(Nos. 56 and 57.)

1882.

TASMANIA.

LEGISLATIVE COUNCIL.

PORTS AND HARBOURS:

CORRESPONDENCE, AND REPORTS BY MR. C. NAPIER BELL.

Laid upon the Table by Mr. Moore, and ordered by the Council to be printed, July 12, 1882.

PORTS AND HARBOURS.

CORRESPONDENCE.

Lands and Works Office, Hobart, 15th February, 1882.

SIR,

I HAVE the honor to request that you will have the goodness, if in your power, to aid the Government of Tasmania by recommending a thoroughly competent Engineer, of undoubted standing in your Colony, who could undertake to examine and report upon certain proposed Harbour Works in various parts of Tasmania,—naming the amount of remuneration he would require.

As it is desirable that the Government should be in possession of his Report by the end of May next, it would be necessary for the Engineer to arrive in the Colony at an early date.

It will be an esteemed favour, therefore, if you will kindly give the subject of this letter your early consideration.

C. O'REILLY, *Minister of Lands and Works.*

The Hon. the Minister for Public Works, Sydney, N. S. Wales.

Similar letters dated 14th February, 1882, to—

The Minister for Public Works, Melbourne, Victoria.
The Minister for Public Works, Wellington, New Zealand.

Department of Public Works, Melbourne, 21st February, 1882.

SIR,

I HAVE the honor to acknowledge receipt of your letter dated the 14th instant, and, in reply, to inform you that I am not aware of any competent Engineer in this Colony at present disengaged who could undertake to examine and report upon the proposed Harbour Works in various parts of Tasmania.

I would suggest the name of Mr. E. O. Moriarty, C.E., of Sydney, Engineer-in-Chief for Harbours and River Navigation for New South Wales, as one thoroughly competent to advise.

I have, &c.

CHARLES YOUNG, *Commissioner of Public Works.*

The Hon. the Minister of Lands and Works, Hobart.

Lands and Works Office, 15th March, 1882.

SIR,

I HAVE the honor, in the absence of the Hon. the Minister of Lands and Works, to acknowledge the receipt of your favour of the 21st ultimo, intimating that there was no Engineer for Harbour Works available for Tasmania, but suggesting the name of E. O. Moriarty, Esq., of Sydney, as one highly qualified for the post.

I have to thank you for your prompt attention and courtesy.

I have, &c.

GEO. F. LOVETT, *Ministerial Clerk.*

CHARLES YOUNG, *Esq., Commissioner of Public Works, Victoria.*

[BY ELECTRIC TELEGRAPH.]

Sydney, 11th March, 1882.

MR. Hickson, of this Department, nominated to report on Harbours, Tasmania. Particulars by post.

JNO. LACKEY, *Minister Public Works.*

To Minister of Lands and Works, Tasmania.

New South Wales,
Department of Public Works, Sydney, 11th March, 1882.

SIR,

IN reply to your letter of the 15th ultimo, requesting the services of an Engineer of undoubted standing here to visit and report upon certain proposed Harbour Works in various parts of Tasmania, I have the honor to inform you that it would have given me great pleasure to have placed the services of the Engineer-in-Chief for Harbours and Rivers at the disposal of your Government, but owing to the various works of magnitude now being constructed under the supervision and control of that officer, it was found that Mr. Moriarty's presence could not be spared for a considerable time to come.

Mr. Moriarty has, however, nominated Mr. Robert Hickson, an Engineer of his Branch of this Department, at present in charge of the Harbour Works, Newcastle, who is fully competent to undertake the duties required by you, and arrangements for his visit can be made upon the receipt of your acceptance of this offer of Mr. Hickson's services.

With respect to the terms of remuneration, I enclose a copy of a memorandum from Mr. Hickson, concurred in by the Engineer-in-Chief for Harbours and Rivers, which I trust will be satisfactory to you.

I have, &c.

JOHN RAE, *pro Minister for Works.*

The Honorable the Minister for Lands and Works,
Hobart, Tasmania.

IT is rather difficult to say what would be a proper charge to make for this work, as I have no idea how long it would take. When reporting for the Melbourne Harbour Trustees at various times I have received from 50 to 85 guineas for work which has occupied me from 3 to 7 days. If the work is likely to keep me a month, I should say £200, including travelling and other expenses, would be about fair. Perhaps the Engineer-in-Chief would not mind saying what he considers right, and I need hardly say I will be quite satisfied at his decision.

R. H.

If the work keeps me more than one month, I would expect £5 per day for every day beyond the month.

R. H.

Lands and Works Office, 17th March, 1882.

SIR,

I HAVE the honor to acknowledge the receipt of your letter and telegram of the 11th instant, nominating Mr. Robert Hickson for Harbour Works in Tasmania.

In reply, I have to inform you that the Hon. the Minister of Lands and Works is now absent on an official visit to the West Coast of Tasmania, therefore the matter must necessarily remain in abeyance until his return, which I anticipate will be about the 25th instant.

Thanking you for your prompt attention and courtesy,

I have, &c.

GEORGE F. LOVETT, *Ministerial Clerk.*

The Hon. the Minister for Public Works,
care JOHN RAE, *Esq., Sydney.*

Lands and Works Office, 28th March, 1882.

SIR,

I HAVE the honor to acknowledge the receipt of your esteemed favour of the 11th instant, nominating Mr. Robert Hickson for employment as Engineer for Harbour Works in Tasmania.

In thanking you for your courtesy and prompt attention in this matter, I beg leave to intimate to you that the Government has decided to accept the services of Mr. Napier Bell, of New Zealand, who has been highly recommended, and has recently been engaged on Harbour Works of a similar character to those contemplated in Tasmania.

I have, &c.

C. O'REILLY, *Minister of Lands and Works.*

JNO. LACKEY, *Esq., M.P., Minister of*
Public Works, Sydney.

Public Works Office, Wellington, 6th March, 1882.

SIR,

I HAVE the honor to acknowledge the receipt of your letter of the 14th February, in which you request me to recommend a thoroughly competent Engineer of undoubted standing in this Colony who could undertake to examine and report upon certain proposed Harbour Works in various parts of Tasmania.

In reply, I beg to inform you that Mr. C. Napier Bell, who has conducted important Harbour Works in Lyttleton, can be recommended as most suitable. I have telegraphed to him to know whether he could arrange to accept the appointment in the event of its being offered to him, and if his reply is in the affirmative I will immediately communicate with you by cable.

I have, &c.

THOMAS DICK, *Acting Minister for Public Works.*

The Minister of Lands and Works, Hobart.

[BY ELECTRIC TELEGRAPH.]

Wellington, Bluff, 12·30 P.M., *7th March,* 1882.

WITH reference to my letter of yesterday, I have now to inform you that Mr. Napier Bell will be prepared to visit Tasmania if you make him an offer to do so. His terms are a fee of Five guineas a day and all expenses. A reply is requested.

THOS. DICK, *Acting Minister Public Works.*

The Hon. Minister of Lands and Works, Hobart.

[BY ELECTRIC TELEGRAPH.]

Hobart, 15th March, 1882.

NEW Zealand nominates by wire Napier Bell, Harbour Works: Five guineas per diem and expenses. Requests a reply.

GEO. F. LOVETT, *Hobart.*

The Hon. W. R. GIBLIN, *Premier,*
Wynyard.

Lands and Works Office, Hobart, 17th March, 1882.

SIR,

I HAVE to acknowledge the receipt of your favour of the 6th instant, also your telegram of the 7th instant, nominating Mr. Napier Bell for Harbour Works in Tasmania.

In reply, I have to inform you that the Hon. the Minister of Lands and Works is now absent on an official visit to the West Coast of Tasmania, therefore the matter must necessarily remain in abeyance until his return, which I anticipate will be about the 25th instant.

Thanking you for your courtesy, I have, &c.

G. F. LOVETT.

Hon. T. DICK, *M.P., Acting Minister of Lands and Works, Wellington.*

[BY ELECTRIC TELEGRAPH.]

Lands and Works Office, 25th March, 1882.

THANKS for letter and telegram. Please instruct Mr. Napier Bell to proceed at once to Tasmania on terms named by you.

C. O'REILLY, *Minister of Lands and Works.*

Hon. Minister of Works, Wellington, New Zealand.

[BY ELECTRIC TELEGRAPH.]

Wellington, 27th March, 1882.

I HAVE instructed Mr. Napier Bell to proceed to Tasmania in terms of your telegram.

J. HALL.

The Hon. the Minister of Lands, Hobart.

Lands and Works Office, 13th April, 1882.

SIR,

I HAVE the honor to instruct you to make a general examination of the Ports enumerated below, and advise the Government of the nature and extent of the works required to make such Ports convenient and suitable for the requirements of traffic, and to give an estimate of the cost of the works proposed in each case:—

Port of Launceston..... (Including the Bar at the bend of the Swamp, and such other places as may be necessary.)	Tamar and Esk Rivers.
Mersey	Mersey River, Port Frederick.
Don.....	River Don.
Forth	River Forth.
Leven	River Leven.
Penguin Creek	Open Roadstead.
Emu Bay.....	Ditto.
Table Cape.....	Inglis River.
North-East Coast.	
Bridport.....	Forester River.
Ringarooma	Ringarooma River.
George's Bay	East Coast.
West Coast.	
Pieman Head.....	Corinna River.
Trial Harbour	Open Roadstead.
Macquarie Harbour	River Gordon.

It will be desirable to proceed first to Launceston, and then work along the North-West Coast. Afterwards proceed to the North-East Coast, and subsequently proceed to the West Coast.

Herewith are enclosed letters of introduction to the Master Warden of Marine Board, Launceston; others will follow to the various Marine Boards along the North-West Coast, who will no doubt render you every assistance.

The cost of necessary assistance of labourers, hire of boats, expenses, &c., where not provided by the Marine Boards, will be defrayed by the Government,—vouchers being supplied and certified to in the usual manner.

Payment as arranged with the Acting Minister of Public Works in New Zealand, viz., £5 5*s.* per diem, and all expenses paid.

Copies of Plans of Harbours or Rivers in possession of this Department are now being prepared for Mr. Bell's use, and fuller details of works required in each case will follow.

Instructions as to Harbours on the West Coast will be deferred until receipt of Reports on the North-West and North-East Ports.

I have, &c.

C. O'REILLY, *Minister of Lands and Works.*

C. N. BELL, *Esq., Hobart.*

Lands and Works Office, 13th April, 1882.

SIR,

I HAVE the honor to introduce Charles Napier Bell, Esq., Engineer for Harbour Works, who has been highly recommended by the New Zealand Government to advise the Tasmanian Government as to works necessary to be constructed for the permanent improvement of various harbours in Tasmania.

He has been instructed to commence by an examination of the Port of Launceston, in the vicinity of the junction of the Tamar and Esk Rivers, including the Bar at the bend of the Swamp, and such other places on the River Tamar as may be necessary.

Your Board will oblige by rendering all facilities for carrying out the instructions of the Government, allowing Mr. Bell access to all plans in their custody, and affording him such other assistance and information as lies in their power.

The question of the best method of improving the navigation of the River Tamar has been so frequently discussed between the Board and the Government that I am assured I may confidently rely upon your hearty co-operation in aiding Mr. Bell to complete his mission in a satisfactory manner.

I have, &c.

C. O'REILLY, *Minister of Lands and Works.*

The Master Warden, Launceston.

Lands and Works Office, 13th April, 1882.

SIR,

I HAVE the honor to introduce Mr. Charles Napier Bell, C.E., Engineer for Harbour Works, who has been highly recommended by the New Zealand Government to advise the Tasmanian Government as to the works necessary to be constructed for the permanent improvement of various Harbours in Tasmania.

He has been instructed to commence by an examination of the Port of Launceston, in the vicinity of the junction of the Tamar and Esk Rivers, including the Bar at the bend of the Swamp, and such other places on the River Tamar as may be necessary.

He is the bearer of a letter of introduction to the Master Warden of Marine Board at Launceston.

Knowing the deep interest you have hitherto taken in the improvement of the Port of Launceston, and that you brought the matter under the consideration of the Government during the last session, I feel assured that you will render every assistance in your power to enable him to carry out the instructions of the Government.

I have, &c.

C. O'REILLY, *Minister of Lands and Works.*

ADYE DOUGLAS, *Esq., M.H.A., Launceston.*

Lands and Works Office, 20th April, 1882.

SIR,

I HAVE the honor to introduce Charles Napier Bell, Esq., C.E., Engineer for Harbour Works, who has been highly recommended by the New Zealand Government to advise the Tasmanian Government as to works necessary to be constructed for the permanent improvement of various Harbours in Tasmania.

After completing and reporting on the Port of Launceston he will visit the North-West Coast Ports, commencing with the Mersey at Port Frederick, and taking Rivers Don, Forth, Leven, Penguin Creek, Emu Bay, Table Cape, and Circular Head in their order.

Knowing the interest taken as to the best method of improving the Harbour accommodation of the various Ports enumerated above, I am assured I may confidently rely upon your hearty co-operation in aiding Mr. Bell to complete his mission in a satisfactory manner, by allowing him access to all plans, and by affording him such other information as lies in your power in respect to those Ports coming within your jurisdiction.

I have, &c.

C. O'REILLY, *Minister of Lands and Works.*

JOHN HENRY, *Esq., Master Warden, River Don.*

Lands and Works Office, 22nd June, 1882.

SIR,

I HAVE the honor to acknowledge the receipt of your Reports on the River Tamar and Port of Launceston, also your Reports on the Harbours of the North-West Coast and Huon River, with Plans and Sections of proposed Works, made under the instruction of this Government; and, while sharing in your expression of regret that the time you had at your disposal did not admit of your reporting on all the Harbours which the Government required, I desire to convey to you, on behalf of the Government, my thanks for the very expeditious and satisfactory manner in which you have discharged the important duty entrusted to you.

I avail myself of this opportunity to acknowledge the obligation I feel I am under to the New Zealand Government for permitting you to undertake the duty, and affording the Tasmanian Government the benefit of your professional advice.

I have, &c.

C. O'REILLY, *Minister of Lands and Works.*

C. N. BELL, *Esq., M.I.C.E.*

Lands and Works Office, 22nd June, 1882.

SIR,

I HAVE the honor to inform you that Mr. Bell, C.E., has reported in a very satisfactory manner on certain Harbours in Tasmania; and, while regretting that time did not permit of his visiting several of the Harbours enumerated in his instructions, I desire to express to you my thanks, on behalf of the Goverment, for placing the professional services of a gentleman so highly qualified as Mr. Bell at the disposal of the Tasmanian Government.

I have, &c.

C. O'REILLY, *Minister of Lands and Works.*

Hon. THOS. DICK, *M.P., Wellington, New Zealand.*

REPORTS BY MR. C. NAPIER BELL, *C.E.*

I.—RIVER TAMAR AND THE PORT OF LAUNCESTON.

Launceston, 26th April, 1882.

SIR,

ACTING under the instructions conveyed to me in your letter of the 13th April, I have examined the River Tamar and the Port of Launceston; and having put myself in communication with the Master Warden and the Marine Board, they were kind enough to accompany me down the river and to point out all the places where navigation is difficult, and to explain the different projects which had been suggested for the improvement of the Port.

I have, therefore, the honor to submit to you the following Report:—

Plans. On arriving here I found that there were no plans of the Port and of the River Tamar, only an Admiralty Chart of the year 1830. In order to design any works for the improvement of the River or Port, plans are absolutely necessary. I at once proceeded to make one of the Port, but I had no time to make one of the River Tamar, which is an extensive work and would take some months to complete.

The Tamar. The River Tamar has a course of about 40 miles from the sea to the Port of Launceston. In the lower part of its course the river forms a wide estuary, with deep water; the upper part is more contracted, but there is deep water as far as Swan Bay, and above this the course is obstructed with shoals on which at low water there is only from 9 to 12 feet.

Tides. The extremerise of tide at Launceston is about 13 ft. 4 in., and at neap tides about 8·6 or 9 feet, varying with the strength and direction of the wind. This range of tide causes very strong currents both into and out of the river, and the tidal flow extends some 7 or 8 miles above Launceston. Throughout the greater part of the year the fresh-water flow of both North and South Esks combined is very insignificant compared to the tidal flow, which latter is the cause of the river maintaining its depth by sweeping out to sea the silt and sand brought down by the rivers.

Deepened by steamers. It was pointed out to me that the channels of the river have increased in depth several feet within the last few years in consequence of the disturbance caused by the passage of steamers over the shoals. In its present condition ships drawing 18 feet and measuring 1000 tons are easily brought up to the wharves by following up the tides; sailing ships usually sail up the river and are towed out of it, as the prevailing winds blow up the stream. Both sailing vessels and steamers suffer more or less delay in waiting for the tides, and it is to remedy this defect that the improvements are wanted in the Tamar. The principal and most serious obstructions to the shipping occur at the Port of Launceston.

Improvements of Tamar. The obstructions to navigation commence at Cimitiere Point; from here to the Port there is a good channel, with sufficient depth of water for the greater part of the distance, but there are four or five places where shoals occur which require dredging:—First, from Cimitiere Point upwards, about half to three quarters of a mile should be deepened four feet. Second, from Big Muddy Creek to Pedder's Point, about one mile, requires to be deepened about three feet. Third, at Pig Island, what is called the Boat Channel for a length of over one mile should be deepened from three to five feet. The dredgings from this channel should be deposited behind Pig Island. What is called the Old Ship Channel at Pig Island was formerly the deepest, but within the last few years the more direct channel called the Boat Channel has been increasing in depth, and becomes deeper with the passage of steamers through it. I think it would assist the scouring action of the tides if the Old Ship Channel were filled up with the mud from the dredgings across its lower part, by which the current, being checked in the channel, it would soon silt up to the level of the rest of the shoal, and the currents at the last of the ebb and first of the flood, when they are most effective for scouring purposes, would thus be concentrated in the New Boat Channel. Fourth, there are two shallow places at Barn's Bar, just below Launceston, which should be deepened 6 or 7 feet for a length of 600 yards. But the whole of the channel for upwards of a mile below the bar at Launceston requires dredging about 2 feet. Altogether, about 3½ miles of the river should be dredged; the rest of its course is free of all obstructions. There are several patches of soft rock in the river, but as there is abundance of room to avoid them, it is only necessary that they should be buoyed. There is, however, a rock in the Whirlpool Reach which should be removed so as to give greater depth than there is on it at present; this is of small extent and could be easily removed.

Nelson Shoal. The dredgings at Pedder's Point should be landed on the Nelson Shoal, close to and below Pedder's Point, in as shallow water as possible, so as to avoid the least chance of the currents carrying any of the mud back into the river. I do not think it would be safe to deposit the mud from the dredging on the mud banks of the river, unless positions completely sheltered from currents were to be found; and this involves the necessity of landing the dredgings on the river banks above high-water mark, which greatly increases the cost of the work.

Quantity raised. The Marine Board has procured a Priestman's dredge, which is said to be capable of raising about 350 cubic yards per day of 8 hours, or 440 cubic yards per day of 10 hours,—equal to 480 and 600 tons respectively. This is an economical form of dredge, but to do the work in a reasonable time two of them should be employed, one in the river channels, and one in the Port of Launceston. Twelve or fifteen punts should be provided for conveying the mud to the shore, capable of holding from 25 to 28 tons each.

Landing the mud. Wherever the dredgings are to be landed, it will be necessary to erect light temporary jetties, extending from the shore as far out as is required to bring the punts alongside at all states of the tide, or rather to half-tide mark, as may be found convenient for working. On the jetties a line of light rails should be laid, and the tramway must be extended as far as is necessary to convey the material. The mud from the punts should be lighted in iron tipping-buckets, holding from $\frac{3}{4}$ to 1 cubic yard; and a steam-winch attached to 6-horse power vertical boiler should be erected on the wharf to raise the buckets, which would be discharged into trucks on the tramway. It is important to procure for the work the best plant and appliances, as the cost is thereby greatly reduced.

Barns' Bar. On the beach near the port at Barns' Bar the dredgings may be landed on the east side of the river, and used to widen the river embankment.

Choice of dredges. The work done by a Priestman dredge is slow compared with a ladder dredge; but under the circumstances in which the dredging must be done in this river, the former would probably do the work quicker and almost as cheaply. Thus a Hopper dredge, to carry 400 tons or 300 cubic yards, would cost, say, £13,000, but it would take 3 days to raise 300 cubic yards, convey it to sea, and return to its work; this would be at the rate of 100 cubic yards per day; while a Priestman dredge would raise 350 cubic yards in the same time. The cost per cubic yard taken by Hopper dredge to sea would be about 1*s.*, that landed from the Priestman dredge would be, say, 1*s.* 5*d.* The Hopper dredge would cost say, £13,000, while the Priestman and its plant for landing would cost £6000. Thus, if the total quantity of mud to be disposed of were 420,000 cubic yards, the dredging by the Priestman would cost, say, £1750 more than by the Hopper dredge, and against this must be placed the delay and risks of the repeated trips of the loaded Hopper out to the open sea in all weathers. I would therefore recommend that the work be carried on by a Priestman dredge.

Cost of work on Tamar River. There are no data by which I can form an idea of the quantity of dredging required in the $3\frac{1}{2}$ miles mentioned above as necessary for the improvement of the upper part of the river,—I can only form an estimate of the quantity which can be raised yearly by one Priestman dredge. Taking the work done per day at 350 cubic yards, and 250 working days in the year, the quantity amounts to 88,000 cubic yards per annum. The cost of landing this would be from £5500 to £6000; and adding for contingencies, management, wear and tear of plant, &c., the cost would be between £5900 and £6650 per annum.

Cost of plant. To undertake this work about £6000 of plant is required, the interest on which sum must be added to the yearly cost.

Time to complete. The length of time that this expenditure will continue can only be ascertained when a survey of the river is completed. And I would here

Chart of river. suggest that a proper chart of the river should be made before any work is undertaken. The chart should extend from the Port to Swan Bay. It should be a "marine survey," showing all soundings reduced to L. W. S. T., and drawn to a scale of, say, 200 ft. to 1 inch.

Tide-gauges. A correct line of levels should be taken down the river, and from it tide-gauges should be erected at convenient points, with all zeros on the same level, and from these gauges the soundings should be taken.

Section of river. From the soundings a section of the river bottom should be plotted, and from the gauges the ranges of the tides and the inclination of the surface of the water should be shown from L.W. to H.W. taken at the same instant, say every quarter of an hour, from

Use of chart. the Port to Swan Bay. Such a section is very useful as a standard reference which will show at any future time the changes in the tidal range produced by the dredging. The chart and section together will show the quantity of dredging to be done, and the depth and extent of the shoals and channels.

Depth of dredging. As regards the depth to which the shoals should be dredged, it would be very costly, and in my opinion almost unnecessary, to provide sufficient depth at L.W. for the deepest

draft of vessels ; and even if contemplated for the future it need not be undertaken at present. If the shoals were dredged to 14 feet at L.W.S.T., I consider that depth would be quite sufficient for the present, and this would very much reduce the delay at present suffered by ships navigating the river.

Improvement of Launceston.

The improvement of the Port of Launceston I have taken as distinct from the dredging of the Tamar, as I have better means of judging of the cost and the nature of the work.

The "Bar."

At the Port, the North and South Esk Rivers joining form the Tamar. At the junction a wide basin is formed which is filled at H.W., but the mud-flats are exposed at L.W., leaving only narrow channels in which each river flows to form a junction at the so-called bar. The Tamar River just below the town suddenly shoals from 12 ft. at L.W. to 4 ft. on the bar, and the depth only increases to 5, 6, and 7 ft. ascending the river up to the bridge. The accompanying plan shows the channels and the soundings at L.W. The bottom on the bar appears to be clay and sand, mixed with boulders and small stones, brought down from the Cataract in the South Esk. Above the bar and up the North Esk the river bottom is mud and sand.

Former proposals.

Present project.

Many proposals have been suggested to improve the Port of Launceston,—among others, to cut across the bend of the river above the bridge, or to cut away the point below the wharf in a line with the same. I consider these works would be too costly, and not of decided utility, and would prefer to recommend that the present channel be preserved, and deepened to 12 feet below L.W.S.T. as shown on the longitudinal and cross sections herewith.

As the material dredged in deepening the channel must be landed somewhere, I propose that it be made use of to extend the wharves and reclaim a valuable site adjacent to them, as shown in the plan herewith.

Additional berths.

By making this reclamation the steamers which require the quickest despatch would be able to occupy the wharf nearest to the main river channel (B. to C. on plan.) This length would hold three steamers, and that from A. to B. would hold three or four ships, according to their length. Thus additional berthage for 6 or 7 ships would be afforded by making this use of the dredgings, and an area of $15\frac{3}{4}$ acres would be reclaimed, the value of which would diminish the cost of the works.

West face to be timbered when wanted.

The west side of the reclamation would only have a stone embankment to keep up the reclaimed land, but a timber wharf could be added to it when required, for the use of small craft, and the scouring action of the South Esk would preserve the depth of water along the greater part of this wall.

Point cut away.

To give a straighter entrance and more room at the wharves, a part of the opposite point should be cut away, and the material placed in the reclamation.

Works proposed.

Mode of construction.

The works which are proposed to retain the reclamation are shown on the drawings, in which Figure 1 is the retaining wall, and wharf from A. to C. on plan; Figure 2 is about 400 feet of the west wall from C. towards D. where it would be most exposed to the current from the South Esk ; Figure 3 is the remainder of the same wall to H. W. mark. This form of wall and wharf is costly, but I could not recommend the use of timber only on these mud-banks with such a weight of earth deposited at the back of the wharf. In constructing this work the mud must first be dredged in a trench, say 6 or 7 feet wide at the bottom, and roughly sloped, say 2 to 1, on the inner side ; in this soft mud with the action of the tides the sides will probably slope themselves; into this trench the stone rubble must be thrown at low water to form the sloping toe of the wall. The stone should be deposited carefully to the proper line, and when the slope has reached the level of the mud-flats the rest of the stone may be thrown in from barges, casting it out along the centre line, care being taken not to waste the stone by throwing it outside the intended slope, which is $1\frac{1}{2}$ to 1 on the outside, and $1\frac{1}{4}$ to 1 on the inside next the shore. The stone if carefully thrown out along the centre line of the top will take its own slope with sufficient accuracy. Above H. W. mark a built wall of rough dry rubble is then up to the level of the reclamation ; this form of top is intended to save stone, as the quantity increases greatly when sloped to the additional height.

Quantity to be dredged.

Sheet II. shows cross sections of the portion of the river inside the port which requires to be deepened; from these and the longitudinal section it is seen that the quantity to be dredged amounts to about 278,000 cubic yards.

Railway wharf.

On the plan is shown 900 feet of a proposed wharf for railway use, and sites are indicated for goods sheds alongside the wharf. The General Manager, Mr. Lord, is however of opinion that the sheds would be better placed inside the railway grounds on the west side of the road, and this is a subject for future consideration. The railway wharf as shown will accommodate five ships, and is capable of extension.

Wharf accommodation.

The wharf accommodation in the Port at present amounts to 1250 ft. used by large ships and steamers, and 1030 ft. of what is called Market Wharf used by schooners and small craft; the total is 2280 ft.: but there is a part of the river frontage extending to Sydney Place, belonging to private owners, which ought to be in the possession of the Marine Board.

Additions to wharfage.

The proposed new works would add 1290 ft. to the wharf accommodation, but it would abolish the Market Wharf; and I would suggest that when the new works are finished the upper part of the old wharves should be used for small craft and market boats, and the lower part of the old and all the new wharf for steamers and large ships. The additional accommodation would thus be only in reality about 260 ft., until the west face of the reclamation is brought into use, when 850 ft. additional would be added to the wharfage, and when this were done there would be altogether 3550 ft. of wharf, exclusive of 900 ft. of Railway Wharf.

Not to interfere with Market wharf.

In order not to interfere with the traffic at the Market Wharf during the construction of the new works, it would be necessary to construct the retaining-wall and wharf, from A. to B. on plan, before obstructing the water space in front of the Market Wharf.

Private frontages.

There is at present a wharf on the south shore of the proposed reclamation which is private property; it is of little use now as a wharf, as there is only 4ft. 6in. of water beside it at H.W., which makes it unworkable; this site should be bought up, or the owner compensated for whatever loss he may sustain by the new works: in any case it is undesirable that private persons should own the frontage of a port, and it would probably pay the Government or the Marine Board to extinguish such titles.

Repairs to old wharf.

If the river is deepened as here proposed, it will be necessary to strengthen and repair the old wharves, which are even now subsiding and falling over by reason of the undermining scour of the water, and they will do so still more when the channel is deepened. I cannot judge accurately of the cost to make such repairs, but in the attached estimate I have added a sum for this purpose.

Estimate of cost.

I estimate the cost of the works proposed in this Report as follows:—

	£	s.	d.
Dredging and landing 278,000 cubic yards of mud....	19,691	0	0
Retaining-wall and wharves of timber	17,929	0	0
Repairs to old wharf, say	2480	0	0
Contingencies, management, &c.....	3009	0	0
	£43,109	0	0

Deduct saleable value of 15¾ acres of reclaimed land—	£	s.	d.			
Railway Wharf, 900 ft.....	6390	0	0			
Extension of embankment, filling up sidings, and shed sites	881	0	0			
				£7271	0	0

Cost of improving the upper reaches of the River Tamar, undetermined.
Annual cost, with interest on plant, say £6260 to £7000.

Continuance of dredging.

As both Esk Rivers in times of flood bring down a large quantity of silt and sand, it will probably be found that some small amount of dredging will require to be carried on at all times, and it is also probable that the dredged channels in the Tamar may require to be dredged again from time to time to remove the silt that may accumulate slowly in them; but experience will be the only guide as to what amount of work this will entail, also whether new shoals will slowly form where at present there is deep water. I cannot recommend the construction of training-walls to protect the channels, as the cost would be very great and the effect doubtful. The force of the currents in the river depends on the quantity of tidal water flowing in and out of it, and training-walls, unless placed with great judgment, might seriously obstruct the range of the tides.

In conclusion, I have to acknowledge the assistance and information kindly afforded to me by the Master Warden, Captain Gilmore, and the Members of the Marine Board, and also by the Harbour Master, Captain Ling.

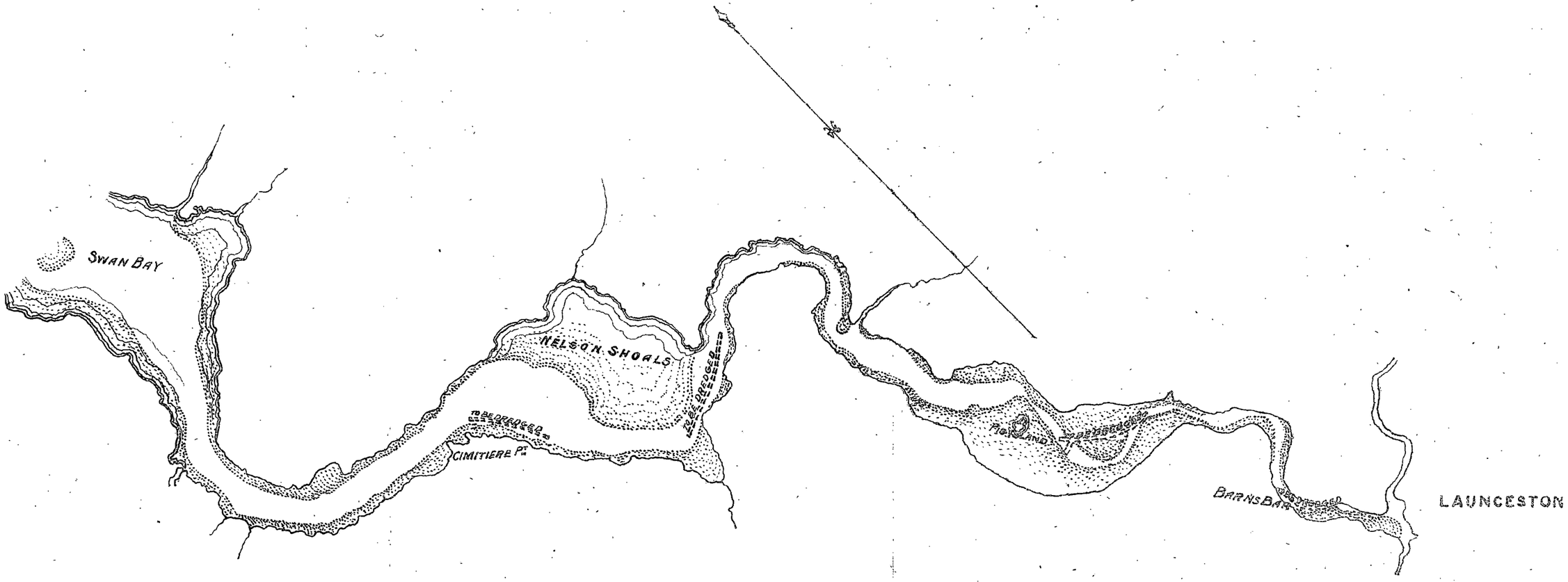
I have the honor to be,
Your obedient Servant,
C. NAPIER BELL, *M. Inst. C.E.*

To the Hon. the Minister of Lands and Works.

— RIVER TAMAR —

— FROM —

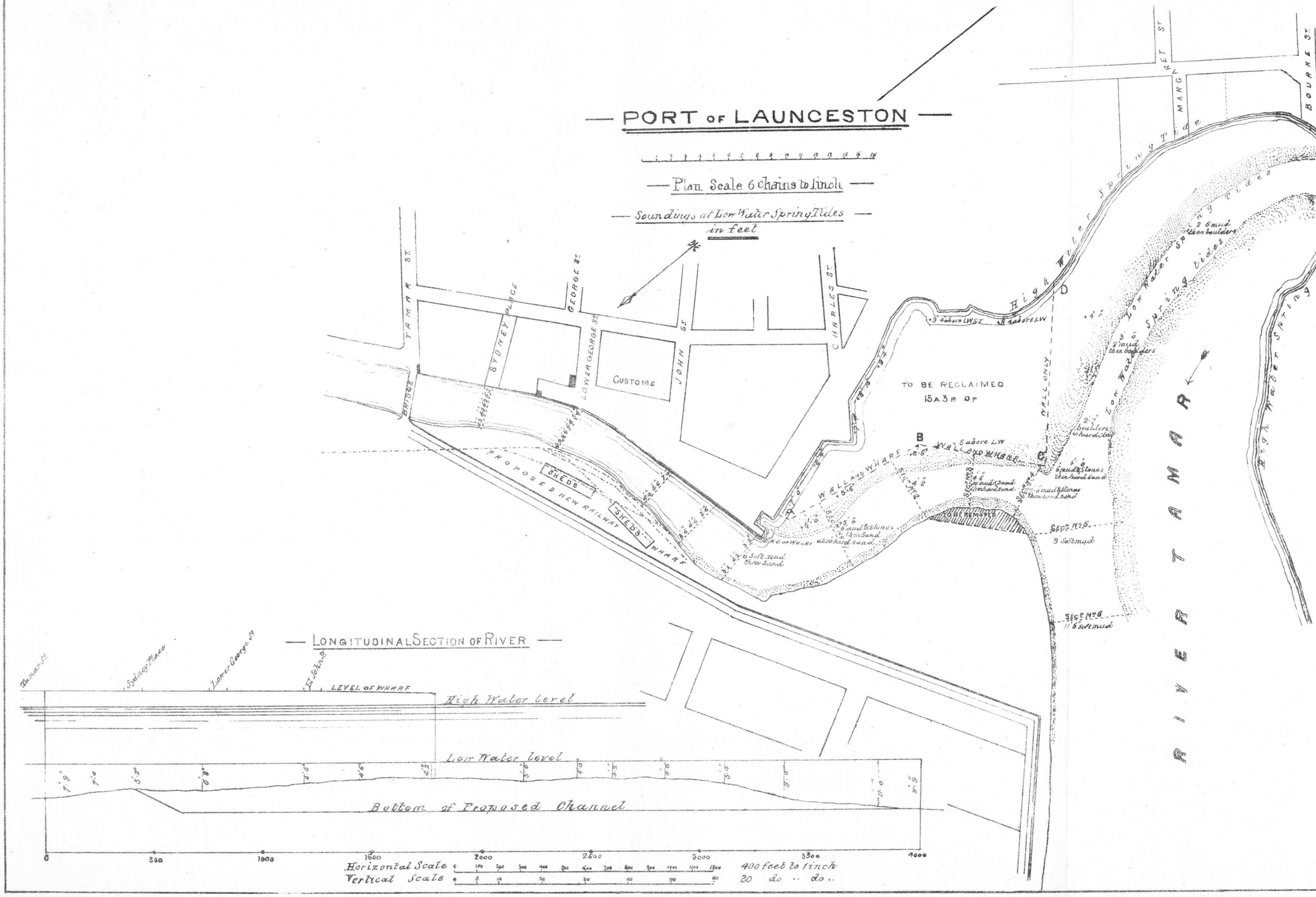
— LAUNCESTON to SWAN BAY —



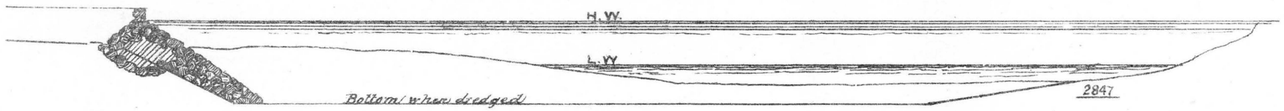
PORT OF LAUNCESTON

Plan. Scale 6 chains to Inch

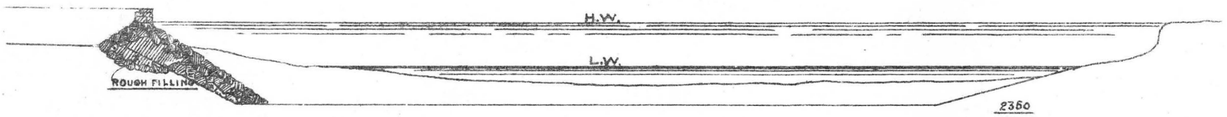
Soundings at Low Water Spring Tides in feet



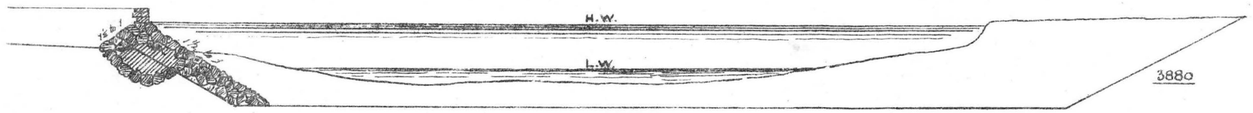
LONGITUDINAL SECTION OF RIVER



SECTION 1

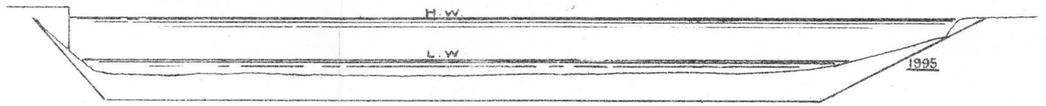


SECTION 2

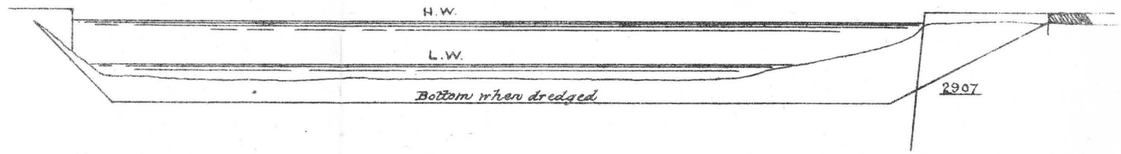


SECTION 3

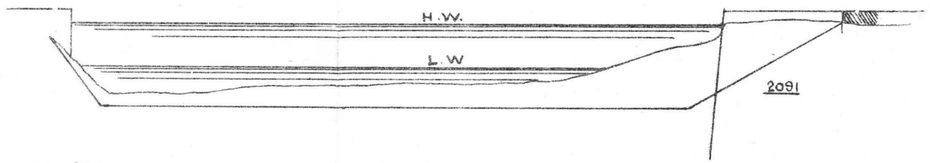
SECTION
of River at lower corner of Wharf



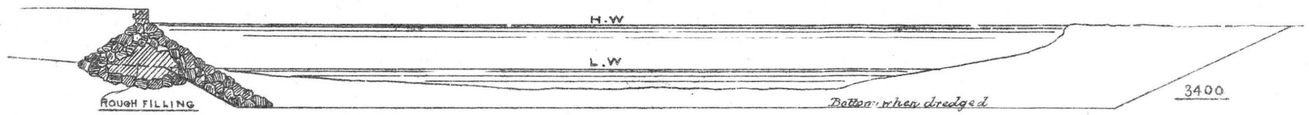
SECTION
Railway between John Street and end of Wharf



SECTION
St John Street

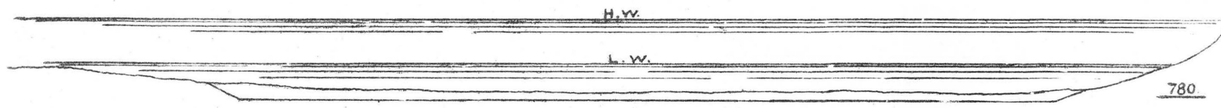


SECTION
at lower George Street

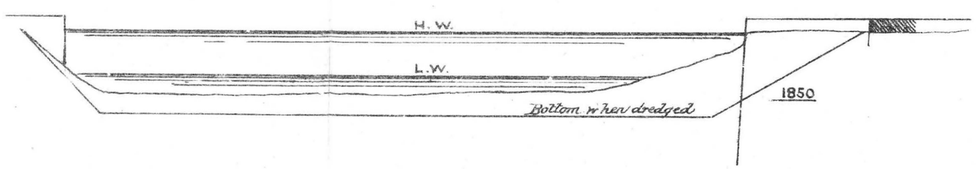


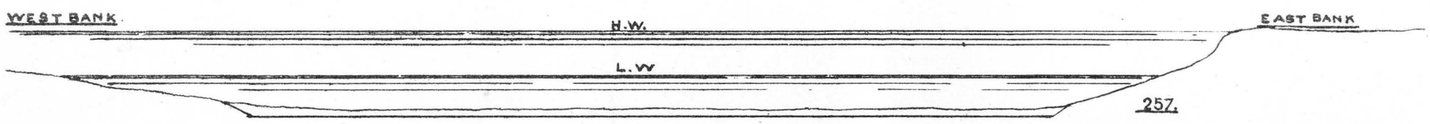
SECTION 4

SECTION
at Sydney Place



SECTION 5.





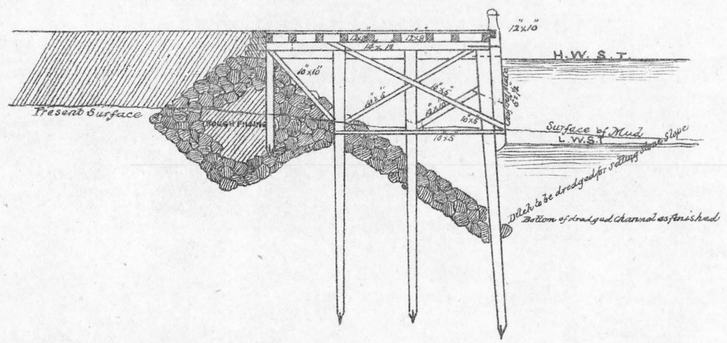
SECTION 6.

SCALE 40 FT to 1 INCH

PORT OF LAUNCESTON.

FIGURE 1.

Wharf to reclaimed land — A to B & C

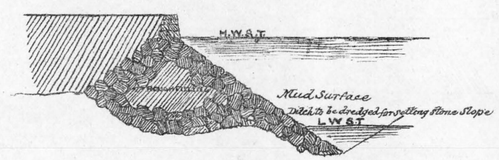


SECTION

SECTION

FIGURE 2

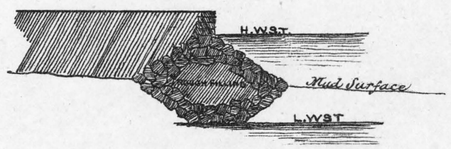
Wharf to reclaimed land to be dredged and wharf added if required from C 400 feet towards D.



SECTION

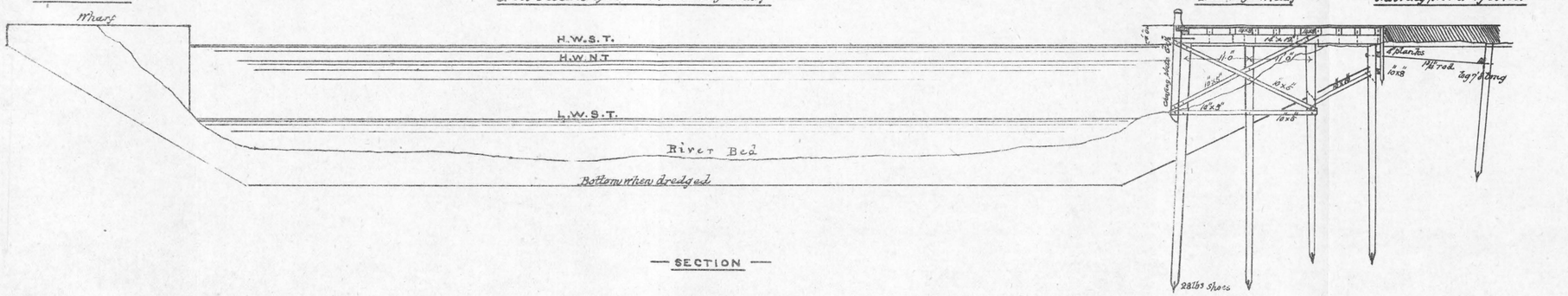
FIGURE 3.

Wharf to reclaimed land from D 450 feet of this towards C



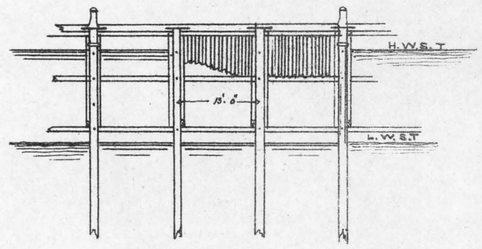
SECTION

FIGURE 4.



SECTION

FIGURE 5.



ELEVATION

SCALE 20 FEET TO AN INCH

5 10 20 40 60

II.—HARBOURS OF NORTH-WEST COAST AND HUON RIVER.

Lands and Works Office, Hobart, 28th May, 1882.

Sir,

Herewith I beg to submit my Reports on the Harbours of the North-West Coast and the Huon River, along with plans and sections of proposed works for the improvement of the same.

I regret that the time which I have at my disposal did not permit of my reporting on all the harbours which you required, as important works on which I am engaged in New Zealand require my immediate return, and I had arranged to be absent only two months.

As there was much data to be collected for the purposes of these Reports, more time has been taken over the work than I anticipated.

I am glad to have this opportunity of acknowledging the kindness and assistance which was cordially given me by the Engineer-in-Chief, Mr. J. Fincham.

I am,
Sir,
Your obedient Servant,
C. NAPIER BELL, *M. Inst. C.E.*

The Hon. the Minister of Lands and Works.

RIVER MERSEY.

In accordance with my instructions I arrived at Latrobe on the 27th April, and at once put myself in communication with Mr. John Henry, the Master and the Members of the Marine Board, who were kind enough to accompany me down the river in a boat. I was thus enabled to examine the estuary, and to make soundings on the bar at low water. I have to thank Mr. J. Henry for placing at my disposal certain plans and soundings of the river made for him by Mr. T. Townshend, C.E., which were very useful to me. From these and from other sources I have made the additions to Captain Stanley's chart, which is submitted herewith; the longitudinal section of the channel is taken from soundings made by Mr. Townshend.

The River Mersey at its lower part is a large estuary, up which the tide flows as far as the Town of Latrobe. The port of Latrobe is formed by a creek which flows out of the river near the town, and enters the estuary at the Ballast Ground after a course of about three-quarters of a mile. It is in fact one of the mouths of the Mersey; but the opening into the river is nearly blocked up, so that very little water from the river flows through it, and the tide merely rises and falls in it with a range of seven feet, sufficient to permit vessels drawing six or seven feet to come up the creek. On the right hand there are several small wharves belonging to private owners. The creek is so narrow that ships cannot be turned, except at places dug out for the purpose; it is therefore contemplated in improving the port to make wharves at the mouth of the creek in the open estuary, where there is more room and the water is deeper. This situation has the disadvantage of being placed on a hillside, with rather steep inclinations, sloping to the water's edge, which would be very inconvenient for the formation of roads, the site of sheds, &c. Altogether the situation is not advantageous.

The Marine Board are taking steps to deepen the creek from its mouth in the estuary to the wharves at Latrobe, and to widen it opposite these latter. This will facilitate the traffic of small craft, which at present are greatly obstructed by shoals and bars in the creek, which are dry at low water.

In addition to the obstructions to navigation occurring in Latrobe Creek, the main estuary is shallow in places, as is seen by the section accompanying this report. The improvement of the Port of Latrobe requires that these shoals should be dredged, and a channel made through them of at least 150 feet wide. Latrobe Creek must also be dredged and widened to make it serviceable for even small vessels. The dredging in the creek would be chiefly boulders and shingle, and there are one or more places where narrow bars of rock crop up in the bottom, which must be removed by blasting.

The shoals in the estuary are mostly sand and mud. With a Priestman dredge there would be no difficulty in deepening Latrobe Creek and the shoals of the estuary, and I believe, when dredged, the channels would be permanent, requiring, perhaps, an occasional re-dredging to remove deposits of silt; although it is quite possible that the tidal currents might prevent any such deposits, especially if steamers were passing frequently through the channels.

Port of Latrobe.

It must be acknowledged that the Port of Latrobe is badly situated, both as regards its site and the character of the waterway leading to it, and much money must be spent to make it even a tolerable port. From the plans and sections herewith it will be seen that to attain a depth of 8 feet at low water right up to Latrobe wharves, the shoals in the estuary and Latrobe Creek must be deepened; the latter must also be widened almost throughout its length of three quarters of a mile, and a turning-basin must be dug for the convenience of turning vessels. If a channel were dredged through the shallows of the estuary only 150 feet wide, as provided for in these estimates, it is likely that a steam-tug would be required to tow vessels through the channels, as it must be difficult for sailing vessels to keep the centre and avoid grounding on the banks.

Lower Mersey.

The lower reaches of the Mersey are very deep, and near the mouth of the river there is from 12 to 23 feet at low-water. The village of Formby offers an unexceptionally fine position for a port, there being deep water close to the banks, and a large extent of level land for the site of a town; the locality is picturesque, which is also an advantage in its favour.

Railway.

I understand that it is the intention of the Government to extend the Railway from Deloraine to Latrobe and to continue it further westward; in that case it would be important to make the line through Formby, where a good port exists, which would thus be placed in communication with the inland districts; and if the line were continued further west, the products which are now shipped at such small rivers as the Don, the Forth, and the Leven could be collected at the Mersey to be shipped in large vessels, whereby great economy in freight is obtained and the sea risks are proportionately reduced.

Comparison of cost.

It is quite likely that the railway from Latrobe to Formby would cost more than it would to deepen the shoals and improve the navigation up to Latrobe; but, if the line to Formby is considered as part of a system for the extension of railway communication along the coast, it would serve both local and general traffic, while the improvement of navigation in the Mersey would only serve the port of Latrobe; from which it appears evident that the money would be better spent in making the railway to Formby.

Continuance of present traffic.

I think it is probable that even were the railway extended to Formby, there would be a number of small coasting craft that would find it more economical to navigate the estuary up to Latrobe than to discharge their cargoes at Formby to be forwarded by rail to Latrobe; and for their convenience it might be advisable to spend some money in improving the Latrobe Creek to make it more suitable for such traffic than it is at present, and for this purpose the work intended to be carried out by the Marine Board would be serviceable in any case.

Deepening bar.

It would be a great advantage to the Port of Formby if the Bar could be deepened by even three feet. At present there is seven feet on it at low-water spring tides; the bottom consists of boulders and shingle, but towards the eastern shore it is sand. I had no means of boring the bottom to find how thick the bed of boulders are, nor to prove whether the sand on the east side of the channel overlies the bed of boulders and shingle.

It seems evident that no concentration of the current by means of training-walls would disturb these boulders, and nothing but removing them by dredging would effect the purpose of deepening the bar. It seems probable, from the similarity of the mouth of the Don to that of the Mersey, that the boulders merely form a covering to a bottom of sand; and if that should prove to be the case, by removing the boulders the bar might become deeper by the current sweeping away the sand below them as soon as it was exposed to the action of the tides.

It will be seen by the section herewith that the sea-bottom just outside the bar is sand, which extends inside the bar along the eastern shore. If the eastern side of the entrance should prove to be sand for some depth down, then, by making a training-wall along the sandbanks just above low-water mark, the tidal currents would be concentrated so as to cause the channel to be deepened on the east side; but borings must be taken to ascertain the nature of the bottom before such works are determined on. A training-wall would be very costly, therefore I think it would be more satisfactory to endeavour to deepen the bar directly by dredging the boulders and shingle for a width of at least 250 feet, and to the depth of 10 feet at low-water spring tides; this, with an ordinary range of tide of 9·6, would allow a ship drawing 13 feet to enter at half-tide, or one drawing 16 feet to enter at ordinary high water.

Of course a signal station would be necessary, to inform ships of the depth on the bar at the time they intended to come in.

Work could be done on the bar only during smooth weather; if therefore it is to be done in a reasonably short time, a considerable cost must be incurred in plant, such as punts and a steam-tug, because it would not be economical to remove the dredge from its work for the purpose of discharging the dredgings.

On the plan accompanying this Report the position and extent of the dredging required to deepen the bar is shown in red lines. The channel would be 250 feet wide and 800 feet long; the depth of stones to be removed would be 3 feet. The width of 250 feet is the very least that would suffice for navigation, and if means were available this width should be increased to 400 feet.

The shingle and boulders on the bar will offer considerable resistance to dredging with a pronged grab-dredge, which must be of extra strength to deal with this kind of material.

Training-wall.

When the bar is dredged it will soon be seen whether the scour of the tides will keep it open or not. I have little doubt that the depth gained by dredging will be preserved; but if it should appear that there is a tendency to silt up to the original depth of 7 feet at L.W.S.T., then it will be necessary to construct the training-wall as shown on the plan; the effect of the work will be to cause a strong current in the opening opposite its outer end which will sweep any deposits into deep water.

The prevailing winds and the heaviest and most frequent gales are from the N.W.; the ebb tide out of the estuary is deflected by the wind and waves towards the N.E., and this carries all sand and silt brought out of the river towards the eastern shore; this action is plainly seen in this river, as the bare rocks are exposed on the west side, and on the east coast the rocks are buried in sand. From this circumstance I should expect that deposits brought out of the estuary by the ebb tide and land floods would be carried past the end of the training-wall and out to sea in a N.E. direction, leaving the channel of the bar unimpeded. The same deposits being washed ashore by the N. and N.E. gales, would accumulate on the east side of the training-wall and protect it from the violence of the sea.

Width of opening.

The width of the opening from the end of the training-wall to the west shore is about 1050 feet. This is a great width, but it is better to have the opening too wide than too narrow, and especially if the bar is only to be deepened to 10 feet in a channel only 250 feet wide. If it were intended to make the bar still deeper, the opening might be narrowed with advantage, but care must be taken not to contract the entrance too much unless the depth can be proportionately increased either by natural scour or by removing the boulders; if the entrance is too small, the effect would be that the upper parts of the estuary would receive less tidal water before the tide at sea began to fall: and it must be borne in mind that it is the tidal flow in and out that keeps the bar open, as the river water is a mere trifle compared with the tidal flow.

Training-walls in upper estuary.

If at any time it should be found necessary to build training-walls along the dredged channels in the upper parts of the estuary, care should be taken not to exclude the tide from any part of the present tidal area; and with this object the training-walls should be raised to the height of half-tide only, whereby all the good effects produced by the walls in increasing the scour are obtained, as it is the first of the flood and last of the ebb which produce the best effects.

In reference to the depth of water on the bar, Captain Stanley observes that the floor of the south jetty at Torquay is considered to be 14 ft. 6 in. above low water spring tides. I am informed by Mr. T. Townshend, C.E., that when the tide falls to that level there

is 7 feet water on the bar. I sounded at L.W. neap tide and found 10 feet on it, and I observed that L.W. of spring tides was 3 feet lower, which corresponds with Mr. Townshend's soundings.

Plans. On Sheet No. 1 accompanying this, the longitudinal section shows the bottom of the channel from Latrobe Creek to the sea, and on it is indicated by a red line the depth of dredging required to secure a channel up to Latrobe of 8 feet at L.W.S.T. Cross sections are also given of Latrobe Creek and the channel in the open estuary. The width to which dredging would be done in the creek is 60 feet, and in the estuary 150 feet.

The dredgings in the creek could be landed on the left bank; that in the estuary might be landed on the mud-flats, provided it were in a sheltered position, where there would be no danger of its being again washed into the river.

Training-wall. The same sheet shows cross sections of the training-wall at the bar. The central part of this wall may be made of stone weighing one or two hundredweight, but the exposed faces must be covered with heavy rock of one to three tons, otherwise there is danger of its being levelled by the waves.

The stones may be deposited from staging, or dropped out of barges, and the waves will arrange the slopes to the best inclination; where the waves are rough this will assume a very flat slope, and the quantity of stone will be proportionately great. It is to be expected that the sand will accumulate on the east side, and be removed on the west, consequently the wall may sink on the inside, and must be made up as it subsides.

Timber wall. The wall is shown as built up to high water of neap tides, this height being sufficient for the purpose. The necessity for using large stone makes such a wall very costly. I have considered the question of making it with timber crib-work, filled with stones, but I am of opinion that such a structure would not be satisfactory, and would cost nearly as much in the long run. The rapid destruction of the timber by decay and sea-worms would soon let the stones loose, and they would then be swept away by the sea.

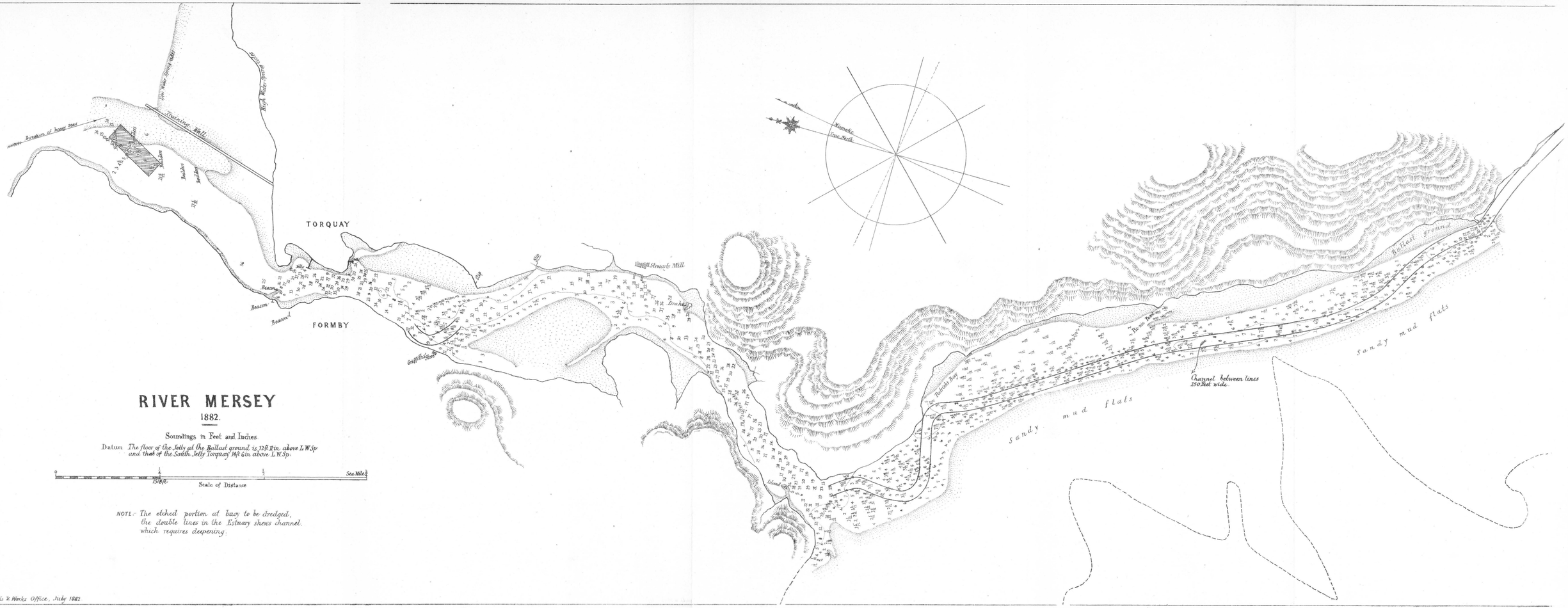
Cost. The estimate of cost given below must be considered as only approximate; a more accurate survey and levels and more time being necessary to attain exact calculations of cost. I have divided the estimate into two parts, one being the cost of deepening the estuary and Latrobe Creek to eight feet at L. W., the other is the cost of deepening the bar; but I have taken no account of any improvements such as wharves and jetties inside the port, as it is probable that funds may not at once be available for more work than is here estimated. The wharves at present are mostly private property.

		£
Dredging Channel to Latrobe to 8 feet at L.W.:—		
Excavation, dredging, removing rock-beds, &c.		13,465
Extra plant in addition to dredge on hand		750
		£14,215
Cost of dredging the Bar to 10 feet at L.W.:—	£	
Dredging Bar	4812	
Plant, dredge, punts, &c.....	2150	
		6962
Training-wall.....	5498	
Extra plant, staging, &c.....	1600	
		7098
TOTAL.....		£14,060

I have, &c.

C. NAPIER BELL.
1 *May*, 1882.

The Hon. the Minister of Lands and Works, Hobart.



RIVER MERSEY

1882.

Soundings in Feet and Inches.

Datum The floor of the Jetty at the Ballast ground is 32ft 11in. above L.W.Sp. and that of the South Jetty Torquay 14ft 6in. above L.W.Sp.

0 1/4 1/2 Sea Miles
1580 Feet
Scale of Distance

NOTE:- The etched portion at buoy to be dredged, the double lines in the Estuary shews channel which requires deepening.

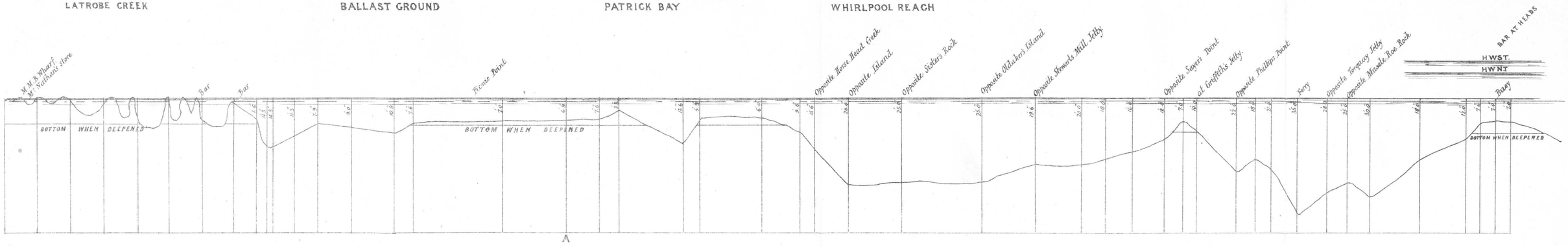
Lands & Works Office, July 1882

SECTIONS

Horizontal 0 5 10 15 20 30 40 50 Chains 60 Scale

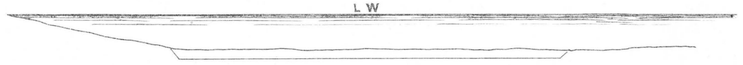
Vertical 0 5 10 15 20 30 40 50 Feet 60 Scale

LATROBE CREEK | BALLAST GROUND | PATRICK BAY | WHIRLPOOL REACH

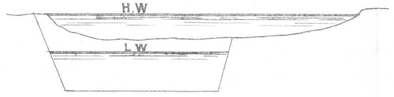


A

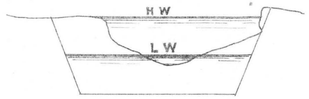
IN OPEN ESTUARY, SECN AT A



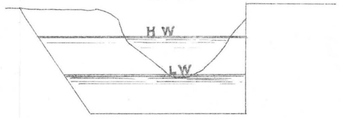
CROSS SECN LATROBE CREEK AT 31.00



CROSS SECTN-LATROBE CREEK AT 14.00

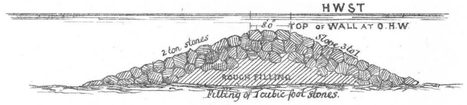


CROSS SECN-LATROBE CREEK AT 5.00



TRAINING WALL AT HEADS ON EAST SIDE SCALE 0 5 10 15 20 30 40 50 Feet 60

SECTION FOR 300 FEET FROM END



SECTION 300 TO 1900 FEET FROM END

SECTION 1000 FEET FROM END TO SHORE

REPORT ON THE DON.

The importance of the Port of the Don is enhanced by the operations of a trading Company, which has drawn much trade to the place by its business transactions, and the employment which the Company's saw-mills give to a large number of men ; a tramway has been laid by the Company 13 miles into the interior, which conveys farm produce and timber for shipment at the port. The township numbers about 400, and there is very good land in the locality.

The Don River is a small mountain torrent, but near its mouth it comes within the influence of the tides and forms a small estuary, the tidal area of which is inconsiderable, but such as it is it keeps the river mouth open, and is able to do so from its sheltered position and the rocky nature of the shore. There is no bar to this river, but the water gradually shoals from 5 feet opposite the end of the breakwater to 2·6 and 2 feet at the upper end of the wharf; the sea deepens to 15 feet in 700 feet from the end of the breakwater.

Dangers to ships.

The river mouth is sheltered by the Don Heads and its reefs of rocks, and is open to N. and N.E. winds only. Notwithstanding its sheltered position a considerable swell doubles in upon it round the Heads in N.W. gales, and as this is a cross sea to vessels entering or leaving there was always a risk of either drifting on the rocks to leeward or bumping on the boulders at the shallower part of the entrance ; to remedy this inconvenience a breakwater has been built, which answers the purpose fairly, and also protects the inner part of the port from the send of the waves.

Construction of present breakwater.

The range of tide is from 8 to 11 feet neap and spring tides. The river mouth is very narrow, and both sides are formed by reefs of basaltic rock, overlying blue clay ; the *debris* of these reefs covers the river mouth and the sea bottom for a short distance out in the shape of boulders, stones, and shingle, but there is clay below them, and about 250 seaward of the breakwater the bottom is sand overlying the clay.

Breakwater.

The breakwater mentioned above is 250 ft. long ; it is a crib of logs filled with stones, and it is beginning to show signs of decay from half-tide level to the bottom, as the logs are riddled with sea worms ; in a short time means must be taken to repair it before the stones tumble out into the channel.

The port and wharves.

Inside the river a short length of timber wharf is also decaying, but the Marine Board are repairing it by building a stone wall against the timber, and it is their intention to make a length of this sufficient to accommodate the shipping frequenting the port.

Island and two channels.

The river channel alongside this breastwork is very narrow and shallow ; on the opposite side there is an island, and the main channel is on the far side of the island. With the object of scouring the channel alongside the wharves an attempt has been made to dam the main channel, but the tide has breached the shingly shore and partly reopened the waterway, and there is danger of this opening becoming larger by the washing away of the bank.

The improvements which I would propose for this port need not be very expensive, as I do not think it would ever be contemplated to bring large vessels into it.

The Master Warden is of opinion that if the port were deepened to 6 feet at L.W. S.T. it would be sufficient for the trade for a long time to come, but as the bottom is stiff blue clay, and the deep water occurs a short distance out, it would be easy by dredging to get a depth of 8 feet whenever that depth is required. To get the port and the mouth of the river to a depth of 6 feet, about 14,000 cubic yards of dredging must be done. The Marine Board have an excellent Priestman dredge in a barge of 60 tons : the total cost of this was £1450 complete.

The clay dredged should be landed on the far side of the island, and the lagoon at the back of the wharves should be filled with it. The above quantity includes widening the waterway before the wharves to a width of 70 feet, which is ample for this part, but beyond the end of the island the dredged channel should be wide enough to allow of a vessel turning round.

Proposed works.

The existing breakwater should be extended about 200 feet, with the object of keeping the heavy cross seas off the narrow part of the river mouth, as, apart from the risk of being driven ashore when the water is rough in such a narrow entrance, vessels are apt to strike the bottom with the send of the sea unless they come in only when the tide is high.

Extension of breakwater.

This extension of the breakwater should be built of close piles braced across, and filled with rock : the piles should be charred and tarred, and the best timber only should

be used. This structure will last ten years, and the plan shows the way in which I would propose to repair it when it becomes worm-eaten. A mound of rubble would not suit this position, as the slopes would encroach too much on the narrow channel.

Existing pier. The existing breakwater must be repaired before very long, and I have shown the manner in which I propose that this should be done.

Dam in channel. As the ebb and flow of the tide in the estuary of the river is essential for keeping the channel open at the mouth of the river, anything which impedes the flow must have an injurious effect, and for this reason the western channel round the island should be enlarged and deepened sufficiently to compensate for the loss of waterway caused by the dam which has been placed across the eastern or main channel. This dam should not be raised above half-tide level, as the scouring effect on the other channel will be obtained fully as well by a half-tide dam as by raising it to the full height of high water. The end of this dam must be made secure at once, otherwise a great quantity of shingle will be scoured out of the bank, and in all likelihood it will find its way to the navigable part of the river mouth.

Should not be raised.

I am much indebted to the Master Warden, Mr. John Henry, and to Mr. Townshend, C.E., for assistance and information afforded to me during my examination of the river.

The estimated cost of the works proposed will be approximately as follows:—

	£
Cost of 200 feet extension of pier	2250
Dredging	770
Repairs to old pier	1137
Repairing breach in dam, say	50
	£4207

C. NAPIER BELL.

REPORT ON THE FORTH.

The Forth is a large river, with a narrow and rocky channel. It is very little influenced by the tide, and its tidal area is small: it has, however, heavy and frequent floods.

The mouth of the river is much exposed, and there is no shelter from N.W., N., and N.E. winds; but as the coast at this place lies a long way to the south of Table Cape, the heaviest seas in N.W. gales cross the river mouth far out to sea, and the bar is then not so rough as might be expected from its aspect.

At the mouth of the river and along the coast on both sides there is an immense accumulation of shingle, which, however, is not brought down the river, but is found on the coast for some distance inland. At the river mouth this shingle forms spits and shoals, which are continually shifting by the action of the waves and the currents of the river, consequently the channel over the bar is always uncertain.

The bar has about 1·6 of water at L.W.S.T., The water deepens rather suddenly on the inside until there is 8 ft. at "the Narrows," which is situated just at the H.W. line of the coast; here the river is contracted by shingle banks to only 160 ft. wide at the L.W., and about 300 at H.W.

It would appear, from the great accumulation of shingle on the west side, and the bareness of the basalt rocks on the east, that the shingle which obstructs the bar is washed into the channel from the west side; so that if this could be kept back the river would be able to maintain deeper water at its confluence with the sea.

The tidal currents are not strong in this river, therefore there is not much assistance to be got from them for scouring out a deep bar; on the other hand, the land floods are frequent and sometimes very strong, so much so that the Warden of the Port, Mr. E. Beacroft, who kindly gave me every assistance and information, tells me that one great flood scoured the bar out to 6 ft. deep, and that depth was maintained for two years.

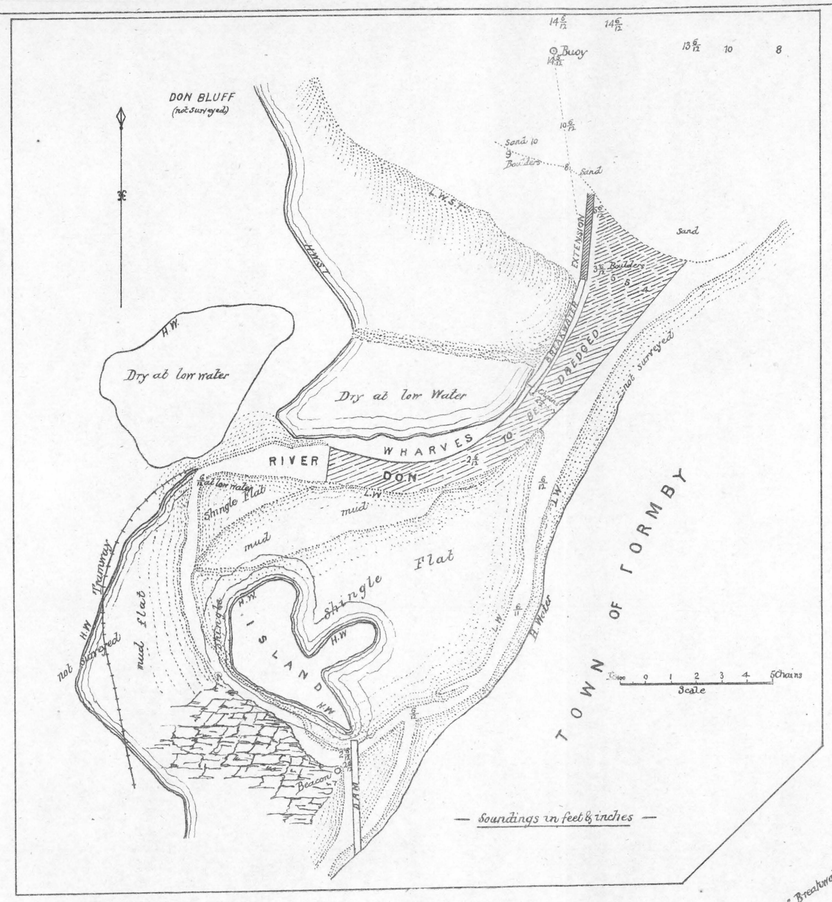
I have shown in the plan herewith a training-wall or breakwater on the west side which would protect the mouth of the river from the drifting shingle. This wall extends

— RIVER DON —

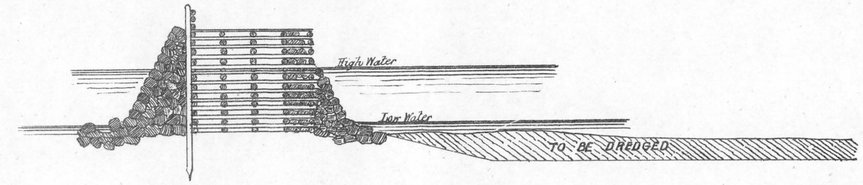
— SCALES —

Horizontal 40 0 1 2 3 4 5 6 7 8 9 10 Chains

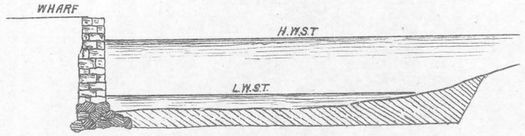
Vertical 10ft 5 0 10 20 30 40 50 Feet



— Soundings in feet & inches —

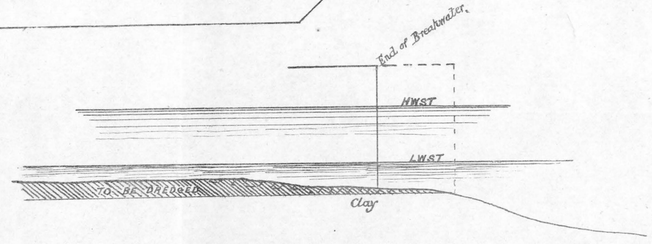


— REPAIRS TO PRESENT PIER —



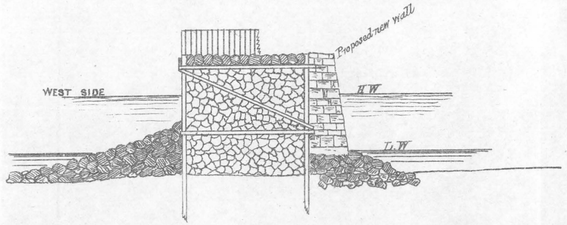
— CROSS SECTION OF CHANNEL —

At end of Timber wharf



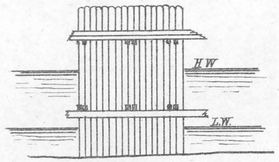
— DON HEADS —

Longitudinal Section of Channel shewing dredging required.



— EXTENSION OF BREAKWATER —

— Stone Slopes & walls to be added when piles are worn away —

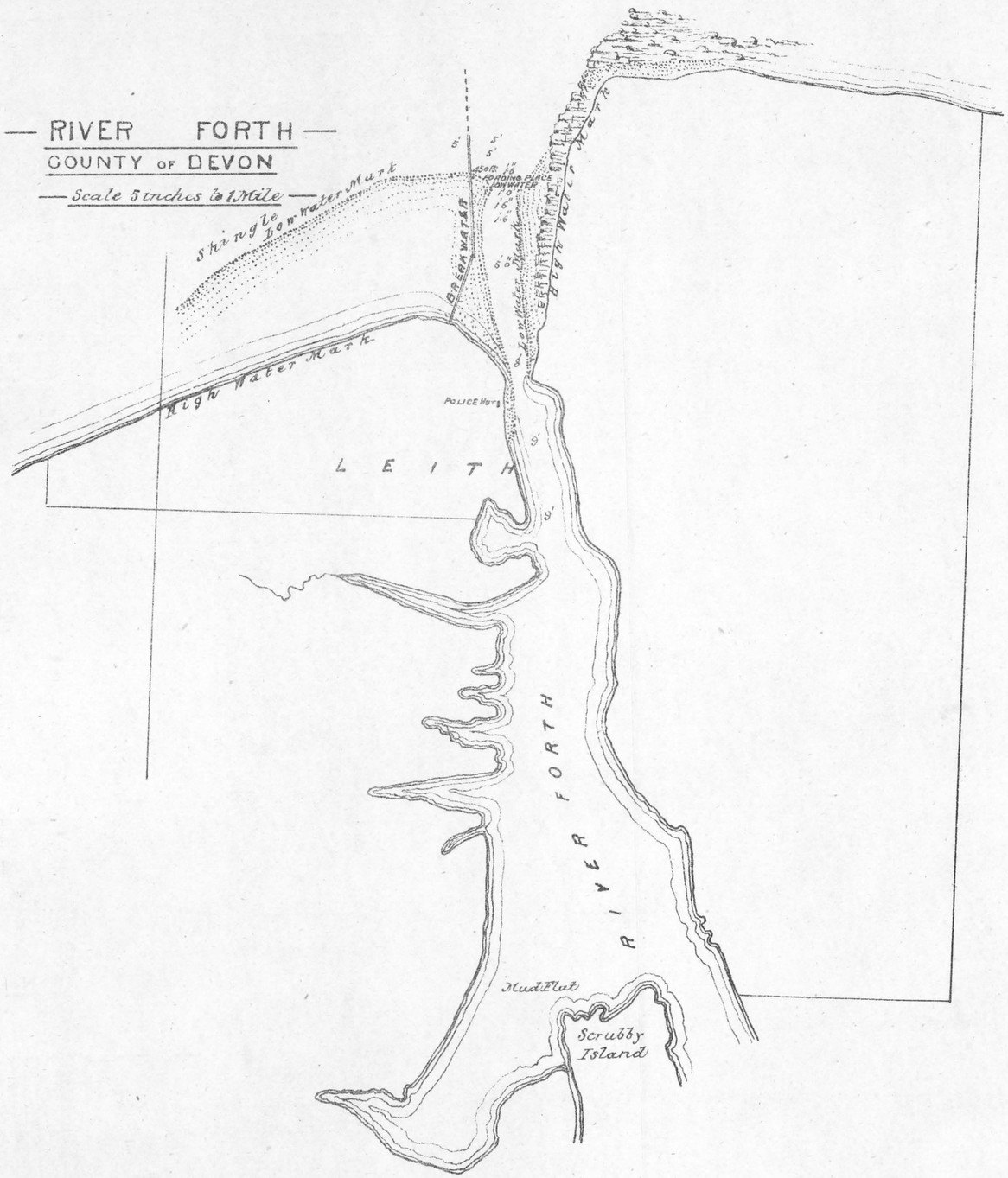


— ELEVATION ON WEST SIDE —

— RIVER FORTH —

COUNTY OF DEVON

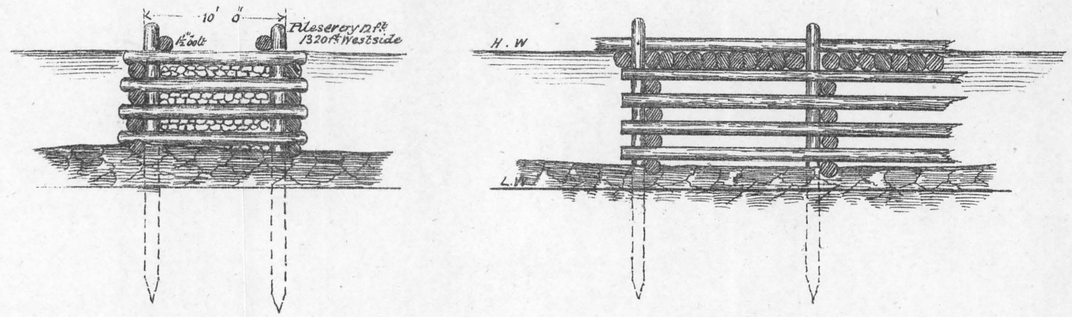
— Scale 5 inches to 1 Mile —



— TRAINING WALL WEST SIDE —

— ABOVE LOW WATER —

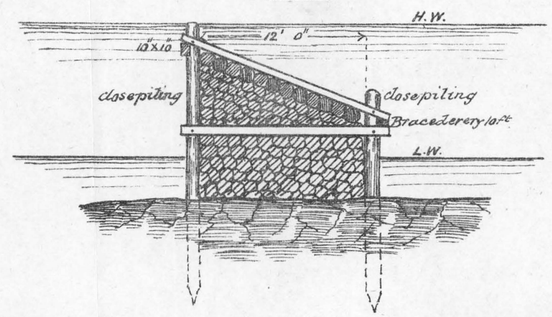
— FIG No 1 —



— TRAINING WALL 260 Ft WEST SIDE —

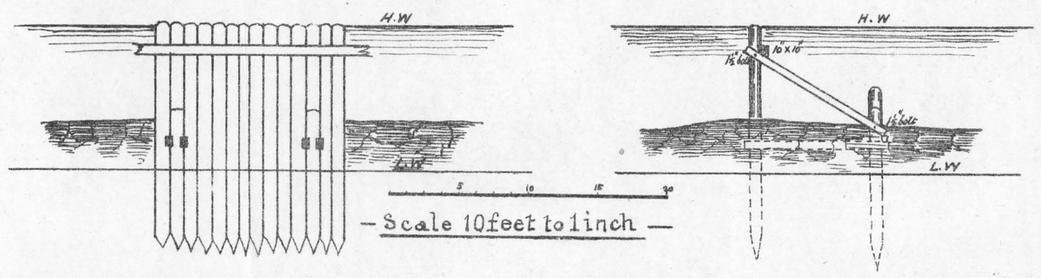
— BELOW LOW WATER —

— FIG No 2 —



— TRAINING WALL OF SINGLE ROW OF PILES —

— FIG No 3 —



— Scale 10 feet to 1 inch —

from H.W.M. to a point about 150 ft. outside the bar, and I am of opinion that this will have the desired effect without any wall on the east side, where the rock is bare and the line of the shore is parallel to the current of the river.

The source of the river should be assisted by dredging, which can be done without much obstruction from the weather, as the sea is often smooth at the river mouth.

I am told that timber lasts a long time in the sea at the mouth of the Forth, as the great quantity of fresh water kills the sea-worm. This is a fortunate circumstance, as stone of the size required for a training-wall is not to be had except at a great cost, and although the materials for making concrete are abundant, this would be still more costly than the stone. In this case, therefore, I would recommend that the wall be constructed of a crib-work of logs filled with stones, which are to be had from the beach about one mile towards the west. This crib should extend to low-water mark. The continuation of the wall into deep water must be close piled in two rows 12 ft. apart, and also filled with stone. The top surface of the stone filling must be covered with logs to prevent the sea washing the stones out; it must be very strongly braced every 10 ft., as shown in the drawing herewith.

The cost of this wall would be as follows:—

	£
West training-wall to L.W.M., 1320 ft.	4000
Ditto beyond ditto, 260 ft.	1400
	£5400

By this wall the currents and floods of the river will be confined and kept in one direction, with the effect of gradually deepening the channel through the shingle. If dredging were to be done to hasten this process the quantity to be removed to give a channel 250 ft. wide and 5 ft. deep would be about 44,000 cubic yards. The material dredged should be deposited in one of the blind creeks of the estuary, which would be a slow process, and would cost about £3600.

The navigation of the Forth is at present considered very unsafe. On account of the shifting shingle the channel is never certain: the bar is so exposed and the channel or channels so narrow, that vessels run great risk of going on shore in coming over the bar. Inside the "Narrows" there is a small but excellent harbour, with water from 8 to 15 ft. at L.W. By the works here proposed the channels will be fixed in position and deepened, consequently the distrust which shipmasters have to the port would be removed, and produce shipped from the Forth would be relieved from the extra freight and insurance which is charged at present for the risk of entering it.

C. NAPIER BELL.

REPORT ON THE RIVER LEVEN.

The River Leven, although a small stream, has a considerable area of estuary, and there is a strong tidal flow in and out of it. The entrance is guarded by reefs of rock projecting a long way to sea; that on the west side projects so far as to give some shelter from N.W. winds; but there is complete exposure to N. and N.E. winds. There is a great extent of sandbanks on the coast line on each side of the entrance; also inside the river there are very extensive flats of sand. Higher up the estuary the bottom is mud and shingle. Between the wharves and the outer bar there are shoals and banks of boulders, and at one place it appears as if the solid rock were exposed in the bottom of the navigable channel; but the boulders are so packed together that it was difficult in the then state of the tide to distinguish between solid rock and boulders, as an iron rod could not be driven through them. In several other places along the channel, and as far out as the "Black Jack" rock, the bottom is covered with loose boulders and sand. Seaward of the said rock the bottom is sand, and of this the bar is also composed.

Coast line at high and low water.

At low water the shore-line differs greatly from the same at high water; the sandbanks and rocks are laid dry a long way out, and the bar is just inside the low-water line of the coast. There is 2ft. 6in. of water on the bar at ordinary low water, and 1ft. 6in. or less at low water of spring tides. The rise of tide is, as usual, between 8ft. 6in. and 11ft.

Rock off the entrance.

A short distance outside the bar towards the N.E. there is a rock, which appears above water at low tides: the "Half-tide rock" lies further to the N.E., and rises to about

half-tide level. The former of these rocks is dangerous to ships entering and leaving the river, and should be removed by blasting, which can be done by erecting a staging over the rock, from which holes can be jumped in it in which charges of dynamite are to be exploded.

Present depth of bar. The present depth of the bar allows ships drawing 9 ft. to enter at high water. Similarly with the Inglis River, it would cost much money to secure, by the erection of suitable works, a depth on the bar sufficient for vessels to enter at low water; and as this port has much the same trade as the Inglis River, a similar increase of depth on the bar would suit it equally well.

Depth required.

Work costly. Any works built with the object of deepening the bar must be here of an expensive character, both from their magnitude and the difficulty of procuring suitable stone.

Character of works proposed. To concentrate the tidal flow, and thus enable it not only to remove the bar, but to prevent any further accumulation of sand, the mouth of the river must be confined between training-banks extending into deep water; at the same time it is probable that in the course of years there will be a tendency for the bar to reform further out to sea in advance of the training-walls, which must, therefore, be capable of extension when necessary. As the sea deepens rapidly outside the bar, it will be many years before the entrance silts up, as this process will not begin until the low-water line has advanced beyond the ends of the training-wall.

Training-walls. The plan shows the east and west training-walls or mounds as I would recommend them to be placed. These should, if possible, be of rubble stone of large size, built up to H.W. spring tides on the west side, and to H.W. ordinary tides on the east side; the slopes exposed to the waves must be at least 3 to 1, and very heavy stone must be placed at the ends; or if this is not procurable, concrete blocks of 5 or 6 tons weight may be thrown in to protect the ends.

Hill of rock. There appears to be any quantity of basalt rock in a hill about half a mile from the site of the west wall, and to convey it to the work a wooden tramway must be laid to the quarry. There is much more difficulty, however, in conveying the rock for the east breakwater, as a tramway laid over the Leven bridge and along the road to the site of the east wall would be of great length; and to load the stone into punts and hoist it out on the other side of the river would add greatly to the cost. The most feasible plan would be to construct a temporary drawbridge for the conveyance of stone across to the east side, unless stone can be found at a reasonable distance on that side. The carriage of such quantities of stone, and of such size as here required, by carts, would be very slow and costly. Small stone can only be used for filling the base of these mounds; it would be worse than useless on the exposed faces.

Stone for east side.

Dredging. It appears by the sounds that after passing the bar there is a channel up to the settlement of about 5 feet at L.W.; therefore it may not be necessary to do any dredging. A bank, apparently of boulders and shingle, called the "Mussel Rock," might be removed with advantage to the navigation, and the channel to the west of it being the one most used, should be dredged to the required depth of 5 feet, the distance being about 450 feet to the wharves, where there is 6 feet of water. The dredging might be done by the Marine Board from time to time as often as the dredge could be spared from work on the other rivers.

The bar being sand, will be removed by the scour created by the training-walls.

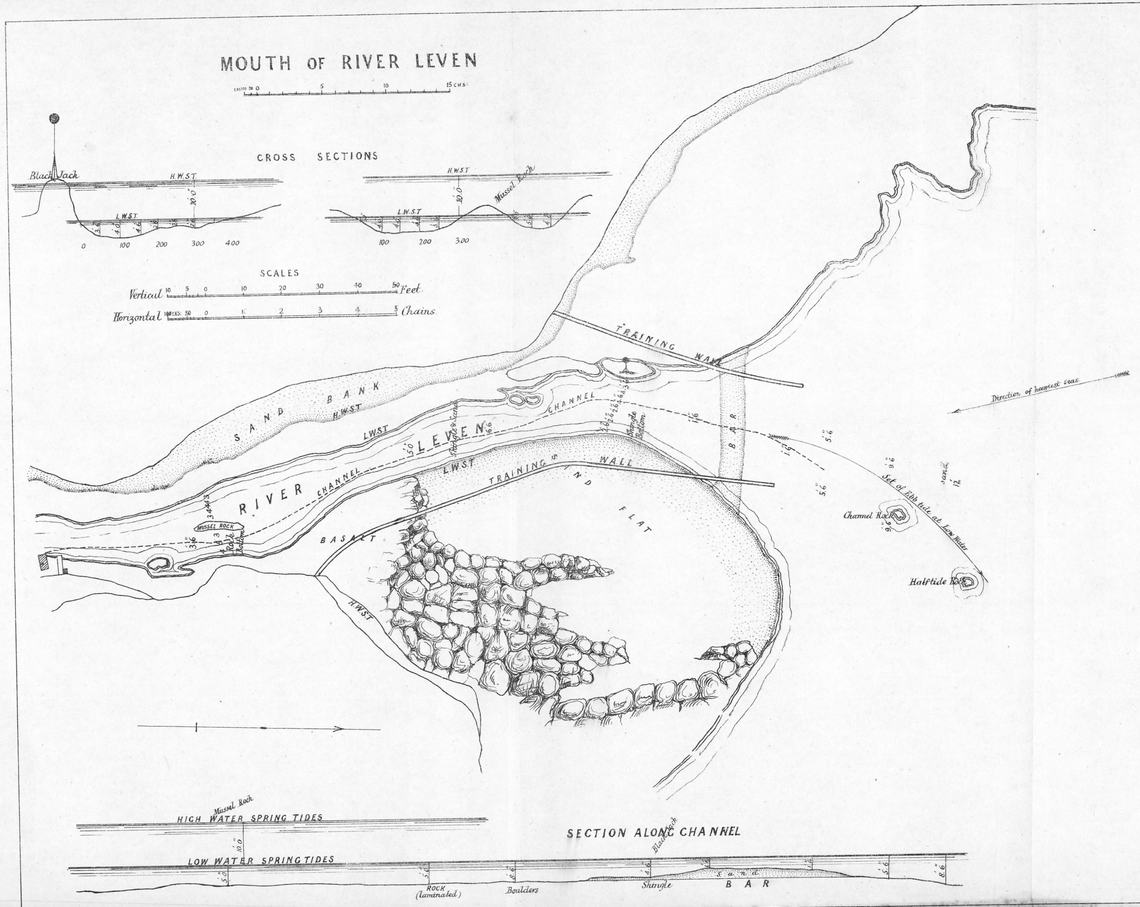
I have not made any plans for extra wharf accommodation, as the position is already fixed for the existing wharves. An extension of the present wharfage is required, at an estimated cost of about £250, and this will be sufficient for present purposes.

The estimate of cost for the works here proposed is £18,383.

Channel rock. The dredging required would cost about £200. I cannot estimate the cost for removing the channel rock, as I could not get a survey of it, the weather being very stormy.

C. NAPIER BELL.

MOUTH OF RIVER LEVEN



SECTIONS OF WEST TRAINING WALL

SCALE 20 FEET TO AN INCH.

SHORE SECTION. 790 FEET.

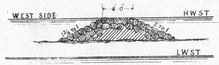
CROSS SECTION. - 530 FEET.

SECTION OF EAST TRAINING-WALL

SCALE 10 5 0 10 20 30 40 50 FEET

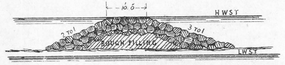
SHORE SECTION

660 FEET

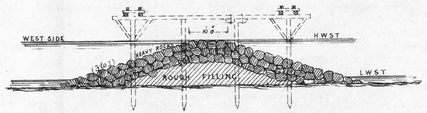


MIDDLE SECTION

530 FEET 1380.



OUTER SECTION.



REPORT ON THE PENGUIN.

The Penguin Creek is a small stream which enters the sea close to a projecting point on the west side of a wide bay; and from this place a reef of rocks extends in a northerly direction for nearly a quarter of a mile, thus sheltering from N.W. winds the corner in which the existing breakwater is placed; but the reefs being covered at H.W. a considerable swell in rough weather from the N.W. doubles round the point and disturbs the mooring-place beside the jetty. From the north there is little shelter under the breakwater, and none from the east.

Accumulation of sand.

The sand covers the beach all round the bay towards the east; and, being driven by the waves during east winds round the curve of the bay towards the pier, accumulates close to it; and apparently it is only the disturbance of the water by the rebound of the waves from the pier, and the slight current out of the creek, which preserves a little deeper water alongside the jetty on the lee side of it. Still the water is so shallow that the smallest craft lie grounded at L.W., and in rough weather they must haul off, or suffer damage by bumping against the ground.

Shallow beside pier.

Existing pier.

The existing pier is in a similar predicament to that at Circular Head,—it is being silted up by the encroachment of the sand,—and considerable accumulation has resulted since the pier was built. This pier is 390 feet long. The outer end, for 90 feet, is bent towards the shore at an angle of 39 degrees; and it cannot be extended in that direction, as the extension would reach into shallow water. The pier is of piles planked and filled with stones. It has lasted 10 years, but is now falling to decay. It cost originally £2300, but it has been repaired to some extent by whole piles driven outside the planking. These repairs are incomplete; and the Wardens estimate that about £500 are necessary to complete them in the same manner, that is, by driving close piling round the old crib and replacing the top sill and some of the bracing.

Repairs to pier.

Project of a harbour.

To make a harbour here that would shelter vessels from all winds, and with a depth at L.W. of 6 to 10 feet, it would be necessary to construct a breakwater of rubble stone from high-water mark over the reef to near its outer end, and curving round in deep water, as shown on the plan herewith.

Trade of District.

This would be a costly work; and I am in doubt whether the importance of the trade would justify the outlay at the present time. The production of the district consists of farm produce and timber, but the district is very thinly settled. The Township, I am told, numbers about 300 people. There is good land in the vicinity, and there is at present the prospect of some minerals being worked.

Extension proposed.

I see no means of making a well-sheltered port at the Penguin by any works short of the breakwater mentioned above. A little more shelter would be afforded and deeper water secured by extending the present pier about 290 feet, as shown on the plan; and, by making a mound of stone from the shore opposite, the sand would accumulate against it, and save the anchorage from silting up. The berthage-room alongside the pier could then be dredged a few feet deeper, as shown on the plan; but this could not be done to sufficient depth to float ships of 8 and 9 feet at low water, as a pit would be formed which would fill up on the occasion of the first storm. The greatest depth that could be dredged with safety would be to about that which is found at the outer end of the extended pier, that is, 2 feet 6 inches at L.W. The cost of the dredging would be about £270.

Duration of work and future protection.

I would recommend the extension of the present pier, as shown on the plan, to be built of whole piles of best stringy-bark or other durable timber; the piles to be charred and tarred two coats from just below mud-level to half-tide level; the structure to be well braced, and filled with the largest stone procurable. In addition to this, the repairs mentioned above should be done. This work will last 10 years or so; and the plan herewith shows the manner in which it may be repaired with stone-work when it begins to give way. On the inside a dry stone wall to be built up against the planking,—the foundation for this to be laid under water,—with an outer row of concrete in bags up to low water, filled in behind with rough stone, and the wall built on this of good large stone, well banded through the wall. The sea side to be backed up with a slope of rubble, as shown. The piles above half-tide last much longer than below that level, where the worm attacks the timber; but, as the upper portion also decays, the slope of stone must be raised to the full height of the pier.

Repairs urgent.

While recommending the extension above mentioned for any increase of shipping that may frequent the port within the next few years, it appears to me that the most urgent necessity at present is for the repairs to be done to the existing pier.

Cost of breakwater.

The complete breakwater shown on the plan would cost about £26,000, exclusive of any timber wharves along it or projecting from it.

Cost of extension.

The cost of the extension of the present pier 290 feet longer, building a mound of stone to keep back the sand, removing the head of the present pier and repairs to same, mentioned above, would be approximately £4070. I have not taken into account the cost of future stone-work to protect the pier when decayed.

C. NAPIER BELL.

23 *May*, 1882.

REPORT ON EMU BAY.

This port has risen to some importance in consequence of the discoveries of tin in the interior, and the traffic carried on at it is almost exclusively confined to exporting tin ore and importing supplies for those employed at the mines. There is little cultivation in this locality, but the tramway which is laid to Mount Bischoff brings down a little timber. It is said that there is some good land on the route of the tramway, most of which belongs to the Van Diemen's Land Company.

The bay.

The bay is an open roadstead, well sheltered from all winds to the west of north, but completely exposed to all winds from north to east. In the summer months strong winds and sometimes gales arise from the N.E. and E., during which communication with the shore would be impossible, and ships lying at anchor must depend for their safety on the excellent holding-ground which is found at the roadstead.

Protecting reef.

At the N.W. extremity of the bay a reef of rocks extend a considerable distance into the sea in a north direction, and under the shelter of this a small jetty has been built. This is constructed of concrete, the base laid in blocks, and the superstructure in mass. It is a very strong piece of work, and the concrete is of excellent quality. The position

Positon of existing pier.

of this jetty is well chosen, and, although it is too short to afford shelter to a ship, it is indispensable for landing cargo from lighters; and when the weather is fair small steamers lie alongside at high water. Without this jetty it would be very difficult to land cargo, as the shore is rocky, and the waves surge among the rocks with great violence.

Locality favourable.

This locality is very favourable for the construction of a breakwater which shall completely shelter vessels in all weathers. The bottom is smooth, and consists of clay covered with a layer of sand. Deep water is found at a reasonable distance from the shore. The works would be considerably sheltered from the most frequent and heaviest gales—those from the N.W.,—and there is plenty of room for ships to make the shelter of the harbour in any weather.

Necessity for a harbour.

Under present circumstances one is perplexed as to what is the proper course to recommend for the improvement of the port. A breakwater which would afford complete shelter in all weathers is of course the most desirable, and would be the most satisfactory; but this would necessarily be a costly work, and the trade of the port is so small that the expenditure incurred in making a well sheltered harbour could only be justified by expectations of a large and rapid growth of settlement and production in the surrounding district. A short extension of the existing jetty would not give any shelter from easterly gales, and therefore it would only form a jetty to be used when the weather was favourable. It would be suitable for steamers, but sailing ships would run considerable risk if moored so close in shore during an easterly gale.

Proposed project.

It would suit present conditions of the place if a work could be made which would satisfy present requirements, and yet be capable of extension; but a good project is generally spoiled if it is made to serve two purposes, which would happen in this case; and the perplexity arises from endeavouring to determine which purpose shall be first served. Under these circumstances I have prepared a plan for a breakwater which would afford good shelter with deep water for a small number of ships, but quite sufficient, in my opinion, for the future requirements of the district.

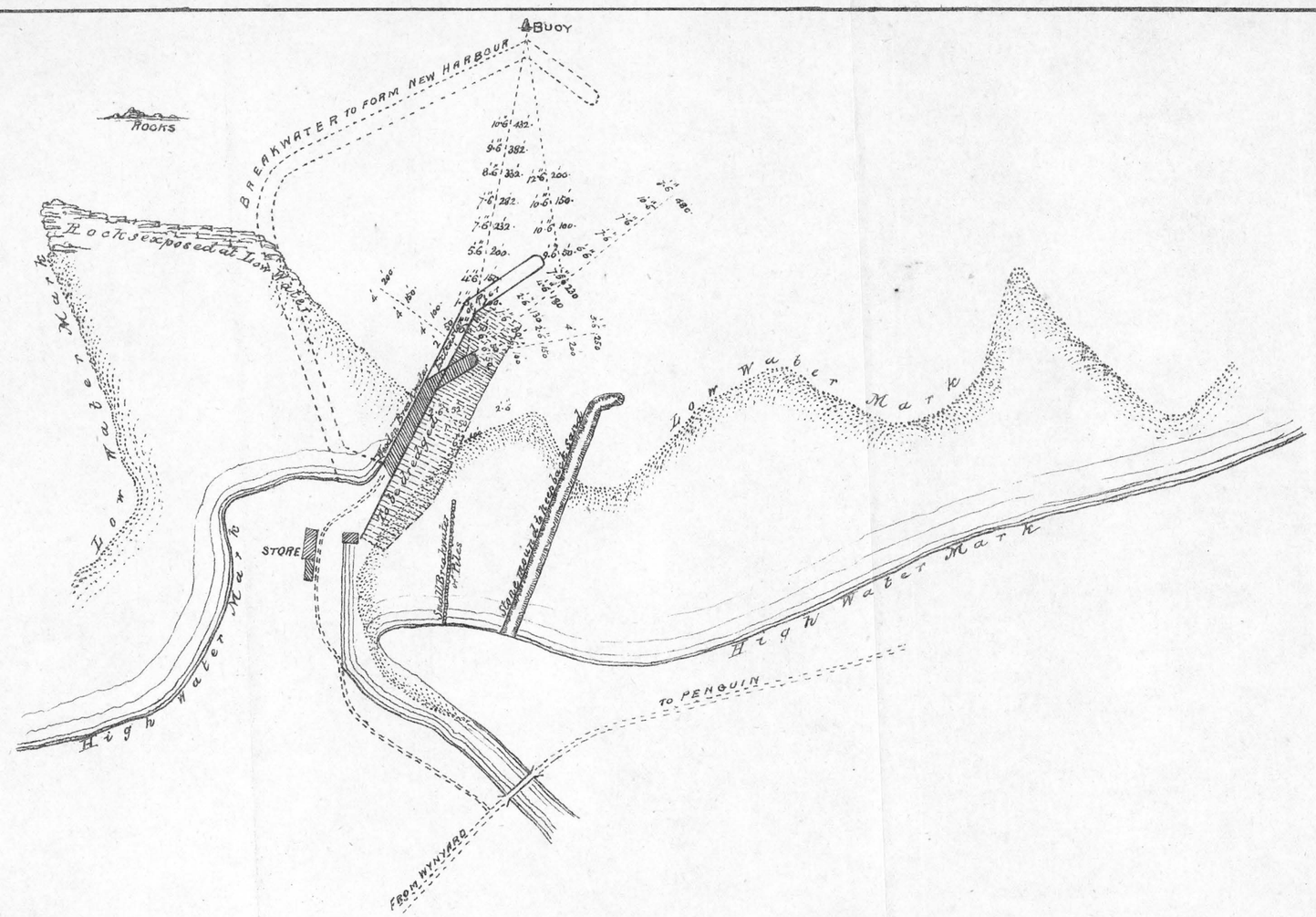
Mode of construction.

In the construction of this work a breakwater entirely of rough rock would be the cheapest, but it has the disadvantage of requiring to be supplemented by timber wharves. I would therefore recommend a face wall of concrete, with an outer slope of rubble, the slopes to be covered with heavy rock. This construction would also economise the rock, a large quantity of which can be procured on the spot; but, in the absence of a survey of the hill out of which it must be quarried, I doubt if the quantity would be sufficient; however, there is a hill containing slate and quartz rock about three quarters of a mile on

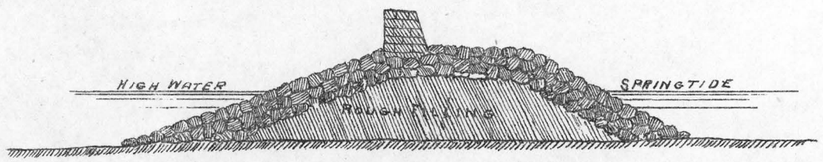
— HARBOUR AT PENGUIN —

0 1 2 3 4 5 6 7 8

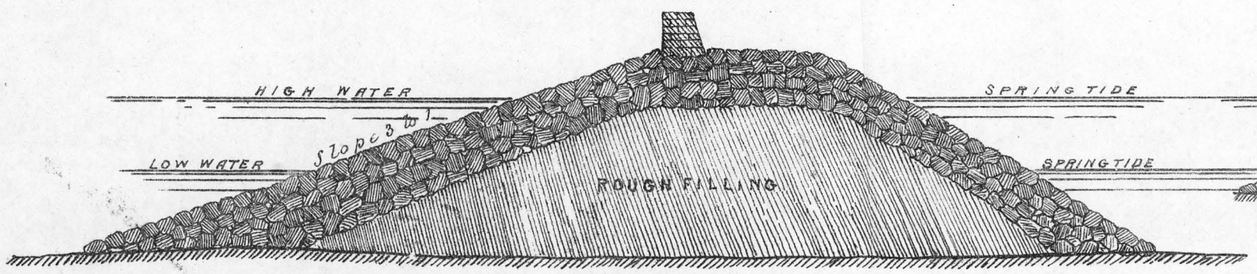
— SCALE 4 CHAINS TO 1 INCH —



— SHORE SECTION —



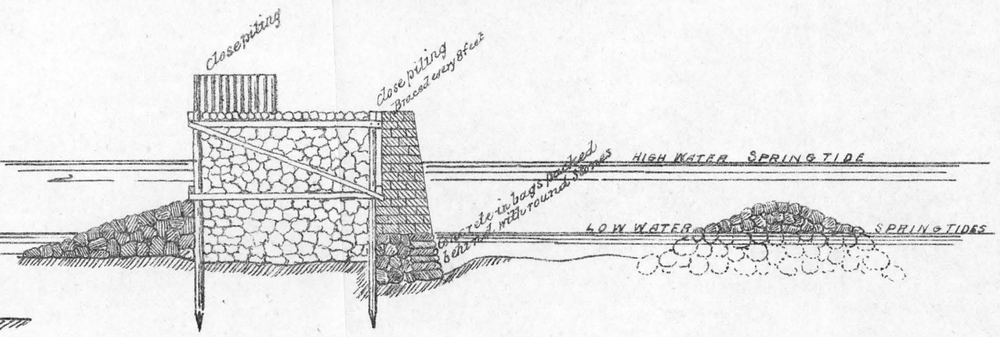
— SECTION OF BREAKWATER BELOW L.W. MARK —



— SCALE 20 FEET TO 1 INCH —

— EXTENSION OF PRESENT PIER —

— *Stone Slope and Wall to be added where Piles are Worm-eaten* —



SCALE 0 5 10 20 40 60 20 FT. TO 1 INCH

EMU BAY

Scale of Distance.

Soundings in Feet & Inches. O.L.W.

Rocks dry at low spring tides.

Low Water S.T.

High Water S.T.

Iron ⊙ Buoy

Direction of Easterly seas.

NORTH TERRACE.

STREET.

ST:

WILMOT ST:

TOWN OF BURNIE.

WILSON ST:

TERRACE.

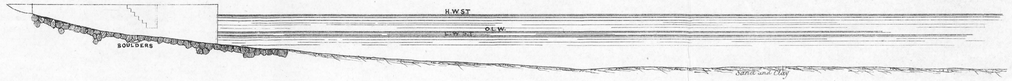
CATLEY ST:

MARINE

Tramway.

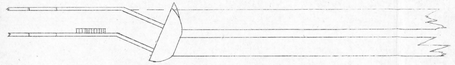
EMU BAY.

EMU BAY



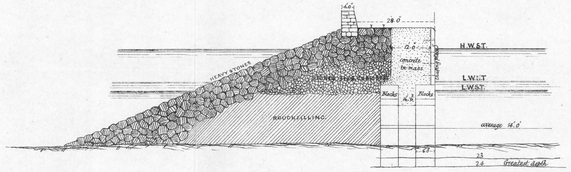
SECTION OF BOTTOM ON LINE OF BREAKWATER

FIGURE 2.

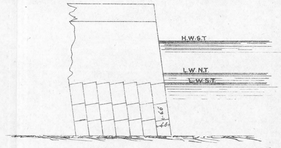


Scale 10 5 0 10 20 30 40 50 60 70 80 90 100 Feet.

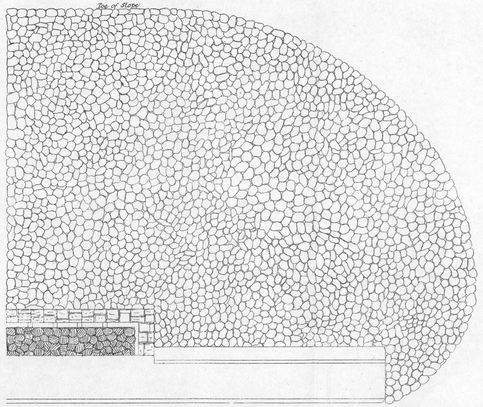
FIGURE 1.



CROSS SECTION OF BREAKWATER



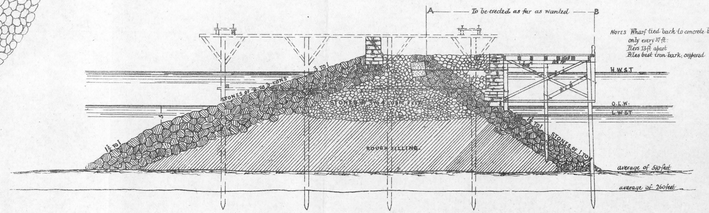
LONGITUDINAL SECTION.



PLAN OF OUTER END

Scale 10 5 0 10 20 30 40 50 Feet.

FIGURE 3.



RUBBLE STONE BREAKWATER

the road towards Table Cape where a supply could be obtained if the rock is found to be suitable. Abundance of gravel and sand for concrete is to be had in the neighbourhood. The concrete blocks, of which the lower part of the face wall will be built, would weigh nine to ten tons, and must be placed in the work by a gautry on piles. The part of the wall above low water should be built in mass whenever the weather permits. The rubble backing should be deposited from a staging, the largest rock being placed on the outer slopes.

Proposal for present requirements. End not to be deflected.

If the Government is not prepared to incur the expense of completing this project, I would recommend a length of, say 200 feet of it, to be built in the same line. There is not much additional shelter to be gained by deflecting it towards the south in the line of the outer end of the present pier, and so doing would prevent the projected harbour from being completed at a future time.

This length of 200 feet beyond the present work would give no shelter in easterly gales, but would be useful to steamers, and to sailing ships in fair weather, and would be very convenient for landing goods from lighters.

Nature of bottom. Borings required.

I had no means of taking borings of the bottom on the site of the proposed breakwater, and the water was too deep to enable me even to probe it with an iron rod. Borings should be taken before the work is undertaken to ascertain if the clay is sufficiently firm to bear the weight of a concrete wall of such a height as is here necessary. The bottom for 40 feet out from the present pier is covered with boulders and basalt rock; beyond that the bottom is sand, but clay underlies the sand.

Captain Stanley, in his report on Emu Bay, recommends the breakwater to be placed further to the north of the existing pier. I should, however, prefer the position indicated on the plan—that is, in continuation of the present river,—as being more protected by the reef from N.W. gales, which are the most violent on this coast.

Height of pier.

I should have thought the present pier was too low, and would be swept by the waves at high water. I was assured by the Harbour Master, however, that it is high enough at all times; nevertheless, a very substantial parapet wall must be built of concrete or heavy stone in cement to prevent all risk of seas breaking over the breakwater.

The estimated cost of the complete breakwater, as shown on the plan, would be £56,444, and for 200 feet only added to the present pier, £13,237.

A breakwater entirely of rubble stone would cost about £34,000 without the wharf alongside of it, and £44,050 with wharf complete the whole length. I would recommend the more costly structure, as being more satisfactory, without the necessity for timber wharfing.

C. NAPIER BELL.

REPORT ON THE INGLIS RIVER.

THE mouth of this river is well protected on each side by reefs of rocks. Table Cape also lies a long way to the north, and completely shelters the river mouth from all winds west of north; it is most exposed to north and north-east winds. A long reef of rock projects seaward on the west side of the river, and on this a breakwater of loose stone has been raised with the object of sheltering the bar from the waves. The estuary or tidal area of this river is small, therefore the ebb and flow are not very strong, but land floods occasionally assist them in keeping the bar open. The bar, which is composed of boulders, shingle, and sand overlying the solid rock, is about 1000 feet long, taking a depth of five feet as the limit; there is only one foot to one foot six inches on the shallowest part of the bar, but the rise of tide being from 8 ft. 6 in. to 12 ft. between neap and spring tides, the river is accessible at H.W. to vessels drawing about 8½ feet.

The port inside the bar is shallow, but the bottom is soft mud. The soundings of the bar and the port are shown on the plan accompanying this.

The trade of this port is chiefly timber, with a small quantity of farm produce. There is said to be a large area of good land in the vicinity, all covered with heavy forest. The growth of trade at the port must necessarily be slow, as it depends on the clearing of the forest and the settlement and cultivation of the land; expectations however are entertained in this place that a main road will be made to the mines of Mount Bischoff, which would give additional importance to the port. The question to be determined

is, therefore, what additional depth of water will best suit the circumstances of this river.

Port only accessible at H.W.

Like the rest of the small rivers on the N. W. Coast, it is a tidal port, accessible only at high water. This inconvenience can only be partially remedied, as the works necessary to secure sufficient depth of water at low tide would be exceedingly costly, and the tidal area of the estuaries is so small that I doubt if the depth of 9 or 10 feet at low water could be maintained except with the aid of much annual dredging. To calculate exactly what amount of scouring power is available at each of these rivers, a complete survey of the tidal areas, with the levels of the sandbanks and channels, and the range of the tides from the sea to the upper part of them, is necessary, and I have not this data to go upon. I do not think, however, that the Government are prepared to incur the expense of such thorough improvements as providing sufficient depth for vessels to enter at L.W., which would be anticipating by many years the requirements of the coasting trade: it is better economy to incur the expense necessary to increase the depth of these rivers when the demand arises.

Depth to be attained.

It is the opinion of the Wardens of this port that an increased depth of 4 or 5 feet would be amply sufficient for present wants, and to secure this depth the usual method of constructing training-walls to confine the tidal flow must be resorted to.

Effect of ebb tide.

Works required.

At present the ebb tide spreads out immediately after passing the high-water line, and its effect is checked and dissipated in the sea, with the result of a bar being formed. To preserve the action of the current and bring it to bear on the bar it will be necessary to extend the present breakwater of loose stone, and to build another on the east side extending as far as is shewn on the plan, but capable of further extension when required. The sea gets rapidly deeper after passing the bar, and any increase of depth can be secured by lengthening the proposed training-walls.

Dredging.

The scouring effects thus produced should be assisted by dredging with a Clam dredge; and, in fact, the more of this work that is done by the dredge the better, as much of the bar is composed of boulders and shingle which the current may sweep outside of the training-walls, but it will be more likely to form a shoal outside than the lighter sand which the waves would sooner or later wash up on the beach.

A dredge necessary for the port.

A Priestman dredge should form part of the plant of these rivers; it removes deposits very cheaply, and in ten days' work might remove as much as the rivers would deposit in a year. The dredge could also be usefully employed in deepening the port and the waterway beside the wharves.

Construction of walls.

The training-walls mentioned above should, if possible, be made of stone; timber cribwork might be cheaper, but I cannot recommend it on that account, as the destruction of the logs by sea-worms is very rapid.

Sandbanks.

On the east side of the river mouth there is a great accumulation of sand; this is washed into the channel during easterly winds, and thus helps to keep the entrance shallow. The east training-wall would keep the sand back, and it would accumulate against the wall with the effect of protecting it from the waves.

Effect of present works.

The Harbour Master tells me that the works already undertaken, that is, the western breakwater and a short training-wall of timber on the east side, have had the effect of deepening the water at the entrance during the course of the last few years, and I have no doubt that, with the works here proposed, the depth of five feet at low water will be permanently maintained by the effect of the increased scour. The opening between the ends of the piers is placed at 400 feet. It is always preferable in such cases to give plenty of width, and observations of the effect produced will be the best guide for contracting the width afterwards if required.

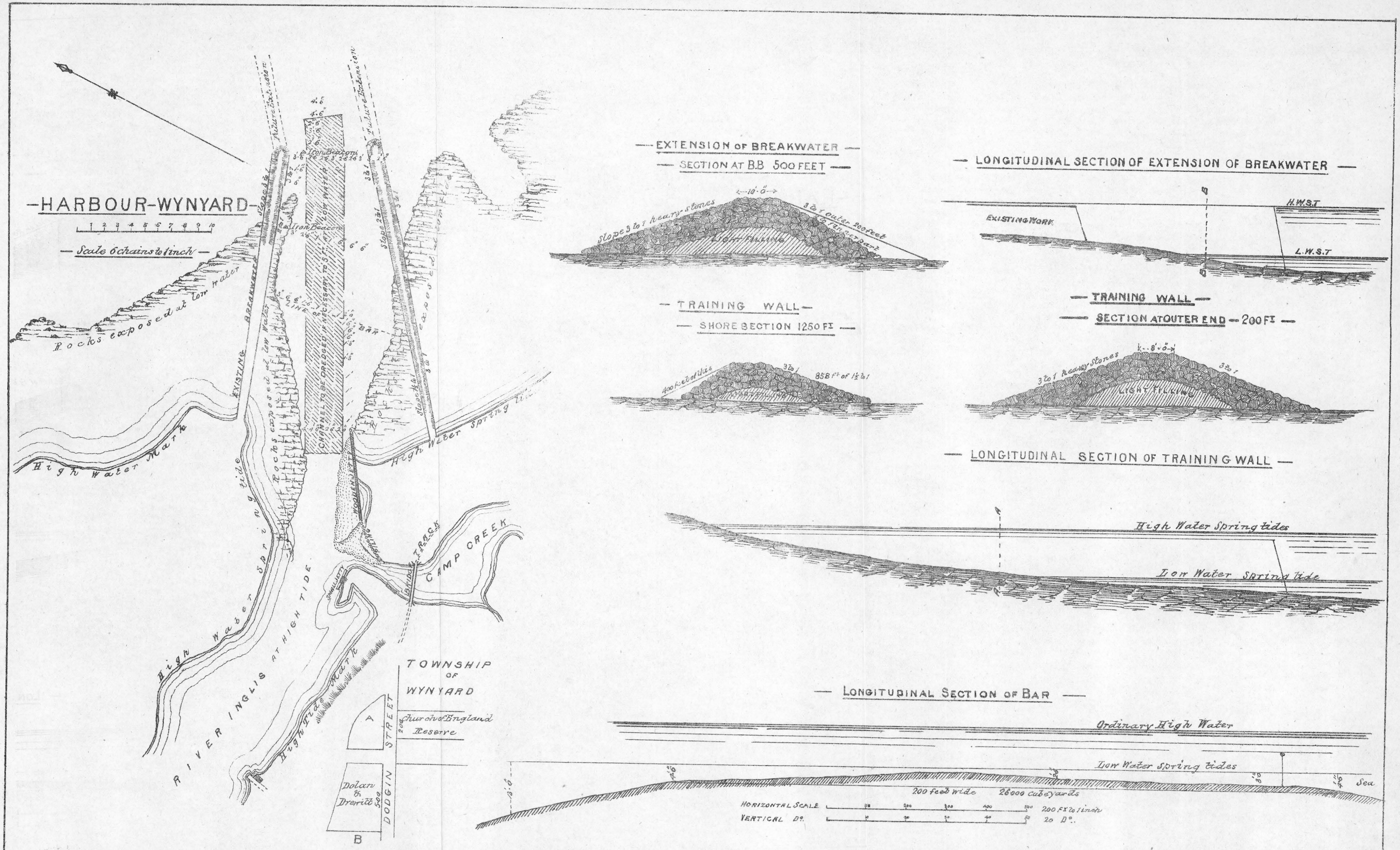
Present wall in bad condition.

The existing breakwater is composed of loose stone, and is placed on a reef of rock about three feet above low water; it is about 1150 feet long, and cost £2000. The stone used in the construction of this mound is of small size; some of it is very soft, and it is weathering rapidly. The wall has stood well for several years, although the original steep slopes have been dragged down by the sea to about 3 to 1. A short time ago, during a very heavy gale with a high spring tide, the waves damaged the wall in many places, washing the small stones down to a very flat slope. To ensure the permanence of this wall it should be raised one or two feet, and covered entirely with heavy rock of harder quality than the sandstone of which it is built.

Must be repaired.

Hard rock procurable.

Hard basalt can be had from a hill about a mile off; but if there is too much earth to be stripped to get at the rock, it must be brought in barges from Table Cape, and the cost would then be considerable. The estimate of cost of this work would be £14,020.


-HARBOUR-WYNYARD-
Scale 6 chains to 1 inch
Rocks exposed at low water
EXISTING BREAKWATER
Future Extension
Iron Beacon
CHANNEL TO BE DREDGED IF NECESSARY TO 5 FT AT LOW WATER
LINE OF BAR
Rocks exposed at low water
High Water Mark
High Water Spring tide
RIVER INGLIS AT HIGH TIDE
High Tide Mark
CAMP CREEK
TOWNSHIP OF WYNYARD
Church of England Reserve
DODGIN STREET
Dolan & Drerritt
-EXTENSION OF BREAKWATER-
-SECTION AT B.B 500 FEET-
Slope 3 to 1 heavy stones
LIGHT FILLING
-LONGITUDINAL SECTION OF EXTENSION OF BREAKWATER-
EXISTING WORK
H.W.S.T
L.W.S.T
-TRAINING WALL-
-SHORE SECTION 1250 FT-
-TRAINING WALL-
-SECTION AT OUTER END-200 FT-
3 to 1 heavy stones
LIGHT FILLING
-LONGITUDINAL SECTION OF TRAINING WALL-
High Water Spring tides
Low Water Spring tide
-LONGITUDINAL SECTION OF BAR-
Ordinary High Water
Low Water Spring tides
Sea
200 feet wide
26000 cubic yards
HORIZONTAL SCALE 200 FT to 1 inch
VERTICAL Do. 20 Do.

Dredging to some extent may be required, but the amount cannot be exactly fixed until the effect produced by the training-walls is ascertained. I should estimate the cost at, say, £1430.

At the request of the Wardens I accompanied them to Table Cape, and took soundings of the bay formed by the projecting bluff. **Breakwater & harbour at Table Cape.**

There is a very good site here for a breakwater, that might be made to enclose a sheltered harbour. The water is very deep, and there is any quantity of stone in the hill overhanging the bay. The position is more sheltered than Emu Bay, and the work could be done at no greater cost, at least if it were made of rough rubble, as the quantity of stone of all sizes is unlimited. A considerable amount of reclamation would be required to get level land for the site of roads, buildings, &c., as the hillside is very steep, and a long and costly road must be formed round the steep shore to reach the settlement at the Inglis River, which is several miles off.

It was not included in my instructions to report on this site, and I mention it only at the request of the Wardens. I have therefore made no plans nor estimate of cost for a breakwater at Table Cape.

C. NAPIER BELL.

REPORT ON CIRCULAR HEAD.

This port is the outlet for an agricultural district of considerable extent, and the exports consist of farm produce and timber. Besides coasting schooners and boats there is one small steamer and about 8000 tons of shipping to Australian ports which annually frequent the harbour. Many ships run in here for shelter in storms from the westward, and find good holding-ground and shelter from all winds except east.

The existing pier is a structure of cribwork filled with stones. The original crib has long since rotted away, and is replaced with close piling, which is also fast decaying. The pier was erected about 50 years ago, and at that time there was depth of water at the shore end of it sufficient for vessels of 10 feet draft. Since then, however, the shore has been slowly silting up with sand, until now low-water mark is close to the outer end. I am informed by the pilot that in 25 years the depth of water at what is called the old jetty has diminished 5 feet. **Existing pier.** **Shore silting up.**

This action of silting up is caused by a strong current which, during easterly winds, sets along the shore in a N.E. direction towards the pier. It carries the sand with it, which is stopped by the pier. Any structure which is projected from the shore is thus liable to be silted up, the supply being kept up by the miles of sandy beach and sand-hills to the eastward, and by what is brought out of the east inlet. At the existing pier the silting up must be much more rapid than at any structure of the kind placed further to the east on the shore of the Bluff or Nutt, as it is called, because the bay has already shoaled to such an extent that little remains to fill up. **Causes.**

It will be seen from the plan that the channel from the east inlet discharges into the bay just in front of the present pier, causing shoals and spits of sand to project out towards it, by which the sea room for vessels is very much confined. As the pier nearly to its outer end is dry at low water, it cannot shelter any vessel except such as are placed alongside it and which lie aground at low water. Outside the pier, however, in the anchorage ground, there is excellent shelter from all winds except east, but vessels caught here in an easterly gale would be placed in a critical position, as they must either ride it out or run aground behind the pier; they could only get under shelter of the pier at high water, and provided they did not draw more than 9 or 10 feet. It would be very difficult, if not impossible, to get out to sea in such a case, as the bay is too much landlocked. **Channel from east inlet.**

The rise of tide is from 8 feet at neap to 12 feet at spring tides; the pier therefore can only be used by vessels drawing about 9 feet, and they lie aground in the soft sand at low water. **Tides.**

Considering the position of this pier, which is slowly silting up and is closed in by shoals, I do not think it would be advisable to spend money on it in extensions; and if it is necessary to get more accommodation for shipping, I would recommend that a new pier be built in the position shown on the plan herewith. This would give a sheltered anchorage and deep water close to the breakwater; and I do not think there is any danger of the sand encroaching on the position so as to diminish the depth for a very long time. **New pier.**

Extension of present pier.

To extend the present pier in the same line would only give 4 or 5 feet of water, and the end of it would be too near the shoals and banks for convenience of navigation. If it were extended in a S.E. by S. direction it would get into deeper water, but the end would be exposed to the waves in a gale from the east, and the direction would give bad shelter to vessels lying alongside.

Owing to the encroachment of the low-water line the position of this pier has become unsuitable for further extension, and therefore I would not advise any to be undertaken.

Pier sufficient for trade of place.

The present pier is said by the Master Warden and the Marine Board to be sufficient for the trade of the place, but the woodwork is fast decaying, and if not repaired at once it will soon tumble to pieces. The stones are falling out where the piles have rotted off, and great holes are made in the roadway, so that it is dangerous to walk on it at night. The end has recently been rebuilt with concrete slabs fixed between iron piles, making a very strong piece of work, but from the end towards the shore it is in a very bad state.

Repairs.

As the existence of the pier is essential to the trade of the District the urgency for repairs is evident. The drawings herewith show the method which I would propose for repairing it. On the harbour side a dry stone wall to be built against the present crib, the back to be well filled up with small stones. The foundations must be taken out with a spoon dredge to 2 or 3 feet below low water, and the excavation must be filled with picked and large stone; on these at low-water mark bags of concrete will bind the lower courses and form a bed for the remainder of the wall. The part of the wall above high water to be laid in cement. Only 250 feet of this work is required at present, as the piling of the pier is sound enough at the shore end to last for some years.

Repairs on weather side.

On the sea side of the pier I would suggest that the worm-eaten portions of the pile-work be cut away to about ordinary high water, or even to half-tide level, and this must be "underpinned" with a dry stone wall 3 feet thick, as shown on the plan. The upper part of the piles are good for many years yet.

The cost of this work would not be great, and this is all which I would recommend to be done at the existing pier; as mentioned above, if more harbour accommodation is necessary a new breakwater should be constructed farther round the bluff, to the N.E. of the present pier.

Dredging.

It was suggested that the berths for ships alongside the present pier might be dredged to the same depth as is found at the outer end. I am of opinion that if this were done without building a wall to keep back the sand, the trench so dredged would fill up after the first gale from the east; a wall to be of use in keeping back the sand should be close to the trench so excavated, but this is impossible, as ships sail over the site at high water. I estimate the cost of the proposed repairs to existing pier at about £1550.

Cost.

The cost of the new breakwater would be, for 540 feet long, including temporary staging, plant, and contingencies, £16,630, exclusive of any wharves built either alongside of it or projecting from the shore under its shelter. These (when required) should be of timber, using ironbark piles sheathed with Muntz metal.

Material of construction.

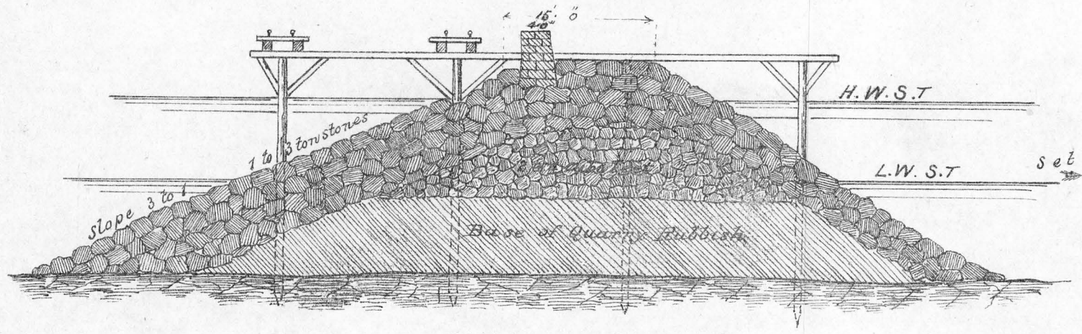
There is abundance of stone of any required size for the construction of a breakwater. It should be constructed, as shown, of rubble, the seaward slopes being covered with heavy stones for 8 feet or so in thickness. The outer slopes should be 3 to 1, and the inner slopes $1\frac{1}{2}$ to 1. The stones must be laid from a staging on piles, in the erection of which there will be no difficulty, as the bottom is sand. The stones being roughly laid, with a proper proportion of smaller stone sufficient to fill up all interstices, the action of the sea will drag the slopes down to a stable position. A strong parapet wall, of concrete or heavy stone in cement, must be built on the weather side to prevent heavy seas at high water from sweeping over the breakwater.

Mr. Anderson, the Master Warden, and the Members of the Marine Board, very kindly gave me all the assistance and information which I required at Circular Head.

C. NAPIER BELL.

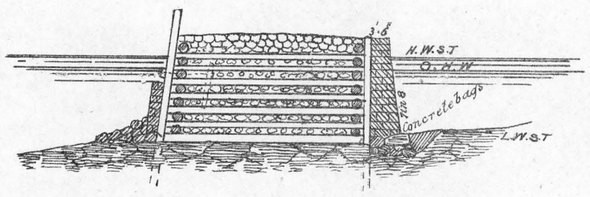
NEW BREAKWATER AT AB

TO BE ERECTED FROM A STAGING



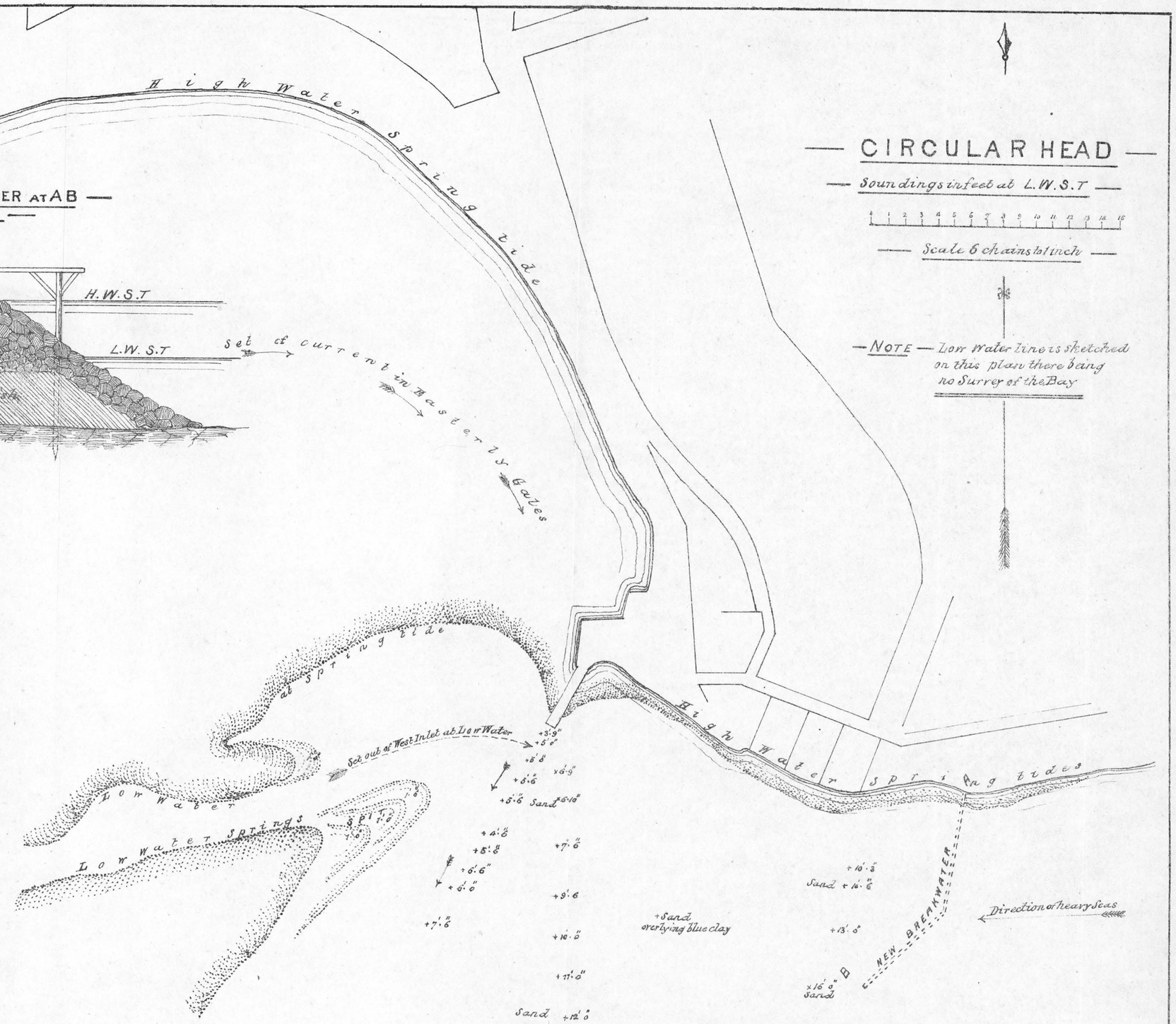
REPAIRS TO PRESENT PIER

SEE PLAN



0 5 10 20 30

SCALE 20 Ft. TO 1 INCH - SECTIONS



CIRCULAR HEAD

Soundings in feet at L.W.S.T

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Scale 6 chains to 1 inch

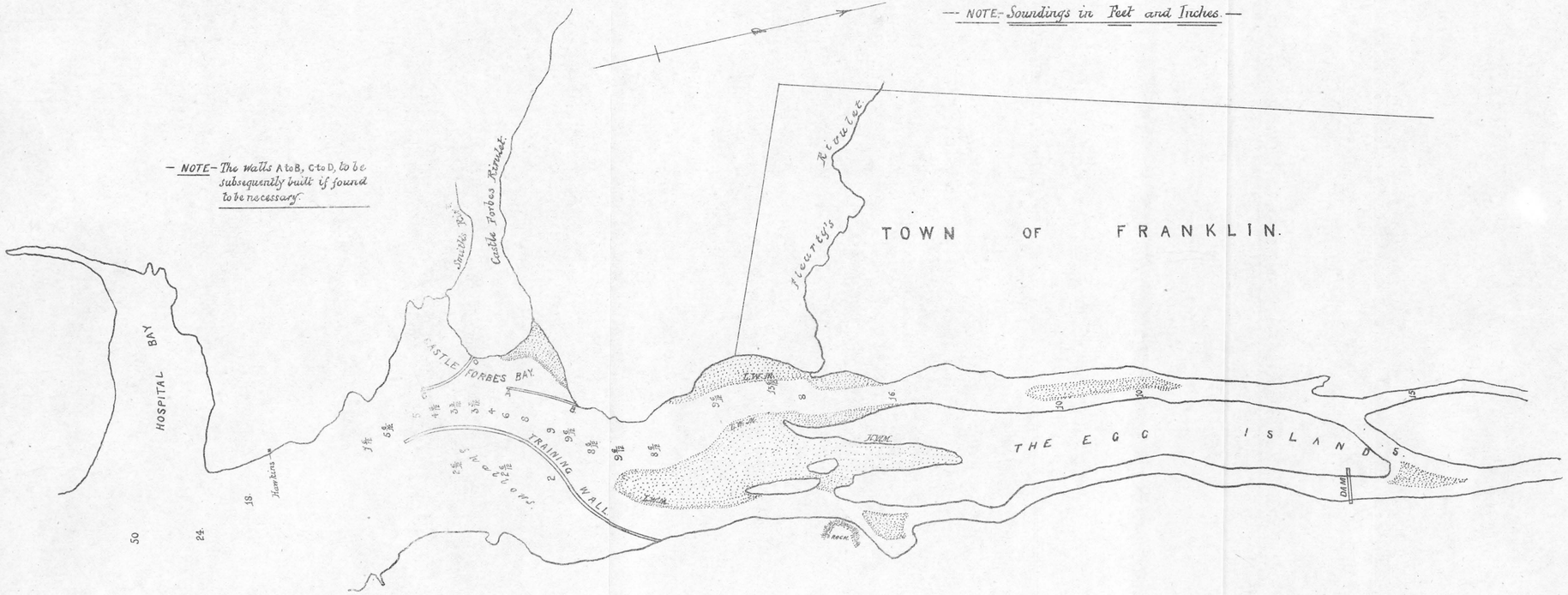
NOTE — Low Water line is sketched on this plan there being no Survey of the Bay

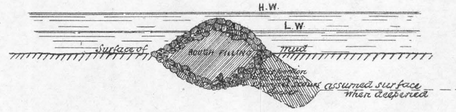
RIVER HUON.

Scale 10 5 0 10 20 30 40 50 60 70 80 90 100 Chains.

NOTE- Soundings in Feet and Inches.

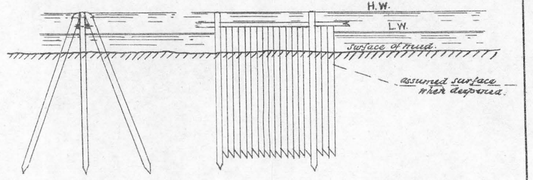
NOTE- The walls A to B, C to D, to be subsequently built if found to be necessary.





SECTION OF TRAINING WALL OF STONE SUBSIDENCE ASSUMED.

Feet 10 5 0 10 20 30 50 50 Feet.



SECTION OF TRAINING WALL OF PILES.

REPORT ON THE HUON RIVER BAR.

The Huon is a river of considerable size, and is subject to frequent and heavy floods. After a course of over 50 miles among the mountains it discharges into a long and wide estuary or arm of the sea. Just below the crossing of the main road the river is divided into two channels by two islands, called the Egg Islands. The eastern of these channels appears to be the main channel; although narrower than the western, it is of more uniform depth, and carries the largest stream. The eastern channel is the widest, but is obstructed by shoals and sandbanks, exposed at low water. On the banks of this channel the town of Franklin is situated. About two miles below Franklin these channels unite in the open estuary, which is here about ¾ of a mile wide. The channels are continued in the estuary for two miles lower, each keeping close to its own shore, and being separated by sandbanks and shallows, until they terminate in bars, and just beyond these the deep water of the estuary is found. **Estuary.**

The range of tide is irregular, depending on the state of the weather at sea, but the average is 3·6. At the top of the estuary the water is nearly fresh in winter and salt in summer. The tidal currents are not strong at Franklin, but when there is a flood in the river a powerful current flows out, overpowering the tide. **Tide.**

The river is navigated, by vessels drawing about 6 feet, as far up as the road bridge; and if they pass through the drawbridge, navigation is practicable two miles further. The western channel is principally used, the depth of which varies from 8 to 15 feet. Opposite the town there is a large sandbank, which is said to be slowly increasing in size, and the navigable channel is on the far side from the town of Franklin. As this western channel approaches the open estuary the depth decreases, until the "bar" is reached, which is situated opposite Castle Forbes Bay, and there is only 3 ft. 3 in. of water on it at the lowest tide. The depth then increases more rapidly, until at Shipwrights' Point there is 18 to 24 feet, and half a mile further down, 50 feet of water.

The bar is caused by the current out of the channels on either side of Egg Island losing its velocity in the wide estuary, and, being checked by the wind and waves of the same, the sediment which it carries is deposited just where the opposing forces are neutralised. The bar is formed of mud covered with a layer of sand. I was able to push a pole 7 feet into the mud, so that it must be very soft. I am told that the depth of water on the bar has decreased 2 feet 6 inches during the last 25 years, which is attributed to the greater quantity of sand which is now washed by the rains off the cultivated land and carried into the river.

It will be seen from the soundings marked on the plan accompanying this report that the bar is of great length, which, together with the width of the estuary, must make any works very costly which are undertaken with the object of increasing the depth. To dredge a channel through it 200 feet wide would necessitate the removal of about 80,000 cubic yards of mud. But I should not recommend dredging alone as the means of deepening the bar, because I fear that, the conditions remaining unchanged, the causes which have produced a shallow bar would continue to operate, and the dredged channel would soon silt up again,—the more speedily because the agitation of the water on the shallows by high winds would drive the mud and sand into the dredged channel, and the currents are so sluggish that they would probably not be sufficiently strong to sweep the deposits away. The tidal currents here are not nearly so strong as they are on the north east, where the range of tide is far greater. It would therefore be safer to confine the tidal currents and that of the river floods so as to increase their scouring power, and bring it to bear on the bar. For this purpose the usual method of a training-wall must be employed; and I have shown on the plan the position of one which would have the effect sought to be obtained. **Great length of the bar.** **Dredging.** **Training-wall.**

This wall would be very costly, and the material and mode of construction require much consideration. A rubble wall of stone, loosely thrown in, would be preferable, if it were not so costly. It should first be ascertained by experiment whether the mud will bear the weight with a reasonable amount of subsidence. It is not improbable that the mud may swallow up the stone to such an extent that the cost would be out of the question, and this can only be ascertained by experiment. As the channel scours out the stone will subside into the new channel, and must be made up to the required height with more stone. **Construction.**

The only other mode of construction for this training-wall which I could recommend would be a dam of close piles, strutted every 16 feet, and tied with a longitudinal walling. The top should be at the level of half tide, and piles at every 30 feet or so should project above high water to show the position of the wall at high water. The **Piles.**

longer the piles are the stronger will the structure be, and experimental piles must be driven to fix the requisite length. It must also be taken into consideration that the increased current will remove a considerable depth of the mud after the piles are driven. There are few, if any, sea-worms in this part of the river, therefore the piles may last about 15 years or more if the timber is properly selected; charring and tarring the piles from just below mud level to the top will increase their durability.

Closing the eastern channel,

The river channel which flows past the Town of Franklin seems to be silting up, and if this should go on to the extent of impeding the navigation it may become necessary to close the eastern channel by a dam, and by this means turn the whole river into the western channel with the object of increasing the depth. I have shewn on the plan the position which I would recommend for this dam if it should be necessary to construct it.

The dam should be made of stone thrown into the channel; and great care must be taken in carrying it out, otherwise there will be much difficulty in closing it, by reason of the soft nature of the banks. The ends at the river banks should be constructed first, of close sheet piles, driven to a considerable depth and extending 30 feet into the banks and 20 or 30 feet into the river. The stone must be made up at the sides first, and the whole bottom covered with stone, before an attempt is made to close the dam from each side. It would be safer not to attempt to close the dam for a long time until the increased current in the western channel should make more room for the flow of the river by sweeping away the sandbanks. The head of the island may also require to be protected by stone or fascines of brushwood, to enable it to resist the increased current caused by forcing the whole river into one channel.

Head of the island.

There is not the slightest doubt that if the above works were carried out the bar would be swept away, and there would be deep water the whole way up the river to the bridge. The bar would naturally tend to reform in advance of the training-wall, but the estuary is of such great depth that this would be a slow process, and could be remedied by carrying the wall forward again.

Until the consistence of the mud-banks is ascertained, the cost of a training-wall of rubble stone can only be guessed at. Supposing the stone to subside half its bulk into the river, the length being about 8000 feet, the cost I estimate at £20,500. The cost of a row of piles strutted would be about £8263, assuming that 25 feet is a sufficient length. If any part of the shoals are sand the stone wall would cost much less than the sum given above; and, on the other hand, piles would be very difficult to drive to sufficient depth.

C. NAPIER BELL.

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