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MADRAS RECORD OFFICE

GOVERNMENT OF MADRAS

Revenue DEPARTMENT

G.O. No.	2046	Press
B.P. No.		Mis.
Dated	30.8.1876	196

Not to be folded or roughly handled

No. 117-W.

No. 7. *Note by the Chief Engineer for Irrigation.*

In G.O., No. 1,250, of the 4th May 1875, certain estimates were sanctioned for the Tripatore large tank, and among the works provided for was the lengthening of the surplus weir at a cost of Rs. 4,530. This extension was completed to 18 inches below F.T.L., as intended, and on the night of the 24th August last nearly the whole of the new work was carried away, the cause of the large supply of water received by the tank being the breaching of four Government* and four Mittah† tanks. The quantity of water discharged represented a depth of 2.42 feet over the old and 4.05 feet over the new portion of the weir, and there was nothing in this to cause the destruction of the new

* Paroomapett.
Jadayanoor.
Canamanthoor.
Muddapully.
† Somalapooram.
Pitchanoor.
Papan.
Vadachee.

work had it been done in a manner suitable to the circumstances. The extension of the weir was on the same section as the old work, a section which is common in the Salem district in which rough stone is abundant. It consisted of a crest wall and a mass of packed rough stone behind it, the slope of the surface being about one in nine. The stability of a weir of this section depends upon two things:—

1st.—The complete security of the toe of the slope;

2nd.—The use of large (*i.e.*, deep) well packed stone for the surface of the slope, and though an endeavor has been made to ascertain the cause of the accident, it

To District Engineer, No. 1,005, 2nd September 1875.
From District Engineer, No. 56, 30th September 1875.
To District Engineer, No. 1,256, 22nd October 1875.

will be seen from the correspondence that no reliable evidence has been obtained. The retaining wall at the toe of the sloping apron was but 3 feet in depth,

corresponding to that of the old weir, and it was unprotected by any outer apron. It is clear that, unless the ground was very hard, this part of the arrangement was not suitable. No part of this retaining wall appears to have been left standing. On the other hand, if the surface stones of the apron were of small depth or not tightly packed, the picking out of some of the stone and washing away of the rest would be a very easy matter. The great depth to which scour reached on the failure of the work indicates that the soil was not such as to make it probable that an unprotected retaining wall at the foot of the apron would be secure.

From District Engineer, No. 56, 30th September 1875.
To District Engineer, No. 1,256, 22nd October 1875.
From District Engineer, No. 93, 12th February 1876.
To District Engineer, No. 246, 23rd February 1876.

2. The question of the best section to be adopted for the restoration of the weir and as to its site, has been fully discussed and several designs have been drawn up. The amounts of the estimate were—

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*Proceedings of the Madras Government, Public Works Department,
1st August 1876. No. 1,947.*

* Dated 11th September 1875.	1st design,* old site ...	Rs. 8,690
† Received with District Engineer's No. 93.	1st design,† new site ...	12,310
‡ Dated 26th May 1876, plans VI and VII.	2nd design,‡ old site ...	7,610

And the old site having been found to be altogether the best and most economical,

5 Vide sketch on margin of design dated 22nd September 1875. Plan marked II, and memorandum No. 246 of 23rd February.

Dated 26th May 1876.

District Engineer's No. 23 S.L., 22nd June 1876.

design now submitted for sanction has been based, and the reconstruction is reported to be in an advanced state.

3. It is to be noticed that in the important matter of copings to the crest and retaining walls the instructions given to the District Engineer have not been attended to, and as regards the crest wall it has been thought necessary to instruct the officer at present in charge of the district to ascertain whether it will be requisite either at once or after the north-east monsoon to adopt special arrangements for securing the coping stones. Should the retaining wall suffer any damage, it will be needful to cope this with concrete in the manner pointed out in memorandum No. 246, paragraph 3; 2ndly (a) (latter part), viz., with concrete *en masse*, and 1½ feet thick. The more effective arrangements suggested to the District Engineer would also have been much cheaper than cut stone, and it was principally on account of the cost of the latter material that a substitute was suggested. A cut stone coping should have been 1 foot thick, and would, it appears, have cost Rupees 824, the entry for a 6-inch coping being 412 Rupees. A concrete coping for the crest would have cost very little if anything, as the rate for concrete in foundations is Rupees 2½ a cubic yard, and the same material in coping would perhaps have been Rupees 3, and would have superseded a good deal of brickwork at Rupees 4½.

4. The need of weep holes in wall between the old and new sections must not be overlooked.

5. The delay in reporting the accident to Government has been occasioned by the difficulty of getting any information as to the cause of it from the District Engineer, Major Hunter, after the first reports, which adduced no reasonable cause, had been submitted.

6. The delay in submitting the estimate has not been explained, and, though it appears to have been completed on the 26th May, Major Hunter left it to be submitted by his successor. The instructions he received were to prepare and submit the estimate as soon as possible, which it was considered might be done within a few days of the settlement of the alignment of the work, and by the end of March at latest the estimate ought to have been sent in. The omission to attend to instructions regarding the copings, and to report for orders if there were any good reason for adopting a different arrangement, is, the undersigned considers, deserving of censure. The fact that stone had been collected is not a sufficient excuse for a radical departure from

No. 246, paragraph 4 of 23rd February.

*Proceedings of the Madras Government, Public Works Department,
1st August 1876. No. 1,947.*

instructions as to the crest wall, for this stone could not at the end of February have been dressed, and it was in its rough state of little value, so that, even if not used at all, the use of concrete would have been economical. At the retaining wall neither stone nor concrete has been used.

7. Major Hunter's supervision of the work, in the first instance, appears to have been far from efficient. In the concluding paragraph of this office No. 246, he was requested to forward the working drawing on which the extension was built and the specification. These have not been sent, and if nothing better than such sections as are shown on plan marked I, dated 22nd September 1875, were used for the purpose, it is not surprising that the real requirements were overlooked.

8. The undersigned regrets to have to make an unfavorable report on Major Hunter in this officer's absence, but there has clearly been every opportunity afforded him of explaining everything in connection with the destroyed work, and not until after he had left for England was it known that the restoration had not been carried out as intended.

9. It will be seen that measures have been taken to render safe the Government tanks above the Tripatore large tank, and that the Collector is endeavoring to get the Mittah tanks attended to.

10. It is recommended that the estimate should be sanctioned as follows:—

Ordinary Agricultural.	
Original Works.	
Reconstructing surplus weir ...	Rs. 7,257
Repairs.	
Repairing old escape ...	353

OOTACAMUND,
24th July 1876.

To the Secretary to Government, Public Works Department.

No. 246.
MEMORANDUM.
IRRIGATION.

THE undersigned has the honor in reply to the letter, No. 93, of the 12th instant, from the District Engineer, Salem, to observe that though the design for a new surplus weir for the Tripatore large tank on the alternative site might be altered so as somewhat to reduce the cost,* it is evident that 500 feet of weir at that site could not be built for anything like the sum needed to restore the damaged portion of the present weir, the length of which requiring reconstruction is 170 feet on the old line, as shown on sheet No. H, dated 22nd September 1875.

2 Estimates.
5 Plans (4 plans sent by banghy, 1 will follow).

* Estimate as designed, Rupees 12,310.

2. The undersigned has considered several arrangements of cross section for rebuilding the destroyed part of the weir at the old site. The section shown on sheet H is an expensive one and would perhaps be still more so were the spaces under the aprons filled with stone as would be necessary and the foundations of the retaining walls placed at a safe level. He has accordingly drawn a revised design on the same sheet, and he thinks this cross section is, under the peculiar circumstances of the site, coupled with the fact that cut stone is estimated to cost 23 Rupees a cubic yard, thus rendering a heavy overfall not feasible at any moderate cost, as inexpensive as possible.

3. The following specification will, it is hoped, give, with the drawing, all the information needed.

1st.—As in the original design sheet H there must be a retaining or cross wall between the old and new portions of the weir. This wall, as shown on the sheet, has rather a weak cross section. If made 1½ feet thick at top with a face batter of 1 in 6, it will do; a few small weep holes may be desirable, as this section would not stand against an accumulation of water in rear.

2ndly.—The new section may be built of the following materials:—

(a.)—The body wall above its concrete foundation and below the coping of brick in chunam or of picked rubble in chunam; the latter will be considerably the cheaper (2½ to 4½), but it will be better to use really good brick unless excellent rubble masonry can be ensured.

The retaining wall may be of either brick or rubble masonry below the coping, but stone being so expensive and it being essential that the copings of the crest or body and retaining walls should be immovable; it is thought that concrete blocks will be the best material obtainable at a moderate cost. For the crest wall coping which is 5 feet wide on the top surface, the following arrangement of blocks will be good. To form the front edge blocks 2 feet × 1 foot wide by 1½ feet deep laid with the length along the wall; then two rows of blocks 2 feet by 1 foot laid with the length along the wall last for the rear of the coping blocks 2 feet long on the upper surface, 2 feet 5 inches on the lower surface, 1 foot wide and 1 foot deep, laid transversely; all the blocks to break joint. Illustrative drawings have been shown on sheet H. At Dowlaishweram, blocks have been made which are so strong as to be difficult to break up with a heavy hand hammer. The moulds should be made of thick plank (about 1½ inches), and the sides should have double tenons passing through the end planks and secured by keys or cotters; a piece of plank detached should be used for the bottom. The concrete should be of small broken stone, of which five or six parts should be mixed with one lime about one and a half burnt clay powder, and one sand. The clay and lime (unslaked) should be mixed together, slaked, then the sand added, then mixed with the stone and immediately put into the mould, in which it should be driven down and consolidated with chunam beater's sticks. The blocks would be ready for use after being kept one month covered up in wet soil; or, if dried in the shade for three or four days, they can be placed in water for a month to harden. Another effective method of forming the coping would be to prepare the wall, as if for block coping then to fix planking on either side and place the concrete *en masse*: if well done, this plan is a very good one. After finishing off the concrete to the required level, it is essential that it be kept quite moist for at least a month: rapid desiccation of cement or mortar is fatal to the strength of all masonry.

(b.)—The curved apron may be built of either brick or rubble stone masonry in hydraulic mortar. It is to be 2 feet in thickness laid on 1 foot of concrete, and the triangular space between the lower surface of the concrete; the ground and the rear face of the crest wall is to be filled with small stone closely packed, and this may be grouted in with waste mortar and brick chips.* If rubble

* Refuses.

masonry be used, the stones must be of the required length of 2 feet or slightly more as they can be driven into the concrete, they must fit fairly well, must be most carefully bedded so that no spaces whatever may be left unfilled, and the joints on the face must be carefully pointed. If this part of the work be of brick masonry, the bricks must be good and hard, the face joints before they become hard must be raked out to a depth of half an inch, and the brick-work thereafter having first been thoroughly soaked, not merely sprinkled, with water should be plastered with hydraulic cement, which should be rubbed and kept moist for a month.

(c.)—Whatever the alignment of the crest wall, the retaining wall must be exactly parallel thereto.

(d.)—The walls must be built up foot by foot from end to end. It will be well to complete the retaining wall and the foundations of the crest wall first; next to lay the outer rough stone apron, the first 15 feet of which should be of large stone 2 feet deep closely packed and the interstices filled with small stone rammed in with crowbars.

Then the curved apron should be carried up to the level of the top of the foundations of the crest wall, and thereafter front wall and curved apron should be carried up equally until the whole is finished and ready for the coping.

(e.)—The reconstructed weir is to be at once completed to full tank level, it being necessary that the coping should be fixed before water is allowed to pass over.

(f.)—The puddle in part of the crest wall down to concrete level and the rubbish there over which rubbish may be excavated soil, refuse stone, or anything heavier than water, should be completed as shown.

(g.)—Reliable arrangements ensuring all materials required being in readiness should be made before any work is commenced. The time it will take to complete the work and the number of workmen of different kinds needed to ensure completion before the time when the tank may be expected to fill must be determined, and a trustworthy maistry should be employed continuously upon the work.

(h.)—All mixtures for mortar, concrete, &c., for each part of the work should be prescribed in writing as soon as the best proportions have been determined.

(k.)—An exact plan showing the alignment of each wall, and longitudinal sections showing the exact depth at which each part of the foundations may be laid should be prepared. Details of the way of joining the old and new work should be noted on the working drawings, or in specifications thereto attached.

4. The District Engineer has reported that he has ordered the preparation of materials.

Letter No. 93.

He can now give directions for the work to be gone on with in conformity with the above

instructions. The estimate should be prepared and submitted for sanction as soon as possible, and should not be delayed more than a few days after the alignment has been settled.

5. The District Engineer has not yet replied to the first part of this office memorandum, No. 1,256, of the 22nd October last, and he is requested to take care that as much information as possible regarding the cause of the failure of the apron and the consequent breaching of the recently constructed portion of the weir may be afforded. In his letter of the 30th September last, No. 56, the District Engineer says, that he has come to the conclusion that the failure was "owing to its section not being sufficient for the additional head at a point where the current set strongly against the new work." The trial to which the work was subjected was, however, simply that due to a depth of 4½ feet of water passing over the crest, and this of itself is not sufficient to account for the damage, and there are many weirs in the Salem district as well as elsewhere of much the same section, that is with dry stone apron at a slope of about 1 in 9½ which have stood as severe a test. Where, then, was the weakness. The sections given on sheet I,* dated 22nd September 1875, are on a

* Herewith returned.

non-natural scale, but they if correct show that

the retaining wall at the foot of the slope was only 3 feet deep, while its thickness is not determinable from the plan; that the surface stones of the apron were only 1 foot deep, and that the retaining wall was left entirely unprotected by an outer apron. If this was the exact arrangement it is not surprising that the work gave way, and it is necessary that the working drawing on which it was built and the specification should be sent up. Again, the destruction of the weir must have taken a good many hours, and probably there is information to be had as to the way in which the demolition commenced and progressed. A large sum of money has been lost by the failure, and it is of importance that the cause of the accident should be rightly understood, so that elsewhere similar sources of weakness may be avoided.

(Signed) JOHN MULLINS, Lt.-Col., R.E.,
Chief Engineer for Irrigation.

23rd February 1876.

P.S.—What has been done to the tanks which breached and caused the large discharge into the Tripatore tank since the weir was carried away should also be reported.

*Proceedings of the Madras Government, Public Works Department,
1st August 1876. No. 1,947.*

From R. E. NORFOR, Esq., Officiating District Engineer of Salem, to Lieutenant-Colonel J. MULLINS, R.E., Chief Engineer for Irrigation, dated Salem, 22nd June 1876, No. 23 S. L.

With reference to your memorandum noted in the margin,* I have the honor to submit for sanction the accompanying revised estimate for the restoration of the Tripatore large escape amounting to Rupees 7,610, with plans, sections, and specification report. The plans and estimate have been altered in accordance with

* No. 246, dated 23rd February 1876.
6 Plans.
1 Estimate.
1 Specification.
1 Copy of letter.

your instructions conveyed in No. 246 of 23rd February, with a few exceptions, which are,—
1st.—“The radius of the inverted arch forming the upper portion of the apron immediately below body;” this has been increased, in order that the top of retaining wall may be brought as far as possible level with the bed of the surplus stream, the sections given on plan sheet No. VI will make this clear.

2nd.—Concrete blocks for sill of the escape. Before the receipt of your instructions, the Range Officer had collected out stone for the sill; there being no other work in Tripatore on which this could be utilized, we are obliged to use it here in place of concrete, which certainly would have been very much cheaper.

2. I inspected this work on the 20th instant, as I thought it advisable to do so before sending up the estimate.

3. I found the body wall had been raised up to coping, with the puddle wall and rubbish in front.

4. The cross wall between old and new work was completed.

5. The retaining wall was completed to its full height, and, like the body wall, built of brick in hydraulic mortar; the advantage of an immoveable coping to the retaining wall formed of concrete laid *en masse* as suggested by you has apparently been lost sight of; this could have very well been done. I am in hopes, however, that with the hydraulic cement plaster, if carefully laid, well rubbed, and kept moist for a month, the work below it will hold. The outer rough stone apron was being laid, and nearly completed. The bricks used are of sound and good quality, and the work, as far as executed and as far as I could see, seemed good. I broke up a small bit of the body wall with the crowbar and found the mortar had set fairly well; the work should have been kept damp, which the Range Officer was instructed to see to.

6. I found a large quantity of hydraulic mortar had been prepared, nearly enough for the whole work; this had already set, and as hard as rock, and is not now of any good. The Range Officer was told to be careful not to allow this to be used. The Contractor, it is said, will be the sufferer by this.

6-A. The cut stone for the coping was being dressed; the thickness is only 6 inches, and when dressed will be barely 5, it would have been better if the stone was 9 inches thick at least, but it is too late to alter this.

7. With reference to paragraph 5 of your memorandum under reference, I beg to report that very little information can be obtained regarding the cause of the failure of this work, owing to the accident having occurred during the night. I, however, beg to submit, for your information, a copy of the Range Officer's report affording what information he can in the matter.

8. In respect to the breached tanks in the catchment basin of the large Tripatore tank, I beg to report that there are four such, viz. :—

Paroomapett.
Jadayanoor.
Canamanthoor.
Muddapully.

The thorough repairs and extensions of escapes of all these are in hand, and work of the two first tanks nearly finished, the others are in progress, and will shortly be completed. I inspected the Canamanthoor tank, and found the breaches were all closed and stone and earthwork elsewhere going on.

*Proceedings of the Madras Government, Public Works Department,
1st August 1876. No. 1,947.*

9. The four Mittah tanks which breached at the same time are the Somalapooram, Pitchanoor, Papan, and Vadachea Gounden tanks. These are still in disrepair, but the Collector is taking steps to get them repaired.

From W. C. WEST, Esq., Range Officer, Tripatore, to R. E. NORFOR, Esq., Officiating District Engineer, Salem, dated Tripatore, 6th June 1876, No. 231.

In continuation of my No. 197, dated 26th ultimo, and your memoranda marginally noted,* I have the honor to report that I endeavored to give you a correct account of the breaching of the Tripatore large tank escape in my letters, also marginally noted.†

* No. 539, dated 28th August 1875.
" 790, " 8th November 1875.
" 142, " 4th March 1876.
Nos. 124 and 125, dated 12th May 1876.

† No. 449, dated 26th August 1875 with sketch.
" 514, " 27th September 1875.
" 711, " 15th November 1875.

2. Moreover, I offered an opinion as to the cause of the failure. From these reports and what I have since observed and noted, I now

begin as requested to give you a condensed, and I hope a more complete, report on the subject.

3. It rained very heavily from 10 p.m. on the night of 24th August last till about 5 a.m. on the morning of the 25th idem. The rainfall registered at 6 a.m. on the 25th, at the Range Office, for the previous 24 hours was 6.6 inches, but most of this fell during the night.

4. On the morning of the 25th August last, the Tripatore Taluq Overseer brought me a report that the Tripatore tank had breached, I therefore started immediately to the tank, visited the Range Office on my way, checked the rain gauge kept at the office and went to the tank, where I met Mr. Benson, the Acting Head Assistant Collector, and the Tripatore Taluq Tahsildar; this was about 7 a.m.

5. I observed that nearly the whole of the new extended portion of the surplus escape, completed in the early part of 1875-76, had been washed away, and the water rushing through the breach in a torrent about 1½ or 2 feet below sill of old escape; also a great portion of the surplus from the escape overflowed the west bank of the surplus stream (which was not very high) washed away an irrigation cut, which had been completed about the same time as the escape, and swept right on to the fields of wet cultivation under the tank, causing considerable damage to both escape and fields and the local fund road from Tripatore to Alangayam. The stream could not be crossed at this time, and the traffic was temporarily suspended until the flow subsided; even then only foot passengers could scarcely walk over, through the whole of the road and ground adjacent having been strewn with the debris, silt, stones, &c., of the escape. Moreover, many days elapsed before a safe road could be made for the traffic. This road has since been diverted along the foot of the new training bank, now constructed across the diversion of the stream and crosses the surplus stream lower down. The new sluice completed in the early part of 1875-76 near the west wing-wall of the escape was in great danger of being undermined, and the whole west wing-wall also would have shared the same fate. Until the water subsided, I saw that nothing could be done. On my return home I sent you a telegram.

6. Next day when the water subsided I ordered the erection on emergency of a small ring bund across the diversion to keep the surplus (which was at this time running a foot deep) from inundating and spoiling the fields.

7. Some time afterwards I observed that the surplus overflowed its banks lower down and swept away two tunnels and a great deal of the embanked road at Vengalapuram on the road from Tripatore to Singarapet, and that the Vengalapuram anicut which was before the accident in a breached state very much shaken and to all appearances made irreparable.

8. From notes taken and observations made immediately after the breaching of the escape, I found that before the escape breached 2.42 of water passed over sill of the old portion of the escape and 4.05 over the new portion which was 1.5 feet below the former, and that 165 feet of the new extended portion had been carried away, leaving about 32 feet of the same well bonded into the old portion, also a portion of a few feet remained well bonded into the west wing-wall.

9. The cause which led to the large supply coming into the tank is that four Government and four Mittah tanks breached and emptied themselves into the Tripatore large tank. There

are thirty-five Mittah and Dusabundam, and nine Government tanks surplusing into the Tripatore large tank, and from information received afterwards I learn that only nine Mittah and six Government tanks in the Paroomapett, Tripatore, and Ponary Tripatore valleys, caused all the damage, or rather that it is the drainage from the adjacent Yalagherry hill which supplies these tanks, as very little rain seems to have fallen to the west of the railway on the night the tank breached.

10. The breach occurred at the greatest depth of the unprotected face wall; at the greatest depth (i.e., 4.05) of water passing over sill over recently constructed work, which I do believe had not properly set, and in my humble opinion I think that the cause of failure is attributable to the great pressure against the face wall (only 2½ feet broad) where the set of the current was very strong, and in consequence of there being no puddle wall or earth bank in front of it, for the greatest depth scoured out according to the levels taken immediately after is (24.10—12.19) nearly 12 feet to lower sill, and with 4 feet head of water there is 16 feet depth of water pressing against this face wall of insufficient section; is it then possible that the face wall could have stood the pressure at this place? especially so, when it is supposed that the mortar had not properly set? Again rejecting the depth of the foundations, as it is possible the face wall had not stood this great depth till after the scour, and supposing the depth of the wall to have been 9½ feet to the ground level, the section does not bear comparison with what it should have been according to the formulæ for reservoir dams. Had there been a puddle wall and a bank in front of the face wall, the pressure would not have been so great against it; in fact, I think there would have been an equilibrium of the structure with a solid puddle bank on the inside, and the sloping floor and retaining wall on the outside, and had the flooring been injured the face wall might have stood; especially so, if there was a better section of the face wall.

11. From the remarks of the Chief Engineer, I beg to report that there is no apron beyond the retaining wall of rough stone in chunam, which is 3 feet broad and 3 feet deep, level with the ground; and from these remarks I think it is possible that some of the sloping floor gave way first, and by degrees enlarged till it reached the face wall, and, through the great pressure against it, it might have burst and carried everything before it.

12. Another point I had observed was that the foundation was not taken down sufficiently deep, and through the face wall being unprotected inside, it is also possible that, through the great pressure against it, it may have been undermined.

13. All these conclusions are only inferences from notes taken and what I had observed; I may therefore be mistaken, as the escape breached in the night between midnight and the morning; and from all inquiries I have made, no one can tell me how and when it breached. It is therefore not possible to find out exactly when the failure of the extended portion commenced, and it is very difficult to ascertain precisely what portion of the work went first.

14. When I visited the escape, the stream was running 165 feet about 1½ or 2 feet below old sill of escape, and no one could cross over. Nothing of the new escape was visible, and it was only after the flood subsided that I was able to take any notes. On applying to the "Nureetty," the only man who was out very early at 4 A.M. and reported the damage, he could not enlighten me any further than what I could see for myself.

15. I have endeavored to the best of my ability and experience to give you all I know and can remember, and I respectfully beg to assure you that I have not willingly kept back any information known to me regarding the failure of the Tripatore large tank escape.

16. The four Government tanks which breached at the same time the Tripatore large tank escape was destroyed are the Paroomapett, Jadayanoor, Muddapully, and Canamanthoor tanks. The whole of these tanks have been estimated for, of which two have been sanctioned; they have been commenced on emergency, and it is expected that they will be put in thorough repair, and their escapes enlarged, before the setting in of the north-east monsoons.

17. The four Mittah tanks which breached during the same time are the Somalappooram, Pitchanoor, Papan, and Vadachee Gounden tanks; these are still in disrepair and are not in a safe condition. I beg a reference to my No. 514, dated 7th September last, in which a report had been sent regarding these tanks.

18. To save the cultivation under the tank of 1875-76, I immediately commenced after approval the construction of the training bank across the diversion and the inside bund and repairs to sluice, &c. These works are approaching completion, and I believe will prevent any more inundations, and water will be saved for this year's cultivation. The water now collected in the tank is about 3 feet below full tank level. I have also commenced on emergency the construction of the escape, according to the approved section of the Chief Engineer for Irrigation, and I expect the tank will be rendered safe in three months.

No. 14-S.L.
MEMORANDUM.
IRRIGATION.

With reference to paragraph 6-A of the letter No. 23 S L of the 22nd ultimo, from the District Engineer, Salem, the undersigned has the honor to state that a stone coping 5 inches thick is less substantial than is desirable, but it is observed from the specification that the stones are to be 5½ feet long on the bed and 1½ feet wide, and their weight will consequently be about 525 lbs. each, and, if carefully set, they may be practically immovable. Should, however, there be any doubt on this point with reference to the description of stone used and the adhesion of the hydraulic mortar thereto, or should any of the stones show a tendency to move, it will be desirable either at once or after the rains of the next north-east monsoon, according to the present state of the work and the time it would take to carry out the alteration, to obtain additional security, as follows:—

1st.—Bar iron 3 inches $\times$ ½ inch should be laid over the coping, the centre line of the bar being 10½ inches from the front edge of the coping. Holes 1½ inch diameter to be punched in the bars at 2 feet intervals, or thereabouts. Half holes being cut at ends of bars, and the intervening length equally divided.

2nd.—One inch round bar bolts 2½ feet long, with 1½ inches hemispherical heads to be prepared and at from 30 to 31 inches from the underside of the head a slot 1 inch long and ¼ of an inch wide to be cut.

3rd.—Each bolt to be fitted with a ¾ inch plate, 6 inch square, sliding freely on the bolt, and a cotter 3 inches long ¾ inch wide at one end, and 1½ inches at the other, the thickness of the cotter being slightly under ¼ of an inch.

4th.—The bars, plates, and cotters being prepared, the bars to be laid in position and the positions of the holes marked on the sub-lying masonry and coping stones (as yet of course not fixed) 1½ inch holes to be then drilled through the brickwork to a depth of 2 feet 10 inches vertically from the crest level, and corresponding holes to be cut in the coping stones.

5th.—Holes 6 inches $\times$ 4 inches to be cut in the face of the crest wall to a depth of 13½ inches, the upper edge of the hole being at 2½ feet below crest and the centre vertical line of the hole corresponding with the centre of the bolt hole, to a depth of 13½ inches.

6th.—The coping stones to be then set in hydraulic mortar, the bolts to be inserted immediately after, the 6-inch plates put over the lower end and the cotters driven in tight. The holes in the face wall to be then refilled.

7th.—The heads of the bolts to be placed at the ends of the bars may with advantage be made 1½ inches by 3½ inches and be slightly turned down at the ends to hold the bars the better.

2. It is observed that there is no coping at all to the retaining wall.

3. It is not clear from the District Engineer's letter paragraphs 3, 4, and 5 whether the curved apron has been completed to coping level in accordance with instructions given in

Memorandum No. 246, dated 23rd February 1876.

latter part of paragraph 3, 2ndly (d) latter part. Explanation on this point is requested.

4. With regard to paragraph 11 of Mr. West's No. 231 of the 6th ultimo, the District Engineer must take care that, if the ground shows any sign of erosion beyond the retaining wall at foot of sloping apron of the old weir, this wall on which the stability of that apron depends is adequately protected by heavy rough stone beyond.

22nd July 1876.

(Signed) JOHN MULLINS, Lt.-Col., R.E.,
Chief Engineer for Irrigation.

Proceedings of the Madras Government, Public Works Department,
1st August 1876. No. 1,947.

CLASS IV, CAPITAL.

Agricultural New Works.

Salem District, No. III or Tripatore Range, Tripatore Taluq. திருப்பதூர் Tripatore Village.

Class of Tank, 1st—Limits and locality, 1 mile east of Tripatore.

Abstract Estimate, No. 14 of 1876-77.

Work.—Restoration of the Tripatore large tank escape.

Quantity	Description of Work.	Per	Rate.			Amount.			Total.		
			RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
652½	Cubic yards of brick in surki mortar ...	C. yd.	4	4	0	2,773	0	0			
332½	Do. of concrete surki chunam ...	"	2	4	0	749	0	0			
396½	Do. archwork in surki mortar ...	"	5	0	0	1,984	0	0			
17½	Do. of cut stone, three line dressed in surki mortar complete ...	"	23	0	0	412	0	0			
33½	Squares of plastering, 1 coat in surki.	Sqr.	1	14	0	63	0	0			
66½	Do. do., two coats do. ...	"	2	8	0	167	0	0			
444½	Cubic yards of dry pitching with old rough stone ...	C. yd.	0	6	0	167	0	0			
300	Do. of puddling ...	"	0	3	0	57	0	0			
300	Do. of gravelling and rubbish ...	"	0	4	0	75	0	0			
220½	Do. of stone jelly (large and small) backing ...	"	0	8	0	110	0	0			
1,442½	Do. of earthwork difficult gravel soil.	"	0	1	4	121	0	0			
60	Squares of concrete pointing in surki, Baling water ...	Sqr.	1	6	0	83	0	0			
	Constructing ring bund in front of escape.					100	0	0			
3,946	Cubic yards of earthwork ...	C. yd.	0	1	2	288	0	0	7,164	0	0
37½	Do. of old stone ...	"	0	6	0	15	0	0	356	0	0
	Superintendence at 5 per cent. ...										
	Repairing the old escape.										
21½	Cubic yards of demolishing brick-work ...	C. yd.	0	8	0	11	0	0			
47	Squares of pointing with concrete ...	Sqr.	1	6	0	65	0	0			
228½	Cubic yards of removing and repacking old rough stone ...	C. yd.	0	6	0	86	0	0			
26½	Do. of brick in cement chunam.	"	4	4	0	87	0	0			
19	Squares of plastering two coats.	Sqr.	2	8	0	48	0	0	316	0	0
	Sundries ...					19	0	0	37	0	0
	Loss by an excavation on new line.										
	Total ...								7,873	0	0
	Deduct.										
350	Cubic yards of rough stone used for revetment of outside bund ...	C. yd.	0	12	0	263	0	0	263	0	0
	Total amount of estimate ...								7,610	0	0

CAMP AT HURROOR,
26th May 1876.

(Signed) W. C. WEST,
Range Officer.
(Signed) R. E. NORFOR,
Offg. District Engineer.

Proceedings of the Madras Government, Public Works Department,
1st August 1876. No. 1,947.

SPECIFICATION.

Report to accompany estimate No. 14, dated 26th May 1876, for the complete restoration of the Tripatore large tank surplus escape. Amount of estimate, Rupees 7,610.

2. Two irrigation statements showing statistics of cultivation and other particulars regarding this tank were submitted with my No. 1,028, dated 15th February 1876, and have not been returned.

3. The escape breached on the 24th August last, at the west end, to a length of 165 feet, carrying away the face wall and apron; the greater portion of the surplus water overtopped the west bank of the surplus stream, swept away an irrigation cut and bund, and inundated the fields below the tank, causing considerable damage to both escape and fields below the tank and the local fund roads from Tripatore to Alangayam and Singarapet.

4. It is now proposed to completely restore the injured portion of the escape to a length of 170 feet, according to the accompanying plan and sections Nos. VI and VII.

5. The foundation of the face wall will be built of brick-in-chunam with surki 6 feet broad and 3 feet deep, resting on a bed of concrete 8 feet broad and 1½ feet in depth for the remaining portion up to the junction of the old escape. The top of the foundations will be 9.5 feet below full tank level or sill of the old portion of escape.

6. The face wall will be built of brick in surki mortar 5 feet at bottom and 3 feet at top to the height of 9 feet having a batter of 1 in 4½ on the outside face, and above this with cut stone 5½ feet broad and ½ foot thick on a level with the sill of the old portion of escape; but the breadth of the sill on top will be 5 feet. The face wall will be plastered with one coat of hydraulic cement plaster on both sides to prevent any leakage.

7. The retaining wall will be built of brickwork in surki mortar 33½ feet from the inside edge of the face wall 3½ feet at bottom and 2½ feet at top to a depth of 6 feet between the wings, the slope being on the outside face. The top of the retaining wall will be 11.31 feet below full tank level. At the lowest point of the scour in the breach a bed of concrete will be laid below this portion of the retaining wall 5 feet broad and 1½ feet in depth to a length of 30 feet to secure a solid foundation.

8. From the inside edge of the retaining wall to the outside edge of the face wall, an inverted arch of brickwork in surki mortar will be built 2 feet thick with a radius of 41.5 feet, resting on a bed of concrete 1 foot in depth throughout. As sufficient rough stone is not available, and as more than enough of brick had been burnt, the archwork will be built of first class ground moulded bricks. The exposed surface of the inverted arch will also be plastered with two coats of surki plaster and polished. In building the inverted arch, as there will most probably be a slight settlement during its progress, it will not be bonded into the side or wing walls.

9. The vacant spaces which will be caused between the inverted arch of concrete and face wall will be filled up in layers of large and small stone jelly, gravel and bricklayers' refuse well watered and rammed.

10. The junction of the inverted arch and face wall will be well bonded and built as shown in the sections, and above this built with three line dressed cut granite stones 5½ feet long and ½ foot thick. No stone less than 5½ × 1½ × ½ will be used.

11. A side wall connecting the old and new portions of the escape will be built of brick in surki mortar 1½ feet at top and 4½ feet at bottom, and 14 feet in height resting on a bed of concrete 5½ feet broad and 1½ feet deep. The bottom of the wall will be on the side of the new portion of escape. This wall will also slope from edge of sill of new portion to foot of old escape apron, and plastered with one coat of surki plaster below the arch work, and two coats of surki plaster to all parts exposed. Similarly, another wall will be built at the west end to prevent any scour or undermining of the exposed west wing-wall foundations.

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12. Where the face wall joins the west wing-wall at the curve, the old wall will be removed and rebuilt in bond 7 feet broad and 3 feet deep in foundation, and 2½ feet at top and 6½ feet at bottom and 18 feet in height, for a length of 12 feet in foundations. All exposed portions to be plastered with two coats of surki plaster.

13. An apron of dry pitched rough stone of the largest size procurable will be built from outer edge of retaining wall at a slope of 1 in 20 upwards, 20 feet broad and 2 feet thick neatly pointed with concrete and plaster. All other hollows formed by scour beyond this breadth to be well filled up in the same way as above described.

14. A puddle wall will be built on layers in front of the face wall at a slope of 1 to 1, and another bank over this from edge of face wall at a slope of 2 to 1, formed on layers with large and small stone jelly, gravel, and rubbish well watered and rammed.

15. The junctions of old and new walls will be stopped and well bonded into one another. The junction of old apron and east wing-wall of new portion will be neatly and securely built of dry pitched rough stone and pointed.

16. A ring bund will be built in front of the breach, and another of smaller size around the work in rear, so that the work may be proceeded with without fear of accidents through floods.

17. The injured portions of the apron and face wall of the old escape requiring repairs will be attended to, and the whole of the escape put in efficient and safe condition before the commencement of the north-east monsoons.

18. *Brickwork.*—The brickwork to be laid with the best hard burnt brick, measuring 9 inches × 4½ inches × 2½ inches in surki mortar, consisting of one part of well burnt lime slaked on the spot, 1½ parts clean river sand, and 1 part of surki or newly burnt brick powder; all interstices to be well pushed up, and each course grouted, the bricks to be well soaked or saturated with water—herring bone bond for face wall foundations and English bond for all other walls to be observed throughout. Joints not to exceed ¼ of an inch if possible, and the brickwork to be kept saturated with water daily. Earth and puddle to be subsequently well rammed round the foundations.

19. *Concrete.*—The concrete to be made up of ¼ parts of fresh lime, 1½ parts clean sand, 1 part of surki, and 5 parts of broken stone and brick jelly. To be laid in six-inch layers thoroughly mixed, moderately watered and rammed.

20. *Archwork.*—The inverted arch to be neatly turned using a template; and only selected whole hard burnt brick to be used with the same kind of mortar as for brickwork with the addition of ½ part of slaked lime. The joints all to radiate correctly, not to exceed ¼ of an inch in thickness, and to be scraped out ½ an inch before being plastered.

21. *Out-stone work.*—The sill of the face wall will be paved with 6-inch granite stone slabs in surki mortar as for brickwork. Stones to be 5 × 5½ × 1½ × 6 inches fair tooled with neat close joints imbedded on a course of mortar. All stones with flaws, (sic), and faults to be rejected. The whole of the stones to be laid as headers.

22. *Plastering one coat.*—The joints of the brickwork where it should be plastered are not to be smoothed off with the face, and will be raked out ½ an inch and plastered with one coat of plaster ¼ of an inch thick, all joints to be flushed up and rubbed down to a smooth surface with wooden floats. The mortar to be made up of 1 part of fresh lime slaked on the spot, 1½ parts of clean sand, and 1 part of surki well ground together in a mortar mill.

23. *Plastering two coats.*—First coat to be as above, and the second coat to be made up of 3 parts of sifted fresh lime slaked on the spot, 1½ parts clean sand, and 1 part of surki well ground together and applied to all exposed work, and finally smoothed off and polished with an agate.

24. The stones will be tightly packed on end for apron 2 feet in depth with close joints, the interstices to be well filled up with jelly and broken stone rammed in with crowbars, the largest stones to be selected and used at the foot of the escape.

25. *Puddling.*—The puddling will be formed in one-foot layers of half gravel and half clay thoroughly wetted and consolidated into one homogenous mass.

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26. *Banking in front of Puddle.*—So soon as the puddling is completed or during its progress a bank of gravel or jelly large and small, rubbish, &c., will be formed thoroughly watered and rammed.

27. *Stone jelly backing.*—The triangular space between face wall and below inverted arch will be laid in one-foot layers of large and small stone jelly, gravel and bricklayers' refuse thoroughly watered and rammed.

28. *Earthwork.*—The excavations to be taken out according to the dimensions noted in the plan and estimate.

29. *Pointing.*—The apron will be pointed with small jelly made into concrete and plastered with two coats of plaster, and all interstices to be flushed up completely.

30. The whole of the work to be executed in a workman-like manner of the best materials procurable, and to the entire satisfaction of the Range Officer.

31. It is confidently expected that all that is necessary is provided for in the accompanying estimate, and that no supplementary works will be required hereafter.

(Signed) W. C. WEST,

Range Officer.

(Signed) R. E. NORFOLK,

Offy. District Engineer, Salem.

CAMP AT HURROOR,
26th May 1876.

MARGINAL NOTES ON SPECIFICATION.

G.O., No. 1,947, dated 1st August 1876.

Paragraph 6.—The plastering on rear face is useless, as if water gets into the wall, it had better get out again. That on front face is unnecessary, as a puddle bank in front is provided.

Paragraph 8.—The omission of bonding is approved. There ought not, however, to be the slightest settlement.

Paragraph 10.—Very much less secure than the concrete coping ordered and much more expensive.

Paragraph 11.—No mention of weep holes which were ordered and are necessary, vide memorandum, No. 246, paragraph 3.

1st, i.e., below curved apron.

Paragraph 13.—This pointing is useless.

Paragraph 15.—This will need special attention. None of the stone used should be less than 2 feet deep from the surface, at right angles to which it should be laid.

Paragraph 18.—Herring bone bond is not necessary; is more expensive and often leads to inferior work from breakage of bricks.

Paragraph 29.—What apron?

No. 8. ORDER THEREON, 1st August 1876, No. 1,947.

IRRIGATION, No. 2.
Account.

The following estimates in connection with the Tripatore large tank, Salem district, are sanctioned:—

Ordinary Agricultural.		
Original Works.		
Reconstructing surplus weir	...	Rupees 7,257
Repairs.	...	
Repairing the old escape	...	353

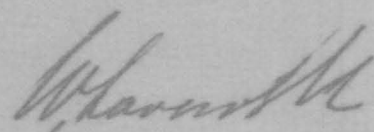
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These sanctions have been registered as Nos. 88 I & 89 I of 1876-77.

2. The papers submitted with the estimates indicate that the work of extending the surplus weir, sanctioned in G.O., No. 1,250, of the 4th May 1875, was not properly carried out, while the instructions given to Major Hunter for the reconstruction of the work have in some important particulars not been attended to, and this work has been nearly completed without any estimate having been until now sanctioned. Major Hunter on his return from furlough will be called upon for explanations.

3. The present Officiating District Engineer will report what amount is required to cover the expenditure of the current year under Original Works, and whether this sum can be provided out of the District grant for Minor New Works.

(True Extract.)



Colonel,

Offg. Under Secy. to Govt., P.W.D.

To the District Engineer, Salem.

- „ Collector of do.
- „ Chief Engineer for Irrigation.
- „ Examiner of Public Works Accounts.
- „ Revenue Department. ✓

Ed. E. C. Shunker.

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Govt. of 1876; Madras.

PUBLIC WORKS.

✓
To THE DISTRICT ENGINEER,

SALEM,

cc. cc. cc.

Dated August 1st.

Issued

Recd.

25th

Encl.

G. O., 1st August 1876, No. 1,947.

AUGUST.

Nos. 7-8.

Tripatore large tank, Salem District.—
Passing orders on Note by the Chief Engineer for Irrigation submitting with remarks estimates, amounting to Rupees 7,610, for certain repairs to the —

Communicated to the
G.O.

20 August 1876

11th Dec. 1876
11th Dec. 1876
11th Dec. 1876