

would be no risk of injury being done by shingle lodging in the channel, but should it be found that shingle had any tendency to collect behind either pier to such an extent as might endanger its being carried round the heads into the channel by the backwash of the waves—and this would be ascertained during the progress of the works—then it might be advisable to extend the piers a short distance further into deeper water; but I apprehend that this will not be required, for some years to come at all events.

As will be seen by the general plan (Drawing No. 1), the mouth of Lake Ellesmere is situate at the western extremity of a deep estuary, three-quarters of a mile in length by an average width between high-water line on either side of about 15 chains, and through which the drainage of the lake passes on its way to the sea when the mouth is open.

Referring to the enlarged plan of the estuary (Drawing No. 2), it will also be seen that the soundings marked in black figures show the depth of water in feet below high water of an ordinary spring-tide, and that it ranges throughout the deep-water channel of the estuary at from 12ft. to 23ft. for an average width of about 6 chains. The soundings outside to seaward show a depth of 15ft. at a distance of only  $1\frac{1}{2}$  chains from the line of high water on the beach at the mouth, and as much as 25ft. at a distance of 3 chains from the same line, which depth is also pretty uniform along the coast on either side of the proposed entrance. These soundings, both inside the estuary and outside to seaward, together with the character of the substratum, as ascertained by actual borings as shown on the plan, and by a series of eighteen cross-sections (Drawing No. 3), present most favourable features for establishing a permanent and deep channel at the point indicated upon the plan.

The works, therefore, that I have to recommend are shown in pink colour in the plan under consideration (Drawing No. 2), and consist mainly of a western and eastern pier or mole each extending from inside the estuary and through the shingle-bank to seaward beyond low-water mark.

The western pier extends in a direct line north and south at right angles with and through the shingle-bank. Including the wingwalls, the work is divided into four sections, each different in transverse dimensions and also slightly in design.

The first or sea sections of the pier from A to B is 300ft. in length, and is to consist of a strong timber framing of round totara or ironbark piles filled with massive concrete blocks set in courses within the framework and protected by loose blocks placed at random to seaward.

The whole of the hearting within the pile-framing to be carried up to 6ft. above high water provisionally, and when perfectly consolidated the superstructure can be added when deemed necessary.

The second section, B to C, being for the most part within the estuary, and backed up by firm ground, will consist of a timber framing similar to that just described, but of less dimensions, and filled with concrete blocks set in courses as shown by the transverse sections on Drawing No. 4 (details of design), which are common to both piers as regards the description of work.

The length of the wing or wharf-wall, CD, is 600ft., and varies in sectional dimensions and strength in proportion to the resistance necessary to be given to the strong ebb-current at this part, and also to the sea entering the channel between the piers. The wing-wall, BN, is 490ft. in length on plan, and is intended to protect and retain the high bank of shingle behind the piers; but it is doubtful whether it will be required, as I apprehend that after the pier is built the shingle will have rather a tendency to accumulate than otherwise at this point. However, I have thought it safe to provide for 200ft. of this wall in the estimate.

The work of the east pier, including the retaining-walls within the estuary, is divided into five sections. The two sections EF and FG, forming the pier, bisect the shingle-bank on a curve of 8 chains radius, so as to direct the current freely through the channel-mouth, and thus contract it to a width of 330ft. between the pier-heads, which form is the best the configuration of the locality will admit of so as to concentrate the scouring-power of the ebb-tide to the greatest advantage, also to act as a wave-trap within the entrance.

The seaward section, EF, is 300ft. in length, and that of the spit section, FG, 400ft. Both sections are the same in transverse dimensions as the corresponding sections of the western pier, as shown on the sheet of detailed drawings No. 4. The retaining-wall may be said to extend from G to J, the several sections GH, HI, and IJ increasing in transverse dimensions and strength as the work approaches the pier, those of the two first named being the heaviest, and their length is 300ft. respectively. The remaining length of this wall is 800ft., and is simply a retaining-wall to prevent the shingle being washed into the estuary by heavy seas breaking over the shingle-bank, which, although very rarely happening at this part, the work may nevertheless be required. It can be formed either with round and sheet piling or with fascines.

Apart from the works of the western and eastern piers, and the walls in connection with them, as already described, the walls KL and KM are necessary, not only as a protection to that part of the north shore of the estuary opposite the entrance against the erosion which would be caused by the heavy seas that will at times roll in through the new channel between the piers, but also to direct both the strong ebb-tide of the estuary and that of the creek towards the mouth.

The wall KL is necessarily of great length, measuring 1,100ft. on the plan, and KM is 400ft., but they need not necessarily be very expensive works, as will be seen by the estimate; and I am of opinion that the greater part of the walling within the estuary might be formed of good fascine work with great rapidity and economy.

The detailed drawing No. 4 is intended to show the description of the work as completed, but it will not be necessary that they should be carried out otherwise than provisionally for the first two or three years after the mouth is permanently opened, in order to allow of the hearting of the work between the close piling to thoroughly settle down and become consolidated by the action of the waves and the scour through the channel before the superstructure shall be carried up to the required height.