the rocky bed of the river. By this change a saving of 100 feet in the length of the Anicut has been effected.

10. The crown of the Anicut will be when completed 2$\frac{5}{10}$th feet higher than was originally intended, the addition of 1 foot being intended to secure an increase of head in the surface level of the Canal and the remainder to meet an alteration made in the level of the Canal bed.

11. The breadth of the work throughout at the crest will be 8 feet with a batir of 1½ inches to a foot on either side, occasionally more, to adapt it to the shape of the rocks. Its height where greatest will be 25 feet and here the base will be 14½ feet broad.

12. The body of the works consists of two strongly built walls of large rubble stone set in chunam, of thickness varying according to the height of the work, but no where less than 3 feet. The space between the walls is filled with good concrete; cross walls at intervals of about 30 feet unite these face walls. The work as far as it has been completed seems perfectly sound and good, and has not been at all affected by the fresh which has passed over it.

13. With a view to economy, and as it is not considered necessary, the cut stone coping will be dispensed with, and the crest of the Anicut be finished off with large blocks of hammer dressed stone. I see no objection to this change.

14. The longitudinal section of the work which accompanied the progress Report for June exhibits very correctly the actual state of progress, scarcely any work having been done since, owing to freshes having come down the river.

15. The north branch when completed will contain of stone work cubic yards..... 3,389
Of which are completed... 1,289

Leaving to complete.....2,100

The south branch will contain 15,403
Of which are completed 11,924

Leaving to complete.....3,479

About $\frac{3}{4}$rds of the work are therefore completed.

16. *Under Sluices*—As originally designed were to have had 12 vents, each 6 feet wide by 11 high, with cross stones for vertical shutters, semi-circular heads filled in, in front. The floor 1 foot above that of head sluice. As being built there will be 12 vents 6' 6"×11' to close with revolving shutters. The floor being 3 feet below that of the head sluice. The additional depth of the floor below that of the head sluice I consider to be decidedly advantageous.

17. These sluices have been completed up to the level of the floor. One abutment is completed, the second built within 2 feet of its full height. Nothing has yet been done to the piers above the level of the floor.

18. *Head Sluice*—Was to have had 12 vents, 6' wide by 8' high with semi-circular heads, closed in front. It is being built with 13 vents. 12 vents of 7' 3"×7 each divided into two openings by a vertical stone post. The object being to make the shutters more manageable. The 13th vent is to be 6'×7' closed with a hanging shutter. The capacity of the sluice has consequently been increased, somewhat inconveniently so, as the work now extends, leaving little room for wings, nearly across the full breadth of the channel at its head.

19. There has been an alteration made in the relative position of the head and under-sluices, their connecting wall and the south bank, the head sluice having been placed about 100 feet lower down the channel. This change was made in consequence of a fault in the rock which was discovered on digging the foundations.

20. All the foundations and flooring of the head sluice are completed. The wing walls of it nearly completed, two south vents carried up to level of covering stones. The other ten piers have been raised to an average height of 2 feet. The work is being executed in a very neat and substantial manner:

About $\frac{2}{3}$ths of the wall connecting the head and under-sluices are built.

21. *Embankments.*—North side of river will when completed contain 8,970 cubic yards of earth-work $\frac{5}{6}$ths of which are done, and 445 cubic yards of revetments none of which is done. South side of river will contain 31,532 cubic yards, of which 24,062 are finished, and 2,275 cubic yards of rough stone of which hardly any is yet done.

The embankment across the island will contain 15,000 cubic yards of earth-work and is completed to within $\frac{1}{15}$th of the full quantity. Nothing has been done to the revetment which will require 1,185 cubic yards of rough stone.

22. There is abundance of rough stone procurable close at hand, and blocks of a superior quality of granite and compact lime stone have been collected in large quantities and are fast

coming in for the cut stone work. There are 400 Stone cutters at work, and bricklayers are procurable without difficulty. Including Artificers the whole working party on the head works and three first miles of channel is at present about 1,600. The work at the head sluice is progressing actively, and work will be resumed on the Anicut and under-sluices about the end of September when the freshes have sufficiently subsided.

23. There is every reasonable prospect of all the head works, viz., Anicut, sluices and embankments, being fully completed by the end of next May or in good time for the reception of the first freshes of 1863.

24. Office buildings and stores completed with the exception of the verandah roof. I do not think that a good site has been selected for these. It is too far from the head and lies between the north bank of the Canal and river on a place liable to inundation; an unnecessary expense has consequently been incurred in giving it a high basement to keep it above flood level.

25. Expenditure on and probable ultimate cost of the head works.

The sanctioned estimates for these works is 1,25,000, I have obtained from the Executive Engineer in charge of the works a statement of his expenditure on them up to the end of July, and also his estimate of the probable expenditure that will yet have to be incurred on their completion. The former does not however exhibit the full expenditure, for the value of stores and plant chargeable to the individual works he was unable to furnish or I to procure at Kurnool. Nor is it possible by means of this statement to compare the rates at which the work has been executed with those estimated, for not only have quantities and dimensions been altered, but much rough material yet to be worked up is charged for in the past expenditure.

26. From this statement it appears that up to the end of July there had been expended by the Executive Engineer 1,10,482 Rupees, and the probable cost of work remaining to be done as estimated by him is 44,697, making a total of 1,55,179 exclusive of stores and plant.

27. The items on which the principal excess has occurred are rubble and cut stone work. In the former there will be an excess in quantity of 2,872 yards and on the work already executed a very considerable excess in rate. The alterations in the work account for the excess in quantity, but I cannot satisfactorily account for the great excess in rate on this kind of work, upwards of 50 per cent., but am inclined to attribute it to the use of concrete, if therefore a more sparing use be made of this hereafter, the remainder of the work ought to be completed within the estimated rate with the exception of the crest, for which an additional allowance must be made on account of the large size and close fitting of the stones necessary there.

28. The cut stone work was originally estimated far too low, and experience has shown that with stone of the hardness used and the mode of dressing common among workmen in this country such work cannot be done at that rate. Judging by the quantity of work yet remaining to be done and its probable cost I think that the Executive Engineer has somewhat under-estimated the cost of completing this part of the work. His rate for embankment, 1 Anna 4 Pice, appears to me rather too low; including additional raising to make up for settlement and finishing off it will not I think cost less than 1 Anna 6 Pice per yard.

If revolving shutters are used the allowance for sluice gates will probably be exceeded, I would therefore add to the Engineer's estimate—

For cut stone work $\frac{\text{co}}{100}$	2,500
For rubble or crest 1 Rupee 12 Annas per yard ...	... 2,300
For earth-work	250
For shutters	... 750
Stores, plant and sundries	10,057
	15,857
Which added to	44,697
Gives as probable cost of completion... ...	60,554
To which add sum already expended... ...	1,10,482
Probable cost of Anicut when completed...	1,71,036
Deducting sanctioned estimate	1,25,000
Making the probable excess...	46,036

29. Canal between Anicut at Sunkasala and Hindry Aqueduct near Kurnool.

The length of this portion of the Canal is 17⅓ miles. It here runs parallel to and not far distant from the river and, with the exception of the 3 miles at its head, and that adjoining the Aqueduct, has a bank on the lower or river side only.

30. The fall was to have been 10 feet between the floor of the head sluice and that of the Aqueduct. It actually has, as I am informed, a fall of 11$\frac{5}{10}$ feet, the head of the channel having been raised, whereby a saving in excavation has been effected. This fall is unequally distributed varying, inversely as the breadth of the channel, from 20" per mile to nearly nothing in parts.

31. The breadth is very variable, but in one part only (the 3rd mile where it is as narrow as 75 feet) is it less than 90 feet at bottom; but generally it is much broader and in most parts a considerable breadth of land on the upper side will be submerged. This land is mostly waste or of a very inferior class. One small hamlet has been removed which stood in the course of the Canal.

32. The height of the bank above the ground also varies considerably. It averages about 16 or 17 feet, but in places where it crosses water courses it is occasionally as high as 34 feet. Its top breadth is from 6 to 9 feet, and the average of a number of sections gives it a mean sectional area of 70 square yards. Since first thrown up it has sunk from 1½ to 2 feet, and will do so yet still and have to be raised to bring it to the designed height of 4 feet above the Canal water level.

33. The slopes vary from 1·1 base : 1 height to 3·3 base : 1 height. The mean being about 1·8 base to 1 height. The soil of which the bank is composed is mostly of a very inferior description being either black cotton earth or a silty soil of a worse quality still. Gravel occurs in places.

34. The quantity of work in this portion of the Canal according to the estimate, is

14,10,215	Cubic yards of earth-work in excavation and embankment.
8,49,672	Cubic yards of rocky cutting or excavation.
22,59,887.	

From a number of rough sections which I had taken, I calculate the quantity of material thrown up in the bank to be rather better than 23,00,000 cubic yards.

35. The banks however still want much trimming, dressing and raising; two large breaches, purposely left open in the 15th and 16th miles, have to be filled in and masses of rock in the 3rd, 4th, 5th, 6th, 7th, 14th, and more especially in the 1st and 17th miles yet remain to be removed. The quantity of earth-work yet remaining to be done is estimated by the Engineers at 92,480 cubic yards, and of rocky excavation at 21,900 cubic yards. The former quantity I take it to be under-estimated, but when compared with the quantity actually executed, what remains to be done is small and the work may be said to be nearly completed. With ordinary activity the whole should be completed by the end of the present year. There are at present 2,523 men and women coolies and 64 buffaloes employed between the 3rd and 18th miles.

36. In the estimate, the proportion of earth-work to rocky excavation is as 14 to 8½, what relation the one bears to the other in the mass actually removed would in the present irregular and incomplete condition of the work be impossible to state with any accuracy. In the three upper miles of the Canal where the section is best defined and where the rocky excavation bears a large proportion to the earth-work, the estimated quantity of work is 1,99,985 cubic yards of earth-work: 4,11,680 cubic yards of rock, total 6,11,665 cubic yards. The Executive Engineer states that the actual quantities in these three miles (which do not correspond with those in the estimate) will amount when the work is complete to 6,00,188, being about 11,500 cubic yards less than the estimate.

37. The channel here has an average width at bottom of 103 feet and supposing slopes of 2 to 1 (which is more than there are) a mean width of 119 feet, allowing then for the difference of width between this and the estimate and the diminished depth due to the raising of the channel head I calculate that there are about 30,000 cubic yards less of work and this mostly rocky excavation in these three miles.

38. These calculations are necessarily founded on somewhat rough data, but the comparison has been made favorably for the work, and I think that when it comes to be measured, as it should be on completion, it will be found that, though the total quantity of work executed may be equal to or even in excess of the estimate, the relative proportion of rock to earth will be less, a fact which must of course affect the rates.

39. The estimated cost of the Canal excavation and embankments is 3,97,966
Add proportion of sundries 23,008

4,20,974

The actual expenditure in cash by the Executive Engineers up to end of August was 3,78,981
Probable cost of completion 26,863

4,05,844

But this does not include either temporary establishments or tools and sundry expenses. I have not yet been able to ascertain either from the local Officers or the Agent what sums are chargeable on these accounts to the different works. It is probable however that the sum to be charged to the Canal on this score will at least swallow up the balance remaining of the sanctioned estimate and possibly cause an excess, but the excess should not be large, and my opinion is that the work has been very economically executed.

40. I have not included in the above Statement of expenditure a sum of 5,920 Rupees expended in rough pitching a length of 1,565 yards of the Canal bank in the 6th mile, no allowance having been made for this in the estimate.

41. I was much struck by the very weak and insecure appearance of these banks. They are of a considerable height, average 16 or 17 feet, rising in one place to 34 (above the natural level of the ground), are formed of a very loose and friable soil for the most part loosely thrown up with insufficient slopes, 1·8 base : 1 height, and in many parts of the Canal will be subjected, in consequence of the extensive outspread of the water, to a very violent and destructive action of the waves when agitated by strong gales of wind ; to protect them from such action they have with the exception of the 6th mile, no revetment.

42. Such revetment I consider to be indispensably necessary for a very considerable length of the Canal, and until it is formed, I look upon the banks as decidedly unsafe ; but even with this there will always I think be a considerable amount of leakage through these black Cotton soil banks, resting on a thin stratum of soil, which again rests on the bare rock. Even now wherever the rain water has lodged in little pools above the bank a corresponding pool is invariably seen on the lower side. The leakage will be necessarily much more considerable when there is a great head of water in the Canal. I suppose that at least 7 miles of this bank will require to be revetted, which judging from the cost of the part already completed would amount to 46,599 Rupees, but the rate may I think be reduced from 12 Annas to 8 Annas which would reduce the cost to 31,066.

43. A deduction of 20,000 Rupees was made from the total of the Canal estimate for the value of stone ; what amount has been already realized on this account I do not know, but have reason to suppose that it is small. Much of the material may however be brought to use hereafter for the revetment.

44. *Calingulahs and culverts between Sunkasala and Kurnool.*—The estimated cost of these works was as follows :—

		Estimated cost including sundries.
9	Calingulahs	22,689
11	Culverts	21,135
		43,824

The number of calingulahs was to have been nine, of a total length of 3,240 feet and with an effective water-way of 2,450.

45. These nine calingulahs are nearly completed. Their lengths have been somewhat altered. Their total length being 3,149 feet, effective water-way 2,362 feet. But a 10th calingulah 100 feet long, on a very low level (at present entirely buried in the bank) has been added at a distance of 3 miles from the head, which it is intended to use if necessary as a large under-sluice to scour the upper part of the channel. There are also 34 feet length of calingulah over one of the culverts, so that the means of discharge (already more than enough for a drainage of only 42 square miles) have been slightly increased. The fault is however on the right side.

46. Some of the calingulahs have had openings left in them for the discharge, in case of rain, of land floods, and others are left open for the purpose of having irrigation sluices formed in them, and under-sluices have been made in several of the calingulahs.

47. Considerable deviations have been made from the original plan in the case of the culverts.

A square culvert in No. 4 mile has been converted into an oval one. This culvert is objectionably short, straightening the banks at the point where it is placed and likely to cause a dangerous set of the current. It will be lengthened.

A four vent culvert in No. 9 mile has had the middle pier removed, and the two middle vents thrown into one, thus forming a road-way large enough for cattle and small carts under the Canal, which will be a very great convenience.

48. I may here observe that the inconvenience which the inhabitants of the villages situated near the Canal will suffer from the stoppage of the thoroughfare must be very serious, and the ferries proposed to be established will but very imperfectly remedy this evil. It is therefore very desirable that as many of the culverts as possible should be made sufficiently capacious to admit of the passage of men and cattle and, when circumstances will admit, of small carts under the Canal.

49. In the upper part of the Canal two culverts have been dispensed with altogether, and three have been superseded by drains conveying the water into the Canal.

50. The estimated cost of the calingulahs and culverts as stated above is Rupees... 43,824
Their cost when completed will be... 53,271

Giving an excess of... 9,447

which is probably rather less than the truth as something will have to be added for stores and superintendence.

51. These masonry works differ so entirely from those originally planned that it is impossible to say, without taking accurate measurements of all, whether this excess arises from increase of quantity or increase of rate. Foundations had to be given to many of the works when none were allowed in the estimate (as the site showed the presence of rock), and a calingulah not provided for at all in the estimate has been built, but on the other hand some works have been altogether omitted. Increase in quantity will probably partly account for the excess, I believe that the rate of 2 Rupees 8 Annas per yard allowed for rubble masonry in chunam has not been found generally sufficient hitherto, but work is now I understand being done within this rate.

52. Of the twenty irrigation sluices two have been completed according to the sanctioned plan, six on a plan slightly different and two have been made in the calingulahs. There will be no excess on those works when they are completed.

53. Nothing has been done to the distributing channels, and the channels for the surplus water below the calingulahs have not been commenced. No tunnels have been built.

54. When inspecting the head sluice I observed that the two south vents, which, as before mentioned, are further advanced than the others, had been cut off from the rest of the work by a temporary dam. This I was told was done when it was contemplated to admit water into the channel for irrigation in June last. That water could have been so passed down the channel there can be no doubt, but that it would have been most imprudent and dangerous to have done so, is equally certain. The bank when I inspected the works in August, as may be

gathered from what has been said above, was incomplete, the masonry works along the channel not finished, and the rocky excavation in many parts yet in progress. The state of affairs must have been still more backward two months before.

To have admitted the river water through such an insecure head opening, with the chance of high freshes finding their way bodily down the channel, would have been exposing the bank to a very great risk.

Moreover all work in the channel must have been suspended or greatly delayed, for irrigation, to be of any use, must have been carried on to the end of the season; and after all what advantages would there have been to compensate for this? There are only 2,000 Acres capable of irrigation between Sunkasala and Kurnool, not one-half of which would have been brought under wet cultivation this year, so that for a prospective gain of 4,000 Rupees, all works along the channel and at the head must have been stopped, or greatly delayed, and the channel banks have been exposed to a most unnecessary and dangerous trial.

55. *Bellary road bridge across Canal at Kurnool.*—The piers and abutments of this have been carried up to the springing line of the arches. As the bed of the Canal has the same level as the road-way, which a bridge across the Hindry would have, and as the road-way of the bridge across the Canal will be 25½ feet higher than the bed of Canal, this structure with its enormous banked approaches will necessarily be both inconvenient and unsightly. It is to be regretted that a swivel bridge, or one on some other plan which would not have required such a great rise, was not adopted at first, and I would recommend that this question be re-considered, before the arches of the bridge are turned. There is another approach, but little more circuitous, and with sufficiently easy slopes under the abutment arch of the Aqueduct. The objection to it is that occasionally the Hindry when in high fresh floods it. But this happens so very rarely, and such floods are of such short continuance, that practically the objection has little importance, at all events this road under the arch would answer all purposes, until the question about the best form of bridge to build above, were decided.

56. *Hindry Aqueduct.*—The piers and abutments of this work have been carried up to the springing line of arches, the wing walls have still to be raised 9½ feet higher.

57. I am rather at a loss to know why it was ever intended to turn the arches of this Aqueduct with bricks, bricks never having been before used at Kurnool, and the soil being particularly unfavorable for their manufacture, whereas stone well adapted for building, is abundant, and in general use. I presume that it was supposed, that time and money would be so saved; if so, that expectation has been disappointed, for the trials which have for several months been made to manufacture bricks sufficiently good for the purpose, have hitherto failed, and it appears to be pretty clearly proved, that if bricks of a sufficiently good quality, can be manufactured at all, they will prove to be quite as expensive as stone. The idea of using brick has therefore I believe been at last abandoned.

58. Each of the 14 40 foot arches of this Aqueduct is 102 feet long, and judging by the rate at which the other masonry works have progressed, and the means at the disposal of the Engineers, I do not think that the whole of this work can be completed by next June.

It has however been suggested, and the suggestion has I believe been adopted, that the arches might be turned in separate and independent sections or ribs, so that a part, say ⅓rd of the breadth of the Aqueduct may be completed this season. If this plan, which has in my opinion other advantages to recommend it, be adopted, as much water may be carried across the Aqueduct next season, as will amply suffice for all the land lying under that part of the channel below Kurnool, which is likely to be completed.

59. This large work as far as it is completed appears to be well and solidly built. Much more difficulty than was anticipated was found in carrying down the foundations on the right side of the river to rock. It was however, I am informed, done at last, and the work may therefore be considered perfectly stable.

60. The estimate for this work was 1,45,000 including 13,113 for sundries.

	Rs.
The expenditure up to the end of August was...	77,717
And the work remaining is estimated at...	1,05,730
Making a total of.....	1,83,447
Being an excess on estimate of...	38,447
The principal items of excess will be baling and excavation estimated at 1,700 excess...	7,904
Rubble excess in quantity...	13,369
Cut stone excess in quantity and rate...	3,024
Arch work...	16,705

Of the allowance of 13,113 for superintendence and sundries, 11,660 have been spent, although the work is not half done, so that an addition will have to be made on this account. Allowing 3,500 additional only for this (which is very moderate) will bring the total excess up to 41,947.

61. I calculate therefore that the excess on all the works down to this point, viz., on the Anicut and head works 17⅓ miles of channel and masonry works, and the Hindry Aqueduct will amount to very nearly one lac of Rupees, being about 14 per cent. on 7,30,000, the total amount of the estimates for them.

62. I do not consider this over-expenditure to be excessive, on the contrary, taking into consideration the novelty and magnitude of the work, the scantiness of labor and increasing cost of it, and the numerous difficulties and discouragements which have had to be encountered, I think that great praise is due to the Officers of the Company for the intelligence, zeal, and industry which they have exhibited, and especially for the care which they all show, in husbanding the resources of their employers.

63. *From Hindry Aqueduct in 18th mile to 43rd mile.*—The excavation and embankment of the Canal are in progress along this portion, but no masonry works have been begun yet.

The 18th mile has only earth-work, about ¼th of it is finished.

In the 19th mile, there is besides embankment much heavy rocky excavation. Some considerable progress has been made probably from ⅓ to ½, but the work does not appear to be getting on very rapidly, and the parties of work people engaged upon it are not large.

In the 20th mile where there will be still heavier rocky excavation, nothing whatever has been done.

64. The estimated rate for the rocky excavation in these two miles varies from 3 Annas to 5-4 per cubic yard, the average being 4½. This I am confident will be insufficient, the rock being for the most part of a most difficult kind to deal with, and containing hard quartz boulders, which can neither be picked nor blasted.

65. In the 21st, 22nd, 23rd miles about ⅔ths of the earth-work are completed, but not $\frac{1}{10}$th of the rocky excavation.

In the miles 24—30, the progress made is small, but the work is going on, though not apparently with much spirit.

31—34 miles, good progress has been made with the embankment, and the work is well advanced, and proceeding satisfactorily, no rocky excavation done yet.

35 and 36 miles. Not commenced.

66. 37 and 38 miles. Some progress made. The Executive Officer complains of the insufficiency of the rate, and I think with reason.

The rates in these two miles are, for embankment 1 Anna 6 Pice and for rocky excavation from 1 Anna 3 Pice to 3 Annas 6 Pice, average 2 Annas 5 Pice. The soil is black Cotton to a very slight depth, resting on clay slate rock, so that what little earth there is, is soon exhausted, and the coolies have to go for a considerable distance to get earth for the embankment, 1 Anna 6 Pice per yard for such work is evidently insufficient, as is also 2 Annas 5 Pice for the rock, though it is easily split.

With the exceptions above noticed and a few other places similarly circumstanced, the rates for earth-work from the Hindry to Nagatoor, seem sufficient; but I cannot say this with respect to the rocky excavation. The rates for this vary from 1 Anna per cubic yard, to 5 Annas 4 Pice, the average being 2 Annas 4 Pice, and although the rock is a laminated clay slate, not generally hard to work, and the excavations are not deep, I consider this rate to be insufficient, and that there must be an excess on this item of the estimate.

67. 39th mile.—Nothing done.

40th and 41st mile.—Work just begun.

42nd bank nearly completed, but some cutting remaining to be done. No people at work.

43rd nothing done. In this mile the Canal will fall into the Nagatoor tank.

68. The whole quantity of work to be done, between the Hindry Aqueduct in the 18th mile and the Nagatoor tank in the 43rd mile is,

Earth-work.....34,77,251 Rocky excavation 8,16,568.

Total work done.. ....9,15,912. do. 32,874, being about $\frac{1}{4}$th of the former and $\frac{1}{16}$th of the later.

69. There is a strength of about 7,000 coolies at work on this portion of the line, and if, as has been recommended to the Chief Engineer, $\frac{1}{3}$rd in breadth only of the channel be excavated this season, water may be conveyed down as far as the Nagatoor tank, and possibly a little further, so as to bring a considerable quantity of land under irrigation, during next year's freshes, but I do not think it will be practicable to complete the whole of this part of the channel to its full breadth by next year; in fact I feel certain, that it will not be done.

70. The soil generally on this part of the Canal course, is of a better description, than that above Kurnool, though black Cotton soil occurs in many parts. The Canal will be mostly single banked, the water over spreading the ground on the upper side to a very considerable extent, especially opposite to the villages of Purdapad, Realumpad, and near Ulloor, where large tanks will be formed. In these places and others where the soil is bad and the banks high, revetments will be essentially necessary for their safety, but I cannot find that any provision for this has been made in the estimates.

71. The additional risk which the banks will be exposed to, and the consequent expense of revetting then, due to the adoption of the single bank mode of construction, added to the injury inflicted on the Ryots by the submersion of much rich and valuable land, of which about 6,000 Acres will be sacrificed, go far in my opinion to counterbalance any advantages to be gained from it.

72. *Canal from Nagatoor to Metacondal cutting.*—Little has been done beyond marking out the course of the Canal. In the 43rd mile a party of 500 people are at work, and about 5,000 cubic yards have been excavated. Ground has just been broken in the 49th mile, and 200 coolies are at work there; work will also soon begin in the 54th, 58th and 59th miles: work has begun in the 62nd, 68th, 69th and 70th miles, the working parties amounting to about 700 men and women.

73. *Cutting near Metacondal.*—This cutting carries the Canal, in the 71st and 72nd mile of its course, through the water shed into the valley of the Kundaur. It is 1 mile 66 chains in length, is to be 64 feet broad, with perpendicular sides, and the fall through it will be 1 foot in a mile. The depth of excavation where deepest will be 28 feet, of which 21 feet in depth is rock, diminishing to nothing on either side. As originally estimated there would have been 1,95,526 cubic yards of excavation in rock at 8 Annas, 95,705 of earth at 1 Anna 6 Pice, but there appears to have been some mistake as to the depth of soil above the rock (as will be seen from the accompanying rough section of the cutting, which shows the actual state of the work) which made the proportion of rock to earth, appear less than it really is. By what quantity the rock excavation will be increased on this account it is impossible, without more accurate sections to say; it may possibly amount to 20,000 cubic yards.

74. All that has yet been done, is to remove the earth down to the surface of the rock, for a length of 1 mile. The quantity so removed is 61,100 cubic yards, and it has cost 2 Annas per yard, it being estimated at 1 Anna 6 Pice. Whether the rock excavation can be done at the estimated rate of 8 Annas per yard is doubtful. The rock is a red clay slate laminated, and not very difficult to break up and remove in slabs, and has not been found, in one trial pit, to become very much harder below, than at the surface. It is just possible that by the use of derricks for raising the soil in the middle of the cuts and rails at the two ends, and by very careful management the work may be done at or near the estimated rate, but as I before said, I think it very doubtful. A Contractor who had undertaken to execute this work, has, I am informed, just thrown up his contract.

75. The stone taken from this excavation is of a very inferior quality, and not fit for use in buildings, if exposed to the action of water. A Contractor who is collecting materials for a bridge in the middle of the Metacondal cutting, is carting his stone for the work from a quarry distant 1 mile, that procurable on the spot, being considered unfit for the purpose. But a sum of 30,000 Rupees has been deducted from the amount of the estimate for the value of this stone. This deduction cannot be admitted.

76. There appears to be no rocky excavation necessary between the 43rd mile and the Metacondal cut. But the rates allowed for earth-work are from 1 Anna 2 Pice to 1 Anna 6 Pice, which appear to me too low, in the 36th, 37th, 50th, 51st, 52nd, 53rd, 54th, 55th, 56th, 57th, 58th, 62nd and 63rd miles, the largest tanks on the line are formed, and the banks there will be of considerable height, in some places as high as 34 feet. The rates allowed, are in my opinion, insufficient for such work.

77. An allowance of 20,000 Rupees has been made for rubble pitching to the inside slopes. But the rate 2 Annas per square yard allowed, seems too low. If the revetment be $\frac{1}{3}$rd yard thick, it would be 6 Annas per yard. The revetment actually put up above Kurnool, has cost just double this, 8 Annas per yard seems to me to be a fair price, and I do not think it can be done for less.

78. It is said, that however high a rate may be, Natives will always contrive to work up to it, and that it is therefore advisable, to fix the rates at a figure lower than the work can really be done for, since, even if the rates be exceeded, the work is in the end done cheaper than it would have been, had the estimates been framed more liberally or fairly. There is doubtless some truth in this, but if work is to be executed by contract, it is bad economy to make a rate so low, that no fair margin for profit is left. In such cases, Contractors after trial throw the work up, and the result is much delay, increased outlay on fixed establishments, and the postponement of remunerative returns. I cannot help thinking, that if the rates in this project had been somewhat more liberal, the work would have progressed more rapidly, and profits have been more quickly realized.

79. No work has yet commenced below the Metacondal cutting, just below it a calingulah 300 feet long in the left bank, will discharge a large portion of the water into the Caulee river; the remainder proceeding along the Canal, the dimensions of which will be reduced. The Canal drops by a series of locks, until it falls into the Caulee at Jootoor. At Jootoor there will be an Anicut, locks, head sluices, &c., all of which are described in the Chief Engineer's specifications already submitted to Government.

80. Between the Metacondal cutting and the Caulee Anicut at Jootoor, *i.e.* from the 72nd to the 91st miles, there are to be 12 locks, 11 culverts, 4 ferries, a calingulah, and a bridge, what the cost of these locks will be is uncertain, for their size and plan are not yet finally decided upon, but for works of that class, they will be comparatively cheap, for they will be almost all founded on rock. The same remark applies to the locks lower down.

81. I examined the site of the Caulee works shortly after the occurrence of a fresh in the river, and found the rock to be so friable after submersion, that I do not consider it to be capable of resisting the action of water, whether falling over, as in the case of an Anicut or scouring as in that of a sluice. Provision must accordingly be made (which has not been done in the estimates sent up to Government) for a hard stone apron for the Anicut and linings for the vents of head, surplus and feeding sluices.

82. After crossing the Caulee at Jootoor, the Canal is continued on its left bank, passing several small drainages and cutting through the Byap Goodoor tank. The portion of the tank bed below the Canal will be converted into Nunjah, and the upper portion of the tank will

be enlarged, so as to make up for the part cut off. From this the Canal proceeds to Nundyal passing above the two large Nundyal tanks, and crossing their supply channel by an Aqueduct or culvert of 5·20 foot vents.

83. I think it would be advisable to hand over this tank bodily to the Irrigation Company, on the condition of their paying annually to Government a sum equal to the average annual revenue less cost of repairs. It would be advantageous to them as their cost of construction would be diminished, and the quantity of irrigated land under the tank, would be largely increased, and it would be advantageous to the existing irrigation, for the supply of the tank would be rendered more certain and more abundant. I believe that the Company would be willing to take over the tank on these terms.

84. Below Nundyal the Canal will proceed along the water shed, between the Kundaur and Vykaloor up to their junction at the 148th mile near Changulmurry. This is an extremely favorable and easy portion of the line. There is absolutely no drainage to cross, the cuttings and embankments, except near the locks, are by no means heavy, and there will (excepting in those places) be no rocky excavation. There will however be 18 locks in this distance, but they should not for the reasons above stated be expensive.

85. The course of the Canal down to the 118th mile has been finally decided upon. I append two sketch maps and a description of it, which I received from the Executive Engineer in charge of that range. The estimates down to Nundyal (the 103rd mile) are now before Government, and those as far as the 118th mile may soon be expected.

86. I see no reason to fear that the cost of the work, between the Metacondal cutting and the junction of the Kundaur and Vykaloor will exceed the Chief Engineer's estimate. There are no engineering difficulties on this portion, and the work will be (locks excepted) by no means costly.

87. Below the 148th mile above the Kundaur and Vykaloor junction, the course of the Canal had not been finally settled, as to its details when I visited the place. The following is a general outline of the scheme.

88. The Canal crosses the Vykaloor by an Aqueduct, but some way above this point an Anicut will be thrown a cross the Kundaur and a channel cut from it to the Canal, the object of which is, to return to the Canal the water, which it will be remembered was allowed to escape higher up across the Caulee Anicut.

89. The immediate construction of this Anicut does not appear to me to be absolutely necessary, and should I think be deferred, until it is known, whether the Canal itself can or cannot carry all the water which it receives from above. Without this Anicut the Kundaur water would find its way into the Pennair, and be picked up lower down.

90. After crossing the Vykaloor the Canal proceeds in a somewhat devious course by Dhoor and Chitta Kontah and north of the Poospagherry hill to the Pennair at Adamapillay (below Komaloor on the map) where it will cross that river by an Anicut.

91. The question was raised, as to whether an Anicut or Aqueduct should be built at this place. I obtained from the Executive Engineer a rough estimate of the cost of both works. He makes out that the Aqueduct with its approaches would cost about 4 lacs of Rupees more than the Anicut. It appears to me that this difference has been much over-stated, but there can be no doubt, but that the one work would be much more costly than the other, and as I find that no line of road crosses the river at this point, no convenience would result from the use of the Aqueduct as a bridge, and there being several other objections to it, I have no hesitation in saying that the idea should be altogether given up.

92. The Adamapilly Anicut will be 2,400 feet long (exclusive of under-sluices) 850 of which will be on rock, the rest on sand. Height of crest 11 feet above deep bed of river. Area of water-way obstructed $\frac{1}{4}$th of greatest sectional area in flood.

93. Starting from the Anicut, the Canal is carried towards the Cuddapah Cantonment, which it skirts on the south side, passing the Boogoo River by an Aqueduct of 20 30 feet arches, the bed of the Canal being 11 feet above that of the river. It then crosses the old road from Chennoor to Cuddapah, passes between the lower part of the town and the upper part of the

Cuddapah large tank. A few huts only will be destroyed near the road. The supply channel of the Cuddapah tank is crossed by an Aqueduct of 3·18 foot arches. It then crosses the road from Cuddapah to Devah Cuddapah where a bridge will probably be necessary. It then trends to the north-east passing near the village of Namonpillay until it meets a range of hills running in a north-westerly direction and bounding the Cuddapah valley on that side. It runs along the foot of this range until it meets the Pennair just below the junction of the Booggah with that river.

94. It will be seen from the Memorandum by Mr. Clarkson, the Exective Engineer, (herewith forwarded) in which he describes the intended course of the line from above the Kundaur and Vykaloor junction to Cuddapah that some heavy masonry works (besides the Anicut across the Pennair) have to be constructed during that distance.

95. The really formidable difficulties however only commence at the point where the Canal strikes the Pennair near the junction of the Boogah with that river. The present design is to carry the Canal along the south bank of the river shaving the different spurs and traversing the intervening vallies as far as a village (Kaligherry) a little above the confluence of the Cheyaur with the Pennair. The Bluffs above this confluence and a little distance below it which are very formidable and the difficulty of crossing the Cheyaur, it is proposed to avoid by means of an Anicut 18 or 20 feet high to be built across the Pennair near Doongasonne 3 miles lower down, which it is supposed will back the water up some distance above the bluffs on the left or upper bank of the Cheyaur and render that part of the river bed navigable.

96. The eventual construction of another Anicut across the Pennair just above the Cheyaur is also contemplated by the Chief Engineer, to obviate the obstruction likely to be caused by the accumulation of sand at the confluence of the Cheyaur.

97. Below the Doongasonne Anicut the channel will be resumed on the south bank and carried to a point a little above the Somaishweram (the last and lowest) gorge. In this gorge the river bed is to be rendered navigable by the damming up of the water by an Anicut to be built just below the gorge at Somaishweram.

98. Besides the difficulties in the Doongasonne and Somaishweram gorges which it is intended to pass by means of Anicuts, as abovementioned, several have to be encountered higher up which must be overcome by other means. There are three difficult and hard rocky spurs at Guindy just below the confluence of the Booggah, 23 chains in length. Rock, vitrified sand stone and slate. Cross section about 2 to 1. Opposite Sideout a rocky projection. Slate Slopes 3 or 4 to 1. A little further on 3 spurs. Cross section 3 to 1; $2\frac{1}{2}$: 1 and $1\frac{1}{2}$ to 1. Length 56 chains.

99. Above Pennypayroor there will be a rocky cutting between two hills of about 870 yards in length and an average of 1 yard deep.

100. Near Bundalapilly however the most formidable of all the difficulties occur. There is first a detached spur 350 yards long with cross section of 2·1. A small valley and then a steep face of rock coming down to the river, 5 chains in length. Section 2·1. Then 16 chains, very precipitous, making an angle of from 10° to 25° with the vertical. Then 12 chains with slopes of 2·1.

101. A tunnel through a rocky hill near Coormaloor 176 yards in length will also be required.

102. It is proposed to pass these rocky spurs, where the face of the rock is not too steep, by partially cutting into the rock and building up a wall resting on the toe of the slope on the river side.

103. But at Bundalapillay the face of the rock is too precipitous to admit of this, and the Canal must be carried along the river at the foot of the rock either by means of a river wall built upon wells or on a rough stone bank. I am of opinion that the latter is the plan to be preferred. A mass of rough stone blasted from above and thrown in, if a sufficient slope is given it on the river side, will soon settle permanently and be afterwards unaffected by the action of the stream. This mode of construction has the advantage of cheapness and facility of execution, whereas a river wall on wells would be difficult of construction and much more expensive.

104. I roughly estimate the cost of building a Canal 30 feet broad on a rough stone bank, with a proper flooring and towing path at 100 or 120 Rupees per running yard. The cost of forming a Canal of the same breadth by part scarping and part wall will be from 50 to 60 Rupees per yard.

105. While examining the difficulties along the proposed course of the Canal along the south bank, I could not help being struck by the apparently less formidable nature of the obstructions which the north bank of the river presented. The rocky spurs on the north bank at Guindy are less formidable than those on the south bank opposite. A little below near Ponisale there is one very precipitous bluff on the north, but it is of no great length and between that and the Cheyaur there are no other serious difficulties whatever on that side. Down to that point therefore it would be decidedly in my opinion easier to carry a Canal by the north than by the south bank (an Aqueduct across the Suggelair excepted). Opposite to the confluence of the Cheyaur and further down at Doongasonne there are two long and difficult faces on the north side but they are not as far as I can judge so difficult, but that a 30 feet Canal might by scarping and building be carried along them. They are unquestionably less formidable than the corresponding difficulties on the south bank which will necessitate the construction of one if not two Anicuts.

106. I cannot help thinking that these Anicuts are a very cumbrous, expensive, and inefficient mode of completing the navigation, and that if they can possibly be dispensed with even at some increase of cost, it should be done. I feel confident that the water will not be found to stand so high above them as is calculated upon, that the accumulation of sand on their upper side will seriously obstruct the traffic and encumber the locks and if of considerable height they will be exposed to risk and cost much in repair.

107. My opinion is that at little, or no increased expense, the Canal may be carried along the rocky faces, and the two Anicuts at the Cheyaur and Doongasonne be altogether dispensed with, and if this be done, the north bank of the river I certainly think presents greater advantages for the course of a continuous Canal than the south.

108. It seems to me also to be a question whether it would not be better to dispense also with the upper Anicut at Adamapillay and bring the Canal by the north bank at once to the Guindy spurs avoiding Cuddapah altogether. Several miles of Canal would so be saved. By doing this some advantages would be unquestionably sacrificed. The communication with Cuddapah and the present line of the Railway would be lost, the opportunity of irrigating the Cuddapah valley and an additional supply of water from the river there, be given up.

109. If it be deemed unadvisable to sacrifice these advantages the upper Anicut might be built below the Poospagherry hill, where it might probably be founded on rock, and the Canal be taken off on the north side, a branch only being taken from the south side for communication with Cuddapah and irrigation, if there be water enough. But my idea is that all the water which is ever likely to be brought down the Canal from the Toombuddra will be barely sufficient for the supply of the irrigation, which is very extensive, in the Kundaur Valley, and for the feeding of the Canal as a navigable one down to Somaishweram.

110. I would strongly advocate a careful examination and survey of the north bank of the Pennair with a view to determining whether the facilities offered on that side for a Canal are not greater than those on the south bank, and especially whether by adopting that bank it would not be possible to make the course of the Canal continuous down to the Somaishweram gorge and so dispense with the Anicuts at Doongasonne and the Cheyaur.

111. As the designs of the works below the Kundaur and Vykaloor junction are not made or even the surveys completed it is impossible for me to offer any certain opinion as to the probable cost of this portion of the line. The masonry works will, as above observed, be heavy, the difficulties along the Pennair are of a very formidable description and the expense of overcoming them, whatever mode of doing so be adopted, must be great, and I think that the excess over the original rough estimate is likely to be considerably larger here than on any other part of the line.

112. The site selected for the Somaishweram Anicut appears to me to be good, and as there can be no doubt about the indispensable necessity for this work, permission to proceed with it at once should be accorded. This work should certainly have a head sluice on the north as well as on the south side.

(Signed) S. O. E. LUDLOW, Lieut.-Colonel, R. E.,
Late Offig. Cons. Engineer for I. & C. Company.

No. 376. MINUTE BY THE HONORABLE THE PRESIDENT.

1. I have read carefully Colonel Ludlow's report upon the works of the Irrigation Company from the Anicut at Sunkasala to Somaishwaram, which is a valuable document, as it not only brings before the Government the state and progress of the works already commenced, but affords some means of judging of the plans which may hereafter be submitted for the completion of the works. It would seem that the excess of expenditure upon the first section, that from Sunkasala to Metacondal, will be in all probability at least 14 per cent. above the estimate, and lower down near the Pennár the works will be more expensive, more difficult, and the excess naturally greater. The point, however, to which I wish to draw the attention of the Government and as to which it seems necessary to make some regulations at once, is the formation of the Canal with only one bank. The Engineer suggested that he should be allowed to substitute a dam for a sunken Canal on the ground that it would be less expensive, and to this the Government acceded. The objections to this were that a quantity of land would be submerged, the amount being variously estimated by the Engineer and the Collector. It appears from Colonel Ludlow's report that the bank by which the water is retained in the Canal has been made of bad materials, of imperfect section, and is likely to receive constant damage. Lower down again the amount of land submerged is stated to be 6,000 acres. The view taken by the Government was that any landt required for the Canal should, under the agreement with the Company, be granted free of charge, bu that this was not intended to cover such land as the Engineer by a change of plan might submerge unnecessarily. I am not aware whether any distinct understanding has been come to on the subject, but looking both to the safety of the work, and of the people who may live below these banks, I am of opinion that directions should be given to the Engineer of the Company to arrange his plans for the whole of the sections of the work not commenced, so as to retain the water of the Canal between two banks, providing of course for the drainage of that part of the country which is below the surface water of the Canal.

2. With reference to the first section where the work has been laid out and commenced in places, the Engineer should be directed to mark off such land as he would consider sufficient to form the Canal with two banks, and the Consulting Engineer should then report as to the competency of the amount required, while the Collector should require the Engineer to compensate the Ryots for any land, in excess of the amount required, which may be taken or inundated by the Engineer. The Company gains largely, at least so says the Engineer, by the single bank arrangement; there is no reason why the Government should pay for this saving by furnishing an additional quantity of land.

3. The suggestions as to the Bellary bridge should be referred to the Engineer, who should be requested to see whether the proposed high level bridge might not be modified.

4. The suggestion as to the Goodoor tank seem's to be worthy of consideration, better refer to Board of Revenue. The suggestion as to the work on the Pennár may be submitted to the Engineer of the Company.

20th November 1862. (Signed.) W. T. DENISON.

No. 377. MINUTE BY THE HONORABLE Mr. E. MALTBY.

1. Lieutenant-Colonel Ludlow's report is a clear and valuable paper, and will aid the Government in dealing with future questions connected with the Irrigation Company's operations. As however it is circulated without the previous papers and correspondence my remarks will at pre-

sent be brief. The question of a single embankment for the Canal has assumed an importance of which I was not aware. As far as I recollect, permission was given for this course, upon urgent application, *in one particular locality only*, and the Company were then informed that they must pay for the land submerged by them, as Government could do no more than supply the land required for constructing the Canal according to the original plan. I had no idea that so much of the Canal was being constructed in this exceptional manner and the subject deserves the attention called to it by the President.

2. I concur in the President's remarks regarding the Bellary bridge and Goodoor tank.

3. Paragraph 48 of Colonel Ludlow's report requires careful notice. The Honorable Mr. Morehead more especially drew attention to the point that the plans of the Company's Officers did not provide sufficient means for crossing the Canal at different places, and orders were given that this inconvenience should be provided against. Why has not this been done?

4. Paragraph 54 shows that instead of Government raising any unnecessary impediment to the commencement of supplying irrigation in the past season, the Company's works were in no fit state for such an impediment. The sum gained would have been very trifling, and the damage and danger great both to the Company's works and the adjoining villages. It is clear that even now water could not with safety be admitted into the Canal until its banks have been revetted and strengthened. It is desirable that the principal papers connected with the Irrigation Company's affairs should be collected and arranged in book form, so that the Members of Government may have them at hand for reference when future points come under consideration.

10*th November* 1862. (Signed.) E. MALTBY.

No. 378. MINUTE BY THE HONORABLE MR. T. PYCROFT.

I concur in the remarks made by the Honorable the President and by Mr. Maltby. It seems to me, too, to be very desirable that this report and the orders which may be passed upon it, should be at once communicated to the Secretary of State, that he may know precisely what is the present state of the works and their prospects.

12*th November* 1862. (Signed.) T. PYCROFT.

No. 379. ORDER THEREON, 19th December 1862, No. 3,045.

1. Colonel Ludlow's report dated 29th October 1862, No. 76, recorded above, is a clear and valuable paper, as it not only brings to the notice of Government the state and progress of the Irrigation Company's works already commenced, but affords some means of judging of the plans which may hereafter be submitted for their completion, and will therefore materially aid the Government in dealing with future questions connected with the Company's operations.

2. Colonel Ludlow* divides the scheme as follows:—

(1.) Between the head at Sunkasala, and the Metacondal cut, a distance of 72 miles.

(2.) Between the cut and a point a little above the junction of the Kundaur and Vykalore streams as far as the 148th mile.

(3.) Between the junction of these streams and Cuddapah.

(4.) Between Cuddapah and the Somaishweram Anicut.

(5.) Between the Anicut and the coast through the Nellore District.

* Paragraphs 2 to 5.
General remarks.
Work in progress.
Course of the Canal settled. Estimate for the portion between the cut and Nundial (103rd mile of Canal) now before Government, and that for the remainder, i. e. down to the junction in a forward state.
Course of the Canal not finally settled.
Course of Canal yet under consideration.
Estimates before Government.

3. It is expected† that all the head works included in the first section, viz., Anicut, sluices and embankments will be fully completed by the end of May next or in time for the reception of the first freshes of 1863. The expenditure upon the works up to the end of July last was Rupees 1,10,482, and the work remaining to be done is estimated by the Company's Engineer at Rupees 44,697, exclusive of stores and plant. Colonel Ludlow, however, notices certain deficiencies in the estimate for completion, and he therefore allows Rupees 15,857 in addition, thus raising the probable cost of work to be done to Rupees 60,554, and the probable total cost of the works when completed to Rupees 1,71,036.

† Paragraph 23.

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The sanctioned estimate having been Rupees 1,25,000, the probable excess amounts to Rupees 46,036, or nearly 37 per cent.

Paragraph 28.

‡ Paragraph 41.

4. The Government learn‡ that the banks of the Canal, comprised in the same section, between the Anicut at Sunkasala and the Hindry Aqueduct near Kurnool, about 18 miles long, present "a very weak and insecure appearance." They are said to average 16 or 17 feet in height and to be formed of a very friable soil loosely thrown up with insufficient slopes. In consequence of the extensive outspread of the water, it is apprehended that the banks will be exposed to the violent action of the waves when agitated by strong gales of wind, and to protect them against such action, Colonel Ludlow considers it to be indispensably necessary that they should be revetted for a considerable length of the Canal, but even such protection it is feared will not prevent leakage. The estimated cost of the Canal and embankments is Rupees 4,20,974. The actual expenditure up to the end of August last was Rupees 3,78,981.

* Paragraph 51.

5. Considerable* deviations are reported to have taken place from the original plan in the case of the culverts and calingulahs constructed between Sunkasala and Kurnool, and while some of the masonry works have been altogether omitted, the designs for others have been considerably modified, and certain works not provided for in the estimate have been carried out. The probable excess on these works is given at† Rupees 9,447.

	Rs.
† Estimate	43,824
Probable cost of completion	53,271
Excess...	9,447

6. In paragraph 48 Colonel Ludlow brings to notice the necessity for rendering the culverts as capacious as possible to admit of the passage of men and cattle, as otherwise the inconvenience which the inhabitants of the villages situated near the Canal will suffer, will be very serious. The Government observe however that in Proceedings dated 11th April 1862, No. 736, they directed that if feasible the culverts should be so constructed as to meet this desideratum, and that additional ferries should also be furnished for the purpose. Further orders on this subject were passed in Proceedings dated 2nd December 1862, No. 2,869.

7. From paragraph 54 of Colonel Ludlow's report, the Government observe that instead of any unnecessary impediment having been raised by them to the commencement of irrigation in the past season, the Company's works were not in a fit state for such a purpose, and that while the sum gained would have been trifling, the damage and danger would have been great, both to the Company's works and the adjoining villages, and that even now water could not with safety be admitted into the Canal until its banks have been strengthened and revetted.

8. With regard to the Bellary road bridge across the Canal at Kurnool, Colonel Ludlow suggests that the plan of the structure should be re-considered. According to the sanctioned design the bridge will be 25½ feet higher than the bed of the Canal, which is on the same level as the roadway. It must necessarily, therefore, be both inconvenient and unsightly. Colonel Ludlow will be good enough to refer the matter to the Company's Chief Engineer, who will be requested to see whether the modification might not be carried out.

Paragraph 55.

9. It appears‡ that the Hindry Aqueduct as far as it is completed, has been substantially built, and the arches will be turned in separate and independent sections, so that a portion may be completed this season. By this expedient it

‡ Paragraph 56.

is anticipated that an ample supply of water will be carried across the Aqueduct next season for all the land lying under that part of the channel below Kurnool which is likely to be completed. The estimate for this work amounts to Rupees 1,45,000; the expenditure up to the end of August was Rupees 77,717, and it is expected that the estimates will be exceeded by Rupees 41,947.

§ Paragraphs 61 and 62.

10. The aggregate excess§ over estimates on the whole of the works between Sunkasala and the Hindry Aqueduct will it is supposed be about 14 per cent., and it is satisfactory to note the opinion recorded by Colonel Ludlow that the excess is by no means large, considering the novelty and magnitude of the works, the scarcity and increasing cost of labor, coupled with the many difficulties which have had to be overcome.

Paragraph 63.

11. The Canal from the Aqueduct in the 18th mile to the Nagatoor tank in the 43rd mile is in different stages of progress, and if as has been proposed to the Chief Engineer one-third in breadth only of the channel be excavated this season, water may be conveyed to the Nagatoor tank and a large extent of land brought under cultivation during next year's freshes. The Canal in the section under notice will be single banked for the most part. Colonel Ludlow

Paragraph 70.

states that the water extends over a large area on the upper side where large tanks will be formed, and that Officer is of opinion that in places where the banks are high and the soil is bad, revetments will be essentially required to ensure their safety, but for this the estimates do not provide. On the question of a single embank-

Paragraph 71.

ment, Colonel Ludlow writes as follows:—"The "additional risk which the banks will be exposed "to, and the consequent expense of revetting "them due to the adoption of the single bank mode of construction added to the injury inflicted "on the Ryots by the submersion of much rich and valuable land, of which about 6,000 Acres will "be sacrificed, go far in my opinion to counterbalance any advantages to be gained from it."

12. The substitution of a dam for a sunken Canal was advocated and sanctioned chiefly on the ground that it would be less expensive. The objections to it, however, were that a quantity of land would be submerged, the amount being variously estimated by the Engineer and Collector. It appears from Colonel Ludlow's report that the bank by which the water is retained in the Canal has been made of bad materials, of imperfect section and is likely to receive constant

* Procs. 17th March 1862, No. 459.

damage. The view taken by the Government was* that only so much land should be furnished by them as will be required for the construction of the Canal with double embankments, and that any land required beyond this must be paid for by the Company; but this was not intended to cover such land as the Engineer by a change of plan might submerge unnecessarily. Looking both to the safety of the works and of the people who may live below the banks, the Governor in Council is of opinion that the Company's Engineer should be requested to arrange his plans for the whole of the sections of the work not commenced so as to retain the water of the Canal between two banks, providing of course for the drainage of that part of the country which is below the surface water of the Canal. With reference to the first section where the work has been laid out and commenced in places, the Company's Engineer should be requested to mark off such land as he would consider sufficient to form the Canal with two banks, and the Consulting Engineer will then report as to the competency of the amount required, while the Collector will require the Company's Engineer to compensate the Ryots for any land which may be taken or inundated, in excess of the amount required. There seems no reason why when the Company gains largely by the single bank arrangement, the Government should be called upon to pay for this saving by furnishing an additional quantity of land.

19

Paragraphs 72 to 74.

13. The course of the Canal from Nagatoor to the Metacondal cutting has been marked out, but little more has been accomplished, and all that has been done to the cutting is the removal of the earth down to the surface of the rock for about a mile. The estimated rates it is said will prove insufficient. The Metacondal cutting carries the Canal through the water shed into the valley of the Kundaur. No work has yet commenced below the cutting. The estimates for the continuation of the Canal from the cutting to the Caulee Anicut at Jootoor, viz., from the 72nd to the 92nd mile, were sanctioned in Proceedings dated 3rd July 1862, No. 1,555. The suggestion therefore made in paragraph 81 of Colonel Ludlow's report should be communicated to the Company's Chief Engineer. The Canal takes off from the Caulee at Jootoor, and then runs through the Byap Goodoor tank, which Colonel Ludlow recommends should be handed over to the Irrigation Company on their paying annually to Government a sum equal to the average annual revenue less the cost of repairs. This suggestion* seems worthy of consideration, and will accordingly be referred to the Revenue Department. From the Goodoor tank the Canal will be continued to Nundial, and thence passing along the water shed between the Kundaur and Vykalore, to their junction at the 148th mile near Changalmurry. The course of the Canal up to this point has been finally decided upon.

* Paragraphs 83 and 84.

14. In paragraphs 87 to 110, Colonel Ludlow gives a general outline of the works to be carried out below the 148th mile until the Canal reaches the river Pennar. Of the works comprised within this section of the Canal, two require special notice, viz., the proposed Anicuts across the Kundaur and Pennar. Colonel Ludlow does not consider the immediate construction of the former to be absolutely necessary, and he is of opinion that it is even advisable to defer it until it is known whether the Canal can carry all the water which it receives from above, or not. With regard to the other work, viz., the Anicut across the Pennar at Adamapilly below Komalore, Colonel Ludlow adverts to the question raised as to whether an Anicut or Aqueduct should be built and he gives the preference to the former. Starting from this Anicut the Canal will be carried in the direction of Cuddapah until it meets the Pennar below its junction with the Booga. The chief difficulties to be overcome are said to begin at this point. The Canal is to be taken along the south bank of the river until it reaches the Somaishweram gorge, an Anicut being constructed across the Pennar near Doongasonne, and another across the same river just above the Cheyaur. Colonel Ludlow explains the manner in which he considers that the very formidable difficulties near Bundalapilly might be overcome, and he then points to the apparently less formidable nature of the obstructions which the north bank of the river presents, and he suggests therefore that the Canal be taken by that bank instead of the south. Colonel Ludlow then advises the expediency of dispensing with the proposed Anicuts at Cheyaur and Doongasoone as well as the upper Anicut at Adamapilly, as being a cumbrous and inefficient mode of completing the navigation, and he shows by what means those works might be avoided. Colonel Ludlow further suggests a careful examination and survey of the north bank of the Pennar with a view to the relative facilities offered by the two banks being ascertained, as also the possibility of dispensing with the Anicuts at Doongasonne and the Cheyaur by adopting that bank. The suggestions specifically adverted to in this paragraph will be referred to the Company's Chief Engineer for consideration.

15. Authority was granted in Proceedings dated 12th November 1862, No. 2,721, for the commencement of the Somaishweram Anicut, and under the views expressed above in regard to the plans for the sections of the Canal not commenced, the Government resolve to return for such revision as they may need, the plans and estimates for works† required between the 92nd to the 103rd mile.

† Consulting Engineer's letter, dated 20th October 1862, No. 74.

(Signed.) W. I. BIRDWOOD, Colonel, R. E.,
Secretary to Government.

The accompanying report from Col. Ludlow on the condition & progress of the works of the Irrigation & Canal Company is submitted for orders. The report was called for in Pro. of 24th July /62. A. 1772.

Chapman. 2

November 1862.

C. Ludlow Col R.E.
Secretary to Government P.W.D.

Consulting Engineer's Office,
Irrigation Canal Company
20th October 1862.

No. 74.

From,

Lieut.t Coll.t J. A. Rundall, R.E.
Cons.g Engr for I.C. Company

To,

The Secretary to Government
Department of Public Works.

Sir,

* No. 132 of 22 Aug.t 62.

1. With the accompaning letter, the Agent forwards for the sanction of Government, Plans and Estimates, amounting to Rupees 135400, for wo.ks required in the 2d section of the Canal, or from the 92d to the 103d mile, or from the village of Sotoor to the town of Rundial.

2. The Canal takes off from the river Cauvery at Sotoor, opposite to the spot which had been reached in the preceding section.

3. The river is crossed by an anicut 346 feet in length, furnished with a set of six under sluices, while the Canal is protected with a head sluice and lock.

4. The capacity of the sluice is sufficient for a discharge of 100000 cubic yards per hour, and the lock is so adapted, as to maintain navigation during the highest floods of the Cauvery.

5. The Canal has a fall of six inches per mile, and obtains a command of the large tank at Rundial,

Nundial and of the land irrigated therefrom.—

6. The supplying channel of that tank is not crossed in this portion of the Canal, but will be provided for in the next.

7. For the drainages which are however intercepted, culverts and calingulahs are provided so that no existing irrigation is interfered with, except that below the tank at Byapa Goodoor, regarding which the District Engineer has suggested an alteration, and also a patch of 189 acres near the village of Aimarikodur.—

The area at Bundi Atmacoor, is reported by the Tahsildar, as lying back of, and therefore above the level of the Canal, while for that at Aimarikodur, the Chief Engineer states, a culvert shall be provided for passing the supply channel under the Canal.—

8. In this length of the Canal, 12000 acres of dry land will be brought under irrigation. The minor slnices will be estimated for separately, as the scheme of distribution has not been yet decided on.—

9. Colonel Ludlow informs me, that while on his tour, he saw the sites of the intended works across the Caulee, and is of opinion, that it would be desirable to add an apron to the Anicut as the rock in which the overfall will be received, is not compact but of a very friable nature, ill-calculated of itself to resist the shock which will be brought upon it.—

10. I have therefore added an apron to the works, the additional cost of which will amount to Rupees 3782-10—.— E5

11. The rates entered in this portion of the project, Colonel Ludlow is of opinion, should be sufficient, as no rock cutting is met with.

12. Two bridges and three ferries are allowed for preserving the communication across the Canal, and are considered by the District Engineer as sufficient, so far as the Canal itself is concerned, but that as the Caulee below Cotoor is to be used as a surplus channel, down which a large body of water will be poured, and be productive of serious inconvenience to the inhabitants of three villages on its banks, he considers that additional ferries should be provided for them, but the Chief Engineer explains, that even with the greatest discharge, there will not be water enough to float a boat, as the river has a fall of 7 feet per mile, and that when the Caulee is filled by local rains, no water from the Canal will be passed down.—

13. The usual report from the District Engineer accompanies these papers, but from his having therein entered on other points than those enjoined in G. O. of 26th March 1861, No. 610 and animadverted on the mode in which the Company's Engineers carry on their operations it has provoked an angry correspondence between himself

From Ag. Dy. Engr. 9/18 July 1862 No. 200.
—— Agent 9/21 Augt/62 No. 124.
—— do 9/21 Augt/62 No. 125.
—— do 9/27 Augt/62 No. 167.
—— Ag. Dy. Engr. 9/30 Sept/62 No. 312.—

× also forwarded — to be returned —

11. I have

himself and the Chief Engineer any notice of which, though it is much to be regretted, the Government will probably consider unnecessary.—

14. With the additional work to the amount of Labour, the sum requiring sanction will be Rupees 135,400—

I have the honor to be,
Sir,
Your most obedient servant,

F. W. Rundall Lieut. Col.,
Comm. Engr. for E. I. C. Company.—

Engr. Bridge R.

No 76

Consulting Engineers Office
Irrigation & Canal Surveys
Chipaunk 29 October 1862

From

Lieut.t Col.o R.E. Ludlow A.D.C.
Late Off.g Consulting Engineer for Irr.n &c.

To

Colonel H. L. Birdwood A.D.C.
Secretary to Government P.W.D.

Sir,

1. I have the honor to submit herewith the accounts
connected with the Proceedings of Government
dated 22.d July 1862 showing expenditure on
account of the Land for Progress on the
Irrigation Canal to Nuseerabad
Account of Amount of Work done on the Main Canal
Establishment employed on the Works of the
Canal & Miscellaneous Charges
Statement of Amount of Work done on the Canal
Statement of Establishment employed on the Canal
Statement of Miscellaneous Charges
Report on the progress of the Canal Works
2. The works are executed in strict
accordance with the plans & estimates
sanctioned by Government

Pro. 26 March 1861 No. 413.
Copy in a Letter to Engd
of 27th January No 5 of 1863.

P.W. 1862 Despatch
Govt. for Decr.
No 3174
The Consulting Engr for Irrigation &c &c.
to
The Secretary to Govt
P.W.D.

Date 30
Rec.d 23 } October 62

No. 74.

Enc 17.
Plans — 10
Abs. Estt — 1
Letter — 1
— 12

forwarded for the sanction
of Govt Plans & Estts: amounting to Rs: 135,400 for works
to be exec.d in the 2nd section of the
Canal or from the 92nd to the 103rd
mile or from the village of Sutrom
to the town of Nimbrial. Jeypore.

No 3015 - 17th December

No. 374

20th Nov. 62. R. 8th Dec.

Metacondal Cut for distance of 12 Miles beyond which no ground has been broken as the largest quantity being towards the upper part of the Canal.

3 Between the Metacondal Cutting and a point a little above the junction of the Kundaur and Vykalour Streams as far as the 108 Mile the course of the Canal has been definitively settled. The Estimates for the works as far as Kundyal the 103 Mile of the Canal have been received and after examination have been laid before Government. The Estimates down to the junction of the 2 above mentioned Streams are in a forward state and will I understand be soon submitted.

4 Between the junction of Koondaur and Vykalour and Cudalapah the course which the Canal will take, when finally settled may be said to be nearly so.

5 Between Cudalapah and the Soonkasala Amicut the course of the Canal is yet under consideration and examination and some time will yet I think elapse before the exact mode in which this part of the Scheme is to be carried out is finally decided and the

Estimates for the works be ready.

6 The Estimates for the Soonkasalaram Amicut and the Canal thro the Nellore Districts are already before Government.

7 I shall now proceed to remark upon the different works executed and in progress and on the course of the Canal from the Soonkasala Amicut downwards.

8 The Soonkasala Amicut across the Toombudra 1713 Miles above Kurnool and its head works comprise

The 2 Branches of the Amicut.

The Imbankment across the intervening Island and those on the North and South sides of the river above the Amicut for the protection of the Lands above from flood

A set of under or Scouring Sluices at the South Extremity of the South branch of the Amicut.

The Head Sluice of the Canal.

Office Buildings and Stores.

Amicut

9 No material alteration in plan has been made in carrying out the North branch of the work. In the South branch a deviation has been made from the line originally proposed in order to accommoda

the

the work to the form of the rocky bed of the river. By this change a saving of 100 feet in the length of the Annicut has been effected.

10 The Crown of the Annicut will be, when completed 2½ feet higher than was originally intended, the addition of 1 foot being intended to secure an increase of head in the surface level of the Canal, and the remainder to meet an alteration made in the level of the Canal bed.

11 The breadth of the work throughout at the Crest will be 8 feet, with a batter of 1½ Inches to a foot, on either side, occasionally more to adapt it to the shape of the rocks. At height where greatest will be 25 feet, and there the base will be 44½ feet broad.

12. The body of the work consists of two strongly built walls of large rubble Stone set in Chunam of thickness varying according to the height of the work but no where less than 3 feet. The space between the walls is filled with good concrete; cross walls at intervals of about 30 feet unite these face walls. The work as far as it has been completed seems perfectly sound and good and has not been at all affected by the freshes which has passed over it.

13. With a view to economy and as it is not considered necessary, the Cut Stone Coping will be dispensed with and the Crest of the Annicut be finished off with large blocks of hammer dressed Stone. I see no objection to this change.

14. The longitudinal Section of the work which accompanied the progress Report for June exhibits very correctly the actual state of Progress. Scarcely any work having been done since owing to freshes having come down the river.

15 The North branch when completed will contain of Stone work Cubic yards 3,389
Of which are completed ——— 1,289
Leaving to complete ——— 2,100
The South branch will contain ——— 15,403
Of which are completed ——— 11,924
Leaving to complete ——— 3479
About 2/3rds of the work are therefore Completed

Under Sluices.

16 As originally designed were to have had 12 Vents each 6 feet wide by 11 high with cross Stones for Vertical Shutters. Some

Circular

Circular heads filled in, viz. from the Floor one foot above that of Head Sluices — as being built there will be 12 Vents 6'.6" x 11' to close with revolving Shutters. The Floor being 3 feet below that of the Head Sluices. The additional depth of the Floor below that of the Head Sluices I consider to be decidedly advantageous.

17. These Sluices have been completed up to the Level of the Floor. 1 Abutment is completed the 2 built within 2 feet of the full height. Nothing has yet been done to the Piers above the level of the Floor.

Head Sluices

18. was to have had 12 Vents 6' wide by 8' high with semi circular heads, closed in front. It is being built with 13 Vents. 12 Vents each 7'.3" x 7 each divided into 2 openings by a vertical Stone post. The object being to make the Shutters more manageable. The 13th Vent is to be 6' x 7' closed with a hanging Shutter. The capacity of the Sluice has consequently been increased by some what inconveniently so. as the work now extends leaving little room for wing walls nearly across the Full breadth of the Channel at its head.

19 There has been an alteration made in the relative position of the Head and Under Sluices, their connecting wall and the South bank. The Head Sluice having been placed about 100 feet lower down the Channel. This change was made in consequence of a fault in the rock which was discovered on digging the Foundations.

20 All the Foundations and Flooring of the Head Sluices are completed. The wing walls of it nearly completed. 2 South Vents carried up to level of covering Stones. The other 10 Piers have been raised to an average height of 2 feet. The work is being executed in a very neat and substantial manner.

About 2/5ths of the wall connecting the Head and Under Sluices are built.

Embankments

21. North side of river will when Completed contain 8,970 Cubic yards of Earth work 3/4ths of which are done and 645 Cubic yards of Revetments none of which is done. South side of river will contain 31,532 Cubic yards of which 24,062 are finished and 2,775 Cubic yards of rough Stone of which hardly any is yet done.

The Embankment across the Island will contain 15,000 Cubic yards of Earth work and

and is completed to within 5/8 of the full quantity. Nothing has been done to the remainder which will require 1185 Cubic yards of rough stone

22. There is abundance of rough Stone procurable, close at hand and blocks of a superior quality of granite and compact Lime stone have been collected in large quantities and are said coming in for the Cut Stone work – There are 100 Stone Cutters at work and Bricklayers are procurable without difficulty including Artificers the whole working party on the Head works and 3 first miles of Channel is at present about 1,600 The work at the Head Sluices is progressing actively and work will be resumed on the Auricular and Under Sluices about the end of September when the Tides have sufficiently subsided.

23. There is every reasonable prospect of all the Head works viz Auricular, Sluices and Embankments being fully completed by the end of next May or in good time for the reception of the first Tides of 1863.

24. Office Buildings and Stores completed with the exception of the Verandah roof I do not think that a good site has been selected for these. Not too far from the head and lies between the north bank of the Canal and river in a place liable to inundation; an unnecessary expensive has consequently been incurred in giving it a high basement to keep it above flood level.

25. Expenditure on and probable ultimate cost of the Head works.

The sanctioned Estimate for these works is 125,000 I have obtained from the Executive Engineer in charge of the works a Statement of the Expenditure on them up to the end of July and also his Estimate of the probable Expenditure that will yet have to be incurred on their completion. The former does not however exhibit the full Expenditure for the value of Stores and Plant chargeable to the individual works he was unable to furnish and to procure my Assistant Norie is possible by means of this Statement to compare the rates at which the work has been executed with those Estimated for which only have quantities and dimensions been altered but not

rates

rough materials yet to be worked up
in charged for in the part of Expenditure.

26. From this Statement it appears
that up to the end of July there had been
expended by the Executive Engineer 1110,182
Rupees and the probable cost of work
remaining to be done as estimated by
him is 66,697 making a Total of 1,55,179
exclusive of Stores and Plant.

27. The items on which the principal
excess has occurred are Rubble and Cut Stone
work. In the Summer there will be an excess
in quantity of 28,872 yards and on the work
already executed a very considerable excess
in rate. The alterations in the work
account for the excess in quantity but
I cannot satisfactorily account for the
great excess in rate on this kind of work
upwards of 50 per Cent, but am inclined
to attribute it to the use of concrete.
If therefore a more sparing use be made
of this hereafter the remainder of the work ought
to be completed within the Estimated
rate with the exception of the Creek for
which an additional allowance must
be made on account of the large size and
close fitting of the Stones necessary there.

The

28. The Cut Stone work was originally
Estimated far too low and experience has
shewn that with Stone of the hardness
used and the mode of dressing common
among workmen in this Country such
work cannot be done at that rate.
Judging by the quantity of work yet
remainning to be done and its probable
Cost I think that the Executive Engineer
has somewhat under Estimated the cost
of completing this part of the work.
His rate for Embankment I think appears
to me rather too low including additional
raising to make up for Settlement and
finishing off at will not I think Cost
less than 1-6 per yard.
If revolving Shutters are used the allowance
for Sluice gates will probably be exceeded
I would therefore add to the Engineers Estimate

For Cut Stone work 20/100	7,500
For Rubble on Crest 1-12 per yard	2,300
For Earthwork	750
For Shutters	750
Stores Plant and Sundries	10,057
	15557
which added to	44697
Gives as probable Cost of Completion	60554
To which add sum already expended	1110,182
Probable cost of Annicut when complete	1,71,036
Deducting Sanctioned Estimate	125000
Making the probable excess	46036.

Canal

29 Canal between Aqueduct at Sonkasala and Shindy & Aqueduct near Kumool.

The length of this portion of the Canal is 31 Miles. It was surveyed in 1773. It here runs parallel to and not far distant from the river with the exception of the 3 Miles at its head and that adjoining the Aqueduct has a Bank on the lower or river side only.

30 The fall was to have been 10 feet between the Floor of the Head Sluice and that of the Aqueduct. It actually has or has lain in for a fall of 11½ feet. The head of the Channel having been raised, whereby a saving in excavation has been effected. This fall is unequally distributed varying inversely as the breadth of the Channel, from 20" per mile to nearly nothing in parts.

31 The breadth is very variable, but in some parts (the 3 Miles where it is so narrow) 75 feet in it is less than 90 feet at bottom. In it generally it is much broader and in most parts a considerable breadth of land on the upper side will be submerged. This land is mostly waste, or of a very inferior class. One small hamlet has been removed which stood on the course of the Canal.

41

32 The height of the Bank above the ground also varies considerably. It averages about 16 or 17 feet, but in places where it crosses water courses it is occasionally as high as 34 feet. Its top breadth is from 6 to 9 feet and the average of a number of sections gives it a mean sectional area of 70 square yards. Since first thrown up it has sunk from 1½ to 2 feet and will also as yet still and have to be raised to bring it to the designed height of 4 feet above the Canal water level.

33 The slopes vary from 1.1 : 1 Base to 1 Height to 3.3 : 1 Base to 1 Height. The mean being about 1.8 base to 1 height. The soil of which the Bank is composed is mostly of a very inferior description being either Black Cotton Earth or a silty soil of a worse quality. Still Gravel occurs in places.

34 The quantity of work in this portion of the Canal, according to the Estimate is

14,10,215

14,10,715 Cubic yards of Earthwork in Excavation and Embankment.

8,49,672 Cubic yards of Rocky Cutting or Excavation.

22,59,887.

There remain a number of rough Sections which I had taken. I calculate the quantity of material thrown up in the Bank to be rather better than 23,00,000 Cubic yards.

35 The Banks however still want much trimming dressing and raising, there are large breaches purposely left open in the 15th and 16th Miles have to be filled in and masses of rock in the 3d, 4th, 5th, 6th, 7th, 14th & 15th and more especially in the 1st and 17th Miles yet remain to be removed. The quantity of Earthwork yet remaining to be done is Estimated by the Engineers at 92,080 Cubic yards and of rocky Excavation, at 21,900 Cubic yards. The former quantity I take to be under estimated but when compared with the quantity actually executed what remains to be done is small and the work may be said to be nearly completed. With ordinary activity the whole should be completed by the end of the present year.

There

There are at present 2,523 Men and Women Coolies and 66 Buffaloes employed between the 3 and 18 Miles. 43

36. In the Estimate, the proportion of Earthwork to Rocky Excavation is as 14 to 8½ what relation the one bears to the other in the Mass actually removed would in the present irregular and incomplete condition of the work be impossible to state with any accuracy. In the 3 upper miles of the Canal where the Section is best defined and where the rocky Excavation bears a large proportion to the Earthwork, the Estimated quantity of work is 199,985 Cubic yards of Earthwork 411,680 Cubic yards of rock. Total 611,665 Cubic yards. The Executive Engineer states that the actual quantities in these 3 Miles (which do not correspond with those in the Estimate) will Amount when the work is complete to 600,188 being about 11,500 Cubic yards less than the Estimate.

37 The Channel here has an average width at bottom of 103 feet and supposing slopes of 2 to 1 (which is more than there actually is) a mean width of 119 feet, allowing then for the difference of width between the

and

loosely thrown in with an inefficient
slope 1:8:1, and in many parts of the
Canal will be subjected in consequence
of the extensive outspread of the
water to a very violent and destructive
action of the waves when agitated by
strong gales of wind. To protect them
from such destruction they have with the
exception of the 6th Mile new revetment.

42 Such revetment I consider
to be indispensably necessary for a
very considerable length of the Canal,
and in this opinion Lt Cookburn
the Bank's Agent has decided. I am
even with this Revetment Leakage I
think be a considerable Amount of
Leakage. This shews black Cotton soil,
Banks resting on a thin stratum
of Soil which again rests on the bare
rock. Even now wherever the rain
water has lodged in hills & holes above
the bank a corresponding leak is
immediately seen on the lower side. The
Leakage will be necessarily much
more considerable when there is a
great head of water in the Canal.
I suppose that at least 3 miles

of this Bank will require to be revetted
which judging from the cost of the
part already completed would amount
to 46,599 Rupees but the rate may I
think be reduced from 12 to 8 which
would reduce the cost to 31,066.

43. A deduction of 20,000 Rupees was
made from the total of the Canal Estimate
for the value of Stone; what amount has
been already realized on this account
I do not know but have reason to suppose
that it is small. Much of the material
may however be brought to use hereafter
for the revetments.

Calingulahs and Culverts
between Soonkasala and Kurnool.

44 The Estimated cost of these works
was as follows.

		Estimated Cost including Supervision
9	Calingulahs	22,689
11	Culverts	21135
		43824

The number of Calingulahs was to have
been 9 of a total length of 3240 feet and
with an effective waterway of 2430.

45 These 9 Calingulahs are nearly com-
pleted. Their length has been some
what altered. Their total length being

3149

3169 feet of effective waterway 2367 feet
Built in 10 Cadingulahs 100 feet long one running
low level (as present entirely buried under
the Bank) has been added at a distance
of 3 Miles from the head which it is
intended to use if necessary as a large
Under Sluice to scour the upper part
of the Channel. There are also 34 feet
length of Cadingulah over one of the
Culverts so that the means of discharge
already more than enough for a
drainage of only 42 Square Miles
has been slightly increased. The Canal
is however on the right side.

46. Some of the Cadingulahs have
had openings left in them for the
discharge in case of rain of land
floods and others are left open for the purpose
of having irrigation Sluices formed in them
and Under Sluices have been made in
several of the Cadingulahs.

47. Considerable deviations
have been made from the original plan
in the case of the Culverts.
A Square Culvert in No 8 Mile has
been converted into an oval one.
This Culvert is objectionable as it
straightening

straightening the banks at the point
where it is placed and likely to cause
a dangerous set of the current. It
will be lengthened.

A 5 Vent Culvert in No 9 Mile has
had the middle Pier removed and
the 2 middle Vents thrown into one,
thus forming a Roadway large enough
for Cattle and small Carts under the
Canal, which will be a very great con-
=venience.

48. I may here observe that the
inconvenience which the inhabitants
of the Villages situated near the Canal
will suffer from the stoppage of the
thoroughfare must be very serious
and the ferries proposed to be establish-
=ed will but very imperfectly remedy
this evil. It is therefore very desirable
that as many of the Culverts as
possible should be made sufficiently
capacious to admit of the passage
of Men and Cattle and when circum
=stances will admit of small carts
under the Canal.

49. In the upper part of the Canal
2 Culverts have been dispensed with
altogether

altogether and 3 have been superseded by drains conveying the water into the Canal

50 The Estimated Cost of the Calingulahs and Culverts as stated above is ——— Rupees 13,824

Their Cost when completed will be ——— 53,271

Giving an excess of ——— 9447

which is probably rather less than the truth as some thing will have to be added for Stairs and Superintendence.

51 These Masonry works differ so entirely from those originally planned that it is impossible to say without taking accurate measurements of all whether this excess arises from increase of quantity or increase of rate. Foundations had to be given to many of the works when none were allowed in the Estimate (as the site showed the presence of Rock) and Calingulahs not provided for at all in the Estimate have been built, but on the other hand some works have been altogether omitted. Increase in quantity will probably partly account for the excess. I believe that the rate of 2-8 per yard allowed for Rubble Masonry in Chunam has not been found generally sufficient hitherto, but works now undertaking being done within this rate.

52 Of the 20 Irrigation Sluices 2 have been completed according to the sanctioned plan, 6 on a plan slightly different and 2 have been made in the Calingulahs. There will be no excess on those works when they are completed.

53 Nothing has been done to the distributing Channels and the Channels for the surplus water below the Calingulahs have not been commenced. No Tunnels have been built.

54 When inspecting the Head Sluice I observed that the 2 South Vents, which, as before mentioned, are further advanced than the others, had been cut off from the rest of the work by a temporary dam. This I was told was done when it was contemplated to admit water into the Channel for irrigation in June last. That water could have been so passed down the Channel there can be no doubt, but that it would have been

Vents,

been most imprudent and dangerous to have done so, is equally certain. The Bank when I inspected the works in August, as may be gathered from what has been said above, was incomplete. The Masonry works along the Channel not finished, and the Rocky Excavation in many parts yet in progress. The state of affairs must have been still more backward 2 months before.

To have admitted the river water into such an insecure head opening with the chance of high freshes finding their way bodily down the Channel would have been to expose the bank to a very great risk.

Moreover all work in the Channel must have been suspended or greatly delayed, for irrigation, to the of any use must have been carried on to the end of the season; and after all

all what advantages would there have been to compensate for this. There are only 2,000 acres capable of irrigation between Doonkasala and Kurnool, not one half of which would have been brought under wet cultivation this year, so that for a prospective gain of 4,000 Rupees, all works along the channel and at the head must have been stopped, or greatly delayed, and the channel banks have been exposed to a most unnecessary and dangerous trial.

55 Bellary Road Bridge across Canal at Kurnool.

The piers and abutments of this, have been carried up to the springing line of the arches. As the bed of the Canal has the same level as the roadway, which a bridge across the Hindry would have, and as the roadway of the bridge across the Canal will be 35½ feet higher than the bed of Canal, this structure with its enormous banked approaches will necessarily be both inconvenient and unsightly. It is to be regretted that a swivel bridge, or one on some other plans which would not have required such a great rise, was not adopted at first, and I would recommend that this question be reconsidered, before the arches of the bridge are turned. There is another approach, but little more convenient, and with sufficiently easy slopes under the abutment arch of the aqueduct. The objection to it is, that occasionally the Hindry, when in high fresh floods it. But this happens so very rarely, and such floods are of such short continuance, that practically the objection has little importance, at all

Engts

wents this road under the arch would answer all purposes, until the question about the best form of bridge to build above, were decided.

56. Hindry Aqueduct.

The piers and abutments of this work have been carried up to the springing line of arches, the wing walls have still to be raised 9½ feet higher.

57. I am rather at a loss to know, why it was ever intended to turn the arches of this aqueduct with bricks, bricks never having been before used at Nurnool, and the soil being particularly unfavorable for their manufacture, whereas stone well adapted for building, is abundant, and in general use. I presume that it was supposed, that time and money would be so saved; if so, that expectation has been disappointed, for the trials which have for several months been made to manufacture bricks sufficiently good for the purpose, have hitherto failed, and it appears to be pretty clearly proved, that if bricks of a sufficiently good quality can be manufactured at all, they will prove to be quite as expensive as stone. The idea of using bricks has therefore I believe been at last abandoned.

58. Each of the 14. 40 foot arches of this aqueduct is 112 feet long, and judging by the rate at which the other masonry works have progressed, and the means at the disposal of the Engineers, I do not think it that the whole of this work can be completed by next June.

It has however been suggested, and the suggestion has I believe been adopted, that the arches might be turned in separate and independent sections or ribs, so that a part, say ⅓ of the breadth of the aqueduct may be completed this season. If this plan, which has in my opinion other advantages to recommend it, be adopted, as much water may be carried across the aqueduct next season, as will amply suffice for all the land lying under that part of the channel below Nurnool, which is likely to be completed.

59. This large work as far as it is completed appears to be well and solidly built. Much more difficulty than was anticipated was found in carrying down the foundations on the right side of the river to rock. It was however I am informed done at last, and the work may therefore be considered perfectly stable.

60. The estimate for this work was 145000 including 13113 for sundries.

The expenditure up to the end of August was Rs. 77717
and the work remaining is estimated at 105730
making a total of 183447
being an excess on estimate of 38447

The principal items of excess will be

Baling and excavation estimated at 1700 excess		7904
Rubble excess in quantity		13369
Cut stone excess in quantity and rate		3024
Arch work		1605

Of the allowance of 13113 for superintendence and sundries 11660 have been spent although the work

work is not half done, so that an addition will have to be made on this account. Allowing 3500 additional only for this purpose is very moderate, will bring the total excess up to £ 4,947.

61 — I calculate therefore, that the excess on all the works down to this point, viz: on the annicut and head works 17⅓ miles of channel and masonry works, and the Sundry Aqueducts will amount to very nearly one lac of Rupees, being about 14 per cent on £30,000, the total amount of the estimates for them.

62 — I don't consider this over expenditure to be excessive, on the contrary, taking into consideration the novelty and magnitude of the work, the scantiness of labor and increasing cost of it, and the numerous difficulties and discouragements which have had to be encountered, I think that great praise is due to the Officers of the Company for the intelligence, zeal and industry which they have exhibited, and especially for the care which they all shew in husbanding the resources of their employers.

63 — From Sundry Aqueducts in 18th mile to 43½ mile.

The Excavation and Embankment of the Canal are in progress along this portion, but no masonry works have been begun yet.

The 18th mile has only earthwork, about ¼ of it is finished.

In the 19th mile, there is besides Embankment much heavy rocky Excavation. Some considerable progress has been made probably from ⅓ to ½, but the work does not appear to be getting on very rapidly, and the parties of work people engaged upon it are not large.

In the 20th mile where there will be still heavier rocky Excavation, nothing whatever has been done.

64 — The estimated rate for the rocky Excavation in these 2 miles varies from 3s. to 5-4 per cubic yard, the average being 4/2. This I am confident will be insufficient, the rock being for the most part of a most difficult kind to deal with, and containing hard Quartz Boulders, which can neither be picked nor blasted.

65 — In the 21st, 22nd, 23rd miles about ⅗ of the earthwork are completed, but not ⅒ of the rocky Excavation.

In the miles 24–30, the progress made is small, but the work is going on, though not apparently with much spirit.

31–34 miles, good progress has been made with the Embankment, and the works is well advanced, and proceeding satisfactorily – no rocky Excavation done yet.

35 and 36 miles – Not commenced.

66 — 37 and 38 miles – Some progress made. The Executive Officer complains of the insufficiency of the rate, and I think with reason.

The rates in these 2 miles are, for Embankment

16

1.6. and for rocky Excavation from 1.3 to 3.6 average at 2.5. The soil is black cotton but a very slight depth resting on clayslate rock, so that what little earth there is, is soon exhausted, and the coolies have to go for a considerable distance, to get earth for the embankment; 1.6 per yard for such work is evidently insufficient, as is also 2.5 for the rock though it is easily split.

With the exceptions above noticed and a few other places similarly circumstanced, the rates for earthwork from the Nindy to Nagatoor, seem sufficient, but I cannot say this with respect to the rocky Excavation. The rates for this, vary from one Anna per cubic yard, to five annas four pice, the average being two annas four pice, and although the rock is a laminated clay slate, or not generally hard to work, and the Excavations are not deep, I consider this rate to be insufficient, and that there must be an Excess on this item of the Estimate.—

69 39th mile.— Nothing done.
40-41 mile.— Work just begun.
42d. Bank nearly completed, but some ending remaining to be done. No people at work.
43d. Nothing done. In this mile the Canal will fall into the Nagatoor Bank.

68 The whole quantity of work to be done, between the Nindy entrenchment in the 10th mile and the Nagatoor Bank in the 43d mile is,

Earthwork 3477251 Rocky Excavation 21560
Total work done 715912 52874 being

being about 1/6 of the former and 1/16 of the latter.

69 There is a strength of about 700 coolies at work on this portion of the line, and if as has been recommended to the Chief Engineer, 1/3 in breadth only of the channel be excavated this season, water may be conveyed down as far as the Nagatoor Bank, and possibly a little further, so as to bring a considerable quantity of land under irrigation, during next year's freshes, but I do not think it will be practicable to complete the whole of the part of the channel to its full breadth by next year, in fact I feel certain, that it will not be done.

70 The soil generally on this part of the Canal course, is of a better description, than that above Nurnad, though black cotton soil occurs in many parts. The Canal will be mostly single banked, the water overspreading the ground on the upper side to a very considerable extent, especially opposite to the villages of Purdapad, Realumpad and near Ullur, where large tanks will be formed. In these places and others where the soil is bad and the banks high, revetments will be essentially necessary for their safety, but I cannot find that any provision for this has been made in the Estimates.—

71 The additional risk which the banks will be exposed to, and the consequent expense of rewetting them due to the adoption of the single bank & mode of construction added to the injury

inflicted

inflicted on the royal by the inclosureion of such rich and valuable land, of which about 6,000 acres will be sacrificed, so far in my opinion to counterbalance any advantages to be gained from it.

72. Canal from Nagatoor to Metaconda cutting.

Little has been done beyond marking out the course of the Canal. In the 43d mile 5 parties of 500 people are at work, and about 300 cubic yards have been excavated. Ground has just been broken in the 49th mile, and 200 coolies are at work there. work will also soon begin in the 54th 58th and 59th miles: work has begun in the 62nd 68th 69th and 70th miles; the working parties amounting to about 700 men and women.

Cutting near Metaconda.

73- This cutting carries the Canal in the 71st and 72d mile of its course, through the watershed into the valley of the Moondair. It is one mile 66 chains in length, is to be 64 feet broad, with perpendicular sides, and the full through it will be one foot in a mile. The depth of excavation when deepest will be 22 feet, of which 21 feet in depth is rock the diminishing to nothing on either side. As originally estimated there would have been 195526 cubic yards of excavation in rock at 2 Annas 95705 — of earth — at 1-6 — but there appears to have been some mistake as to the depth of rail above the rock for will be seen from the accompanying longitudinal

section of the cutting, which shews the actual state of the work, which made the proportion of rock to earth, appear less than it really is. By what quantity the rock excavation will be increased on this account it is impossible, without more accurate sections to say, it may possibly amount to 20,000 cubic yards.

74. All that has yet been done, is to remove the earth down to the surface of the rock, for a length of one mile. The quantity so removed is 6100 cubic yards, and it has cost 2 annas per yard, it being estimated at 1-6. whether the rock excavation can be done at the estimated rate of 2 annas per yard is doubtful. The rock is a red clay slate laminated, and not very sufficient to break up and remove in slabs, and has not been found in one trial pit to become very much harder below, than at the surface. It is just possible that by the use of derricks for raising the soil in the middle of the cut and rails at the two ends, and by very careful management the work may be done at or near the estimated rate, but as I before said, I think it very doubtful. A Contractor who had undertaken to execute this work, has, I am informed, just thrown up his contract.

75- The stone taken from this excavation, is of a very inferior quality, and not fit for use in buildings if exposed to the action of water. A Contractor who is collecting materials for a bridge

in

in the middle of the Metacondal-Cutting, is exacting this stone for the work from a quarry distant one mile, that procurable on the spot, being considered unfit for the purpose. But a sum of 30,000 Rupees has been deducted from the amount of the estimate for the value of this stone. This deduction cannot be admitted.—

76. There appears to be many excavations necessary between the 43d mile and the Metacondal-Cut. But the rates allowed for earth-work are from 1-2 to 1-6, which appear to me too low—in the 36. 37. 38. 51. 52. 53. 54. 55. 56. 57. 58. 62. and 63d miles, the largest banks on the line are formed, and the banks there will be of considerable height in some places as high as 34 feet. The rates allowed, are in my opinion insufficient for such work.—

77. An allowance of 20,000 Rupees has been made for rubble pitching to the inside slopes. But the rate 2 annas per square yard allowed, seems too low. If the revetment be 3 yard thick, it would be 6 annas per yard. The revetment actually put up above Nurwal, has cost just double this, & Annas per yard seems to me to be a fair price, and I do not think it can be done for less.—

78 It is said, that however high a rate may be, natives will always contrive to work up to it, and that it is therefore advisable, to fix the rates at a figure lower than the work can really be done for, since, even if the rates be exceeded, the work is in the end done cheaper than it would have been, had the estimates been framed more liberally or fairly. There is doubtless some truth in this, but if work is to be executed by contract, it is bad economy to make a rate so low, that no fair margin for profit is left. In such cases, contractors after trial throw the work up, and the result is much delay, increased outlay on fixed establishments, and the postponement of remunerative returns. I cannot help thinking, that if the rates in this Project had been somewhat more liberal, the work would have progressed more rapidly, and profits have been more quickly realized.

79. No work has yet commenced below the Metacondal-Cutting—just below it a Culvert of about 300 feet long in the left bank, will discharge a large portion of the water into the Caulee River; the remainder proceeding along the canal, the dimensions of which will be reduced. The canal drops by a series of locks, until it falls into the Caulee at Soatoor. At Soatoor there will be an anicut, Locks, Head-sluices &c., all of which are described in the Chief Engineer's specifications already submitted to Government.

80. Between the Metacondal-Cutting and the Caulee Anicut at Soatoor, ie from the 72d to the 91st mile, there are to be 12 locks, 11 culverts, 4 ferries, a reaching-lock, and a bridge, what the

Cost

cost of these locks will be is uncertain, for their size and plan, are not yet finally decided upon, but for works of that class, they will be comparatively cheap, for they will be almost all founded on rock. The same remark applies to the locks lower down.—

81 I examined the site of the Callee works, shortly after the occurrence of a freck in the river, and found the rock to be so friable after submersion, that I do not consider it to be capable of resisting the action of water, whether falling over, or in the case of an ammicut or scouring basin that is proposed. Provision must accordingly be made, which has not been done in the estimate recently sent to Government, for a hard stone apron for the ammicut and linings for the vents of head surplus and feeding sluices.—

82— After crossing the Caulee at Vadoor, the canal is continued on its left bank, passing several small drainages and cutting through the Byepar Vadoor Tank. The portion of the tank bed below the canal, will be converted into a Nunjay, and the upper portion of the tank will be enlarged, as far as may be required for the purpose. From this the canal proceeds to Nundyal, passing above the two large Nundyal tanks, and crossing their supply channel by an aqueduct or culvert of 5.20 feet waterway.—

19 83. I think it would be advisable to hand over this tank bed, to the Irrigation Company, on the condition

condition of their paying annually to Government, a sum Equal to the average annual revenue less cost of repairs. It would be advantageous to them as their cost of construction would be diminished, and the quantity of irrigated land under the tank, would be largely increased, and it would be advantageous to the existing irrigation, for the supply of the tank would be rendered more certain and more abundant. I believe that the Company would be willing to take over the tank on these terms.—

84. Below Nundyal the canal will proceed along the watershed, between the Nundyal and Cumbum valleys up to their junction at the 140th mile near Changalmurry. This is an extremely favorable and easy portion of the line. There is absolutely no drainage to cross, the cuttings and embankments, except near the locks, are by no means heavy and there will (excepting in those places) be no rocky excavation. There will however be 18 locks in this distance, but they should not for the reasons above stated be expensive.—

85— The course of the canal down to the 140th mile has been finally decided upon. I append 2 sketch maps and a description of it, which I received from the Executive Engineer in charge of that range. The estimates down to Nundyal (the 103rd mile) are now before Government, and those as far as the 140th mile may soon be expected.—

I exe

86. I see no reason to fear that the cost of the work, between the Metaconda Cutting and the junction of the Noondair and Cy Kalour will exceed the Chief Engineer's estimate. There are no engineering difficulties on this portion, and the work will be /locks excepted/ by no means costly.—

87. Below the 148th mile above the Noondair and Cy Kalour junction, the course of the canal had not been finally settled, as to its details when I visited the place. The following is a general outline of the scheme.—

88. The canal crosses the Cy Kalour by an aqueduct, but some way above this point an annicut will be thrown across the Noondair and a channel cut from it to the canal, the object of which is, to return to the canal the water, which it will be remembered was allowed to escape higher up across the Caulee Annicut.

89. The immediate construction of this annicut does not appear to me to be absolutely necessary; and should I think it be deferred, until it is known, whether the canal itself can or cannot carry all the water which it receives from above. Without this annicut the Noondair water would find its way into the Pennair, and be picked up lower down.—

90 After crossing the Cy Kalour the canal proceeds in a somewhat devious course by Khoor and Chittakondah and north of the Poorpagherry hill to the Pennar at Adamapillay /below Nonicaloor on the map/ where it will cross that river by an an-

-nicut.

91. The question was raised, as to whether an annicut or aqueduct should be built at this place. I obtained from the Executive Engineer a rough estimate of the cost of both works. He makes out that the annicut with its approaches, would cost about 4 Lacs of Rupees more than the aqueduct. It appears to me that this difference has been much overstated, but there can be no doubt, but that the one work would be much more costly than the other; and as I find that no line of road crosses the river at this point, no convenience would result from the use of the aqueduct as a bridge, and there being several other objections to it, I have no hesitation in saying that the idea should be altogether given up.—

92 The Adamapillay Annicut will be 2400 feet long /exclusive of timber sluices/ 850 of which will be on rock, the rest on sand. Height of crest 11 feet above deep bed of river. Area of waterway obstructed 1/4 of greatest sectional area in flood.—

93 Starting from the annicut, the canal is carried towards the Cuddapah Cantonment, which it skirts on the south side, passing the Bogoo River by an aqueduct of 20- 30 feet arches, the bed of the canal being 11 feet above that of the river. At the cross-

crosses the old road from Chennoor to Cuddapah passes between the lower part of the Town and the upper part of the Cuddapah large Tank. A few huts only will be destroyed near the road The supply Channel of the Cuddapah Tank is crossed by an aqueduct of 348 feet arched. It then crosses the road from Cuddapah to Devaly Cuddapah where a Bridge will probably be necessary. It then trends to the N. E. passing near the village of Nannonpillay until it meets a range of hills running in a north westerly direction and bounding the Cuddapah valley on that side. It runs along the foot of this range until it meets the Pennair just below the junction of the Boggah with that river

94 It will be seen from the Memo: by Mr Clarkson the Executive Engineer (herewith forwarded) in which he describes the intended course of the line from above the Kundar and Vytilaur junction to Cuddapah that some heavy masonry works (besides the Annicut across the Pennair) have to be constructed during that distance.

95 The really formidable difficulties however only commence at the point where the canal strides the Pennair near the junction of the Boggah with that river. The present design is to carry the canal along the south bank of the river shaving the different spurs & traversing the intervening vallies as far as a village Kalleghery a little above the confluence of the Cheyaur with the Pennair. The Bluffs above

above this confluence and a little distance below it which are very formidable and the difficulty of crossing the Cheyaur it is proposed to avoid by means of an Annicut 18 or 20 feet high to be built across the Pennair near Dongasanne 3 miles lower down which it is supposed will back the water up some distance above the Bluffs on the left or upper bank of the Cheyaur and render that part of the riverbed navigable

96 The eventual construction of another Annicut across the Pennair just above the Cheyaur is also contemplated by the Chief Engineer to obviate the obstruction likely to be caused by the accumulation of sand at the confluence of the Cheyaur

97 Below the Dongasanne Annicut the channel will be resumed on the south bank and carried to a point a little above the Somaisweram the last & lowest Forge In this Forge the river bed is to be rendered navigable by the damming up of the water by an Annicut to be built just below the Forge at Somaisweram

Besides

98. Besides the difficulties on the Dongasonne and Somasseveram forges which it is intended to pass by means of Aqueducts as above mentioned several have to be encountered higher up which must be overcome by other means. There are 3 difficult and hard rocky spurs at Sundy just below the confluence of the Boggah 20 chains in length Rock vitrified sand stone and slate. Cross section about 2 to 1. Opposite side and a rocky projection. Slate slopes 3 or 4 to 1. a little further on, 3 spurs. Cross Sections 3 to 1, 2½ to 1 and 1½ to 1 Length 5 Chains.

99. Above Penny pay roo there will be a rocky cutting between 2 hills of about 870 yards in length and an average of 1 yard deep.

100. Near Bundalapilly however the most formidable of all the difficulties occur. There is first a detached spur 350 yards long with cross section of 2:1. A small valley and then a steep face of rock coming down to the river, 5 Chains in length. Section 2:1. Then 16 Chains, very precipitous, making an

12

an Angle of from 10° to 25° with the vertical Then 12 Chains with slopes of 2:1.

101. A Tunnel tho' a rocky hill near Coormaloor 170 yards in length will also be required.

102. It is proposed to pass these rocky spurs where the face of the rock is not too steep by partially cutting into the rock and building up a wall resting on the toe of the slope on the river side permanently and be afterwards unaffected by the action of the stream. This mode of construction has the advantage of cheapness and facility of execution. Where as a river wall on wells would be difficult of construction and much more expensive.

103. But at Bundalapilly the face of the rock is too precipitous to admit of this, and the Canal must be carried along the river at the foot of the rock either by means of a river wall built upon wells or on a rough Stone Bank. I am of opinion that the latter is the plan to be preferred. A mass of rough stone blasted from above and thrown in, if a sufficient slope is given it on the river side, will soon settle permanently and be afterwards unaffected by the action of the stream. This mode of construction has the advantage of cheapness and facility of execution. Where as a river wall on wells would be difficult of construction and much more expensive.

104. I roughly estimate the cost of building a Canal 30 feet broad on a rough stone bank, with a proper flooring and Towing path at 100 or 120 Rs per running yard The cost of forming a Canal of the same breadth by part scarping and part wall will be from 50 to 60 Rupees per yard

105. While examining the difficulties along the proposed course of the Canal along the south bank, I could not help being struck by the apparently less formidable nature of the obstructions which the north bank of the river presented. The rocky spurs on the north bank at Guinsy are less formidable than those on the south bank opposite. A little below near Ponisalo there is one very precipitous bluff on the north but it is of no great length and between that and the Cheyaur there are no other serious difficulties whatever on that side. Down to that point therefore it would be decidedly in my opinion easier to carry a Canal by the north than by the south bank (an Aqueduct across the Suggelair excepted). Opposite to the confluence of the Cheyaur and

and further down at Diongasonnee there are 2 long and difficult faces on the north side but they are not so far as I can judge so difficult, but that a 30 feet Canal might by scarping and building be carried along them. They are unquestionably less formidable than the corresponding difficulties on the south bank which will necessitate the construction of 1 if not 2 Anients.

106. I cannot help thinking that these Anients are a very cumbrous, expensive, and inefficient mode of completing the navigation and that if they can possibly be dispensed with even at some increase of cost, it should be done. I feel confident that the water will not be found to stand so high above than as is calculated upon, that the accumulation of sand on their upper sides will seriously obstruct the traffic and encumber the locks and if of considerable height they will be exposed to risk and cost much in repair

107. My opinion is that at little or no increased expense, the Canal may be carried along the rocky faces and the

the 2 Anicuts at the Cheyaur and Doongasonnee be altogether dispensed with, and if this be done, the north bank of the river I certainly think presents greater advantages for the course of a continuous Canal than the South.

108- It seems to me also to be a question whether it would not be better to dispense also with the upper Anicut at Adamapillay and bring the Canal by the north bank at once to the Guindy Spurs avoiding Cuddapah altogether. Several miles of Canal would so be saved. By doing this some advantages would be unquestionably sacrificed. The communication with Cuddapah and the present line of the Railway would be lost the opportunity of irrigating the Cuvaypah Valley and an additional supply of water from the river there be given up.

109. If it be deemed inadvisable to sacrifice these advantages the upper Anicut might be built below the Poopashony Hill, where it might probably be founded on rock, and the Canal be taken off on the north side, a branch only being taken from the south side

side for communication with Cuddapah and irrigation, if there be water enough. But my idea is that all the water which is ever likely to be brought down the Canal from the Soombuddra will be barely sufficient for the supply of the irrigation, which is very extensive, in the Koondaur Valley and for the feeding of the Canal as a navigable one down to Sonaiswaram.

110. I would strongly advocate a careful examination and survey of the north bank of the Penniar with a view to determining whether the facilities offered on that side for a Canal are not greater than those on the south bank and especially whether by adopting that bank it would not be possible to make the course of the Canal continuous down to the Sonaiswaram forge and so dispense with the Anicuts at Doongasonnee and the Cheyaur.

111. As the designs of the works below the Koondaur and Vikalaur junction are not made or even the surveys completed it is impossible for me to offer any certain opinion as to the probable cost of the

portion

portion of the line. The Masonry works will as above observed be heavy, the difficulties along the Penmar are of a very formidable description and the expense of overcoming them, whatever mode of doing so be adopted, must be great; and I think that the excess over the original rough Estimate is likely to be considerably larger here than on any other part of the line.

112. The site selected for the Sonaisewaram Anicut appears to me to be good and as there can be no doubt about the indispensable necessity for this work, permission to proceed with it at once should be accorded. This work should certainly have a head sluice on the north as well as on the south side.

I have the honor to be,
Sir,
Your Most Obedient Servant.
J. B. Hudson Lieut.-Col. R.E.
Late Officiating Consulting Engineer
for Irrigation & Canals &c.

Compared & Typed

Pro: 24th July 1862 No. 511-512
Copy in a letter to Engineer
of 27th January No. 5 of 1863

P.W. 1862 Despatch
Rec'd of Govt. for Desp.
No. 3259

From
Lieut. Col. J.C.E. Ludlow
Late Off. Consulting Engineer
for Irrigation & Canals &c.

To
Colonel H. St. Berkwood C.B.
Secretary to Government
in the P.W.D.
Fort St. George

Dated 29 October 1862
Rec'd 30

No. 76

Enclosures 5
3 Plans & 2 reports

Reports on the condition
& progress of the Company's
Works as required in the
Proceedings of Government
dated 24 July 1862 No. 1772

No. 3705

No. 3045 - 19 Dec. 1862

C. 20 Nov. 1862. Rs. 8-8-0

Madras Irrigation Canal Company
Pennair Division
8 October 1862

It is proposed that the 9th section of the main line of Canal by an Annicut across the river Pennair at a point about half a mile above the village of Rajoly.

The length of the proposed annicut is about 100 yards, its height above the ordinary low water line of 9 feet, the bottom is rock all the way across.

The water level of the Canal at the offtake is proposed to be 1 foot below the Annicut Crest. The Channel at the offtake to be 30 feet wide with 2 to 1 slopes, fall 1.33 feet per mile, and with 6 feet depth of water.

At a distance of about 2¾ miles below the offtake it is expected that the Canal will run out to such a level that the water line will Coincide with the surface of the ground, and that the excavation will be sufficient to form a bank high enough to keep out the river floods. At this point a dept of 13 feet would bring the Canal from the 8th section into the Cut.

Below this junction the Canal would be widened to 60 feet mean width, and 6 feet depth, with a slow fall of 2 to 3 inches a mile.

3 or 4 miles below this, the Canal will cross the Vaikolair by means of an Aqueduct. The bottom of the Canal will be 18 or 19 feet above the natural bed of the river. The foundation will most probably be rock of a red clay stone, affording a sufficiently good foundation

11

to require no protection from wash, but not sufficiently good for building. About four arches of 30 feet span will be required. The area of the basin drained is about 280 ~~Miles~~ Square Miles.

After crossing a drainage probably draining 6 Square miles of Country & requiring a bridge of two 10 feet Arches the Canal runs close to the Cano Goodoor by two locks falling 18 feet in all, into a line that has been levelled from the Junction of the Roondair Poikkeair. This line runs parallel to the river, crossing two streams of about the same size as that last mentioned & requiring works of similar Character.

From a point near Goodwarum ~~where~~ this line again ~~comes close~~ to the river, it turns inland & ~~runs~~ the two ground divide the drainage that passes Dhoor, passing immediately below that village on a bank. An Aqueduct of 3 15ft arches will be required to pass drainage that occur here.

After Crossing the drainage near Dhoor the line again turns towards the river, passing about half a mile above Nattoor. From this point to the Wobopully bank it runs nearly parallel to the river at a distance from it varying from ½ to 2 miles. On this distance two drainages have to be crossed of much the same character as those mentioned above. The line then rounds the upper side of the Wobopully bank. Here an Aqueduct will be required to pass the drainage into the bank. Two twenty ft arches will probably suffice for this.

From the Wobopully bank the line takes a Southerly direction, passing above Cheyapaud, at about a mile from the bank it meets a large drainage not shewn on the map. Here a drop of 16 feet brings the water

5

line to a level suitable for an Annicut. Another drop of ten feet at the next drainage about a mile & a ½ further on gives a level suitable for an Annicut there also; these two Annicut will together require a length of about three hundred yards of overfall. Two miles further on, the line, still skirting the side of the slope passes near the village of Alladuppully; and two miles further on strikes the watershed between the Roondair and the drainage running from Mudukoor to Poospagarry hill. One mile down this watershed is a lock of 10 ft drop. another of the same drop 1¼ mile further on. another same drop 7 furlongs further, from which point to the river, a distance of 3 miles a drop of 17 feet is required to bring the water to the level of the Pond of the proposed annicut. The total lockage drop from the Roondair Annicut to the Punnair Annicut will thus amount to 84 feet.

The Annicut across the Punnair is proposed to be 2500 feet in length and eleven feet in height above the deepest bed of the river. Two sets of Scouring Sluices are proposed, of 9 openings each, one at each end of the Annicut with their sills on the level of the lowest bed of the river. Each opening to be 7 ft wide and 10 high. The Sluices on the South bank, & one third of the length of the Annicut on that side will be founded upon rock, the remainder of the Annicut will be on deep sand. The portion of the Annicut on rock foundation will be a simple wall, 6 feet in thickness at top, and increasing by a regular batter to a thickness of ten feet at bottom in the deepest part, where its foundations will be about 8 feet below the present deepest bed. The remaining portion of the Annicut will consist of three parallel walls on brick well foundations & connected by aprons of solid

(2)

rubble Masonry Sloping down from the crown of the Annicut to the level of the river bed. a rough Stone apron will be formed beyond the lowest walls The Head Sluices will have five openings 5 feet high & 3 feet wide each. The Sill of the Head Sluices will be 5 feet above that of the Scouring Sluices or about the level bed of the river. The Crown of the Annicut will thus be one foot above the top of the Head Sluices, which are calculated to pass 2500 Cubic yards of water per hour. The face of the Head Sluices will be at an angle of about 45° to that of the Scouring Sluices, and distant from it only a few feet. The head Lock to be made about 200 yards above the Annicut, two pair of 20 feet gates will be required, as the flood waters have been known to rise to 19 feet above the level proposed for the Sill, which Coincides with that of the Head Sluice Sill.

It is proposed to have a bridge of 15 feet width over the Head Sluices and also over the tail bay of the Head Lock for a roadway for the Convenience of the Villages lying between the river and the Channel.

A Slop bank will be required about a mile and a quarter in length, running out to nothing from about 12 feet high at the river bank, in order to prevent the flood waters of the river from finding their way behind the line of Canal.

The Channel is proposed to be 60 feet mean width of water & nine feet in depth.

Starting from the Annicut with about 17 feet of Cutting, it runs out pretty evenly to 4 feet Cutting in a length of about 1¼ miles.

From this point the Line will be in easy cutting and light bank to the crossing of the large drainage that enters the river opposite Poompagamy hill. For crossing this Stream, which drains about 80 Square Miles, an Aquaduct of 6 Arches of 30 feet Span is proposed. The foundation is rock, & good building Stone is on the spot.

From this point the line runs in light bank and

(2)

easy Cutting about 5 Miles. Crossing two small drainages by two ten feet openings and running for a upwards of a mile close along the north side of the Goolty road.

At the Crossing of the Cheenoor road a Lock 6 feet drop will be required, with a bridge over the Lock bay. Immediately below this point the line will begin to skirt the north side of the Contonement. Two more Locks will be required between this and the Guindy Spur giving a total fall of 36 feet for the three Locks.

J. Clarkson

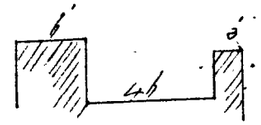
Lt. Engineer

(3)

Copy in a Ltr. to Langton
P. 27 January 1853.

Rough Estimate of Aqueduct at Ardrinafully. 85

Width over all, at top 55 feet



towing path 6. waterway 46. wall 3.
waterway to allow two boats to pass

Arches { No. 55. 2 at on rock 6 on sand
30 feet span

Height of Springing to correspond with highest known flood.

Depth of foundations average level of 2 at piers on rock 19 feet below Springing

Level of foundations of 6 piers on sand, 24 feet below springing, not including 3 feet footing, part of solid flooring below present deepest bed of river, & having its top at that level.

Width of flooring 72 feet as follows

width of superstructure 55, 3 cutwaters 10½ width of 2 walls at end of arch 6½.

Wells. two rows to each pier, wells 6 inches apart, 4' 6" external diameter gives 28 wells to each pier, 28 × 60 = 1680.

Add 5 wells in each opening at each end of arch
10 × 61 = 610.

At abutment three rows, 14 in a row, 42
under wing walls 2 × 3 rows of 16 each 96

Total. No of wells 2428

Height of banks, approaches, above Springing, 18 feet.
thus rise of arch 7. 5 ft. thickness at crown 2. Voussoirs.
water 5. Bank above water line &c.

(4)

[illegible]

[illegible] 12.30

[illegible] 103.51

[illegible] 10.81

[illegible] 1050.00

J. Gallacher
Govt Surveyor

Copy in a letter Maryland
to Brig Genl Barnard 25 Jany 1863.

Earth work in Aqueduct Approaches.

Double Bank, each bank 8 feet wide at top.

Slopes 2 to 1.

On South side of the river.

3 Miles 52 Chains long th; Bank 8 feet wide base
[illegible] corresponding with height of aqueduct
Total Embankment 1.312.320 Cubic yards

On North side of river

Deep excavation for double bank, average 12 feet high
(This is necessary for a width of 8 feet immediately back
the aqueduct). 110.850. C. yds
Deep [illegible] average 6 feet high 70.752. "
Deep side excavation 6 feet wide 56.112 " "
Total excavation 237.714

This distance of 3¼ miles is the maximum 1¼ mile
of the summit channel, as the summit be with
materially long thereof in running from the aqueduct
to the higher ground, or else there must be a second
flight to bring the channel to the level proposed for
that from the summit. This would involve the necessity
of a deep bank, the same as for the summit, & in the
case the cost of each bank on the side of the river
would be

Bank 70 Chains 81.020 Cubic yds
" 55 Chains 47.365 Cubic yds

Total Embankment in the Aqueduct
Approaches in Maryland case, 1.539.995 C. yds

In the Virginia case

In North Bank 1.312.320
" South " 158 " "
" Deep Excavation " " 1,478.847

164

Estimate of Annicut
at Siddimpully

Total length of annicut 2400 feet exclusive of under sluices

Length on rock foundation		850 feet
On	sand	1550 "

Section of annicut

on rock, a single wall, 6 feet wide at top, increasing to 9 feet at bottom at its greatest depth 11 feet below the crown

On sand) 1st a front wall, forming the crown of the annicut

2d a Central wall 3 feet thick

3d a tail wall, top level with the deepest bed of the river, 3 feet thick, 4½ feet high.

All the walls founded on walls 4 ft external diameter, 6 feet below the foot of the walls

Trouble masonry 2 from 4½ feet thick extend in a nearly uniform slope from the Crown of the annicut to the level of the tail wall. On interval of 27 feet clear between each two walls

A loose rubble stone apron to be thrown in below the masonry, 30 yards wide, average 2 yards deep.

Height of annicut Crest. 11 feet above deepest present bed.

Proportion of waterway (in greatest known flood) occupied by the annicut, about one fourth of the whole area.

Under Sluices

on South side, on rock foundation excavated to level of present lowest bed, this being the level of the sluice sills.

9 openings 10 ft high, 7 ft wide, the top of the openings 15 ft below the Crest of the annicut.

A cut stone flooring immediately under the sluices openings faced with cut stone.

(7)

On North Side the same in all respects except as regards foundations which will be in sand—

The piers will be [illegible] thick, extending [illegible] with the wall & splayed, the upper [illegible] with the three walls of the annicut Section & Continuous with them.

Roadway for working the Sluices at 20 feet above the deepest bed of the river, being the level of highest known flood. A parapet 3 feet high protects the roadway on all sides. The roadway supported on three arches of 25 feet span each, embracing three Sluice openings and two piers

Piers will be 12 feet above lowest bed of the river, exclusive of parapet & 10 feet thick. Foundations 2 feet below lowest bed of river, and 4 feet above found bed of the river, wherever excavated close to Sluices.

Foundations on North side on sand, on wells 6 feet deep with their tops 3 feet below present lowest bed.

Head Sluices of 5 openings 5 feet high by 3 wide, six wing walls of under Sluices. Sills 6 feet below annual Crest.

to discharge 25000 Cubic yards of water per hour

Foundation on rock

A Roadway 12 feet wide in the clear to be carried over the head Sluices by a single arch of 25 ft span for accommodation

(8)

Annicut Estimate Continued

These Conditions avie the following quantities

Stone work

619 Cube yards in under Sluices, South Side
611 —— @ —— ditto
755 —— @ 22 per platform in @ —— "
876 —— @ in head Sluice ——
710 —— @ in wing walls on South side
1770 —— @ —— in —— do —— North side
18719 —— @ —— in Annicut on Sand
1712 —— @ —— in —— @ —— on rock

25463 Cube yards @ Rs 4 ½	Rs	114583
No. 18 Large Shutters 10×7 @ Rs 250		4500
5 Small —— @ Rs 40		200
25000 Cube yards loose rubble in ½ @ Rs 90		21060
3012 Cube yards Masonry in head Sluices @ 4 ½ Rs		13554
		180407
Add for Contingencies		19593
Total Rupees		200000

J. G. Clarkson
Superintendent

Copy in a letter to Brig Genl
Bernard 27th January 1835

Earthwork in Connicut Approaches

North side of the river, Double bank, 8 feet top 2 to 1
slopes; Bank 6 feet above highest known flood,
3 Miles 53 chains in length ranging from 2 to 16 feet
(base of slopes) 379,467 C yds

110

Copy in a letter Mayfield
dated 2nd January 1863

Summary.

Masonry

Aqueduct (Sheet 5) ——— Rs 4.50,000
Viaduct (Sheet 7) ——— Rs 2,70,000
Bridge in place of Culvert ——— Rs 2,60,000

Earthwork

All cuttings & aqueducts in case of Masonry
in hard ground, which [illegible]
[illegible] ——— 1,66,111 C. Yds.
[illegible] ——— 17,141
542,974 C. Yds.
Rs 1,07,584

All cuttings in Concrete with rounds &c
[illegible] ——— 147,947 C. Yds.
All [illegible] ——— 697947
In Earthwork ——— 780,900. C. Yds.
Rs 1,48,418

Total Summary Rs 4,07,858
Rs 3,48,415

J. Clarkson
Surveyor

(111)

C. 20th Nov. 1862. [illegible]

Enclosure in Letter
No. 76 to Government
dated 29 Oct. 1862

Copy with a letter to England
No. 27 of January 1863

P.N. 3259/62

C.20 Feb. 1862. 2 sheets

and Length Yard –

From the 100th to 102d Mile Line runs in very shallow cutting – From the 102d to 103d the cutting is about 6 feet on an average and the Canal crosses two small Streams by means of Culverts –

Observed 3 Barrier over the Section one near the 99th one at the 99½ Bridge Section and 1 at Excavation near the 100th –

The 5th Section ends 1808 feet before the 103d Mile is reached –

The 6th Section commences with cutting just above the 103d Mile and terminates at Hundred Yards – The main feeder of the Canal will be passed by an Aqueduct of 3 Arches 20 ft. span each – From the 104th to the 107th the cutting is rather heavy averaging about 6 ft. – In the 106th the Canal crosses the main road from Nuneaton to Tamworth and is Bridged –

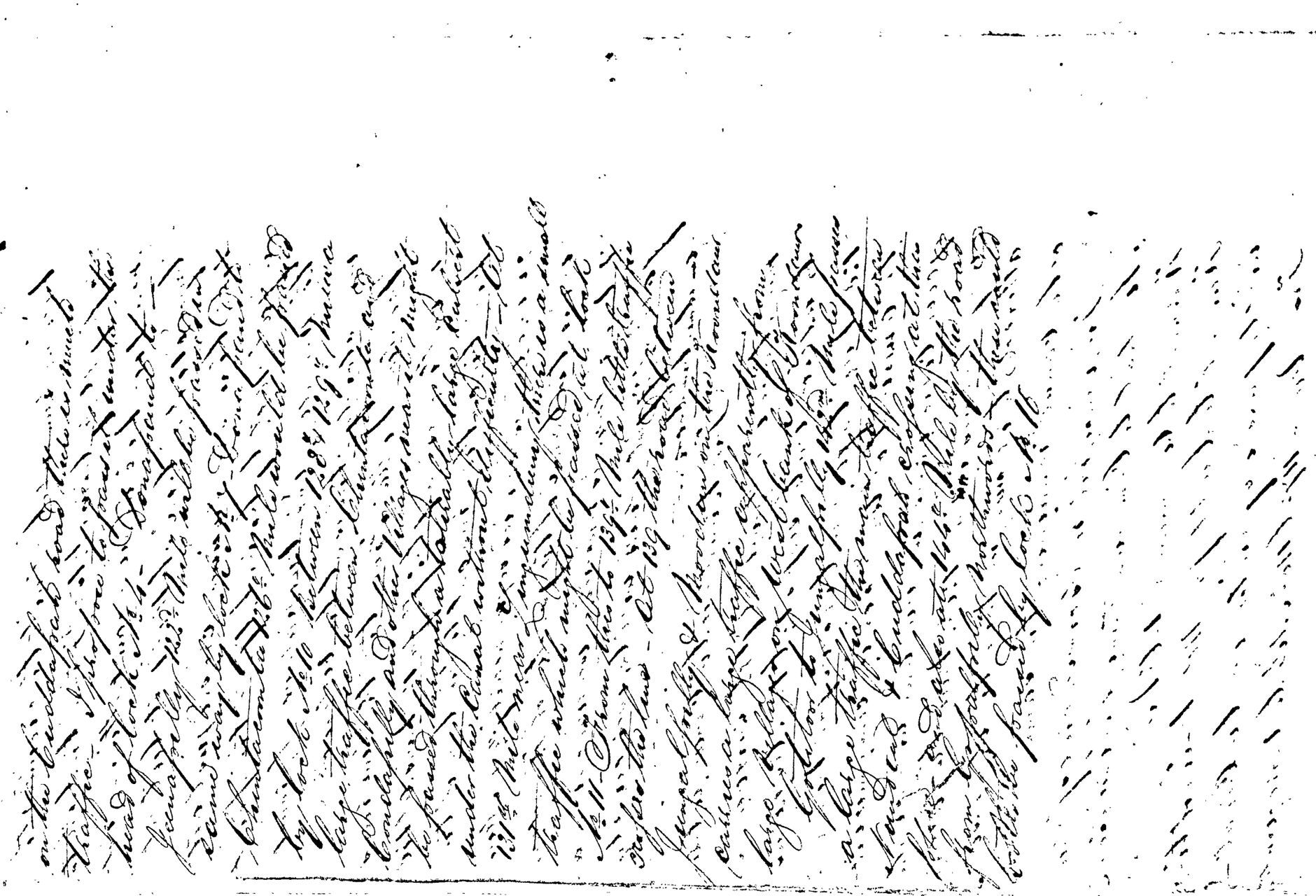
Observed at this point that the Head quarters of the Division are fixed – From the 107th to 110th Mile there is nothing peculiar to notice as the cutting is of a good standard and the drainage passed is small – At the 110th the line crosses the present main road to Birchley Park – From this point to the 115th Mile there is nothing to notice but that the line chosen is a favorable one and the cuttings no drainage nor any heads of importance –

Within a few Chains of 115th Mile the first lock is placed – There a fall of 10 feet overcome by this Lock – The Banks above gradually increase to a maximum height of 10 ft. above the lock as the ground has a regular slope – Below the lock there is 10 ft. cutting gradually diminishing to 1½ at the end of the Mile just beyond the 116th Lock No. 2 is placed at 115 6 is also 10 ft. the raised slope from this lock to the end of the Mile brings us to another lock of 10 ft. lift – From this found the cutting for 2 Miles is of a good average depth just beyond the 117th Mile Lock No. 3 is placed – Here a quarter of a Mile before this is reached the banks are kept increasing from 8 ft. to 13 at the head of the lock; below the lock the ground slopes rapidly so that at 900 ft. beyond the 120th Mile we have lock No. 5 of same lift & same height of Bank & depth of cutting as No. 4 – Lock No. 6 a little beyond the 121st Mile is approached & left with very much the same portions of ground as No. 5 – From No. 6 to No. 7 scarcely a Mile the fall is rapid giving just 10 ft. in the distance as it takes the case between 7 & 8 which latter is just at the 123d Mile & is of 10 ft. lift – At ¼ of a Mile beyond 124th Mile No. 9 of same dimensions is situated the Bank between this & the last lock are rather high between this & the last lock No. 10 near the 126th Mile is a lock of 15 ft. lift the

Copy in a letter Maryland
of 27 January No 5 of 1863

Enclosure in letter
No 76 b from dated
29 Oct/62

O.N. 32598/62.



Private

I have read carefully & considered
report upon the works of this
Irrigation company from the
Principal Conductor to
Secretary of State which is a
valuable document and will
only bring before the Govt
the state & prospects of the works
already commenced but
I doubt some means of
pledging the State should
may hereafter be demanded
for the completion of the work.
It would seem that this
except Expenditure upon
this point alone, that from
Condamala to Comisbuco
Petacondal will be only
probability at least 14 per cent

20th Nov. 1862

above the Estimate and
lower down near the Demarcation
the work would be more expensive
and the result naturally
precarious - The point however
which I wish to draw the
attention of the Govt, and
as which it seems necessary
to speak make some re-
=gulations about, is the
formation of the Canal with
only one Bank. - The Engr
suggested that he should
be allowed to substitute
a dam for a deep cut Canal
on the ground that it would
be less expensive - and to
this the Govt acceded. The
directions to this were that
a quantity of land would
be submerged the amount
being variously estimated by
the Engr & the Collector - It
appears from Col Dickens
Report that the bank by
which the water is retained in
the Canal has been made of
land materials - of simple
description & it is likely to
receive considerable damage
from down upon the amount
of land submerged, it is stated
to be 6000 Acres - the dam
taken by the Govt was that
originally required for the
Canal should under the
agreement with the Company
be paid for by them but
that this was not intended
to cover land taken at this
Engineer by a change of plan
might subsequently become
=ary. I am not aware whether

C. 20 Nov 1862.

any distinct understanding has been come to on this subject - but looking both to the safety of the work and the public who may have to use these banks I am of opinion that directions should be given to the Engr of this company to arrange his plans for the whole of the sections of this work not commenced so as to retain the width of the Canal between two banks. providing of course for the drainage of that part of this country which is below the surface water of the Canal. —
with reference to the fourth section of this work between land and land

113

commenced in place - the Engineer should be directed to mark off such land as he would consider sufficient to form the Canal with two Banks, and that consulting Engr should then report to the amount of the currency of this amount required - which the Engineer should report to the Engr to compensate the Engr for any land, the Right for any land, in excess of this amount required, which may be taken or inundated by the Engr - the company to pay the Engr, at least so says the Engr, by this arrangement there is no reason why the

20th Nov 1862

Grout should pay for the
Leaving by furnishing an
additional quantity of
Land — ——
The suggestions as to the
Bellary Road should be
referred to the Engr who
should be requested to say
whether the purchase by
Civil Engr might not be
modified — —
The suggestions as to the
Goodoor Tank seem to
be worthy of consideration —
Letter refer to Board of Revenue
The suggestions as to the
work in the Seringa may
be submitted to the Engr
to the Company

20th Nov. 1862.

Copy in a letter 27th January 1883.

Rec'd 1883 Jan 29 Gov. Office
No. 1: 34/82.
Claim Co. by the Right Hble the Secretary of State
Rec'd 1st Feb 1883

No 30: 46: 19th Dec

Observing that the Report of Lt Col Ludlow on the works of the Irrigation Company is very valuable & satisfactory and stating that the Company should be required to arrange new plans for the Canal with the embankments and mark off the land it would surrender sufficient for that purpose and directing that the question regarding the Bellary Bridge and the Godavery Tank be referred to the Engineer and the Board of Revenue - Respectively

No. 376.

No. 20th Nov/82 R.S. Fort

Lt Col Ludlow's report is a clear & valuable paper, and will aid the Govt in dealing with future questions connected with the Irrigation Company's operations.

As however it is circulated without the previous papers & correspondence the remarks will at present be brief.

The question of a single embankment in the canal has opened an enquiry of which I was not aware - its nature as I recollect, permission was given for this course upon urgent application in one particular locality only & the Company were then informed that they must pay for the land taken & charged by them, as Govt could do so

more than verifying the land required
constructing for the Canal according to the original
plan. - I had no idea that so much
of the Canal was being constructed in
this exceptional manner & the subject
deserves the attention called to it by
the President -
I concur in the President's remarks &c.
finding the Bellary bridge & Gordon
tank -
P 48 of Col Ludlow's report requires
careful notice - The Board should more especially draw attention to the point that the plans of the Company's Officers did not provide sufficient means for keeping the canal & its

forest-flaces, & orders were given that
this inconvenience should be provided
against - Why has not this been done
P 54 shows that instead of providing
any unnecessary impediment to the
commencement of supplying irrigation
to the Carnatic
in the first season the Company's
works were in no fit state for such
an undertaking - The dam joining
rock-bank have been very trifling, &
the damage & danger from both
to the Company's works & the ad-
joining villages. - It is clear that
when new water could not with
safety be admitted into the canal
until its banks have been rivetted & strength

It is desirable that the principal papers connected with the Irrigation Company's affairs should be collected & arranged in book form, so that the members of Govt may have them at hand for reference when future point come under consideration.

10 Nov/62 Elle

I concur in the remarks made by the Hon'ble President and by Mr Bradley. It seems to me, too, to be very desirable that this report and the orders which may be passed upon it, should at once be communicated to the Secretary of State, that he may know precisely what is the present state of the works and their prospects.

12.11.62 JP

Copy in a letter to England
dated 27th January 1863.

No. 3045 of 1862
Dated 19th December 1862
Rec'd 24th "

Public Works Department

Proceedings of the Madras Government
Under date the 19th December 1862.

Read the following papers.

From the Consulting Engineer
Irrigation & Canal Company

Remarks for sanction
Plans & Estimate amounting
to Rs 135,000 for works req^d
in the 2^d Section of the Canal
(from the 92^d to the 103^d Mile)
from the Village of Jolarpet to
the Town of Trindivanam.

A. to A. No 76 dated 20 Oct 1862

Reports on the condition
& progress of the Company's
works as required in Govt
Order dated 26th July 1862, No 1772.

A. to A. No 76 dated 29th Oct 1862

Minute by the Honorable Vice
President.

A.E. " 7 Nov 1862

Minute by the Honorable Mr
F. Maltby

A.E. " 10 Nov 1862

Minute by the Honorable
Mr F. Ryerscft

A.E. " 12 Nov 1862.

No. 377-378

Rec'd 21st Nov 1862.

No. 3483 of 1862 Despatch
from Govt for Decn
dated 5th January 1863

Minute by the Right
Hon'ble Sir C. E. Trevelyan
Bart G.C.B. Maltby
Dated 10th Nov 1862
Rec'd 14th "

Concurring in the Remarks
of the Hon'ble President and Mr
Maltby and suggesting that
the Report with the orders thereon
may be communicated
to the Secretary of State.

Col. Ludlow's Report
of 29 Oct 1862, No 76, recorded
above, is a clear & valuable
paper, as it not only brings
to the notice of Government
the state & progress of the Irri-
gation Company's works already
commenced, but affords some means
of judging of the plans which
may hereafter be submitted for
their completion, and will therefore
materially aid the Govt in
dealing with future questions
connected with the Company's
operations.

2 Col. Ludlow divides the
scheme as follows -

1st Between the Head at Soon-
Ravala, & the Mahacondal Cut,
a distance of 72 Miles.

2d Between the Cut & a point
a little above the junction of the
Koondaur & Cyklaloo streams as far
as the 148th Mile.

3d Between the junction of
these streams & Cuddapah.

4th Between Cuddapah & the
Bonnasheveram Anicut.

5th Between the Anicut &
the Coast through the Nellore Dt.

3 It is expected that
all the Head Works included in the

* Para 26 & 5

General remarks

Works are progress.

Course of the Canal settled. Ests
for the portion between the Cut &
Mandeal (105 Mile of Canal) sent
before Govt, & that for the remainder
are shown to the junction and after-
wards shall.

Course of the Canal not finally settled

Course of Canal yet under consideration

No Ests before Govt.

† Para 25

20th

25

first section, viz. Anicut, Sluices &
Embankments will be fully com-
pleted by the end of May next
or mid time for the reception of
the first freshes of 1863. The ex-
penditure upon the works up to
the end of July last was Rs 110,482,
and the works remaining to be done
is estimated by the Company's Engrs
at Rs 44,697, exclusive of Stores
& Plant. Col. Ludlow, however,
notices certain deficiencies in the
Estimate for Completion, and he
therefore allows Rs 15,857 in addition,
thus raising the probable cost of
works to be done to Rs 60,554, &
the probable total cost of the works
when completed to Rs 171,036. The
Sanctioned Estimate having been
Rs 125,000, the probable excess amounts
to Rs 46,036, or nearly 37 per Cent.

4 The Govt learn that the
Banks of the Canal, comprised
in the same section, between the
Anicut at Soon Ravala & the Chindra
Aqueduct near Nurnoor, about 18
Miles long, present a very weak
and insecure appearance - they
are said to average 16 or 17 feet
in height & to be formed of
a very friable soil loosely thrown
up with insufficient slopes. In
consequence of the extensive out-
spread of the water, it is
apprehended that the Banks will
be exposed to the violent action
of the waves when agitated by
strong gales of wind, and to protect

Para 28

† Para 41

them against such action, Col. Ludlow considers it to be unalterably necessary that they should be revetted for a considerable length of the Canal, with such protection as it is feared will not prevent leakage. The estimated cost of the Canal and embankments is Rs 620,974. The actual expenditure up to the end of August last was Rs 378,981.

5. Considerable deviations are reported to have taken place from the original plans in the case of the Culverts & Calingulahs constructed between Soonkasala & Burnoll, & while some of the Masonry works have been altogether omitted, the designs for others have been considerably modified, & certain works not provided for in the Estimate have been carried out. The probable excess on these works is given at Rs 9647. × Para 57

× Note — Rs 4382
Probable cost of Completion 5327
Excess 944

6. In Para 48 Col Ludlow brings to notice the necessity for rendering the Culverts & Cascades as possible to admit of the passage of cows and Cattle, as otherwise the inconvenience which the inhabitants of the Villages situated near the Canal will suffer, will be very serious. The Govt observe however that in Proc. dft 11 April 52 No 756, they Govt directed that if practicable

the Culverts should be so constructed as to meet this desideratum, & that additional ferries should also be furnished for the purpose. ~~In further orders on the subject were passed as to be enforced when there has not been done.~~ Proc. dft 2d Decr 52 - 2567

From Para 52 of Col Ludlow's report, the Govt observe that instead of any unnecessary impediments having been raised by them to the ~~cultivation~~ communication ~~experienced~~ in the past season, the Company's works were not in a fit state for such a purpose, and that while the sums gained would have been trifling, the damage and danger both to the Company's works & the adjoining Villages. ~~would have been great~~ Even now water could not with safety be admitted into the Canal until the Banks have been revetted and strengthened. 2 3

8 With regard to the Billary road Bridge across the Canal at Burnoll, Col Ludlow suggests that the plans of the structure should be reconsidered. According to the sanctioned design the Bridge will be 20½ feet higher than the Bed of the Canal, which is on the same level as the roadway. It must necessarily, therefore, be both inconvenient and unsightly. Col Ludlow ~~suggested~~ to

Para 55

refer the matter to the Company's Chief Engineer who will be requested to see whether the modification might not be carried out.

Para 56

It appears that the Sandy Aqueduct as far as it is completed has been substantially built. ~~Several arches~~ The Arches will be turned in separate & independent sections, so that a portion may be completed this season. By this expedient it is anticipated that an ample supply of water will be carried across the Aqueduct next season for all the lands lying under that part of the Channel below Burnood which is likely to be completed. The Estimates for this work amounts to Rs 145,000. The expenditure up to the end of August was Rs 77,717, and it is expected that the Estimates will be exceeded by Rs 41,967.

P. 61 & 62

The aggregate excess over Estimates on the whole of the works between Doonkerala & the Mundra Aqueduct will it is supposed be about ~~14 per cent~~, and it is satisfactory to note the opinion recorded by Col Lindlow that the excess is by no means large, Considering the novelty & magnitude

of the works, the scarcity & increased cost of labor, coupled with the many difficulties which have had to be overcome.

Para 68

The Canal from the Aqueduct on the 18th Mile to the Navigator Tank on the 43rd Mile is ~~observed to be~~ in different stages of progress, & as has been proposed to the Chief Engineer 33 in breadth only of the Channel has been excavated ~~on~~ this Season, water may be conveyed ~~down~~ to the Navigator Tank & a large extent of land brought under cultivation during next years freshes. The Canal on this section under notice will be single banked for the most part. Col Lindlow states that the water extends over a large area on the lesser side where large tanks will be formed & that Officer is of opinion that in places where the banks are high & the soil is bad, revetments will be essentially required to ensure their safety, but for this the Estimates do not provide.

Para 70

On the question of a single embankment, Col Lindlow writes as follows:- "The additional works "which the banks will be exposed "to, & the consequent expense "of Revetting them are due to the "adoption of the single bank "mode of Construction added to the "injury inflicted on the Roads by "the submersion of immense tracts of "valuable land, of which about

Para 71

"6000 Acres will be sacrificed, so
"far in my opinion to Counterbalance
"any advantages to be gained from
"it."

12. The substitution of a dam for a sunken Canal was advocated and sanctioned chiefly on the ground that it would be less expensive. The objections to it, however, were that a quantity of land would be submerged, the amounts being variously estimated by the Engineer & Collector. It appears from Col. Sidlow's reports that the banks by which the water is retained in the Canal has been made of bad materials, & imperfect section & is liable to receive Constant damage. ~~[illegible]~~ The view taken by the Govt was that only so much land should be furnished by them as will be required for the Construction of the Canal with double embankments, & that any land required beyond this must be paid for by the Company; but this was not intended to cover such land as the Engr by a change of plan might submerge unnecessarily in Looking both to the safety of the works & of the people who may

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live below the banks, the Governor in Council is of opinion that the Company's Engineer should be requested to arrange his Plans for the whole of the sections of the work not Commenced so as to retain the water of the Canal between two banks, providing of course for the drainage of that part of the Country which is below the surface water of the Canal. With reference to the first section where the work has been Staked out & Commenced in places, the Company's Engineer should be requested to mark off such land as he would consider sufficient to form the Canal with new Banks, & the Consulting Engineer will then report as to the Competency of the amount required, while the Collector will enquire the Company's Engr to compensate the Ryots for any land which may be taken or inundated, in excess of the amount required. There seems no Reason why, when the Company gains largely by the single bank arrangement, the Govt should be called upon

Jay Jr Kissaring by Jurnishing
to ~~[illegible]~~ additional portion of Land.

13 The Course of the Canal from Nagatoor to the Metacondal Cutting has been marked out, but little more has been accomplished, & all that has been done to the Cutting is the removal of the earth down to the surface of the rock for ~~[illegible]~~ about a mile. The estimated sides as it is said will prove insufficient. The Metacondal Cutting carries the Canal through the Watershed into the valley of the Noondauer. No work has yet commenced below the Cutting. The Rs to for the Continuation of the Canal from the Cutting to the Caulee Aricut at Jrobroor ~~[illegible]~~ from the 92d to the 92d Mile were sanctioned in Pro. of 3d July 62 to 1858; & the suggestions made in Para 81 of Col Ludlow's report should be Communicated to the Comps Chief Engineer. The Canal takes it from the Caulee at Jrobroor, & then ~~[illegible]~~ through the Bypass Goodoor Tank, which Col Ludlow recommends should be

† 72. 674

† Paras 83 & 84

handed over to the Coy on their paying annually to Govt a Sum equal to the average annual revenue less the Cost of Repairs. This suggestion seems worthy of Consideration, & will accordingly be referred to the Board of Revenue Deputy for Report. From the Goodoor Tank the Canal will be continued to Sundial, & thence skirting along the Watershed between the Noondauer & Pycaloe, to their junction at the 148 Mile near Changal. ~~[illegible]~~ The Course of the Canal as to this point has been finally decided upon by Paras 87 to 110, Col Ludlow gives a general outline of the works to be carried out below the 148 Mile until the Canal reaches the River Pennar. Of the works comprized within this Section of the Canal, there require special notice, viz. the proposed Aricuts across the Noondauer & Pennar. Col Ludlow does not consider the immediate Construction of the former to be absolutely necessary, & he is of opinion that it is even advisable to defer it ~~[illegible]~~ until we know whether the Canal can carry all the water which it receives from

1/4

above, or not. With regard to the other work, viz: the Aniecut across the Pennar at Nolamu fully below Ponnakra, Col. Ludlow adverts to the question raised as to whether an Aniecut or Aqueduct should be built, & he gives the preference to the former. Starting from this Aniecut the Canal will be carried in the direction of Cuddapah until it meets the Pennar below its junction with the Borga. The chief difficulties to be overcome are said to regard at this point. The Canal is to be taken along the South bank of the River until it reaches the Komaishwaram Gorge, an Aniecut being constructed across the Penniari near Doongasinne, & another across the Lanes River just above the Cheyaur. Col. Ludlow explains the manner in which he considers that the very formidable difficulties near Pindalapilly might be overcome, and he then points to the apparently less formidable nature of the obstructions which the north

bank of the River presents, & he suggests therefore that the Canal be taken by that bank instead of the South. Col. Ludlow then advises the expediency of dispensing with the proposed Aniecuts at Cheyar & Doongasonne as well as the Upper Aniecut at Adamapilly, as being a cumbrous & inefficient mode of completing the navigation & he shows by what means those works might be avoided. Col Ludlow further suggests a careful examination & survey of the North bank of the Pennar with a view to the valuable facilities offered by that bank being ascertained, as also the possibility of dispensing with the Aniecuts at Doongasonne & the Cheyaur by adopting that bank. — The suggestions specifically adverted to in this Para will be referred to the Company's Chief Engineer for Consideration.

15. Authority was granted in Pro: of 12th Nov 1802 - No 2721, for the Commencement of the Komaishwaram Aniecut, & under the views expressed above in regard to the plans

for the Sections of the Canal not Commenced, the Govt Resolve to retain for such Revision as they may need, the Plans & Estes for works required between the 92d & the 103d Mile. ~~Those for the Section between the Lemonade Branch Aniceut & the Canal were submitted with Rep. of 2 July 62, for $625.~~

W.B.

Engr Reports Letter, d/20 Oct/62 No 74

4 Sections
5
6

The Engr Reports for the T. of C. with 17 Encls. Dispd 20
4. Agents for
17 Bd of Cleveland Dispd

Copies in a letter to England
dated 27th January 1863 No 5 of 1863

(111)

P.O. No. 1862 Despatch
Pleas of Govt. for Decr
No. 39405.
Copy of the Govt
of 19th Decr 62
10710

From the Comptr Engr & Surveyr
No 38 dated 23 Decr 62 No 3538

Returning for revision
to the Consulting Engineer's Estimate of
Canal Company's Claim for Extra
for work required between the 92nd &
the 103rd Miles with Copious observa-
tions -

Nos 374 & 377

4