M.R. O. 1—89,000—16-10-29.

MADRAS RECORD OFFICE.

Government of Madras.

Revenue DEPARTMENT.

G.O. No. 326 Press ~~Mis.~~

37-38 Dated 3-12-~~1868~~

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MRO 21-1-30

Proceedings of the Madras Government, Revenue Department,
3rd December 1868.

No. 37. Read the following Proceedings of the Madras Government in the Public Works Department :—

Passing orders on papers relative to the state of the Irrigation Company's works, as ascertained between the 30th August and 22nd September 1868. } (Here enter 17th November 1868, No. 3,586.)

No. 38. ORDER THEREON, 3rd December 1868, No. 3,026.

Irrigation, No. 1. Communicated to the Board of Revenue.

(True Extract.)

(Signed) F. BRANDT,
Under Secretary to Government.

To the Board of Revenue, with Proceedings Public Works Department, No. 3,586.

Exd. F. R. Bantleman.

Govt. of [1868] Madras

REVENUE.

To

THE BOARD OF REVENUE.

Dated December, 3rd.

Recd.

Encl.

G. O., 3rd December 1868, *No.* 3,026.

DECEMBER.

Nos. 37-38.

Irrigation Company's Works.—Orders on papers relative to their state, as ascertained between the 30th August and 22nd September 1868, communicated to Revenue Board.

Read the following papers:—

No. 314. From the Consulting Engineer for Irrigation and Canal Company, to the Secretary to Government, Public Works Department, dated Madras, 26th September 1868, No. 68-

1 Letter in original from Agent, No. 103, dated 15th June 1868.
2 Copies of letters to Agent.
1 Plan.

1. I have the honor to submit, for the information of Government, the subjoined particulars of the state and circumstances of the works of the Madras Irrigation and Canal Company, as ascertained during an inspection made between the 20th ultimo and the 22nd instant:—

Soonkasâla Anicut and Head Works.

See also paragraph 42, below.

2. At the Anicut all the coping stones have been laid, with the exception of some seven or eight on the upper part of the ramp leading to the roadway over the under-sluices. The upper surface of these stones has still to be dressed, and the bevel to be cut at the up-stream edge. The coping has stood well, and, so far as is known, none of the stones have been displaced. On the 20th of August one foot nine inches of water were passing over the Anicut, and the highest level of this year's freshes had been, up to that time, four and a half feet.

The under-sluice flooring was repaired during the last dry season, and pointed with Portland cement. The pivot beams or spears of four of the revolving shutters have been strengthened with battens and iron rings, and this arrangement has, I was informed by the Assistant Engineer in charge, been found advantageous.

Proceedings Madras Government, No. 1,953, dated 2nd July 1867.

The groyne intended to divert the water on its way to the under-sluices, so as to scour away the silt from the bay above the head-sluice, does not produce any effect beyond a limited distance (about 100 to 120 feet) from its nose. It has been lengthened this year, and until it shall have been carried to within a short distance of the vents of the head-sluice, it is, I think, clear that the desired result will not be obtained. So far as I could learn, the data as to nature of river bed, &c., required for determining the cost of so extending the groyne, have not as yet been collected, and without them it does not appear to be practicable to decide whether it will be advisable to incur further expenditure. The further correspondence, as per margin,* on the subject of this groyne is enclosed.

*From Agent, No. 103, dated 15th June 1868.
To Agent, No. 72, dated 23rd June.

Below the head sluice, masonry walls have been built in supersession of the revetments which had previously failed, and the new work appears to be well built and substantial. There were three and a half feet of water on the lower side of the sluice, and for some time four and a half feet had been maintained in the canal.

Main Canal, 1st Section, miles 1 to 18.

3. A good deal of work has been done during the past season, as it was found on examination that many parts had not been taken out to proper bed level. In the first three, the 7th and 14th miles, the bottoming out has not been completed, and at several places there is rock yet to be removed.

In the 2*nd mile*, culvert No. 4 leaks a good deal, and I was informed that every year the covering stones get more or less displaced. It should be reconstructed, or done away with by the diversion of the drainage, before next year, for though a very small work, its failure might lead to serious damage, and to the cutting off of the supply. In this mile a small breach occurred at the wing of the inlet attached to No. 6 culvert, owing to the separation of the earthwork from the masonry, the form of the latter not being well adapted to make a good junction.

Koontalapad. The people of this village complained of the absence of a crossing in connection with a ferry across the Toombuddra. There is a bridge in the next mile at Dudiyala, and that site was chosen because the lands of the village lie for the most part to the south of the canal and the village is on the north. Koontalapad and most of its cultivation are, on the other hand, on the south side. I found, however, on enquiry, that the bed of the river near Dudiyala is dangerous for a ferry boat, and on the north side of the canal the Koontalapad ferry is cut off from the Dudiyala bridge by the out-fall channel of culvert No. 6, which is generally impassable. All the inconvenience experienced, except that resulting from a short detour, can however be at once remedied by making a ramp up on to the left bank of the canal, above culvert No. 6, levelling the top of the bank, which is a wide one, and giving another ramp further down; all kinds of traffic will then be able to reach the Dudiyala bridge from the ferry, and this work, which will cost but a few rupees, should be carried out at once.

Dudiyala Bridge, 2nd class, 3rd mile. This bridge has been completed; the work is rough, but serviceable. The tow-path wants attending to, and the approaches on the south side may with advantage, and at a very slight expense, be placed in somewhat better form.

Left bank in upper three miles wants levelling. This bank is still in a very rough state, and it should be levelled so as to allow of walking and riding along it. Inspections cannot be properly made except from the top of the bank, that being the only place from which the state of the canal itself and of leakage on the lower side, condition of out-falls, &c., can be seen at once. Trees also should not be allowed on the inner slope and berm, or on the top of the bank.

At the commencement of the 4th mile, there was a slight leak through the bank, which has been stopped. In the 5th mile there is still a good deal to be done to the revetments, which are in many places considerably below full water level.

In the 6th mile, at waste weir No. 1, there is more leakage than is right. At the Yedarur tank in this mile, a short distance below the old breach, there were two or three leaks which would have proved serious but for timely attention, since they were stopped the bank has given no further trouble.

Yedarur bridge, 2nd class. At the lower end of this mile this bridge has been completed. The approaches, especially on the south side, want a little dressing.

In the 9*th mile*, No. 10 culvert, which is one of the crossings, is not at present practicable. The lower end of the floor, the apron, and the retaining wall have been washed away, there is no proper approach, and on the north side a road is required from the cross bank a short distance to the west. Pitching also is needed at the pool at the upper end. The leakage through the culvert from the canal is moderate.

I have asked the Agent, who was making a tour along the canal, to request the Chief Engineer to issue instructions to the Divisional Engineers, with a view to all crossings being maintained in an efficient state, and in order that those which are under the canal may receive special attention after every heavy fall of rain. It is only fair that the villagers should be put to as little inconvenience as possible, and any damage which the crossings may receive should be attended to without delay. I have no doubt that when the Engineers are informed that the maintenance of crossings is as much part of their duty as the construction and conservation of the canal works, all cause of complaint on the part of the villagers will disappear.

Nidajood Bridge, 3rd class. In the 12*th mile* is the first bridge of this pattern and, with reference to the Orders of Government as per margin,* I have to report that the bridge is far more useful than a ferry, that I saw many sheep and goats, and several bullocks, cross it without difficulty, but that as, at present, pairs of bullocks cannot cross it with their yokes, to which in this part of the country the agricultural implements are usually attached after reversal, and so carried to the fields, and as consequently the ryots have to remove these implements, carry them over the bridge, and then replace them, it is advisable that the paved slopes at the side of the roadway, and the steps, be removed, and the roadway re-formed and gravelled at a slope of not less than one in four inside the parapets and one in six outside. The parapets also should be three feet above roadway and not higher, and then the yoke bars will clear them. These modifications will make the bridges of this class quite efficient, and will add but very slightly to their cost.

* Proceedings Madras Government, No. 2,192, dated 9th July last.
Do. do. No. 2,539, dated 7th August last.

The north abutment of this bridge has settled and cracked the face wall: the roadway at top has not been completed, and a short length of the parapet over the crack has been taken down.

Mungalapad Bridge, 3rd class. This bridge is in the 14*th mile*. There will be no difficulty in making the approaches at a slope of one in five, or one in six, and indeed the spoil banks have been cut down to get the level for the one in two gradient; the roadway at top is incomplete.

Mamdialpad Bridge, 3rd class. This bridge is in the 16*th mile*. It is a very high bridge, there being seventeen steps, and there will be some difficulty on the north side in getting a good approach, but I think one in four is nevertheless the steepest gradient that will be convenient, and therefore this should be given.

Irrigation Sluices. The irrigation sluices generally want attention, as many of the shutters are out of order and water runs to waste.

Leakage.

The quantity of leakage has greatly diminished since water was first admitted, and this year also there is less than there was before. I think, however, that something more may be done in the way of prevention with regard to all that portion which finds its way through or near waste weirs, sluices, and banks. The subsoil leakage cannot be remedied, except perhaps to some extent by the gradual closing of the crevices in the shaly strata by silt.

Hindry Aqueduct.

4. The construction of the parapets has been deferred until the full water line shall have been experimentally determined, it being as yet somewhat doubtful what level the water will take, this being dependent upon varying surface inclinations above and below. The depth of water on the floor was two feet three inches, that at the head sluice being, as above stated, three and a half feet. Were the canal in a complete state this difference of depth would represent a difference of discharge of about 40,000 cubic yards an hour, after allowing for irrigation and town supplies; but the presence of rock above bed level in the upper miles renders it certain that the actual is less than the calculated discharge, and I have not the particulars of the area of sluice open at the head sluice, which, with the head of water, would give better data for determining the quantity of water admitted to the canal. It may be added also that the discharge at the Hindry aqueduct is probably considerably less in reality than that calculated from the arranged fall, as the latter is interfered with by obstructions in the 20th mile, which are near enough to influence the surface fall, the depth at the bridge in the 19th mile being two feet ten inches or seven inches more than at the aqueduct, and this shows that the water is ponded by the incompleteness of the cutting in the 20th mile. However it is certain that the total amount of leakage in the first eighteen miles is considerable, and that it will be worthwhile to examine into the subject with a view to the remedy of all removable causes of loss in this way.

2nd Section, Main Canal, 18 to 32 miles. Result of works for stopping leakage.

5. In this section the result of the exertions made during the past working season, in carrying out the alterations and additions required to render the canal safe, is very creditable. In several miles where, when last tried, the leakage was enormous, and altogether beyond control, there is now either no leakage except subsoil, or the leakage is but slight, and not likely to occasion damage. The masonry revetment walls have been well built, and the rate has been very moderate. Elsewhere, puddling has been inserted with good effect. The progress report up to the 30th June last shows that Rupees 86,091 were expended in the previous twelve months on works for stopping leakage, and the money has been well spent. About 3,526 lineal yards of walling, containing 32,000 cubic yards of masonry, have been constructed, and about 730 lineal yards of bank puddled.

Considerable leakage has still to be dealt with.

Although, however, so much has been done, an inspection of the section showed that much remains to be done, both to ensure safety and to prevent an excessive loss of water. In many of the miles the subsoil is so porous that, at least for several years to come, the loss of water in this direction will be great, and perhaps it will always be considerable. In some places the water rises to the

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surface upwards of a quarter of a mile from the canal, some of the land below is completely saturated, and all the natural drainages convey to the river very considerable quantities of water. In addition to this leakage, which must be left to be remedied, so far as may be, by time and the deposit of silt, there is a great deal of leakage through old masonry, and core section, walls, and altogether not a little through, and perhaps more especially under, the embankments, and in the latter cases the water rises to the surface immediately behind the banks and forms a film or thin layer over wide areas. The walls can, and should, be made at any rate more water-tight than they now are, sometimes by plastering or pointing where the joints are manifestly defective, or where the mortar has been washed out, elsewhere by placing a bank of good soil against them on the inside. The core walls should be re-formed by taking out all unsuitable soil, and replacing it with material capable of being made water-tight, and almost everywhere the core should be carried down three or four feet below the original surface of the ground. I had occasion to notice that the way in which these walls were being constructed showed insufficient attention to their requirements, and when this arrangement was first submitted for sanction, it was pointed* out that the cross section admitted of improvement by altering the uniform breadth of the core to one of equal breadth at top, increasing by a considerable batter on both sides, so as to give a bottom width proportioned to the height, and admitting of settlements with a diminished risk of horizontal cracks. The core wall arrangement is thought badly of from the behaviour of the walls constructed in this way, but I am still of opinion that the plan was very well suited to the circumstances of some parts of the section, and that, if well executed, it would have made an efficient and economical substitute for an ordinary embankment.

* Letter to Agent, No. 291, 25th October 1864, copy enclosed.
Vide also Proceedings Madras Government, No. 321, dated 4th February 1865, paragraph 7, end of part referring to 26th mile.

6. I will now notice those places where leakage is still apparent, to which attention should be given during the next working season.

In the 21*st mile* there is a little leakage under the bank all along, which perhaps may be remedied at a moderate expense by the insertion of puddle at the inner toe of the bank, as shown in the enclosed cross section of the 42nd mile, No. 124.

In the 22*nd mile* the leakage is moderate, and I think less than in former years, so that this mile may be left without any general alterations.

In the 23*rd mile* there is leakage nearly all along the long wall, which can be remedied by a bank of good soil against the inner face. Subsoil leakage is considerable at the lower end of the mile, but I am doubtful whether the arrangement suggested for the 21st mile would have much effect, as the pits in rear of the bank are deep, and the puddle trench would have to be carried down a long way at the inner toe to get below the strata by which the water now finds vent.

The Kadrabagh Aqueduct is in much the same state as before, and has not suffered any damage. There is a small leak under the bank at back of left upper wing, which might be stopped.

At the former breach in the right bank below the aqueduct the earth slipped greatly, and has given much trouble. It has worked out until it has taken a slope of about four to one; and, though it is now considered safe, it is not certain that it has taken a permanent bearing.

In the 24*th mile* wall there are several heavy leaks, and a bank of good earth on the inside is certainly necessary; the wall does not appear to have suffered.

Between this wall and No. 13 waste weir in the 25th mile there is leakage all along, the subsoil being lime kunkur. There are no special leaks, and the bank is in good order.

There is a great amount of leakage through or under the body-wall of the weir, for a length of about 140 feet from the sluices, this leakage rises through the packed rubble and passes over its retaining wall.

In the 25*th mile*, down to the commencement of the first new wall, a little above twenty-four miles sixty chains, there is leakage under the banks all along, but the banks themselves are said to be tight.

In the 26*th mile* there is a great deal of leakage just below the junction of about 385 yards of new wall with an old core-section wall, and there are two or three leaks which are very considerable, and again at the junction of a masonry and core wall the leakage is very heavy, and appeared to me dangerous, but nothing can be done until the water is shut off for the season.

Noticed also on a former occasion. Proceedings Madras Government, No. 3,474, dated 31st October 1866. Report, paragraph 13.

In the 27*th mile* there is much leakage under, and through, the high masonry wall, and for this, I think, a bank of earth on the inside is the only remedy: part of the backing of this wall was driven out by the rush of water, and it has been replaced by heavy rubble: at the lower end of the mile there is a good deal of subsoil leakage.

In the 28*th mile* I noticed that the earth backing to a new revetment wall was being somewhat loosely thrown up. Care should be taken to consolidate it thoroughly for at least ten or twelve feet in rear of these walls, or much of the efficiency of the work will be sacrificed. A comparatively small compact bank is better than a large one ill-made. There is considerable leakage under the old masonry wall immediately below the new walling,* and there is also a heavy leak at fifty feet below the commencement of the next old masonry wall; at the lower end of this wall there is a core-section wall, in the 29*th mile*, which has given much trouble, and there is still some leakage, which though not very great, must be a source of danger.

* That immediately below Bungalow hill.

In the 30*th mile* there is much leakage under and through the banks, and there have been some slips, which have been stopped by packed rubble stone.

To the 31*st mile* somewhat similar remarks apply.

Poodoor Bridge, 2nd class. This bridge has been built up to towing path level.

At the core wall, about 400 yards below bridge, the core was washed out, and now the rear stone facing has been left, and a bank with puddle and shingling has been placed in front; there is some leakage still, but the work was carried out under great difficulties. There is a heavy leak under the ordinary bank just above. Through the single masonry wall with rubble backing there is great leakage all along.

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In the 32*nd mile* the banks are rough and rather soft, but they hold water well and have stood very well; there is but little leakage, and only one or two small leaks through the bank.

7. The cuttings of this section are generally incomplete, and a good deal of work of this description remains to be done.

3rd Section, Main Canal, miles 33 to 43.

8. The expenditure in this section on work for stopping leakage amounted, up to the 30th June last, to Rupees 52,296. It consisted chiefly of puddling carried along continuously from the beginning of the 33rd to the beginning of the 35th mile, and of short lengths of the same sort of work put in wherever the nature of the soil made it certain that such precaution was necessary. The effect of this work has been very good. The high banks of white soil in the 33*rd* and 34*th miles* have stood very well, and the settlements have been extremely slight, and they are for the most part fairly water-tight. There was, however, in the lower of these miles, one leak which gave much trouble, but the bank has been opened and re-made and a drain put in, and the quantity of water now coming out is but small. The old bank contained layers of gravel, which allowed the water to pass through.

Sultanpoor Culvert. This work, which is in the 33rd mile, was built for a crossing. The leakage through the abutments is very great, and there was a stream nearly six inches deep running out of it. Puddle must be put in behind the abutments. A water cushion has been added to waste weir No. 16 (15), to receive the over-fall.

The 35*th mile*, nearly three miles in length, is not puddled, except where the banks cross the natural drainages and are high. The leakage is for the most part slight.

Ulloor Aqueduct. This work leaks through, and round, the wings; there is a heavy leak also under the east contour bank, which it is intended to stop by puddling, next season.

One arch of this aqueduct was intended to be used as a crossing, and a good deal of expenditure has been incurred in endeavouring to make the roadway efficient; at the time of my visit it was, however, impracticable, and the villagers presented a petition on the subject of the inconvenience which they suffered in consequence. I have spoken to the Chief Engineer about this crossing, and he is inclined to think that even now it will be cheaper and better in the long run to build a bridge than to have to remove silt and make good the causeway after every considerable rain-fall. The necessity for this latter work, so long as the aqueduct remains the only crossing, has been pointed out.

The cutting opposite the waste weir No. 18 (17), at the lower end of the mile, is not yet complete: much of it is in tough rock, which had to be blasted, and the blasting has thrown down one of the piers of the weir, and injured one or two other piers.

In the 36*th and* 37*th miles* the banks are in fair order, though in places very soft: the revetment has fallen out in a few places in the former mile. This is due to the absence of a backing, and it may be noticed that the great importance of a good backing, where the soil is liable to become soft when brought in contact with water, has not as yet been sufficiently recognized, even where work has been recently executed.

Importance of backing to revetments or pitching.

In the 38*th mile* a ramp for the convenience of the Shytancotta ryots was under construction. On referring to the Order of Government as per margin,* it will be seen that when the list of crossings for this portion of the canal was made out, it was doubtful whether any bridge between Ulloor and Malayala would be required. It has been ascertained however, that, the ryots of Shytancotta have been inconvenienced in getting to their cultivation since the gap in the bank in this mile was closed and water admitted to the canal, and it is with a view to remedy this that a ramp was under construction. When, however, more water shall be passed down, the ramp will be no longer of much assistance, and it will be necessary therefore next year to construct a 3rd class bridge for their accommodation. Wall No. 12 in this mile leaks much, and with a greater depth of water the leakage will certainly increase greatly. It has been backed with loose rubble, and a bank of good earth will be wanted on the inside.

* No. 3,119, dated 1st October 1866; letter paragraph 12. See also Proceedings Madras Government, 28th August 1866, No. 2,715; Chief Engineer's letter, paragraph 7.

A 3rd class Bridge is required in the 38th mile for Shytancotta.

Waste weir No. 19 has had a masonry apron nearly completed.

At wall No. 13 in the 39*th mile* the leakage is great. A backing of packed rubble has been given; at the short wall, a little lower down, there is a considerable leak at the deepest part. This wall is backed with loose rubble.

Malayala Bridge, 2nd class.

This bridge in the 40*th mile* has been built nearly up to the springing, the stone and work are both good. The bank below the cutting has been puddled, and there is now no leakage. The channel below the deep sluice has not been revetted, and some of the field alongside has consequently been washed away. This should receive the Chief Engineer's early attention.

Report paragraph 18, Proceedings Madras Government, No. 3,474, of the 31st October 1866.

Madigutla requires a 3rd class Bridge.

In the 42*nd mile* a 3rd class bridge is, I think, required for Madigutla, without one the fields south-east of the village cannot be reached without a detour of three miles, and the inconvenience would therefore be too great were the villagers to be obliged to go to their fields by the bridges at Malayala and Nagatore. This question was under consideration before,† and it will be better now to decide that a bridge be constructed during the next working season.

† Proceedings Madras Government, 1st October 1866, No. 3,119. Last crossing mentioned in paragraph 15 of this Office letter.

The leakage at the site of the breach in the bund of the old tank of this village, now incorporated in the canal, has been attended to.

Depth of water in first three sections.

9. It may be interesting to note the depth of water in these sections. Additional water was let into the canal at the head sluice in order to facilitate the passing down of the basket-boat in which the Agent travelled, but the increase had not been felt at the time I reached Nagatore, where, on the morning of the 25th August, the register at the bridge showed nine inches above bed level; but by the following morning this depth had increased to one foot one inch.

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The depth at the head of the canal below the head sluice was 3 Ft. 6 In. up to 21st.

at the Hindry aqueduct,	18th mile	... ...	2	3	on the	22nd.
,, Gooty road bridge,	19th ,,	... .	2	10	,, ,,	,,
,, Zorapore ,,	20th ,,	... ...	2	9	,, ,,	,,
,, Kadrabagh aqueduct,	24th ,,	... ...	2	6	,, ,,	,,
,, Do. do.	... ...		3	1	,, ,,	24th
,, Wall,	26th ,,	... ...	3	3½	,, ,,	,,
,, Sluice,	28th ,,	... ...	2	7¼	,, ,,	,,
,, Poodoor bridge,	31st ,,	... ...	2	2½	,, ,,	,,
,, Ulloor aqueduct,	35th ,,	... ...	1	7	,, ,,	,,
,, Do. po.	,, ,,	... ...	2	0	,, ,,	25th
,, Malayala bridge,	40th ,,	... ...	0	10	,, ,,	,,

The variations are not in all cases to be easily accounted for, some are due partly to frequent alterations of fall, and partly to the incomplete state of cuttings, but the diminution from three feet one inch on the Kadrabagh aqueduct on the 24th, to one foot seven inches at Ulloor on the same day is no doubt due, to the extent of something under six inches, to the increase of water at the head not having reached Ulloor, and the rest is accounted for by leakage. There is not, I think, much doubt that between the Hindry aqueduct (18th) and Malayala (40th mile) upwards of 30,000 cubic yards an hour were passing out of the canal by leakage, and probably four-fifths of this quantity were being lost in the 2nd section.

Fourth Section, Main Canal, 44th to 60th miles.

10. From the 44*th to the* 47*th miles* the canal is complete and in good order.

In the 48*th mile* the 2nd class bridge has been completed, and the approaches are nearly finished. This bridge is a fair example of what may be done in the way of securing good plain work and a creditable appearance, by care and attention. The rates paid were for rubble Rupees 2-12-0 a cubic yard, for arch work Rs. 7-8-0, and for cut-stone 10 Rupees. This work has had the advantage of very excellent stone, but it might nevertheless have looked very different to what it now does. In connection with this bridge, a road is being made in the Department of Public Works from Nagatore to Moorumconda.

In the 49*th mile* the eight feet culvert, which is the crossing for Moochmurry has been rendered impassable by the silt washed in by the drainage, and I learnt from the villagers, and also from the Assistant Engineer, that it had been in this state for some time. I have no doubt that for the future this and other crossings, similarly situated, will receive due attention. Access to the fields was obtained across the canal which was fordable.

In the 51*st mile* the bund of the tank formed by the canal has not yet taken its ultimate bearing, but it is in fair order, and there is hardly a trace of leakage.

The fourteen feet culvert in the 53*rd mile*, close to Puggydial, the inconvenience of which as a crossing was complained of by the villagers last year, is now in good order. The leakage over head is but slight, and many parts of the arch are quite dry. There is a leak at the right lower wing, which will be attended to in due course.

In the 54*th mile* the low level sluice has been completed, the bank near it has settled a good deal, which shows that the artificial consolidation was not sufficiently attended to when filling in the gap.

In the 55*th mile*, not far below the sluice in the preceding mile, there are several small leaks, and some slips occurred, the outer toe of the bank has, for a length of about 250 yards, been supported by a dry rubble wall. Bank below this good, and leakage very slight.

In the 56*th mile* the banks are nearly water-tight. The waste weir in this mile is complete, with the exception of the sluice shutter gearing; the over-fall has a water-cushion. A new irrigation sluice has been constructed just below the weir.

3rd class Bridge, Bolawaram.

In the 57*th mile* a 3rd class bridge for Bolawaram has been constructed, and is in use. The roadway is gravelled, and the approaches are a little flatter than one in three. All that is necessary to make it quite convenient is to flatten the lower parts of the slopes a little, so as to make the roadway three feet, instead of nearly four and a half feet, as at present, below the tops of the horizontal wings. The bullock yokes will then clear these walls. The Executive Engineer promised that this slight modification should be carried out at once, and the approaches will then be one in five or six, except for a very short distance. The rates paid were 4½ Rupees per cubic yard for rubble masonry, and 8 Rupees for archwork.

In the 58*th mile* a new irrigation sluice has been built near the commencement. The banks were in good order, and the leakage very slight. The heavy bank at the nullah is very nearly water-tight. A few feet below, a low level sluice has been constructed; it will require a second apron, and it should not be used to lower the water in the canal until this addition has been made. I do not think that the shingling of the inner slope will stand, for the tank* is a large one, the area of the water spread when full being over two and a half square miles, and the depth at the sluice thirty-three feet, and consequently in gales there will be a very heavy wash. It appears to me, therefore, necessary for safety that a substantial revetment, with a well rammed and fairly water-tight backing of gravel and small kunkur, should be constructed along the deeper part—say, wherever the width of water exceeds 200 yards.

* Usually called Tangadunchy Tank.

Breaches in the Tangadunchy Tank.

11. My inspection of the 57th and 58th miles was made on the 27th August, and, considering the great depth of water against them, the amount of leakage was very slight indeed, and they had kept their form remarkably well. On reaching Ayalore (107th mile), however, on the 3rd September, I heard that this large tank had breached, and I learnt afterwards, on the arrival of the Chief Engineer, who had been obliged to run in to Kurnool for three or four days, that two breaches, one in the 57th and the other in the 58th mile, had occurred on the morning of the 31st August. At that time the Agent, the Chief Engineer, the Executive Engineer of the Division, and myself were all at Valepanoor, only fifteen or sixteen miles from the tank, and we were detained there by the rain until the morning of the 1st instant. The young Engineer at Jupad, a station about a couple of miles from the tank, appears to have been so affected by the occurrence, that he was unable to send any intelligence of it. At Valepanoor 2·89 inches of rain fell after 2 P. M. on the 29th and on the 30th; but this fall was in no way remarkable and occasioned no anxiety. At Jupad, however, the fall was 6·25 inches, and this raised the level of the water in the canal from two feet to 5·75 feet above bed level. The breach in the 57th mile is at a part where the depth of water above ground level was seventeen feet, its width is two chains at bottom and about two and a half chains at top. It is reported that the leak commenced at 4 P. M. on the afternoon of the 30th August, and that the breach was complete at 4 A. M. the next morning. If so, had the Executive Engineer been at Jupad, I have but little doubt the accident would not have occurred, as there would have been plenty of time to stop it. This officer, in his report, says nothing as to the nature of the soil of which the bank is composed, as shown by the section at the breach; but, on referring to the report marginally noted,* the following remark on this mile will be found:—"the earth, "works are very irregular, and some parts are not much more than three feet "above present water level *(this was, I think, about bed level of canal)* * * * "The soil is generally good, but at the low parts of the bank I observed that some "shale and gravel have been put much further into the bank than is at all safe- "and in one or two places they form a layer right through, and would probably "cause a leak, if not a breach." These defects, where visible, may perhaps have been remedied, but probably there were other similar places, and any one of these may account for the breach. The cost of repair is estimated at Rupees 2,270. The breach in the 58th mile occurred at about six chains below the low level sluice, at a point where the depth of water was twenty-four feet above ground surface, the height of the bank being thirty-two feet. Except the upper six feet, the earthworks were executed, it is reported, in 1863-64, and this agrees with my recollection of their state in 1864: the leak appeared about fourteen feet above ground, and would seem to have rapidly increased. The Executive Engineer says the bank is composed chiefly of soudoo* and kunkur gravel. The breach measures about two chains on the ground line and three and a half chains at top, and in rear on the line of the toe of the bank a hollow nineteen feet deep has been scooped out. The cost of repairing the damage is estimated at Rupees 8,950. As already noticed, there was nothing, a few days prior to the accident to, indicate danger, and I think the Executive Engineer was justified in the expressed opinion that he was ready to pass down a full supply (nine feet above bed) as all his banks were in fair, and most of them in perfect, order. Whether the breach was caused by bad work in the lower part of the bank, or by a vermin hole, it is impossible now to say, but the possibility of the existence of the latter cause is established by the fact that a fox earth was discovered in the 35th mile, where the hole on the surface was found to communicate with a long passage leading down to about ground surface, and there there was a chamber of considerable size in which three foxes were captured. In his report the Executive Engineer speaks of getting the damage made good by the end of the year, but it appears to me that an effort should be made to close the breaches completely by the end of November at latest, so that water may be re-admitted, and the banks fully tried before the time at which the head sluices have to be closed for the season, and a month will be none too much for doing this. These banks had been proved to be safe and water-tight up to about three feet above bed level, but these

* Proceedings Madras Government, No. 3,474, 31st October 1866, report paragraph 20.

* Saline earth.

accidents have shown that there may be defects somewhat higher up, and it is of importance that these, if existing, should be discovered as early as possible, and while the Engineer possesses the command of labor necessary for dealing promptly with any leaks which may show themselves. Until indeed the canal has been proved to at least full water level, and perhaps it would be safer to say up to one foot above that level, seeing that a heavy fall of rain would be liable to raise the surface above the cuttings for a time to at least that point, there will be no certainty that a failure may not occur at any time, and a breach would be a very much more serious matter were it to occur after the cultivation shall have been extended, and this will most probably be the case to a very considerable extent next year. Having learnt that the breaches did not occasion loss of life or serious damage to property, I did not consider it necessary to return to the 4th section. Some stacks of produce were however swept away, and certainly a considerable area of cultivated land must have been injured, and the amount of compensation which may be due to the ryots should be met from the estimates. I have asked the Chief Engineer to send me a plan showing the way in which it may be intended to close the breaches.

Jupad Bridge, 1st class.

12. The rest of the 4th section is complete with the exception of the 1st class bridge in the 60th mile, the centring of the last arch of which was lowered on the 27th August, and it will be finished in two or three weeks. The rubble masonry has cost Rupees $4\frac{1}{2}$,* and the arch-work Rupees 8.

* A cubic yard.

In the same mile there is a culvert through which there is some leakage, though the water in the canal is but just level with its crown. At the time of my visit the water had been bunded off just above the bridge, in order to allow of the work there being carried on more easily, but shortly before it had been allowed to run to a point some distance further down.

Saving on Estimates, 4th section.

13. The Executive Engineer, Mr. Dodson, gave me the following particulars showing the expected saving on the estimates :—

	Sanction.	Saving.	
	Rs.	Rs.	
Earth-works	4,86,698	51,706	
Catch-water drains	4,143	2,737	
Revetments	2,45,875	54,526	
Masonry works	1,67,475	24,002	
			1,32,971
Contingencies of Masonry ..	17,007	16,941	
Do. General ...	85,876	18,313	
Plant, &c.	50,000	26,600	
Total sanction ...	9,57,074	61,854	
Deduct for four months, to end of September, at 250	... ...	1,000	
			60,854
Anticipated saving	... ...	...	1,93,825

This result is very satisfactory. The recent work has been carefully executed, and with one exception there has been no sacrifice of efficiency. This exception is in a part of the work under revetments, for which in the lower miles lime kunkur pitching has been substituted, and this pitching where on the banks of deep tanks is, as I have already mentioned, not sufficiently substantial for security. Should, however, no further accidents occur, it may, I think, be assumed that after providing for the closing of the breaches in the Tangadanchy tank, and for the reconstruction of some few hundred yards of revetments, there will remain a saving of nearly one and a half lacs, or about fifteen per cent. on the estimates.

5th Section, Main Canal, 61st to 72nd mile.

14. This portion of the canal is complete down to within a short distance of the Teragopila aqueduct in the 63*rd mile*. To the high banks on either side of the aqueduct a good deal of pitching remains to be done, and these banks will, I think, give some trouble before they take a permanent bearing, for there has been a considerable slip in the right bank on the lower side, and from the way in which the earlier and lower part of the banks was thrown up, this will probably be not the only slip.

Teragopila Aqueduct.

The aqueduct has been finished up to string course, and the wings on the lower side are about six feet above this level. It is expected that the whole of the work will be completed by the middle of October. One of the wings received some little damage by the rush of water down the canal on the 31st ultimo, the cross bund not having been made high enough to stop the flow.

Crossing at Aqueduct.

The freshes in the stream below the aqueduct made a great mess of the roadway under the upper arch, and breached also the road in connection therewith, which had been made in the Department of Public Works. The crossing under the aqueduct should be formed in the same manner as that at the Hindry aqueduct, and its level should be about two and a half feet below springing, which will give ten and a half feet headway, and render it liable to submergence only in extreme freshes and for a short time. The district road in connection therewith will not be safe if lower than five feet above springing, as the freshes this year rose to two feet above that level. Indeed, I am not at all sure that it would not be more prudent to avoid the diminution of waterway, which using one arch as a roadway will occasion, and to build a 2nd class bridge on the higher ground above, close to the village.

Vide crossing No 5, para. 28 of Report, P. M. G. No. 3,474, 31st October 1866.

Culvert No. 4 of eight feet span in this mile has been blocked up, and the drainage diverted.

In the 64*th mile* the outfall channel from the sluices (formerly weir) has not been cut.

In the 66*th mile* culvert No. 5 has been opened out, puddled, and plastered. It was found to leak much before this work was done; since then there has been no water.

In the 67*th mile* the banks are very soft, and much cracked longitudinally. At the lower end on the right side a wall is being built for seventeen chains in length down to the culvert, to protect the outer slope of the bank from drainage

scour. The culvert was to have had one vent of fourteen feet, but this has been changed to three vents of ten feet. It was also to have been a crossing, but as the headway is now insufficient, it is intended to construct a second class bridge at such point a little higher up as may be most convenient for Jootoor and Rudraveram, and the Executive Engineer is to fix the site, after enquiry, from the villagers interested. The culvert was injured to some small extent by the freshes which came down before the archwork was dry. The water marks on the right bank show that the water rose to seven feet three inches above the inside of the crown of the arch, and probably five vents instead of three would have been none too many.

Pamulpad bridge.

In the 70*th mile*, at Pamulpad, a second class bridge is under construction; the piers and abutments are on an average six and a half feet above bed. The rubble masonry is costing 5 Rupees a cubic yard.

At the lower end of the section, the Mittakondal cutting requires trimming and bottoming out. The spoil has been moved back from the edge of the cutting. Further sanction will be required for the works of the section.

Proceedings Madras Government, 17th February last, No. 537.

Bowanassy Irrigation.

15. The trans-Bowanassy distribution project is under investigation. It is intended to take off an irrigation channel from the 71st mile, and to carry it across the river to water a tract of country, about 15,000 acres of which will, it is expected, be irrigated. A channel with twelve feet sole, two to one side slope, a depth of five feet, and a fall of one foot a mile will carry the requisite supply, but the investigation has not yet proceeded far enough to enable the details to be put on paper.

Area of basin about 231 square miles.

The drainage of the Bowanassy valley is at times very large, and the river overflows its banks in all directions. Masonry works to pass extreme floods without obstruction would certainly be very expensive, and perhaps render it unadvisable to take up the irrigation of this part of the country, at least until more accessible lands shall have been supplied. The Chief Engineer, however, thinks that it will be safe to provide waterway sufficient to pass the discharge with a velocity due to a head of three feet. This may be feasible should the site for the aqueduct afford rock foundations, though even then revetments to the high banks close to the river, and works to prevent scour along them elsewhere, will probably add much to the cost. The smallest aqueduct which will pass the floods with a three feet head would have five spans of thirty feet with piers twelve feet high, and the river itself has not room for more than three arches. Indeed, if the water be all conducted to this one passage, it can be so only for the width of the canal, as the river bed, both above and below, is quite incapable of carrying the flood discharge.

6th Section, Main Canal, 73rd to 91st mile.

16. The rock cutting at the commencement is being carried down to proper bed level, and made full width. Above the regulating lock there is some earthwork to be done, and a good deal of pitching.

Proceedings of the Madras Government, Public Works Department,
17*th November* 1868.

Only the upper gates of the lock have as yet been hung, and their levers were made of country wood, which has become quite rotten. The earthwork filling at back of lock walls remains to be done.

In the 73*rd mile*, below the lock, and in the 74*th and* 75*th miles*, the earthworks are being rapidly pushed on; below this they have only just been recommenced, but the banks are, from this to the end of the 78th mile, for the most part in a forward state, and the Executive Engineer expects to have the canal, so far, ready for water by the end of the year.

Paragraph 31 of report, Proceedings Madras Government, No. 3,474, 31st October 1866.

The defects before noticed are being remedied by the insertion of a core of good soil, inside and outside of which the shale and other porous material will be placed. This work appeared to me to be well adapted to prevent leakage.

The 79*th mile* is at the head of the still-water navigation. The masonry works below this are in the state in which they were left in 1865.

A revised plan for the locks has been prepared, and several defects of the original plan have been remedied. Several modifications also of the falls are intended to be made. For instance, Lock No. 7 was designed, and has been partly constructed with a double fall, the upper part of which is eight feet and the lower ten feet. This would have been very inconvenient, as the lower chamber could not be filled by the upper, without admitting one-fourth more water at the upper valves; two falls of nine feet will, therefore, be substituted. At other locks, also the Chief Engineer thinks that alterations of fall will be advantageous.

In the 80*th and* 81*st miles* a good deal of earthwork has lately been done.

In the 82*nd mile*, two drainages cross the line, and it is proposed to provide for those by a culvert of three vents of fifteen feet each in connection with Lock No. 6 at 81 miles 75 chains.

In the 84*th mile*, two drainages from breaches in an abandoned tank were originally provided for by two culverts of ten feet span each; but recent floods show that seven spans of twelve feet each, with piers four feet to springing, and two feet rise of arch are required.

In the 85*th mile*, Culvert No. 7 at 84 miles 25 chains was partly built in 1864, and is in the same state still. It was intended to be used as a crossing for Valepanoor, but the Collector having sent me a petition from the villagers on the subject, I examined it, and I think it would never be an efficient crossing, as it receives much silt, and is very much below the ground level. A second class bridge will, therefore, be built at 84 miles 41 chains, which will be a convenient site not only for the Valepanoor cultivation, but also for the Pessaroy and Valepanoor road, which at present crosses the canal at 86 miles 10 chains.

In the 86*th mile*, Culvert No. 8 at 85 miles 24 chains was to have had one vent of ten feet: it is now proposed to allow two vents of twelve feet, and I think three vents of this latter size would be safer.

Below the cutting in the 84*th mile*, which is in hard lime kunkur, and at which two to three hundred men have been employed during the past month, work has not as yet been recommenced.

Revised Estimates.

17. Revised estimates for this section from the 79th to the 91st mile are under preparation. At present the original sanction is still in force, and the masonry works especially have been found to need considerable modification.

Crossings.

18. The crossings originally allowed for this section were as shown below. The Chief Engineer and myself have now considered the requirements in this respect with reference to the position of the villages affected, and I have also ascertained on the ground that the sites chosen will be convenient:—

Crossings formerly allowed.

No.	Miles and chains.	Description.
1	73—9	10 feet single tunnel, No. 1
2	74—4	Do. do., ,, 2
3	74—52	Bridge ... ... ,, 1
4	76—62	10 feet tunnel ... ,, 4
5	78—65	Lock ... ... ,, 3
6	81—4	Do. ... ... ,, 5
7	81—39	Tunnel ... ... ,, 5
8	82—70	Lock ... ... ,, 7
9	83—20	Tunnel ... ... ,, 6
10	84—51	Ferry
11	84—14	Tunnel ... ... ,, 7
12	85—38	Do. ... ... ,, 8
13	86—25	Ferry
14	87—18	Lock ... ... ,, 8
15	87—64	Tunnel ... ... ,, 10
16	88—18	Do. ... ... ,, 11
17	89—50	Lock ... ... ,, 11

Of these, Nos. 1, 2, 4, 5, 7, 9, 11, 12, 15, and 16 will still be as much available for crossings as ever, but they are not now considered as regular crossings either because the headway is insufficient, or because they are otherwise unsuitable.

Crossings now proposed.

No.	Miles and chains.	Villages accommodated.	Class.	Description.	For what traffic.	Remarks.
1	74—50	Mittacondal, Banakacherla, Vamepenta.	1st	Bridge	All kinds ...	Completed.
2	78—24	Toorcherla and Vamepenta.	2nd	Bridge at tail bay of of No. 2 Lock	Do.	
3	80—4	Wonalla and Muddoor	2nd	Under-bridge at Lock No. 4.	Do.	
4	81—75	Penchkapully ...	2nd	Culvert, three vents of 15 feet at Lock No. 6.	Do.	
5	82—65	Ragady and Goodoor	2nd	Under-bridge, Lock No. 7.	Do. ...	Partly built.
6	84—41	Valepanoor and road to Pessaroy.	2nd	Bridge	Do.	
7	87—3	Pessaroy and Madawaram.	2nd	Under-bridge, Lock No. 8.	Do.	
8	89—40	Bojanum	2nd	Under-bridge, Lock No 11.	Do.	

There will thus be eight crossings in nineteen and a half miles, and as the direct distance between the two ends of the section is but thirteen miles, the accommodation afforded will, I think, be found sufficient. The culvert at Lock No. 3, and two or three of the drainage culverts, not included in the above list, will also, I have no doubt, be used in dry weather for taking cattle to the fields.

Provision for drainage.

19. The provision in the original estimates for drainage in some of the lower miles will require to be increased. Thus the ten feet culvert intended to be built at 87 miles 77 chains is quite inadequate to carry all the drainage of the preceding mile, which will be concentrated at this point. There are a great many small drainages, and the one at the culvert site is considerable; two vents of fifteen feet or perhaps three of twelve feet would not give too much waterway. There is a drainage also at 89 miles 70 chains which carries much water at times, and which requires a culvert of one vent of fifteen feet or two of ten feet each.

Pitching of high banks.

Wherever the cuttings near the locks yield kunkur or other material adapted for pitching, it will be advisable to make use of this material for the protection of the inner slopes of the high banks above the locks. As, morover, these banks, if of cotton soil, will certainly settle down very much when in contact with water, if kunkur be merely laid upon them, I think it will be worthwhile to give a backing of small kunkur and gravel, and to lay the larger kunkur on this, otherwise the work would in all probability be thrown away.

Seventh section, Main Canal, Miles 92 to 114.

20. I found that some misconception existed as to the submission of revised estimates for masonry works with reference to the Orders contained in Proceedings Madras Government, No. 3,611, dated 22nd November 1867. The only general sanction for masonry is at present the original one, though two bridges have been separately sanctioned recently. A revised general estimate for these works has to be sent in, so soon as the designs and estimates of all the individual works may have been prepared, and its sanction will then supersede that already given. As the Chief Engineer considered that the preparation of copies of plans for all the works would occasion delay, I have told him that it will be unnecessary to submit separate plans for bridges intended to be built on the same general elevation, but with varying widths of roadway according to the class; that the working drawings of the culverts may be sent to me, and that they will be returned immediately after inspection; that the idea of an oblique Anicut at Jootoor having been given up, a cross section of the direct weir, with particulars of the levels of its crest, of that of the head and under-sluice roadways, and of the wings, and of that of the head and under-sluice cills, will alone be required; that a general plan of the head works, showing their position and the arrangements intended for the navigation head will be needed, as also a plan of the lock, which will differ materially from that included in the former estimate. The re-arrangement of the navigation head

Procs. Madras Govt., No. 1,558, dated 15th May last.
Do. do. No. 2,545, dated 8th August.

is very necessary, and the defects of the original plan were noticed in 1864. Besides these, a revised plan for the outlet weir at 94 miles 45 chains, or at 94 miles 48-49 chains, the site now proposed for it, has to be prepared; also particulars of the modification proposed for the outlet weir, which has been partly built at 96 miles 55 chains, are requisite; I believe a water-cushion is intended to be substituted for the aprons which were considered needlessly expensive. The plans also of the Nundial tank channel aqueducts have yet to be approved. These are, I think, all that are wanted, and I have informed Mr. Latham that, if more convenient to him, the plans prepared for record in his office can be sent to me, and I will have copies taken in my office of those which it may appear desirable to keep on record.

Procs. Madras Govt., No. 2,438, dated 24th August 1864, report paragraph 106.

Jootoor Anicut and Head Works.

21. The body wall of the Anicut has not been raised as yet to its full height. It was found that the shale on which it was built had been washed out to a considerable extent from under the footings on the lower side, and this part has been underpinned all along, 120 cubic yards of masonry having been required for this purpose. A water-cushion has been substituted for the apron formerly intended, but never commenced. It was begun in May, and about 110 feet out of 246 feet completed with coping, but the freshes came down before the work was dry, and washed away fifty-two cubic yards of masonry out of 320 cubic yards: only thirty feet in length of the flooring of the cushion, which is eighteen feet wide, and five and a half feet below the bed of the river, were finished before the freshes stopped the work: it has not been injured. The cushion extends at present only as far as the west bank, but it will have to be carried on up to the west wing. The west end of the Anicut was buried in the river bank, and the latter has now been cut down to a little below the crest level. A good many trees came down the river during this year's freshes, and knocked out some stones from the top of the weir: the damage done was, however, of small extent, but it shows that special precautions for the security of the crest will be needed.

Canal.

22. In the 93*rd mile*, inlet weir No. 1 has been completed, the masonry is rather rough; and there is some leakage through the body from the water ponded outside, and which was standing three feet below the crest. It has a sloping apron, which is perhaps strong enough for the work it will have to do. The bridge which is to be built at 92 miles 50 chains has not yet been commenced.

In the 94*th mile* another inlet weir (No. 2) has been completed, there is more leakage than there should be, but I was informed that the water came over it two days after it was finished. The leakage can easily be stopped, and that between the wings and the bank should be attended to as soon as may be. The ponding up of the land drainage by this weir submerges about 200 acres, and I did not at all understand that this would be the case when the proposition to substitute a weir for a culvert was brought forward. However, to obviate this, it is intended to carry the water down to the next culvert below, taking care to regulate the drainage so as not to allow too much

Procs. Madras Govt., No. 3,611, dated 22nd Nov. 1867, letter paragraph 13.

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water to come down on the culvert at once, and this arrangement will reduce the area which will continue submerged for any length of time to something very small.

In the 95*th mile* a culvert of two vents of five feet span has been built nearly up to springing (at the 35th chain). The outlet weir, No. 1, has to be constructed in this mile, and I was informed that the site was intended to be changed to the nullah, where a work of less length would suffice.

Additional bridge.

At 94 miles 74 chains, a second class bridge will be required for the traffic between Singaram and Bundy Atmakoor and Kakanoor.

The culvert of two vents of five feet in the 96*th mile*, and a similar work in the 97*th mile* have not yet been commenced. The outlet weir in the latter mile (55 chains) is to have a water cushion instead of the aprons before estimated for, but the plan has not yet been drawn out.

Eranapad bridge.

The Eranapad bridge at the 50th chain of the 98*th mile* has not been commenced. The culvert, two vents of twenty feet each, at the 5th chain of the 99*th mile* is not yet begun. At the 14th chain a culvert will be needed for a channel which communicates with the waste weir of the Byup Goodoor tank, and by which a small tank belonging to Jawar Coodoor is fed; an estimate for this will be prepared at once.

Third class Bridge for Byup Goodoor.

At the end of the 99th or beginning of the 100th mile, a third class bridge will be required for Byup Goodoor to enable the villagers to reach the bund of their tank, and those fields which lie to the eastward of the canal. Between the 99th and 105th miles no masonry works have yet been started. In the latter mile, at the 20th chain, the second and principal aqueduct for passing the supply of the Nundial tank has been built up to springing. Hard slate having been found at a small depth, the design of fifteen arches of ten feet, with piers eight feet high, has been altered to one with twenty-two arches of the same span, the piers being five feet three inches high.

Some discussion took place as to whether the first aqueduct (five arches of ten feet) were really necessary, but after considering the drainage area, and the possible rain-fall, both the Chief Engineer and myself came to the conclusion that the waterway allowed is not in excess of what should be provided.

Second class Bridge required.

A second class bridge is needed for the accommodation of the traffic which comes round the northern side of the Nundial tank, and for that which uses the bund between the two tanks. The exact site is to be determined after consulting the Deputy Collector, and the villagers interested.

Ayalore Bridge.

In the 107*th mile* the public road bridge at the half mile is in the state, three or four feet above water level, in which it has stood for a long time.

It was commenced as a skew bridge, and now it is thought that it will be cheaper to pull it down and build it straight. I have suggested the construction of the skew in straight ribs placed in echellon, a plan which has been carried out in a great many instances in England, and also in this country, and there is no difficulty whatever in constructing a skew in this way. It would be certainly cheaper than pulling down and re-building abutments, and it is not very satisfactory either to destroy good work which has cost a good deal of money.

Third class Bridge for Chabole.

In the 108*th mile*, at the 53rd chain, a third class bridge will be required for Chabole. It is unfortunate that the requirements of this village were not considered before the Cumbum road was laid out, for had the Ayalore bridge been built at Chabole it would have done better for the roads, and this additional crossing for Chabole would have been unnecessary. As it is, the villagers would have to go a long distance round to their daily work in the fields were not a crossing given, and so the Chief Engineer has assented to this provision.

Second class Bridge for Sambwaram.

In the 110*th mile*, at the 12th chain, a second class bridge is required for Sambwaram and Mussudpore.

In the 111*th mile*, a culvert of two vents of eight feet each at the 71st chain has been built up to springing.

Dipaguntla Bridge, first class.

In the 112*th mile*, at the 7th chain, this bridge has been built to within a few feet of the springing. Stone good, work rough.

General state of the masonry works.

23. It will be seen from the above remarks that the masonry works are much behind-hand. I have, I think, referred to all that have been commenced, though, to save writing, I have not mentioned a great many which are not yet started.

The Division was unfortunately, from the early part of 1867 up to the beginning of this year, in the charge of an Engineer who appears to have done nothing. He has left the Company's service, and the present Executive Engineer hopes, during the working season now about to commence, to finish all the masonry works.

Earthworks.

The earthworks are, for the most part, in an advanced state: some of the miles are quite finished, others will be completed in from two to six or eight weeks, and all that remains to be done of this kind of work will be easily completed within six months.

Crossings of the seventh Section.

24. Most of the crossings have been referred to, but it will be convenient to give a complete list. They have all been assented to by the Chief Engineer.

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No.	Miles and chains.	Villages accommodated.	Class	Description.	For what traffic.	Remarks.
1	92—50	Kurramadala and road to Devalapore.	2nd	Bridge ...	All kinds.	
2	94—74	Singaram, Kakanoor, and Bundy Atmakoor.	2nd	Do. ...	Do.	
3	97—50	Eranapad and road from Nundial.	2nd	Do. ...	Do. ...	Sanctioned.
4	99th, 100th miles.	Byup Goodoor ...	3rd	Do. ...	Foot and cattle.	
5	101—54	Bolawaram... ..	2nd	Do. ...	All kinds	
6	104—10 (about)	Kootala and fields...	2nd	Do. ...	Do.	
7	105—30	Ponapoor	3rd	Culvert, three vents of eight feet.	Do. ...	Do.
8	106—40	Ayalore and public road.	1st	Bridge ...	Do. ...	Do.
9	107—53	Chabole	3rd	Do. ...	Foot and cattle.	
10	109—12	Sambwaram and Mussudpore.	2nd	Do. ...	All kinds	
11	111—7	Dipaguntla and roads	1st	Do. ...	Do. ..	Do.

The Chief Engineer will also probably arrange for making the head sluice passable by foot-passengers and cattle. Its width is now only four feet, but by corbelling out in raising the work four feet to its proper level, an additional width of nearly eighteen inches may be obtained, and then it will be almost equal to a third class bridge.

In the report on the revised masonry estimates of the section, it was mentioned that additional crossings would be necessary, and these have now, I think, been provided on a sufficiently liberal scale, and the convenience of all the villages situated near the canal has been considered.

Eighth section, Main Canal, 115th to 144th mile.

25. The works in this section have not as yet been re-started, but an Executive Engineer has just been placed in charge, and he is to commence operations at once.

Re-arrangement of the lower part of the section.

26. The section was originally designed with an equal capacity throughout, and the effect of taking off water for irrigation was not duly considered. This part of the canal will receive its supply through the seventh section, from the Anicut across the Caulee at Jootoor, and the supply for the two sections will be 100,000 cubic yards an hour. In order to maintain a depth of five feet of water in the canal, it will be necessary to reserve 65,000 cubic yards of water for the eighth section, and to limit therefore irrigation in the seventh section to that which can be supplied by the remaining 35,000 cubic yards.

The land commanded having an area very greatly in excess of the means of supply which will, at least under existing arrangements, be available, it became necessary to consider in what manner the water could best be distributed, and it has been determined to allot it for the present to lands which can be reached without difficulty, and the following is the plan proposed.

The first lock is at the end of the 115th mile; above it irrigation sluices will be given for 10,000 cubic yards on the right bank and for 9,000 cubic yards on the left bank. The weir connected with the lock will be arranged to discharge 46,000 cubic yards into the Main Canal below the first lock, and as it will be necessary to dispose of all the water entering at Jootoor, and not capable of being sent below the first lock, in case none should be drawn off above the 115th mile, surplus sluices capable of discharging 54,000 cubic yards an hour into the Kistnapoor vagú, a tributary of the Koondaur, will be placed in the right bank of the canal immediately above the lock. A surplus channel in connection with those sluices will be formed, as far as may be found requisite, to prevent injury to the adjacent lands.

* 117 miles 23 chains.

In the left bank above the third lock* an irrigation sluice for 4,000 cubic yards will be allowed, and this sluice will be made large enough to surplus 15,000 cubic yards an hour into the Wonakadinna vagú if required, a cut separate from the irrigation channels being made to the vagú. In the same bank, above the fourth lock,† a sluice for 4,000 cubic yards, and in the right bank one for 5,000 cubic yards, will be given.

† 119 miles 38 chains.

In the right bank, above the fifth lock,‡ a sluice is to be built to discharge 5,000 cubic yards an hour for irrigation, and in the same bank above the seventh lock§ an irrigation sluice for 20,000 cubic yards will be provided.

‡ 120 miles 36 chains.

§ 122 miles 27 chains.

Above the eighth lock,‖ a surplus sluice for 30,000 cubic yards an hour will be connected with the vagú or drainage, a little to the west of Donapad, and thus provision will have been made for getting rid if necessary of 45,000 cubic yards out of the 46,000, to be passed over the weir of lock No. 1, and with the exception of the 15,000 from above the third lock, which will find its way into the Vaikalair, all the water which may be surplused will run into the Koondaur, and can be taken up at the Rajoly Anicut for the ninth section of the canal.

‖ 123 miles 28 chains.

It has been arranged that surplus shall not be passed down any of the irrigation channels; as, were this done, instead of diminishing their size progressively, it would be necessary to make them large enough throughout to carry a much greater quantity of water than they need do, if their use be confined to distribution for irrigation purposes.

Above the eighth lock, in the right bank, a small irrigation sluice for 1,500 cubic yards will be necessary, and above the ninth lock will be, in the left bank, the last irrigation sluice with a maximum discharge of 6,500 cubic yards an hour.

Thus above the first lock the Main Canal in this section will carry 65,000 cubic yards an hour.

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From 1st to 3rd lock, 46,000 cubic yards an hour.
„ 3rd to 4th „ 42,000 „ „
„ 4th to 5th „ 33,000 „ „
„ 5th to 8th „ 30,000 „ „
„ 8th to 9th „ 6,500 „ „

and below the ninth lock no irrigation water will be conveyed, so that the lower part of the canal, a distance of nearly twenty miles, will be a still-water navigation.

The arrangements thus sketched out will, I think, be a very great improvement on those originally proposed

High banks to be protected where materials available.

27. As in the sixth section, it will be advisable, wherever suitable material may be available from the cuttings, to pitch the interior slopes of the high banks above the locks.

Cross drainage will be provided for.

28. Although the country has a considerable fall in the direction of the canal, it appears to be advisable not to allow drainage to run for any great distance along the side cuttings or catch drains, and wherever, therefore, transverse drainage exists, it will be passed under the canal by small culverts in connection with the locks.

At the lower end of the section, from about to end of the 141st mile, there is much cross drainage. In the latest sanction for masonry works (Proceedings Madras Government, 22nd February 1865, No. 514,) there were two culverts, two vents of four feet and three of four feet respectively. These appear to have been concentrated in one larger culvert at 141 miles 40 chains, but this will not be a convenient arrangement, and another culvert will, therefore, be provided in the 143rd mile, and a similar work will also be given at the last lock, this latter may require a shutter to keep out Koondaur floods.

Crossings.

29. The requirements of the villages as regards crossings have been carefully considered, and I subjoin a list of those deemed necessary. The Chief Engineer and myself have fixed the exact sites after an inspection of the relative position of the canal and of the villages concerned.

No.	Miles and Chains.	Villages accommodated.	Class.	Description.	For what traffic.
	About				
1	114—40	Jillala and Camananepilly ...	2nd	Bridge	All kinds.
2	116—53	Yaloor and Kotapad... ...	2nd	Do. tail bay of Lock No. 2.	Do.
3	119—38	Jeenapilly and Cottapilly ...	2nd	Do. do. No. 4 ...	Do.
4	122—27	Nullatimapilly, Adjanapoor, and Sukkenjumla.	2nd	Do. do. No. 7 ...	Do.
5	124—47	Donapad and Condapoor ...	2nd	Do. do. No. 9 ...	Do.
6	128—10	Chintacoonta	2nd	Do. do. „ 10A ...	Do.
7	131—10	Lingumdinny	2nd	Do. do. „ 11 ...	Do.
8	133—1[illegible]	Pathakundakoor	2nd	Bridge	Do.
9	134—40	Soodapully and Vengumpully.	2nd	Do.	Do.
10	139—30	Jungalpully	2nd	Do. tail bay of Lock No. 14.	Do.
11	142—30	Oopaloor and Balapooram ...	2nd	Bridge	Do.
12	143—27	Rajoly and road over head sluice.	3rd	Do. tail bay of Lock No. 16.	Foot passengers and cattle.

The entire length of the section is 29 miles 28 chains.

Ninth section, Main Canal, 144th to 178th mile-Head Works.

30. This section will be supplied from an anicut across the Koondaur. The anicut has not been commenced as yet, but the foundations of the under-sluices are in, and the head sluice is about two-thirds built. The work is good, and the limestone as excellent as can be desired. Any quantity of admissible building stone is obtainable close to the site of these works.

Canal works, Masonry.
* 144 miles 67 chains.

31. In the 145*th mile* a culvert* of two vents of twelve feet each has been commenced, and is up to six feet above floor level. It has rock foundations.

† At 145 miles 25 chains.

In the 146th mile, the second class bridge† has its left abutment ready for the skew back, and the right abutment five feet above bed level. At the 77th chain a culvert of five vents of five feet has been commenced, but the work was under water.

149 miles 20 chains.

In the 150*th mile* the Vaikalair aqueduct has made good progress. The abutments and seven piers are up to within a few inches of springing, the remaining three piers are a little lower. The arches are of thirty feet span each. The freshes of this year, which were unusually high, rose to nine inches above springing. The stone used is good, and the work, though rough, appears to be substantial.

At 150 miles 12 chains, the foundations of a five feet culvert are in.

At 150 miles 31 chains, the public road bridge has its left abutment up to springing, and the other four and a half feet lower.

At 150 miles 52 chains an aqueduct of five spans of twelve feet each has its piers and abutments finished up to springing, and the wings are four and a half feet above that level. The only other masonry work which has been commenced is the Canagudur second class bridge at 152 miles 50chains, the foundations of which are in.

Progress of masonry works not good.

32. The progress made in the construction of masonry works during the past working season has not been satisfactory. The contractor appears to have been unwilling to make a commencement until the greater part of the best time for this sort of work had passed, and the consequence has been that the amount of work done has fallen very far short of what might reasonably have been expected. The total quantity of masonry work of the section will be approximately 55,355 cubic yards ; that of the first two Ranges (ten miles) in which masonry has been in progress is cubic yards 8,933, and the total executed up to the 20th August, since which date the contractor has done very little, is cubic yards 3,395.

† Length 34 miles.

Vide this office letter, Para. 2, Procs. Madras Govt., No. 2,786, dated 10th September 1867.

This contractor arranged to execute all the works of the ninth section† in three years, and allowing for the time occupied during the first season in starting work, some 10,000 or 12,000 cubic yards ought to have been completed by this time. It has been considered necessary, under these circumstances, to relieve the contractor of all the work below the first fifteen miles, and to take out of his hands the Vaikalair aqueduct ; and I think that the adoption of this arrangement was very

requisite, for I believe that the contractor is quite incapable of managing such a large extent of work, or of organizing the arrangements necessary for ensuring a proper and satisfactory progress month by month.

Earthworks.

33. The earthworks have been carried on by the same contractor, and they have made much better progress. Ground has not been broken below the first fifteen miles, but in those miles this work is everywhere nearly complete, and in a month or six weeks it should be entirely finished. At the east side of the Vaikalair, where the banks are high, and much of the soil stony, the best earth has been used for a core. This arrangement has also, I was informed, been carried out in other places.

The sub-soil is, in very many miles, hard lime kunkur (nodular limestone), and it is, therefore, very necessary to take care that the little surface soil generally available is made the most of.

Drainage requires attention.

Near Bailapully, in the 152nd mile, and below the Canagoodur bridge in the 153rd mile, I observed that cultivated land had been swamped by the obstruction of the drainage by the canal bank. In the former case the water should be conducted to the culvert about 500 yards higher up, and I have mentioned to the Executive Engineer that, in all cases, such matters should be attended to at once, in order that the villagers may not be needlessly inconvenienced or subjected to loss.

Alteration of line from beginning of 160th to end of 169th mile.

* Proceedings Madras Government, No. 60, dated 8th January last, letter paragraph 28.

34. In a report* made last December, it was mentioned that some errors in the levels below the 159th mile had been detected, and that these affected the quantities so far as to make it advisable to move the line a little lower down the slope of the ground for a distance of some ten miles. The corrected estimate for the old line required an addition of 72,000 cubic yards of earthwork. The new line is 500 yards shorter than the old, and contains 8,000 cubic yards less of earthwork, but 64,000 cubic yards more than that in the incorrect estimate of the old line. On the whole, therefore, the revised line is the better of the two, and I have informed the Chief Engineer that there is no objection to its adoption.

In the 167th and 168th miles there was an idea entertained that a single banked canal might perhaps offer advantages. On investigation, however, it was found that this arrangement would be more expensive, and that there would be considerable difficulties in carrying it out efficiently ; consequently it is now intended to retain the double banks, and to keep the line to the west of the Cuddapah and Kurnool road, which was crossed twice by the old line near Peechapaud. On the new line the headway at the two large nullahs or rivers is considerably greater, and the works now proposed† for each are aqueducts of seven spans of fifteen feet each.

† Since my return to Madras I have examined the plans, and I find eight spans of fifteen feet are required for the upper of the two aqueducts.

Paragraph 20 of letter.
Procs. Madras Govt., 8th Jan. 1868, No. 60.

The size of the culvert required for the drainage at 163 miles 75 chains has been considered, the water which it

will have to pass as a maximum is, first, that from the waste weir of the Chintacoonta tank, which is forty-five feet long, and on which the depth may reach one and a half feet; and, secondly, the drainage from four square miles of country. A culvert of four vents of nine feet each with piers four feet to springing has been allowed, and this appears to be sufficient.

Still-water navigation and modifications and arrangements connected therewith.

35. As before mentioned, it is proposed to have a still-water navigation from the first lock at 169 miles 20 chains down to the Pennair, and it became necessary, therefore, to determine at what points irrigation water would be taken off, and then what modification of fall would be necessary to maintain five feet of water with a decreasing discharge in the Main Canal. These details were, therefore, discussed and settled, and the arrangements proposed are as follow.

The irrigation sluices with their position and the water to be discharged are given below. The country is naturally divided by drainages into a succession of small areas, and it has been assumed that in the country above Dhoor 350 acres per square mile will be irrigated, and 250 acres per square mile in the larger areas below Dhoor.

Above the Vaikalair aqueduct there will be a few acres of irrigation, perhaps on the left side near the aqueduct, but the quantity of water will be very small.

Position.		Discharge cubic yards per hour.
Bank.	Miles.	
Left	148th	600
Right	148th	2,000
Do.	152nd	700
Right	153—4	1,500
Do.	155—6	1,000
Do.	157th	2,000
Do.	158th	4,000
Do.	161st	4,000
Do.	162nd	4,500
Do.	164th	4,000
Do.	168th	5,000
Do.	169th	14,000
Do.	,,	10,000
Left		
Total, cubic yards.	.....	53,300

The full capacity of the canal is for cubic yards 60,000, so that 6,700 cubic yards remain to be utilized wherever a larger area per square mile than that allowed for may be brought under irrigation.

Alteration of fall.

In order to maintain approximately the full depth of water, five feet, throughout, irrespective of abstraction of water for irrigation, the fall per mile down to the end of the 158th mile will remain as at present, four inches; from the 159th to the 162nd mile the fall will require to be reduced to three inches per mile, and from the 163rd to 169 miles 20 chains, where the first lock will be placed, the fall will be two inches per mile, as originally intended.

Surplus sluices.

When water is not being used at all, or to the full extent, for irrigation, it will be necessary to discharge the surplus at or near the points where the changes

of fall are effected. For this purpose three sluices will be required, and they will all be in the right bank of the canal and discharge into drainages close by. The first will be in the 160th mile, and will surplus into the vagú at 159 miles 66 chains; it must be capable of discharging 12,000 cubic yards an hour.

The second sluice will be for 15,000 cubic yards, and will be placed near the lower end of the 162nd mile, and surplus into the drainage which falls into the vagú crossed by the canal at 162 miles 73 chains.

The last surplus sluice will be required in the 168th mile, and should be arranged for the discharge of 25,000 cubic yards an hour into a small drainage, a short distance to the south of the Peechapaud river.

Whatever water may be surplused in this manner from the ninth section will be available for the tenth section, Main Canal.

At 169 miles 20 chains.

The first lock of the section should have the walls above the upper gates raised to eight feet above canal bed level, so as to guard against overflow, should there be any delay in regulating the surplus sluices. A flow over the gates themselves will do no harm, and will at once attract attention.

Revised plans of masonry works.

36. Revised masonry plans for the 1st and 2nd Ranges (upper ten miles) of the section were received in this office on the 3rd July last, and were approved, with a few slight alterations, on the 1st August.

Those for the 3rd, 4th, and 5th Ranges reached the office on the 14th instant, and were kept until my return to Madras; they will be disposed of immediately.

Anicut and Head Works, Adimapully.

37. There appear to have been some rather remarkable discrepancies in the data obtained for these works. The length of the anicut as originally designed* was 2,376 feet: the length in the revised design, which is to occupy the same position, was stated to be 2,510, feet and Colonel Bean made some remarks about this length when submitting the estimate.

* 1864.

Procs. Madras Govt., No. 2,394, dated 28th July last, letter paragraph 5.

The present Executive Engineer informs me that the total length from wing to wing will be 2,383 feet, of which 146 feet will be occupied by the under-sluices, leaving 2,237 feet for the discharge of flood-waters. Mr. East also states that the normal flood level is 307·29, and not 306, as before reported. With these revised data the probable effect of the anicut will be to raise the flood-waters two feet three and a half inches and, allowing four and a half feet margin for the head works, their proper leve will be 314.

307·29 normal flood.
2·29 increase.
4·50 margin.

314·08

Sloop bank, south side.*

38. As a new line had been chosen, and I was not quite sure as to its exact position, I walked over some two or two and a half miles of it, and found that a great many irrigation channels had been ignored altogether in preparing the survey. This should certainly not have been done. The estimate

was submitted for sanction on the 5th instant, and the amount will in all probability suffice to do all the work that is required, as the level of the top of the ank at the head lock may be 315 instead of 317. I regret, however, that the information furnished is inadequate to enable me to say what the proper level at the western end of the bank should be, for the survey of the river Pennair, prepared in December last, terminates at the junction of the Papugnee, and the western end of the stop bank will be not far from the latter river and opposite a point about one and a half miles above its junction with the Pennair. If then the surface fall of the flood-waters of the Papugnee be similar to that of the Pennair, their level may be more than 319·90, which is the height proposed for the stop bank; what is necessary to be done, therefore, is to continue the survey of the Pennair (plan No. 5 A) up the Papugnee to the Railway; to lay down upon that survey the line of the stop bank, and to ascertain by enquiry at Camalapore on the west of the river, and at Taputla, Wulloor, and any other villages on the east, to what level the flood of 1852, reached at those points, and then to allow five and a half feet, above the deduced level of the flood at the end of the bank, for its proper level at that point. A fresh survey also is required of the stop bank itself upon which every irrigation channel, small as well as large, should be shown, and in all cases, in which it is proposed to stop a channel, it must be clearly explained, after enquiry from the ryots interested, that the substituted arrangement will be unobjectionable. Where the bank will occupy cultivated land, the land plans should be revised so as to provide only for the area actually required; where the ground is waste, the land plan already prepared need not be altered.

Letter No. 61.

Masonry work.

39. No masonry work has as yet been commenced, either at the anicut, or on the Main Canal, tenth section, but preparations have been made for commencing the latter as soon as the rains are over, and the former directly the freshes of the north-east monsoon subside.

Adamapilly anicut design.

40. As designed, the body wall of the anicut with a six feet base was to be supported on a single row of wells of four and a half feet outside diameter. This oversight will be corrected by giving two rows of wells, and I have suggested that these be sunk to nine feet below bed level (282), and that upon them a foundation of masonry seven and a quarter feet wide and two feet deep be laid to carry the wall above. Wells cannot be got down precisely in a straight line, and a battered wall cannot, therefore, conveniently be carried up directly from them without the intervention of a basement wider than its own base.* It will be advisable, I think, that a corrected estimate should be prepared with reference—

* That of upper wall.

1*st.*—to the considerable difference in the length of the Anicut, and

2*nd.*—to the modifications of arrangement, number of wells, &c. It will be better, however, to postpone this revision until after the commencement of work, as other alterations may then be found necessary.

Earthworks, 10th Section, Main Canal.

41. The earthworks in the 3rd, 4th, and 5th miles are making rapid progres,s and will soon be completed. The land in the upper miles will be made over to the

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Company in the course of a few days, and the earthworks there will then be at once commenced. The work is being done in a careful and regular manner, and it has stood the recent rains well.

Breach at Soonkasala Anicut.

42. I regret to have to report that on the 17th instant the Chief Engineer, who was with me, received intelligence of the occurrence of a breach in the north branch of the anicut. The breach appears to have taken place during the height of the recent freshes, and it was some time before the villagers who had observed it could cross the river and inform the officer in charge. The length of the breach is said to be 100 feet, and the height of the Anicut is at one end six feet only above the rock, and nine feet at the other end, and the Executive Engineer reports that the lowest point is one foot three inches above head sluice cill, so that there will be no difficulty in maintaining a supply in the Main Canal, and I hope that the breach will very shortly be temporarily closed. This is the first time a breach has happened at the north branch. The Chief Engineer tells me that some of the stones of the rear face were displaced last year, and that the necessary repairs were executed during the past working season. I have no doubt the damage is due to the badness of the original work, and there would have been no ground for surprise had the greater part of it fallen down long ago, and its preservation has been due solely to the goodness of the lime used. I had hoped, however, that after the mortar had become thoroughly hard and seasoned by the freshes of several years, the wall would have stood firm, notwithstanding defects of design and material. The repair of the breach will cost but little, but I am afraid that so long as any bad work remains there will be liability to accidents. As soon as a full report of the nature and extent of the damage reach the Chief Engineer, a copy will be sent to this Office, and such further information as may be received will then be communicated to Government.

Five feet three inches on crest.

Telegraph.

43. The line has been completed from Soonkasala to Kurnool, and is being worked. Below Kurnool nothing has as yet been done, and it is not at all satisfactory that there should have been so little progress made. I understood the Chief Engineer to say that the cause of delay has been the difficulty experienced in getting posts from the Nullamullay forests; but stone is abundant, and it would have been better to put up masonry pillars than to postpone for so long a time the completion of the telegraph, which was required more perhaps during the last few months than it will ever be again. Had a telegraph been at work between Jupad and Valepanoor, it is very probable that at the latter place information would have been received by the Executive Engineer of the heavy rain-fall last month at the former station, and of the considerable consequent rise in the water, and perhaps Mr. Dodson might thus have been enabled to reach Jupad in time to adopt precautionary measures, and provide for the watching of the banks; and such measures might possibly have prevented the breaches in the fifty-seventh and fifty-eighth miles. Until indeed the canal works shall have been fully proved, and all defects made good, the power of communicating by telegraph, and thus of having the water well under control is of great value, and each year thereafter, on the first admission of water, the advantage of the rapid communication, which it will render possible,

will be very great, and every effort should therefore be made to get the line completed as early as possible.

This year's experience shows also that it will be advisable that the line should be taken to more stations on the canal than has recently been in contemplation, so that the distance, over which a messenger will have to be sent, may in no case be great. When the canal is in good working order many of the stations will not need to be kept at work, except just at the time of admitting water, or for a month or six weeks after the 1st June in each year.

Distribution.

44. The staff at present engaged on distribution work is not sufficient to allow of satisfactory progress either in the preparation of designs and estimates, or in carrying out sanctions. I have already recommended an addition to the number of Assistant Engineers, and I hope that it will not be long before this important class of work will receive due attention.

Letter No. 63, dated 14th September 1868.

Navigation.

45. Nearly eighty miles of continuous navigable canal will be open in two or three months, and next season, therefore, something ought to be done in the way of starting navigation; and it is time also that some system, to be introduced from the first, should be decided upon. Under any circumstances, the Company should provide a few cargo-boats as early as practicable, by way of making a commencement, and to enable a trial of cost of water carriage, &c., to be made; and I would suggest that six iron barges be sent out, of about fifty-six feet length, and nine feet beam, with four feet maximum draught of water. A steamer of somewhat similar dimensions will also be required, partly as an inspection boat, and partly for towing cargo-boats, with a view to the collection of reliable data, regarding the conditions under which the navigation will have to be worked. As regards general navigation, I am myself strongly in favor of the introduction of the system under which any one who chooses can have a boat on the canal by paying a yearly or periodical sum based upon the tonnage, or dimensions, of the boat. I feel sure that this is the best and most economical arrangement, and that by it the traffic will, when once fairly started, be rapidly developed. Produce will want to be shipped and landed at very many points; and while, on the one hand, it would be financially impracticable for the Company to have traffic establishments for every village, it would on the other hand deprive the canal of much of its value were produce to be brought to some few stations, as on a railway. Boats belonging to private owners will probably not be put on the canal until the Company shall have shown the way, but it will be of advantage to notify the terms on which private boats will be allowed to use the canal, and the limiting dimensions of boats should also be made known. Boats of nine feet beam and of about thirty-eight or fifty-seven feet length will be the most convenient, as six of the former and four of the latter can be locked at once, and perhaps, if a little trouble be taken at first, boats of these convenient sizes will be constructed; and I would suggest that pattern boats of all the sizes which it may be desired to introduce be built; and perhaps the boat-builders of the Coast canal would be able to produce the smaller descriptions, which could be transported by railway and cart, at a moderate price, and if so, their mode of construc-

tion would probably be more suitable for the imitation of the villagers of the Kurnool District, than would be boats built on the European system.

Besides the first seventy-nine miles of the canal there will be available for navigation in the latter part of 1869, about twenty-five miles of canal below Jootoor (92 to 115, or probably a few miles lower down) and fifteen to twenty miles from the 144th mile downwards.

Crossings.

46. I observed that several new roads in connection with the bridges and other crossings of the canal have been started during the past year, and if the lists of crossings in the 6th, 7th, and 8th Sections, mentioned in this report, be approved, I would suggest that the Superintending Engineer of the 3rd Division be requested to take measures for the laying out and construction of district roads in connection with these crossings also.

From the Consulting Engineer for Irrigation and Canal Company, to the Agent and Manager of the Madras Irrigation and Canal Company, dated Madras, 25th October 1864, No. 291.

1. I have the honor, with reference to paragraph 11, Hindry Division, of the Chief Engineer's letter, No. 851, of the 27th ultimo, a copy of which was received with your letter No. 1,527, of the 15th instant, to request that you will be good enough to ask Colonel Cotton for information as to the extent to which he proposes to substitute the stone and clay bund on Mr. Smith's design for masonry walls, and for an approximate estimate at least of the cost of this revised section, as compared with the original arrangement, showing the probable saving by the adoption of the former.

2. I may add that I consider Mr. Smith's design in general excellent for situations where stone is abundant, and good soil scarce. The points which appear to be worthy of consideration however are—

1*st*.—That while the section offers to the pressure of the water a resistance of about five times that pressure, the ultimate stability of the work depends upon freedom from leakage, and it would be better, therefore, to increase the width of the base of the clay core to two-thirds the height of the water surface from the base. In the section given the width at base instead of nine feet would be $\frac{22\times2}{3}=14'\ 8''$.

2*nd*.—Again, as designed, the stone wall will exercise a horizontal pressure against the clay, and there will be no transmission of vertical pressure, while, as the stone will not be liable to settlement, should the clay part with any moisture and therefore shrink, there will be nothing to make it settle, and the stone will tend to prevent settlement. By giving a small batter to the outer surfaces of the clay, the stone would rest upon and tend to compress it both horizontally and vertically.

3*rd*.—Great care will be needed to make a good foundation for the clay core. If on soil, this soil should be trenched so as to increase the extent of surface contact. If on rock, I should recommend benching, unless the surface be very rough, and the slope towards the canal. The best arrangement is of course that by which the pressure of the water against the clay will force it against its foundation, and so render leakage less probable; and, if the foundation face [illegible] canal approximate to steps, this tendency would be promoted.

From the Agent and Manager of the Madras Irrigation and Canal Company, to the Consulting Engineer for Irrigation and Canal Company, dated Madras, 15th June 1868, No. 103.

In transmitting copy of the Chief Engineer's letter, No. 248 of 12th June 1868, I have the honor to request you will move the Government to sanction the plan and estimate for a groyne in connection with the Soonkasala Anicut, which were submitted with my letter No. 60, of 14th May 1867.

From the Assistant to the Chief Engineer, to the Agent and Manager of the Madras Irrigation and Canal Company, dated Kurnool, 12th June 1868, No. 248.

1. I am instructed to ask that you will obtain leave for us to carry out at once the groyne at Soonkasala, drawing and estimate of which were submitted with our No. 128, of 7th May 1867.

2. Nothing has been done to it except what was necessary to secure and make useful the portion begun previously to July 2nd, 1867.

3. The action of the groyne seems satisfactory so far.

4. If desired it can be included in the estimate for the first mile.

From the Acting Consulting Engineer for Irrigation and Canal Company, to the Agent and Manager of the Madras Irrigation and Canal Company, dated Madras, 23rd June 1868, No. 72.

1. In reply to your letter of the 15th instant, No. 103, enclosing copy of one from the Chief Engineer, dated 12th idem, No. 248, in which Mr. Latham requests that the estimate for a groyne, at the Soonkasala Anicut, submitted with his letter of the 7th May 1867, may be forwarded to Government for sanction, I have the honor to request that the Chief Engineer will state the grounds on which he bases this second application for the sanction of the work.

2. Government in their Order of the 2nd July 1867, No. 1,953, did not approve of the erection of the groyne, being of opinion that its construction would not effect the object in view, and unless some evidence is put before them of the benefit which has ensued already from a partial erection of the work, I see no ground for recommending the resumption of operations. Government, I consider, will not be satisfied without some such guarantee as to the good effects of the groyne, and I observe that the same paragraph of their order points out that a consideration of the means to be devised for keeping the head of the canal clear, after last year's freshes had subsided, should result from observing such effects of the work already done, though no remark has hitherto been made, I believe, on this point by your officers.

No. . Endorsement of the Consulting Engineer for Irrigation and Canal Company, dated Madras, 30th September 1868, No. 70.

From the Chief Engineer, to the Agent and Manager of the Madras Irrigation and Canal Company, dated Camp at Cuddapah, 24th September 1868.

1. It is right that I should report, for the information of the Consulting Engineer, that during the freshes of this month a part of the north anicut at Soonkasala, where it is of inconsiderable height, is reported to have been carried away.

2. The water prevents any examination, but it may be a chain long and possibly nine feet deep, and a rocking motion, described as appearing in the water when the breach commenced, may have been due to some holes having been first blown through the body of the anicut. No inconvenience is expected in maintaining irrigation.

No. 238.

Communicated to the Consulting Engineer.

(Signed) F. H. HENSLOWE,
Agent and Manager.

MADRAS,
28th September 1868.

Proceedings of the Madras Government, Public Works Department,
17th November 1868.

Transmitted for the information of Government, with reference to paragraph 42 of this Office letter No. 68, of the 26th instant.

(Signed) J. MULLINS, Captain, R. E.,
Consulting Engineer for I. & C. Company.

No. 316. ORDER THEREON, 17th November 1868, No. 3,586.

IRRIGATION, No. 14.

1. The Government have perused this report with much interest, and request that the suggestions and remarks of the Consulting Engineer may receive the early consideration and attention of the Officers of the Madras Irrigation and Canal Company.

2. His Excellency the Governor in Council regrets to learn that both the Anicut at Soonkasala and the Canal itself have received serious damage, though not, it is hoped, to such an extent as materially to interfere with the irrigation that has been taken up.

3. The revised lists of crossings proposed to be provided in the 6th, 7th, and 8th Sections of the Canal are approved, and the question of constructing district roads in connection with those crossings will be considered in the Revenue Department.

4. The proposals and arrangements in paragraphs 26, 34, and 35 are also approved.

5. Ordered that Captain Mullins' report be forwarded to the Home Government.

(True Extract.)

Colonel, R. E.,
Secretary to Government.

To the Consulting Engineer for Irrigation and Canal Company.
,, Manager for do. do.
,, Revenue Department.

Exd. S. T. Augustin.

List

3° Dieux/68

Revenue Dept.
No. 3638.

Govt. of {1868} Madras.

PUBLIC WORKS.

To

THE CONSULTING ENGINEER FOR

IRRIGATION AND CANAL COMPANY.

&c., &c., &c.

Dated November, 17th.

Recd. 20th ____ Inst.

G. O., 17th November 1868, *No.* 3,586.

NOVEMBER.

Nos. 314-316

Rev. 37-38.

No. 3026. 3 Dec

Works (Madras Irrigation and Canal Company).—Passing orders on papers relative to the state of the Company's works, as ascertained between the 30th August and 22nd September 1868.

Further order