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Public works DEPARTMENT.

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1871 Apr 5/71

No. 220 Read the following Memorandum from the Chief Engineer for Irrigation, dated Fort Saint George, 2nd March 1871, No. 62 :—

THE enclosed observations relate to the delta of the Godavery, in which I have recently spent three weeks in inspecting the canals and discussing with the Superintending Engineer, who was good enough to accompany me during nearly the whole time, such matters affecting the efficiency of the delta works as came under notice.

2. ANICUT AND HEAD WORKS.—The anicut was examined so far as the state of the river would permit. All its aprons appeared to be in very good order, and the repairs required to the work itself will be inconsiderable. Only in a few places are additions to the lower rough-stone apron required. I have in the note as per margin, upon the Superintending Engineer's letter recommending certain works for the purpose of making the discharge of the river by the western branch or Vasista Godavery greater than it is at present, together with some other alterations, pointed out what measures appear to me to be necessary in the present condition of the river bed above the dam. The annual chart, which will now shortly be prepared, may show that some additional work is necessary, and, prepared in the way intended for the future, this chart will be a valuable guide in deciding how the river bed may best be regulated.

The *Dowlaiswaram Under-sluiques* were kept open this year for an unusually long period; the cut-stone apron has not suffered, but from the part of the rough-stone apron below the retaining wall a good deal of stone was washed away, and there is rather a deep hole which was being filled in with rubble. Anything almost will do for the lower part of the hole, but the surface should be packed with stone of not less than $1\frac{1}{2}$ feet cube; the water was at 5 feet below the under-sluique sill, and the rough-stone may with advantage be packed on a slope of 1 in 8, so as to conform the better to the now lowered bed of the river.

The *Bobba Lanka under-sluiques* have been kept shut for the greater part of the season, as the water from them had cut into the lunka below. Some groynes have been placed along the bank to prevent further erosion, and navel planting has been successfully resorted to. I have no doubt that by a judicious use of groynes and planting all that is necessary may be effected. The bulk of the groynes should be of earth, revetted first with navel, and then with stone, the noses alone being of stone only. The groyne in continuation of the west abutment of the sluiques has its outer end too far to the eastward, and the navel should not be advanced beyond the line it is desirable to maintain.

The *Vijeswaram Under-sluiques*.—The right bank below these sluiques has been revetted, and a large bank of stone has been placed on this side in continuation of the lower wing. Navel has been planted in continuation of these and also extensively on the left bank, where there was formerly much erosion from the return current; the bay thus formed will soon be reclaimed. A small stone dam has been placed across the channel, about 300 yards below the sluiques, and this is very useful in keeping water, which acts as a cushion, on the sluique floor, thus diminishing wear and tear. The apron is generally in good order; a few stones have been displaced at the edge of the cut-stone apron.

The several head-slucies require only moderate repairs; the small piers of the sluice vents are very thin, and get a good deal knocked about by the shutters. Whether or no a second line of shutters be given, the shutter platforms should be raised, angle irons should be placed in the grooves to form the surface on which the shutters are to slide, and the shutters should be improved and worked by screw gearing. I am of opinion, after inspecting the head-slucies, that a second set of shutters, rolling like those at Bezorah, might without difficulty be placed a few feet in rear of the front line, and that the taking down and re-building of the face wall on a new alignment would be attended with no risk whatever. The roadways are wider than is necessary, and it would be a useless expense to build out piers in rear to carry the additional shutters.

The Under-slucie Shutters are worked with great difficulty, angle irons would be an improvement in the grooves, and can be given from time to time as the shutters need renewal; the new shutters might be of the form suggested for the Kistna.

3. DOWLAISHWERAM STONE QUARRIES.—In travelling through the delta I have on several occasions noticed that the stone sent down for masonry works is by no means as good as it should be. The material for cut-stone work, for copings, sills, etc., is good enough, and though much of the sandstone is coarse grained and uneven in texture, it is, when fairly regular, well adapted for strong masonry. Small irregular stone is unfit for any situations in which bond is essential, and besides in one way or another there is a great deal of waste in its use. Having understood that a rupee a cubic yard for this inferior stone was charged for at the river near Dowlaishweram, I went over all the quarries and made enquiries into the details of cost. The getting of good stone is now somewhat difficult, owing to the depth of soil over the good stone, and to the quantity of debris from old quarrying. The greater part of the stone taken out is unfit for first-class rubble masonry, or for any position in which good bonding is necessary; if carefully packed and grouted it will do for work where vertical pressure alone has to be sustained. There is some fine stone of large size, and a small proportion of really good ordinary building stone; there is also an enormous quantity of small stone adapted for concrete, and I have spoken to Captain Hasted, the Executive Engineer in charge, on the subject of manufacturing concrete blocks, which, if successfully made at low rates, would utilize this small material, help to clear the quarries, economize the stone adapted for face work, and supply a want which is yearly becoming more and more pressing. Captain Hasted wants to lay down a line of rail to the quarries near the old Sapper field works, where the stone is good and nearer the surface, but he has not the rails required, or money to purchase flat bar iron for the purpose. The quarry plant is in a wretched

state, and needs thorough renovation. I

* i.e., about 3 miles of line with sidings and quarry branches.

would recommend the early sanction of

10 miles* of rails of the pattern called

contractor's foot rails, weighing about 18 lbs. to the yard run. With this addition to the plant of the quarries, I think that they may, without further assistance, be placed on an efficient footing. At present the Executive Engineer is like a man endeavouring to carry on a large business with little or no capital, and such a plan is fatal to efficiency and economy. The rails I have recommended make a consi-

derable saving in sleepers, and they diminish wear and tear of wagon wheels, besides greatly reducing the cost of haulage; it must be remembered that the lead is a long one, and that consequently good railways from the entrance to the quarries are of much importance. I saw silstones being carted along an indifferent track, from the Alikonda quarries for the locks now under construction, and such an arrangement cannot but be a great waste of money, which the Executive Engineer cannot prevent unless he is supplied with the means of carrying on his work in a proper manner. The cost of 38,402 cubic yards quarried and disposed of last year was Annas 14-0-59 a cubic yard, which rate was made up of the following items:—

	A.	P.
Clearing quarry	3	4-50
Quarrying	5	7-38
Sundries	0	2-79
Steamers	1	5-03
Draught	1	10-43
Loading on boats	0	6-86
Superintendence	0	11-60
	14	0-59

I consider that the steamer charge is altogether improper; the quarries, in the absence of any specific sanction for the up-keep of the steamers, have to pay the whole cost of the maintenance of these vessels, less the amount recovered from private persons or others using them. The results are an improper addition to the cost of the stone, and, for want of money, an impossibility of keeping the steamers and their machinery in order, and so every service which they perform costs much more than it should do. I found that the quarry accounts are carefully and clearly kept, and that all details of expenditure were readily obtainable. It appeared to me that all that the officers in charge could do had been done, but that they had been crippled by the circumstances under which they had been obliged to work, and as a desire to keep down expenditure under certain heads of charge, such as tools for plant, results in a direct waste of money, I trust that proper provision for such services will be made in future.

4. CONCRETE BLOCKS.—Considerable facilities for the manufacture of concrete blocks are to be found at Dowlaishweram. There are several varieties of lime-stone, and small stone and good sand are abundant close at hand. Some experiments will be necessary to determine the proper proportions of materials, and a mill worked by steam-power will be needed for grinding the lime, as upon this part of the operation will depend in a great measure the strength of the blocks and their suitability for building purposes. A stock of moulds also will be needed. Until the best process of manufacture shall have been ascertained, I propose that the work shall be carried out on a small scale, and the open ground near the dry dock will be a suitable place for this purpose. Here there is an engine ready for the work, which is now used only occasionally for pumping out the dock, and which can readily be employed to drive the mortar mills; the available space will do for the experimental manufacture, but, should this prove economically successful, a much larger area on the opposite side of the canal will be needed for preparing blocks for use generally in the delta, and then a separate engine will be needed. I would recommend that 5,000 Rupees be devoted to this experiment, and that

three years be allowed for fully carrying it out. Some part of the money will be spent in setting up the mill, providing a stock of moulds, purchasing materials, etc. Blocks of various composition will be made up and buried beneath about a foot of damp soil, where they should remain for periods varying from one to twelve months. The general object of the experiments should be to prepare blocks capable of sustaining a pressure and a transverse strain equal to the crushing and breaking weights for good, well burnt, table-made bricks, at a cost not exceeding that of common rubble masonry. Incidentally the proportions of far stronger blocks will no doubt be discovered, but what is wanted is a substitute for inferior rubble, and the generality of the delta works do not require for interior work anything stronger than first-rate brick masonry. Good blocks of this quality, if of suitable sizes, will bond well and make such masonry as is needed. I may add that the blocks should not be of larger size than can be readily handled, and probably 18 inches by $8\frac{1}{2}$ $\times$ $8\frac{1}{2}$, and $16 \times 12 \times 7\frac{1}{2}$ will be good dimensions to adopt at starting. The cohesive strength of the several descriptions of lime available can readily be ascertained by experiment on prisms of small cross section, formed of pure lime, i.e., unmixd with sand or other material; and their relative strength will probably remain almost unchanged when mixed with other materials, and the strongest lime will, if of the same cost at the kiln, bear the greatest extent of dilution, and therefore produce the cheapest concrete. Slow drying is of importance in securing the full strength of the cement, and rich lime can be used, even for blocks intended for foundations, as the lime will have set completely before the blocks are placed in position and hydraulic mortar will be needed only for cementing them together. These remarks are not intended to be exhaustive, but to indicate the object of the proposed manufacture, and the points which will need attention at the outset in order to avoid waste of money. Captain Hasted is fully competent to carry on the experiments satisfactorily, and to determine whether results sufficiently satisfactory can be obtained to justify a manufacture on a considerable scale. I may mention here that I should have proposed the use of concrete in bulk for the walls of large works, but for the difficulty of conveying appliances from place to place, and, without these, I should fear there would be considerable risk of failure. Concrete suitable for foundations is a different thing from that required for the mass of a wall, such as the side walls of locks, etc.; the latter needs a much more equable mixture of materials as also greater cohesion.

All mixtures which may be tried should be run into moulds of small size for experiments on the strength of the resulting material; for transverse strain these experimental blocks should be 16 inches $\times$ 2×2 , and for crushing 2 inches cube; the former should be tested on supports 1 foot apart, and the latter perhaps may most readily be tested either by a lever or under a punching machine, the power being applied by weights.

5. DRY DOCK.—This is on the right bank of the main canal, about 400 yards below the head-sludge. Its close proximity to the river, the water in which is during freshes many feet higher than that in the canal, has led to leakage which may be much reduced, if not altogether stopped, by putting in a puddle wall all round to a depth of 3 feet below the floor of the dock, where, if the soil be good, it may terminate. The trench for the puddle should be cut sufficiently far from the masonry to prevent risk of settlements. The gates are not sufficiently

water-tight, and a wooden sill bar should be inserted. Strips of felt also should be nailed to the heel-posts and to the lower bar of each gate to stop leakage. It is not satisfactory that a mud bank in front of the gates should at present be necessary; its construction adds much to the expense of docking boats, and, besides this, the gates being left dry for weeks together will become less and less water-tight.

6. I have recently, in submitting to Government the completion estimates for the western and eastern sections of the delta, reported in considerable detail on the works required to render the irrigation, the drainage, and the navigation in these tracts efficient, and my remarks now will, as regards these sections, be confined to points which were not then finally decided upon, or to circumstances which did not then come under notice.

7. WESTERN DELTA.—At the time of my visit I found Mr. Randall in charge, without any Assistant Engineer or any one who could take the place of an Assistant Engineer to help him. It is quite impossible for any officer to work a range of this size and importance properly under such circumstances. Mr. Randall has had a long experience of the range, and takes great interest in his work, but that work is altogether beyond the power of one unassisted officer to accomplish. The head-quarters of the range also at Nursapore are badly located, and an early opportunity should be taken of moving the range office up to a point on the main canal, just above Chettipett, which is close to the heads of all the secondary canals, and not far (6 miles) from the head-sludge at Vigeshweram. The entire regulation of the supply to the delta, including the management of the surplus works, would then be under the eye of the officer responsible for the safety and efficiency of the works. The range should be permanently divided into two sub-divisions, and the Gostanuddi and Yennamadurru drains will be the proper boundary between the two. In the eastern sub-division the area of irrigation will be 122,500 acres, and under the western 171,600 acres. Both the Assistant Engineers should have their head-quarters near Chettipett, because they will from this point be able to reach, with most facility, and without loss of time, whatever part of their charges may need their presence, and the transaction of business with the Executive Engineer will also be rendered easy. One office building will then do for the whole engineering staff of the range, and the multiplication of plans and correspondence will be avoided. The Superintending Engineer should prepare a plan and estimate for the office, and pending its sanction the rest-house at Chettipett, which has been included in the delta estimates should not be proceeded with, as it will probably not be necessary. The accommodation which will be required will be—

- 1 Room about 24×18 for the Executive Engineer.
- 1 " " 24×18 " " Drawing Office.
- 1 " " 30×18 " " Clerks generally.
- 2 Rooms " 18×18 " " Assistant Engineers.
- 3 Bath-rooms.

A room for instruments and small stores will be needed either in the main, or in a detached building, and there must be a store-shed close at hand.

Since I was at Dowlaisweram the Superintending Engineer has posted Mr. Assistant Engineer Martin to the Western Delta, and another officer of this grade should be given as soon as possible.

8. **CHEETIPET WEIR.**—This important regulating work has five bays of 20 feet, divided into 10 by cast-iron standards. The old shutters were almost fixtures; the new shutters are fitted with screw gearing, and they work admirably. As a remodelled work the weir is very creditable and efficient; for a new weir several modifications would be advisable, the principal being that the cushion wall is about 8 feet and the cushion floor $4\frac{1}{2}$ to 5 feet too high, and the cushion itself too narrow. It would have been more convenient had the bridge planking been continued over the shutter girders.

9. **ELLORE CANAL.**—The lunkas or berms of this canal are far too wide, and being for the most part just on a level with the water, the tow line has to be taken to the embankment some 60 feet from the edge of the canal, and this is inconvenient; the difficulties are further increased by the bullrushes and lunka grass on the berms. The grass is useful for some purposes, and it will perhaps repay the cost of preventing its becoming a nuisance, but the bullrushes should be entirely exterminated, for they spread so rapidly from the seed blown about by the wind, that they not only contract the canal and impede the navigation, but they threaten to block up the outfall channels from the drainage works altogether. No time should therefore be lost in providing for their eradication; the proceeds from grass rents after providing for any charges already met therefrom and properly belonging thereto, should be devoted to this work, and these funds should, if necessary, be supplemented by allotments from the Agricultural Repair grant.

In carrying out the improvements to the canal, a tow-path should be formed close to its edge wherever earth for the purpose may become available, and the excavated soil should, after allowing for this, be used for raising the lunkas, which may then be planted with a view to obtain fuel for the steamers and for lime and brick-burning, etc. Silt clearances can from time to time be used in the same way.

The *Under-tunnel above Bathampudi* is of one vent of 10 feet, and it is much too small to carry off the drainage in years like that just ended. A breach was made into the canal to drain the lands, and a side-channel was being cut with a bottom width of $2\frac{1}{4}$ yards, to carry off some of the water to the inlet opposite what is called No. 1 escape, below the village.

This channel to be of any use should be much larger, but I think the proper arrangement would be to construct an additional under-tunnel, for the canal itself cannot reduce the drainage water to the desired level. The Superintending Engineer should submit an estimate for an under-tunnel for sanction as a Minor New Work, as the amount will exceed the limit of his powers of sanction.

The *Bathampudi self-acting Escape* does not act; probably because the counterpoise is buried in silt, and this should be seen to from time to time.

Irrigation Sluice, 28th mile.—This is one of the new pattern sluices. As built it is almost useless, and the cultivation has been carried on from a temporary cut; the sluice can be adjusted for a small acreage, but it cannot supply the area which the size of the vent would indicate.

Kykaram new Aqueduct.—Five vents of 10 feet; there is far more leakage through the face walls than is right. It is only an ooze, but it indicates indifferent building, or the use of lime which was not hydraulic. The outfall wants clearing of silt and bullrushes.

Bimadole Aqueduct.—This was originally a small work of, apparently, two vents of 10 feet span each; it was carried away and was re-built; it fell again and was enlarged to five vents of 10 feet; then the side wall on the lower side upset and was reconstructed. The masonry is indifferent, as the thickness of the side walls would be ample, were the masonry good, to stop leakage, which is considerable; the floor is about 18 inches below the proper level, and the upper parts of the wings are of the roughest rubble, quite unfit for works of this class. The outfall channel is much choked and is full of bullrushes, and this remark applies also to the aqueduct in the 43rd mile. The 44th mile outlet is one of Captain Ryves' pattern of self-acting escapes; it was built about 15 inches too low, and it has to be banded in front to prevent loss of water.

10. **JUNCTION CANAL BETWEEN THE ELORE CANAL AND THE WEYAIRU.**—This canal, which has been recently sanctioned, has just been commenced. It was intended to be carried to the east of Mudapuram, the low level channel being immediately to the north-west of the village. The villagers, however, represented the inconvenience which they would suffer from being shut in between the two channels, and so the bifurcation has been moved lower down. The alteration will not add to the expense, and the area of land occupied will be much the same, and I therefore approved of the change. The double lock to be built at Mudapuram has been sanctioned as one of the first-class, and the Superintending Engineer having mooted the question whether a second-class canal would not suffice, thus saving some 8,000 Rupees, I deferred coming to any decision until I had been down the Venkiah and Weyairu and a considerable length of the Ooputeru. It then appeared to me that it would be advisable to let the sanction stand without change, as the navigation may be made excellent almost throughout; vessels of a large class may be expected to come up into the delta, and the traffic is likely to be heavy.

11. **VENKIAH, WEYAIRU, AND OOPUTERU.**—The navigation above the Perimolla lock, except for a short distance near Dava, is very good, and the tow-path may, with a little trouble, be made all that is requisite at a small outlay. There are two powerful weirs discharging into the lower Weyairu, one of six bays of 9 feet $4\frac{1}{2}$ inches each, the other two bays of 15 feet each, divided by cast-iron posts. The former has been considerably modified recently, and for an old work which has been adapted to modern requirements it is very efficient; it wants a shutter platform; the regulation is by screw gearing. The smaller weir has a heavy over-fall, which is received by a wide cut-stone apron; part of the platform bridge needs renewing.

Perimolla Lock.—This is a second-class lock; the head walls and embankments are too low; the canal receives a great deal of drainage, and the masonry, as far as the gate buttresses, should be raised to 2 feet above ordinary maximum supply level. The gates are very rotten, and they have been raised at different times; new gates should be provided as soon as possible. The front wing returns should be made 4 feet above maximum supply level at the outer ends, so as to join on properly to the embankments, which should be brought to the same level, and strengthened. The gate planking may be 6 inches above water level, or lower than it is now. A breach at this lock would be a very serious matter. There were 11 feet 1 inch of water on the lower sill, and 11 feet 1 inch difference of level; the lock is double, but with so much water below a boat drawing 3 feet of water

can pass through both chambers at once. Air holes are required over culvert chambers, and proper levers for the culvert gates. One valve of the mid gates had been disabled by the breaking of the rack.

The *Chinnakapaveram Head-sluiice* is an old work; it would be the better for screw gearing. A new regulator below the head-sluiice has been recently built and it works well.

Aqueduct over Drain.—This is a new work of five arches of 10 feet each. It is built of stone up to the crown of the arch with brick side walls above, a stone coping with hand rails and an asphalted floor. It is a very useful work, and the design is suitable.

Chinnakapaveram flood or Escape Weir; five spans of 20 feet each, built in 1868. The bays are divided by cast-iron standards; the abutment and pier ends of the shutters slide on angle irons, and the weir is altogether very efficient. The introduction of the cast-iron standards is due to Mr. Rundall, and they answer extremely well for the sub-division of large spans into convenient widths. The shutters are fitted with screw gearing. At this point the main line of navigation leaves the Weyairu and runs along the Rudroykodu to Akeed, but the Chinnakapaveram lock on the Weyairu enables boats to go down into the Colair lake. On this latter line, however, the traffic is not very great. The Weyairu from Perimella to Chinnakapaveram is not a very convenient line of navigation at present, and the Executive Engineer thinks that it would have been advantageous had the navigation been taken along the Chinnakapaveram channel. It appeared to me, however, that the formation of tow-paths in the comparatively shallow water at the sides would be a great improvement if combined with banks across the creeks and bays, openings being left for drainage; then tracking would be easy, and there would be nothing of importance against the present line. Below Chinnakapaveram, that is in the Rudroykodu, the navigation is easy, but some corners want to be eased off, and the bullrushes, grass, and weeds should be got rid of entirely. A girder bridge was built last year across the new cut, just below the point where the navigation leaves the Rudroykodu.

Yaturpad Lock.—This is a new tidal lock of the first-class. Masonry good; difference of water level 4 feet 7 inches

* Very nearly high water.

at the time* of my visit; the chamber

was filled in 2½ and emptied in 3 minutes. Depth on lower sill 8 feet 7 inches. Rise and fall of tide said to be 3 feet. The upper gates have double valves; the side culvert at the upper end has a pivot valve which would be quite efficient were one end of the lever bent at right angles to the other so as to keep both over the masonry; it is fairly free from leakage. The gates are not particularly good, and they want, as also the wood-work of the tail bay bridge, two coats of tar.

The channel from the lock to the Ooputeru requires to be widened and straightened; near the lock it is narrow and very crooked. The Ooputeru would be a most convenient navigation were good tow-paths provided on both sides; the water is deep and the channel is wide; for some miles very little work is needed, but, without this little, tracking is impracticable, and the dhonies, which are numerous and some of them large, sail, drift with the tide, or are poled according to circumstances; a little clearing away of grass and bushes would alone be necessary, both should be rooted out. Below this there is a belt of jungle (mangrove)

on both sides, and 10 to 15 yards of this would have to be cleared away to get to ground high enough for a tow-path; much of the cost would be covered by the value of the firewood obtained, and the improvement and saving of time to boats would be so great that these facilities ought to be given as soon as possible. At the outfall of the Yennamadurru, the Executive Engineer and myself left the Ooputeru and proceeded up the drain to Bimavaram. The part of the Yennamadurru drain below Pusalamarru would be an excellent navigation were a tow-path on either side cleared and kept in order. As it was, though our progress was slow, there was plenty of water and an ample width everywhere. Above Pusalamarru the channel becomes narrower; near Yennamadurru the drain begins to be embanked, and just opposite the village there are two channels, and from this point upwards both sides are embanked. The navigation may be much improved by clearing grass away, removing trees from the inside of the banks, etc. There is a considerable traffic, and we met several sea-going vessels which had loaded with grain at or near Bimavaram.

12. PART OF NERSAPORE CANAL.—The upper part of the Nersapore canal had been closed and unwatered to allow of the Peravelly and Itempudi new locks being commenced.

Peravelly Lock.—This is near the head of this canal, and the old kutchu lock, which has fully answered its purpose and has been in use for many years, is about to be replaced by a new first-class lock. Materials had been collected, the canal bunded, and excavations were about to be commenced when difficulties were met with in consequence of the land between the lock and the weir channels having passed into private hands. Such an arrangement ought never to have been allowed; it appears that part of this land, which has been in the uninterrupted possession of the Public Works Department, for, if I remember right, 12 or 14 years, and on which the lock establishment huts stand, has been included in the puttah of the present owner, though exactly when this occurred is not quite clear. The owner now demands, what seems to me, an exorbitant price, nearly 500 Rupees an acre, and measures have consequently been taken, with the approval of Government, for acquiring the land under Act X. of 1870. The loss of time which has resulted has been unfortunate, as the season during which deep foundations can be got in is very short; but I think it was advisable to resist the attempt to obtain an excessive price for the land even at the risk of adding to the cost of the lock. It would be difficult perhaps to lay down a rule which would meet all cases of the kind which has thus been brought under notice. An officer formerly in the delta built a small bungalow, and, when he left sold or gave it away; he appears to have obtained a grant of land, part of which at any rate ought not to have been given to any private individual, and this land went with the building. It was a mistake to allow the bungalow to be built, where it is, as private property, for it is upon the line, or rather within the line, of the canal bank; a recurrence of such a proceeding may be prevented, and I will take measures for rendering it unlikely. With regard, however, to the grant of lands by the Revenue authorities to applicants for them, all I can suggest is that the Collector should endeavour to ascertain where they are situated before giving a title, and, when the lands are shown in the

Revenue Survey Maps, it will be easy to see whether they are so situated with regard to Government works as to make it desirable to ask the Superintending Engineer whether the grant would be in any way objectionable.

Lock Weir.—This is a new work of six bays of 9 feet each. The masonry of the crest of the main wall, of the floor of the cushion, and of the crest of the cushion wall is not good enough for work so situated, and I informed the Executive Engineer that I was on the whole disappointed with this weir, the material and workmanship of which is decidedly inferior to those of many works which were constructed years ago. I have noticed in another part of this memorandum the unsuitability of much of the stone supplied from the Dowlaishweram quarries for ordinary rubble masonry, and much of that brought down for the new lock is fit only for concrete. The girder bolts of the weir are too short; they should be 5 to 6 feet long; as it is, the upper course of masonry of some of the piers has been started. The rear revetments are at too steep a slope, and much of the stone is too small. It is of great importance that all the new works in the delta should be built in a thoroughly substantial manner, and the Executive Engineers should pay special attention to this point; no excuse for indifferent work can be accepted; if competent supervision be limited, the progress of works must be limited to correspond therewith; if contractors cannot be depended upon, the work must be done without them.

Sluice at the head of the Boopiah Channel.—This sluice is just above the lock weir, and it has been recently built; the masonry is much better than that of the weir. The water level was high and was discharging over the top of the shutters: the water cushion appeared to me to be too small, and there was consequently much greater commotion than is advisable; with the experience gained at works already constructed it will not be difficult to design weirs which will fulfil all necessary conditions. Below Palkole there was still-water. A road runs along the left bank; there are a good many bullrushes, principally on the right bank, which should be got rid of.

Tidal Lock.—This communicates with the Vasista branch of the Godavery, it is a first-class lock (150 × 20). The rise in the tail channel above high water level, caused by freshes in the river, does not exceed 3 feet; this channel needs some deepening, and the banks, where not occupied by the road, might be in better order.

13. EXECUTIVE ENGINEER'S OFFICE, NURSAPORE.—The building was formerly a cloth godown, for which purpose it may have done pretty well, but it is utterly unsuited for an Engineer's office. Were the head-quarters to continue at this station, the office would need entire re-roofing, ten additional windows, and verandahs; the accommodation would hardly be considered suitable for convicts.

14. MOGULTUR EXTENSION OF NURSAPORE CANAL.—In paragraph 10 of my note on the Western Delta estimates, I expressed some doubt of the propriety of incurring the large expenditure, Rupees 47,830, required for connecting the Nursapore canal with the Ooputeru, seeing that this canal is already navigable to tide water in the Vasista Godavery by the tidal lock at Nursapore. I rode out with Mr. Randall to see the proposed outfall beyond Mogultur into the Ooputeru, and from the Deputy Collector and others, inquiries were made as to the value of the arrange-

ments estimated for. It appears that the bar of the Godavery at Point Nursapore is unfavourable, that it has but seldom a depth of more than 4 or 5 feet upon it,

* Dhonies.

that laden boats* cannot pass it but that they have to lie outside to take in cargo.

On the other hand, the Ooputeru bar is always passable, there being 9 to 12 feet of water upon it, and dhonies of considerable size pass by this river into the interior and take up grain and other cargoes. Another point is that there will be, when the Kistna Delta improvements are carried out, direct communication with Masulipatan *via* Mogultur, and I am told that there is much trade between the two places. These considerations have convinced me that it will not be a waste of money to carry out the works provided for, and therefore the estimates as submitted to Government, may be allowed to stand.

15. OUTFALL SLUICE OF KAZA DRA.—This work is a short distance from the tail channel of the tidal lock at Nursapore. It has two cracks right through it, due to the omission to provide concrete for the foundations, a very necessary precaution where wells are not used. It is said not to have settled for some time past. A proper shutter platform should have been included in the design; the revetments connected with the work are too steep.

16. BANK CANAL.—The head requires to be laid out again; at present the entrance is unnecessarily awkward and inconvenient. I have in another memorandum* referred to the set of the river

against the bank close to this canal above Khandavelly. It is a difficult place to deal with, but after providing for stopping further erosion at the most dangerous place, which may be accomplished by a combination of stone groynes, (solid noses with earthen core covered with grass revetment and then with stone elsewhere,) and palmyra horse fencing, as explained to the Executive Engineer, efforts must be made to train the river away from the set, and induce the current to run parallel with, instead of nearly at, right angles to the general direction, by planting out from some distance above the set. Some 300 yards of lunka have been swept away in the last two or three years, and only 25 yards remain at one point between the edge of the river and the embankment; immediately behind the latter is the Bank canal, and the depth of the river bank is 25 feet and nearly vertical. In my

note† on the completion estimates, it was mentioned that a new lock at Khandavelly appeared to be unnecessary. It was advocated by the Superintending Engineer principally on the ground that without it the water would be maintained at too high a level. When I was there it so happened that the water above the existing lock was 2½ feet higher than it will be in the revised arrangements without a lock, and I could see no reason for having a lock at this point at all; the existing lock is a very temporary affair, and should be removed whenever this can be done conveniently with reference to the progress of the improvements. When my note was written, it was supposed that the Siddantam lock lower down was efficient and suitable, but I found that it contains very little masonry, and the walls are cracked; it wants new gates, and it took 9½ minutes to fill with 1 foot less difference of

† Paragraph 11.

level than would exist with a full supply. A new lock should therefore be built and the levels should be revised as follows:—

Siddantum new lock upper sill + 21 (instead of 19).

lower „ 15

Water level above, allowing a surface

fall of 4 inches a mile ... 26.66

Water level below ... 20.00

Do. above Kodair lock ... 18.00

Kodair lock, upper sill ... 13.00

Do. lower sill ... 7.00

Tail lock, upper sill ... 5.00

Do. lower sill about — 7.50, but in accordance with

the conditions prescribed in this Office Circular, No. 30, dated 12th November 1870. Though the Siddantum lock now to be built will cost rather more than the Khanda-velly lock, for which it is to be substituted in the estimates, there will be a saving on earthworks which will, I think, more than make up for the difference, and so no change in the total of the estimate as recommended for sanction is proposed. Proper cattle crossings are much required on this canal: 1 in 6 will be a proper gradient for the ramps on either side, and the sides of these ramps should be revetted so as to oblige cattle to keep to them.

Bridges across the Side Channels should be allowed for each village; there is generally no room for ramps between the canal and the side channel, and the bridges will be only a reasonable convenience; they can be constructed as minor new works, or from Local Funds, according to circumstances. The left bank of this canal is the *river embankment*, and this latter should not be less than 6 feet above the level of the flood of 1852-53, which is the highest in recent years; it is said that Colonel Haig has evidence of a much higher flood in 1818, and it might be possible to deduce the level of the water in the delta from that in the Upper Godavery. About 4 miles above Kodair the general course of the river on both sides is excellent, but the scarped banks on the right side are slipping in at many places, and the lunka here, which is wide enough, but none too wide, for safety, will soon be lost if proper measures for its maintenance be not adopted without delay. Near Kodair the river bank is in a very dangerous state; there are only a few yards of lunka left, and the stream sets against this side, there being a very extensive shoal on the other bank. Just a little above this part, there is a considerable channel between an island and the main land, and this was just being planted up with nanel, whereas every endeavour ought to be made to keep it open and rather to increase its capacity by rooting up nanel on the edge of the island. The river bank should be planted with nanel just up to the proper line and no further. I have elsewhere spoken of the necessity for charts, by the use of which it may be hoped that any decided mistakes will be avoided. The laying out of operations of this kind must on no account be left to subordinates; the Executive Engineer should lay out the work on paper, and he or one of his Assistants should lay it out on the ground; then only should subordinates carry out the planting or other work in detail. Here as elsewhere a margin of 5 yards of lunka should belong to the river banks, measured from the toe of the embankment when of full height and of proper section. Also 20 yards of the lunka next the river should be reserved as a permanent

margin; but, in laying out the ground to be made over or acquired, it will be advis-

able, where the proper line of the river is more than 20 yards outside the present line, to take up only such a

width (not less than 5 yards) of the present lunka as may be absolutely necessary for defensive purposes. I observed ploughing and planting on the slope of the river bank and on new deposits, which had barely had time to dry, and it would be useless to try to prevent these encroachments so long as the Government are not in actual possession of the river margins; the ryots recognize no boundaries riverwards, but those which the water from time to time imposes. The bank of the river itself should have a slope of 3 to 4 to 1, the whole being carefully planted with nanel; a scarped bank cannot be maintained against erosion: islands should be similarly treated, and nowhere within the embankments on either side of the river should any nanel planting by private individuals be allowed, but whatever defensive works may be required should be carried out departmentally.

17. *THE GOSTANUDDI*.—I inspected the greater part of this river above Tanuku. It is a natural line of drainage, and it also carries irrigation water. It is very winding, but it would be a very useful line of navigation were facilities afforded for tracking. Boats have not a fair chance at present, as the margin is at many places blocked by bushes, and all along there are Tooma trees on the edge. I saw a good many boats; one had come all the way from Kuldindy on the Ooputeru, and it was at Dongaypundu when the Executive Engineer and myself turned up the Yennamadurra drain. The first thing to be done, and it should be done at once, is to clear both banks completely for 5 yards from the edge, afterwards tracking paths should be laid out, and such additional clearances as may be necessary made, and after that again the infall drainages should be bridged, perhaps temporarily at first, on the line of the tow-paths, and then the river will really be useful as a means of communication. Some corners likewise may be cut off the bends with advantage when the improvements included in the completion estimates are carried out.

Gostanuddi Head Lock.—I was told that this was rebuilt in 1868; it is a pity that the details were not duly considered; the chamber is 59×12, there were only 1½ feet of water on the lower sill, though there were 2½ to 3 feet in the Gostanuddi all the way to Tanuku. The masonry is too light for lock work. Some of the gearing is not in good working order. The completion estimates provide for a new second-class lock, the lower sill of which will be placed 3 feet lower than the present sill.

18. *CHETTIPET LIME KILN*.—Here lime for the Western Delta works is prepared. The stone comes from Pungudy, a village 10 miles to the north, and due west of Rajahmundry. It is supposed to be hydraulic, but it was suggested to the Executive Engineer that it ought to be tested, especially as the description of stone varies greatly, some being full of shells, others with no apparent trace of fossils. The necessity for such an examination was afterwards clearly demonstrated, some lime from this kiln having been sent for a lock on the Cocanada canal where it was found to be a rich lime and not hydraulic at all. There are seven or eight different descriptions of limestone in use in the delta, and all ought to be carefully tested both for strength and as to whether they are hydraulic, and then the kinds best adapted to

the several kinds of work should alone be used. Engineers will generally do well to take nothing for granted; they should satisfy themselves that all materials used by them are what they appear, or are believed, to be.

19. LAND IRRIGATED.—The difficulty of obtaining information as to the area of land irrigated in the Godavery District has been already noticed, and measures have been taken to remove the uncertainty. When travelling in the Western Delta I was surprised to find that though so many years have elapsed since the anicut was built and canals constructed, no proper settlement of the area of lands previously irrigated, and therefore now entitled to water free of any additional charge, had, as regards the Nidadavole Zemindary, ever been made. I heard that Mr. Horsfall had made a report on the subject in 1868, and I have learnt* since my return to Madras that the subject is under the consideration of the Board of Revenue. Whatever may be the ultimate decision of Government in the matter, it appears to me to be necessary that the officers in charge of the delta should be furnished regularly with the area of land irrigated or requiring to be irrigated in each village of every Zemindary tract, for without this information it is impossible that the supply can be properly regulated or the distribution to the several canals correctly made. I believe the Collectors receive monthly returns of cultivation, and probably, therefore, the machinery for giving the information, for Government villages, required by the canal officers, exists; but however that may be, such information is essentially necessary for the regulation of the sluices, and it should be sent from each Government and Zemindary village alike direct to the Range Office, the statements being forwarded by lock tappal. Annually the Executive Engineers in charge of the sections of the delta should receive from the Collector's Office statements showing for each village,

* Proceedings Board of Revenue, No. 624, 29th January 1869.

- (1.) The area of first crop irrigated.
- (2.) Do. second do.
- (3.) The area of land under each crop on which water rate was charged, with the amount so levied.
- (4.) The area of land irrigated without charge.

If there are lands on which a consolidated assessment is charged, the area of these should likewise be shown.

I presume that no remissions of water rate are ever granted without the concurrence of the canal officers, and probably, when the works are completed, no applications for remissions should be received unless accompanied by a certificate from the officer controlling the water-supply who will be able to tell accurately whether there are any good grounds for the claim.

I would also recommend that the Board of Revenue should be requested to furnish a statement showing the areas of Zemindary lands cultivated in years subsequent to the construction of the anicut, and distinguishing the portions on which water rate, or assessment due to the water-supply, has been collected. The canal officers on the information furnished to them by the villagers should distribute the water available rateably, according to the acreage under each canal or branch channel.

20. EASTERN DELTA, BANK CANAL.—The completion estimate for the Bank canal required revision,* and the subject of the arrangements to be adopted was discussed with the Superintending and Executive Engineers on the spot. The particulars were noted down at the time and detailed instructions,* have since, at the Superintending Engineer's request,

* G. O. No. 2,335, dated 23rd September 1870. Note paragraph 13.

* Memorandum No. 39, 13th February 1871.

been sent to him. After going from Cocanada to Yanam, and seeing what a considerable traffic there is on the Coringa river, it appeared to me that it would be unwise to have 38 miles of navigable canal brought to within a few yards of the river and then left unconnected with it. I therefore decided that the estimates should include a tail or tidal lock, and I am of opinion that the traffic returns will justify its cost. The Kadiyapalunka lock can be retained, the upper sill being lowered 1 foot, and the navigation should be kept in its present channel, for, though there may be considerable leakage through the river bank, the worst of it would seem to be where there is no alternative channel, and with the deposit of silt, which is going on yearly on the river side, the leakage will be likely to diminish. There is no objection to such slight modification of the head of the navigation canal as will tend to keep it as far to the eastward, near the bifurcation, as can be managed. There will then be four new locks, namely:—

At Kowlaishwaram	16 miles.
Do. Kula	21 "
Do. about	30 "
Do. Yanam	38 "

The Kadiyapalunka weir is an excellent work, and with small modifications will do very well. The area of land under the Bank canal appeared to me to have been over-estimated, and the canal, which for 13 miles carries water for the Coringa canal, also will, unless my estimate should on further examination be found to need modification, be designed to carry water for 59,257 instead of 72,656 acres, the supply diminishing as branch channels are taken off. Below Kowlaishwaram the probable acreage will be 20,972. I wished very much to arrange the canal in such a way as to keep the old locks at Kowlaishwaram and Kula, which are examples of efficient works constructed with a minimum of masonry; the levels, however, did not suit, and the locks would not bear alteration, so after much consideration it appeared better to lay out the canal properly once for all.

Kula River Groynes.—Several groynes and a great deal of rough-stone pitching have been done near the lock to stop the encroachments of the river, which had proceeded so far as to endanger the canal. The work has been effectual as regards its immediate object, and what is now required is to work out to a good line on both sides of the river. As the work proceeds the stone should be taken from the rear and carried to the front, and this is one reason why pitching should be very sparingly used, as much stone is liable to be buried and lost. The use of solid stone should be restricted to the ends of long groynes, the greater part of which can be made of earth revetted, first, with mangel, and then with a yard in thickness of stone over the top and sides, with a little apron to prevent undermining.

21. CORINGA CANAL.—The *Almar lock* is near the head of this canal; its side walls require to be raised from 31.23 to 31.63 by a new coping in connection

with the revised arrangements of the Bank canal, while for purposes of regulation the following works will be needed:—

1st.—A weir for the supply of the Coringa canal.

2nd.—A sluice close to the above for the supply of the Angara channel.

3rd.—A weir for the discharge of surplus from both the Coringa and the Bank canals into the Teki main drain.

These works will render an aqueduct for the Angara channel and a weir at the head of the Teki drain in the right bank of the Coringa canal *below* the lock unnecessary.

The lock has a drop of 8.87 feet; the gearing wants attention, and the lower wings should be buttressed, as they are cracked, and care should be taken at this and all locks to maintain a good rough-stone apron at the tail bay and revetments in continuation of the wings, so that the action of the water which is often violent may not undermine or shake the walls. There is a neat little girder foot bridge over the tail bay.

Lock Weir.—Two bays of 14 feet 3 inches, divided into four by iron posts.

* Depth on upper sill of lock 5 feet 9 inches, on lower sill 2 feet 1½ inches only.

Difference of level of water* 12 feet 7 inches. This work stands very well, but three-fourths of the fall is down a

rough-stone apron at a slope of about 4 to 1.

Aqueduct 18th mile.—Mallur drain, five arches of 10 feet span each. The wings require inside and outside revetments. The side walls should have proper copings and iron railings.

Aqueduct 20th mile.—Kartair drain. All four wings are much cracked, and they must be taken down and rebuilt; the tow-path timbers are quite rotten and should be removed, and the trees growing out of the holes in which the wood work was inserted should be entirely rooted out. A coping and iron railing should be added. This aqueduct has three vents; the action of the water in the drain below the aqueduct is very violent, and both sides require to be revetted. The substructure should be examined.

Vellah Lock.—The drop is 7.98 feet; it fills in 2½ minutes, and empties in 4¾ minutes. It is in fair order; the side walls might be treated in the manner suggested (below) for the Munjair lock.

Lock Weir.—One bay of 19 feet, divided into three by iron posts. It has a light girder bridge. I think simple T iron would do very well for small foot bridges up to 15 to 20 feet span.

Munjair Lock.—This is a tidal lock with a drop of 9.91 feet. It has double culvert shutters at the upper end which revolve on a vertical axis. Two men turned one, but four were required for the other; the levers might be lengthened and doubled. Chamber filled in 2½ minutes. Lower gate valves out of repair. The chamber walls leak very considerably and the water when the lock is filled gets behind them and then spurts out on the chamber being emptied. The earth behind them should be taken out; all joints and cracks should be pointed on both faces, and two feet of puddle should be placed at the back of each wall and should be carried up to 1 foot above maximum water level. The tail bay bridge is too low. At low water the minimum depth on the lower sill is said to be 5 feet 5 inches,

but the channel below the lock is so shallow that even a range boat cannot without difficulty be got to the lock; the mud should be cleared out to the level of the sill for a width of at least 30 feet.

The Lock Weir would be the better for a water-cushion; the bridge is in the way of the shutters, which should have screw gearing. Tow-paths should be formed along the left bank of the lock channel, and along the creek by which it communicates with the Coringa river. All the bushes also should be cleared away from the banks. There is some cultivation in these swamps, and probably this would be largely increased were tide water shut out. It is said that 1,200 acres would be so irrigated. A low embankment, which will also do for a tow-path, will, with two or three outfall self-acting sluices, suffice, and the total outlay will be very small. The soil appears to be well adapted for cultivation.

Injeram Canal.—The completion estimates for this amounted to Rupees 78,600, and they were reduced by me to Rupees 28,050. The Superintending Engineer then reported* that the alteration of his arrangements would greatly add to the cost of the earthworks. He was under the impression that the existing Yerrapotharam lock was to be done away with, but this was a mistake. The reduced estimate will therefore suffice. Appended to this memorandum will be found an explanatory letter from the Superintending Engineer, and the only remark I need make is that Captain Ryves' section retained the lock.

Ventur Weir.—This weir is substantial, and has stood well a very heavy discharge. It should be retained and modified, for which provision is made in the estimate.

Yerrapotharam Lock.—This is a very good lock of its kind and is in good order. Drop, 4 feet, filled in 5¼ and emptied in 5½ minutes. The *irrigation sluice* in the right bank above the lock needs repair.

Lock Weir, three bays of 5 feet each. A very good and effective little work, which does not at all need to be replaced by a new one. At the end of this canal, which is at present blind, a dhony of about 20 tons was lying in the Teki drain, loading with paddy brought by coolies from Koyeru. The canal is a very good navigation, and the detour by the Coringa canal though considerable is by no means prohibitory. I think expenditure should for the present be confined to, raising the banks, which are in places much too low, raising the crest of the Ventur escape to 3 feet below full supply level and the wings in proportion, and any other trifling works which may be found necessary. It is my opinion, after seeing the canal, that there is no sufficient trade to necessitate the construction of a tidal lock; there will be nothing to prevent one being added hereafter should the circumstances alter.

22. *MUNDAPETTE CANAL.*—Weir 1 mile above *Thapeswaram Lock*, one bay of 20 feet. It should have a masonry cushion-wall, and shutters with screw gearing. It is otherwise efficient.

Thapeswaram Lock.—A very good kutchia lock, but the sills are much too high, and the new lock provided for in the estimates will therefore be required. The lower sill of the new lock should be + 19.00 instead of 19.50.

Lock Weir.—A very good work of 18 feet crest, divided into three by cast-iron posts. It should be retained and a masonry cushion-wall added. Only a very

* Rupees 3,070.

small amount out of the estimate* for a new weir will be required for improvements to the present work.

Pusalapudi Lock.—A kutchia lock; masonry very good and substantial; the lower gates leak a great deal, and a wooden sill-bar should be inserted. Filled in $5\frac{1}{4}$ and emptied in 3 minutes. A small sum can be spent on the improvement of

† Rupees 21,960.

this lock out of the estimate† for the new one, which is not needed.

Lock Weir.—The design and work good; it should have a cushion-wall added as the fall is heavy, and other minor improvements can be carried out; the new

‡ Rupees 3,000.

weir estimated‡ for is unnecessary. Some revetment required below both lock and weir.

The estimate for this canal amounted to Rupees 74,100. Probably Rupees

[i. e., deducting one lock and two weirs Rupees 28,030 and adding Rupees 1,900 for alterations to present weirs.

48,000] will suffice for all the improvements which are really required.

23. *SAMULCOTTA CANAL.*—*Biccavole* escape three spans of $13\frac{1}{2}$ feet each. Five

feet of water against the shutters with a full supply; this escape was unequal to the discharge of the flood waters last season, and the canal was consequently breached in several places. It will be advisable to provide additional escapes lower down as, in addition to the large inlet opposite Biccavole, there are many considerable ones which have no corresponding outlet. The Biccavole escape should have screw gearing fitted to its shutters. Proper platforms for working the shutters should also be provided.

24. *Biccavole Bridge.*—Several reports on the cracks which have appeared in this bridge have been laid before Government. The dimensions of the walls appear to me to be ample, the damage is due to the pressure of the earth behind the wings, but I consider that had not either the masonry in the foundations, or the soil on which they were built, been bad, and I am told that the latter is not the case, that pressure could not have injured the work. It is not at all creditable that this new bridge is in this state, and the only excuse for it is that the then Executive Engineer was expected, or left, to do by himself an amount of work which would have given ample occupation to two Assistants as well. Satisfactory work without competent supervision must not be anticipated. I consider that the masonry ought to be taken down and rebuilt. I dare say the walls would stand, but new works should be fairly sound and substantial and this bridge is not so. The cost of reconstruction would not be very great, as all the face stone is ready dressed, and the girders need not be taken down.

In the 28th mile there is an escape of three bays of 9 feet span each with cast-iron posts; this also should be fitted with screw gearing.

The banks of this canal all along are much less regular than they should be, and this is not satisfactory when there has been a large recent expenditure on earthworks; they ought to have been regularly sectioned.

The estimate provided for a side channel and sluices. Nothing has been done as yet towards carrying out this work, but it is a most important one, as it will supersede the numerous palmyra sluices, which are a danger to the canal as well as a cause of waste of water. The scheme was prepared by Captain Ryves, but it would appear that there was no detailed estimate, and the levels and plans of most of the sluices were burnt in the Assistant Engineer's bungalow in 1869. Captain Hasted has recently had a Surveyor placed at his disposal for taking fresh levels.

Bimaveram double lock.—This was lengthened some years ago. It has side culverts as well as gate valves, and the culvert openings into the lower chamber are under the mid sill.

Lock Weir.—This was undermined a few months ago, and it has split across the body and through the right lower wing return. As no water went over the side-wall of the Bimaveram aqueduct the water could not have risen as much as 2 feet 4 inches above full canal level, and I have therefore but little doubt that the accident was due to the bund at the further side of the weir not having been maintained at a proper level. The masonry of the weir was excellent, and the soil on which it was built as good as could be desired. I have noticed a great many places in various parts of the delta where embankments are not kept at a safe level, and Range Officers should be particularly careful to see that all such matters are properly looked after; the subordinate establishments are quite sufficient to attend to this duty, and, after proper instructions have been given, no instance of neglect should be passed over.

The accident to the weir has been attended with considerable inconvenience; it necessitated the closing of the junction canal just at the time when it was wanted for the traffic between Cocanada and Dowlasnweram, and when the closing of the Cocanada Canal for the construction of the new locks would have greatly facilitated that work. As the canal had to be closed the Executive Engineer arranged for having it thoroughly cleared, and it was to be opened as soon as possible. It is intended to provide sluices in lieu of a weir for filling the lower reach, and, in order to meet the contingency of another flood like that of the past year, Major Fischer proposes to lower the right side wall of the Bimaveram aqueduct, and to construct a water-cushion below to receive the overfall. I find that this arrangement would cost about 3,350 Rupees, and as it would afford efficient relief to the canal in heavy floods it may be adopted; a strong iron railing will be necessary to prevent risk of light boats being carried over the side wall. Care must be taken also that with 2 feet of water going over the aqueduct into the river, the lock walls have a margin of 18 inches. Good revetments are required below the aqueduct, as there are no water wings; the side walls of the water-cushion will act as water wings, and the revetments can be continued above these. The outfall channel of the aqueduct is contracted, and would be the better for clearing, which might be done with the surplus water for a few rupees.

Tidal Lock.—The upper sill is + 1.04, lower sill—7.96. The lower gates are not coppered, and they do not seem to have suffered at all. Wooden sill bars are required; the masonry wants pointing, and the wing returns should be covered by revetments and a rough-stone apron.

The estimate for the canal amounted to Rupees 1,31,000, and was framed in 1862. Afterwards in 1867 an estimate of Rupees 1,04,200 for a road along the south bank of the canal was sanctioned, and immediately after this funds for the canal were provided. It was then arranged that the two estimates should be worked out together. The road has actually been made on the north bank. The canal estimate provided 84,000 Rupees for widening, and the rates were 1½ Annas a cubic yard for silt, and 1 Anna for turning over spoil banks. Hard soil was met with and the cost has been Rupees 1,09,875; Rupees 23,415 were allowed for inlets, and the cost has been Rupees 18,125. Arches were substituted for timber platforms. For bridges overside channels Rupees 2,430 were allowed; they will cost altogether Rupees 4,800, the difference being due to the substitution of arches for timber platforms. The cutting of side channels, at an estimated cost of Rupees 15,200, has not been commenced; the sluices therewith connected were to cost Rupees 5,955, but certain alterations ordered by Captain Ryves will increase the cost to Rupees 9,050. These several particulars show that the canal estimate will be exceeded by Rupees 26,480, but to meet this increase the road will contribute, it is supposed, for—

Earthworks	4,000
Masonry	18,655
Other items	5,350
	27,005

so that the absolute increase will not be very great. The adjustments of expenditure debitable to the Canal and to the Local Fund road respectively should be carried out as soon as possible. With regard to the masonry works I will only say that I hope those about to be built throughout the delta will be much better in every way: material, design, convenient arrangements for working shutters, etc., are all less satisfactory than I should like to see.

25. COCANADA CANAL.—There is an island at the head of this canal, and the entrance is very narrow and inconvenient. In carrying out the improvements one good channel rather than two indifferent ones should be secured. This canal is to have all the old locks replaced by new first-class locks, and an additional lock is to be built to reduce the surface fall. At *Melapudi* the canal is perfectly straight, and it will be difficult on this important line of navigation to build the new lock on the present line. However, as the Samulcotta canal might be used as an alternative line until this one is needed for irrigation again, perhaps the new lock might be built, during the closure after next season's irrigation, sufficiently far to allow of the work being continued after the canal is re-opened: in this case the straight line could be adhered to. The Executive Engineer must make the best arrangements he can, and I have no doubt he will give them due consideration.

The additional lock is to be built at Thosapudi; the foundations had been taken out to a depth of 2 yards, and 5 feet more had to be excavated. About six times as many coolies as were present might have been employed with advantage on the foundations. The small quantity of lime sent down for this work is not in the least hydraulic, and without being rendered so it would be useless for the concrete

of the foundations. It came from the Chetipett kiln. The Archimedian screws used for unwatering in the Godavery do not act well; this is partly due to the inside of the cylinder being rough, indeed ribbed, and partly to the angle of inclination being too high. The pattern used in Nellore was obtained from the Godavery, and the screws made up in the former district answer admirably, so that all that appears to be necessary is greater attention to the details of manufacture at Dowlaishweram. The turn channel in connection with the new lock to be built at *Chintalapudi* was nearly ready, and the lock excavations will be begun at once; the present lock is an old and very shaky structure, and it should be superseded as soon as possible. The stone collected for the rubble masonry is not good.

The two *arch aqueduct* over the weir channel has a crack through the spandril, and it is otherwise not in good repair.

The lower gates and gearing of the *Cvoor lock* are in bad order, and, as it will be some time before the new tidal lock will be built, they should be repaired as soon as possible.

The *lock weir* is to be retained; the masonry is not as good as it should be, but the weir, with a cushion-wall, will be substantial enough.

The *best site* for the *new lock* would be at the point on the right bank a little below the present lock, where there are now a few Native mud houses, which might be bought up. I think the saving in getting in the foundations on such good soil would pay for the houses, and the alignment of the canal would be much improved.

26. GRASS RENTS.—The grass rents of the Eastern Delta amounted from the 1st April to the 31st December to Rupees 9,961-7-7; they are credited to Local Funds, but they should be devoted primarily to the conservation of the banks and banks on which the grass is grown, and to the formation and maintenance of the canal plantations. These rents belong to the canals, and they should be deemed part of the assets of the irrigation works, and should be used to make the latter more useful, convenient, and complete. So long as this is done the way in which they are in the first instance exhibited in the treasury accounts is perhaps immaterial, but, should there be any difficulty in carrying out such arrangements, such rents ought, I think, to be credited to imperial revenue as part of the canal returns. Similar remarks apply of course to the other sections of the Godavery and to the Kistna Delta.

27. ENGINEERING STAFF.—The Executive Engineer has in the Eastern Section of the delta one Assistant Engineer, Mr. Larminie. Another Assistant is much required, and will, I hope, be made available immediately, and as soon as a third Assistant Engineer can be spared I trust he will be given for the work detailed in my memorandum of the 2nd January 1871, No. 2. Young Assistant Engi-

G. O., No. 331, dated 3rd February 1871. neers are not qualified for any independent work, but they can do good service in carrying out the instructions, issued by the Executive Engineer, in an intelligent manner, and in seeing that all underground work is faithfully and properly executed. There is a great deal of important work going on, and unless the Government are prepared to hear of repetitions of such results as are shown at the Bicavole bridge, with waste of money as a consequence, and discredit and inconvenience as well, it is necessary to provide a fair amount of reliable supervision. Until this is given, the Executive Engineer should restrict his operations to work which can be thoroughly looked after.

28. CENTRAL DELTA.—The Superintending Engineer has recently submitted completion estimates for this part of the delta. My visit enabled me to go into the subject of the required improvements with the Superintending Engineer, and the modifications considered advisable will reduce materially the sum for which sanction will be asked.

29. The improvements required at the head of the delta to maintain a good approach to the head lock have already been mentioned in the memorandum marginally noted.

30. MAIN CANAL.—The main canal runs for a distance of 8 miles when it is divided into the Eastern and Western Bank Canals, and from the latter at a short distance lower down the Andalpur canal, which nearly bisects the delta, is taken off. I find that a considerable saving will be effected in the canals below if the main canal bed be lowered 1.64 feet below head sluice sill; the

bed will then be	at + 26.86
full supply level at head	32.86
do. at 8 miles	31.20
bed at do.	24.20

On the Western Bank Canal the arrangements are determined in a great measure by the Gunnaram aqueduct in the 28th mile, the floor of which is at the upper end (by scale) 13.50 and the top of the side wall 18.40. It follows then that water level at this point must approximate to 18.00, and at the 8th mile it will be, as above, 31.20; the distance is just over 19 miles, and the fall of water surface 13.20 feet. A surface fall of $4\frac{1}{2}$ inches a mile will be convenient, and then the fall in the slope of the canal will amount to 7.125 feet, leaving 6.07 feet to be provided by locking. The best arrangement seems to me to be the removal of the Ralli or head lock, the abandonment of the present Ramachendrapuram lock, and the construction of one new lock.

At or about the 15th mile with the water surface above it at	28.57
Do. do. upper sill	22.57
Do. do. water surface below	22.50
Do. do. lower sill	16.50

By this plan one instead of two new locks will suffice; from Ramachendrapuram to the Gunnaram aqueduct the arrangements will not differ materially from those submitted by Major Fischer—the water surface and bed of canal immediately below the 15th mile will each be six inches higher than he proposed, and the water surface at the upper end of the aqueduct six inches lower; there will consequently be one inch a mile more surface fall than that officer intended. The length of the aqueduct is 2,248 feet, and the Superintending Engineer allows a surface fall of two feet per mile, or of 0.85 on the aqueduct. The water level at the lower end will then be 17.15. At a short distance below the aqueduct, though that distance seemed to me much more than the half mile noted on the section, there is a nearly new and substantial kutchia lock, which was constructed to diminish the great fall which previously existed over the aqueduct, but which was not as well arranged as it should have been. The upper sill is at 9.35, and there were, on the 2nd January, 5 feet 11 inches on the upper sill, so that the water was at 15.27.

Major Fischer proposes to build a new third-class lock at this point, and to make the water surface above the lock 16.50. This level is perhaps as favourable as can be obtained under existing circumstances, but I would secure it by raising the lock walls to 18.00 from their present level of 16.52, as this will cost but little, and the masonry is, I think, quite good enough to allow of this alteration being successfully carried out. The gates will require new heel and mitre posts (probably the present ones will do for some other lock), and the cross beams will have to be respaced. Similarly, instead of building a new weir, the present structure can, if it be long enough, have its crest raised to the necessary level, and the side walls to 18.00, and with a proper water cushion and revetments it will then do very well. The lower sill of this lock is at 5.85, and the water surface was, when I saw it, at 10.68. Major Fischer's revised section gives 13.00 as the intended water level, and 6.00 as the bed level below the lock. I would substitute 11.85 and 5.85, and the water fall at the lock will then be 4.65 feet. I think it is very advisable to make this canal a through navigation. It is a very fertile part of the delta, and were a tidal lock given at or near Sakinatapilly, about the 45th mile, boats would go down the river 3 miles to the Nursapore lock, and be in communication with that large town, with the Ooputeru and the sea, and ultimately with Masulipatam. Allowing the upper sill of the tidal lock, which should be of the second-class, to be at + 0.0, the bed fall in the 17 miles from Nundapaluuka would be just over four inches a mile; the surface fall might be the same, and there will then be 45 miles of navigation with only three locks. The above is, I hope, a fairly complete outline of arrangements, which will cost much less than those included in the estimate, and which will facilitate to a greater extent the trade of this part of the delta. Unless there be some special object in placing the bed of the canal at the end (52nd mile) on a very low level, such as that — 5.50, or one foot below low water level, shown on the section, I should think it would be better to make the bed in the last 7 miles either horizontal at high water level, or at most to carry it down to mean tide level, — 2.25. I do not suppose that lands much below mean tide level will be irrigated, as their drainage would be a difficult matter. A weir might be placed either near the tidal lock, or at the tail of the canal, to discharge surplus: the former would be the better plan if there be nothing against this arrangement.

31. DRAINAGE.—No drains are marked on the sketch map in the Nuggaram island, nor is any provision made for drains in the Western Bank Canal estimate;

at the end of paragraph 23 of the Superintending Engineer's letter it is stated that the island requires no drainage works. Unless, however, there be a complete system of drainage already, a large tract of country like this can hardly fail to need some special provision for getting rid of surplus from irrigation and rain-fall, and some account should, therefore, be given of the present circumstances of this part of the delta.

32. DIVERSION 13 $\frac{1}{2}$ TO 17 MILES.—It is stated in paragraph 16 of the Superintending Engineer's letter that a very large sum* has been provided to make a diversion near the Ramachendrapuram lock, it being feared that the river, which has already encroached seriously, will work up to the present line of the canal.

* The amount is not mentioned, and it is not any where clearly shown. The earthworks, however, appear to amount to Rupees 20,650.

It appears to me that a diversion of the canal would in no way obviate the necessity for putting a stop to the encroachments of the river, and unless in the event of a failure to stop further erosion, which I do not anticipate, it will not be advisable to construct $3\frac{3}{4}$ miles of new canal. The encroachments of the river extend from opposite Polarum to near Ramachendrapuram; the severity of the set is a result of the erosion on the opposite side of the river, near Khandavelly, which has been noticed in paragraph 16 above. There is still, however, a lunka or berm of considerable width, and this will allow time for correcting the sets and diverting the current, even should the measures adopted be not entirely successful from the first. Major Fischer has been doing some nanel planting, and he has commenced a sort of palisading of palmyras; the site chosen is a good one. Without proper surveys, the arrangements for obtaining which have, however, been recently sanctioned, the details of the works cannot be accurately determined, but the following appeared to me to be likely to answer:—

1st.—The nanel planting to be pushed forward as fast as possible, the grass being planted at 8-inch intervals.

2nd.—An earthen bank or groyne core, with a solid stone nose, grass revetment, and then a yard of stone pitching all over, to be placed between the palisading and the river bank, and connected with the embankment in the usual manner. Palmyra horses to be substituted for the palisading, and to be run out in a south-east direction for 140 yards, beyond the end of the stone groyne.

3rd.—Some 300 yards below this a groyne about 90 feet long to be placed.

A third groyne a short distance below a large fallen tree.

A fourth groyne 250 yards lower down, where there are three small tooma trees close to the edge of the river bank.

4th.—There are the remains of a groyne at old Ramachendrapuram, but this was thrown out in a wrong direction; it has breached, and it has also caused a great erosion behind it, the outer part should be turned some 40 or 45 degrees down the river.

5th.—Nanel planting to be carried out wherever practicable within the line of the ends of the groynes.

Works of the nature thus sketched out will, I hope, stop all further damage, and also recover some of the ground lost. Afterwards the river must be pushed back to its proper line by degrees, the stone being advanced as the groynes are extended. The Superintending Engineer must be careful to see that the works near Khandavelly on the one side, and those between Polarum and Ramachendrapuram on the east bank, are arranged in concert.

33. AMLAPUR CANAL.—The Amlapur canal has its head on the Western Bank Canal, a short distance below the commencement of the latter. The estimate submitted by Major Fischer for improving

8½ to 40 miles. the 31½ miles of this canal amounts to Rupees 1,60,850, and is made up of the following items:—

	RS.
1. Earthworks	65,472
2. Land compensation	2,261
Contingencies	6,567

	RS.
3. Second-class Lock at Pullavella	24,000
4. Weir at do.	4,500
5. Do. Lock at Mukamala	26,000
6. Weir at do.	5,100
7. Do. Lock at Nadupudi	25,600
8. Weir at do.	5,000
9. Third-class Lock at Chintalapudi	11,100
10. Weir at do.	2,500
11. Thirteen minor head sluices from 400 to 600 Rupees each	6,250

A note at the bottom of the abstract estimate suggests that the present Pullavella lock may be altered for Rupees 500.

With the arrangements I have proposed, the bed of the canal at the 8th mile will be 24·20, and the present Pullavella lock, upper sill, at 19½ miles being 21·21, the bed fall will be 3 feet in 11½ miles, or a little over 3 inches a mile: the 7 feet depth of water at the 8th mile may be reduced to 6 for an ordinary supply at Pullavella, and the surface fall will then be 4 inches a mile, or nearly 4·10 inches, which will do very well. The maximum depth on the upper sill may be taken

at 7 feet,* and there will then be 3 feet

* Actual depth on 3rd January, 6 feet 11 inches. at the head with still-water. This lock can therefore be retained. It is an efficient lock, or would be if the gear were in proper order, but the side culvert at the upper end had not been used for a long time, because the lever, an extremely old and rotten stick, had been broken. There is a temporary bridge over the tail bay, which can be replaced by a light iron girder bridge; there is a road bridge over the canal, a short distance below the lock.

The lock weir is a long distance up the left bank of the canal; it has two bays of 10 feet each, and it is a carefully built work in good order; there were 3 feet of water on the apron, and 4½ feet on crest; it is said to be without a cut-stone apron, which, with a cushion wall, may be allowed. It can be made a perfectly efficient work at a moderate cost, and it should therefore be retained.

The lower sill of the Pullavella lock is at 14·36; the upper sill of the Mukamala lock at 26 miles is 13·36, and the bed fall in 6½ miles will therefore be 1½ feet; the surface fall may be made somewhat greater, namely, 4 inches a mile, and the water surface below the Pullavella lock will then be 21·43, and that at the Mukamala lock 19·36. This reach can then always be kept navigable as a still-water canal with a minimum depth of 4½ feet. The Mukamala lock is kutcha, but the masonry is quite serviceable; the upper gates leak a good deal, and should be put to rights, a wooden sill bar being inserted if necessary; the planks of one valve are broken; the lower gates are very free from leakage. This lock has no bridge. A small outlay will make it all that is required for efficiency. The lock weir has two bays of 15½ feet each, with two cast-iron posts to each bay; it is generally an efficient work, but the wings are very short; these may be lengthened and the shutters can be fitted with screw gear; it will then, with perhaps some minor modifications, do very well. The lower sill of the Mukamala lock is at 7·90; the upper sill of the Nadupudi lock at 29½ miles is at 7·00; the bed fall is, therefore, 0·90 in 3½ miles, or 0·24 a mile; the surface fall may be the same, as this is what is allowed in the

Superintending Engineer's section, and the water levels at the upper and lower ends of the reach will then be 13.90 and 13.00 respectively; this reach will consequently always be navigable. The Nadapudi lock is, with the exception of the gates, in good substantial order, and there is, therefore, no need of a new lock; all that is necessary to make it efficient should be provided for in the estimates. It has a foot-bridge over the tail bay. The lock weir has a crest 18 feet long with cast-iron posts; the water was running several inches deep over the tops of the posts; it is built principally of good brick masonry; it should have proper shutters with screw gearing, and a cast-iron standard will be the best way of dividing the crest into two convenient bays. Any minor improvements which may be found necessary should be also provided for, and a new weir will not then be required. The lower sill of the Nadapudi lock is at 3.00, and the upper sill of the *Chintalapudi lock*, 34½ miles, is at 2.75. I did not see this lock, and cannot therefore say whether it should be retained, or superseded by a new work, but probably a small outlay will render it efficient, as also the weir connected with it. This canal ends at a surplus weir a little below the 40th mile near Sullapilly, the crest of which is at — 2.00, full supply level being 0.00.

Masonry	rs. 1,10,050	These remarks will show that out of
Deduct minor head sluices	6,250	Rupees 1,03,800, provided in the com-
	1,03,800	pletion estimates for new locks and
		weirs, only a comparatively small sum

will be needed to make the existing works quite efficient and convenient, and the estimates should be revised accordingly. I should add that it will be advisable to construct a surplus weir at about 11½ or 12 miles to discharge into the Gorinkula drain. The ordinary depth of water in the Amlapur canal below this weir can be 6 feet, but 7 feet may be allowed as a maximum, and the embankments and other works, down to the Pullavella lock, can be arranged accordingly.

34. EAST BANK CANAL.—I did not inspect this canal, but I discussed with the Superintending Engineer its requirements. The completion estimates, as submitted, amount to Rupees 97,310, of which Rupees 66,010 are for masonry works, including one new second-class lock at the head, three locks of the third-class, four lock weirs, a surplus weir at the 43rd mile, and four minor head sluices. The

necessary arrangements are governed in a great measure by the junction canal,*

between the 22nd mile of the bank canal, and the Amlapur canal, just above the Mukamala lock. To suit this junction the water level in the Bank canal at 22 miles must be 22.16; the present *head lock* can be retained, it is katcha, but with the exception of the gates, it is in substantial order, and quite serviceable; the top of the walls is at 31.37, and, as the revised water level will be 31.20 above this lock, these walls should be raised by a coping to 32.70. The chamber is 102 × 154. New gates will probably be needed. The lock channel was being cleared, and care should be taken to place the spoil where it will be out of the way and useful in bringing the embankments to a proper level. The lock weir has three bays of 15 feet each; it is in good order, and a water cushion with shutters and screw gearing will make it quite efficient, the crest being at the same time arranged to correspond

† 31.20.

level† of the water at the lower end of the main canal. The lower sill of the lock is at 20.70, and the water surface, with

a depth of 6 feet, will be 26.70, so that the surface fall to the 22nd mile will be
Distance, 14 miles. $26.70 - 22.16 = 4.54$, or 3.88 inches a

mile, which will do very well. With these arrangements the new locks and weirs at the head and at Mandapilly, 18 miles, will be unnecessary, and, after allowing for additional earthworks, and for improvements to the present head works, the cost will be about 25,000 to 30,000 Rupees less than the arrangements estimated for. As an alternative line also, when the upper part of the Amlapur canal requires to be closed for clearances, it will be more convenient than were a third-class lock built at Mandapilly. Below the 22nd mile the Superintending Engineer has proposed third-class locks of 4.5 and 3.03 feet drops at the 25th and 32nd miles, but perhaps one lock between the 22nd mile, where the water surface will be 22.16, and the weir in the 43rd mile, where it will be 6.00, will suffice; for, out of the difference, a surface fall of, say, 5 inches a mile would absorb 8.75, leaving 7.41 for a lock; the surface fall might be made a little less if that would be more convenient with reference to the earthworks. There is no objection, I think, to a third-class lock on this lower part of the canal. All the improvements required will probably not cost more than 50,000 Rupees.

35. POLARUM ISLAND.—This is at present irrigated by the delta canals, and no provision has been made for carrying water across to it, because, in the first place, it is Zemindary, and, in the next place, it would seem that there is at present no demand for canal water. About 40 square miles would be available for irrigation, and there will be no difficulty in supplying 10,000 acres from the East Bank Canal at some future time, should the Zemindar desire to have water provided for the island.

36. BENDAMUR LUNKA CANAL.—I have not seen this canal, but from the longitudinal and cross sections it appears to be a great irregular ditch, out of all proportion to the quantity of water to be carried. As far as I can judge it would be better to construct a new canal, unless there are reasons for keeping to the present line. I notice that the distribution or water table contemplates a depth of water of 7 feet at the head, and no less depth anywhere, while in parts the depth would be over 15 feet. The width of water at surface would at the same time be so great in many places that the only plan, if the present line be kept, would be to allow no surface fall beyond that due to the draft of the sluices: with a fall of .24 feet a mile, the intended water levels could not be maintained. It will be well, I think, to have this part of the project carefully gone into by the present Executive Engineer. Bendamur Lunka is a place of considerable trade, and if the Vainteyam branch of the Godavery has a bar admitting of produce being carried by coasting vessels, the locks should be of the second-class, and not of the third-class, as estimated for. Some of the villages mentioned are not shown on the sketch map. Indapilly, where the canal crosses the line of the Cowsica drainage, is not marked. If one bank of this canal forms the river embankment, the Godavery flood levels should be shown on the longitudinal and cross sections.

37. DRAINAGE.—The proposed arrangements should be reported on in detail, in the same manner as has been done for the Eastern and Western Deltas. The estimate for drains amounts to Rupees 35,400, and provides for about 116,409 cubic yards of earthwork for widening and deepening the Sakurru drain, which it

will probably be then seen which estimate, if either, is fairly reliable. It will make some difference in the arrangements of the canals, though perhaps not a very great deal, if the additional area be more than doubled; it will make a most important difference in the returns on the completion estimates, or in other words on the further outlay contemplated, if the larger, rather than the smaller, estimate of area be adopted, and it is only right, therefore, that pains should be taken to secure accuracy. In the meantime attention should be given to those parts of the delta in which the canal banks are dangerously low, and these should be raised at once in carrying out the annual repairs; also some improvements to existing masonry works may be carried out as minor new works, so that the delay which must occur before the general improvements can be introduced may not prejudicially affect the delta. As far as I am able to form an opinion the Bendamur Lanka canal and the drainages are the works which press most for early improvement, and probably it will be practicable to render these more efficient at an outlay which could be met from Repair Funds, or from the Reserve.

(Signed) J. MULLINS, Major, R.E.,
Chief Engineer for Irrigation.

No 3/29 Jan 71 No 624.
 No 27 Sept 70 No 481 + 484
 " 14 Oct " 70 P.D. No 1
 Circular from the Chief Eng for Irrigation
 of 12 Nov 70 No 30
 No 1 Dec 70 No 115
 " 3 Feb 71 " 68 C 70
 " 7 " " 163 - 164
 Circular from the Chief Eng for Irrigation
 of 13 Feb 71 No 33
 No 13 March 71 " 319 - 322
 " 30 " " 700 - 701.

Public Works 1871 Department
 App of Govt for April
 From ~~28~~ 12 71
 The Chief Eng for Irrigation
 To The Secretary of Govt.
 W.W.D.

Dated 2nd
 Recd 20th March 1871
 Recd 21st
 N 62.

Godavery Delta
 Inspection Report.

No 1077 - 18 April 71

No 220

No 1211

Public Works Department
 No 1077
 Proceedings of the Madras Government.
 Under date the 18 April 71
 Read the following
 From The Chief Engineer for Irrigation.
 { A.E. No 62 of 2nd March 1871 }
 Ordered that the
 above Memorandum by
 the Chief Engineer for Irrigation
 be communicated to the Super Engineer of
 the 1st Division for information and guidance.
 The Super Engineer will make the usual
 application for sanction under Tools and Plant
 extraordinary for the 10 miles of rails referred
 to in para 3 of the Memorandum in the
 Government consider that

being immediately complied with, but His Excellency in Council, recognizing the necessity of providing the most effective supervision for the important works in progress or in contemplation in the Godavary District, will endeavour to afford the necessary assistance as soon as officers are available.

5. These Proceedings will be communicated to the Revenue Department for the consideration of the points referred to in paras 19, 26, 41 and 42 of the Chief Engineer's Memorandum, and

and for the issue of such instructions as may be necessary.





Do.

The Supy Engrs. 1st Div. /
Controller P. W. Secty. /
Chief Engr. for Div. /
Rev. Dept. /

Recd 22/6/71

1743
City of 1871

PUBLIC WORKS.

The City Superintending Engr.
1st Division

City

Engr.

18th April 1877.

No. 220 & 221

London Bridge. Copying or-
ders in the Inspection Re-
cord, submitted by the
Inspector for the
City of London.