Public Works (1896) Department.

G.O., No. 3187-88/V

Dated 7th November 1896.

[Despatch Abstract.]

Port of Cocanada: Resolution of Govt. acknowledged to Mr. J.R. Bell for the very important and suggestive note which he has written on the subject of the improvement of the — and the S.E. Irish directed to report on the suggestions made.

Port of Cocanada: Requesting that the thanks of His Government may be conveyed to Mr J.R. Bell for his very important and suggestive papers on the subject of the improvement of the —.

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7/11

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	2445W.		24.8.96				

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G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

BUILDINGS AND ROADS.
CIVIL WORKS.

Government {1896} of Madras.

PUBLIC WORKS.

Recd. } 1896. *Enclosures*
Regd. } *Spare copies*

Letter, No. 3188 W., 7th November 1896.

NOVEMBER.

Port of Cocanada

Requesting that the thanks of this Government may be conveyed to Mr. J. R. Bell for his very important and suggestive paper on the subject of the improvement of the —.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

LETTER—from

THE HON'BLE COLONEL D. McNEIL CAMPBELL, R.E.,
Secretary to the Government of Madras,
Public Works Department,

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
PUBLIC WORKS DEPARTMENT.

SIR,

I am directed to acknowledge the receipt of your letter, No. 241 M., dated 4th July 1896, forwarding, for the information of His Excellency the Governor in Council, copy of a note, dated 18th March 1896, by Mr. J. R. Bell, Consulting Engineer to the Government of India for State Railways, on the subject of the improvement of the port of Cocanada; and I am to request that the thanks of this Government may be conveyed to Mr. Bell for his note which is, in the opinion of His Excellency in Council, a very important and suggestive paper.

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

Colonel, R.E.,
Secretary to Government.

FORT ST. GEORGE,
7th November 1896.

Exd. A. F. Eccleston.

BUILDINGS AND ROADS.
CIVIL WORKS.

Government {1896} of Madras.

PUBLIC WORKS.

Recd. / *Regd.* } 1896.

Enclosures

Spare copies

G.O., No. 3187 W., 7th November 1896.

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

Read—again the following paper:—

G.O., No. 2800 W., dated 30th September 1896.

From N. F. MACKENZIE, Esq., Under Secretary to the Government of India, Public Works Department (Civil Works—Miscellaneous), to the Secretary to the Government of Madras, Public Works Department, dated Simla, the 4th July 1896, No. 241 M.

I am directed to forward herewith, for the information of His Excellency the Governor of Madras in Council, copy of a note, dated the 18th March 1896, by Mr. J. R. Bell, Consulting Engineer to the Government of India for State Railways, on the subject of the improvement of the port of Cocanada, and to invite attention to paragraph 1 of that note, which explains the circumstances under which the Consulting Engineer recorded his opinions on the subject for the consideration of the members of the Cocanada Port Trust.

2. I am to add that the Government of India have not formed an opinion on the theories discussed or the suggestions made in Mr. Bell's note.

Order—No. 2800 W., dated 30th September 1896.

Recorded with reference to G.O., No. 2445 W., dated 24th August 1896.

(True Extract.)

(Signed) D. McNEIL CAMPBELL, Col., R.E.,
Joint Secretary to Government.

Enclosure.

Note by the Consulting Engineer to the Government of India for State Railways on the Port of Cocanada.

In passing through Cocanada I was invited by Mr. Kipping, resident partner in Hall, Wilson & Co., and a leading member of the Port Trust, to look into the questions treated of below. I am not clear how far Resolution No. 2502 G. intends me to undertake an investigation of this sort in anticipation of instructions from the Government of India, but I have thought it right not to decline, and have, moreover, shown the printed note below *unofficially* to the authorities concerned with a clear intimation that it in no way commits the Governments concerned till such time, if ever, as they take definite action thereon. All I in any case recommend, moreover, is the consideration by preparing estimates of two suggestions, *viz.*:—

(*a*) Embanking the mud-spills which shoal-up the bay either wholly or in part as may appear praticable; and

(*b*) extending the Cocanada canal, to Vakilapuddi with an entrance to the bay protected by groynes.

2. Since the note below was penned, I have seen Colonel McNeil Campbell, the Secretary to the Madras Government, and learned that he has formed a preliminary idea in favour of building out a pile-pier, similar to that at Madras, near Vakilapuddi. That would be very much cheaper in prime cost than the canal extension, and would, if successful, promote the interest of the East Coast Railway, very materially, for it would cut the canal out of circuit and would force Cocanada to lay down a tramway of its own to the new pier.

3. There is no question that the railway suffers seriously, and indeed unfairly, from the canal's competition in the present state of canal tolls, and I see no need, now that the railway offers adequate facilities, for maintaining excessively low canal dues, when, If I am rightly informed, this involves a loss of irrigation revenue. But I am not in favour of so drastic a remedy as that of removing the port to a point where the railway alone can serve it. The railway purports as a famine-line to serve the Madras Presidency's most vital interests. It now can only touch a large field of its proper traffic during the few months when the parallel canals are closed: and it would, I think, be fairest to all parties to either draw down those canals in the interests of further irrigation or to enhance the tolls on the parallel canals and hand over the profits to the railway. I am very sure that had the East Coast Railway remained under the Presidency that promoted it, *i.e.*, if the railway and the canal were not worked in separate interests, statesmanship would have already devised a system of differential tolls for feeding the railway rather than opposing it.

4. Cocanada is the only anchorage on the East Coast where ships are fairly secure in bad weather. It is, moreover, the only port on the East Coast Railway where landing and shipping operations are as yet done in decent sized lighters; at all others, owing to the surf, open masula boats, carrying each a bare two tons, can alone be used. The great value of this consideration for Cocanada can best be gauged by the importance which, in other ports like Vizagapatam, is attached to the attainment of even a boat harbour quite apart from any such shelter for sea-going ships as the roads of Cocanada afford under the lee of Point Gódávari.

5. Point Gódávari is only a salient instance of a class of action which is natural to the embouchure of any great alluvial river that falls into a sea, where the littoral currents show a marked preponderance in one direction. In this case, and in a less marked degree in that of the Mahanuddi at False Point, the preponderating current appears to run up the Bay of Bengal; while in the case of the southern arm of the Kistna at Divi False Point and at Madras itself, the preponderance is the other way. The river, when in flood, carries various kinds of detritus forward at different levels—coarse sand at the bottom and finely divided silt at the top. Deposition occurs in the same order—firstly the heavier and coarser, lastly the lighter and finer matters. The effect on these of the littoral current is that the agitation of waves tends to keep the lighter particles, which ultimately deposit themselves as mud, longer in suspension, while it stirs up and rolls along the bottom those heavy sand particles which the river has previously dropped. At some point or other, or rather along some line or other, the motions of the littoral and river currents neutralize each other and produce retarded motion in a resultant direction. The retardation of river-flow is increased by loss of fall as the flood and sea levels approximate. Tidal rise and fall add an intermitting effect to the action of both currents; but the invariable resultant effect is the deposition, along a line of maximum mutual retardation, of a sandy bar which ultimately rises under the influence of sea waves and wind into a beach appreciably higher than mean high-water level. As an inevitable consequence,—in despite of desultory efforts to break through the raised bar and attain a direct sea outlet,—the river arm flows, as a rule, along the inside of a bar on which the sea beats outside. Under these circumstances the outer face of the bar is necessarily a sandy beach, while its inner face becomes coated in part with vegetable soil, which the river deposits, when backed up into a sluggish flow by the tides, at a high level. This form of river mouth forming a "hook" is too well-known a feature of physical geography to need further description here. The question for discussion is the terms of its permanence and extensions.

6. It is very clear that a river running inside a hook and parallel to the sea which it ultimately enters, can only maintain its channel against the tendency to silt up, by dint of flow, and that, as flow depends on fall, the channel's bed and banks within the bar must be slowly but continuously rising by dint of accretions of the river-borne sands and silts. Owing to that rise the day must come when it will be easier for the river to force a new channel over the bar (which now diverts its course from, say, east to north) than to continue forcing its way parallel with the sea for several miles. That is seemingly exactly what has occurred over and over again in this arm of the Gódávari; the Coringa river must have had a bar to seaward, than a new mouth must have crossed that bar and started its own bar further to seaward, then a still newer mouth and so on, till between the Coringa river and the present main Gódávari we find traces of four or five successive mouths with bars between, each mouth trending northwards and falling into the bay, now nine miles wide, which lies between the original shore line and the north end, at Gódávari Point, of the present "hook." On this view each physical step of this process has forced the shore line seaward by the width of one channel *plus* one bar.

7. At the moment of each channel giving up the attempt to extend northward and bursting its bar to seaward the old channel will doubtless become largely inactive, but not wholly so. The new outlet with a great velocity and consequent deep scour will carry off the course sand, which mainly served to choke the old mouth. In time the new mouth will turn to the north and the bed will again begin to rise, but meanwhile the old channels remain open as spills and help in flood time to rob the main channel of water which carries a large share of mud-making detritus into the bay. In this way it was estimated some years ago that Gódávari Point, the direct product of the action of the main channel on the littoral current, was advancing northward at the rate of a mile in fourteen years, its substance being mainly sand, while the silting of the bay, wholly with mud, progressed a mile in forty years. It is not wholly easy to verify these exact figures by modern experience. My impression is that recent advances are much more rapid in both ways. From the charts shown me by Captain Wicks and information added by Mr. Kipping, it seems clear that from 1816 to 1856 the anchorage that held the H E.I. Company's fleet became dry at low-water,—that from 1856 to 1896 the visible nose of the Gódávari Point has advanced some nine miles and the anchorage itself some four miles, if not more. On the other hand, it is clear that the increased draught of shipping is a factor in the anchorage question, and it is generally believed that the shoaling of the Coringa creek was much accelerated by a storm wave which swept the delta and would tend to eradicate sluggish channels by sweeping the surface of adjacent lands into their beds. There are, too, some grounds for the popular belief that irrigation works have modified the course of nature in these instances. These cause practically all the freshets to run suddenly into the sea and entirely stop the dry season flow, which formerly must have had some effect in keeping the main channel open and a further effect, in conjunction with reversed littoral currents, on the bars. My opinion is that the effect of these causes as a whole, coupled with that of several old mouths opening into the bight, is distinctly deleterious.

8. The effect on my mind of all these considerations is that the practicability of closing some, if not all the old mouth outlets for mud, to the bay demands careful consideration. A mere dividing embankment raised four or five feet above the highest flood level, if retired from the main channel sufficiently far to avoid erosion, would, I think, cause the riverward land to warp up and become fruitful soil in a very moderate period. The increased discharge then thrown on the main channel would, in the first instance, lengthen the spit northward more rapidly than now, and thereby accelerate the probability of the bar bursting and starting a fresh one *de novo*; and in either case the stability of the anchorage would, I think, be sure to increase. Mr. Willock, with whom I have had the advantage of discussing these matters, whose intimacy with the whole littoral of Madras acquired as Salt Commissioner is immense, reminds me, while on the subject of the probable effect of irrigation weirs, that a similar class of action is due in such rivers to the denudation of forest land. This, like a weir, reduces the amount of dry season discharge and brings down all the floods at once, along with a far greater amount of ditritus than formerly. I am unable to say how far that action in the Gódávari has intensified that which I attribute to the works at Dowlaishweram, but there can be no doubt that it exists and is at least an appreciable factor.

9. Whatever be the ultimate causes of the deterioration of the Cocanada anchorage, there is no doubt of the fact, or that the primary causes are themselves irremediable. I incline, on the other hand, to believe, as I have said, that the case is susceptible of local treatment. Half a century has seen Coringa abandoned for Cocanada and now sees the latter emporium at a greatly increased and increasing distance from the shipping. The haven is the only one on this whole coast where it is thought safe for ships to await the onset of a cyclone. All we want is to stop, or at least reduce, the influx of mud which, I think, we can divert to the purpose of raising fruitful land. With even less chance of success than I expect, some attempt in this direction is, I think, an essentially Provincial, if not Imperial duty, quite outside the scope of the local Harbour Board which, as I now propose to show, has enough to do with the works already in its charge. The interests of Cocanada, as distinguished from those of any old or new trade emporium on that bay, are that Board's concern. Those that I would have enquired into above, concern the only Harbour of Refuge on the eastern shore of the Peninsula.

10. The foundation of Cocanada, which followed on the recession of the anchorage from what was known as Coringa bay, occurred, I understand, almost within living memory. The town lies mainly on the north bank of the Yelleru river which rises in the neighbouring hills and is, or rather was, distinct from the Gódávari system, but debouched into the sheltered bay formed by the Gódávari Point hook. A branch of the northerly Gódávari canals was next led into the river and gives it the advantages of inland navigation coupled with a, perhaps small, perennial discharge. The river itself is now an extension of the canal, dredged and revetted so as to form the chief high-way of the town. A good deal of money is sunk in warehouses on either bank of the canalised river which is bridged and fitted with ferries, jetties, cranes, and a railway goods-station for transhipping exports and imports to and from barges. Since the anchorage has receded, something like half-a-dozen steam launches are employed in towing barges from this inner harbour to the ships; the distance is some five miles, and the wind, when fair, one way, is foul the other; and as usual, on this coast, there is very little wind at all in the early forenoon during fine weather. Some years ago the Cocanada lighthouse at the north side of the river mouth was in use, but it is now substituted by the Vakilapuddi light five miles further north on the mainland shore of the bay. Outside of the hook which defines the bay, the tide makes almost directly from the eastward along the whole coast, and there is scarcely an hour's difference in this respect between Madras and False Point. Inside the bay the tide makes from the northward along the landward shore, and highwater at Cocanada itself is hence later than at Vizagapatam. The tidal wave carries a small amount of sand from the once surf-beaten beach, now sheltered by Gólávari Point, southwards towards the mouth of the inner harbour. A more serious encroachment of mud from the old mouth of the Gódávari also threatens and is in fact enfolding the mouth of the canalised river from the south. Up to a few years ago both forms of encroachment were adequately kept at bay by moderate extensions of two stone groynes and by dredging between them with one or two Priestman's grabs. Just before the present extension was undertaken, the southern groyne was the more advanced and acted for a time as at once a stop to the mud encroachment from behind and directed the combined ebb tide and landwaters into a fairly direct prolongation of the channel. There was nevertheless a bar across this channel and, just as the meeting of the Gódávari flow with the littoral current outside begot the Gódávari spit, so the meeting of this outflow with the littoral flood tide current begot a submerged spit parallel with the channel, and in fact a rude extension of the northern groyne raised a few inches (I imagine) above low water. The ebb channel thus left was of course slightly tortuous and, as already said, it became shallower and had in fact a bar at its mouth, where the force of the ebb and landwaters became dissipated. These forces had not, and I think never could have had, power to scour away the gradual encroachment of tough Gódávari mud. They could keep it a little longer in suspension and so cause it to settle somewhere else; they could, and did, for a time to keep the tidal influx of sand at bay, but only for a certain distance and as long as the ebbing force remained concentrated.

11. Here,—and it is easy to be wise after the event—a serious mistake was made; instead of lengthening the southern groyne and intensifying the action of the ebb on the bar the northern arm was extended on top of the spit, which offered it an obviously cheap foundation, by some 2,000 lineal feet. The result is, I fear, little less than disastrous. Instead of the advancing mud being excluded from the channel, it is retained within it. Instead of the tide making promptly into the river across the spit, it must now run round the end of the northern groyne and double, back on its former direction;—the spit itself, or at least the foreshore, once its root, is being eroded and the sand carried forward to deposit in a horse-shoe-shaped new spit which enfolds the end of the new groyne on the line near which I have described the rising tide as doubling back; and the ebb itself, reduced in volume, dissipates its entire force by idly doubling back southward against the advancing mud on which it makes no impression whatever. Cargo boats cannot now cross the bar at all at low-water. It is doubtful if even at high water they will long continue at neeps to carry full loads. The present entrance is by a circuitous channel, impracticable after dark, and is only maintained by constant dredging with which the present plant is unable to cope.

12. As may be gathered from the above, I certainly hold it a mistake to have lengthened the northern instead of the southern groyne, but I am far from saying that the latter device would be a complete or even an adequate success. In comparatively deep water it would certainly cost three or four times as much, and the present arm has cost over Rs. 20 per foot run. Continuing it straight out to the eastward gets no nearer to deeper water, for the mud is advancing steadily along the whole line. Curving it round to the northward would continue to still more deflect the course of the flood tides action. The Board might, in short, spend two or three lakhs in the next five years on this plan only to find after all that they must spend another two or three lakhs on heavy dredging plant and, perhaps, be beaten in the end. The southern groyne is distinctly better, but it makes no pretence at finality, nor ever will unless, by some such process as the earlier part of this paper advocates, the influx of mud to the inner side of the bay is itself stopped. On the whole, I think it would be wise even now to pull out the stone from the northern groyne and use it to form a short and slightly curved extension of the southern. Perhaps stone could be economised by setting it in cribs and backing it with dredged spoil, but I am not, as already indicated, prepared to recommend any very large expenditure, certainly not more than half a lakh at the outside on this scheme, nor on it unless there be a prospect of the influx of mud being at least limited at an early date.

13. Captain Wicks has revived a more radical scheme which is I think, on the whole, far the best yet formulated. The lighthouse has been moved to Vakilapuddi; why not take the canal there too? It could be dug in the dry across the flats for, I think, four lakhs of rupees. The tide out there has but little sweep along shore; in fact there is a slight tendency to surf-indicating. I take it, that the tide beats on the coast instead of running parallel to it. The deep water is no great distance from shore, and the same groynes that would shortly be silted up at the present site might suffice for ages at Vakilapuddi. The bar would still have to be dredged; but by connecting with a local back water, fed, I imagine, by a spill from the same Yelleru river, we should get a fair amount of tidal area and both flood and ebb acting on the same line nearly perpendicular to the shore. It would cost no more to boat from the town to the anchorage then

than now, nay less, for the men could tow along the canal bank for five miles, if need be, who now labour at the oar or spend endless time in beating to windward under sail and then in waiting for water on the bar. In the end no doubt the railway would run a branch to the new mouth of the canal and later a new town would itself grow up at the new maritime centre of operations. I do not see much to regret in all that. The canal connection would keep the town in as good touch as now, nay far better, with the shipping. If a suburb sprang up at the new canal mouth, the town would have through its Harbour Board the opportunity of developing that site.

14. That then is, as I apprehend it, Captain Wicks' scheme. I think it could with economy be done for five lakhs and kept up with existing dredging plant, even if, as I think essential, a considerable amount of land is taken up for the purposes of the port and the railway. The Government of Madras should certainly be asked to assist the Port authorities by preparing a regular estimate and by encouraging the local land-owners to grant the required sites. As I understand it, the revenues of the place can well afford to devote Rs. 25,000 to Rs. 30,000 a year to provide a sinking fund. Once godowns, &c., sprang up at "Wicks' port" the same boats and men would do thrice the work they now do, and as Mr. Willock as well observed they would have a fair wind both ways, when there was any wind at all.

(Signed) J. R. BELL.
Secretary.

18th March 1896.

Order—No. 3187 W., dated 7th November 1896.

The thanks of Government will be conveyed to Mr. Bell for the very important and suggestive note which he has written on the subject of the improvement of the port of Cocanada; and the Superintending Engineer, I Circle, will report on the suggestions made, particularly as to the possibility of preventing the ingress of mud into the bay blocking up some of the old mouths of the Gódávari.

[Here enter No. 3188 W., dated 7th November 1896.]

(True Extract.)

(Signed) D. McNEIL CAMPBELL, Colonel, R.E.,
Secretary to Government.

To the Superintending Engineer, I Circle.
" Consulting Engineer for Railways.
" Marine Department.

Exd. C. M. Thumbuswamy.

Cocanada Port Imp.

Read again Lr 2800 W dt 30 Sept 1896

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No 3188 W dt 7th November 1896

A.S.H. 4.11.96

(Reminder issued 23-1-97)

To
The Secretary to the Govt of India P.W. Dept.
Sir.
I am directed to acknowledge the receipt of your letter No 141 M dt 4th July 96, forwarding for the

The S.E. I Circle
C. Engrs
Marine Dept

A.S.H. 4.11.96

Public Works (1896) Department.

CURRENT No. 8661

Order No. 2800. W. dated 30th Sept. 1896.

Recorded with reference to R.P. 2445 W of 26th August 1896.

From Govt of India

No. 241 M.

Dated July 4th

Received " 14th

Regd. 28-9-96

Enclosures 1

Spare copies

SUBJECT.

Cocanada Port.

Forwd, for information, Copy paraté to the Comp. Engr. to the Govt of India for State Dep. on the subject of improvement to the _____

[P. W. 25. 1,000—4-9-96.]

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C.S. 3/11/96

27/11/96

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G.O.	No.	Department.	Date.

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5. Point Gódávari is only a salient instance of a class of action which is natural to the embouchure of any great alluvial river that falls into a sea, where the littoral currents show a marked preponderance in one direction. In this case, and in a less marked degree in that of the Mahanuddi at False Point, the preponderating current appears to run up the Bay of Bengal; while in the case of the southern arm of the Kistna at Divi False-Point and at Madras itself, the preponderance is the other way. The river, when in flood, carries various kinds of detritus forward at different levels—coarse sand at the

bottom and finely divided silt at the top. Deposition occurs in the same order —firstly the heavier and coarser, lastly the lighter and finer matters. The effect on these of the littoral current is that the agitation of waves tends to keep the lighter particles, which ultimately deposit themselves as mud, longer in suspension, while it stirs up and rolls along the bottom those heavy sand particles which the river has previously dropped. At some point or other, or rather along some line or other, the motions of the littoral and river currents neutralize each other and produce retarded motion in a resultant direction. The retardation of river-flow is increased by loss of fall as the flood and sea levels approximate. Tidal rise and fall add an intermitting effect to the action of both currents; but the invariable resultant effect is the deposition, along a line of maximum mutual retardation, of a sandy bar which ultimately rises under the influence of sea waves and wind into a beach appreciably higher than mean high-water level. As an inevitable consequence,—in despite of desultory efforts to break through the raised bar and attain a direct sea outlet,—the river arm flows, as a rule, along the inside of a bar on which the sea beats outside. Under these circumstances the outer face of the bar is necessarily a sandy beach, while its inner face becomes coated in part with vegetable soil, which the river deposits, when backed up into a sluggish flow by the tides, at a high level. This form of river mouth forming a "hook" is too well-known a feature of physical geography to need further description here. The question for discussion is the terms of its permanence and extensions.

6. It is very clear that a river running inside a hook and parallel to the sea which it ultimately enters, can only maintain its channel against the tendency to silt up, by dint of flow, and that, as flow depends on fall, the channel's bed and banks within the bar must be slowly but continuously rising by dint of accretions of the river-borne sands and silts. Owing to that rise the day must come when it will be easier for the river to force a new channel over the bar (which now diverts its course from, say, east to north) than to continue forcing its way parallel with the sea for several miles. That is seemingly exactly what has occurred over and over again in this arm of the Gódávari; the Coringa river must have had a bar to seaward, then a new mouth must have crossed that bar and started its own bar further to seaward, then a still newer mouth and so on, till between the Coringa river and the present main Gódávari we find traces of four or five successive mouths with bars between, each mouth trending northwards and falling into the bay, now nine miles wide, which lies between the original shore line and the north end, at Gódávari Point, of the present "hook." On this view each physical step of this process has forced the shore line seaward by the width of one channel *plus* one bar.

7. At the moment of each channel giving up the attempt to extend northward and bursting its bar to seaward the old channel will doubtless become largely inactive, but not wholly so. The new outlet with a great velocity and consequent deep scour will carry off the coarse sand, which mainly served to choke the old mouth. In time the new mouth will turn to the north and the bed will again begin to rise, but meanwhile the old channels remain open as spills and help in flood time to rob the main channel of water which carries a large share of mud-making detritus into the bay. In this way it was estimated some years ago that Gódávari Point, the direct product of the action of the main channel on the littoral current, was advancing northward at the rate of a mile in fourteen years, its substance being mainly sand, while the silting of the bay, wholly with mud, progressed a mile in forty years. It is not wholly easy to verify these exact figures by modern experience. My impression is that recent advances are much more rapid in both ways. From the charts shown me by Captain Wicks and information added by Mr. Kipping, it seems clear that from 1816 to 1856 the anchorage that held the H. E. I. Company's fleet became dry at low-water,—that from 1856 to 1896 the visible nose of the Gódávari Point has advanced some nine miles and the anchorage itself some four miles, if not more. On the other hand, it is clear that the increased draught of shipping is a factor in the anchorage question, and it is generally believed that the shoaling of the Coringa creek was much accelerated by a storm wave which swept the delta and would tend to eradicate

sluggish channels by sweeping the surface of adjacent lands into their beds. There are, too, some grounds for the popular belief that irrigation works have modified the course of nature in these instances. These cause practically all the freshets to run suddenly into the sea and entirely stop the dry season flow, which formerly must have had some effect in keeping the main channel open and a further effect, in conjunction with reversed littoral currents, on the bars. My opinion is that the effect of these causes as a whole, coupled with that of several old mouths opening into the bight, is distinctly deleterious.

8. The effect on my mind of all these considerations is that the practicability of closing some, if not all the old-mouth outlets for mud, to the bay demands careful consideration. A mere dividing embankment raised four or five feet above the highest flood level, if retired from the main channel sufficiently far to avoid erosion, would, I think, cause the riverward land to warp up and become fruitful soil in a very moderate period. The increased discharge then thrown on the main channel would, in the first instance lengthen the spit northward more rapidly than now, and thereby accelerate the probability of the bar bursting and starting a fresh one *de novo*; and in either case the stability of the anchorage would, I think, be sure to increase. Mr. Willock, with whom I have had the advantage of discussing these matters, whose intimacy with the whole littoral of Madras acquired as Salt Commissioner is immense, reminds me, while on the subject of the probable effect of irrigation weirs, that a similar class of action is due in such rivers to the denudation of forest land. This, like a weir, reduces the amount of dry season discharge and brings down all the floods at once, along with a far greater amount of detritus than formerly. I am unable to say how far that action in the Gódávari has intensified that which I attribute to the works at Dowlaishweram, but there can be no doubt that it exists and is at least an appreciable factor.

9. Whatever be the ultimate causes of the deterioration of the Cocanada anchorage, there is no doubt of the fact, or that the primary causes are themselves irremediable. I incline, on the other hand, to believe, as I have said, that the case is susceptible of local treatment. Half a century has seen Coringa abandoned for Cocanada and now sees the latter emporium at a greatly increased and increasing distance from the shipping. The haven is the only one on this whole coast where it is thought safe for ships to await the onset of a cyclone. All we want is to stop, or at least reduce, the influx of mud which, I think, we can divert to the purpose of raising fruitful land. With even less chance of success than I expect, some attempt in this direction is, I think, an essentially Provincial, if not Imperial duty, quite outside the scope of the local Harbour Board which, as I now propose to show, has enough to do with the works already in its charge. The interests of Cocanada, as distinguished from those of any old or new trade emporium on that bay, are that Board's concern. Those that I would have enquired into above, concern the only Harbour of Refuge on the eastern shore of the Peninsula.

10. The foundation of Cocanada, which followed on the recession of the anchorage from what was known as Coringa bay, occurred, I understand, almost within living memory. The town lies mainly on the north bank of the Yelleru river which rises in the neighbouring hills and is, or rather was, distinct from the Gódávari system, but debouched into the sheltered bay formed by the Gódávari Point hook. A branch of the northerly Gódávari canals was next led into the river and gives it the advantages of inland navigation coupled with a, perhaps small, perennial discharge. The river itself is now an extension of the canal, dredged and revetted so as to form the chief high-way of the town. A good deal of money is sunk in warehouses on either bank of the canalised river which is bridged and fitted with ferries, jetties, cranes, and a railway goods-station for transhipping exports and imports to and from barges. Since the anchorage has receded, something like half-a-dozen steam launches are employed in towing barges from this inner harbour to the ships; the distance is some five miles, and the wind, when fair, one way, is foul the other; and as usual, on this coast, there is very little wind at all in the early forenoons during fine weather. Some years ago the Cocanada light-house at the north side of the river mouth was in use, but it is now substituted by the Vakilapuddi light five

miles further north on the mainland shore of the bay. Outside of the hook which defines the bay, the tide makes almost directly from the eastward along the whole coast, and there is scarcely an hour's difference in this respect between Madras and False Point. Inside the bay the tide makes from the northward along the landward shore, and highwater at Cocanada itself is hence later than at Vizagapatam. The tidal wave carries a small amount of sand from the once surf-beaten beach, now sheltered by Gódávari Point, southwards towards the mouth of the inner harbour. A more serious encroachment of mud from the old mouth of the Gódávari, also threatens and is in fact enfolding the mouth of the canalised river from the south. Up to a few years ago both forms of encroachment were adequately kept at bay by moderate extensions of two stone groynes and by dredging between them with one or two Priestman's grabs. Just before the present extension was undertaken, the southern groyne was the more advanced and acted for a time as at once a stop to the mud encroachment from behind and directed the combined ebb tide and landwaters into a fairly direct prolongation of the channel. There was nevertheless a bar across this channel and, just as the meeting of the Gódávari flow with the littoral current outside begot the Gódávari spit, so the meeting of this outflow with the littoral flood tide current begot a submerged spit parallel with the channel, and in fact a rude extension of the northern groyne raised a few inches (I imagine) above low water. The ebb channel thus left was of course slightly tortuous and, as already said, it became shallower and had in fact a bar at its mouth, where the force of the ebb and landwaters became dissipated. These forces had not, and I think never could have had, power to scour away the gradual encroachment of tough Gódávari mud. They could keep it a little longer in suspension and so cause it to settle somewhere else; they could, and did, for a time to keep the tidal influx of sand at bay, but only for a certain distance and as long as the ebbing force remained concentrated.

11. Here,—and it is easy to be wise after the event—a serious mistake was made; instead of lengthening the southern groyne and intensifying the action of the ebb on the bar the northern arm was extended on top of the spit, which offered it an obviously cheap foundation, by some 2,000 lineal feet. The result is, I fear, little less than disastrous. Instead of the advancing mud being excluded from the channel, it is retained within it. Instead of the tide making promptly into the river across the spit, it must now run round the end of the northern groyne and double, back on its former direction;—the spit itself, or at least the foreshore, once its root, is being eroded and the sand carried forward to deposit in a horse-shoe-shaped new spit which enfolds the end of the new groyne on the line near which I have described the rising tide as doubling back; and the ebb itself, reduced in volume, dissipates its entire force by idly doubling back southward against the advancing mud on which it makes no impression whatever. Cargo boats cannot now cross the bar at all at low-water. It is doubtful if even at high water they will long continue at neeps to carry full loads. The present entrance is by a circuitous channel, impracticable after dark, and is only maintained by constant dredging with which the present plant is unable to cope.

12. As may be gathered from the above, I certainly hold it a mistake to have lengthened the northern instead of the southern groyne, but I am far from saying that the latter device would be a complete or even an adequate success. In comparatively deep water it would certainly cost three or four times as much, and the present arm has cost over Rs. 20 per foot run. Continuing it straight out to the eastward gets no nearer to deeper water, for the mud is advancing steadily along the whole line. Curving it round to the northward would continue to still more deflect the course of the flood tides action. The Board might, in short, spend two or three lakhs in the next five years on this plan only to find after all that they must spend another two or three lakhs on heavy dredging plant and, perhaps, be beaten in the end. The southern groyne is distinctly better, but it makes no pretence at finality, nor ever will unless, by some such process as the earlier part of this paper advocates, the influx of mud to the inner side of the bay is itself stopped. On the whole, I think it would be wise even now to pull out the stone from the northern groyne and

use it to form a short and slightly curved extension of the southern. Perhaps stone could be economised by setting it in cribs and backing it with dredged spoil, but I am not, as already indicated, prepared to recommend any very large expenditure, certainly not more than half a lakh at the outside on this scheme, nor on it unless there be a prospect of the influx of mud being at least limited at an early date.

13. Captain Wicks has revived a more radical scheme which is I think, on the whole, far the best yet formulated. The light-house has been moved to Vakilapuddi; why not take the canal there too? It could be dug in the dry across the flats for, I think, four lakhs of rupees. The tide out there has but little sweep along shore; in fact there is a slight tendency to surf-indicating. I take it, that the tide beats on the coast instead of running parallel to it. The deep water is no great distance from shore, and the same groynes that would shortly be silted up at the present site might suffice for ages at Vakilapuddi. The bar would still have to be dredged; but by connecting with a local backwater, fed, I imagine, by a spill from the same Yelleru river, we should get a fair amount of tidal area and both flood and ebb acting on the same line nearly perpendicular to the shore. It would cost no more to boat from the town to the anchorage then than now, nay less, for the men could tow along the canal bank for five miles, if need be, who now labour at the oar or spend endless time in beating to windward under sail and then in waiting for water on the bar. In the end no doubt the railway would run a branch to the new mouth of the canal and later a new town would itself grow up at the new maritime centre of operations. I do not see much to regret in all that. The canal connection would keep the town in as good touch as now, nay far better, with the shipping. If a suburb sprang up at the new canal mouth, the town would have through its Harbour Board the opportunity of developing that site.

14. That then is, as I apprehend it, Captain Wicks' scheme. I think it could with economy be done for five lakhs and kept up with existing dredging plant, even if, as I think essential, a considerable amount of land is taken up for the purposes of the port and the railway. The Government of Madras should certainly be asked to assist the Port authorities by preparing a regular estimate and by encouraging the local landowners to grant the required sites. As I understand it, the Revenues of the place can well afford to devote Rs. 25,000 to Rs. 30,000 a year to provide a sinking fund. Once godowns, etc., sprang up at "Wicks' port" the same boats and men would do thrice the work they now do, and as Mr. Willock as well observed they would have a fair wind both ways, when there was any wind at all.

18th March 1896.

J. R. BELL.

Secretary.

G. I. C. P. O.—No. 2105 P. W. D.—6-4-96.—12.—P. C. B.

All communications should be addressed to The Secretary.

No. 241 M.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.

Miscellaneous.

To

The Secretary to the Government of Madras,

Public Works Department.

Simla, the 25 July 1896.

Sir,

I am directed to forward, herewith, for the information of His Excellency the Governor of Madras in Council, copy of a note, dated the 18th March 1896, by Mr. J.R.Bell, Consulting Engineer to the Government of India for State Railways, on the subject of the improvement of the Port of Coconada, and to invite attention to paragraph 1 of that note, which explains the circumstances under which the Consulting Engineer recorded his opinions on the subject for the consideration of the members of the Coconada Port Trust.

2. I am to add that the Government of India have not formed an opinion on the theories discussed or the suggestions made in Mr. Bell's note.

I have the honour to be,

Sir,

Your most obedient servant,

N. F. Mackenzie

Under Secy. to the Govt. of India.

Document accompanying.

Copy of note referred to.

O.L.C. 8661/56