

the western or Waikareau arm of the estuary with the water from the southern or navigation branch. These two tide streams meet each other practically at right angles, thus producing a considerable "heading back" and useless absorption of much of the scouring power, and, as is always found in such cases, a bar or shoal is found across the mouth or channel, the stream in which is the weaker of the two. This evil is further aggravated by reason of the preponderance of westerly winds over those from the eastward, both in duration and force, in consequence of which the materials swept along with the waves from the westward are driven towards the eastern or leeward shore of the estuary, and there accumulate.

Having regard to these facts, which may be said to describe the disease in this particular case, we obtain a clue to the measures which should be adopted by way of remedy.

Seeing that it is both impracticable at any reasonable cost, as well as undesirable in every sense, to stop permanently the eastern end of the Waikareau Channel, it only remains to be considered how the two currents, which now conflict, can be so regulated and controlled as to insure a greater depth in the navigable channel leading to the town. There are two modes of accomplishing this object—namely, either by concentrating the scour in the navigable channel by means of a training bank along its western side; or the same end may be attained by forming training works at the mouth of each channel, so devised that the two streams may unite and run seawards without opposition. Either of these remedies should produce the desired result: the former, by causing a stream of preponderating strength to run in the navigable channel leading to and from the town, would dissipate the present shoal, and result in the lodgment of a bar of somewhat similar character in the mouth of the Waikareau; but no ill effects would be caused by this latter obstruction, and the fairway in the navigable channel, by reason of the increased scour, would be maintained at an adequate depth.

The training bank I would suggest to accomplish the object referred to above is shown by red colour on the accompanying drawings. It would commence at the north-east point of the sand-spit, and extend therefrom in a direction almost north and south, but curved to a radius of about 16,000 feet for a total length of 1,000 lineal yards, with a "perch" or beacon at its termination. It will be seen that the waterway will be about 400 feet less in width at the north than at the south end, thus concentrating the currents to that extent. This training bank would be formed throughout of rubble-stone deposited from barges. Its top would be 6 feet in width, and at a uniform level of high water of ordinary neap tides, the slopes being  $1\frac{1}{2}$  to 1. In forming the bank care should be taken to deposit at an early stage of the work a thin layer of stone over the site of the mound, so as to economize materials by preventing the scour of the sand upon which the bank will subsequently rest. If the work were carried on with a steep end without this provision there would be much deeper water at its seaward termination during progress than subsequently, or than would be necessary for the safety of the bank, and thus more stone would be consumed than would be required if the plan referred to were adopted.

With regard to the alternative proposal for increasing the depth in the navigable channel, by training the currents in both channels at their confluence, so that the streams might unite and run seaward without interference: this would necessitate not only a training bank on the west side of the navigable channel of greater length than that shown on the drawings, but also two banks of similar construction, one at each side of the entrance to the Waikareau, that on the south side being joined to the training bank on the west side of the navigable channel so as to form therewith a V-shaped tongue. The other bank on the north side of the entrance to the Waikareau would be curved, and parallel to that on the south side. Thus the works for the latter mode of procedure would be fully twice as extensive and costly as those shown on the accompanying drawings, and may therefore be abandoned in favour of the former proposal, especially as it may be considered reasonably certain that the less costly project will be found to afford the relief required; and, if not, the training bank contemplated would form an essential instalment of the more extensive scheme. I do not apprehend, however, that any further works will be required in addition to the training bank of 1,000 yards in length shown on the drawings, except a wing or side bank to the westward of its northern termination, as shown by red dotted line on the drawing, which may possibly be necessary, although in all probability the main training bank will be found of itself to fulfil the objects in view without such a wing.

The precise line for the proposed training bank, and the extent to which it should contract the sectional area of the waterway at the mouth of the navigable channel, necessarily depends altogether upon the relative strength of the currents at different periods of the tide in the two channels at their present point of junction. The information available here, although ample for the determination of the principle to be adopted and the character of the work to be executed, is not sufficient to enable me to decide with certainty upon the precise direction for the training bank, so that on its completion the stream in the navigable channel shall be of preponderating strength, as compared with that into and out from the Waikareau arm of the estuary. I would therefore suggest that, if it should be decided to proceed with this bank, a set of observations on the strength of the currents should be taken, under the direction of Mr. Blackett, the Chief Engineer of the Marine Department, before actually commencing the work, and that he should be asked to decide therefrom to what extent, if at all, a departure is necessary from the direction of the bank shown on the accompanying drawings, in order to insure a sufficient concentration of the current where the two branches will meet.

#### *Estimate.*

I estimate the cost of the works recommended will be as follows:—

	£
74,238 cubic yards of rubble-stone, deposited from barges at 6s. 8d. ...	24,746
One perch or beacon ... ..	50
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	£24,796
Contingencies, 10 per cent. ... ..	2,480
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	£27,276
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Say £27,300.