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Government of Madras

Public Works. DEPARTMENT

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Dated 13. 5- 1873.

Not to be folded or roughly handled

Proceedings of the Madras Government, Public Works Department, *13th May* 1873.

No. 164. Read the following letter from Captain H. W. WOOD, R. E., Officiating District Engineer, Malabar, to Colonel G. W. WALKER, R. E., Secretary to Government, Public Works Department, dated Camp at Cochin, 28th April 1873, No. A:—

I HAVE the honour to submit the following report on the operations carried out up to date on the work of closing the Cruz Milagre Gap at Cochin.

2. G. O., dated 19th December 1872, No. 3,016, was communicated by me, on 4th January 1873, to the Officer in charge of the Cochin and West Coast Canal Range, and Mr. Grimes commenced work at the gap on the 23rd January, in conformity with the approved project. I visited the work in February and found that as the first sand-bag groyne was being projected into the gap, the expectations expressed in paragraph 2 of the letter of the Superintending Engineer, No. 45, dated 8th June 1872, to the address of the Secretary to Government, Public Works Department, were being realized. At the time of my visit about three-fifths of the groyne had been completed, and a spit of sand was being deposited on the sea-face of the groyne, concurrently with its advance into the gap. On the completion of the groyne, however, this spit of sand did not project, as was anticipated, beyond the head of the groyne. It is to be remembered that this sand-bag groyne was situated in deeper water than the experimental groyne was, and was besides exposed to stronger currents at its head, in consequence of the water-way of the gap having been diminished *pro tanto* by its construction. It is possible that had sufficient time been allowed the spit of sand would eventually have formed to the extent anticipated by Colonel Farewell in the paragraph of his letter already referred to. However that may be, in default of a proper base having immediately been obtained from which the second sand-bag groyne could be projected, and in consideration of the limited time at our disposal for executing the work of closing the gap, Mr. Grimes, with my entire approval, constructed a return of sand-bags, 55 feet in length, at right angles from the head of the groyne running seawards. The sand-bag return was constructed by placing sand-bags along the bottom of the gap in a line joining the head of the completed groyne, and the point from which the construction of the second sand-bag groyne was to commence. Sand was intercepted by this line of bags, and on the deposited sand a second line of bags was placed slightly within the first line. This second course of bags in turn intercepted a second layer of sand, and the work was continued in this manner until the return reached such a height as allowed of its being built up regularly with bags. Having thus reached the point from which the second sand-bag groyne was to be commenced, a line of sand-bag wall was carried back from thence, some little distance in the direction of the point whence the construction of the first sand-bag groyne had commenced. This wall materially hastened the deposition and retention of the sand-spit upon which the second sand-bag groyne was to be based.

3. The second sand-bag groyne commenced in 18 feet of water, and has been successfully completed in a depth of 24 feet of water. Precisely as the anticipated effect of the first sand-bag groyne fell short of what was realized by the experimental stone groyne, so the anticipated effect of the second sand-bag groyne has fallen short of what was realized by the first sand-bag groyne. The sea flank is

being gradually silted up, but at a slower rate than the silting up of the first sand-bag groyne took place, and the causes are, I think, obvious.

4. A comparison of the average depths to be silted up and the water-way of the gap, in the three cases, respectively shows:—

1st.—In the experimental groyne an average depth to be silted up of 9 feet, and a water-way in the gap of 700 feet.

2nd.—In the first sand-bag groyne an average depth to be silted up of 12 feet, and a water-way in the gap of 420 feet.

3rd.—In the second sand-bag groyne an average depth to be silted up of 21 feet, and a water-way in the gap of 300 feet.

5. It is manifest in the third case, where the head of the groyne is situated in the deepest part of the gap, enormous obstacles offer themselves to the deposition and retention of a sand-bank on the sea-face of the groyne. Such deposition of sand is, however, certainly taking place (though slowly), and the principle on which this project of closing the gap was grounded is in full operation. I have little doubt that immediately a second sand-bag return is commenced to be constructed from the head of the second groyne at right angles and seawards, the spit on the flank of the second groyne will rapidly increase and be consolidated. The construction of this second return will no doubt be a more difficult matter than that of the first was, but I have every hope of its successful construction under Mr. Grimes' superintendence. If it does succeed, a spit of sand will have been gained which will narrow the gap to 180 feet.

6. Some of the records of the soundings of the gap (which are taken twice daily) placed me under the apprehension that the revetment and southern bank of the gap had commenced to give way under the increased current due to the great contraction of the water-way of the gap. This apprehension I found, from soundings taken in my presence, to be groundless, as the recorded soundings alluded to were unreliable and erroneous. No displacement whatever has taken place at the point on which the most destructive action occurs. In accordance with my request, Mr. Grimes, a month ago, added a quantity of stone to these defences, and I have again directed his best attention to this most important point, and have desired him to keep 500 sand-bags always ready filled to provide for any emergency. I think it however a happy augury that the contraction of the water-way has had no ill effect of the kind referred to up to this date. From watching the tides constantly and daily, Mr. Grimes is of opinion that the ebb-current is now thrown much more on the eastern flank of the southern limit of the gap, and if this be the case the danger of the southern defences of the gap being carried away will day by day diminish. When the second sand-bag return, at the head of the second sand-bag groyne, has been completed, the question of attempting to close the gap entirely must be immediately settled. As already stated, though the construction of this return will, I think, be successful, the work will be a difficult and a very tedious one, owing to the great depth of sand which must be deposited to complete the spit on the sea flank of the second groyne. If Mr. Grimes completes the return within the 15th day of May, I would recommend the third groyne should be constructed. Every sand-bag placed in this groyne will take the work into shallower water, and we may reasonably expect

the ebb-current to be deflected almost entirely on to the eastern flank of the southern limit of the gap. There will thus be less action seawards on the head of the groyne, and the sand at the head of the forming spit will be less exposed to erosion. Again, in consequence of the proximity of the southern limit of the gap, and the fact of the groyne advancing into shallower water concurrently with its progress, that southern limit will, to a great extent, act in the same way as the sand-bag returns constructed at the head of the first and second groynes.

7. It is impossible of course to speak with certainty, but I have great hopes that, with the construction of the third sand-bag groyne, the work of closing the gap may not improbably settle itself without any further intervention on our part. A reference to the tracings of the plan and sections of the gap now sent, showing the work already executed and the position of the second return and third groyne, both of which still remain to be executed, will show the grounds on which I venture to entertain these hopes.

8. If unfortunately the construction of the second sand-bag return should prove to be a more difficult and tedious a work than is even anticipated, and if no time remains for completing the closing of the gap before the monsoon sets in, the spit of sand gained by the second sand-bag groyne and its return should be strongly revetted with sand-bags, and made good against the attacks of the sea. It is satisfactory to note that if this course is necessitated, the gap is now in such a position as is sheltered to a great extent from the monsoon rollers by the stone groyne P, which is the northernmost of the defences of the strip of beach between Cruz Milagre and Vypeen Point.

9. Having described the engineering aspect of the work, I will now proceed to explain its financial state. With his letter No. 246, dated 24th February 1872, the Superintending Engineer, 7th Division, submitted an estimate, amounting to Rupees 15,277, for closing the Cruz Milagre Gap, etc. This estimate was sanctioned, but in April 1872 the mode of closing the gap which had been approved, and for the execution of which this estimate had been sanctioned, was abandoned, and in his letter No. 45, dated 8th June 1872, (recorded in Proceedings of Government, Public Works Department, 24th July 1872,) the above named officer made another proposal that the Cruz Milagre Gap should be closed by a series of sand-bag groynes constructed *en echelon*; and this project is now in course of execution. Colonel Farewell remarked in paragraph 3 of the letter last referred to, that the estimate, amounting to Rupees 15,277, which had previously been sanctioned for closing the gap, "will probably be more than sufficient for the work to be carried out in the manner I (now) propose, but including the cost of the protective works rendered necessary by deferring the work till after the monsoon, I think the whole amount will be required, and request it may be sanctioned; to submit a correct estimate for so new and experimental a work is next to impossible." It will be noted this letter bears date 8th June 1872, the monsoon had then just set in, and it was impossible to predict what changes might take place in the position of the gap, or what further protective works might become necessary to be executed, in order to preserve such ground as had already been gained and to prevent the gap being cut any deeper. The effect which the monsoon had upon the gap was explained by Colonel Farewell to Government in his letter

No. 174, dated 30th October 1872, recorded in Proceedings of Government, Public Works Department, 19th December 1872. He noted that unremitting attention had been found to be necessary to prevent the extension of the gap, and that a great number of sand-bags had been expended on the work. He also stated that "no change in the dimensions of the gap had taken place."

10. As regards this latter statement there appears to have been some misunderstanding. The section taken in November 1872, supplied by Mr. Grimes, shows that the perimeter of the gap on the north side had sunk to some considerable extent, and that the sectional area of the gap had materially increased. Mr. Grimes, on my referring the discrepancy to him, explains that he understood Colonel Farewell's inquiries on this head to apply merely to the position of the sand-bag lining of the deepest part of the gap and that his report was intended to be to the effect that this sand-bag lining was intact and unchanged. Mr. Grimes appears to have omitted to bring under Colonel Farewell's notice the increased size of the gap as shown on the section of 15th November 1872. However the mistake arose; it is manifest that the effect of the monsoon on the gap was to enlarge its section materially, and to increase considerably the quantity of work required to be executed in order to close it permanently.

11. With his above-mentioned letter Colonel Farewell submitted a statement marked B, Item 2 of which showed the expenditure which had been incurred on the necessary protective works to the gap during the continuance of the monsoon of 1872. That statement is not in the records of my office, but I found from the Progress Reports of the West Coast Canal and Cochin Range that this expenditure was as follows :—

	RS.	A.	P.
In May	1,272	1	9
,, June	2,299	13	10
,, July	2,846	3	11
,, August	*Nil.*		
,, September	292	8	9
Total ...	6,710	12	3

12. To the above sum must be added the expenditure incurred for the same purpose subsequent to the date of Colonel Farewell's letter, viz. :—

	RS.	A.	P.
In October	179	8	8
,, November...	396	6	5
,, December...	21	14	10
Total ...	597	13	11

making the whole expenditure on protective works executed to the gap amount to the sum of Rupees 7,308-10-2. Deducting this from the sanctioned estimate of Rupees 15,277, a balance of Rupees 7,969 nearly was left available for executing the work of closing the gap.

13. The actual expenditure up to date has been largely in excess of this sum, and I will now proceed to enumerate the causes of this excess. In the first place it should be remembered that Colonel Farewell in a letter already quoted informed the Government that "it was all but impossible to submit a correct estimate" for the work. I find it difficult, from a careful perusal of the correspondence on the subject, to specify what the amount was within which the Government considered the expenditure would be restricted. However I cannot suppose any authority concerned thought the work would be completed within the sum of Rupees 8,000.

14. The gap which required to be closed was in a full tide-way, having a breadth of 420 feet and an average depth of 18 feet. The experimental stone groyne which had been previously carried to a length of 200 feet in an average depth of 9 feet of water was constructed when the waterway of the gap measured 700 feet across from bank to bank. This groyne, which cost Rupees 120 per foot, was thus easily constructed in tolerably shallow water, and in a situation which, owing to the great water-way of the gap, was sheltered from the full action of the ebbing and flowing tides. The sand-bag groynes, on the other hand, had to be constructed in a considerably greater depth of water, a circumstance which entailed the expenditure of an enormous quantity of material; being besides exposed to an increased action of the flowing and ebbing tides, much settlement took place, and the quantity of material expended was thus considerably augmented. The average depth of water in which the first sand-bag groyne had to be constructed was 12 feet; that of the second was 21 feet; and as the groynes progressed in length into the deeper water, and the gap was concurrently narrowed, the detrimental effect of the tides was increased and frequent slipping had to be made good by the expenditure of a further quantity of sand-bags. In order to procure a proper sectional base for the groynes, it was necessary to pitch the sand-bags into the water, and allow this mass to assume a natural slope, having recourse only to built work in courses, when the depth at low tide allowed men to place the bags regularly from that stage to a height of 4 feet above high water mark.

15. It was to be expected that the number of sand-bags used in constructing the groynes under such conditions would be very large, and the circumstances of the sand, not following the projection of the groynes into the gap (so fast as, or to the extent which, was anticipated), and of the necessity which arose for constructing a sand-bag return at the head of the groyne in order to furnish a firm base, from which the projection of the second groyne might be commenced, both added besides most considerably to the expense of the work which has been executed. The expenditure on the first groyne, the return and the second groyne has been respectively Rupees 5,860, Rupees 1,330, and Rupees 8,400, or in all an expenditure of Rupees 15,590. The cost per foot of these works has thus respectively been Rupees 58-⅗ Rupees 24-¼ and Rupees 84, and they have been built in average depths of a full tide-way of 12, 18, and 21 feet respectively. From the above data I calculate the second return will cost Rupees 60 per foot, or a sum of Rupees 3,300, and the third groyne Rupees 70 per foot, or a sum of Rupees 7,000. Adding 50 per cent. nearly for contingencies I suppose the work should be completed for, say, Rupees 15,000, in addition to the sum already spent, which is about Rupees 7,550 in excess of the funds already allotted. The amount requiring to be allotted for completing the work will therefore be Rupees 22,550.

16. This sum appears to be a large one, but I am bound to say I cannot find Mr. Grimes has not conscientiously superintended the expenditure already

incurred on which this estimate is founded. The items of the expenditure are but three :—

1*st.*—Sand-bags which have been procured from leading houses both on the East and West Coasts, as well as in the Cochin bazaar. The prices were generally high, being on the average Rupees 29-5-6 per hundred. But it is to be remarked we have been obliged to procure them at a season of the year when there is the greatest demand for them, and we had no option but to buy.

2*nd.*—Cost of filling bags with sand, sewing up their mouths, loading them on carts, conveying them with a lead of from 200 to 350 yards to the groyne, and building them in a sea-way of depths before mentioned. This is a difficult charge to check, and Mr. Grimes tells me it comes to 1 anna 4½ pies per bag, which price does not seem out of the way.

3*rd.*—Cost of plant and sundries, which does not reach 4 per cent. on the expenditure of the first and second items.

17. The further expenditure required to complete the work may be stated at Rupees 15,000 as has already been mentioned. About Rupees 3,300 of this will be required for the second sand-bag return, and if it is decided to defer the closing of the gap, about Rupees 1,700 in addition to the last named sum will probably be required to make the flanks of the gap safe. In this case, therefore, Rupees 5,000, in addition to the excess expenditure already incurred, viz., Rupees 7,550, or a sum of Rupees 12,550 will require to be allotted for the works.

No. 165. ORDER THEREON, 13th May 1873, No. 1,323.

CIVIL WORKS, No. 7.

His Excellency the Governor in Council cannot but conclude that the project of closing the Cruz Milagre Gap has been jeopardized by needless delay in acting on the sanctions accorded by Government.

2. In ordering that the estimate of Rupees 15,272 for carrying out that work should be re-submitted shortly before Lieutenant-Colonel Farewell proposed to undertake it, which "presumedly would not be later than January 1873," (*vide* G. O., No. 1,125, of 2nd May 1872,) it was not intended thereby that he should be precluded from exercising his discretion as to the date of commencing the work so as to insure its completion before the ensuing monsoon. And as that estimate was finally sanctioned, after further report, by G. O., No. 1,757, of 24th July, and Lieutenant-Colonel Farewell, under date the 30th October 1872, reported his opinion that the work might be proceeded with in November or December, His Excellency the Governor in Council is disappointed now to learn that no action whatever was taken till the 23rd January 1873, with the result of throwing the work unfinished into the monsoon of 1873, which should have been avoided.

3. Earlier action by the Superintending Engineer would have enabled the District Engineer to report at an earlier date what he has now submitted for information of Government, from which His Excellency the Governor in Council is led to believe that the procedure by means of groynes *en echelon* has not been nearly so effective as was anticipated, and has proved practically a more expensive and less efficient method of closing the gap than would have been a sand-bag dam directly across the gap, well secured on the flanks and raised gradually from the bottom.

4. Much must be left to the discretion of the District and Inspecting Engineers, but it would appear that on completion of the second sand-bag return, sand-bags should be deposited in a direct line between its end and the nearest point of the opposite shore so as to shallow the gap as quickly and directly as possible.

5. Such excess outlay as may have been incurred last official year, and understood by the District Engineer's letter to be about Rupees 7,550 cannot now be especially appropriated, but will appear in the accounts as an excess. Provision of the Rupees 15,000 stated as necessary to complete the work will be considered in the Financial Department.

(True Extract.)

(Signed) G. W. WALKER, Colonel, R.E.,
Secretary to Government.

To the Inspecting Engineer for Ports and Communications, with ~~eight~~ three Tracings.
,, Marine Department.
,, Financial do.
,, Controller of Public Works Accounts.
,, District Engineer, Malabar.

Exd S. T. Austin.

No. A.

District Engineer's Office
Camp Cochin 28th Ap. 1873

From, The District Engineer of
Malabar
To, The Chief Engineer P.W.D.
Madras.

Sir,

I have the honor to submit the following report on the operations carried out up to date, on the work of closing the Cruz Milagre Gap at Cochin.

G.O. dated 19th December 1872, No 3016 was communicated by me on 4th January 1873, to the officer in charge of the Cochin and West Coast Canal Range and Mr Grimes commenced work at the Gap on the 23rd January, in conformity with the approved project. I visited the works in February and found that as the first sand bag groyne was being projected into the Gap, the expectations expressed in para 2 of the letter of the Superintending Engineer, No 445 dated 8th June 1872, to the address of the Secretary to Govt. P.W. Dept. were being realized. At the time of my visit about $\frac{3}{5}$ of the groyne had

been

completed a spit of sand was being deposited on the sea face of the groyne, concurrently with its advance into the gap. On the completion of the groyne however, this spit of sand did not project, as was anticipated, beyond the head of the groyne. But be remembered that this sand bag groyne was situated in deeper water than the experimental groyne was, and was less exposed to stronger currents at its head; in consequence of the water way of the gap, having been diminished proportionately by its construction. It is possible that had sufficient time been allowed, the spit of sand would eventually have formed to the extent anticipated by Colonel Forrest in the [illegible] of his letter already referred to. However that may be, a default of a proper bed having immediately been obtained from which the second sand bag groyne could be projected, and in consideration of the limited time at our disposal for

for executing the work of closing the gap; Mr Guines with my entire approval constructed a return of sand bags, fifty five feet in length, at right angles from the head of the groyne running seawards. The sand bag return was constructed by placing sand bags along the bottom of the gap, in a line joining the head of the completed groyne, and the point from which the construction of the second sand bag groyne was to commence. Sand was intercepted by this line of bags, and on the deposited sand, a second line of bags was placed, slightly within the first line. This second course of bags in turn intercepted a second layer of sand and the work was continued in this manner, until the return reached such a height as allowed of its being built up regularly with bags. Having thus reached the point from which the second sand bag groyne was to be commenced, a line of sand bag wall was carried back from thence, some little distance in the direction of the point whence the construction of the first sand bag groyne had commenced. This wall materially hastened the deposition and retention of the sand spit, upon which the second sand bag groyne was to be based.

The second sand bag groyne was commenced in eighteen feet of water, and has been successfully completed in a depth of twenty four feet of water. Precisely as the anticipated effect of the first sand bag groyne fell short of what was realised by the experimental stone groyne; so the anticipated effect of the second sand bag groyne, has fallen short of what was realised by the first sand bag groyne. The sea flank is being gradually silted up, but at a slower rate than the silting up of the first sand bag groyne took place, and the causes are I think obvious.

A comparison of the average depths to be silted up and the water way of the gap, in the three Cases, [illegible] perhaps, shows;

1st In the experimental groyne, an average depth to be silted up of nine feet,

and a water way in the gap of seven hundred feet.

2nd In the first sand bag groyne, an average depth to be silted up of twelve feet and a water way in the gap of four hundred and twenty feet.

3rd In the second sand bag groyne, an average depth to be silted up of twenty one feet and a water way in the gap of three hundred feet.

It is manifest in the third case, where the head of the groyne is situated in the deepest part of the gap, enormous obstacles offer themselves to the deposition and retention of a sand bank on the sea face of the groyne. Such deposition of sand is however certainly taking place (though slowly), and the principle on which this project of closing the gap was grounded, is in full operation. I have little doubt that immediately a second sand bag ~~groyne~~ return is commenced to be constructed, from the head of the second groyne at right angles and seawards; the spit on the flank of the second groyne will rapidly increase and be consolidated. The construction of this second return will no doubt be a more difficult matter, than that of the first was; but I have every hope of its successful construction, under Mr. Grimes' superintendence. If it does succeed, a spit of sand will have been gained which will narrow the gap to one hundred and eighty feet.

Some of the records of the soundings of the gap (which are taken twice daily) placed me under the apprehension that the revetment and southern bank of the gap, had commenced to give way, under the increased current due to the great contraction of the water way of the gap. This apprehension, I found from soundings taken in my presence to be groundless; as the recorded soundings alluded to were unreliable and erroneous. No displacement whatever has taken place, at the point on which the most destructive action occurs. In accordance with my request, Mr. Grimes, a month ago, added a quantity of stone to these defences, and I have again directed his

best

best attention to this most important point, and have desired him to keep five hundred sand bags, always ready filled to provide for any emergency. I think it furnishes a happy augury that the contraction of the water way, has had no ill effect of the kind referred to, up to this date. From watching the tides constantly and daily Mr. Grimes is of opinion that the ebb current is now thrown much more, on the eastern flank of the southern limit of the gap; and if this be the case, the danger of the southern defences of the gap being carried away, will day by day, diminish. When the second sand bag return at the head of the second sand bag groyne has been completed, the question of attempting to close the gap entirely must be immediately settled. As already stated, though the construction of this return will I think be successful, the work will be a difficult and a very tedious one, owing to the great depth of sand which must be deposited to complete the spit on the sea flank of the second groyne. If Mr. Grimes completes the return within the fifteenth day of May, I would recommend the third groyne should be constructed. Every sand bag placed in this groyne will take the work into shallower water, and we may reasonably expect the ebb current, to be deflected almost entirely on to the Eastern flank of the Southern limit of the gap. There will thus be less action seawards, on the head of the groyne, and the sand at the head of the forming spit, will be less exposed to erosion. Again in consequence of the proximity of the Southern limit of the gap, and the fact of the groyne advancing into shallower water concurrently with its progress; that southern limit will to a great extent act in the same way, as the sand bag returns constructed at the head of the first and second ~~and third~~ groynes.

It is impossible of course to Speak

Speak with certainty, but I have great hopes that with the construction of the third sand bag groyne, the work of closing the gap may not improbably settle itself without any further intervention on our part. A reference to the tracings of the plan and sections of the gap now sent, showing the work already executed and the position of the second return and third groyne, both of which still remain to be executed, will show the grounds on which I venture to entertain these hopes.

If unfortunately the construction of the second sand bag returns, should prove to be a more difficult and tedious a work than is even anticipated and if no time remains for completing the closing of the gap before the monsoon sets in; the spit of sand gained by the second sand bag groyne and its return, should be strongly revetted with sand bags and made good against the attacks of the sea. It is satisfactory to note that if this course is necessitated, the gap is now in such a position, as is sheltered to a great extent from the monsoon rollers, by the stone groyne P. which is the northernmost of the defences of the strip of beach, between Cruz Mila-gre and Vypeen Point.

Having described the Engineering aspect of the work, I will now proceed to explain its financial state. With his letter No 266 dated 24th Feby 1872, the Superintending Engineer 7th Circ submitted an Estimate, amounting to Rs 15277 for closing the Cruz Milagre gap &c. This Estimate was sanctioned, but in April 1872 the mode of closing the gap which had been approved, and for the execution of which this Estimate had been sanctioned was abandoned and in his letter No 445 dated 8th June 1872 (recorded in Proceedings of Government P.W.D. 24th July 1872) the above named officer made another proposal that the Cruz Milagre gap, should be closed by a series of sand bag groynes, constructed En Echelon. And this project is now in course of execution. Colonel

Colonel Farewell remarked in para 3 of the letter last referred to, that the Estimate amounting to Rs 15277/ which had previously been sanctioned for closing the gap; "will probably be more than sufficient for the work to be carried out in the manner I (now) propose, but including the cost of the protective works rendered necessary by deferring the work, till after the monsoon, I think the whole amount will be required and request it may be sanctioned — to submit a correct Estimate for so new and experimental a work is next to impossible"

It will be noted this letter bears date 8th June 1872, the monsoon had then just set in and it was impossible to predict what changes might take place in the position of the gap or what further protective works might become necessary to be executed, in order to preserve such ground as had already been gained and to prevent the gap being cut any deeper. The Effect which the monsoon had upon the gap, was explained by Colonel Farewell to Government, in his letter No 174 dated 30th October 1872 recorded in Proceedings of Govt. P.W.D. 19th December 1872. He noted that "unremitting attention had been found to be necessary, to prevent the extension of the gap, and that a great number of sand bags had been expended on the work. He also stated that "no change in the dimensions of the gap had taken place".

As regards this latter statement, there appears to have been some misunderstanding. The section taken in November 1872 supplied by Mr Grimes, shows that the perimeter, of the gap on the North side, had sunk to some considerable extent, and that the sectional area of the gap had materially increased. Mr Grimes on my referring the discrepancy to him, explains that he understood Colonel Farewell's enquiries on this head, to apply merely to the position of the sand bag lining at the deepest part of

the

the gap and that his report was intended to be to the effect that this sand bag lining was intact and unchanged. Mr Grimes appears to have omitted to bring under Colonel Farewell's notice, the increased size of the gap, as shown in the section of 15th Novr 1872. Howsoever the mistake arose, it is manifest that the effect of the monsoon on the gap, was to enlarge its section materially, and to increase considerably the quantity of work required to be executed, in order to close it permanently.

With his above mentioned letter Colonel Farewell submitted a Statement marked B. Item 2 of which showed the expenditure, which had been incurred on the necessary protective works to the gap, during the continuance of the monsoon of 1872. That statement is not in the records of my office, but I found from the progress reports of the W.C. Canal and Cochin Range that his expenditure was as follows:

In May .. Rs 1272—1—9
" June .. " 2299—13—10
" July .. " 2846—3—11
" August " Nil
" September " 292—8—9

Total Rs 6710—12—3.

To the above sum must be added the expenditure incurred for the same purpose, subsequent to the date of Colonel Farewell's letter, viz

In October -- Rs 179—8—8.
" November — 396—6—5
" December — 21—14—10

Total Rs 597—13—11

making the whole expenditure on protective works executed to the gap amount to the sum of Rs 7308—10—2. Deducting this from the sanctioned estimate of Rs 15277 a balance of Rs 7969 nearly was left available, for executing the work of closing the gap.

The actual expenditure up to date has been largely in excess of this sum, and I will now proceed to enumerate

enumerate the causes of this excess. In the first place it should be remembered, that Colonel Farewell in a letter already quoted, informed the Government, that "it was all but impossible to submit a correct estimate" for the work. I find it difficult, from a careful perusal of the correspondence on the subject, to specify what the amount was, within which the Government considered the expenditure would be restricted. However, I can not suppose any authority concerned, thought the work would be completed within the sum of Rs 8000.

The gap which required to be closed, was in a full tide way, having a breadth of four hundred and twenty feet and an average depth of eighteen feet. The experimental stone groyne which had been previously carried to a length of two hundred feet, in an average depth of nine feet of water; was constructed where the water way of the gap measured seven hundred feet across from bank to bank. This groyne which cost Rs 120 per foot, was thus easily constructed in tolerably shallow water and in a situation, which owing to the great water way of the gap; was sheltered from the full action of the ebbing and flowing tides. The sand bag groynes on the other hand, had to be constructed in a considerably greater depth of water, a circumstance which entailed the expenditure of an enormous quantity of material. Being besides exposed to an increased action of the flowing and ebbing tides, much settlement took place, and the quantity of material expended was thus considerably augmented. The average depth of water in which the first sand bag groyne had to be constructed, was twelve feet, that of the second was twenty one feet, and as the groynes progressed in length into the deeper water, and the gap was concurrently narrowed, the detrimental effect of the tides was increased and frequent slipping had to be made good by the expenditure of a further quantity of sand bags. In order to procure a proper sectional base for the groynes, it was necessary to pitch the sand bags into the water, and allow this mass to assume a natural slope; having recourse only to built work in courses, when the depth at low tide allowed men to place the bags regularly, from that stage to a height of four feet above H.W. mark.

It was to be expected that the number of sand bags, used in constructing the groynes, under such conditions, would be very large; and the circumstances of the sand, not following the projection of the groynes into the gap (so fast as, or to the extent which was anticipated) and of the necessity which arose for constructing a sand bag return at the head of the groyne, in order to furnish a firm base, from which the projection of the second groyne might be commenced, both added besides, most considerably to the expense of the work which has been executed.

The expenditure on the first groyne, the return and the second groyne, has been respectively – Rs 5860 – Rs 1330 and Rs 8400, or in all an expenditure of Rs 15590. The cost per foot of these works has thus respectively been – Rs 58 3/5 – Rs 24 4/5 and Rs 84 – and they have been built in average depths of a full tide way of 12, 18 and 21 feet respectively.

From the above data, I calculate the second return will cost Rs 60 per foot, or a sum of Rs 3300 and the third groyne Rs 70 per foot or a sum of Rs 7000. Adding 50 per cent nearly for contingencies, I suppose the work should be completed for say Rs 15000, in addition to the sum already spent, which is about Rs 7550 in excess of the funds already allotted. The amount requiring to be allotted for completing the work, will therefore be Rs 22,550.

This sum appears to be a large one: but I am bound to say I can not find Mr Grimes has not conscientiously superintended the expenditure already incurred, on which this Estimate is founded.

The items of the expenditure are but three.

1st Sand bags, which have been procured from trading houses, both on the East and West Coasts, as well as in the Cochin bazaar. The prices were generally high, being on the average Rs 29-5-6 per hundred. But it is to be remarked, we have been obliged to procure them at a season of the year, when there is the greatest demand for them, and we had no option but to buy.

2nd Cost of filling bags with sand, sewing up their mouths, loading them on carts, conveying them with a lead of from 200 to 350 yards to the groyne and building them in a sea way of depths before mentioned. This is a difficult charge to check and Mr Grimes tells me, it comes to one anna four and a half pies per bag, which price does not seem out of the way.

3rd Cost

3d Cost of plant and sundries, which does not reach four per cent, on the expenditure of the first and second items.

The further expenditure required to complete the work, may be stated at Rs 15000, as has already been mentioned. About Rs 3300 of this will be required for the second sand bag return, and if it is decided to defer the closing of the gap, about Rs 1700 in addition to the last named sum, will probably be required, to make the flanks of the gap safe. In this case therefore Rs 5000 in addition to the excess expenditure already incurred of Rs 7550 or a sum of Rs 12550 will require to be allotted for the works.

I have the honor to be Sir
Your most obedient servant
H. Wood, Capt R.E.
Offg D.E. Malabar.

Pro 2nd May /72 No 31-33
" 24 July ___ 373-374
" 19 Decr ___ 410-411

P.W. 1873 Department
Pro of Govt for May
No 2676

12

From.

The Dist. Engineer,
Malabar.

Dated 28th April
Recd 30th —— } 1873.

No. A.

Enc: 6 ~~Plans~~ Tracings

Reporting on the operations on the work of closing the Cruz Milagre Gap at Cochin —

No. 1323. 13th May /73.

No 164

[illegible] 30 Apl /72

No. 1323

His Excellency the Governor in Council cannot but conclude that the project of closing the Cruz Milagre Gap has been jeopardized by needless delay in acting on the sanctions accorded by Government.

In ordering that the estimate of Rs 15272 for carrying out that work should be resubmitted shortly before Lieut Col Farewell proposed to undertake it, which "presumedly would not be later than January 1873" (vide G. O. No 1125 of 2nd May 1872) it was not intended thereby that he should be precluded from exercising his discretion as to the date of commencing the work so as to insure its completion before the ensuing Monsoon. And as that estimate was finally sanctioned, after further report, by G. O. No 1757 of 3d July and Lieut Colonel Farewell under date the 30th October 1872 reported his opinion that the work might be proceeded with in November or December, His Excellency the Governor in Council is disappointed now to learn that no action whatever was taken till the 23d January 1873; with the result of throwing the work unfinished into the monsoon of 1873 which should have been avoided.

Earlier action by ~~Lieut Col Farewell~~ the Supg Engineer would have enabled the

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District Engineer to report at an earlier date what he has now submitted for information of Govt., from which His Excellency the Governor in Council is led to believe that the procedure by means of Groynes in echelon has not been nearly so effective as was anticipated, and has proved practically a more expensive and less efficient method of closing the Gap than would have been a Sand Bag dam directly across the Gap, well secured on the flanks and

raised gradually from the bottom.

Much must be left to the discretion of the District and Inspecting Engineers but it would appear to His Excellency the Governor in Council that on completion of the second Sand Bag Return, Sandbags should be deposited in a direct line between its end and the nearest point of the opposite shore so as to shallow the Gap as quickly and directly as possible -

Such excess outlay as may have been incurred last Official year, and understood by the District Engineer's letter to be about Rs 7,550 cannot now be specially appropriated but will appear in the accounts as an excess.

Provision of the Rs 15,000 stated as necessary to complete the work will be considered in the Financial Department.

GNW.

5 To. The I. E. for Ports & Comns W. & Irrigns ✓ M.L. Despd 13-5-73
11 " Marine Supdt ✓
11 " Civil " ✓
5 " Controller ✓
8 D. E. Malabar ✓

Despd 4th June 1873.

Cl. No 2676

Govt. of (1873) Madras

PUBLIC WORKS.

To The Inspecting Engr
for Ports and
Communications

Dated

Recd. Encl:

G. O. 13th May No. 1323.

Nos. 164 & 165

Cruz Milagre Gap at Cochin

Passing orders on letter from the Dt. Engr., Malabar, reporting on the ~~question~~ work of closing the Cruz Milagre Gap.

No. 164-65.