

AGGREGATE COST OF RECLAMATION AT THE COMPLETION OF A COMPREHENSIVE SCHEME COVERING,
SAY, TEN YEARS.

	£	£
(1) Amounts already spent—		
Out of breakwater loans (see Exhibit No. 148)	22,000	
1912 reclamation loan	30,000	
	52,000	52,000
(NOTE : It is certain that more than this has been spent out of loan-money on reclamation, but the exact amount cannot be obtained.)		
(2) To be expended (Hay and Rochfort's dewatering scheme and estimates (Exhibit No. 44) modified to co-ordinate with Mr. G. F. Clapcott's scheme in relation to the Richmond Block)—		
(a) 28-acre Block—		
Cost of completing reclamation	2,900	
Cost of surveying, roading, &c.	4,800	
	7,700	7,700
(Deducting reserves and roads leaves 19½ acres net, or 117 allotments.)		
(b) Richmond Block, 722 acres.		
Deduct suburban 500 acres (to be raised by pumping).		
Rural .. 222 acres at £27 per acre (Exhibit No. 44, page 6)	5,994	
(c) Awatoto Block (all rural), 590 acres at £12 10s. per acre (Exhibit No. 44, page 6)	7,375	
(d) Reclaiming by pumping silt (Hay and Rochfort's scheme (Exhibit No. 46)—		
North Ponds, 550,000 cub. yd. at 1s.	27,500	
South Ponds, 265,000 cub. yd. at 10d., 60 acres	11,040	
Roading, £200 per acre over all	12,000	
	50,540	
Less cost of dredge (included in Mr. Clapcott's figures)	7,000	
	43,540	43,540
(Deducting roads and reserves leaves 37 acres net, or 185 lots.)		
(e) G. F. Clapcott's estimates (page 489, evidence)—		
Richmond Block, 500 acres, suburban—		
Reclaiming banks, dredge, &c.	107,000	
Roads, bridges, &c.	78,000	
	185,000	185,000
(Deducting 170 acres for reserves and roads leaves 330 acres, or 1,930 allotments.)		
Total cost	£301,609	

Annual charges : (a) Interest and sinking-fund charges, £18,000 per annum ; (b) cost of operating pumping-stations.

AGGREGATE RENTALS FROM RECLAIMED LANDS WHEN RECLAMATION OF AWATOTO, RICHMOND, 28-
ACRE BLOCKS, AND THE NORTH AND SOUTH PONDS ARE RECLAIMED AND FULLY LET.

	£	
Awatoto Block : Rural—590 acres at £3 per acre	1,770	
28-acre Block : Residential—117 allotments at £7 per lot	819	
Richmond Block—		
Rural—222 acres at £3 per acre	666	
Residential—1,980 lots at £7 each	13,860	
Ponds : Residential—185 lots at £6	1,110	
	18,225	
Plus present rentals, £8,000 (less any rents now received from any of the above blocks)	8,000	
Aggregate rental (subject to above deduction)	£26,225	

NOTE.—These statements must be considered in the light of the following considerations :—

Cost of reclamation (1) Must be *kept within estimates* if the above result is to be attained ; (2) must be loaded with interest on loans during reclamation and period of land standing unlet ; cost of advertising and letting ; (3) contribution to Hawke's Bay Rivers Board must be contemplated as an addition to cost. (See section 17, Hawke's Bay Rivers Act, 1919.)

Increased rentals from blocks let for industrial and other special sites will tend to better the position, but against this must be considered the possibility of some areas being taken by public bodies at cost or at low rentals.

PART 20.—ALLEGED NON-SUBMISSION OF PLANS OF PROPOSED WORK.

HAS THE HARBOURS ACT, 1923, SECTIONS 168 TO 171, BEEN COMPLIED WITH ?

In the recitals introducing our order of reference there appears, "And whereas by the Napier Harbour Board Empowering and Loan Act, 1914, the Board was, subject to the provisions of the Harbours Act, 1908, and of the said Act of 1914, duly authorized to construct such harbour-works as should, by the Board, be considered necessary . . . in and about the construction, completion, and development . . . of the Inner Harbour portion of the said harbour, but has not, as required by the Harbours Act, 1908, submitted plans of the proposed works for the approval of the Governor-General in Council, except in so far as relates to the reconstruction of certain existing works."

Amongst the questions submitted to us is the following, viz.: "Generally to inquire into and report upon the premises and any matter arising thereout which may come under your notice in the course of your inquiries, and which you consider should be investigated in connection therewith."

It is premised by the recital quoted above that the Board has, in breach of the Harbours Act, failed to submit to the Governor-General in Council plans of works which it has undertaken in the direction of constructing and developing the Inner Harbour. This allegation was, at the hearing before us, denied by the Chairman of the Harbour Board, and, according to the documentary evidence, is questioned by the Harbour Board. It seems to us, therefore, to be a matter into which we should inquire and on which we should make a finding.

The relevant provisions of the Harbours Act (now Act No. 40 of 1923) are in sections 5 and 168 to 171, inclusive. In section 5 appears a definition of "harbour-works." Firstly, there is a definition in general terms, in the words "any works for the improvement, protection, management, or utilization of a harbour"; and, secondly, there is an enumeration of the various works and structures that usually form part of a harbour and its equipment.

There is no general inherent power in Harbour Boards to construct harbour-works, but by sections 168, 169, and (in special cases) section 179 Harbour Boards may, in the manner therein prescribed, obtain authority to construct harbour-works. Section 168 prescribes that, in the case of four major harbour-works—viz., (1) reclamation of land from sea or harbour waters, (2) graving-docks, (3) docks, and (4) breakwaters—no construction shall be entered on except under the authority of a special Act of Parliament. There is a proviso to this subsection which has no application to the present case. The applicant for such special Act must deposit at the office of the Marine Department a plan . . . prepared by a licensed surveyor, showing all tidal waters coloured blue, and the extent of the land sought to be obtained for the purpose of the said Act.

Section 169 provides that with respect to harbour-works other than those referred to in section 168 (*i.e.*, other than the four major harbour-works enumerated above) no Board shall commence or . . . construct such works without the sanction of the Governor-General in Council first obtained in the manner cited in a succeeding section.

These two sections between them cover all possible harbour-works that any Harbour Board might wish to construct, and they prescribe the source of the authority that must be obtained before the work is undertaken. In the case of the four works described above as major works the authority must be an enactment of the Legislature; in all other cases it must be the sanction of the Governor-General in Council.

Section 171 then prescribes the procedure that must precede the actual commencement of the making or construction of the harbour-work. It enacts that the constructing authority shall deposit at the office of the Marine Department a plan in duplicate of the whole work, showing all the details of the proposed work and the mode in which it is proposed the same shall be carried out. It provides further that if it appears to the Governor-General in Council that the proposed work will not be or tend to the injury of navigation he may approve the deposited plan.

It is, we think, clear that the restriction placed on the actual commencement of works by section 171 applies to all or any harbour works or work, whether it is the construction of, for instance, a breakwater under the authority of a special Act of Parliament obtained under the provisions of section 168, or, say, the building of a jetty under the authority of the Governor-General in Council obtained under the provisions of section 169. No matter which source of authority the constructing Board relies on, it must, before commencing the actual construction, lodge a plan showing details of the proposed work and the mode in which it is to be carried out, and procure the approval of that plan by the Executive Council. It may be noted that in the case of a breakwater, for instance, the approval of the detailed plans and specifications would be the approval by the Executive of detailed plans of a work already authorized in general terms by the Legislature; whilst in the case of a jetty the minute of the Executive's approval of the detailed plans would be, at the same time and by the same act, the granting of the sanction which by section 169 is the basis of the authority to undertake the work. This distinction, however, does not affect, in our opinion, the universal application of section 171 to all classes of harbour-works.

In the present case the Napier Harbour Board, being desirous of embarking on the construction of its Inner Harbour according to the plans (more or less modified) described in and accompanying Messrs. Cullen and Keele's 1912 report, sought legislative authority by a Bill, and obtained it when that Bill became the Napier Harbour Board Empowering and Loan Act (No. 14, Local) of 1914. That Act provides that it shall be lawful for the Board (subject to the provisions of the Harbours Act, 1908) to construct such works as are defined by the words "harbour works" in that Act as shall be considered necessary for the requirements of the Harbour of Napier in and about the construction, completion, development, and improvement of the Inner Harbour portion of the said harbour. The Act then bestowed on the Board power to borrow, subject to the provisions of the Harbours Act, up

to £300,000, to be applied in and about the construction, execution, and carrying-out of the works above described. The Act referred to—No. 14, Local, of 1914—was a special Act within the meaning of the Harbours Act, 1908, and the Harbour Board, when applying for such Act, complied with the provisions of the Harbours Act (now section 168, referred to above) by depositing a plan, prepared by a licensed surveyor, showing all tidal waters coloured blue, and the extent of the land sought to be obtained for the purpose of the said special Act. A copy of that plan, described as M.D. No. 4057, was produced to us as Exhibit No. 124.

The Harbour Board has, since the passing of its 1914 Empowering and Loan Act, undertaken certain works that fall within the general description of "Harbour-works" in and about the construction, completion, development, and improvement of its Inner Harbour scheme—viz., the building of a boundary embankment, a deepening of the entrance of the inner entrance channel, and a rebuilding in concrete of certain piers and quays. The Marine Department contends that before commencing any of this work, as a part of the Inner Harbour construction authorized by the Act of 1914, the Board should, in compliance with section 171, have deposited with the Department a plan of the whole work, showing all the details of the proposed work and the mode in which it is proposed the same shall be carried out. It is common ground that the Harbour Board has not deposited such a plan. The Harbour Board submits, in reply, that, as to parts of the work in question, it has acted under special sanctions, and with the full knowledge and approval of the Executive of the Dominion; and as to the remainder that it has from time to time submitted plans of the portions of work it proposed to immediately embark on, and has obtained Orders in Council approving of such works. It further submits that this method of procuring from time to time piecemeal permits only of portions of a whole harbour scheme accords with the Department's interpretation and administration of the Act in the past, and that such practice is a sufficient compliance with the Harbours Act, 1923.

The application of the law to the Acts of the Napier Harbour Board since 1914 is complicated by the peculiar circumstances governing those actions and the nature of the works undertaken. We shall refer later to the position thus created, but for the present we propose to deal with the general principle raised by the respective contentions of the Marine Department and the Harbour Board. We are of opinion that when a special Act empowers a Harbour Board to carry out a certain work, that work is in its entirety a "whole work" within the meaning of section 171, and before the Harbour Board, pursuant to its empowering Act, commences the making or construction of the work it must, to comply with its statutory duties, deposit a plan in duplicate of the whole work, showing all the details of the proposed work and the mode in which it is proposed the same shall be carried out. We are of opinion that it commences the making or construction of the work when it commences the making or construction of any portion of the whole work. It is a question of fact, to be decided fairly and reasonably on a consideration of all the circumstances, whether any particular work commenced by a Harbour Board is a "harbour-work" complete in itself, or a portion of a general scheme which is, on a view of the Board's policy and authorities, a "whole work" within the meaning of section 171 of the Harbours Act. It is, we think, quite clear that the plan deposited under section 168 with the application for a special Act cannot be viewed as a plan that also meets the requirements of section 171. The first plan (section 168) is a surveyor's plan, indicating the position of tidal works in relation to the proposed harbour-works, and showing the areas affected. The second plan (section 171) is an engineer's plan, showing details of the proposed work and the mode in which it is proposed to construct the work. Furthermore, we think that it is equally clear that the work *as a whole* must be laid before and considered by the Department and be submitted for the approval of the Governor-General in Council, and that the Governor-General in Council is entitled and expected, when the plan is submitted for approval, to see each portion not as a separate work, but in its true setting as a part of a whole work. If any object-lesson is necessary to point to the wisdom and necessity of such a provision in the Harbours Act, we think that it will be found in the methods, actions, and expenditures of the Napier Harbour Board. If, in the opinion of the legal advisers of the Governor-General in Council, there should be any doubt as to our interpretation of the law on this present point, we strongly recommend that the doubt should be removed by legislation, so that the policy and practice of piecemeal construction of a harbour be made impossible for the future.

We come now to a consideration of the problem raised by the application of the law to the actions since 1914 of the Napier Harbour Board. We wish briefly to refer again to the Act (No. 14, Local) of 1914. By section 7 the Board was empowered to carry out "harbour-works" in the construction of its Inner Harbour, and this includes, *inter alia* (*vide* interpretation clause, section 5, Harbours Act), the building of an embankment, and the undertaking of dredging to deepen a channel.

By section 8, the Board is entitled, out of the loan-money thereby authorized, to repair and renew its quays and structures appertaining thereto, and to purchase the necessary material and a new reclamation dredger. By section 14, the Board was empowered to fill up and reclaim certain lands.

The Board's harbour scheme, based on Cullen and Keele's 1912 report and plans, required the building of an embankment to define and enclose the Inner Harbour, and also to connect Port Ahuriri with the West Shore. It was quite apparent that this embankment could, and should, be constructed so that it would serve to carry the East Coast Road and Railway north of Napier, and by conference between Cullen and Keele, the Harbour Board, the Public Works Department, and the Hawke's Bay County Council it was agreed that it should be so constructed. Agreements were entered into between, firstly, the Harbour Board and the Minister of Public Works, and, secondly, the Harbour Board and the Hawke's Bay County Council. These agreements were validated by and incorporated into the Port Ahuriri—West Shore Road and Railway Act, 1914, an Act which authorized the three parties to the agreements "to construct and use a combined road and railway embankment and bridge across the Inner Harbour at Port Ahuriri from Port Ahuriri to West Shore." It was under the authority and provisions of this Act that the Board constructed the embankment in question in accordance with

plans lodged with the Public Works Department, marked "P.W.D. 35187." The Harbour Board considers, and submits through its counsel, that the authority given by the Port Ahuriri-West Shore Road and Railway Act, 1914, was a sufficient authority, and relieved it of the necessity of depositing plans and seeking approval of the Governor-General in Council under section 171 of the Harbours Act, 1908. With this contention we agree. We think it is a reasonable view to have taken, and, seeing that the Port Ahuriri-West Shore Road and Railway Act, 1914, is not a special Act under the Harbours Act, but a special legislative authority to build a certain work under special circumstances, we think also that that view is correct in law. We think the special authority of the Port Ahuriri-West Shore Railway Act lifts the building of this embankment out of the category of general harbour-works which are governed by the provisions of the Harbours Act.

As to the dredging-work authorized by Order in Council following on the deposit in May, 1923, by the Harbour Board of its plan M.D. 5652, we consider that it is proved that this was a piece of experimental dredging of the channel between the moles of the entrance to the Inner Harbour. We are satisfied that it was undertaken as experimental dredging, and that on that basis it was approved as a separate and complete piece of "harbour-work." It therefore does not tend to strengthen the submission (otherwise sufficiently proved) that it has been the Department's practice in the past to sanction piecemeal plans of harbour-construction.

We now approach the question of quay-construction. The Act (No. 14, Local) of 1914 authorizes this work under two distinct sections—*i.e.*, under section 7 as construction of the Inner Harbour, and under section 8 as repairs and renewals of the then-existing quays. The Board has since then embarked on and completed works that fall clearly within section 8 as renewals of quays and structures. It has also embarked on the construction of quays in concrete, on the lines of the West Quay, that are equally clearly an instalment of the construction of the Inner Harbour according to Cullen and Keele's report and plans. Inextricably mixed with work under this latter heading is some work that might in fairness be described as renewals of quays existing in 1914. We cannot say precisely just where the line between these two classes of work is to be drawn, but we can and do say that that line has indisputably been crossed, and that work has been undertaken that constitutes a fairly substantial instalment of quays constructed in part realization of Cullen and Keele's plans. No plan of the whole work of which this is a part has ever been *submitted*. This, in our opinion, constitutes a breach of section 171 of the Harbours Act as interpreted by us above. We are aware of the fact, which we find to be proved as a fact, that in the past the Department seems to have accepted and approved plans of portions of works without necessarily requiring plans of the whole work; but, in our opinion, that has no bearing on the question before us. That question is the interpretation of section 171 of the Harbours Act, and, where a statutory provision is as clear as we hold that section to be, departmental practice cannot be invoked to assist in its interpretation. At the same time, we think it is reasonable that in considering our attitude, and the Department's attitude to the position of the Harbour Board in this matter of this breach of its statutory duties, the past practice of the Department should be taken into account. It must be assumed that in the past the Department's officers at least acquiesced in the view which the Napier Harbour Board now puts forward, and in those circumstances we think that the Board must be excused for its lapses in this connection. The important point is that such a position should not be allowed to arise again.

There now remains the proposed purchase of the dredge "Kaione." The evidence adduced at the hearing made it quite clear to us that the Board sought to acquire this dredge for the purpose of using her in the prosecution of Cullen and Keele's scheme of Inner Harbour construction. The letter of the Chairman (Mr. A. E. Jull) of the Board to the Minister for Marine, under date 4th June, 1927, leaves no room for doubt on that point. We are therefore of opinion that the expenditure of £35,000 to £40,000 on that proposed purchase would be an expenditure on the work of construction of the Inner Harbour, and is incidental to the dredging-work. In nearly all the engineers' estimates of cost of dredging for harbour-construction submitted to us the cost of the necessary equipment, including dredges, is included in the unit cost of dredging. The proposed purchase of this dredge is therefore, we hold, an initial step in the work of dredging, and therefore a part of the harbour constructional work, and should not be the subject of a piecemeal approval, but should be considered in relation to the whole work. It should not, *a fortiori*, be permitted without authority, and the question raised by the Chairman of the possibility of the Board purchasing it out of revenue is, in our opinion, wholly beside the present point. Section 171 makes no distinction between harbour-works constructed out of loan-moneys and those constructed out of revenue.

PART 21.—A PROPOSED REFUND BY STATE TO HARBOUR BOARD OF PART COST OF RAILWAY AND ROAD EMBANKMENT.

It was suggested by Mr. A. E. Jull, Chairman of the Harbour Board, in the course of his evidence that if as a result of this Commission the Inner Harbour is not to be completed, the Harbour Board should be recouped for its expenditure on the embankment which now carries the East Coast Railway and road. The basis of this claim is that the embankment is of much heavier construction than it would have been had the Harbour Board built it for its own purposes merely as a harbour boundary, and that if now the harbour is not to be proceeded with the embankment is of no use to the Harbour Board.

We are not prepared to make any such recommendation, as we cannot see any just basis for it. Mr. R. W. Holmes, who was at that time Engineer-in-Chief of the Public Works Department, made it clear in his evidence that the embankment was pushed further back than it would otherwise have been, so as to enclose a larger area for harbour purposes, and this made it more costly to the Public Works Department.

It may be very unfortunate from the point of view of the Harbour Board that this money is sunk and gone, but we can see no principle at all on which it can be suggested that their loss should be shared by the State. We have, therefore, no recommendation to make.

PART 22.—CONSTITUTION OF HARBOUR BOARD AND REPRESENTATION THEREON.

Your Excellency's order of reference requires us to report on any matter arising out of the foregoing premises which might come under our notice in the course of our inquiries and which we consider should be investigated.

One matter which we were asked to report on, and on which evidence was adduced, is a matter comprised in the Napier Harbour Board Empowering and Loan Bill of 1926, appearing in section 4, the marginal note to which is, "Alteration of constitution of the Board." We were asked to hear evidence in support of the proposal therein contained—viz., that the number of members to be elected as representing the Borough of Hastings should be increased from one to two.

We are of opinion that if the constitution of the Harbour Board is to be continued as it is at present, either with or without the presence of non-elective members on the Board, a good case has been made out for the increase by one member in the number of representatives for Hastings, and we are of opinion that this proposal should be given effect to.

We were also asked to consider the question of making a recommendation to the effect that no further non-elective members to the Board should be appointed by the Governor-General. No evidence was placed before us touching the principle on which in certain cases non-elective members are nominated to a Harbour Board by the Governor-General, and we do not feel qualified to make any recommendation in the absence of a knowledge of that principle. Taking the view we have taken of the past and present policy of the Board, we are inclined to think that the presence of the Government nominees on this Board in the past has had a steadying and beneficial effect. We think we should, however, place on record that evidence was given of a resolution passed unanimously at a Harbour Association Conference in 1918. That resolution was to the effect that "the Conference affirms the opinion that the principle of Government nominees on the Harbour Boards is unsound."

There is, however, a larger aspect of this matter that we desire to deal with. We are unanimously of opinion that the matters brought to light in this inquiry reveal a fundamental weakness in the constitution of the bodies by which harbour affairs are governed. We have in the case of the Napier Harbour Board a Board of eleven elective and two nominative members. The elected members represent a comparatively large district, comprising two fairly large boroughs, a number of small towns, and a large rural population. The elective members are elected according to more than one standard of qualification in the electors, and there is no attempt to preserve a reasonable relation between voting-powers and financial responsibility. The policies of different portions of the Board have been taken up on party lines, and all the worst features of party government have been introduced into the controversy that has been engendered. The facts governing the subject-matter of the dispute are technical and professional, and the carrying-out of the various policies involves the expenditure of large sums of public money. Yet so well organized has been the party spirit, and so successful the propaganda, that in the words of Mr. Jull (page 43, Notes of Evidence), "That portion of the district which is responsible for 84 per cent. of payment of any rates has since 1911, *and in spite of any recommendations of engineers to the contrary* been steadfast in their adherence to the Inner Harbour proposal."

We think it shows an inherent weakness in the system that a policy involving the expenditure of a large sum of money for the creation of what should be a permanent and elaborate unit in the transport system of the Dominion can be carried through, almost to fruition, on a popular vote obtained from such a constituency by such propaganda as appears in Exhibit No. 51, read in the light of the history of the port at Napier.

From a national aspect all harbours are part of a composite Dominion transport system. They are really complementary to the roads and railways of the country, although occasionally their interests may conflict with land transport. Furthermore, the development or operation of ports which are bad, either in the navigational or financial sense, inevitably tends to raise the general flat rates for overseas transport to and from the Dominion, and to penalize in that way the whole of the country by raising the general cost of living. For these national reasons we submit that all harbour-development schemes should be carefully scrutinized by expert and unbiased advisers at the initial stage, and especially before the question of shouldering the financial risk is put to payers of rates or dues. We are of opinion that the records of harbour development in this country demonstrate that only by some such methods of supervision can both local and national interests be effectively safeguarded.

In the electioneering pamphlet which we have already referred to (Exhibit 51) there appears the statement, "Napier is crowded with amateur engineers who can predict all kinds of difficulties to any harbour scheme"—and this statement is probably true. It is equally true that in Napier, as in other towns in New Zealand which are in difficulties in the matter of harbour-construction, there is no lack of amateur engineers who can put forward attractive schemes of harbour-construction, and who are very impatient of the adverse criticism of men who have spent their lives studying the problems of harbour-construction. We think that this national problem should be dealt with in a comprehensive way. We do not feel competent, after having made a close study of the affairs of one New Zealand harbour, to formulate the precise remedy, but the principles we are advocating have some precedent in various measures of safeguarding community interests, as, for instance, in the provisions of the Town-planning Act.

CONTRACT PRICES AND DAY LABOUR.

Another matter which we considered should to some extent be investigated in the course of our inquiry, and on which much evidence was tendered, had relation to the cost of construction in concrete of certain works undertaken by the Harbour Board. This evidence took the form of testimony by various contractors of experience as to the cost per cubic yard of making concrete blocks. We also took evidence on the same subject-matter from representatives of public bodies—viz., the Engineer-in-Chief of Public Works; the Engineer of the Napier Borough Council, and (speaking from his cost records) the Secretary of the Napier Harbour Board. There was a great discrepancy between the prices of these two classes of witnesses. For instance, Mr. Furkert deposed he was able to make a cubic yard

of concrete at a minimum price at which, according to the same specifications, private contractors alleged they were quite unable to turn out a cubic yard of concrete. The cross-examination of some of the private contractors left no doubt whatever in our minds that they had been extremely liberal in their estimates of the details of cost, and that the prices they arrived at were decidedly high. We make no finding on any individual prices or figures submitted to us, but we recommend very strongly that the Napier Harbour Board, as custodian of public money, should, before accepting any contract involving such work, require close inquiry to be made as to the prospects of doing the same work at a much lower cost by day labour under the supervision of its own foreman and officers.

PART 23.—COSTS OF THIS INQUIRY.

We have been further directed by Your Excellency to consider what sums representing the whole or any portion of the costs of our inquiry should be borne by the Harbour Board, and by the respective corporate bodies represented by the local authorities of any district lying wholly or partly within the Napier Harbour Rating District as now constituted, and any other corporate body and individual, or by any of them, and in consideration of this matter we were directed by Your Excellency to have regard to the local scope of the Commission.

We have given due consideration to this matter, and we have had the benefit of being addressed on the point by counsel for the Harbour Board (Mr. A. Gray, K.C.) and counsel for the Marine Department (Mr. H. B. Lusk). In our opinion, the whole of the costs of the inquiry should be borne by the Napier Harbour Board. We are of opinion that the appointment of this Commission and the conduct of the hearing was necessary, and that the said necessity arose entirely through the actions and policy of the Board; and, further, that the result of the inquiry is to the benefit of the Harbour Board and its constituents.

In this connection we refer to the brief history of the Board set out in Part No. 8 of this report; to the vacillations of policy shown therein; to the numerous costly reports obtained, only to be rejected and scrapped whilst the Board resumed its search for an engineer who would give an answer agreeable to the Board; also to the Board's inaction in the matter of reclamation for a period of approximately twenty-five years—an inaction that has inflicted great hardship and injustice on the residents of Napier.

The costs will be comparatively high, and we regret that they must be visited on those who find the revenue of the Napier Harbour Board, but on no principle of fairness can we justify to ourselves the suggestion that any other body or person should be visited with a portion of them.

We beg to hand to Your Excellency herewith an order for payment of costs in accordance with the above, for transmission to Your Excellency's Minister for Marine.

PART 24.—HARBOUR BOARD OFFICIALS AND STAFF.

Our inquiry at Napier involved the officials and staff of the Harbour Board in a great deal of work. Much of this had to be done at high pressure, and it was in most cases associated at some stage with the ordeal of examination and cross-examination in the witness-box, and we wish to express our appreciation of the manner in which all concerned performed their duties.

It was suggested by counsel for the Harbour Board, when we were addressed on the matter of costs, that we might make a recommendation that an allowance should be made to the Chairman of the Board, Mr. A. E. Jull, in recognition of the fact that during the six weeks covered by the inquiry he was in constant attendance, living at Napier during that period, and devoting all his time and energies to the presentation of the case. We fully recognize those facts. We have not agreed with Mr. Jull's views, we have not been able to endorse his policy, but those facts do not prevent us from recognizing that Mr. Jull, as representative and champion of the majority party of the Harbour Board, sacrificed all his time and energy for six weeks, and presented the case of that party with vigour, with a great deal of ability, and, above all, in an excellent spirit. While recognizing all this, however, we do not think that we should make the suggested recommendation. If it were made in favour of the representative of the majority party, it must in fairness be made also in favour of Mr. P. F. Higgins, the representative of the minority party. He also displayed a great deal of ability in putting his facts and views before us, and it was not suggested that we should recommend an allowance to him. Both are elected members of a local body, and there are obvious objections to recommending payments for services rendered in the advocacy of policies for such bodies.

As to the work of the clerical and working staff of the Harbour Board, we feel constrained to place on record our appreciation of this. Particular mention must be made of the Secretary, Mr. J. P. Kenny; his energy and ability were beyond praise. We submitted numerous questions to Mr. Kenny (see Exhibits 95 to 100 and 147 to 162), and the preparation of the answers to these must have involved days and nights of work, the bulk of which in the matter of organization and co-ordination must have fallen on Mr. Kenny, and not once did his intelligent ability, his knowledge of his subject, or his courtesy fail him. We have no doubt that the remuneration of the staff for all this extra work will receive attention from the Harbour Board. It may assist the Board in assessing a just recompense to Mr. Kenny if we place on record our belief, firstly, that Mr. Kenny's energy and ability reduced the expenses of the Commission by the cost of fourteen days' sitting, and, secondly, that if his secretarial knowledge had not been supplemented by a good grip of accountancy principles it would probably have necessitated our requiring the services and report of a public accountant. We beg to recommend a special remuneration of £100 to Mr. Kenny.

We have the honour to be, Your Excellency's obedient servants,

JOHN S. BARTON, Chairman.

A. C. MACKENZIE, M.Inst.C.E., Commissioner.

JOHN B. WATERS, Commissioner.

Dated at Wellington, this 29th day of September, 1927.

APPENDIX TO REPORT.

TABLE A.—LIST OF NEWSPAPERS IN WHICH NOTICE OF SITTINGS WAS ADVERTISED.

Hawke's Bay Herald, Napier; *Daily Telegraph*, Napier; *Hawke's Bay Tribune*, Hastings;
Waipukurau Press; *Waiparua Mail*.

TABLE B.—DAYS ON WHICH SITTINGS WERE HELD.

AT NAPIER.	AT NAPIER—continued.
Friday, 5th August, 1927—10 a.m. to 5 p.m.	Monday, 5th September—10 a.m. to 5 p.m.
Saturday, 6th August—10 a.m. to 12.20 p.m.	Tuesday, 6th, to Friday, 9th September—9.30 a.m. to 5 p.m.
Monday, 8th, to Friday, 12th August—10 a.m. to 4.30 p.m.	Saturday, 10th September—9.30 a.m. to 12.30 p.m.
Monday, 15th, to Friday, 19th August—10 a.m. to 4.30 p.m.	Monday, 12th September—9.30 a.m. to 5 p.m.
Monday, 22nd, to Friday, 26th August—10 a.m. to 4.30 p.m.	Tuesday, 13th September—9 a.m. to 5 p.m.
Monday, 29th August, to Friday, 2nd September—10 a.m. to 4.30 p.m.	AT WELLINGTON.
	Monday, 19th September—2 p.m. to 4.40 p.m. (Hearing declared closed.)

TABLE C.—WITNESSES WHO APPEARED BEFORE COMMISSION.

Name of Witness.	Description.
1. Jull, A. E.	Chairman of Napier Harbour Board.
2. Higgins, P. F.	Member of Napier Harbour Board.
3. Earney, H. D.	Wharfinger, Napier Harbour Board.
4. Pengelly, R.	Boring expert, Public Works Department.
5. Holmes, J. D.	Of Holmes and Son, Harbour Board's consulting engineers.
6. Hartman, Captain W. H.	Captain of s.s. "Tamaroa."
7. Chatfield, Captain S. A.	Captain of s.s. "Kaituna."
8. Waller, Captain Wm.	Harbourmaster, New Plymouth.
9. Worrall, Captain L. C. H.	Retired master mariner.
10. Edwin, Captain A. M.	Coastal pilot, New Zealand.
11. Collins, Captain H.	Harbourmaster, Nelson, New Zealand.
12. Nicholson, Duncan	Builder; foreman carpenter for Harbour Board.
13. White-Parsons, Captain H.	Harbourmaster, Napier.
14. Holmes, R. W.	Of Holmes and Son, Harbour Board's consulting engineers.
15. Robertson, A. M.	Member of executive of Fruitgrowers' Association.
16. Brown, Captain A. H.	Captain of s.s. "Port Melbourne."
17. Chudley, Captain T. H.	Marine Superintendent, of Shaw, Savill, and Albion Co., Ltd.
18. Olphert, Captain W.	Marine Superintendent, of New Zealand Shipping Co., Ltd.
19. Foster, Captain P. J.	Marine Superintendent, of Union Steamship Co., Ltd.
20. Rochford, Guy	Licensed Surveyor.
21. Latham, G. A.	Building contractor.
22. McLeay, K.	Shipping and lighterage company manager.
23. McDonald, J.	Farmer.
24. Canby, F. S.	Manager of meat-freezing company.
25. Kenny, J. P.	Secretary, Napier Harbour Board.
26. Allen, William R.	Shoremaster for Richardson and Co., Ltd.
27. Ferkert, F. W.	Engineer-in-Chief, Public Works Department.
28. Hollis, Captain Hugh	Marine Superintendent, Commonwealth and Dominion Line.
29. Kennedy, C. D.	Civil engineer.
30. Maxwell, J. P.	Civil engineer.
31. Martin, T. W.	Dredgemaster, Wellington Harbour Board.
32. Oldham, J. H.	President Land Agents' Association, Napier.
33. Harvey, William	Member Land Agents' Association, Napier.
34. Godfrey, G. C.	Secretary for Marine.
35. Hobson, H.	Chemist; president Napier Chamber of Commerce.
36. Russell, A. C.	Chairman Waipukurau County Council, and representing two other local bodies.
37. Kelly, George	Chairman Hawke's Bay Woolbrokers' Association.
38. Maddison, G. H.	Mayor of Hastings.
39. Clapcott, G. F.	Engineer for Borough of Napier.
40. Miller, J. H.	Chairman Hawke's Bay Rivers Board.
41. Pulley, C. F.	Contractor.
42. Morse, C. O.	Contractor.
43. McMillan, D. N.	Contractor.
44. Northe, W. E.	Contractor.
45. Brooks, E. S.	Contractor.
46. Martin, William G.	Member Napier Borough Council.
47. Ferguson, A. H.	Clerk to Hawke's Bay County Council.

TABLE D.—LIST OF EXHIBITS.

Exhibit No.	Exhibit No.
1. Book of various reports.	62. Return of coastal and intercolonial vessels at breakwater, two years, 1/7/25 to 30/6/27.
2. Sir John Coode's plan.	63. Return of coastal and intercolonial vessels at Inner Harbour.
3. Mr. Culcheth's plan.	64. Comparative statements, charges various Harbour Boards.
4. Extract from minute-book of that period, 1882.	65. Statement, charges various New Zealand ports on vessels, 2,321 tons net register.
5. Goodall's plans (in five parts).	66. Locality map of Hawke's Bay.
6. Marchant's report.	67. Litho map showing coloured shoal patch near breakwater.
7. Marchant's plan.	68. Report of Holmes and Son to Harbour Board on shoaling.
8. Nelson's report and plan (printed pamphlet).	69. Photograph (1887) of West Shore.
9. Maxwell, Williams, and Mason's report.	70. Plan showing shore-line at various periods.
10. Transcript of oral report, Mr. Ferguson.	71. Jar of material from bore 85 or 86.
11. Kennedy's report on soundings.	72. Tin of sample of bottom at Whakariri patch.
12. Finch's report on soundings.	73. Blue-print plan accompanying Cullen and Keele's 1925 report.
13. Plan of Kennedy's soundings.	74. Plans of Glasgow Wharf (five plans).
14. Cullen and Keele's report, 1912.	75. Particulars of reclaimed sections offered for sale (see Chairman's report for 1926).
15. Cullen and Keele's plans (three).	76. Piece of rock from foundation of breakwater.
16. Questions to, and answers by, Cullen and Keele.	77. Plan of borings by Holmes and Son—Inner Harbour; two plans.
17. Cable to Cullen and Keele, and their reply.	78. Plan of subdivision of suggested early reclamation.
18. Plan submitted under Harbour Act, with application for special Act, 1914.	79. Plan of leases for sale by auction, 22/12/24.
19. Furkert's report, 1924.	80. Blue-print, breakwater, showing reclamation area for leasing (it accompanied Cullen and Keele's 1925 report).
20. Plan with Mr. Furkert's report, with graphs (five sheets).	81. Large plan of Napier Harbour.
21. Cullen and Keele's 1925 report.	81. (a), (b), (c), (d), (e), (f), (g), (h). Supplementary plans.
22. Cullen and Keele's plans (three).	82. Report, Dominion Royal Commission on Harbours.
23. Plan of borings supplied to Cullen and Keele: Ground plan by Pengelly; individual reports on each bore by Pengelly; graphs and plans (twelve in all).	83. Three jars material from soundings—bore 41-38 and one unidentified.
24. Minutes as to Mr. Keele's advice. . . . checking borings.	84. Statement of areas to be reclaimed, and estimated values.
25. Extract from p. 530, minute-book, 4/5/25.	85. Plan of dredging by Browning crane.
26. Plans of soundings by Holmes and Son, 1927.	86. Sample of bottom where blasting was required.
27. Letter, Harbour Board to Marine Department, and reply to Board, 14/4/26.	87. Correspondence <i>re</i> silt in Breakwater Harbour.
28. Comparative lighterage and wharfage costs.	88. Return of accidents (both harbours).
29. Return cost of labour on general cargo at breakwater shed.	89. Statement of Fruitgrowers' Association.
30. Statement of charges by New Zealand Railways for haulage and delivery charges at various ports in New Zealand.	90. Plans, Mr. Napier Bell, accompanying his report of December, 1899.
31. Dissection of total costs, Wellington to Dannevirke and Napier to Dannevirke.	91. Plan of Brisbane Harbour entrance.
32. Railway rates.	92. Copies of minutes of Harbour Board.
33. Statement valuation and population, rating district.	93. Report of engineer <i>re</i> state of breakwater wharf.
34. Dredging return covering seventeen years.	94. List of loadings in roadstead; time occupied: (a), (b), (c), (d), (e), (f), (g), (h) attached (McLeay's return).
35. Statement of published accounts for 1923.	95 to 99 (inclusive). General questions submitted to and answered by Board's Secretary.
36. Statement of published accounts for 1926.	100. Photograph of breakwater in a storm.
37. Return showing liners using roadstead for two years.	101. Blue-print of tide-levels.
38. Return showing liners using breakwater for two years.	102. Plan of soundings.
39. Return showing coastal boats and liners using Inner Harbour.	103. Plan of roadstead.
40. Return showing berthage rates, 1924 to 1/7/1927.	104. Plan of soundings on beacon line.
41. Return showing amount of aggregate berthage paid, cargo landed and shipped, and cost per ton.	105. Plan of soundings (west beach) on roadstead.
42. Report by D. N. Campbell (on reclamation).	106. River diagram prepared by Mr. Furkert.
43. Plan accompanying Campbell's report.	107. Tracing from Exhibit No. 26.
44. Report by Hay and Rochfort of 8/5/26 (on reclamation).	108. Graphs made up from soundings.
45. Five plans (a), (b), (c), (d), and (e) accompanying Exhibit No. 44 (on reclamation).	109. Plan of cross sections, West Beach.
46, 46A. Report of Hay and Rochfort of 4/10/26 (on reclamation).	110. Rough graph showing ratio of increase of siltation.
47. Report by Holmes and Son (on reclamation).	111. (a), (b), (c), (d), (e) contour maps (underwater).
48. Report by George Nelson, June, 1922 (on reclamation).	112. Tracing from Admiralty chart, Napier Harbour.
49. 1927 Empowering and Loan Bill.	113. Diagram showing depths water on bar (nineteen years).
50. List of vessels drawing 20 ft. or upwards.	114. Diagram showing tidal levels.
51. Election propaganda sent out by Board in 1920.	115. Wind diagram (three years).
52. Copy of letter to P. F. Higgins, 18/7/24, from Secretary, Harbour Board.	116. Tracing of Admiralty chart, Colon Harbour.
53. Set of shipping documents	117. (a), (b). List of ports visited by Mr. Furkert.
54. Bills of lading, showing alteration of destination.	118. Tide-table for August, 1927, at Napier.
55. Two bundles of letters (seven letters, 2/3/26 to 1/10/26, and ten letters, 2/3/26 to 3/8/26), put in by P. F. Higgins.	119. Longitudinal and lateral sections over dredged patch.
56. Copies letters, Harbour Board and Canadian Government Marine Board.	120. Sketch of type of cutter for dredge.
57. Lists of soundings at Inner Harbour (ten bundles, April, 1924, to June, 1927).	121. Tracing, comparative sections of outer channels.
58. Return of quarrying-costs.	122. (a), (b). Mr. Furkert's estimates of costs.
59. Report of C. D. Kennedy on the flooding problem.	122½. Land-agent's plan.
60. Return of cargo imported, 1/7/25 to 31/6/27.	123. Marine Department Report, 1924.
61. Cost of handling cargo at breakwater.	124. Plan No. 4037, submitted to Marine Department.
	125. Letter, 4/6/27, Harbour Board to Auditor-General (bound in with notes).
	126. Map showing Napier Harbour district.
	127. Reclamation plan, showing pumping-stations.
	128. Subdivision plans, Richmond Block.

TABLE D.—LIST OF EXHIBITS—*continued*.

Exhibit No.	Exhibit	Exhibit No.	Exhibit
129.	History of Napier Harbour legislation (put in by Mr. Gray).	147-162.	General questions submitted to and answered by Board's Secretary.
130.	List of towage fees in New Zealand.	163.	Proposed subdivision of town lots (Borough Council).
131.	Letter from Mr. Clapcott to Commission.	164.	Cost of new wharf, Outer and Inner Harbour.
132.	Hay and Rochfort's file <i>re</i> Awatoto water-levels.	165.	Letter, Harbour Board Secretary to Minister of Marine, 26/8/24.
133.	Return showing levels and flood-levels, Awatoto Block.	166.	Copy resolution, Harbour Board, 26/9/24.
134/135.	Graphs showing variations in areas of contours of shingle-bar.	167.	Correspondence between Harbour Board Engineer and Engineer-in-Chief, P.W.D.
136.	Cross-sections showing losses and gains, Petane Beach (sixteen sheets in all).	168.	Plan M.D. 5652.
137.	Map of rivers, Board district.	169.	Plan M.D. 5679 and 5847.
138.	Letter, Harbour Board to Minister, 17/9/26.	170.	History of suffrage provisions, Napier Harbour Board.
139.	Report <i>re</i> "Canadian Challenger."	171.	Return showing size of B and F sheds at Inner Harbour.
140.	Report <i>re</i> complaints of delay, certain ships.	172.	Return of annual expenditure on Inner Harbour, 1910 to 1927.
141.	Various bills of lading.	173.	Return of number of men on mould-work.
142.	Return showing discharge of five vessels.	174.	Reports on breakwater construction.
143.	Return comparative working of gaugs, Napier and Lyttelton.	175.	Return showing cost per lineal foot of breakwater.
144.	Return showing population, rates, and representatives.	176.	Dredgemaster's report on "Whakariri" dredging in 1911.
145.	Estimated cost making 30-ton block, concrete (Morse).	177.	Schedule of charges, Wellington Harbour Board.
146.	Estimated cost of 30-ton concrete blocks (Brooks).		

TABLE E.—LIST OF PRINTED REPORTS STUDIED BY THE COMMISSION AND NOW COMPRISED IN COMMISSION'S EXHIBIT No. 1.

	Date of Report.
1. Report on Napier Harbour, by John McGregor	1875
2. Report on Napier Harbour, by C. H. Weber, Engineer to Harbour Board	1879
3. Report on Napier Harbour, by Sir John Coode, C.E.	1880
4. Report (competitor and prize-winner) by W. W. Culcheth, C.E., F.M.S.	1883
5. Report on Breakwater Harbour, by John Goodall, M.Inst.C.E.	1884
6. Report on Mr. Goodall's breakwater scheme, by Messrs. Napier Bell and Scott	1884
7. Reply to Napier Bell and Scott's criticism, by John Goodall, M.Inst.C.E.	1884
8. Report and recommendation by Nautical Commissioners	1892
9. Memorandum upon Report No. 8 by J. T. Carr, Engineer to Napier Harbour Board	1892
10. Report on damage to breakwater, and completion of harbour, by C. Napier Bell, M.Inst.C.E., and J. P. Maxwell, M.Inst.C.E.	1894
11. Report on Inner Harbour dredging problem, by C. Napier Bell, M.Inst.C.E.	1899
12. Reply by C. Napier Bell to criticisms of his report No. 11 above	1900
13. Report on dredging and encroaching silt, Inner Harbour, by C. Napier Bell, M.Inst.C.E.	1900
14. Report on harbour accommodation at Napier, by F. W. Marchant, M.Inst.C.E.	1906
15. "The Napier Harbour Question," by George Nelson, M.I.Mech.E. Undated, but it collects and incorporates various documents dated 1906 to 1910, and some dated by months only	..
16. Report on Napier Harbour for vessels of deep draught, by Messrs. J. P. Maxwell, M.Inst.C.E., Cyrus J. A. Williams, M.Inst.C.E., M.Am.Soc.C.E., and J. Blair Mason, C.E.	1909
17. Transcript of shorthand notes of conference between William Ferguson, M.Inst.C.E., and the Napier Harbour Board members, 19th July	1911
18. Reports, eight in number, from 15th January, 1912, to 7th August, 1913, by Mr. C. D. Kennedy, C.E., regarding the experimental patch dredged by the "Whakariri" in 1911-12	1912
19. Report on proposed Inner and Outer Harbours at Napier, by E. A. Cullen, M.Inst.C.E., and T. W. Keele, M.Inst.C.E.	1912
20. Correspondence by letter and cablegram between Harbour Board and Messrs. Cullen and Keele, arising out of Report No. 19	1912
21. Report by Mr. F. W. Furkert, M.Inst.C.E., A.M.I.M.E., on the proposed Inner and Breakwater Harbours	1924
22. Report by Messrs. Cullen and Keele (Ms.Inst.C.E.) on Inner and Breakwater Harbours at Napier	1925

TABLE F.—MR. A. C. MACKENZIE'S REPORT ON DREDGING.

As far as the Inner Harbour is concerned, the dredging of the outer approach channel is the crux of the situation. The channel designed by Cullen and Keele (see Exhibit 21, page 5) is to have a bottom width of 600 ft. and to give a depth of 35 ft. at low water. The Napier Harbour Board's Plan A (Commission's Exhibit 3), issued in 1919, shows this depth as 34 ft.

Taking points along the centre-line, the depth of dredging required and the length of channel are as follows:—

Distance from End of Eastern Mole.	Depth to obtain 34 ft.		Depth to obtain 35 ft.		Distance from End of Eastern Mole.	Depth to obtain 34 ft.		Depth to obtain 35 ft.	
	Ft.	Ft. in.	Ft.	in.		Ft.	Ft. in.	Ft.	in.
0	16	0	17	0	2,970	3	3	4	3
165	17	0	18	0	3,300	11	0	12	0
330	15	0	17	0	3,630	14	6	15	6
660	10	6	11	6	3,960	12	0	13	0
990	9	0	10	0	4,290	10	0	11	0
1,320	6	0	7	0	4,620	6	6	7	6
1,650	4	9	5	9	4,950	5	3	6	3
1,980	3	0	4	0	5,280	2	6	3	6
2,310	2	3	4	3	5,610	0	6	1	6
2,640	2	3	4	3	390	Nil.		Nil.	

} Spit.

} XX

As we proceed seaward from the eastern mole the present slopes of the sea-bed show a fall of 1 ft. in 94 ft.; then there is a further fall of 1 ft. in 198 ft.; between this point and the beginning of the sandspit, a distance of 1,815 ft., the fall is 1 ft. in 257 ft.; the south side of the sandspit rises for a short distance on a gradient of 1 ft. in 82 ft., and then rises sharply on a gradient of 1 ft. in 37 ft.; from the top of the sandspit, which is 3,630 ft. from the east mole, it falls seaward upon a gradual slope of 1 ft. in 157 ft.

In estimating the quantity of material to be removed by dredging from this channel the batter of the side slopes on the eastern and western sides must be assumed, as it would obviously be wrong to estimate only for a channel 600 ft. in width with plumb sides, similar to a railway-cutting through tough rock. In an ordinary road and railway cutting through sand provision has to be made for the flattening of the slopes due to the prevailing winds, more particularly if the strong winds blow across the road or railway. On the lee side the slopes may become flatter by the sand forming the top of the cutting being blown away from the centre-line. The effect, however, on the weather side is possibly for the top of the cutting to be reduced by the sand being blown into or beyond the road; and also other sand well on the weather side may be transported and deposited in or beyond the original cutting. In the channel under consideration we have a fine sand saturated with water subjected to the transporting-power of very heavy seas running across the channel. The seas, in rough weather, when approaching the sandspit are said to be at least 15 ft. in height, so that by the time they arrive at the sandspit, where the depth of water at the top is only 19 ft., they have become waves of translation with an abundance of transporting-power. It will be noticed that the outer (or sea) side of this spit has, under the conditions it is subjected to, assumed a comparatively flat slope of 1 ft. in 157 ft. The question is as to whether the side slopes of the channel can safely be left at a steeper slope without incurring heavy maintenance dredging. We would point out that to provide for slopes of 1 in 157 the width at the shallowest part of the spit would be 600 ft. at the bottom and some 5,040 ft. at the top, which would result in practically the whole of the spit being removed.

We here set out some relevant extracts from the various engineers' reports and evidence.

Messrs. Maxwell, Williams, and Mason in their reply of the 19th October, 1909, addressed to the Secretary of the Napier Harbour Board (see Exhibit 8, page 34), express their opinions as follows: "The question [asked by the Secretary] suggests that the underlying idea is that a channel something like a cutting in solid material on dry land, with defined slopes, can be made. No such simple conditions are, however, involved." The conditions are—(1) The open ocean subject to the greatest recorded seas, due to a vast reach and the greatest ocean depths off the coast; (2) about 4,000 ft. of continuous sand-drift to get through for a depth of 35 ft. (the distance in 1927 is 5,808 ft.); (3) the natural inclination of the sandy bottom, apparently about 1 in 200, more or less, varying with the weather.

Sir John Coode, M.Inst.C.E., in his report of 1880 does not deal with dredging an entrance channel outside the moles, and suggests dredging between the moles only to a depth of 12 ft. below low water.

Mr. W. Culcheth, M.Inst.C.E., in his report of 1883 provides for only dredging between the moles to a depth of 20 ft. at low water, no dredging being required outside the moles.

Mr. J. Goodall, M.Inst.C.E., in his report of 1884 does not deal with dredging an approach channel, as he suggested a breakwater harbour.

Messrs. Bell and Scott in their report upon Mr. Goodall's scheme do not deal with dredging an approach channel to the Inner Harbour, as they approved of Mr. Goodall's breakwater scheme.

Messrs. Bell and Maxwell in their report of 1894 do not deal with dredging an approach channel, as this report is principally concerned with damage to the breakwater by storms in 1894.

Mr. C. Napier Bell in his report of 1899 on dredging only refers to dredging between the moles to a depth of 19 ft. below low water, and also for a distance of 900 ft. seaward. Mr. C. Napier Bell in his report of 1900 deals only with dredging and reclamation within the entrance between the moles.

Mr. Marchant, M.Inst.C.E., in his report of 1906 provides a mole on the east side of his proposed entrance channel, the mole to extend in line with the existing eastern mole and to terminate in 27 ft. of water; the channel to be dredged to a depth of 27 ft. on the lee side of the proposed new mole; the bottom of channel to be 400 ft. wide. He states that the annual cost of maintaining this full depth of water under the lee of breakwater (mole) is a matter of conjecture, and states that it would probably cost not less than £4,000 a year. In referring to the assistance to be anticipated by the lagoon scour, he states it is certain that under the lee of such a breakwater (mole) there will be some deposit which must be removed by dredging, allowing to the current all the scouring-power of which it is capable (see Exhibit 6, page 1). The important point in Mr. Marchant's provision of a mole is that he considered it absolutely necessary to protect the approach channel on the eastern side against accretion, and the attendant heavy maintenance costs, and the possibility of serious shoaling after completion.

Mr. George Nelson, M.I.Mech.E., in 1909 submitted a scheme to the Napier Harbour Board for an Inner Harbour, in which he states in relation to the dredging of the approach channel: "According to Mr. Marchant's survey of 1906, the 5-fathom line is 75 chains distant, measured due north off the eastern pier-head. So as to give access to the proposed harbour for vessels of the largest size it would be necessary to dredge a channel out to this line. The material is, no doubt, Tutaekuri silt, ideal stuff for suction dredge to handle. In 1906 the average depth of water between the pier-head and the 5-fathom line was 23 ft. at low water; a channel through this 7 ft. deep, so as to give a depth of 30 ft. at low water, with an average bottom width of 400 ft., and its banks sloped down to a batter of 10 to 1, would cost under £20,000. The formation of this channel presents no difficulty whatever." (See Exhibit 8, page 9 or page 11.) The quantity to be dredged he estimated at 770,000 cubic yards. To enable the Commissioners to gauge the value of Mr. George Nelson's opinion upon harbour matters, seeing that his qualifications are those of a mechanical engineer, Mr. R. W. Holmes, who recently retired from the position of Engineer-in-Chief of Public Works, was asked whether Mr. Nelson had experience

in the design, construction, or maintenance of harbour works. Mr. Holmes reply was that, as far as he was aware, Mr. George Nelson had no practical experience in harbour construction and maintenance. (See Notes of Evidence, page 266.) It will be noted that Mr. Nelson is quite wrong in his statement that the spit is composed of silt, and that the formation of the channel would present no difficulty whatever. (See evidence of T. W. Martin, dredge superintendent, page 359 *et seq.*)

Messrs. Cullen and Keele in their 1912 report (see Exhibit 14, page 3) comment upon the dredging through the sandspit, and contend that there is no evidence of sand-drift, and that the sand is coarser than that occurring off the breakwater and the beach south thereof, and that they find upon examining records of previous surveys that the present conditions of the bottom off the moles, as shown by contours of equal depth and soundings generally, are unchanged outside the 3-fathom (18 ft.) contour since the date of the first survey in 1855.

In regard to sand-drift, the evidence submitted to your Commission shows that the spit has altered its shape considerably, as shown by a comparison of the plans showing the contours of equal depths in 1855, 1882, 1895, 1906, and 1927. We submit that these alterations can only be due to sand-movement, and that the movement of this sand will continue and cause siltation in the channel, unless an Inner Harbour improvement scheme included the provision of moles designed to protect the sandspit from the effects of cross-currents of heavy seas or a heavy ocean swell. In regard to the sand the spit is formed of being coarse, this was not borne out by the sample of fine sand submitted for our inspection by Mr. J. D. Holmes as having been recently dredged from the spit by the grab dredge "J.D.O." This sample was also stated by Mr. T. W. Martin to be similar to that he had dredged up in 1911 with the ladder dredger "Whakarire." In this connection we use the words "movement of sand" as distinct from littoral sand-drift. In conclusion, Messrs. Cullen and Keele say, "We fully recognize the heavy breaking seas there would tend to fill in the cutting on the sides, and that some maintenance dredging may always be necessary; favourable factors are that the bottom consists of heavy and compact dark sand, and that big breaking seas are not of frequent occurrence"; and they continue that, in their opinion, it is feasible to dredge and maintain an entrance channel. Their estimated cost for dredging the channel to a depth of 35 ft. is £12,900, and that the annual maintenance would cost £7,276 (see Exhibit 14, page 6). In their 1925 report they give the estimated cost of dredging as £25,310, and the cost of maintenance dredging £13,500, less cost of maintenance to quays and cargo-sheds (say, £1,500), leaving cost of maintenance dredging £12,000 per year.

Mr. F. W. Furkert, M.Inst.C.E., Engineer-in-Chief of Public Works, in his report of 1924 deals with the question as follows: "It would be a comparatively easy task to dredge material such as exists along the line of this cut, but the amount to be removed would be very much greater than indicated simply by a consideration of the proposed length and cross-sections. Assuming the channel to have been dredged, its maintenance would involve considerable expense." (See Exhibit 19, page 6.)

Mr. R. W. Holmes, M.Inst.C.E., in his evidence on page 194, points out the difficulty in getting a full load with the use of a suction dredge, and estimates that it is necessary to dredge twice as much as the contents of the hopper before it becomes full. (This will necessarily increase the cost of dredging.) Mr. Holmes, however, recommends the use of a suction dredge fitted with a cutter in preference to a ladder bucket dredge, and concludes (page 195), "In view of the large scouring action which has of recent years taken place outside the Inner Harbour not only in the deep hole but also along towards the west shore, I have not the slightest hesitation in saying that once a channel is opened through the bar, that the scour from the Inner Harbour combined with the action of the propellers of vessels using that channel will keep it permanently open." On page 211, Mr. R. W. Holmes, states, "It is anticipated that the sides of the dredged channel will fritter down and some of the sea-bed will drift across." The removal of such material from the channel will come under two headings—one of purely maintenance and the other of construction—and he continued that the point at which he would consider construction dredging would cease would be the point where the mariners considered they had a sufficient width and depth of channel for navigation in ordinary weather. In regard to the width of channel required in ordinary weather, the evidence of the navigation experts is that they would require the full bottom width of 600 ft. Mr. Holmes's contention is that you could leave the sides on a steep side slope, allowing the sides to fritter away and lodge in the channel, reducing the original 600 ft. width. This accretion he would remove by dredging and charge to maintenance. Your Commissioners do not agree with this suggestion. On page 266, Notes of Evidence, Mr. Holmes states that a batter of 1 in 5 in the construction of the outer channel would be sufficient, and that the charge of doing same would be charged to capital, and further states that he would not expect any maintenance expenditure on 600 ft. channel in the first three years.

Mr. J. D. Holmes, M.Inst.C.E., Ass.M.I.Mech.E. (page 94), produced sample of material taken from the vicinity of the area dredged by the "Whakarire." On page 104 Mr. Holmes gives the quantity of material to be dredged from the outer channel to a depth of 34 ft. as 985,000 cubic yards at 1s. 3d.—£61,500. Page 301: Batter of slopes in channel taken as 1 in 3. Page 310: Mr. Holmes states that he thinks there is a general tendency for the whole sea-bottom to erode away in a westerly direction over the patch between the breakwater and the Inner Harbour channel.

Messrs. Holmes and Son consider that the "Kaione" suction dredger fitted with the cutter-head would be suitable for dredging through the sandspit, and would be able to work more continuously than a ladder bucket dredger such as the "Whakarire." They therefore have recommended the Harbour Board to purchase the "Kaione."

Mr. J. P. Maxwell, M.Inst.C.E., in giving evidence before your Commission (page 355) expresses the opinion that to dredge the proposed channel through the spit is a mistake, as he considers it will allow the seas to sweep in, and the shipping would not be able to use it under such conditions. He further states that he could not indicate the extent to which silting might occur, but undoubtedly the easterly drift would tend to shallow it to the same depth as surrounding area. On page 356 he states

that he does not think it would be possible to maintain such a trench, and that it would fill up again if not dredged out, which would be a troublesome matter. He does not agree with Mr. Holmes, sen., that maintenance dredging would not be required for three years after completion, and further states that his main objection is that it is inviting a calamity to make such a channel and invite shipping into it. Page 358: He says, "When I reported in 1909 I condemned the idea of an approach channel in the open sea. I have the same idea now. Nothing would induce me to change my mind in respect to the Inner Harbour. The effect of a wider and deeper opening would be to let sea of greater velocity into the Inner Harbour. If the channel was kept of uniform depth right through, the waves would not decrease as they reached the harbour."

Mr. T. W. Martin, Mech. Eng., and dredge superintendent to the Wellington Harbour Board, recounted his experiences with the dredge "Whakarire" when she was employed upon dredging an experimental patch of some 3 acres on the sandspit in 1911, which was started on 8th November and worked until 6th January, 1912. The material dredged during that period—approximately for two months—was 33,450 cubic yards. Upon numerous occasions the mooring-chains parted, and a good deal of delay took place, the dredge not being able to work, owing to the range and high winds. During the first day's dredging the tumbler-bushes were broken, and later on damage was done to the main gear mitre-wheel which necessitated a new wheel being sent for and fitted (see pages 359-364). Page 368: "Would not like to undertake the dredging of channel with 'Kaione.'" Page 364: "The tube is worse than the bucket, because it is rigid. I would say a bucket dredge was not the best for a job like the patch." Page 366: "It was hard work dredging with bucket dredger in patch." Page 622: "You would want actual experience there before you could express an opinion how any dredger would work." Page 623: "As I found things at Napier, I do not think that I could successfully load up a hopper. I would require to have a long stretch of experimental work to find out how I could best work a dredger—that is, any dredger—on the patch. I say the sand would never let me fill the hopper more than half to three-quarters full; three-quarters would be the maximum. That would increase the cost per load."

SUMMARY OF EXPERTS' OPINIONS.

Maxwell, Williams, and Mason: "We say that even if it were practicable to cut this channel, there is no doubt that in heavy weather it would be liable to be obliterated wholly or in part. It is quite impossible to estimate the cost of maintaining an unprotected channel through a sand-bar when, as stated, the channel is liable on occasions to wholly disappear." They consider a protecting mole would be required estimated to cost £120,000.

Mr. Marchant considers that a protecting mole on the eastern side of the channel would be required. On the estimate he gives of £206,000 for moles, the portion to protect the channel would in 1906 have cost £124,266, and the estimated cost of dredging would have been not less than £4,000 per year.

Mr. George Nelson states that the formation of the channel presents no difficulty whatever, and gives the quantity to be removed as 770,000 cubic yards.

Messrs. Cullen and Keele in their 1912 report state that they fully recognize that heavy breaking seas would tend to fill in the cutting, and that some maintenance dredging may always be necessary; but they consider it feasible to dredge and maintain an entrance channel. Estimated cost to dredge same to 35 ft., £12,900; annual cost of maintenance, £7,276. In their 1925 report they give the cost of dredging as £25,310, and annual cost of maintenance £12,000 per year.

Mr. Furkert in his 1924 report considers that it would be a comparatively easy task to dredge the channel, but that its maintenance would involve considerable expense.

Mr. R. W. Holmes considers that it would be difficult to get a full load (thereby increasing the cost), and that he has not the slightest hesitation in saying that, once the channel is open through, no maintenance dredging would be required for three years; the side slope he suggested being 1 in 5.

Mr. J. D. Holmes adopts a side slope of 1 in 3, and estimates the quantity of material to be dredged at 98,500 cubic yards and the cost at £61,500.

Messrs. Holmes and Son consider that the "Kaione" would be a suitable dredge for this work.

Mr. J. P. Maxwell considered that the channel, when dredged, would tend to shallow to the same depth as the surrounding area, and that he does not agree with the suggestion that no maintenance would be required for three years; and that he considers that the dredging of such a channel is inviting a calamity to shipping.

Mr. T. W. Martin, dredge superintendent, after having two months' experience with the "Whakarire" on dredging the site of this proposed channel, stated that he would require to have a long stretch of experimental work to find out how he could best work a dredge there—that is, any class of dredge.

Your Commission is of the opinion that the evidence of the experts examined is unanimous, that it is feasible to dredge the channel to a depth of 34-35 ft.

In regard to maintenance, the following five witnesses considered that maintenance dredging would be required of a costly nature: Maxwell, Williams, and Mason; Mr. Marchant; Cullen and Keele; Mr. Furkert; and J. P. Maxwell. R. W. Holmes considered that no maintenance dredging would be required for three years. The following either did not express an opinion or would not commit themselves on this subject: G. Nelson, J. D. Holmes, T. W. Martin.

In regard to the quantity of material to be removed, the following side slopes were suggested as a basis of calculation: 1 in 3, 1 in 5, 1 in 10, and 1 in 200. On these figures the widths of channel where the water is shallowest would be, taking depths of cutting as 14 ft. 6 in. to obtain 34 ft. of water,—

				1 in 3.	1 in 5.	1 in 10.	1 in 200.
				Ft.	Ft.	Ft.	Ft.
Top width	..	..	..	687	747	890	6,400
Bottom..	..	..	..	600	600	600	600
Average	..	..	..	644	674	759	3,500

We are of the opinion that to avoid the danger of an inconvenient amount of siltation taking place after the desired width of 600 ft. has been obtained and during the construction of the channel, and also subsequently to avoid constant maintenance dredging, the side slopes would have to be not less than 1 in 40. The quantity of material to be removed to provide for this at a depth of 34 ft. at low water would be 1,673,198 cubic yards. We use Mr. Holmes's unit price of 1s. 3d., which under the circumstances we do not consider high. The resultant cost would be £104,575.

However, in conclusion, we would say that, in our opinion, moles are required, as the only sure and safe way to protect a dredge employed upon constructing the channel, to economize in width of channel required, to reduce to a minimum possible maintenance dredging, to ensure the channel always remaining navigable, to protect the Inner Harbour from inconvenient range, to facilitate navigation of the channel by large vessels, and to allow of the present entrance being opened sufficiently to reduce the velocity so that vessels drawing at least 26 ft. could enter or leave at any stage of the tide, day or night. To afford this measure of protection these moles would have to extend into 34 ft. of water, they would be some 6,000 ft. long, and so placed that they would dissipate the range before it reached the Inner Harbour entrance. The approximate cost of these moles would be £500,000, plus the cost of dredging whatever width of channel is finally decided upon.

DREDGING BETWEEN MOLES.

The moles protecting the present entrance channel to the Inner Harbour are 400 ft. apart, and the velocity of the tidal current between high and low water and slack water varies from nil to from 5 to 6 knots. The channel is 1,450 ft. long, and the least depth at low water is 15 ft. From approximately the north end of the freezing-works to the end of the west mole, about 800 ft., the borings taken by Mr. Pengelly show that from the present bottom, 15 ft. to 18 ft. below low water, the material to be dredged to provide 34 ft. or 35 ft. of water largely consists of boulders and some shingle. From the north end of the Iron Pot to the north end of the freezing-works the borings show some 5 ft. of shingle overlaying silt.

The chief difficulty in dredging this channel is that the velocity of the current precludes a dredge from being moored without the mooring-chains extending the whole width across the channel, rendering it useless for navigation by any boat or vessel. Mr. Pengelly states (on page 85) that to keep his boring-punt in position he had to use five moorings. Sometimes one and at other times two of these were fixed on shore (page 82). He mentions that his anchors dragged, and that, in his opinion, it would be very difficult indeed to hold a dredge of any size in the channel between the moles. Mr. Pengelly (on page 80) stated that the boulders would be up to about 1 ton in weight. Mr. T. W. Martin, dredge superintendent, was examined in reference to dredging the channel between the moles. On page 370 he states that the captain of the "Whakarire" refused to come in close to the pier-heads at the Inner Harbour unless at slack water; and on page 371, in reply to the Chairman, he stated, "if leaving the moorings in the channel with load, the lines would have to be slipped ashore; if chains used, you could slip and get away in twenty minutes. (Dredge-chains could not be used in this channel.) It depends upon the tide as to the time taken to pick up moorings again; it might take all day or a week to pick up moorings with a 6-knot current. I do not know how I could do it."

Mr. Nicholson, foreman and leading carpenter to the Napier Harbour Board, described the attempt made by the Board about 1922 to dredge this channel with a grab dredge erected on a timber pier which extended towards the centre of channel at right angles to the eastern mole. The result of the experiment was a hole 10 ft. deep by 80 ft. by 108 ft. The outer edge of this hole when dredging was discontinued was about 138 ft. out from the west mole. On page 166 Mr. Nicholson stated that he believed that the reason the work was stopped was that it interfered with navigation.

Your Commissioners consider that the class of dredge required to remove the boulders, which form some four-sevenths of the whole of the dredging required, is a powerful grab or ladder bucket dredge, and that unless the dredging were delayed until the contemplated widening has taken place the entrance to the Inner Harbour would have to remain closed during the dredging operations. Quite recently, when the Porpoise Rock was being removed in the Tamar River, Launceston, the "Loongana" and other passenger-vessels between Melbourne and Launceston had to be diverted during the time the rock's removal was in progress. The velocity of the current at the Porpoise Rock is 7 knots.

To dredge this channel to 34 ft., having a bottom width of 300 ft. and side slopes of 1 in 2.5, as shown on Cullen and Keele's plan, and using Mr. J. D. Holmes's unit price of 2s. per cubic yard (for which figure we think it possible the work could be done), the quantity of material to be removed would be 429,629 cubic yards, and the cost £42,963. Mr. J. D. Holmes estimates the cost of this dredging at £46,175.

In addition to the dredging, one mole has to be built 100 ft. from its present position. Some 400 ft. of the new slopes on each side of the channel will require protecting with stonework, as the borings show that the last 15 ft. of the dredging is through silt. We estimate the cost of these works, using the contract price the Board is now paying for stone—viz., £1 14s. 1d. per cubic yard—at—

Mole, £34,000; protecting slope, £4,000: total, £38,000. Mr. J. D. Holmes estimates the cost of mole and protection at £26,300. Neither our estimate nor, presumably, Mr. Holmes's, makes provision for extending the mole seawards, as suggested by Mr. Holmes, to form wave-traps to reduce the range in the Inner Harbour when the channel between the moles is widened.

DREDGING BASIN FOR INNER HARBOUR SOUTH OF THE IRON POT.

Messrs. Cullen and Keele provide for dredging out a basin 1,000 ft. wide. In considering the length to be dredged, we would point out that the work now in progress of reconstructing the wharf along the West Quay provides for the possibility of dredging only to a depth of 20 ft. below low water. Therefore to obtain a minimum depth of 30 ft. required for oversea vessels drawing some 26 ft., practically the whole of the dredging will have to be done on the south side of the old timber bridge, where a great deal of the area to be dredged is dry at low water and the remainder only has about 1 ft. 6 in. depth of water at low tide. (See Exhibit 77, borings by Hay and Rochfort.) Adopting the evidence that four berths will be required if lightering is eliminated, a minimum length of 2,400 ft. will be required. We estimate that the quantity of material to be dredged, giving a uniform depth of 30 ft. below low water at the berths and 26 ft. in the basin, as 2,700,000 cubic yards. Mr. J. D. Holmes, for two berths, makes this figure 1,221,600, which at his original estimated unit cost of 1s. equals £61,080. Before stating our estimated cost for this work we wish to point out that as some of the area is dry at low water, and that the greater portion of it has only a depth of 1 ft. 6 in. at low water, a dredger that can cut its own floatation would be required. The dredger "Kaione" as at present fitted is not suitable for this work, and before she could efficiently deal with same the whole area would have to be dredged to a depth of some 15 ft.—1,300,000 cubic yards. Unless the dredge were built on shore and launched into a specially prepared pond on the south side of the bridge, the only available starting-point would be on the north side of the timber bridge at the south end of West Quay. The depositing of this excavated material in the North or South Pond would be a troublesome and expensive undertaking, as, in addition to a shore pipe-line, which to fill the South Pond, even, would be some 1,600 ft., there would have to be a floating pipe-line up to a 1,000 ft. in length. Two other alternatives offer themselves; one is to fill the hopper of the dredge and then steam into the Iron Pot and discharge the material into the North Pond, and the other is to steam out to sea and discharge the material. As the Iron Pot would be a most awkward place to get into and out of during the flood and ebb tides, and as the cost of the disposal of this material for reclamation purposes by the pumping schemes cannot be estimated with any reasonable degree of accuracy, we must adopt the unit cost for depositing at sea; this we consider would be 1s. 3d. per cubic yard. For the remainder of the work to be done by the "Kaione" or other suitable dredger we use Mr. Holmes's original unit price of 1s. per yard. We therefore estimate the cost of this portion of the work at 1,400,000 cubic yards at 1s., £70,000; and 1,300,000 cubic yards at 1s. 3d., £81,250: total, £151,250.

In regard to the Breakwater Harbour the dredging is a simple matter, more particularly as it would not be necessary to do it until the breakwater was extended and the western mole completed. To provide 30 ft. at the berths and 26 ft. elsewhere, Mr. Holmes estimates that the quantity to be removed is 300,000 cubic yards, at a cost of £18,700. Our estimate for this depth is 317,185 cubic yards at 1s. 3d.—£19,824.

Inner Harbour.—Cost of dredging.

	Mr. Holmes.	Commissioners.
	£	£
Outer channel	61,500	104,575
Between moles	46,175	42,963
Basin	61,080	151,250
	<u>£168,755</u>	<u>£298,788</u>

Note that the above does not in either case include the cost of moles, or protecting sides of channel, or wave-trap. Neither does it include the dredging to the north-west of tide-deflector from West Bridge to harbour-entrance included in Cullen and Keele's scheme and estimated by Mr. Holmes at £42,500.

TABLE G.—MR. A. C. MACKENZIE'S ESTIMATED COST TO COMPLETE THE INNER HARBOUR AND PROVIDE FOUR BERTHS FOR OVERSEA VESSELS DRAWING 26 FT.

The following estimates are not submitted with any degree of assurance that they correctly represent the ultimate total cost of the Inner Harbour scheme as outlined by Messrs. Cullen and Keele. I have neither had the material nor the time to go into this matter in sufficient detail. Furthermore, by the time the whole of the evidence had been submitted the Commissioners were of the opinion that the financial position of the Board would not warrant its undertaking extensive harbour improvements for some years to come. It is therefore apparent that by the time a constructional programme could be adopted present-day estimates would be of little value. I am, however, confident that the various works estimated for would not at the present time, in the matter of cost, vary seriously from the amount of my estimate. The works I have estimated for are as outlined in the plan issued by the Harbour Board in the year 1919—*i.e.*, Plan A in Commission's Exhibit 3. I have adopted four berths for overseas vessels, and have provided for dredging the channel to 34 ft. to accommodate vessels drawing 26 ft. With the exception of the estimated cost of dredging, the cost of mole, and protecting 800 ft. of the channel between the moles, I have adopted Mr. J. D. Holmes's estimates for his two-berth scheme in arriving at my cost for four berths. The estimates I give are principally useful as a comparison in the cost of a

four-berth scheme at the Inner Harbour, as against a two-berth scheme at the Inner Harbour or the completion of the Breakwater Harbour.

In evidence Mr. Holmes stated (on page 104) that his unit costs included plant. Messrs. Cullen and Keele in their 1925 report do not include the plant in their dredging-costs, but they estimate the dredging, plant, and pipe-lines at £98,300, which at Mr. Holmes's estimate of 3,518,350 cubic yards to be dredged (including the quantity behind deflectors) would absorb 0.5617 of 1s. per yard of his unit prices. The average of the unit prices adopted by Mr. Holmes is about 1s. 3d. Deducting the unit cost of plant—viz., 0.56 of 1s.—leaves 0.7 of 1s., or approximately 8½d. per cubic yard to pay for all costs of dredging, including interest, sinking fund, and repairs to plant. Under the Napier conditions I am satisfied that the works cannot be done at this price. In my estimates I have not included any cost of plant. My unit prices include the cost of dredging, interest, sinking fund, and repairs to plant. The unit prices I have adopted are—Dredging at outer channel, 1s. 3d. per cubic yard; between moles, 2s. per cubic yard; basin, 1s. and 1s. 3d. per cubic yard.

Messrs. Cullen and Keele's scheme, 1912 and 1925, provide for a tide-deflector and dredging on the north side of same. We have seen no detailed designs for this, so have included Mr. Holmes's estimated cost. Forming and making roads Mr. Holmes includes under reclamation. For comparative purposes I provide an amount in each estimate to cover this item, and also for railways, which Mr. Holmes does not mention.

	J. D. Holmes :		Commissioners :	
	Two Berths.		Four Berths.	
	£		£	
Dredging outer channel	61,500		104,575	
Dredging between moles	46,175		42,963	
Dredging basin	61,080		151,250	
Dredging north of tide-deflector	42,500		42,500	
Rebuilding and removing mole	26,300		34,000	
Protecting banks between moles .. .. .	..		4,000	
Quay-wall	81,200		162,400	
Cargo-sheds	19,800	4	39,600	
Cranes	4,000	berths	8,000	
Concrete floors, sheds of quay }	10,000		20,000	
Buoys	1,000		1,000	
Roads, at back of wharf only	9,000		18,000	
Railways, at back of wharf only	2,500		5,000	
Moles to reduce range	40,000		40,000	
Mole to tide-deflectors	23,600		23,600	
	428,655		696,888	
Contingencies, 5 per cent.	21,433		34,844	
	£450,088		£731,732	
Cost per berth	£225,044		£182,933	

Or, correcting what we consider is an underestimate by Mr. Holmes for dredging and mole, the totals become—

	£	£
Total cost	598,908	731,732
Cost per berth	299,454	182,933

It will be seen that the estimate of Mr. F. W. Furkert, Engineer to the Public Works, who only provides for two cargo-sheds and cement floors for same, is £660,000. By adding the cost of two additional cargo-sheds and floors to same, plus roads and railways, his total cost, exclusive of dredging plant, is £708,800. This is in close agreement with my estimate. I am of the opinion that, including plant, an approximate estimate of the cost of this work may be taken as £830,032. My opinion is, further, that if these works were carried out the port may at any time be closed owing to the silting of the Outer Channel wholly or in part, and that, at the best, overseas vessels drawing 26 ft. could only enter or leave the port in moderate weather, during daylight, at high-water slack tide, and would require the assistance of a tug to do so.

In estimating the annual overhead charges I have adopted the following rates: Interest on capital, 5½ per cent.; Sinking fund, ½ per cent.; Renewals, 1 per cent.; Maintenance, 2¾ per cent. As I have provided for interest and sinking fund and repairs in my unit cost of dredging, the additional annual charge will be—

Dredging—		£	£
Maintenance dredging: £341,288 at 2¾ per cent. . . . .	..	9,385	
Renewals of plant: £98,300 at 1 per cent. . . . .	..	983	
		—————	10,368
Wharves, sheds, and structures—			
Interest: £731,732 at 5½ per cent. . . . .	..	40,245	
Sinking fund: £731,732 at ½ per cent. . . . .	..	3,658	
Renewals: £731,732 at 1 per cent. . . . .	..	7,317	
Maintenance: £731,732 at 2¾ per cent. . . . .	..	20,123	
		—————	71,343
			£81,711

TABLE H.—Mr. A. C. MACKENZIE'S ESTIMATE OF COST OF COMPLETION OF BREAKWATER.

BREAKWATER.

The following are the estimated costs submitted for our consideration for the completion of the Breakwater Harbour:—

F. W. Furkert (23rd August, 1924).—Completion of breakwater over the Auckland Rock, the ending being in 35 ft. of water; height, 6 ft. above H.W. or about one-half the extension proposed by Cullen and Keele in their 1912 report. The construction of the western mole, leaving a width at entrance of 600 ft.; one new jetty, 550 ft. long by 180 ft., providing two berths, with two cargo-sheds; dredging between jetties and to form a swinging-basin to a depth of 30 ft.; reclamation on foreshore (see Exhibit 21, page 8)—£100,000.

Cullen and Keele (23rd November, 1925).—Completion of breakwater over Auckland Rock, 1,550 ft., as against some 2,880 ft. proposed in 1912. Thus, accepting the lengths suggested by Mr. Furkert, height as at present, 6 ft. above H.W.; western mole, 3,800 ft. long (about similar lengths to Mr. Furkert's), entrance 600 ft. wide; reclamation; dredging, 31 ft. generally, with 35 ft. at berths; two jetties, 500 ft. long, 178 ft. wide, with cargo-sheds on each side 350 ft. by 35 ft.; shed on reclamation, 200 ft. by 60 ft.—£511,009, which is exclusive of engineering contingencies and plant. Similar to above, with one pier and two sheds, and shed on reclamation, also exclusive of engineering contingencies and plant—£393,082.

F. W. Furkert (September, 1927). Deposited by Mr. Furkert as a safe estimate—

	£
Completion of breakwater	185,000
West mole	85,000
Wharf, 600 ft. by 200 ft., with shed	120,000
Dredging	50,000
Reclamation	10,000
	£450,000
<i>J. D. Holmes (August, 1927).</i> See evidence, page 101	£
Extension of breakwater, 1,550 ft., 6 ft. above H.W.	386,800
West-mole construction	330,000
Wharf, 550 ft. by 200 ft., with approach 664 ft.	161,000
Cargo-shed, 300 ft. by 170 ft.	7,600
Four cranes	4,000
Reclamation-wall, 2,900 ft. (22½ acres)	12,000
Dredging basin to 26 ft., berths to 30 ft.	18,700
Removal of Auckland Rock	3,400
Removal of other rock	2,000
Engineering contingencies	47,500
	973,000

(Note.—On page 101 Mr. Holmes makes the total £983,000.)

Extra not provided for by Mr. Holmes on page 101—

	£
Dredging to 31 ft.—	
Per A. C. Mackenzie	24,000
Per J. D. Holmes	18,700
	5,300
Extra removing portion of Auckland Rock to provide 34 ft.	7,500
	12,800
	985,800
Mr. J. D. Holmes's estimate for raising breakwater 10 ft.	223,000
	£1,208,800

A. C. Mackenzie's Estimate.

To complete the Breakwater Harbour and to provide four berths for overseas vessels drawing 26 ft., I consider the following work would have to be done: Extend the present breakwater 1,550 ft., either with concrete blocks as at present or in stone, whichever is cheaper. The height to remain as it is at present—*i.e.*, 6 ft. above H.W. Construct the west mole; length, about 3,800 ft. Construct a new wharf 600 ft. by 178 ft. Provide two cargo-sheds on wharf, 400 ft. by 35 ft., with roadway between sheds and 4 ft. below deck-level. Provide two railway-lines in front of sheds and one at back of each shed on roadway. Provision to be made for cranes in case they are required. Provide wall for reclamation somewhat as shown on Cullen and Keele's 1925 plan, about 2,900 ft. long (see Plan B, Commission's Exhibit 3). Provide for dredging between wharves and swinging-basin to 31 ft. below low water. Remove portion of the Auckland Rock at entrance to 34 ft. and other rock in enclosed area to 31 ft. As the trawlers and small coastal vessels are well provided for at the Inner Harbour, which

will provide more room than required if the main portion of the lightering is eliminated by the completion of the breakwater, I do not make any provision for them in my estimate for Breakwater Harbour extension.

It will be noticed that a large discrepancy in the estimates submitted is occasioned by Mr. J. D. Holmes having thought fit to make provision in his estimates for raising the whole of the breakwater a further 10 ft. above H.W., or 16 ft. in all. The following is a short summary upon this subject of the opinion of the designer of the breakwater, John Goodall, M.Inst.C.E., and other eminent civil engineers, who have undoubtedly had years of experience in the design, construction, and maintenance of harbour-works:—

J. Goodall (1884), says: "In this section is shown in plain lines the superstructure of the breakwater, &c., surmounted by a parapet wall of concrete, &c. The cost of the latter is not included in the estimate, as it will not be advisable for years, until the work has thoroughly subsided, to attempt to build the parapet wall." (See Extract 1, page 16.)

Messrs. Bell and Scott in their report of May, 1884, state: "We consider the height of the breakwater—namely, 6 ft. above H.W.—is not sufficient for the safety of ships inside, &c., and that it will be found necessary sooner or later to raise a parapet to keep heavy seas from sweeping over the works." (See Extract 1, page 18.)

J. Goodall in his report of May, 1884, in reference to Messrs. Bell and Scott's suggestion that the breakwater must be raised sooner or later, points out that the 6 ft. height was designed for economy, and that a low breakwater without a parapet did not require so wide a base. (See Extract 1, page 20.)

Messrs. C. Napier Bell and J. P. Maxwell reported in 1894 upon the damage to the breakwater in the severe storm which took place in February, 1894, and were particularly asked to advise means to prevent further damage and to advise as to future construction. They considered that the width of the concrete was ample, and to protect same from further damage recommended piling heavy masses of rubble blocks up to high water. This was done. They go on to state, "Although we think it necessary to thus strengthen the exposed part of the structure, we do not look upon the damage sustained as a serious failure, &c. There is no alternative, now that a great extent of the structure is built, but to continue the design as we find it, &c. We consider that the best method of expending the money in hand, so as to make the works as complete as possible, is to finish the breakwater to the Auckland Rock (see Exhibit 1, page 26). The recommendation for these repairs and the extension of the breakwater as designed—*i.e.*, 6 ft. above high water—have been carried out, but the breakwater is still some 1,200 ft. from the Auckland Rock."

Mr. F. W. Marchant in his report of 1906 recommends the completion of the breakwater, and says, "There is no doubt whatever about the complete stability of the work as it is now being constructed, &c. No suggestion can be offered for improvement of either design or detail or in the manner of working-operations." (See Exhibit 6, page 2.) He, however, goes on to state, "In order to render the water in the enclosed areas as calm as possible a parapet along the first cant of the breakwater and the piling-up of more blocks on the wave-breaker on the second cant would almost entirely stop any water breaking over into the harbour." (See Exhibit 6, page 3.)

Messrs. Maxwell, Williams, and Mason in their report dated July, 1909, recommended the completion of the breakwater upon the lines upon which it was then constructed, which they point out had proved quite adequate for the purpose. (See Exhibit 9, page 6.)

Messrs. Cullen and Keele in their 1912 report recommended that the breakwater should be raised 10 ft. (See Exhibit 14, page 9.) In their 1925 report they evidently reconsidered this matter, as in Exhibit 21, pages 6 and 7, they state, "We recommend that the type of section for the extension should be the same as that of the existing breakwater. The latter appears to have stood the exposure well without any serious injury from wave-stroke, &c. It consists of a rubble foundation brought up to a level of about 19 ft. below low water, on which concrete blocks are built up in a rectangular section 25 ft. wide* to a height of 30 ft.—*i.e.*, to 6 ft. above high water, spring tide, with a wave-breaking apron of large stones and concrete blocks on its seaward side."

Mr. Furkert in his evidence on page 325(?) points out that Messrs Cullen and Keele modified their 1912 recommendation, and in their 1925 report adopted 6 ft. as the height of the breakwater above high water; also, on page 526, in referring to his own estimate he states, "I worked approximately to Cullen and Keele's latest plan in taking out the quantities in regard to the breakwater and mole. I did not think it necessary to take the moles 6 ft. above high-water mark, and made reductions in quantities accordingly, &c. I think I allowed 2ft. 6 in. above high water for the moles."

From the foregoing it will be seen that Mr. Goodall, the designer of the breakwater, had most excellent reasons for not including the provision of a parapet—at least, for many years. Therefore, prior to the laying of the foundation stone in 1887, the only engineers of standing who thought a parapet should be provided were Messrs. Bell and Scott, which, in their opinion, was required for the safety of ships. Up to 1894 the Gladstone Wharf had been constructed and the second cant of the breakwater was in progress. In February, 1894, a storm damaged the breakwater, and Messrs. Bell and Maxwell, who were commissioned to report (1) on the present condition of the works, (2) to devise means to prevent further damage, (3) to advise as to future construction, do not recommend the addition of a parapet. In 1906 Mr. Marchant recommended a parapet to render the water in the enclosed area as calm as possible and to stop any waves breaking over into the harbour. Messrs. Maxwell, Williams, and Mason in their report of 1909 do not recommend a parapet; and finally Mr. Furkert in his 1924 report and Messrs. Cullen and Keele in their 1925 report do not recommend the construction of a parapet. Since the breakwater was used by shipping we have only Mr. Marchant and

* Note.—This should be 36 ft. wide.—A.C.M.

Mr. J. D. Holmes who consider a parapet necessary; and as Mr. Marchant only advises it to prevent seas coming over and to provide calm water, and as the evidence tendered to your Commission was that seas coming over the breakwater did not cause rough water, we are left with Mr. J. D. Holmes as the only advocate in 1927 for the provision of a parapet. I am of the opinion that as the Breakwater Harbour has now been in use for thirty years, and that as no serious damage to vessels has taken place, that there is no justification for the inclusion of the additional cost of a parapet in Mr. J. S. Holmes's estimate, and therefore eliminate same from further consideration.

The greatest discrepancy between Mr. J. D. Holmes and Mr. Furkert's evidence are their respective estimates of the west mole. I have taken out the quantity of rock required in accordance with Cullen and Keele's 1925 plan, and find that after deducting 40 per cent. for voids and adding 10 per cent. for loss in settlement, 180,000 solid cubic yards would be required. At Mr. Holmes's estimate of £330,000 this works out at £1 16s. 8d. per cubic yard.

Mr. J. D. Holmes (page 102 of evidence) mentions that Cullen and Keele's estimate of £49,690 equals a unit cost of 4s. 4d. per cubic yard. The £49,690 therefore represents 229,515 cubic yards, which must be taken as Mr. Holmes's estimate of the quantity of stone required. On page 102 he states that he adopted 15s. as his unit cost. I would point out that 229,515 cubic yards at 15s. equals £172,136, and not £330,000 as given by Mr. J. D. Holmes on page 101 and included in his estimate.

Mr. Furkert states that Mr. Clapcott, Borough Engineer of Napier, informed him that local quarries near the Bluff were supplying the Council with spalls at 4s. 6d. per yard. Mr. Furkert considers that even if stone had to be brought fifty miles by water the cost would not exceed 12s. per cubic yard.

Mr. Furkert suggests that there is no necessity to construct this mole to a greater height than 2 ft. 6 in. above high water. See his evidence, page 526. This will reduce the quantity required to 140,000 solid cubic yards, which at his estimate of £85,000 equals 12s. 0-14d., which agrees very closely with his unit price of 12s. as per his evidence, page 375.

Messrs. Hay and Rochfort estimate the cost of stone from the Lighthouse Reserve at 4s. (see Exhibit 46, page 2). Mr. J. P. Kenny, Secretary to the Board, in Exhibit 155, gives the cost of rubble as 5s. 6d. per cubic yard. Adopting Messrs. Hay and Rochfort's estimate that 20 per cent. of the bluff at the Lighthouse Reserve would be stone (see Exhibit 46, page 2), and also that the height of the bluff at the base of the breakwater is 300 ft., about 2 acres would be required to supply the 180,000 cubic yards of stone required, and the surplus spoil would almost complete the reclamation of the North and South Ponds, which, per Hay and Rochfort, require 815,000 cubic yards.

The cubic yards in 2 acres, 300 ft. deep, equal 968,000. 180,000 cubic yards required for the moles leave 788,000 for reclamation purposes. As 2 acres can readily be made available on the outskirts of the Bluff Reserve, and as the foundations for the present breakwater were obtained from this source, I see no adequate reason for looking elsewhere for the stone required for the construction of the west mole. After allowing for all contingencies, such as somewhat confined working-space, and the selection and reserving of the larger stones for the western face of the mole, I am of the opinion that 10s. a yard is an ample price to allow for obtaining the stone required and placing it in the mole. My estimate for this portion of the work 6 ft. above high water, as designed by Cullen and Keele, is therefore £90,000. In the event of its being decided to adopt Mr. Furkert's suggestion of reducing the height to 2 ft. 6 in. above high water, the estimated cost could be reduced to £70,000.

I note that in Mr. J. D. Holmes's detail of estimate of his £330,000 for the mole he provides for the expenditure of £225,000 for a concrete apron, for which I can see no justification, as the whole of this mole on the lee side of the breakwater is well protected from the heaviest seas.

EXTENSION OF BREAKWATER.

In regard to Mr. J. D. Holmes's estimate for the extension of the breakwater at £386,800 he gives the following details:—

Breakwater extension, 1,550 lineal feet (at present level)—	£
Concrete in cap: 43,000 cubic yards at £2 15s.	118,000
Concrete in blocks: 72,000 cubic yards at £2 15s.	198,000
Rubble in foundation: 59,000 cubic yards at £1	59,000
20 per cent. allowance for loss: 11,800 cubic yards at £1	11,800
	<hr/>
	£386,800

In the first place, I do not agree with the quantities adopted by Mr. Holmes. I estimate that to extend the breakwater 1,550 ft., with concrete cap and blocks and ballast foundation, the following materials are required: Concrete cap to breakwater, 20,000 cubic yards; concrete blocks in breakwater, 42,000 cubic yards; concrete blocks, wave-breaker, 18,000 cubic yards; ballast foundation, 45,000 cubic yards.

The next question is as to why Mr. Holmes should adopt £2 15s. a cubic yard as the unit price of his concrete, when the Board's Secretary gives the actual price of concrete as made by the Board's employees with their existing plant at £1 8s. 6½d. per cubic yard (see Exhibit 155), or placed in position £1 11s. 0½d. See Mr. Furkert's evidence, page 373. To justify his price Mr. Holmes referred to tenders which had recently been received by the Board, the lowest price being £2 18s. 9d.; also, to support Mr. Holmes's estimate, the Board tendered the evidence of several contractors, whose prices for concrete placed in the moulds ranged from £1 19s. 6d. per cubic yard to £2 4s. 11d. Dealing in detail with the price of £2 4s. 11d. per yard, it is made up as follows (cost of cement in store, £5 14s. per ton): Shingle, 4s. 3d. per cubic yard of

concrete; sand, 3s.; cement, £1 2s. 2d.; mixing and placing in moulds, 4s.; erection of moulds, 2s. 6d.; cost of plant, 4s.; overhead, 5s.; total, £2 4s. 11d.

I would point out that under the Harbour Board's specification (page 33) the sand and gravel required would be supplied by the Board at the cost to the contractor of 3s. per cubic yard. To comply with the specification for a 1-2½-5 mix the materials required would be—Cement, 1·22 barrels; sand, 0·40 cubic yards; shingle, 0·90 cubic yards. The sand and gravel would therefore cost the contractor $1·3 \times 3s. = 3·9s.$, or say 4s. per cubic yard of concrete, as against the 7s. 3d. included in the price of £2 4s. 11d. Taking the cement at £5 14s. per ton, and assuming that six casks go to 1 ton, the cost per cask equals 19s. and the cement required £1 3s. 2d.

In Exhibit 173 Mr. Kenny shows that two drivers and about ten labourers are required to operate the Board's mixing plant, fill the moulds, and place the spalls. Allowing £1 per day for driver and 16s. for labourer, and that the output is 83 yards per day, as shown in Exhibit 173, the cost of labour per yard is 2s. 4·9d., and not 4s. as included in the price of £2 4s. 11d. It should be noted that the price of 2s. 4·9d. includes fixing moulds and placing spalls. This eliminates a further item of 2s. 6d. per yard included by the contractor. In reference to the 4s. included in the £2 4s. 11d. for cost of plant, I would point out that the Board specify in their printed conditions that the plant required for the completion of the breakwater will be hired to the contractor at the following rates: Browning crane—4 hours or less £1 5s.; eight hours or less, £2 10s.; sixteen hours or less, £3 15s.; concrete-mixer, 10s. per day; steam winch and boiler, 15s. per day; dredge "J.O.D.," £2 per hour. The total quantity of concrete required is—concrete in cap, 20,000 cubic yards; concrete in blocks, 42,000 cubic yards; concrete in wave-breaker, 18,000 cubic yards: Total, 80,000 cubic yards. An output of 83 yards per day, $\frac{80,000}{83} = 964$.

The only items which can be properly charged to concrete mixing and placing are the concrete-mixer, and possibly the steam winch and boiler. Presuming that these would be required for the whole of the 964 days, the cost to the contractors would be $\frac{£1,205}{80,000} = 3·61d.$ However, to cover the cost of repairs to moulds, &c., we include 1s., as against the 4s. included in the cost of £2 4s. 11d. It is interesting to note that the estimate of 4s. for plant in 80,000 cubic yards would give the contractors a gross return of £16,000. Including overhead, my estimate of the cost of a cubic yard of concrete in the moulds, is—

Shingle and sand	0	4	0
Cement	1	3	2
Mixing, erecting moulds, cleaning moulds, placing concrete and spalls	0	2	5
Hire of plant	0	1	0
			1 10 7
Overhead and insurance, 10 per cent.	0	1	5
			1 12 0
Less 20 per cent. for spalls	0	6	4·8
			1 5 7·2
Spalls at 5s. 6d. per yard at 20 per cent.	0	1	1·2
			1 6 8·4
Contingencies allowance	0	2	3·6
Per cubic yard	£1	9	0

Allowing 2s. 6d. per cubic yard for placing, Mr. J. D. Holmes's price, in moulds, would be £2 12s. 6d. per cubic yard; contractor's price, £2 4s. 11d.; Mr. Furkert's price, £1 10s.; Mr. Kenny's price, £1 8s. 6½d.; A. C. Mackenzie, £1 9s.

Adopting my own quantities and a rate of, say, £1 10s., I estimate the cost of extending the breakwater at

Concrete in cap: 20,000 cubic yards at £1 10s.	£	30,000
Concrete in blocks in position: 42,000 cubic yards at £1 12s. 6d.	68,250	
Concrete blocks in wave-breaker: 18,000 cubic yards at £1 12s. 6d.	29,250	
Rubble foundation: 45,000 cubic yards at 12s.	27,000	
	<u>£154,500</u>	

As against Mr. J. D. Holmes's £386,800.

WHARF CONSTRUCTION AND IMPROVEMENTS.

Messrs. Cullen and Keele's recommendation is for one wharf 600 ft. by 187 ft., with two cargo-sheds 350 ft. by 35 ft. Messrs. Cullen and Keele estimate the cost of wharf and cargo-sheds at about £97 per 100 square feet of wharf area, and Mr. Furkert at £100 per 100 square feet of wharf area; Mr. J. D. Holmes at about £162 per 100 square feet of wharf area. In my estimate I have adopted £120 per 100 square feet of wharf area, which also covers the cost of two sheds as recommended by Messrs. Cullen and Keele. The high price included by Mr. Holmes is probably due to his having adhered to the contract price for concrete already quoted.

Wharf and cargo-sheds, $600 \times 187 = 1,122$ squares at £120 = £134,640.

CRANES.

Four cranes are provided for in Mr. Holme's estimate. Messrs. Cullen and Keele and Mr. Furkert did not provide for same. However, if they are necessary at the Inner Harbour, it appears to me that they are necessary at the breakwater, so I provide £4,000 for this item.

RECLAMATION.

For Messrs. Cullen and Keele, to provide $3\frac{1}{2}$ acres, £3,985; Mr. Furkert provides acres, £10,000; Mr. J. D. Holmes provides for $22\frac{1}{2}$ acres, £12,000. As I see no purpose in spending capital in reclaiming land at the breakwater until it is required, I adhere to Messrs. Cullen and Keele's area of $3\frac{1}{2}$ acres, which are required for a convenient approach to the wharves. The sea face would consist of a ballast mole, which I estimate will cost £6,000.

DREDGING.

As I have estimated the dredging for the Inner Harbour for the requirements of vessels drawing 26 ft., and in that case allowed for a depth at the berths of 30 ft. and in the basin 26 ft., I am allowing in the case of the breakwater for a depth at the berths and in the swinging-basin at 31 ft. throughout. I estimate the quantity to be removed as 384,000 cubic yards, which at 1s. 3d. equals £24,000.

Auckland Rock, removal to 34 ft.; As there is no sufficient information available to check the quantities, I include the amount provided by Mr. Holmes—£10,900.

Removal other rock to, say, 21 ft., £2,750.

Breakwater Extension, £154,500; west mole, £90,000; wharf and sheds, £134,640; cranes, £4,000; reclamation mole, £6,000; dredging, £24,000; removing part of Auckland Rock, £10,900; removing other rock, £2,750; contingencies at 5 per cent., £21,310: total, £448,130.

A comparison of the estimates for the completion of the Breakwater Harbour are:—

Cullen and Keele (23rd November, 1925)—	£
Including one new wharf	393,082
Including two new wharves	511,009
F. W. Furkert (23rd August, 1927)—	
Including one wharf	400,000
Including one wharf (safe estimate)	450,000
J. D. Holmes—	
Including one wharf	973,000
Including one wharf and additional dredging to 31 ft.	985,800
Including one wharf and raising breakwater 10 ft.	1,208,800
A. C. Mackenzie (29th September, 1927)—	
Including one wharf	448,130

In regard to plant required, the items included in Messrs. Cullen and Keele's 1925 estimate are as follows: Hopper dredge, £65,000; two steam rock-drills, £5,000: total £70,000.

I would point out that the reclamation of the North and South Ponds would not require any pipe-line, power-house, or motors and pumps for boosting, as provided in Messrs. Cullen and Keele's estimates for the Inner Harbour, as the surplus material excavated from the Bluff in obtaining the stone required for the mole, foundations for breakwater, and reclamation moles would be deposited from trucks.

In regard to a dredge, I estimate the material to be removed at 384,000 cubic yards. This quantity would not fully employ a dredge such as the "Kaione" for twelve months' dredging, including pumping on shore, so the Board's obvious policy would be to hire a suitable dredge, for which in my unit cost, I have provided, over and above Mr. J. D. Holme's estimate for operating the dredge; a sum of £8,065 per year, a portion of which will provide for hire. As this work when once completed would not necessitate an expensive dredge forming part of the Board's permanent plant, I do not make any provision in my estimates for maintenance for a sea-going suction or bucket dredge. As it is possible that some maintenance dredging will be required after completion of the Breakwater Harbour, and for the purchase of one rock-drilling plant, I provide a sum of £20,000, which, plus the sale price of the "J.D.O.," should be sufficient to purchase a larger second-hand grab dredge and drilling plant. In estimating the annual overhead charges I have adopted similar rates to those I used in connection with the Inner Harbour. I have provided for the hire of dredges, including interest and depreciation, under the unit cost of dredging. As the Board already have the plant required for the construction of the breakwater, the annual additional charge will be—

Dredging—	£
Maintenance: 24,000 yards at $3\frac{3}{4}$ per cent.	900
Net plant, interest, sinking fund, and general: £20,000 at 7 per cent.	1,400
	2,300
Breakwater, mole, wharf, &c.: £448,130 at $10\frac{1}{4}$ per cent.	45,933
	<u>£48,233</u>

TABLE J.—SHORT SUMMARY OF NAVIGATION EXPERTS' EVIDENCE.

Witness.	Inner Harbour.	Breakwater Harbour.
W. H. Hartman, master s.s. "Tamaroa." Trading to New Zealand for past twenty-seven years. (See Evidence, pages 112, 113, 114, 115, 116, and 117.)	With big vessel would wait for slack water before navigating channel; tug necessary at flood and ebb tides, and possibly at slack water; harbour safe; velocity of current no detriment; when entering subjected to beam sea and wind; if strong wind or heavy sea would wait outside or inside; consider range would not be increased by widening channel between moles; subsequently considered would be increased	No difficulty in navigating; enter head-on in easterly weather; prefer breakwater; 1,300 ft. swinging-basin sufficient; tug required; safe harbour; vessel would not lay so steady; bound to get range, which will be less when harbour completed; owners will not allow him to use present unfinished Breakwater Harbour.
S. A. Chatfield, master s.s. "Kaituma." Trading here a good deal. (Pages 118, 119, and 120.)	No difficulty in bringing the "Kaituma," drawing 17 ft. 6 in., into the present Inner Harbour at high water; velocity of current between moles, 6 to 7 knots	Never had to leave breakwater; have been there several times.
W. Waller, Harbourmaster. New Plymouth. Experience since 1874; a great deal of experience on this coast. (Pages 121, 122, and 123.)	Would wait for slack water before navigating proposed channel; would not work proposed channel at night; proposed Inner Harbour more sheltered than Breakwater Harbour; current at end of moles would tend to deflect vessel's course; beam sea would tend to force vessel on to side of channel	Worked present breakwater for five years; never had to leave owing to bad weather; consider there would be no difficulty in entering harbour when completed.
L. C. H. Worrall, captain; retired from Union Steamship Co. Retired twelve months ago; experience since 1876. (Pages 123, 124, and 125.)	In big seas would not attempt to take large vessel in, even with tug; considers it would not be advisable to work channel at night; a tug would be required in calm weather; the current at end of moles would deflect vessel	Worked breakwater; never had trouble; have been alongside in S.E. seas; never had to go past breakwater; thinks complete harbour would be a success; Breakwater Harbour decidedly safer; no trouble from range.
A. M. Edwin, master. coastal pilot. Been at sea thirty-six years; worked Napier weekly for two years. (Pages 125, 126, and 127.)	Difficult to navigate entrance to Inner Harbour; could only work it at slack water once in twenty-four hours; a tug would be required	Worked breakwater; occasionally broke things up (springs); stayed in all weather; prefers Breakwater; can enter and leave at any state of tide; when swell too big worked under lee of breakwater.
H. Collins, Harbourmaster, Nelson. Twenty years Harbourmaster at Nelson; before that 2nd and 3rd officer Union Steamship Co. (Pages 127, 128, 129, 130, 131, 132, and 133.)	Entrance quite safe with moderate breeze; channel could be worked at night; no tug required; prefers Inner Harbour; 7-knot current dangerous; 2 to 3 knots not dangerous; currents caused by tide-deflector increase risk; always be a certain amount of range	Swinging-basin 1,300 ft. big enough; considers height of breakwater not sufficient.
H. White-Parsons, Harbourmaster, Napier. Harbourmaster at Napier for thirteen years; total of thirty-five years' experience at sea. (Pages 167, 168, 170, 171, 172, 173, 174, 175, and 176.)	Would bring vessels in at high and low water slack; doubts if channel could be worked at night; a tug would be required; beam sea and wind; would not take vessel in if there was a range; considerable range in harbour at present	During thirteen years as Harbourmaster have not had an accident; when harbour completed no difficulty in entering during reasonable N.E. weather; only 3 per cent. per year have had to leave owing to bad weather; during strong easterlies easier to enter breakwater; during heaviest seas, range at present from 3 ft. to 3 ft. 6 in., then not safe to berth; if completed, consider it would be satisfactory in every respect; in all but abnormal weather no difficulty in entering. Maximum draught of vessel berthed to date, 26 ft. 3 in.; if harbour completed as proposed, no necessity for vessels to leave breakwater owing to bad weather; by using the breakwater considers saving to vessel, as against working the roadstead, up to 40 per cent.
H. Brown, master of s.s. "Port Melbourne," 12,450 tons. Trading to Napier since 1904. (Pages 206, 207, 208, 209, and 210.)	In ordinary weather no difficulty in working proposed channel; would work in moonlight; would require a tug; prefers the more sheltered aspect	His owners will not allow him to use the present Breakwater Harbour; he would require a tug; Breakwater Harbour more easily affected by bad weather.
T. H. Chudley, marine superintendent, Shaw, Savill, and Albion Co. At sea actually thirty years, ashore thirteen years; holds master's certificate; trading to New Zealand since 1891. (Pages 223, 224, 225, and 226.)	Doubtful; could only be worked at top of high water, and then would require smooth water and no more than moderate breeze; would require two tugs; heavy swell would cause vessel to roll and draw extra 2 ft.; prefer lightering in bay to entering proposed Inner Harbour or completed Breakwater Harbour	Could use breakwater Harbour at any state of the tide; entrance satisfactory considering prevailing winds; swinging-basin 1,300 ft. satisfactory; sees no reason why ocean-going vessels should not use Breakwater Harbour when completed; of the two completed harbours, prefers Breakwater, but would prefer lightering in bay to using either.

TABLE J.—SHORT SUMMARY OF NAVIGATION EXPERTS' EVIDENCE—*continued*.

Witness.	Inner Harbour.	Breakwater Harbour.
Wybrant Olphert, marine superintendent, N.Z. Shipping Co. Thirty-six years' experience with N.Z. Shipping Co.; prior to present appointment in command. (Pages 229, 230, and 231.)	Does not like proposed channel; considers 600 ft. too narrow; would not work channel at night; channel would only be used once per day; considers the use of a tug the first essential	Considers breakwater entrance easier and safer to work; does not consider tug would be required; not much in favour of either harbour.
R. J. Foster, marine superintendent, Union Steamship Co. Thirty years at sea and seven ashore; great deal of experience with Napier. (Pages 232 and 233.)	Would not care to work channel unless under perfect conditions, not at night; would not like to bring Union Co. vessels in under any condition	Had worked Breakwater Harbour a lot, and never had to put to sea owing to range, &c.; sometimes it was hard to hang on; prefers breakwater, as easier means of escape in bad weather.
H. Hollis, marine superintendent, Commonwealth and Dominion Co. Master for line 1902-16; at sea since 1889; frequently in port of Napier. (Pages 334, 335, 336, 337, 338, and 339.)	Considers navigating proposed channel safe at H.W. slack if moderate wind, not too much sea; would not work channel at night; would require one tug. During August, 1927, vessels could only enter once per day on twenty-seven days and twice on four days	Once vessels inside completed harbour very good indeed; his company's vessels do not use the present Breakwater Harbour; when harbour completed range will be reduced; range is not caused by seas if they come over the breakwater.

TABLE K.—PLANS AND MAPS COMPRISED IN COMMISSION'S EXHIBIT No. 3.

- (a) Litho plan of Napier Harbour and reclamation areas.
- (b) Litho from Furkert's report.
- (c) Locality-map, Napier—Kidnappers to Whakariri.
- (d) 1855 to 1927—Five contour plans.
- (e) Cross-sectional plan based on Plans D1855 to D1927.
- (f) Sectional depths and sea-bottom, 1880 to 1925.
- (g) Plan of Colon Harbour.
- (h) Plan of Napier Harbour.
- (i) Map of trading-area of Napier Harbour Board District (by Chamber of Commerce).
- (j) Holmes 1906-27 soundings in red and black.
- (k) Photograph of breakwater.
- (l) Cullen and Keele's plan, 1925.
- (m) Plan M.D. 5652. Plan of proposed dredging by Browning crane.
- (n) Plan of soundings, "Whakarire," 10-acre patch, 1911.
- (o) Longitudinal section through 10-acre patch.
- (p) Relative tidal diagram, Inner Harbour and outer bay.
- (q) Plan showing comparative contours at West Shore, indicating erosion.
- (r) Plan, Napier Harbour Board reserves.

Approximate Cost of Paper.—Preparation, not given; printing (550 copies), £90.

By Authority: W. A. G. SKINNER, Government Printer, Wellington.—1927.

Price 1s. 6d.]

TABLE I. GROUPS OF VARIATION FACTORS

Group	Factors
1	Temperature, Humidity, Wind, Rainfall, Clouds, etc.
2	Soil moisture, Soil temperature, Soil pH, etc.
3	Plant density, Plant height, Plant color, etc.
4	Light intensity, Light quality, Light duration, etc.
5	CO2 concentration, O2 concentration, etc.
6	Plant age, Plant size, Plant sex, etc.
7	Plant species, Plant variety, etc.
8	Plant location, Plant orientation, etc.
9	Plant health, Plant stress, etc.
10	Plant growth rate, Plant yield, etc.

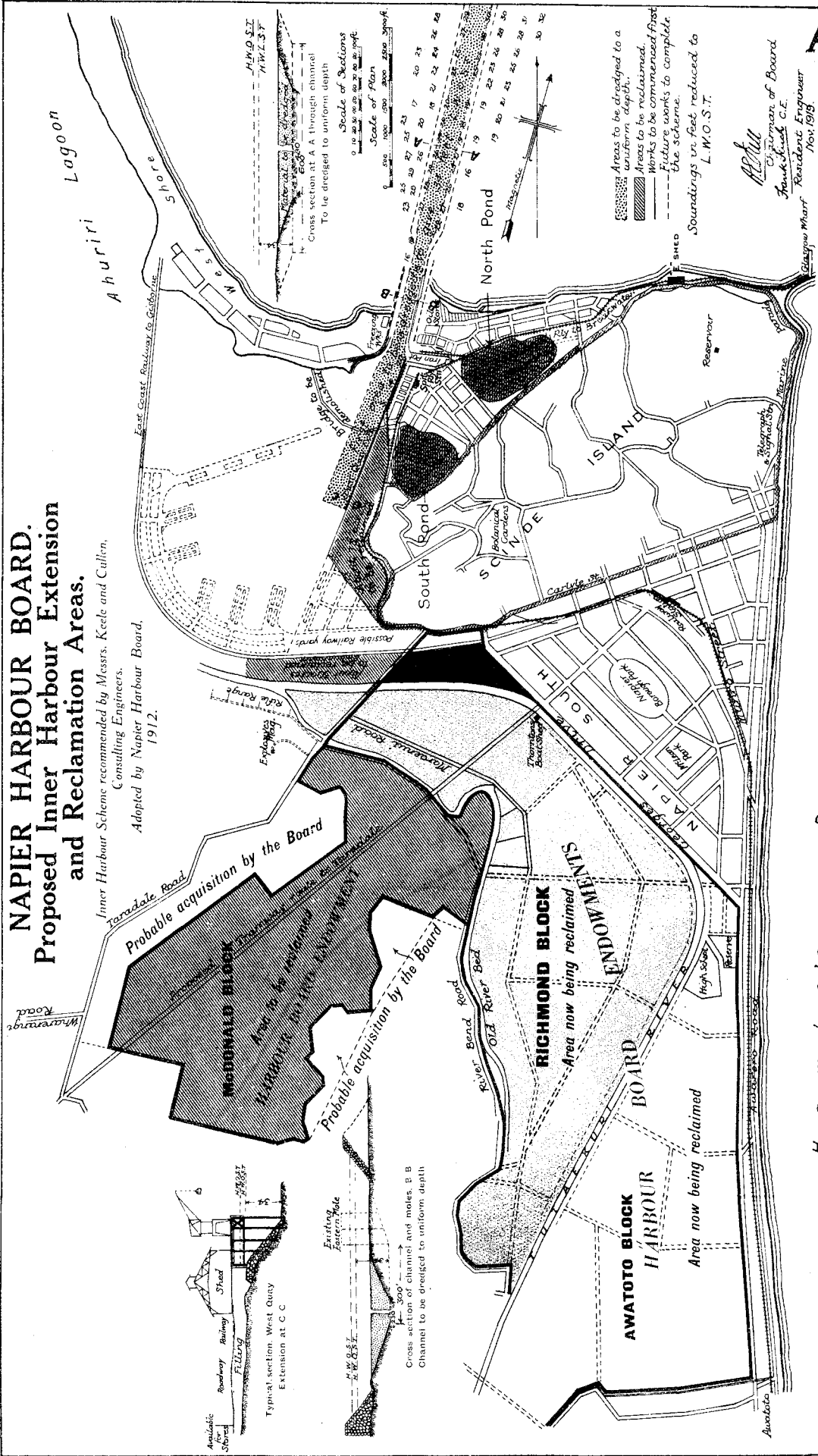
APPENDIX I. LIST OF REFERENCES

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- (20) ...

NAPIER HARBOUR BOARD. Proposed Inner Harbour Extension and Reclamation Areas.

Inner Harbour Scheme recommended by Messrs. Keels and Cullen,
Consulting Engineers.

Adopted by Napier Harbour Board,
1912.

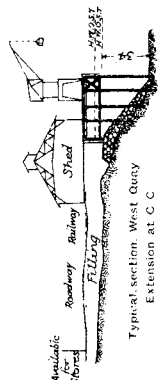


Areas to be dredged to a uniform depth.
 Areas to be reclaimed.
 Works to be commenced first.
 Future works to complete the scheme.
 Soundings in feet reduced to L.W.O.S.T.

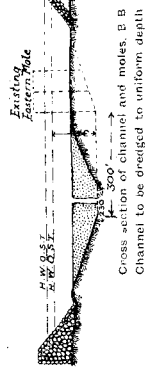
A. C. Bell
 Chairman of Board
 Auckland C.E.
 Resident Engineer
 Nov. 1912

H a w k e e ' s B a y

A



Typical section West Quay Extension at C C



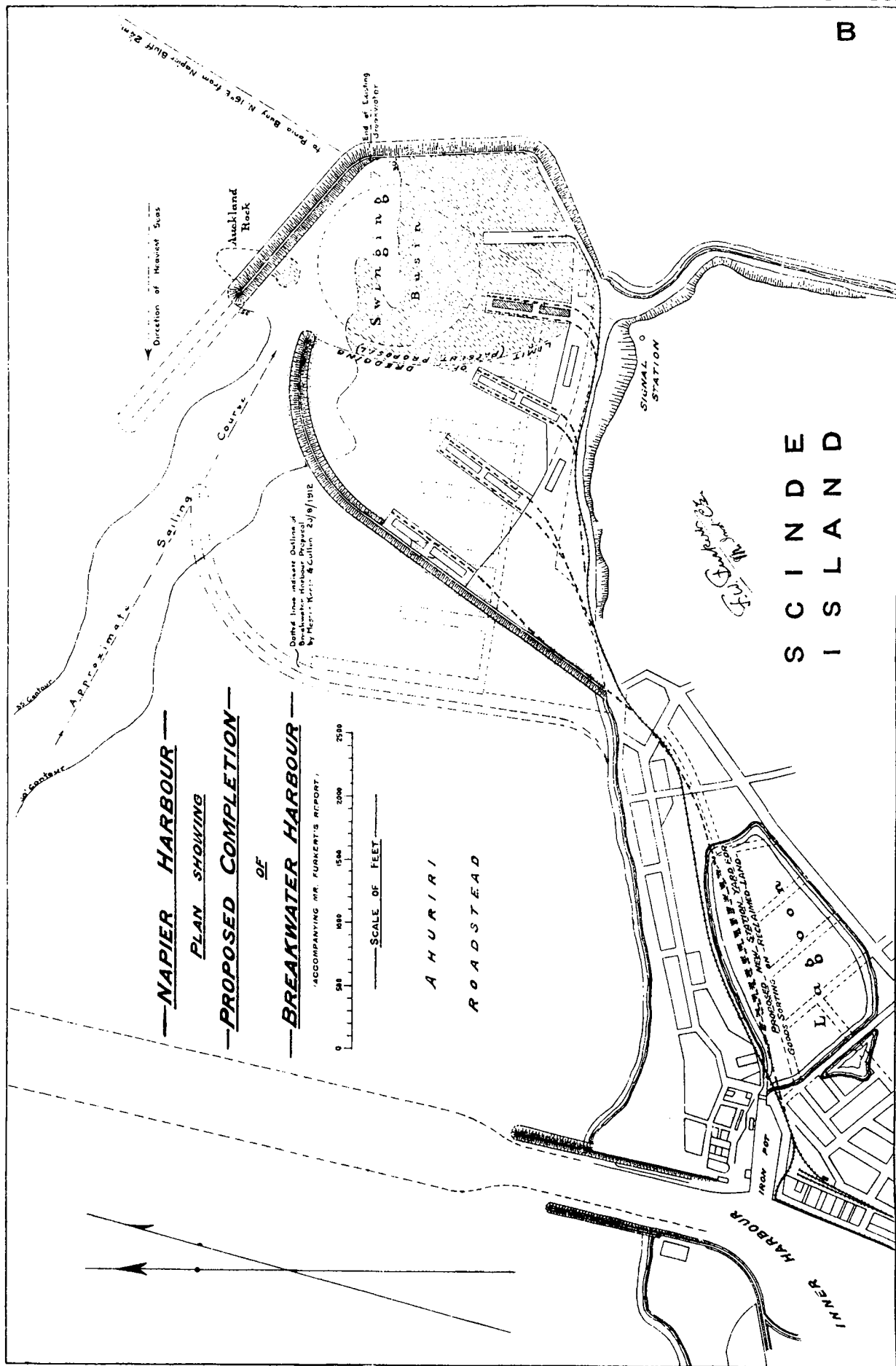
Cross section of channel and moles B B Channel to be dredged to uniform depth

A



MILITARY DIVISION
 EXHIBIT

B



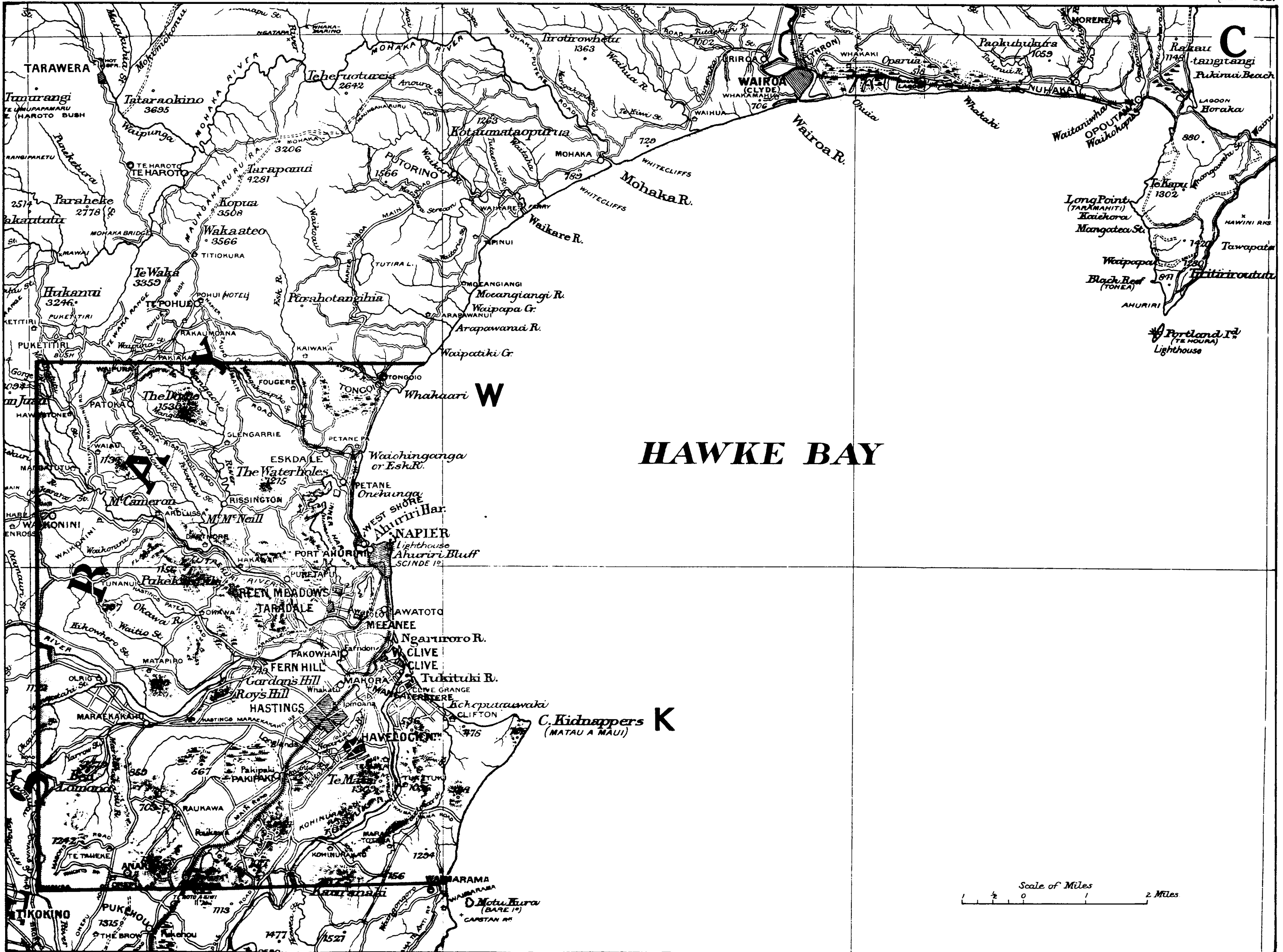
1 2 3 4 5 6
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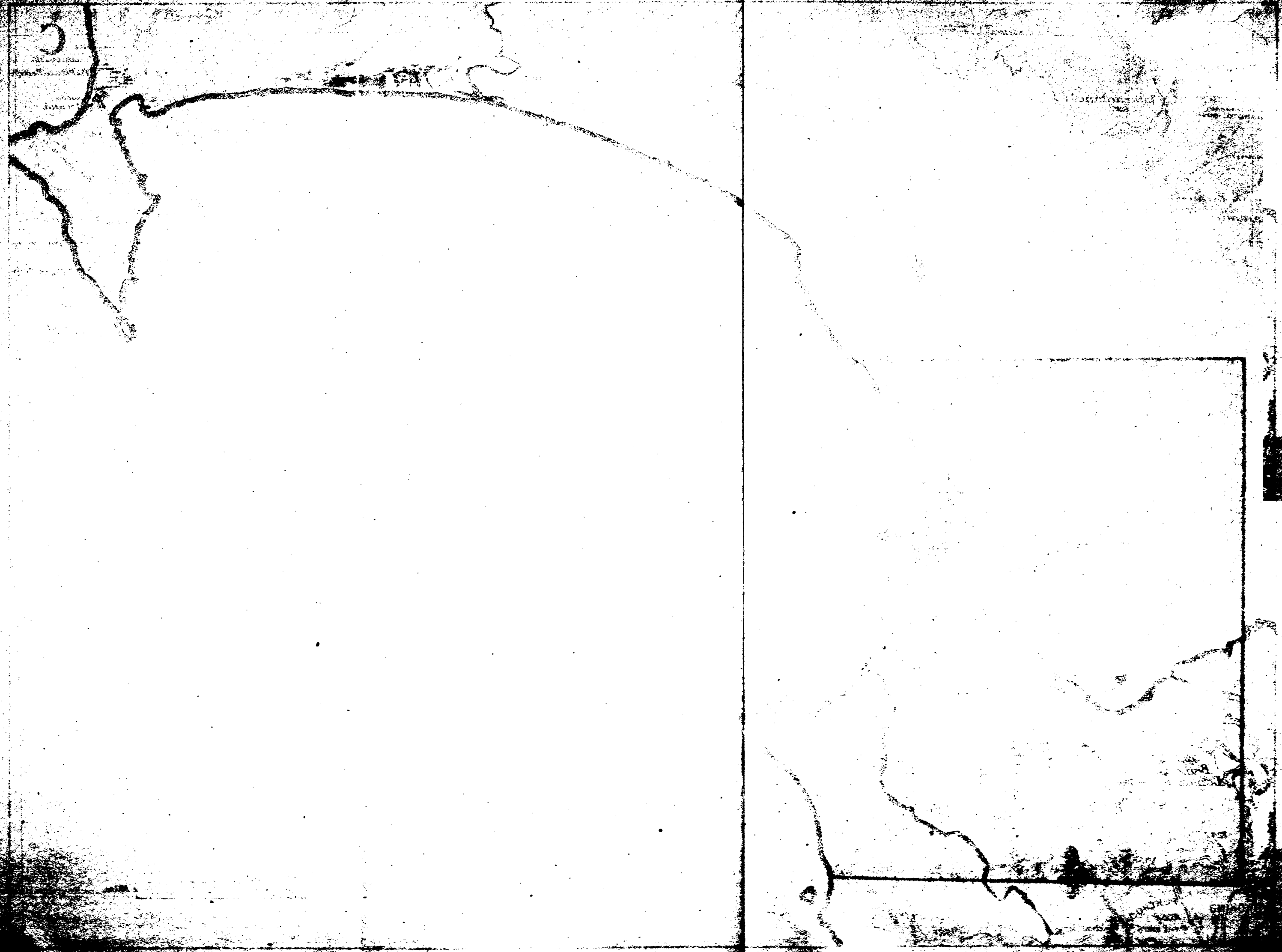
C
Rakau
taugitangi
Pukimui Beach
LAGOON
Horaka

Long Point
(TAKAMAHITI)
Kaiehora
Mangotea St.
Tawapata
Waipapa
Black Reef
(TOHEA)
AHURIRI
Portland Id.
(TE HOUARA)
Lighthouse

K
C. Kidnappers (MATAU A MAUI)

Scale of Miles
0 1 2 Miles

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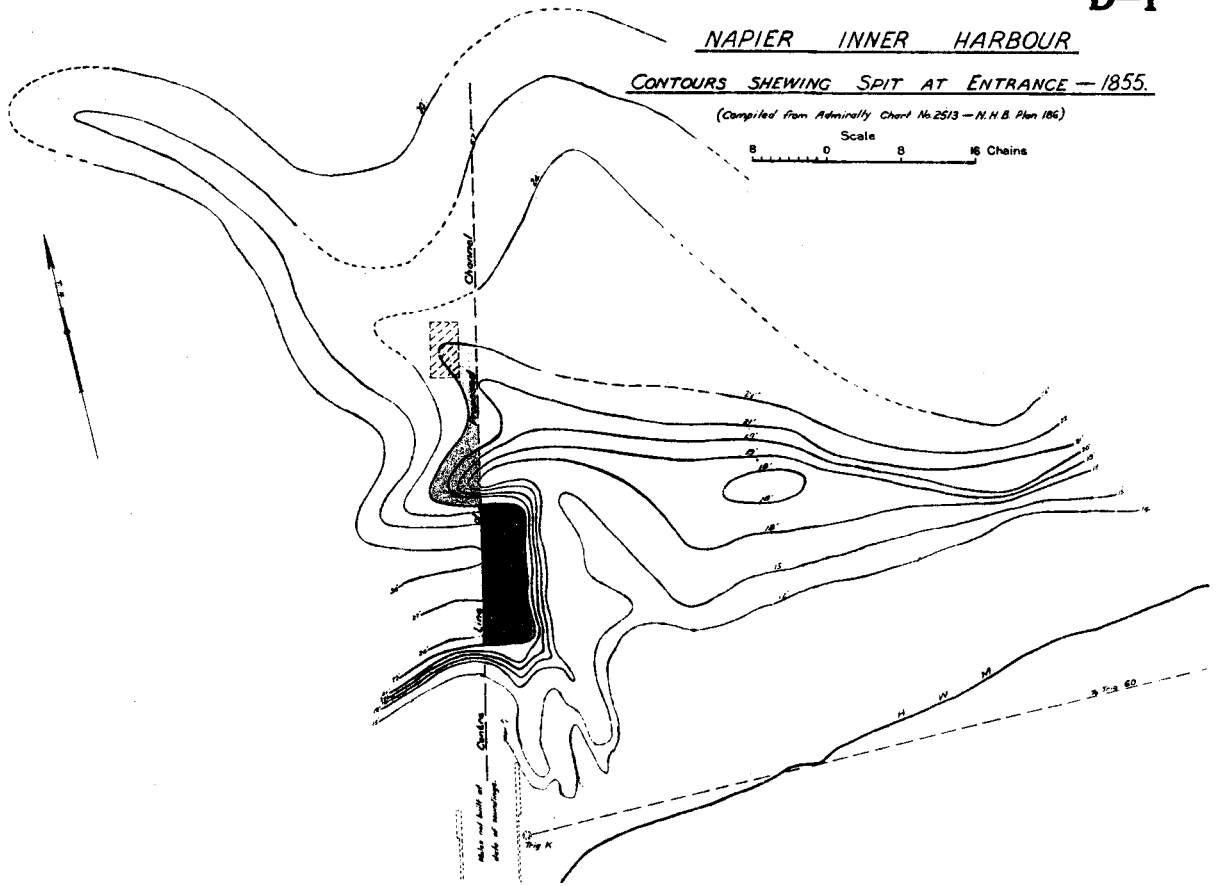
D-1

NAPIER INNER HARBOUR

CONTOURS SHEWING SPIT AT ENTRANCE — 1855.

(Compiled from Admiralty Chart No. 2513 — N.H.B. Plan 186)

Scale
0 8 16 Chains



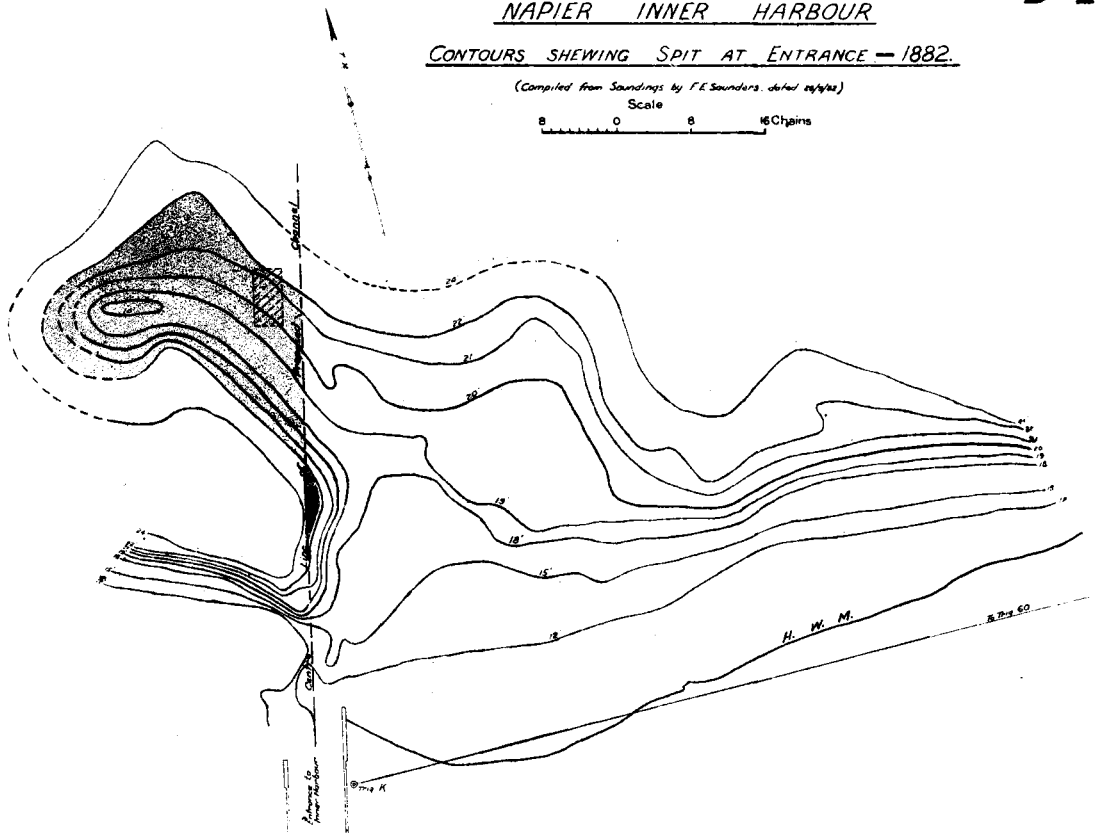
D-2

NAPIER INNER HARBOUR

CONTOURS SHEWING SPIT AT ENTRANCE — 1882.

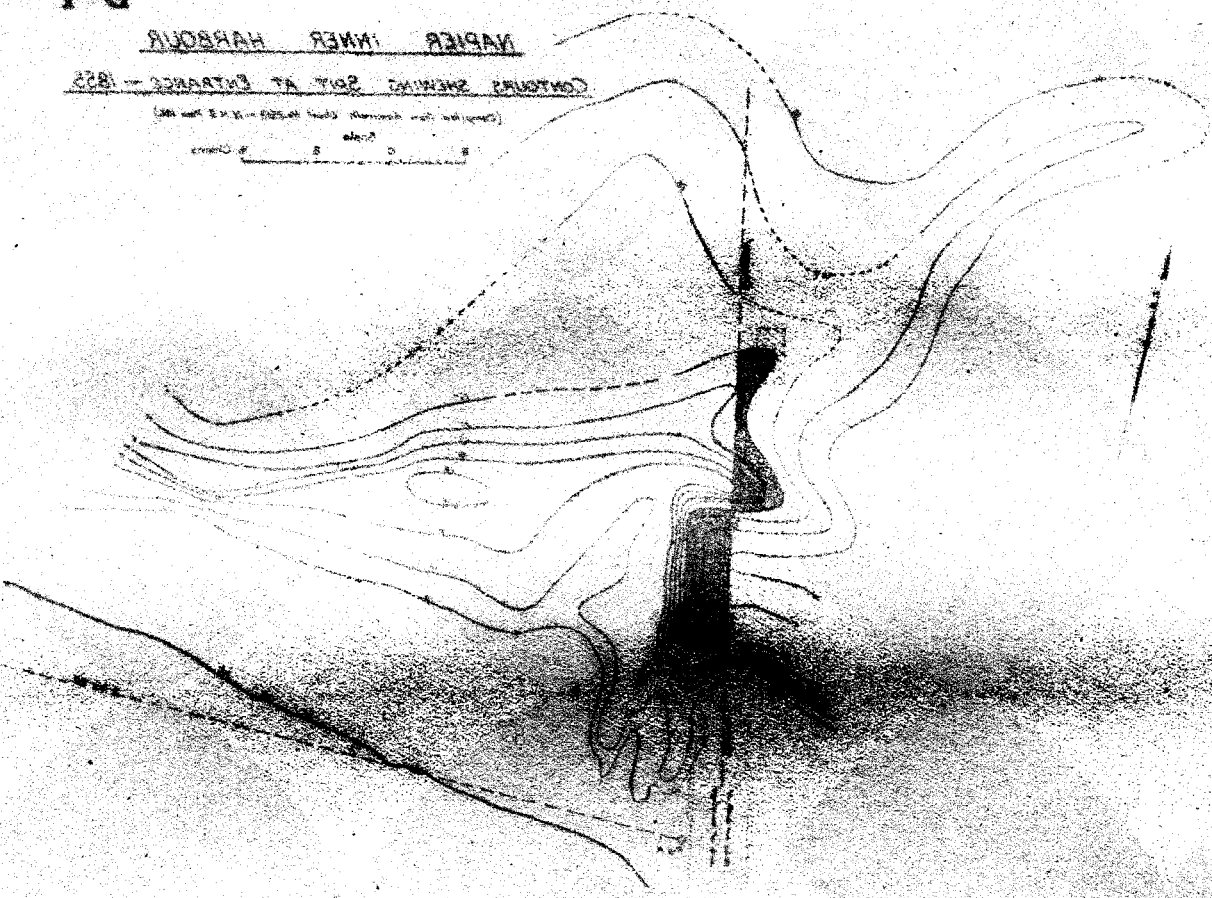
(Compiled from Soundings by F.E. Saunders, dated 1872)

Scale
0 8 16 Chains



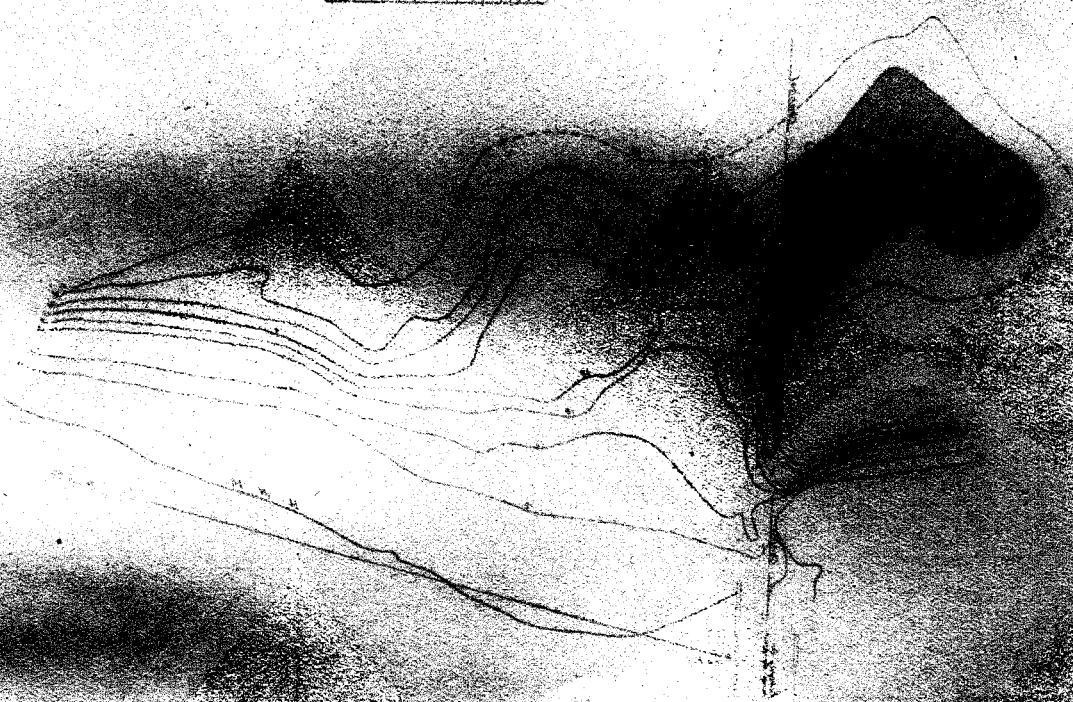
D-1

VAPIER INNER HARBOUR
 CONTOUR SHEWING SOLE AT ENTRANCE - 1855
 (Original from Admiralty Chart No. 1025 - 1855)
 Scale 1:50,000
 W. G. C. 1855



D-2

VAPIER OUTER HARBOUR
 CONTOUR SHEWING SOLE AT ENTRANCE - 1855
 (Original from Admiralty Chart No. 1025 - 1855)
 Scale 1:50,000
 W. G. C. 1855

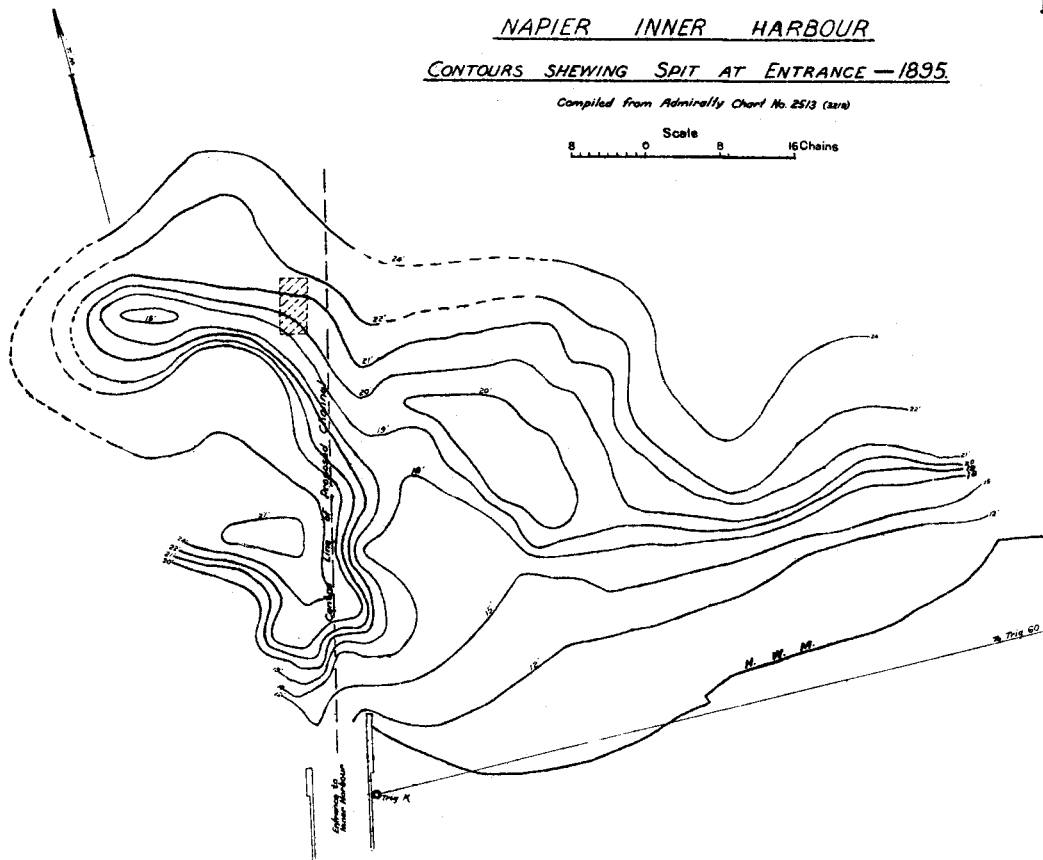


D-3

NAPIER INNER HARBOUR
CONTOURS SHEWING SPIT AT ENTRANCE — 1895.

Compiled from Admiralty Chart No. 2513 (1878)

Scale
0 8 16 Chains

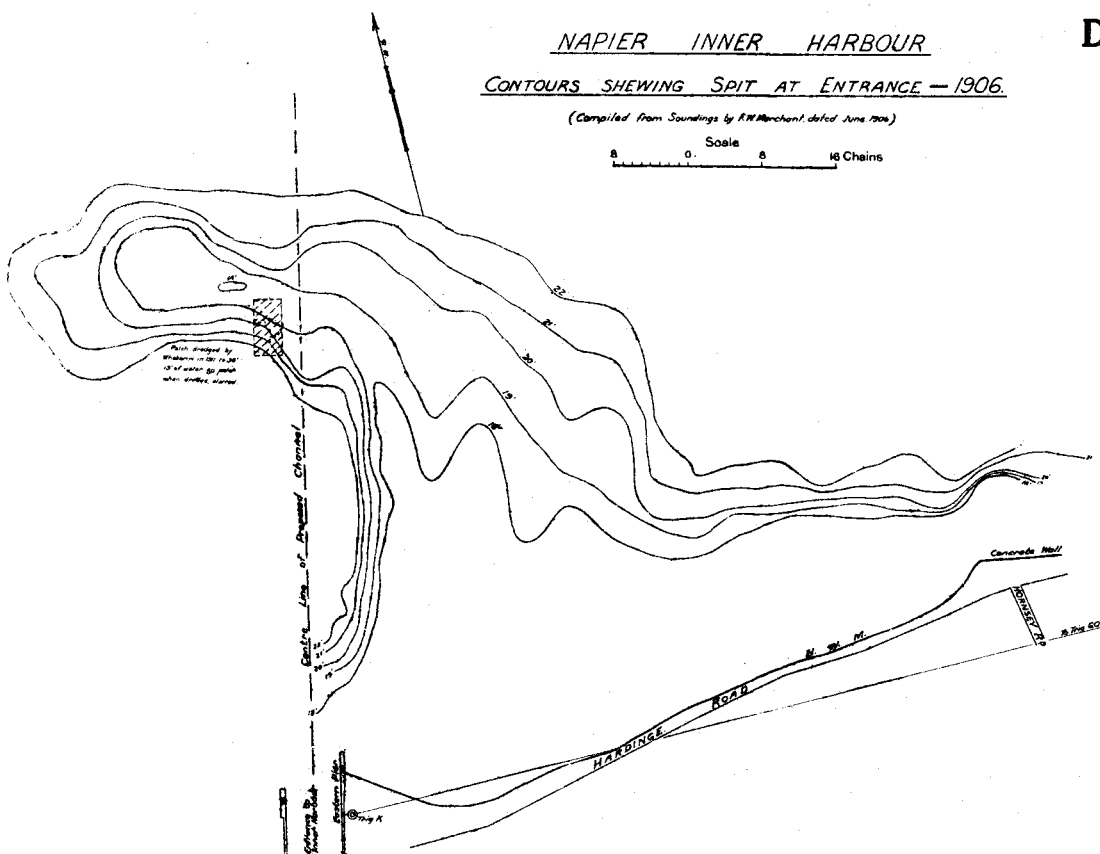


D-4

NAPIER INNER HARBOUR
CONTOURS SHEWING SPIT AT ENTRANCE — 1906.

(Compiled from Soundings by R.W. Merchant, dated June 1906)

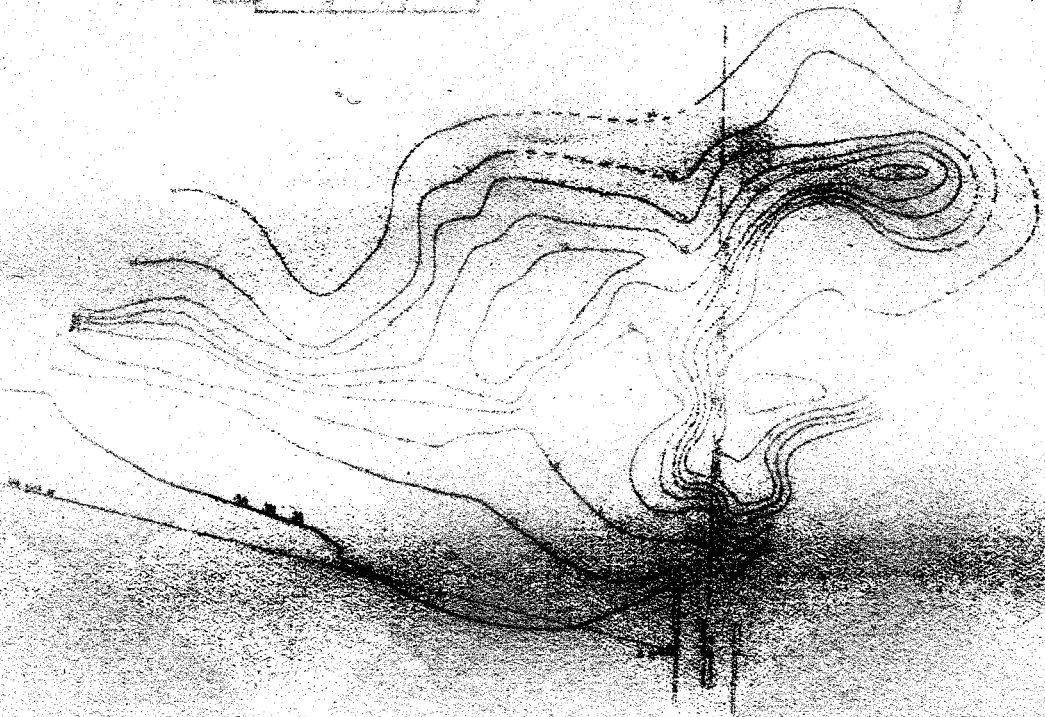
Scale
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D-3

HARPER INNER HARBOUR
CONTOUR SHEWING SPIT AT ENTRANCE - 1892

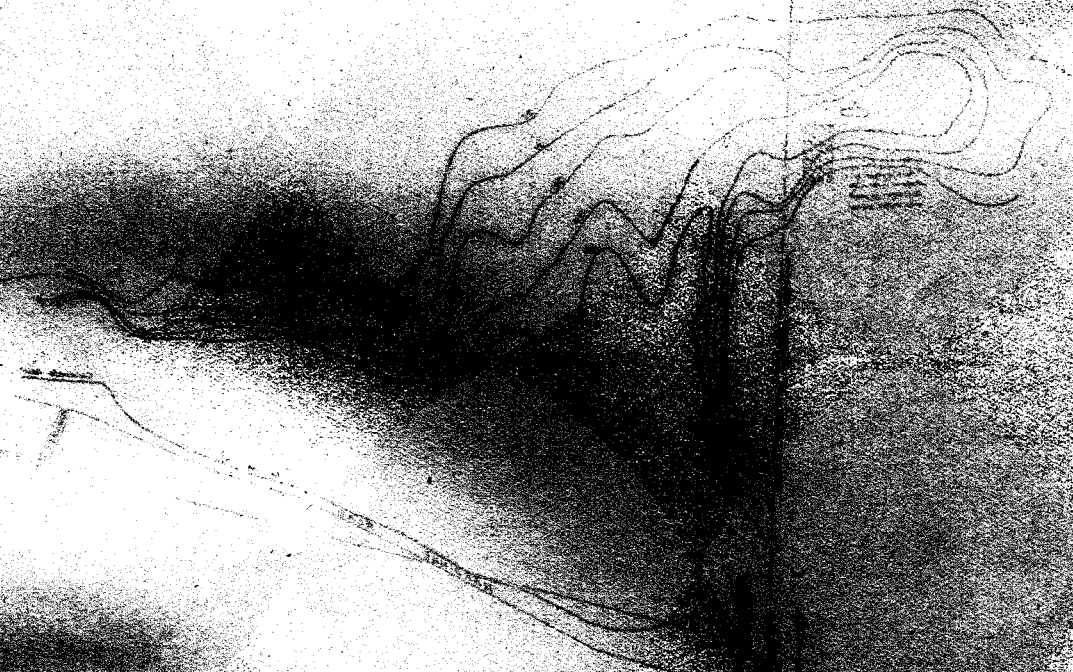
Contours from ...
Scale ...



D-4

HARPER INNER HARBOUR
CONTOUR SHEWING SPIT AT ENTRANCE - 1892

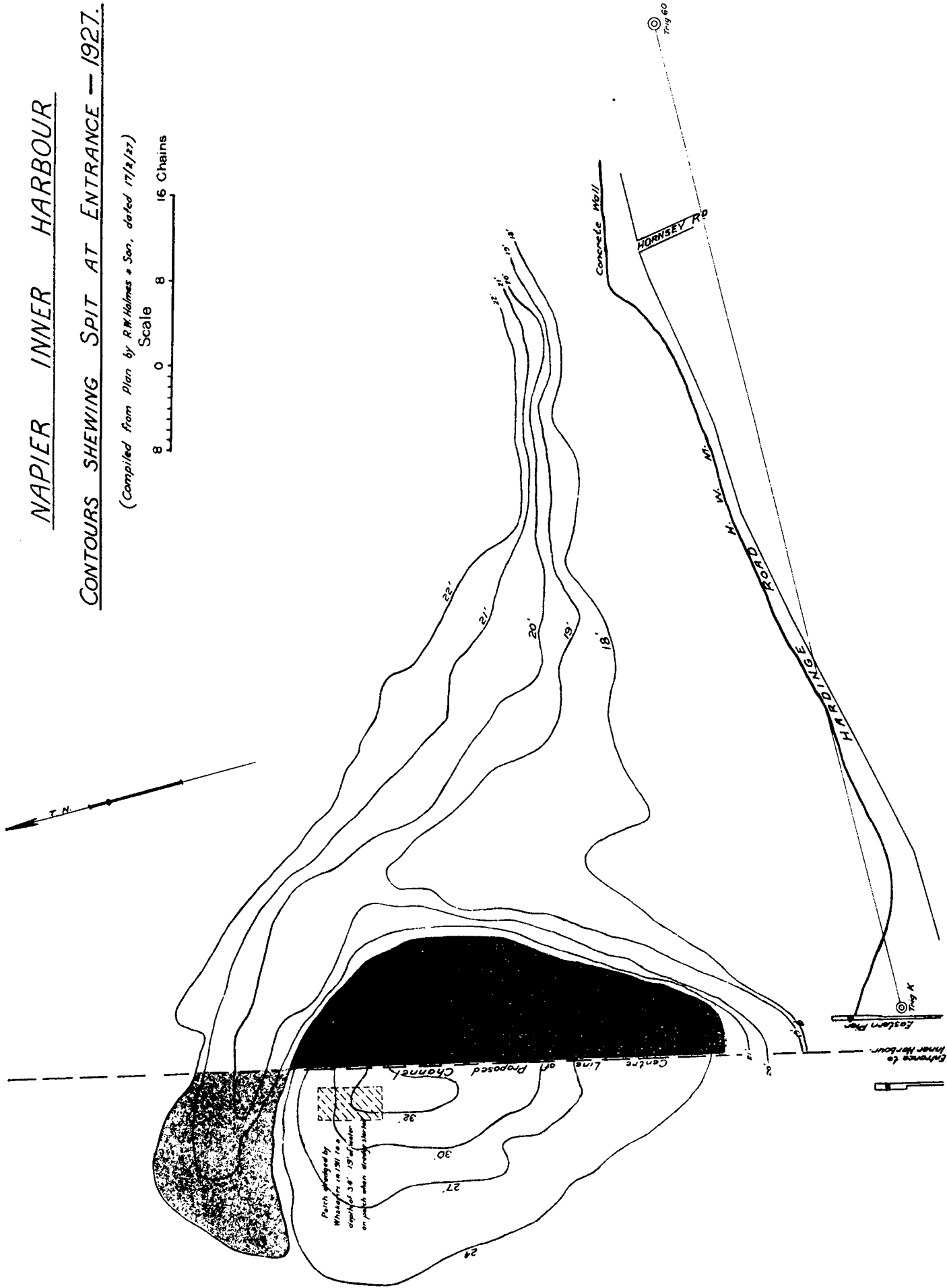
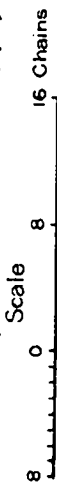
Contours from ...
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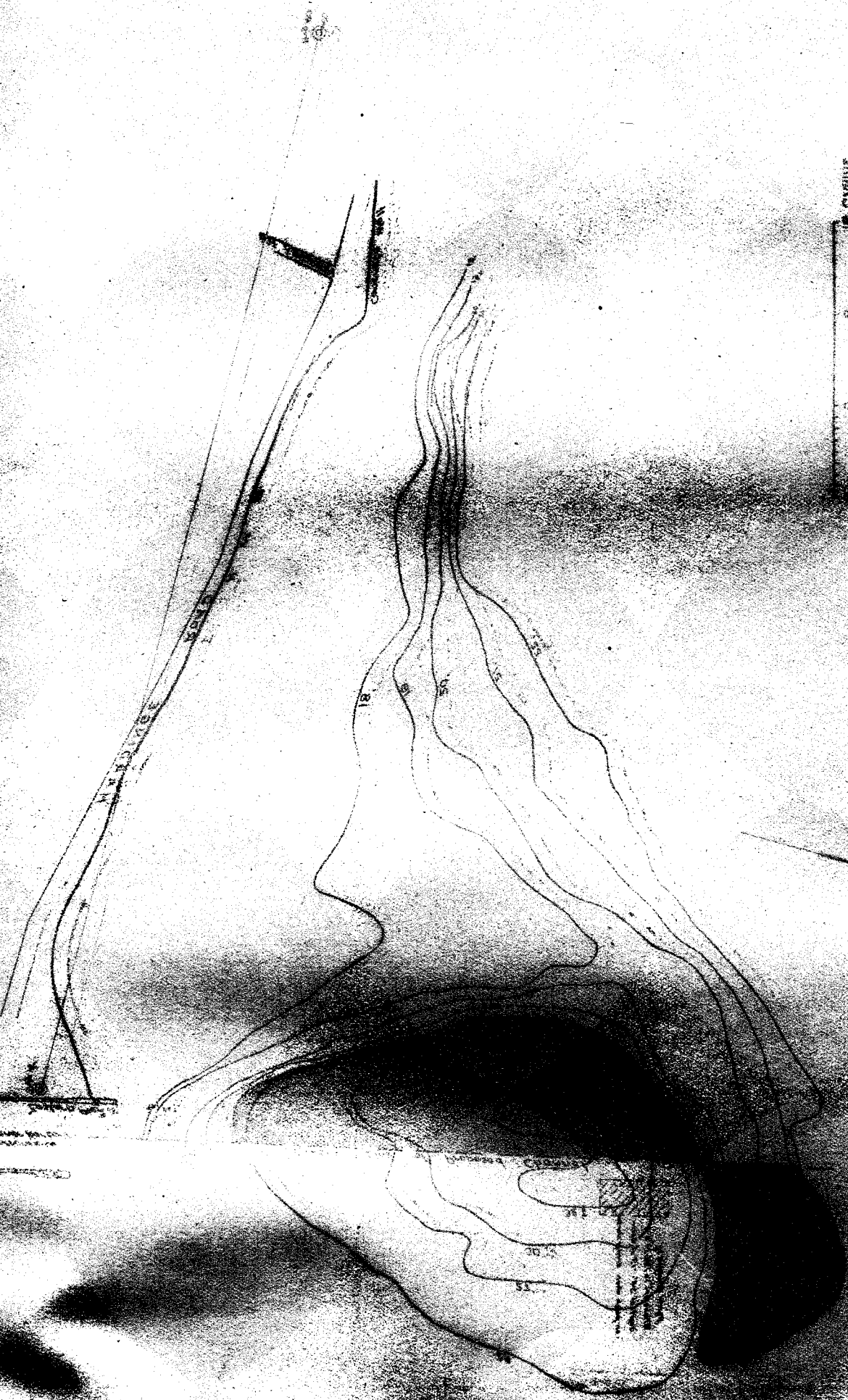
NAPIER INNER HARBOUR

CONTOURS SHEWING SPIT AT ENTRANCE — 1927.

(Compiled from Plan by R.W. Holmes & Son, dated 17/2/27)



10-19

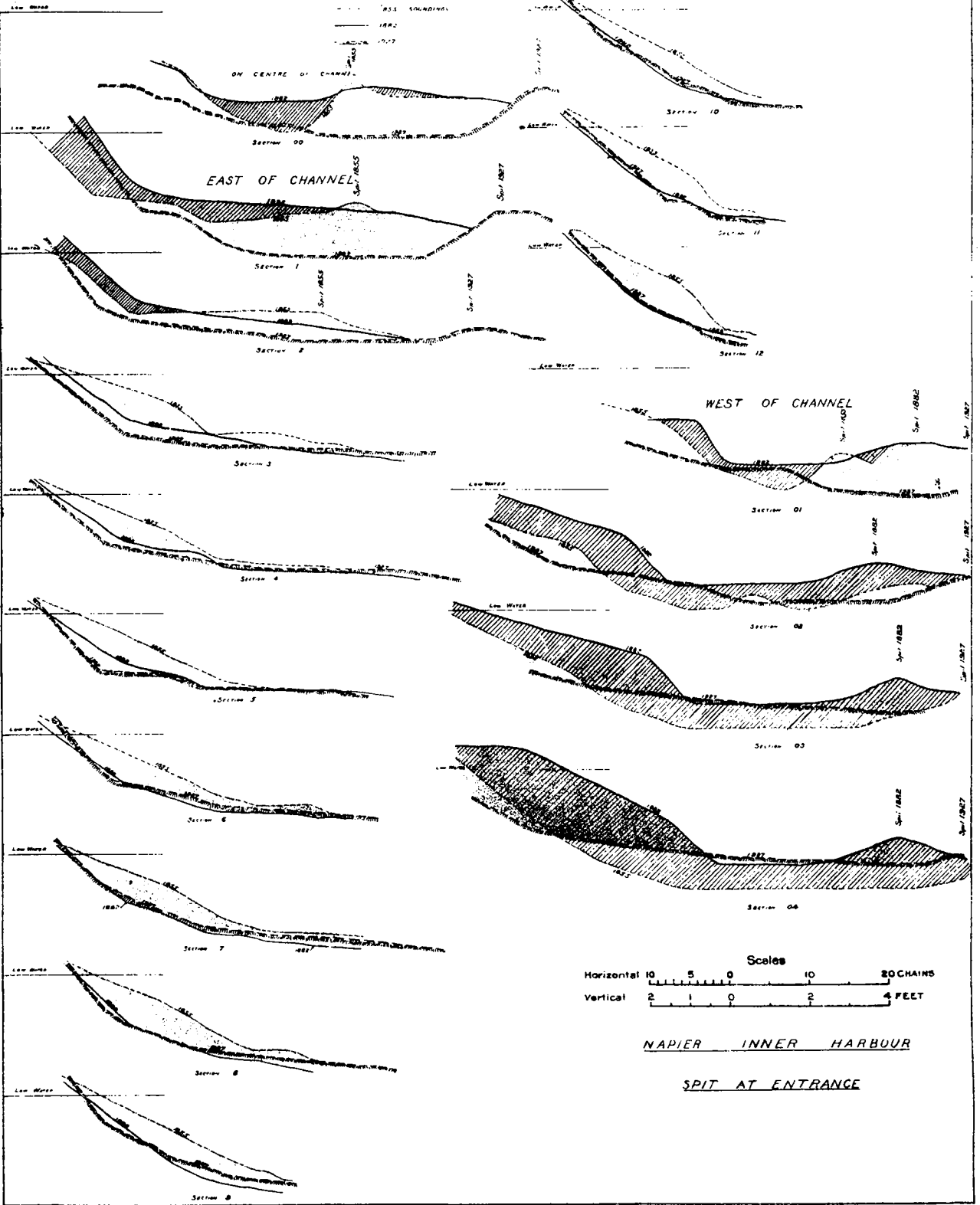


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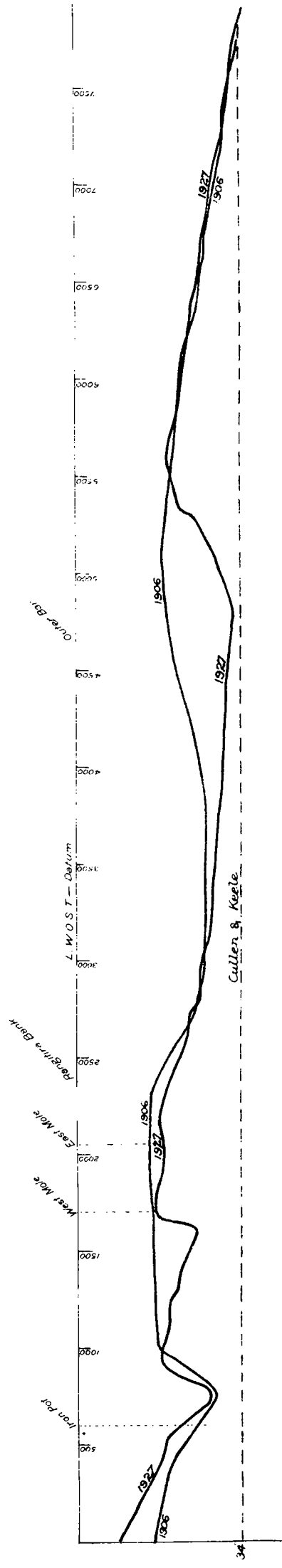
E

SECTIONS AT 5-CHAINS INTERVALS
ACROSS SAND SPIT

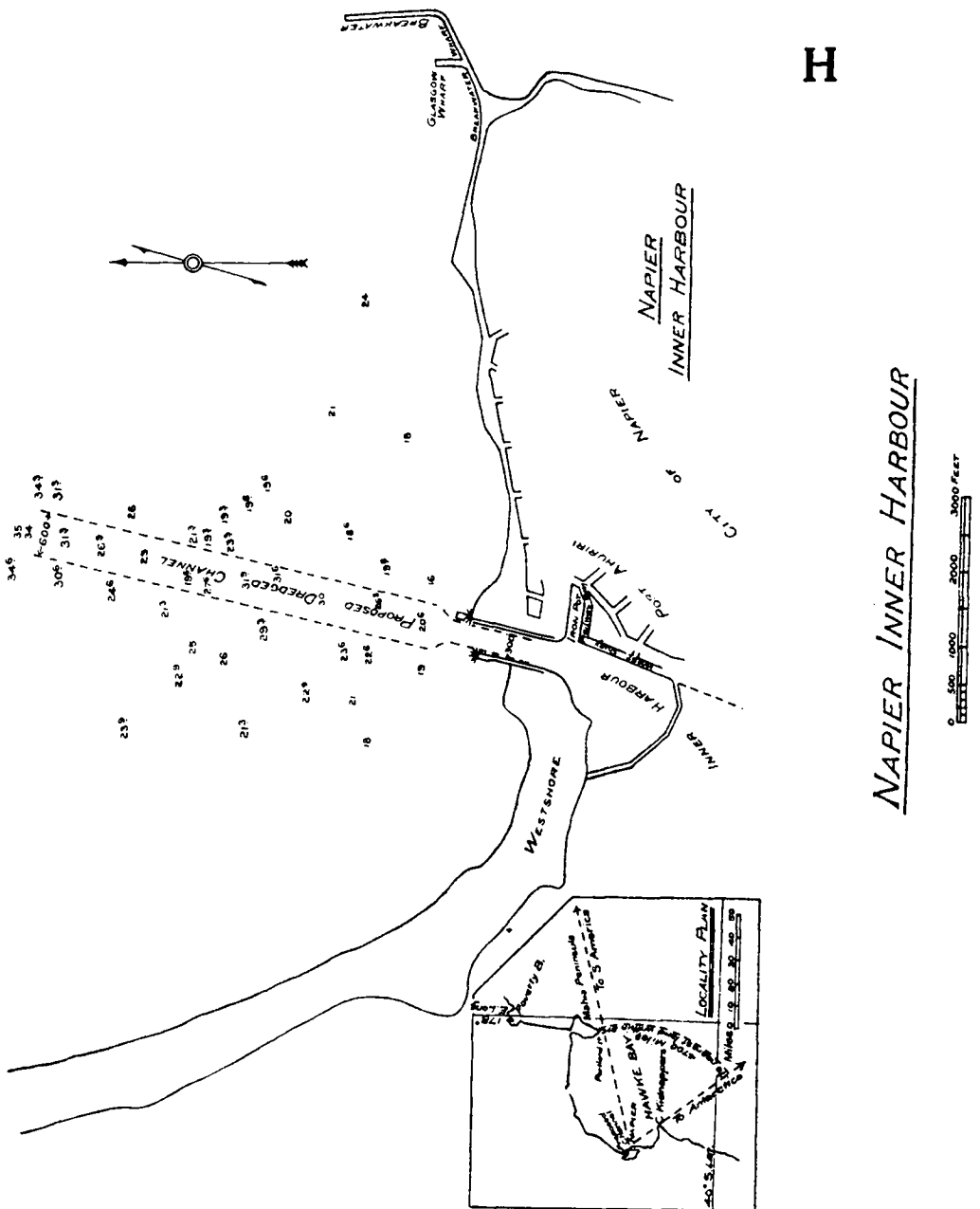
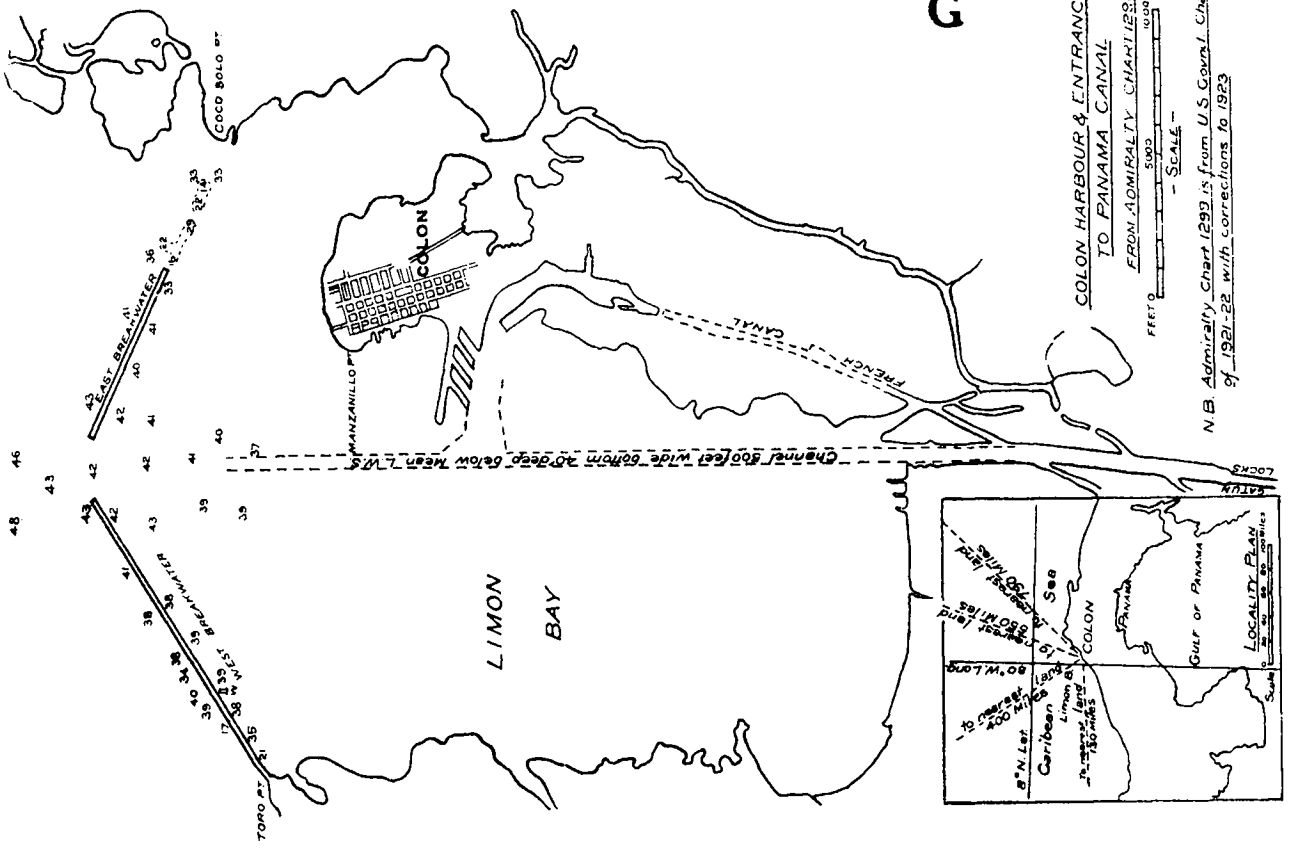


NAPIER INNER HARBOUR
Comparative Sections from West Quay to Outer Bar

Scales: Horizontal 1" = 100 feet
Vertical 1" = 10 feet

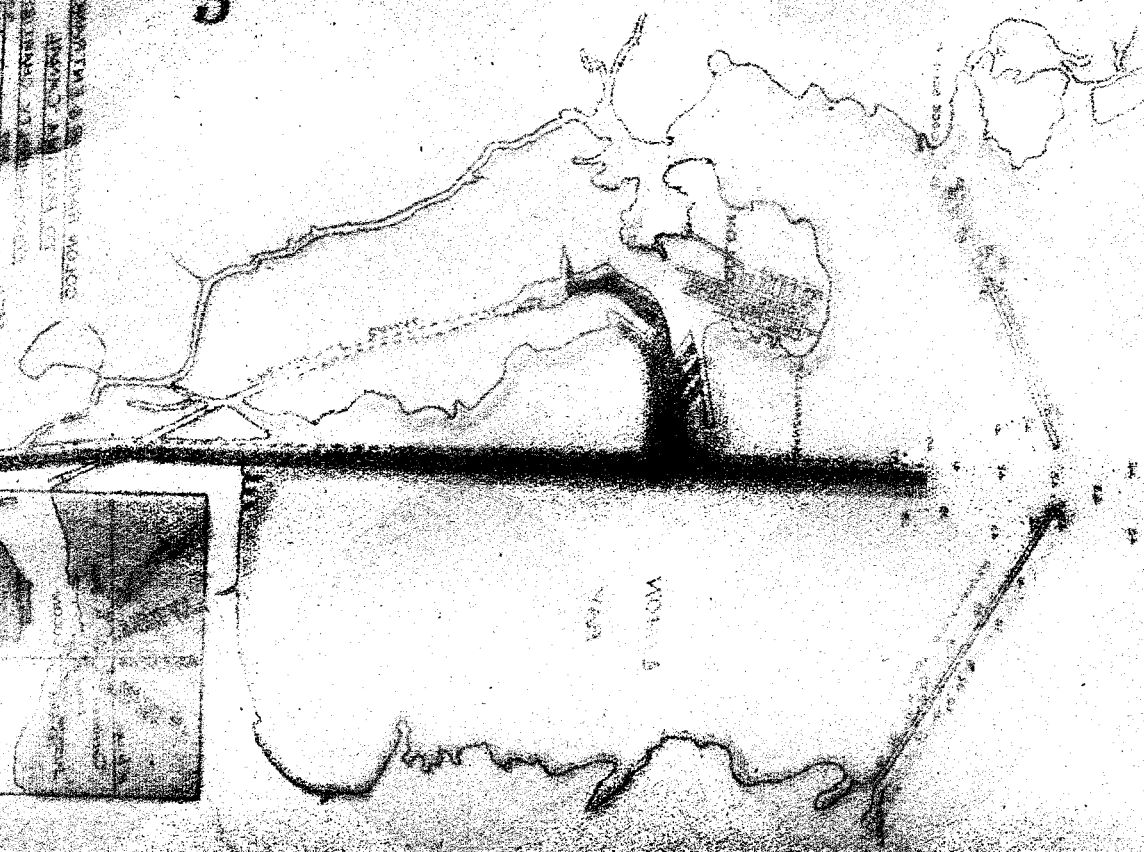
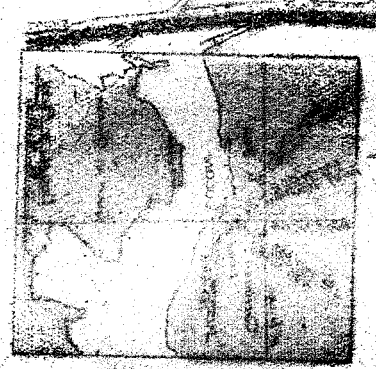


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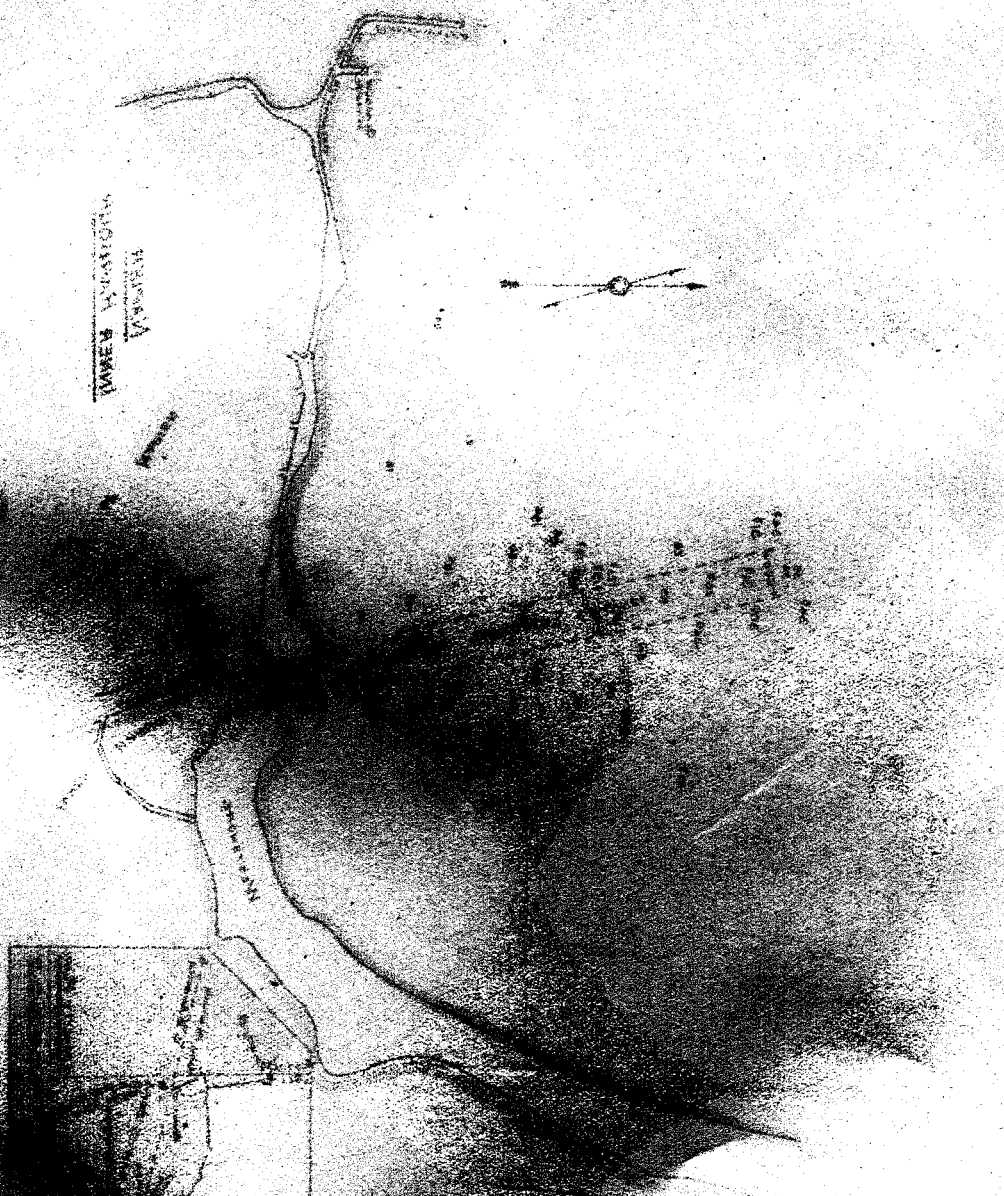
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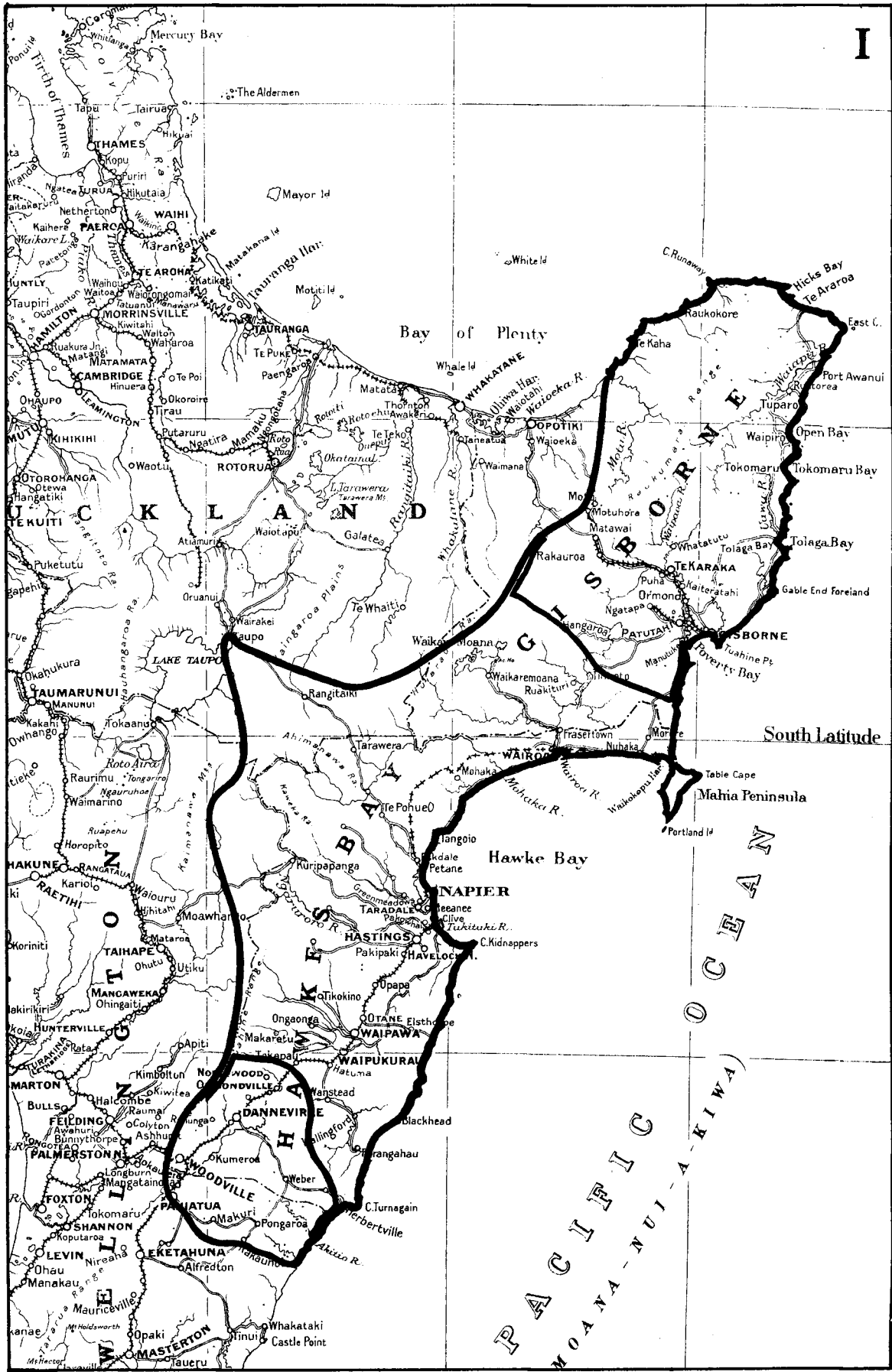


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WAKES HARBOR
 WAKES HARBOR



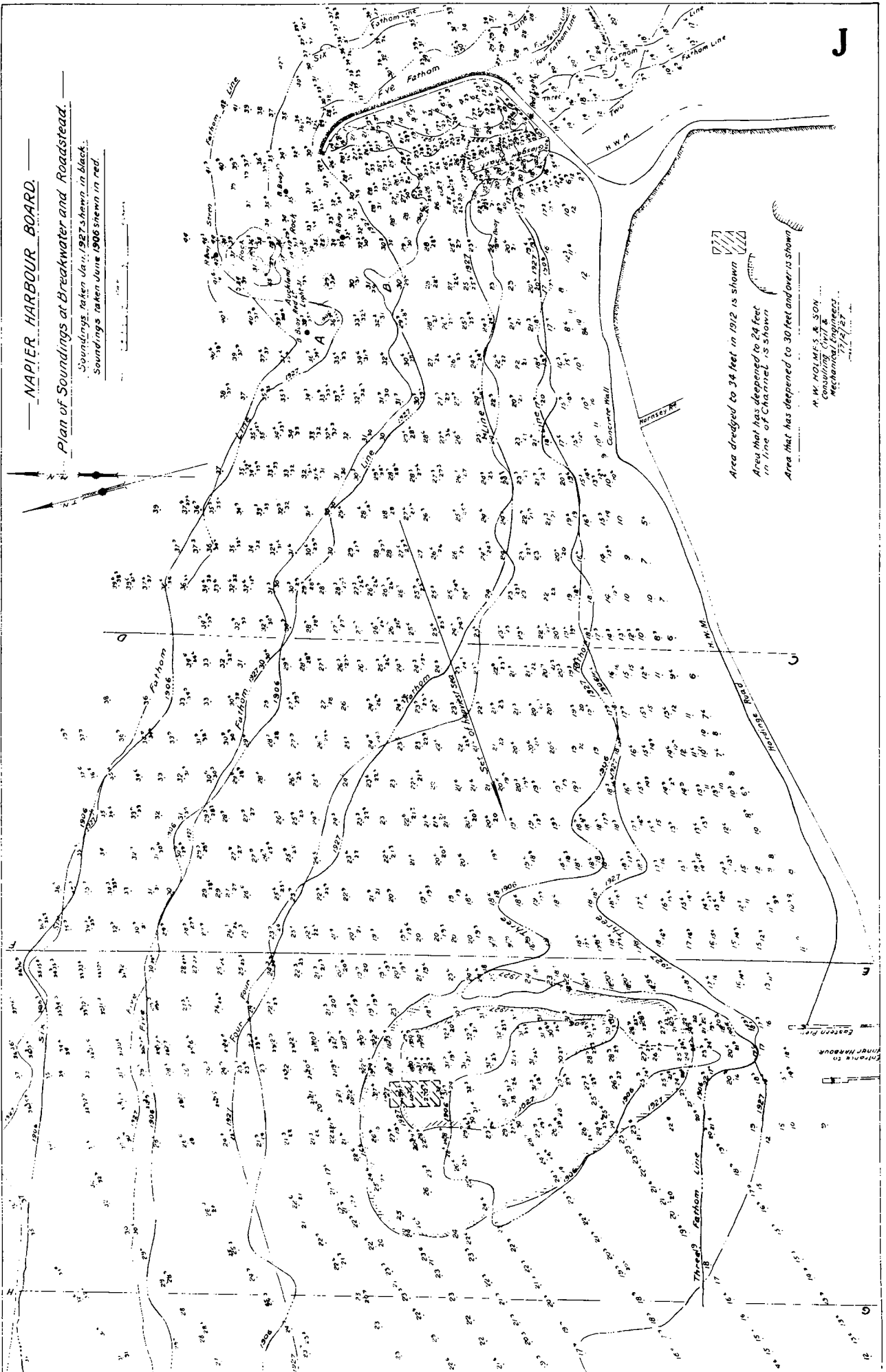


J

NAPIER HARBOUR BOARD.

Plan of Soundings at Breakwater and Roadstead.

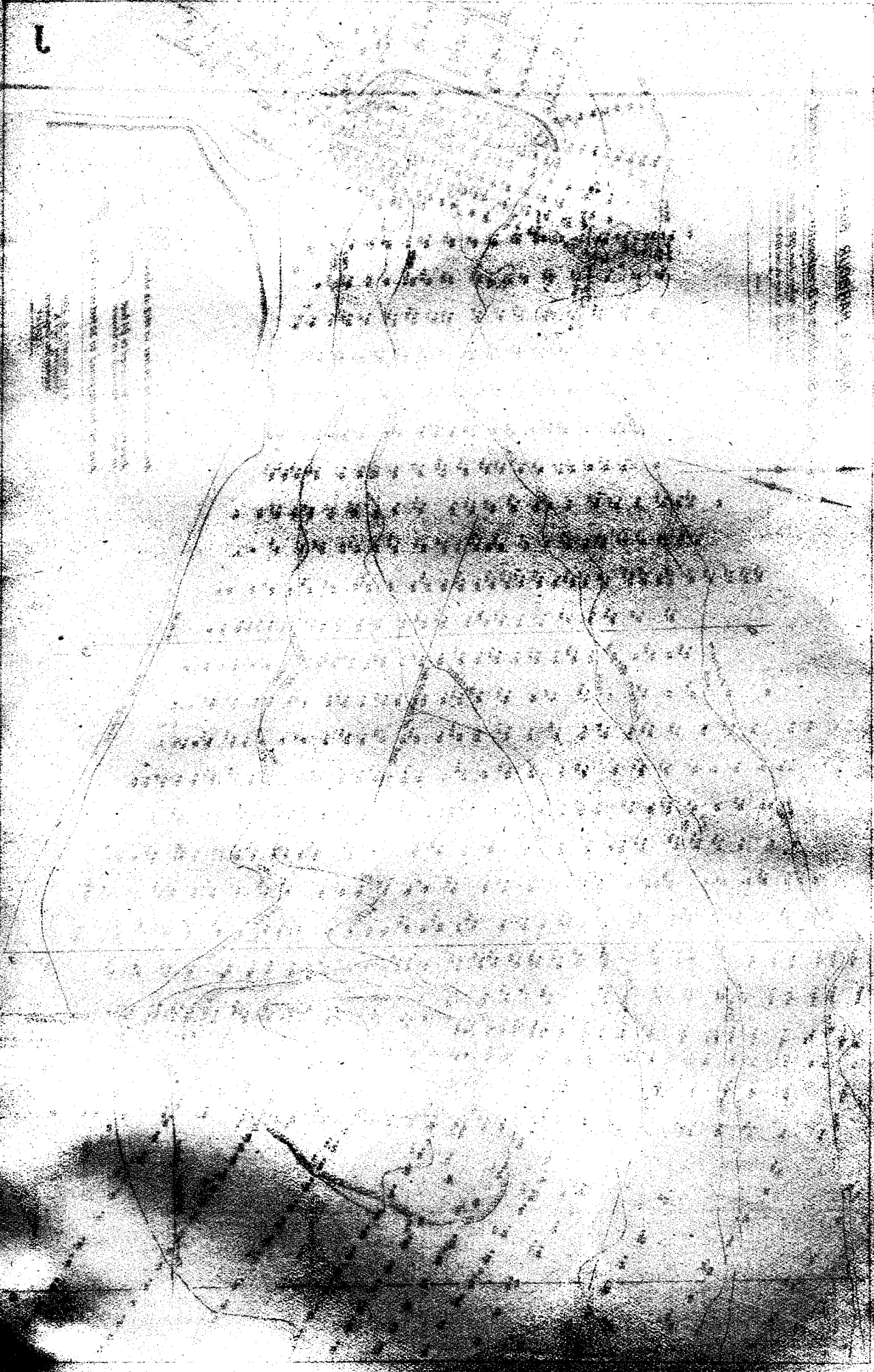
Soundings taken Jan. 1927 shown in black.
Soundings taken June 1906 shown in red.



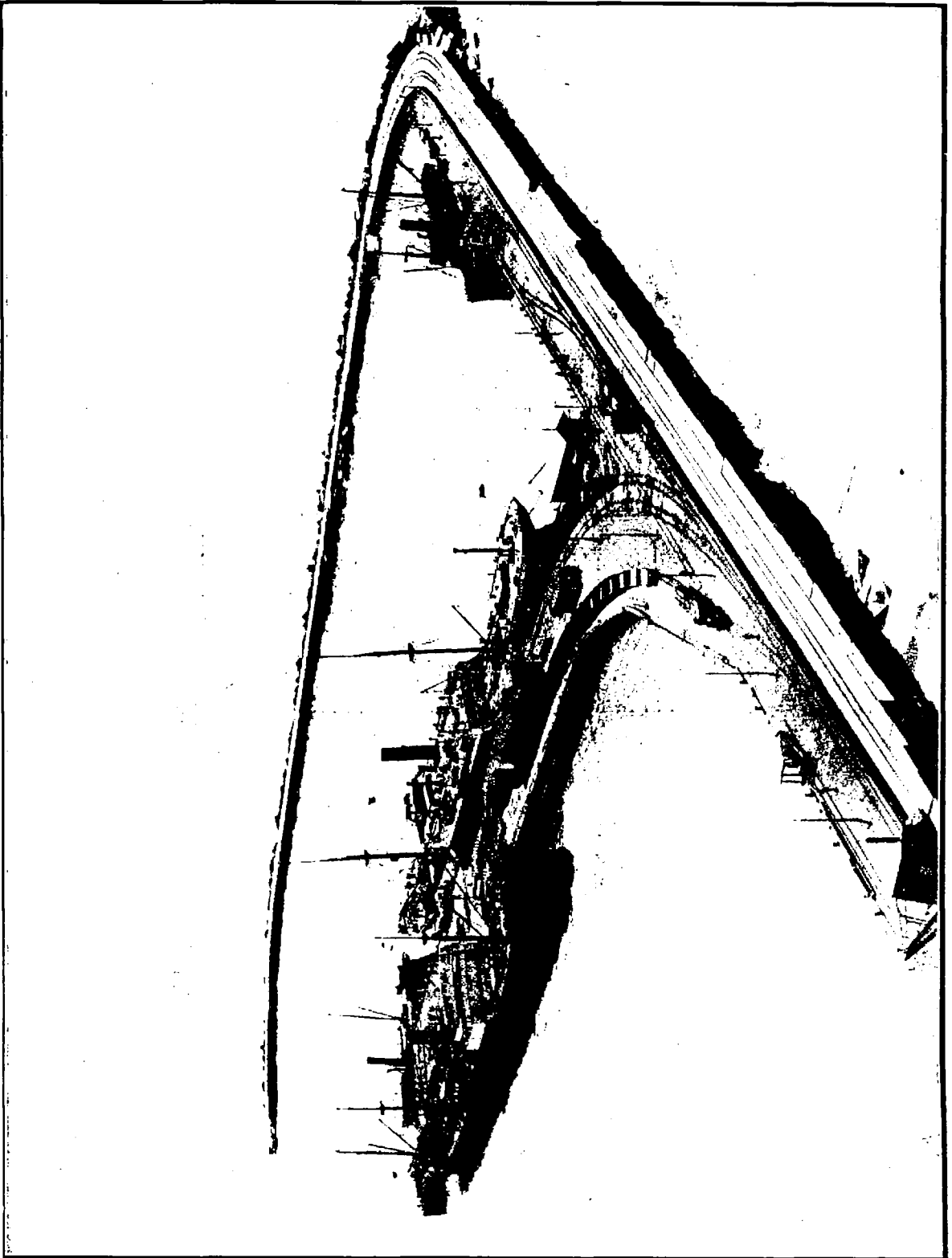
Area dredged to 34 feet in 1912 is shown
 Area that has deepened to 24 feet
 in line of Channel is shown
 Area that has deepened to 30 feet and over is shown

A. W. HOLMES & SON
 Consulting Civil & Marine
 Engineers
 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227, 229, 231, 233, 235, 237, 239, 241, 243, 245, 247, 249, 251, 253, 255, 257, 259, 261, 263, 265, 267, 269, 271, 273, 275, 277, 279, 281, 283, 285, 287, 289, 291, 293, 295, 297, 299, 301, 303, 305, 307, 309, 311, 313, 315, 317, 319, 321, 323, 325, 327, 329, 331, 333, 335, 337, 339, 341, 343, 345, 347, 349, 351, 353, 355, 357, 359, 361, 363, 365, 367, 369, 371, 373, 375, 377, 379, 381, 383, 385, 387, 389, 391, 393, 395, 397, 399, 401, 403, 405, 407, 409, 411, 413, 415, 417, 419, 421, 423, 425, 427, 429, 431, 433, 435, 437, 439, 441, 443, 445, 447, 449, 451, 453, 455, 457, 459, 461, 463, 465, 467, 469, 471, 473, 475, 477, 479, 481, 483, 485, 487, 489, 491, 493, 495, 497, 499, 501, 503, 505, 507, 509, 511, 513, 515, 517, 519, 521, 523, 525, 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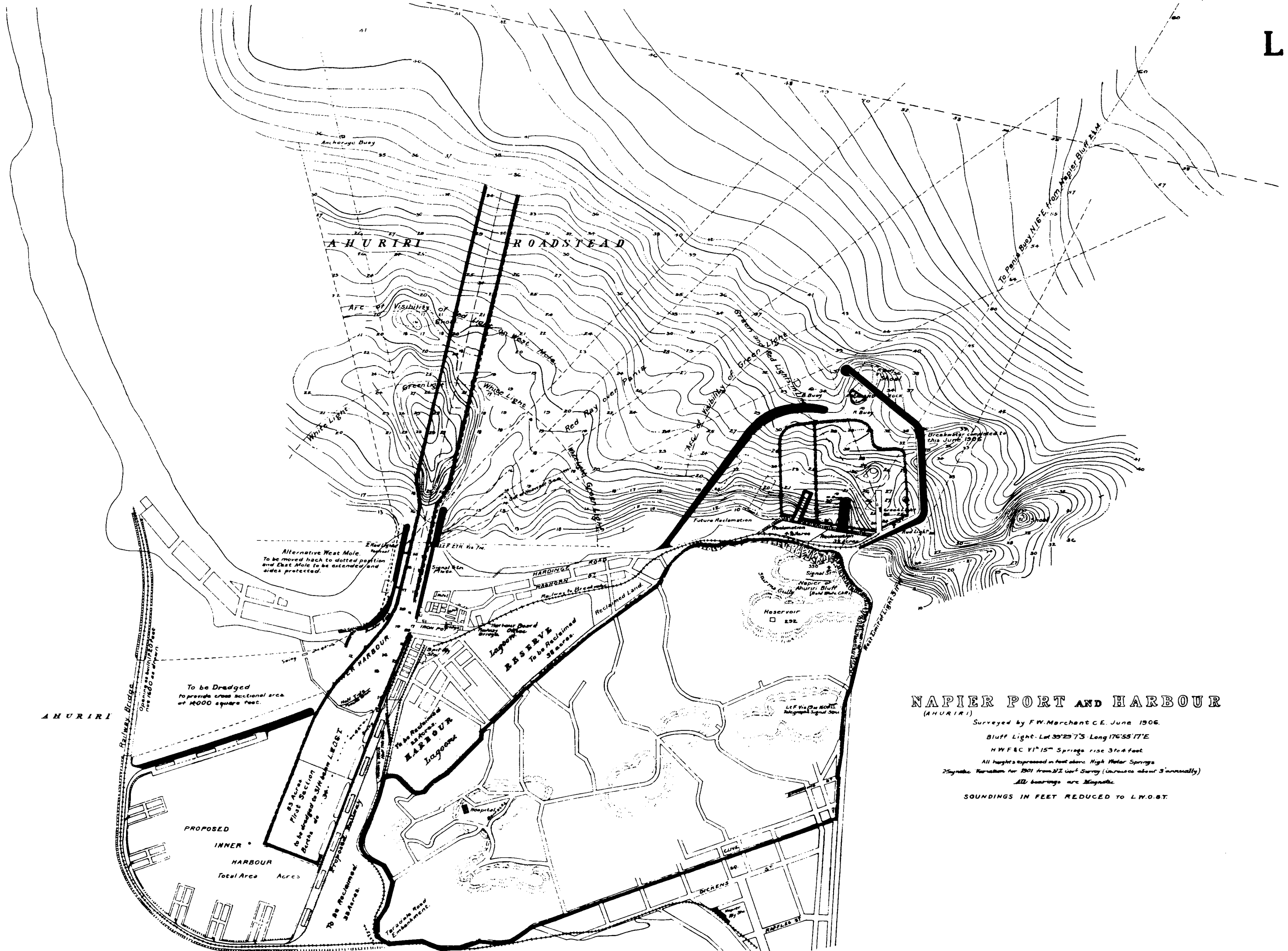


K.



NAPIER BREAKWATER, 1927.





NAPIER PORT AND HARBOUR

(AHURIRI)
 Surveyed by F.W. Marchant C.E. June 1906.
 Bluff Light - Lat 39° 25' 73" Long 176° 55' 17" E
 H.W.F.C. VI 15" Springs rise 3 to 4 feet
 All heights expressed in feet above High Water Springs
 Synthetic Variation for 1901 from N.Z. Coast Survey (increases about 3" annually)
 All bearings are Magnetic.
 SOUNDINGS IN FEET REDUCED TO L.W.O.S.T.

To be Dredged
 to provide cross sectional area
 of 14000 square feet.

83 Acres
 First Section
 15 to be dredged to 3 1/2 fathoms LEAST
 Burths do 3 1/2

RESERVE
 To be Reclaimed
 38 acres.

PROPOSED
 INNER HARBOUR
 Total Area Acres

To be Reclaimed
 38 acres.

Alternative West Mole.
 To be moved back to dotted position
 and East Mole to be extended and
 sides protected.

Future Reclamation

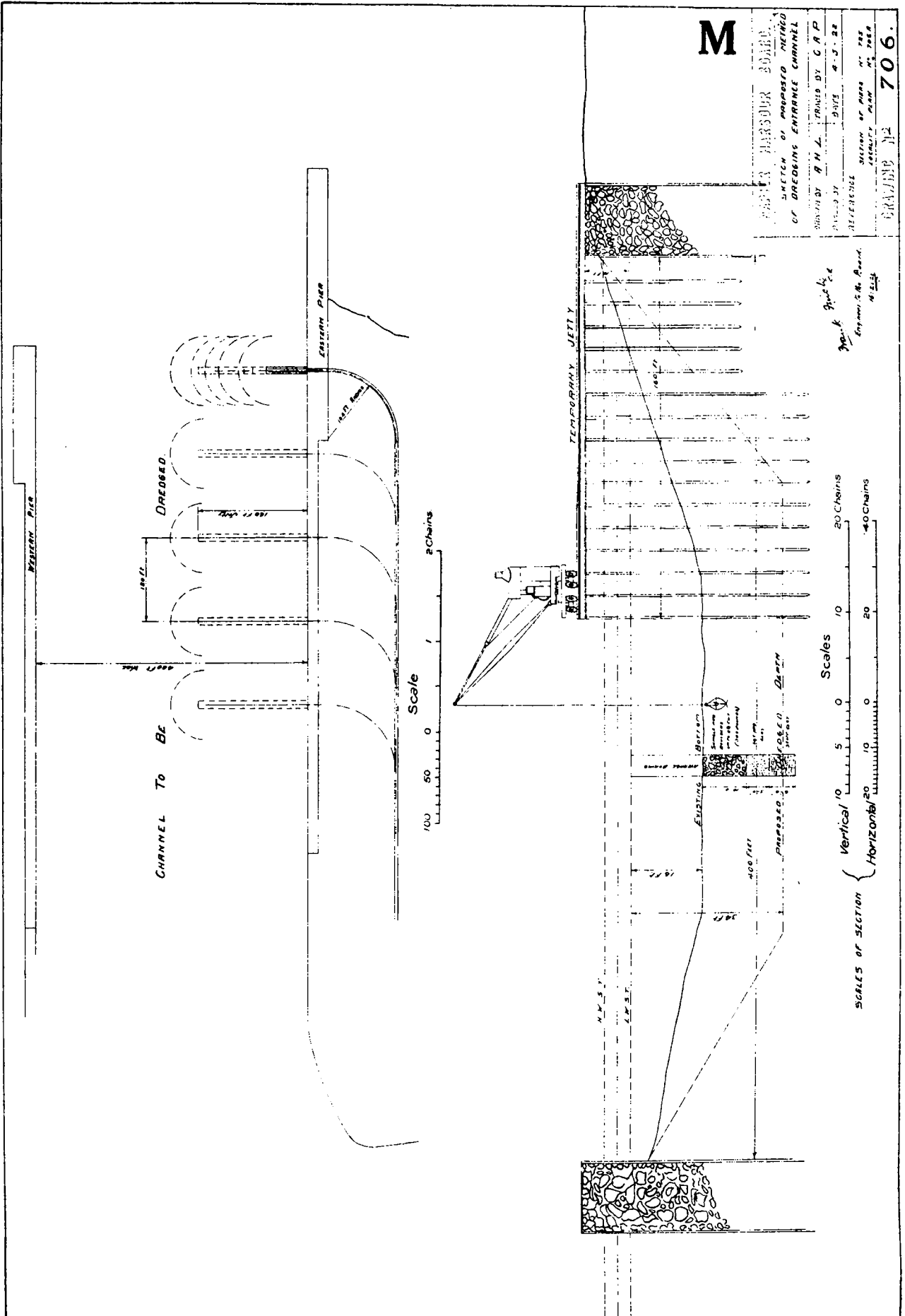
Drainage completed to
 this date 1906

Railway Bridge
 Opening 200 feet
 180 feet above water

AHURIRI

Tysons Road
 Embankment





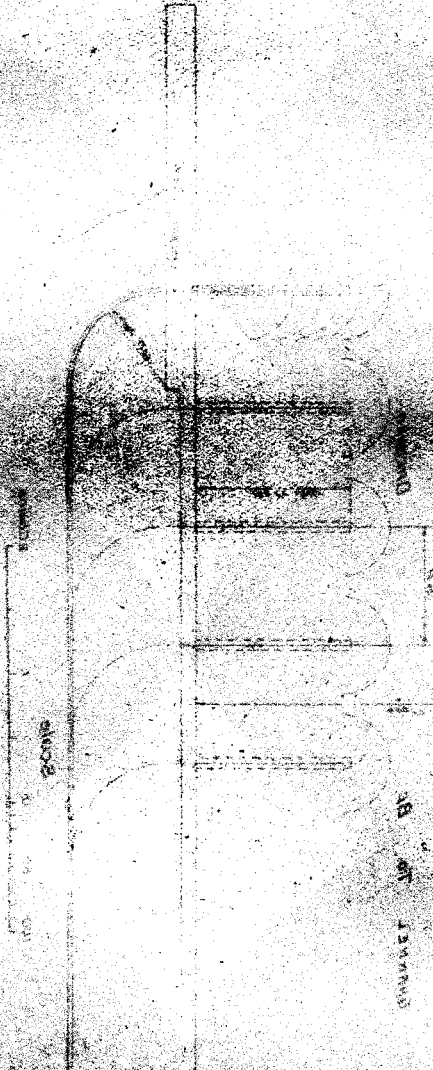
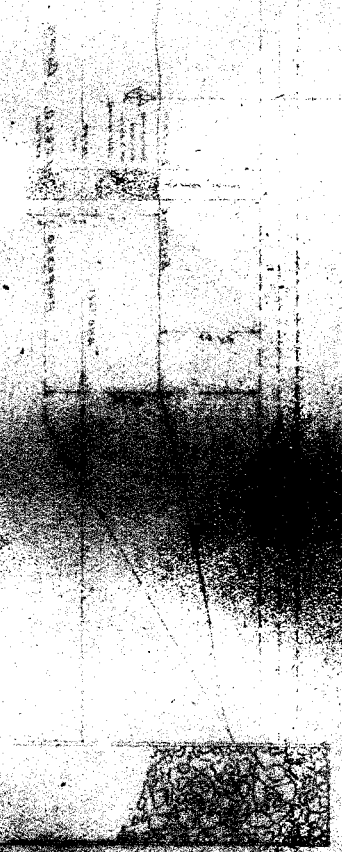
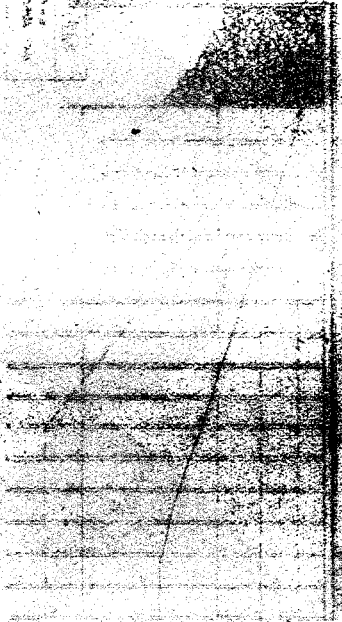
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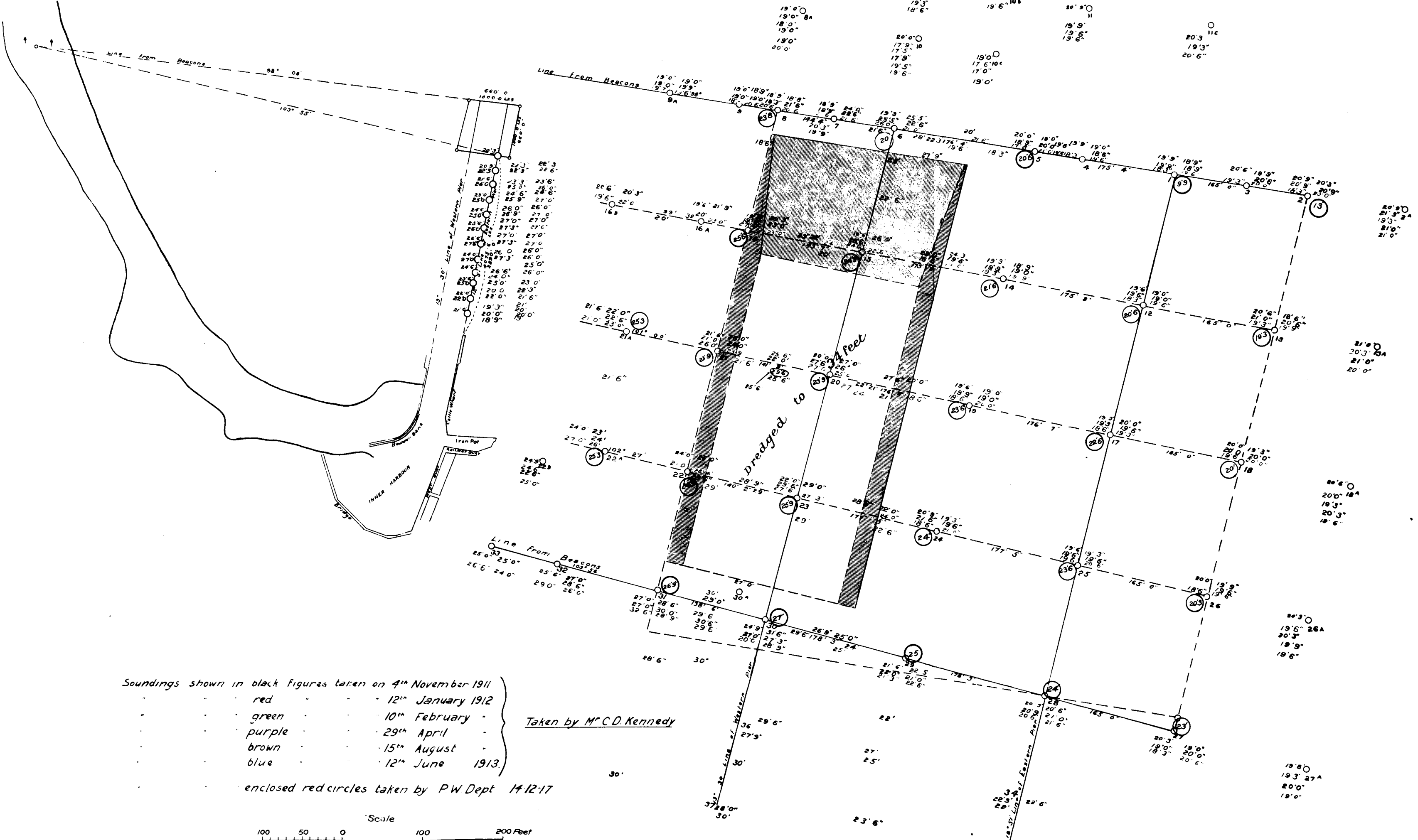
SCHEMATIC

SCHEMATIC

NAPIER HARBOUR BOARD

Soundings on 10-acre patch previous to dredging Oct 27th to Nov 4th 1911

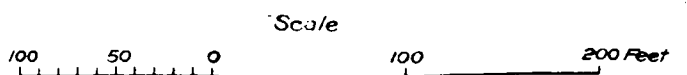
Depths as at mean low water



Soundings shown in black figures taken on 4th November 1911
 red - 12th January 1912
 green - 10th February
 purple - 29th April
 brown - 15th August
 blue - 12th June 1913

Taken by M. C. D. Kennedy

enclosed red circles taken by P.W. Dept 14.12.17



N

WALTER HARBO

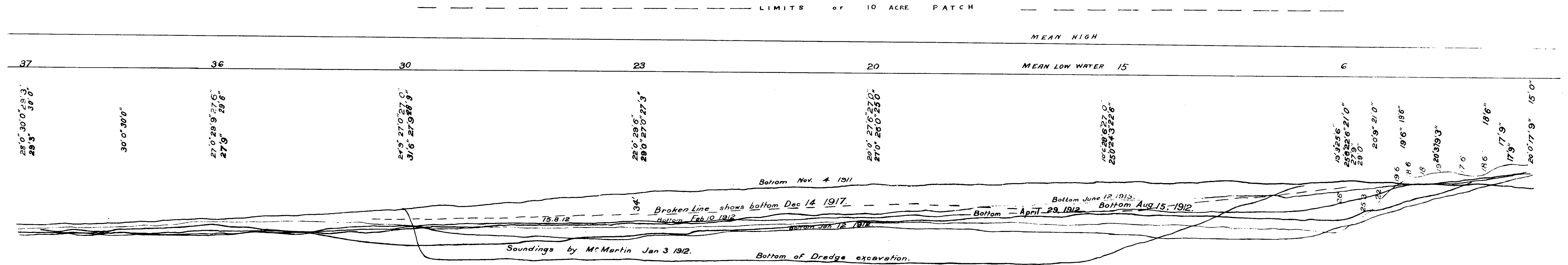
NAPIER HARBOUR BOARD

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SOUTH

Longitudinal Section through 10ac. patch (in continuation of line of Western Pier) N. + S

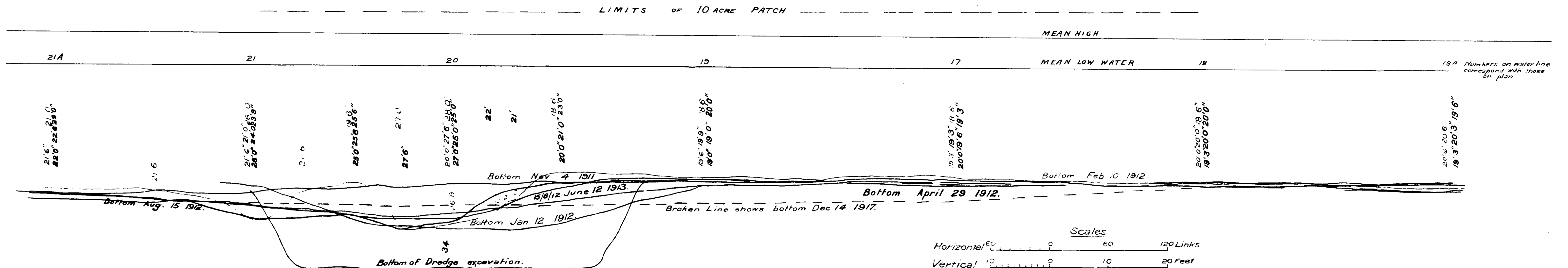
NORTH



← WEST

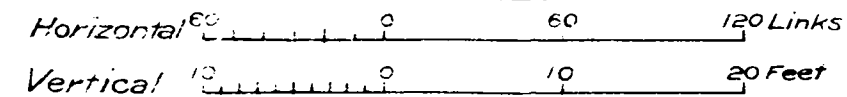
Section across centre of patch E & W

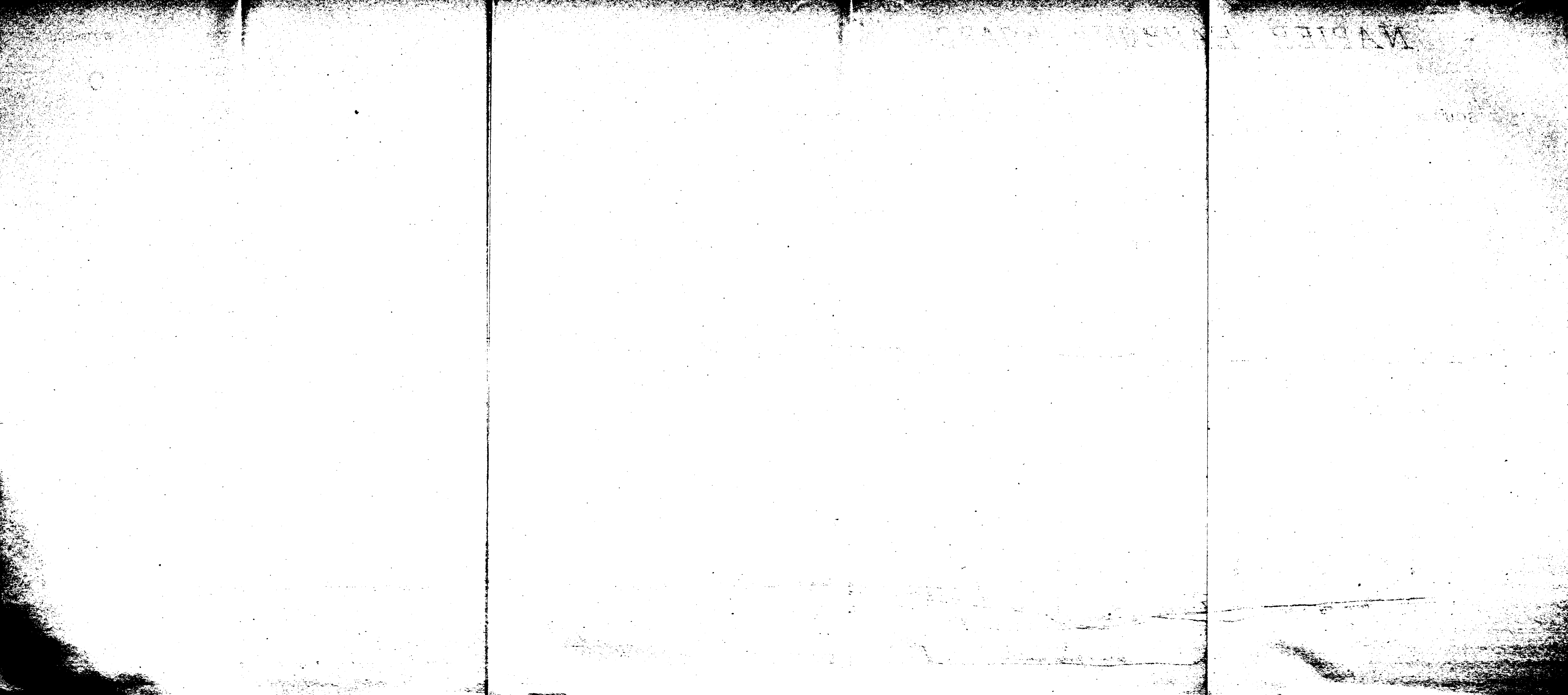
EAST →

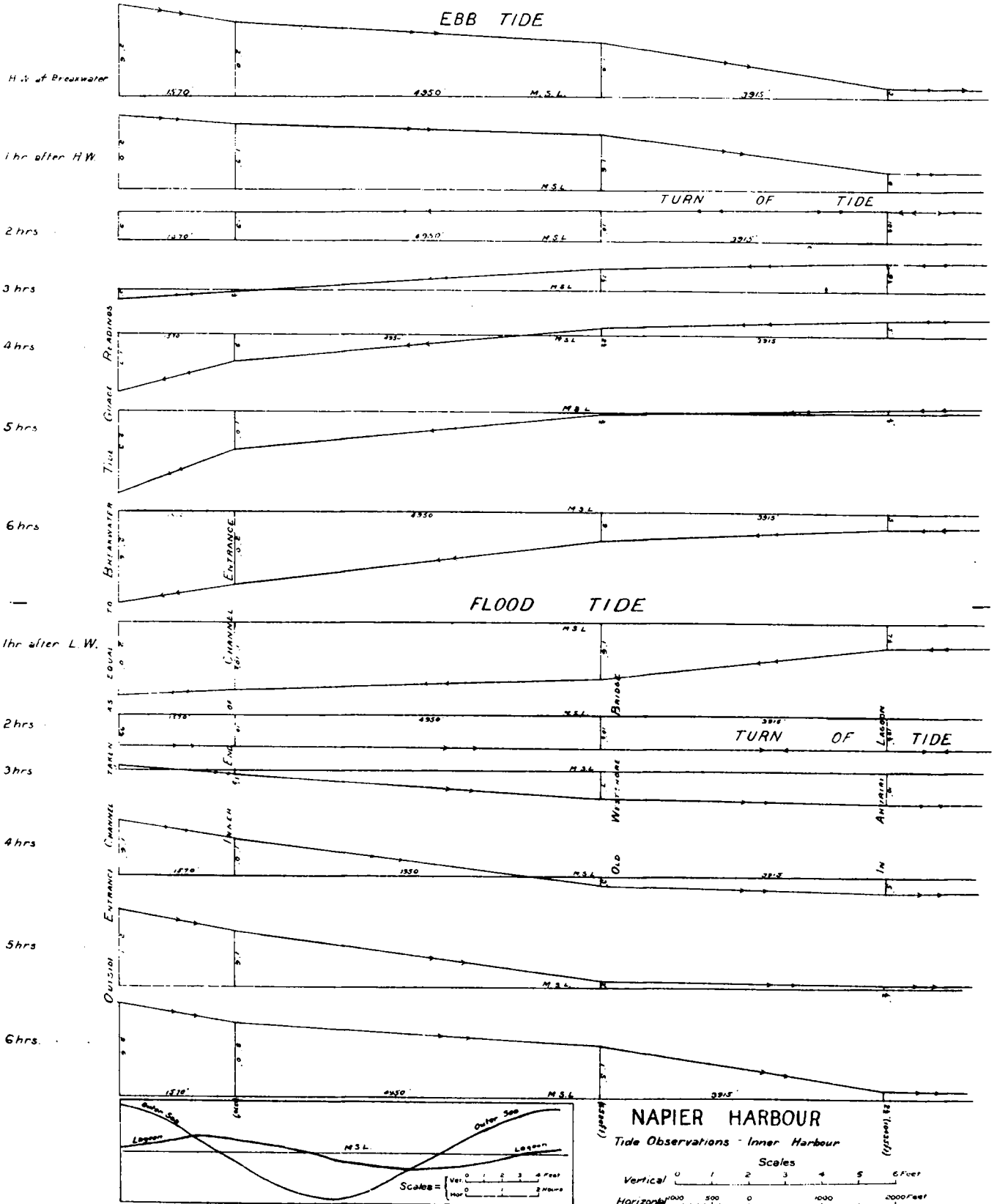


18A Numbers on water line correspond with those in plan.

Scales







B

883 TIDE

TIDE OF

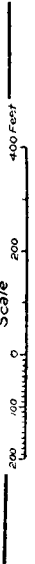
FLOOD TIDE

TIDE OF

HARBOUR - NAPIER

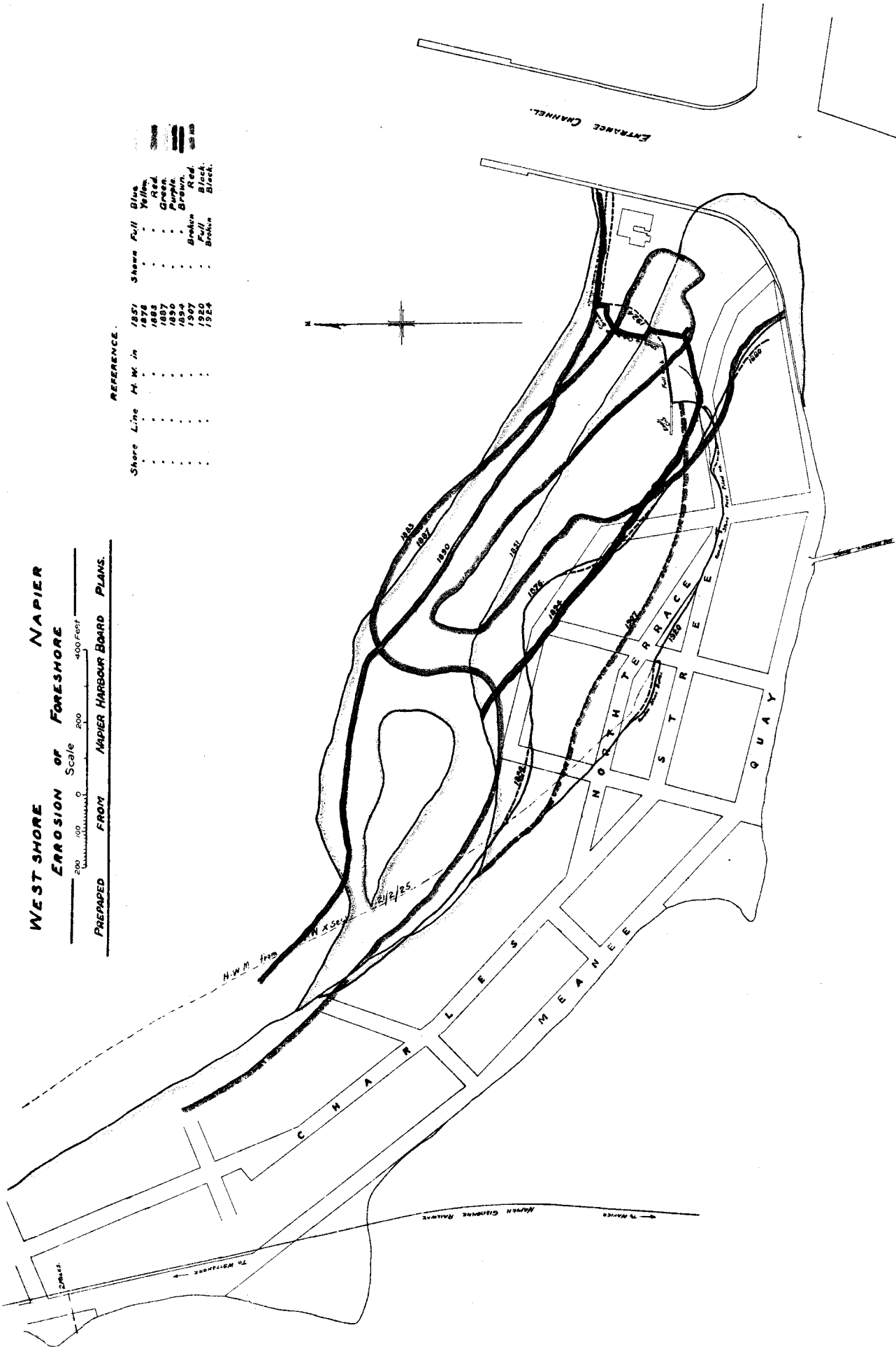


**WEST SHORE
EROSION OF FORESHORE
PREPARED FROM NAPIER HARBOUR BOARD PLANS.**



REFERENCE.

Shore Line	H. W. in	1857	1878	1887	1888	1889	1890	1897	1924	Shown Full	Blue	Yellow	Red	Green	Purple	Broken	Red	Full	Black
.....



BOARD

