
HARBOUR ENGINEER'S REPORT ON TUTICORIN
HARBOUR

HARBOUR ENGINEER'S REPORT ON TUTICORIN HARBOUR.

Letter from R. C. Baisrow, Esq., M. INST. C.E., Harbour Engineer to Government, to the Secretary to Government, Finance (Marine) Department, dated the 8th November 1922, No. M. W. 2006.

With reference to G.O. Mis. No. 282, Finance (Marine), dated the 26th July 1922, approving the expenditure of Rs. 13,000 for boring and other work at Tuticorin and in continuation of my report No. T.H. 4, dated 8th February 1921, I have now the honour to submit the following account of the work done, together with plans and estimates for the making of a deep water port at Tuticorin.

2. It may be well to refer at the outset to the steps taken prior to this report. The proposals of Messrs. Sir John Wolfe Barry and Partners were forwarded to Government on 23th February 1920. They provided for an approach channel through Hare Island with a basin inside, together with wharves, power-house, and various other works at an estimated cost of about 127 lakhs. In order to justify this expenditure, the firm considered that an increase of 40 per cent in the maximum trade of the port was necessary, together with an increase in the dues from about four annas to Rs. 1-8-0 per ton.

3. These proposals were considered in detail by the Harbour Engineer in his report above mentioned (paragraphs 26 to 31) and the opinion was expressed that owing to the general rise in prices, the estimates would have to be increased, and that additional sources of revenue would have to be found before the scheme could be regarded as financially sound. To this end, it was suggested, among other things, that one of the disabilities of Tuticorin was the absence of a through sea-passage northwards, and it was pointed out that if Tuticorin could be placed on a main ocean route as a port of call, its revenues were quite likely to increase.

4. The question of cutting the Rameswaram canal was therefore re-opened, and eventually it was agreed that an investigation should be made *de novo* into this important matter. That investigation has now been made, and is fully described in Harbour Engineer's report No. M. W. 540/22-2, dated 8th November 1922. Briefly this shows that the proposal for a canal 'qua canal' must be abandoned as financially weak, although quite feasible from an engineering point of view and practicable financially as a canal and port.

5. The investigation at Tuticorin stated in paragraphs 19 and 20 of Harbour Engineer's report No. T.H. 4/21 of 8th February 1921 to be essential before a firm estimate could be made for the dredging of the approach channel and basin, has now been completed. It confirms the view previously expressed that the dredging conditions at Tuticorin are rather difficult, hard coral and rock existing in varying thicknesses and at varying depths over the whole of the area through which an approach channel and basin might conceivably be excavated.

6. On preparing estimates for the work on the lines of the Wolfe Barry report which recommended a scheme similar in all essentials to one of the alternatives put up by the Port Conservancy Board for their consideration, it was found that the cost would be Rs. 87 lakhs for the dredging and contingent items only, or 93 lakhs for a slightly different scheme put up to the *Ad Hoc* Committee at a roughly estimated cost of 90 lakhs.

7. The importance of the canal investigation is apparent at this point. Had the canal scheme been found practicable, it might have been possible to justify such a scheme for Tuticorin by reckoning on a material increase in shipping, but no such help from other sources is now seen to be possible, and Tuticorin cannot rely on developing more traffic than the old pre-war tonnage, at least for many years and until after the harbour is made. The tonnage in 1920-21 was about 300,000. In the best pre-war year it was about 416,000. These figures with a small increase in dues—all that the port is inclined to agree to—justify a loan of 40 or 50 lakhs.

(Note.—This part of the report is fully dealt with later.)

8. It was therefore decided to abandon as impracticable all previous proposals for Tuticorin, to examine the new evidence of borings, current observations, etc., and from these to ascertain if any other scheme was possible. The lines of investigation and reasoning were all very similar to those used in the examination of the Rameswaram project which has been of the greatest assistance in this respect, and it will be necessary only to state the results arrived at. These are as follows.

9. *Approach channel.*—As the maximum 'swell' of sea is only four feet instead of six feet as at Rameswaram, the depth is reduced from 31 to 30 feet, made up as follows:—

Draught 26 feet; downward movement of swell 2 feet; clearance 2 feet; total depth at low water 30 feet. Width of channel, say, 400 feet, narrowing to 300 feet at the shore.

10. *Currents.*—Littoral currents were found not to exceed 3 of a knot—a practically negligible quantity.

11. *Erosion and accretion.*—There is no evidence of either, the whole of Hare Island being protected by a wide coral reef at low water level.

12. *Wind, etc.*—Weather charts are enclosed which show the local conditions.

13. From the above evidence it was clear that there could be no objection to the proposal to cut the approach channel at right angles to the littoral and the borings showed that there was less hard material in the position previously chosen through the centre of Hare Island than anywhere else—vide the complete boring plan No. 4 attached.

14. It was at this point that a comparison with the Rameswaram Canal scheme was made, with a view to ascertaining why, for much less length of excavation, the cost at Tuticorin should be approximately the same. The reason at once became obvious, viz., that whereas at least half the total length of the Rameswaram scheme consists of a narrow land-locked canal, it has always been proposed at Tuticorin to continue the wide approach channel across the whole width of the shallow reef and through Hare Island into the harbour area behind.

15. On consideration it was clear that the familiar expression about 'getting the ships into the harbour' was not applicable to Tuticorin. There was no need to make a wide approach channel, and then to dredge at great cost a large area between Hare Island and the mainland. *It was only necessary, as at Rameswaram, to make a narrow land-locked canal through the reef and Island with sidings for vessels to lie in, and with a small but sufficient turning basin at the western extremity.* If and when required the railway could easily be brought to the banks of the canal; and meanwhile, vessels could unload direct into boats lying alongside either in the canal or turning basin.

16. This solution is at once so simple and convincing that it seems strange it has not been discovered before. Really, however, it is very natural to think of the water area behind Hare Island as the 'Harbour', in the same sense that the Backwaters at Cochin constitute the Harbour there, and to regard the dredging of an approach channel as the first essential towards the realization of this interior harbour. The fact is that the conditions at Hare Island and Tuticorin are uncommon, and the mistake was made in the first instance of applying a conventional remedy before the case was fully diagnosed.

17. Drawing No. 1 may be referred to here. It shows the old scheme for Tuticorin in green, the Rameswaram Canal scheme in yellow plotted to the same scale to show its relative length, and the new proposals for Tuticorin in red. It will be seen (1) how similar to the north end of Rameswaram the conditions are at Tuticorin and (2) what an enormous saving in excavation must result from the latest proposals.

18. These proposals may be divided into three parts as follows:—

Part 1.—The dredging of an approach channel 30 feet deep at L.W.O.S.T. up to the edge of the coral reef—about three-fourths mile east of Hare Island. The average depth of water is not about 24 feet over this line and the dredging will be in sand, mud, coral and rock. The work to be done by a bucket dredger.

Part 2.—The excavation by grabs or other means of a canal from east to west across the reef, about a mile long by 90 feet wide at bottom and 30 feet deep at L.W.O.S.T. The excavation of two sidings for vessels each 700 feet long, one on each side of the canal at its western end—Material as in part 1. The construction of one and perhaps two rubble breakwaters at the canal entrance.

Note.—The width available in this canal for tugs or other vessels drawing, say, 8 feet would be 186 feet.

Part 3.—The dredging or excavation by grabs or other means of a turning basin 1,000 feet square or thereabouts beyond the western extremity of the canal with banks on the north and south sides at which two more vessels can lie—Material as in part 1. This turning basin would be enclosed on three sides by banks and even without tugs, vessels could turn by running out ropes ashore to bollards, and using their own winches. If, however, other vessels were lying alongside, a tug would be necessary, and suitable private craft are already available at the port.

19. In part 1 the material can be deposited at sea. In parts 2 and 3 it is required to form a reclamation on each side of the canal. All three parts may be proceeded with simultaneously; and if labour at a very cheap rate is available, e.g., Mappilla prisoners, parts 2 and 3 can be done by hand labour, at least in part.

20. The work will be hard and heavy throughout, necessitating considerable resource and careful supervision. Apart from the difficulties of actual construction, however, no complications are anticipated, and subsequent maintenance in respect of silting, etc., is likely to be moderate.

21. The estimate for the scheme works out to 40 lakhs:—

Part 1—Dredging and depositing at sea.

Item.		Rs.
1	236,804 cubic yards—sand, mud, etc., at As. 12 per cubic yard	1,77,603
2	58,333 cubic yards—soft coral and rock, at Re. 1	58,333
3	58,333 cubic yards—hard coral and rock, at Rs. 1-8-0 ..	87,500
4	218,749 cubic yards—very hard coral and rock, at Rs. 2 ..	4,37,498

Parts 2 and 3—Excavation by grabs and placing on reclamation areas.

5	1,378,800 cubic yards—sand, mud, etc., at As. 9 ..	7,75,575
6	99,500 cubic yards—soft coral and rock, at Re. 1 ..	99,500
7	135,500 cubic yards—hard coral and rock, at Re. 1-8-0 ..	2,03,250
8	197,100 cubic yards—very hard coral and rock, at Rs. 2 ..	3,94,200
9	7,000 units labour only forming retaining walls for spoil, at Rs. 10	70,000
10	2,040 units labour only forming breakwaters, at Rs. 8 ..	16,320
11	4,000 units labour only forming embankment from mainland, at Rs. 10	40,000
12	Camp for 1,000 workmen at Hare Island	30,000
13	Accommodation for staff	49,000

24,38,779

10 per cent contingencies 2,43,878
(This will include planting the banks of the canal if found necessary.)

14 *Note.*—The prices for dredging are those at which it is considered the "Manar" may do the work. As part of it may have to be done by contract and a dredger brought out from home, it is necessary to allow a lump sum to cover the extra cost involved, say 5,00,000

Tools and plant, etc.

	RS.
15 Lengthening ladder of dredger "Manar" to dredge to 27 feet below water	33,000
16 Pumps and boilers	16,000
17 Crowbars and excavation tools	4,000
18 Blasting apparatus and shed for explosives	2,000
19 Grab cranes, lifting and hauling gear	3,00,000
20 Railway track, trucks, etc.	50,000
21 Blacksmith shop for sharpening tools, forge, anvil, etc.	5,000
22 Miscellaneous	25,000
	4,35,000
Total ..	36,17,657
Proportion of Harbour Engineer's staff for five years ..	3,50,000
Grand total ..	39,67,657

23 Add for dolphins for berthing ships and say, 40 lakhs.

It has now to be seen how the cost can be met, and the attached diagram * shows the trade tonnage figures since 1906-07. It will be seen that prior to the war the tonnage rose to 416,754; that it then declined to 276,741 in 1918-19, and has since increased to 300,252 in 1920-21 and to 325,000 approximately in 1921-22. At the same rate of increase the tonnage would get back to its pre-war level in about 1926-27.

22. Assuming that the scheme is approved and commenced in 1922-23, the tonnage which might be adopted for estimate purposes would therefore be (vide chart *)—

1922-23	345,000	1925-26	395,000
1923-24	365,000	1926-27	400,000
1924-25	385,000	1927-28	400,000

23. Assuming also that in these six years the dues were gradually raised, the income from tonnage would be—

Tonnage.	Dues per ton.	Amount.
		RS.
1922-23	As. 4½ to 6	1,15,000
1923-24	„ 8	1,82,500
1924-25	„ 9	2,16,562
1925-26	„ 10	2,46,875
1926-27	„ 12	3,00,000
1927-28	Rs. 1	4,00,000

24. It will be noted that the above increases in dues are *very* moderate. A rate of 10 annas, which is already in force at Negapatam, Cuddalore and Mandapam, is not reached until 1925-26, and a rate of one rupee, which is already in force at Cochin, is not reached until 1927-28. The rate apparently need not rise above one rupee which is *only half* the approximate figure at Madras.

* Not printed.

25. In addition to tonnage dues, however, and apart from the Port dues which support the Minor Ports Fund, the Port derives income under the following heads:—

Crane receipts, Ground-rents, Miscellaneous receipts, etc.

26. In the years 1918-19 to 1920-21 these sub-heads gave additional revenue as follows:—

1918-19.	1919-20.	1920-21.
RS.	RS.	RS.
8,389	17,768	19,695*

27. It is difficult to estimate what increase in these figures, if any, is likely to arise. In Madras, revenue from the same auxiliary sources amounts to about 50 per cent of the income derived from tonnage dues. At Tuticorin it is exceedingly probable that the receipts for rent on land alone will increase very largely as the work proceeds. The Port owns a great deal of land—practically the whole of Hare Island and the adjoining ground and that part of it alongside the canal should fetch a very good price.

Allowing moderate increases, however, and reckoning also shed rent which is now credited to the Port Conservancy Board, assume the following totals for 'auxiliaries':—

1922-1923.	1923-1924.	1924-1925.	1925-1926.	1926-1927.	1927-1928.
RS.	RS.	RS.	RS.	RS.	RS.
30,000	40,000	40,000	60,000	70,000	80,000

28. So that the total revenue from all sources would be (paragraphs 23 and 27)—

1922-1923.	1923-1924.	1924-1925.	1925-1926.	1926-1927.	1927-1928.
RS.	RS.	RS.	RS.	RS.	RS.
1,15,000 30,000	1,82,500 40,000	2,16,562 40,000	2,46,875 60,000	3,00,000 70,000	4,00,000 80,000
1,45,000	2,22,500	2,56,562	3,06,875	3,70,000	4,80,000

29. From these total figures must be deducted sums to pay for the working expenses of the Port,—repairs and maintenance, minor new works, etc. From 1918-19 to 1921-22 these averaged Rs. 65,000. Allowing for a necessary increase—

1922-1923.	1923-1924.	1924-1925.	1925-1926.	1926-1927.	1927-1928.
RS.	RS.	RS.	RS.	RS.	RS.
1,00,000	1,00,000	1,10,000	1,20,000	1,30,000	1,40,000

30. The net revenue after paying all expenses would be, therefore,—

	1922-1923.	1923-1924.	1924-1925.	1925-1926.	1926-1927.	1927-1928.
	RS.	RS.	RS.	RS.	RS.	RS.
Paragraph 28	1,45,000	2,22,500	2,56,562	3,06,875	3,70,000	4,80,000
Minus.						
Paragraph 29	1,00,000	1,00,000	1,10,000	1,20,000	1,30,000	1,40,000
Total ..	45,000	1,22,500	1,46,562	1,86,875	2,40,000	3,40,000

* Excluding extraordinary items such as Manar's lay-up charges refunded by the Minor Ports Fund and ground-rent on cast-iron pipes landed for the Madura Municipality, both of which aggregated Rs. 42,870 and odd.

31. Comparing now these figures with the amount required yearly to carry on the work, assuming loan at $6\frac{1}{2}$ per cent over 25 years, or say, 8 per cent for sinking fund and interest—

(For further information on this point see Appendix No. 2.)

Year.	Estimated expenditure.	Amount required for sinking fund and interest at 8 per cent.	Add for previous year's loans for this work.	Total outgoings for loan.	Amount available to meet loan (paragraph 30).	Surplus carried forward to 'amount available.'
1922-1923	LAKHS. 1.50 Depends upon starting in December 1922 at latest.	RS. 12,000	RS. ..	RS. 12,000	RS. 45,000	RS. 33,000
1923-1924	6.00	48,000	12,000	60,000	1,22,500 33,000	95,500
1924-1925	8.00	64,000	60,000	1,24,000	1,55,500 1,46,562 95,500	1,18,062
1925-1926	10.00	80,000	1,24,000	2,04,000	2,42,062 1,86,875 1,18,062	1,00,937
1926-1927	10.00	80,000	2,04,000	2,84,000	3,04,937 2,40,000 1,00,937	56,937
1927-1928	4.50	36,000	2,84,000	3,20,000	3,40,937 3,40,000 56,937	76,937
Totals, five years ..	40	3,20,000	..	..	3,96,937	..

32. It may be noted that although it would be quite possible to finish the work in less time than five years, the setting of a moderate pace suits the financial resources best, unless indeed the Port Conservancy Board were to adopt a more progressive policy and raise the dues to Re. 1 per ton forthwith as was done at Cochin as soon as something definite was decided upon.

33. In the above analysis it has been considered advisable to err on the side of safety, if at all, and even on this basis there appears to be conclusive evidence as to the soundness of the financial position at Tuticorin should it be decided to proceed with the scheme any further. In this respect it may be observed that a loan of $2\frac{1}{2}$ lakhs has been provided in this year's budget, of which, however, only $1\frac{1}{2}$ lakhs could now be spent.

34. The proposals put forward herein alter so completely the whole aspect of the case at Tuticorin that the plans and estimates previously asked for in respect of a shallow water scheme of development on the existing port frontage should, in my opinion, be regarded as cancelled, at least until a decision is reached on the deep-water project.

NOTE.—Figures of tonnage for past years are those provided by the Port Officer for the use of the *Ad Hoc* Committee at Tuticorin.

Figures of revenue and expenditure for past years are taken from the budget of the Port Conservancy Board for 1922-1923.

APPENDIX 1.

Explanation of drawings accompanying this report.

Drawing No. 1.—As stated in paragraph 17 of report, this is intended to show the relative sizes of the various schemes which have been under consideration in regard to Rameswaram and Tuticorin.

The reduction in the amount of dredging at Tuticorin is especially valuable owing to the amount of hard rock which is likely to be encountered.

The Wolfe Barry scheme is not shown precisely on the line recommended by the firm, but as overlapping the scheme now recommended, for the purpose merely of facilitating comparison.

It may be noted, as a matter of interest, that it was the previous consideration of the approach channel and opening of canal on the north side at Rameswaram which suggested the possibility of applying the canal idea in the case of Tuticorin also.

Drawing No. 2.—Details of proposals.

There is nothing that is not self-explanatory in this drawing.

Drawing No. 3.—Meteorological chart.

Previous to the investigation made by the Harbour Engineer there were no official records kept at Tuticorin. The chart is somewhat incomplete owing to delays and difficulties in getting the system in good working order.

Drawing No. 4.—Boring sections.

This shows the various materials to be encountered. The sections are plotted on zigzag lines in order to give a more adequate conception of the material throughout the area covered.

Drawing No. 5.—This is specially made in order to show at a glance the areas in which the dredging of hard and very hard material is likely to be least. It will be seen that the line proposed is in the most advantageous position in this respect.

Drawing No. 6.—The plotting of borings in this way led to the idea that the excavation of the large turning basin might be more economically carried out in this alternative position. It is proposed, however, to cut the canal first and then decide from the experience gained where the turning basin should go.

APPENDIX 2.

The fixing of a rate of interest to cover liquidation of loan over a period of years is difficult to arrive at exactly owing to the fact that the market value of money may change from year to year.

2. Although, for example, the rate of interest is at present, say, six and a half per cent., it is more than possible that in two or three years' time it may be down to five and a half per cent or even lower.

3. It follows therefore that the liability for loan from year to year will vary both on account of the amount of loan, the period allowed for liquidation and the rate of interest.

4. A few examples may be given. The percentage of loan for providing for sinking fund and interest over a period of twenty years is—(vide chart * herewith).

Interest at	Per cent. 3	Per cent. 4	Per cent. 5	Per cent. 6	Per cent. $6\frac{1}{2}$	Per cent. 7
	6.72	7.36	8.02	8.7	9.06	9.41

For the same over a period of 25 years, at the same rates of interest:—

	5.74	6.40	7.09	7.86	8.25	approximately, 8.67
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For the same over a period of 30 years—

	5.10	5.78	6.50	7.31	7.77	8.21
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5. If, therefore, it became necessary to borrow money always at $6\frac{1}{2}$ per cent and to liquidate in twenty years, a rate of sinking fund and interest of 9.06 per cent would have to be paid. If for 25 years' period, the rate would be $8\frac{1}{4}$ per cent and for 30 years 7.77 per cent. These figures are a close approximation without going into very close mathematical details and are taken from actual tables in Hurst's Handbook.

6. It is more probable, however, that the loan could be got at, say, $6\frac{1}{4}$ per cent, $6\frac{1}{2}$ per cent, 6 per cent, 5 per cent, 5 per cent or an average of, say, 6 per cent, over the whole period of construction.

7. Six per cent *plus* sinking fund over a liquidation period of twenty years gives 8.7 per cent; over twenty-five years, 7.86 per cent; and over thirty years, 7.31 per cent.

8. The approximation of 8 per cent for sinking fund and interest is therefore considered sound for estimating purposes, as it is presumed that for a work so important in the national interest, Government would lend money at least for twenty-five years.

* Not printed.

WORKS.

COMPLEMENTATIVE PLAN.

Vide Para 10 Harbour Engineer's Report No 2006/22 Dtd 8th Nov:22.

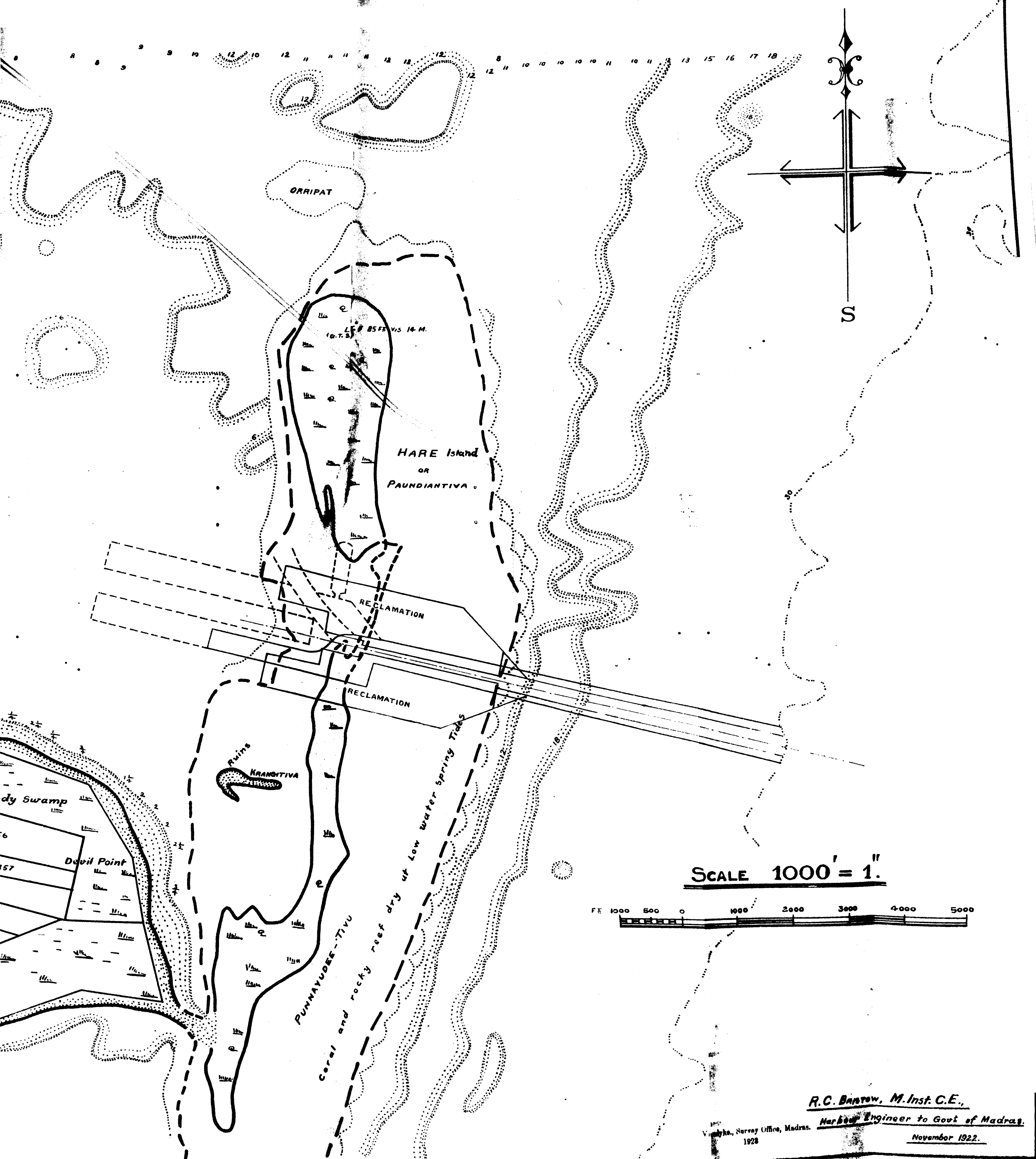
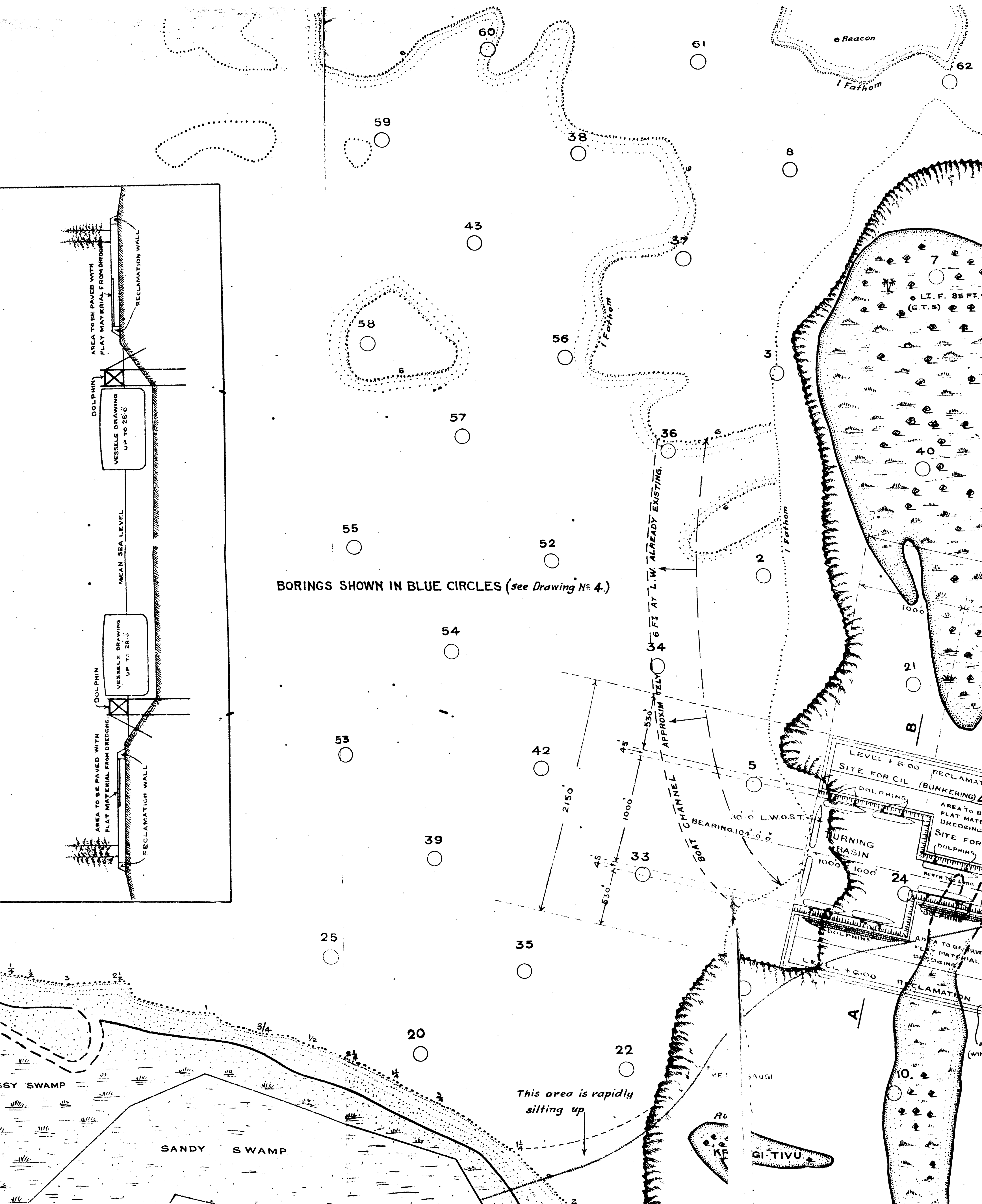
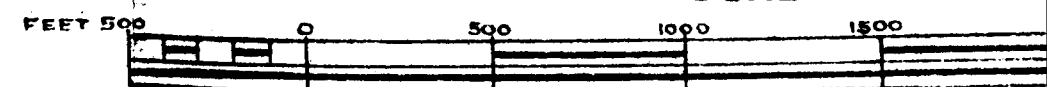


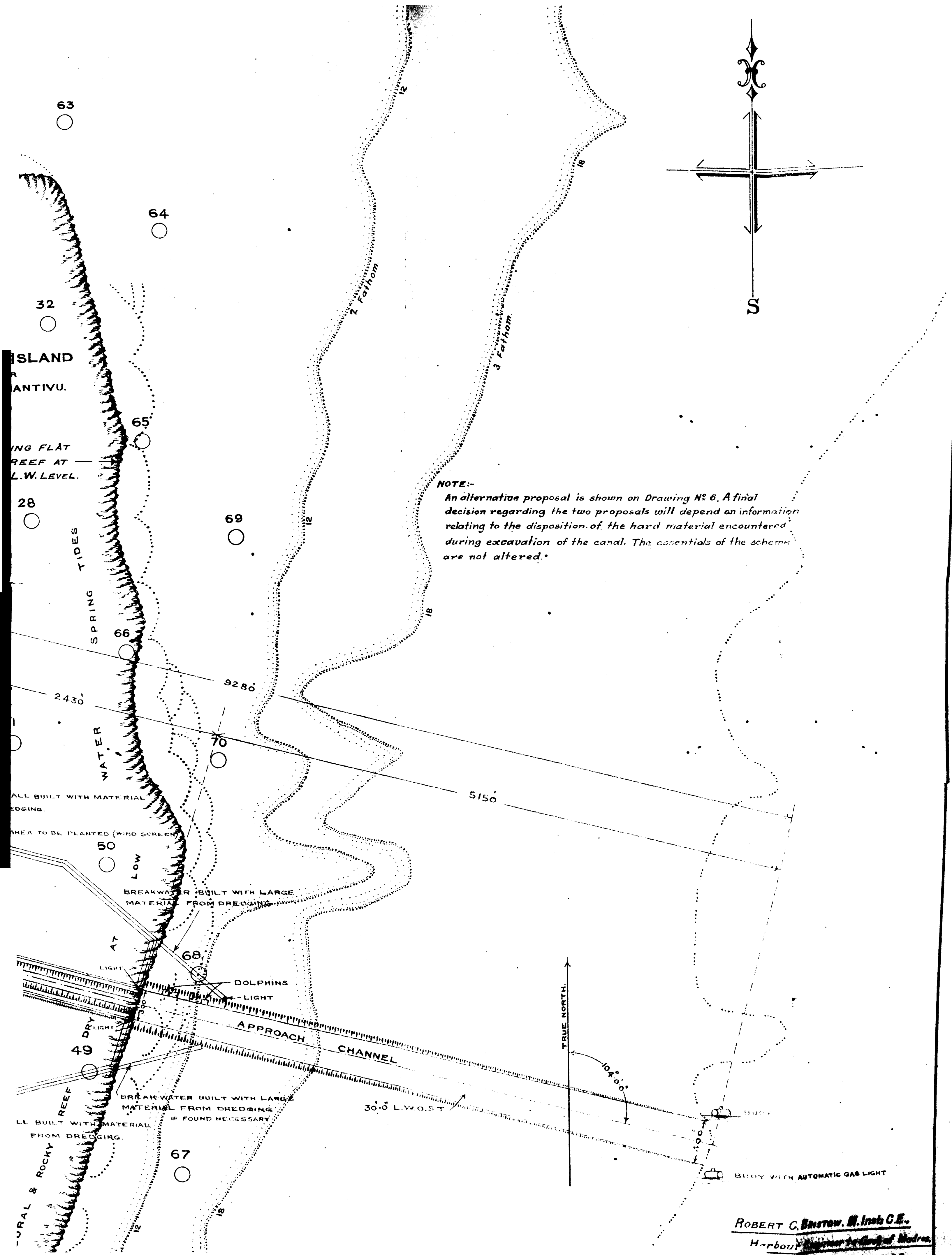


FIG. 1. RIN HAF

DETAILS OF

SCALE 500 FT.

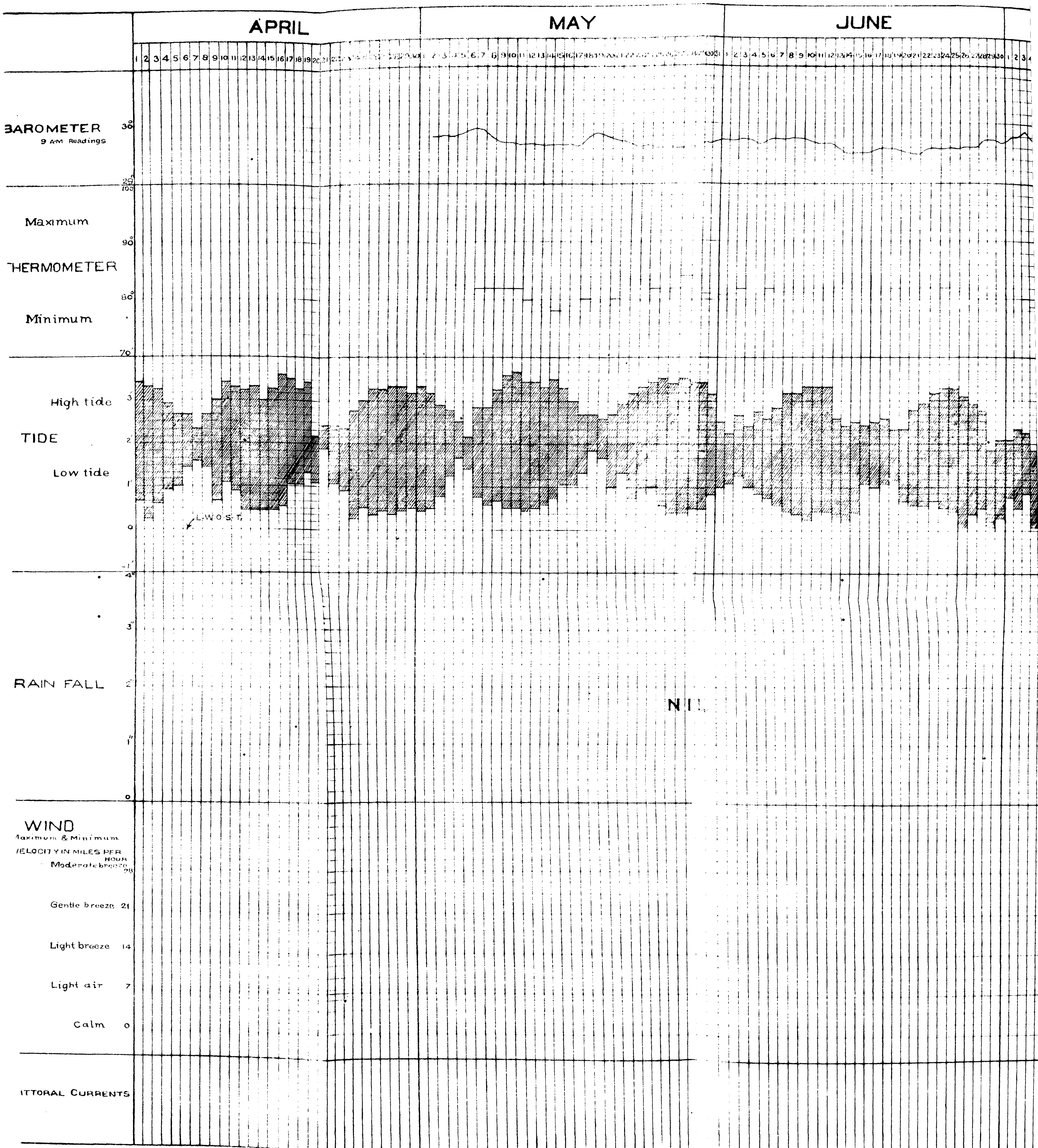


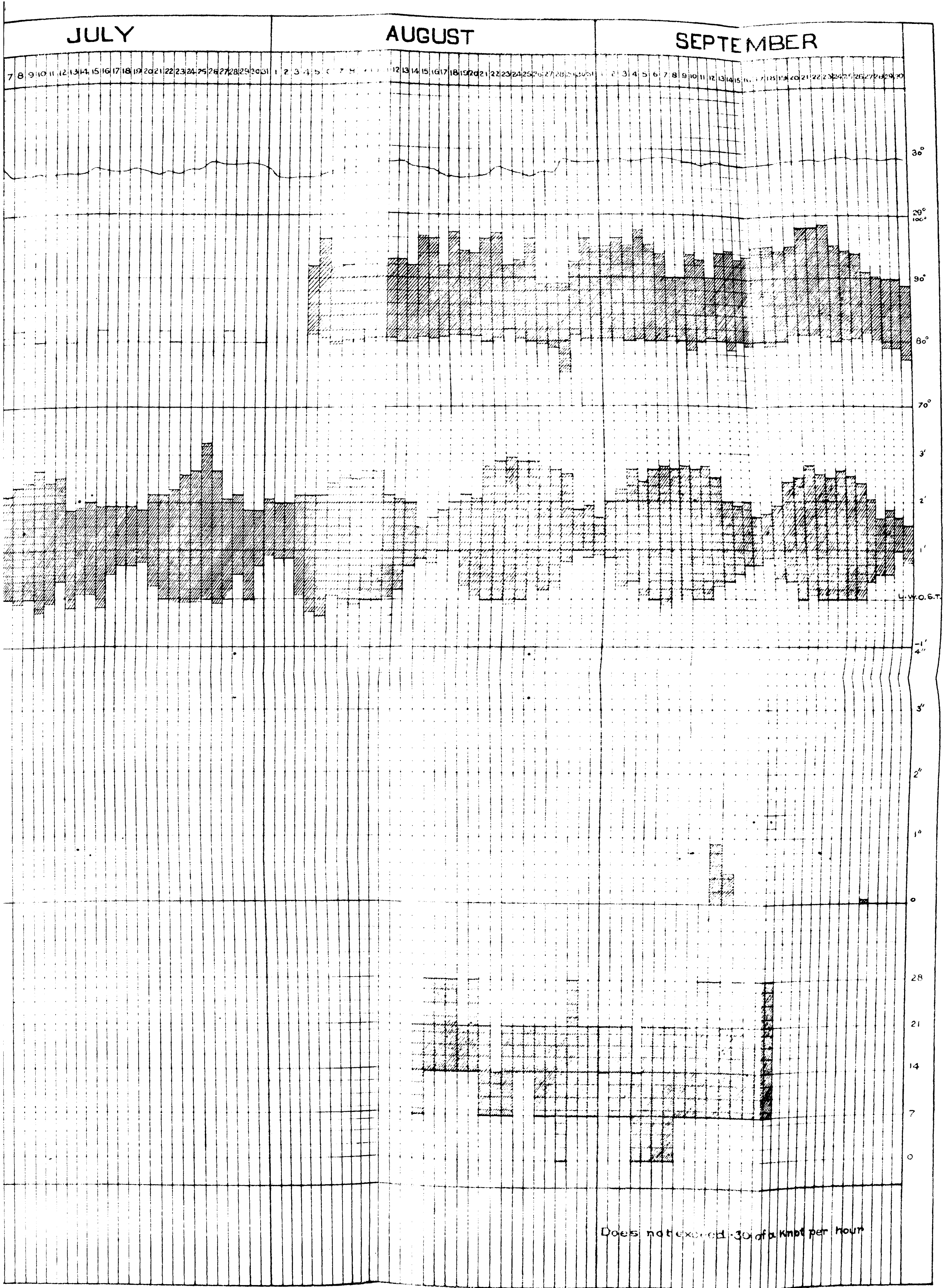


TUTICORIN HARBOUR PROJECT

METEOROLOGICAL CHART

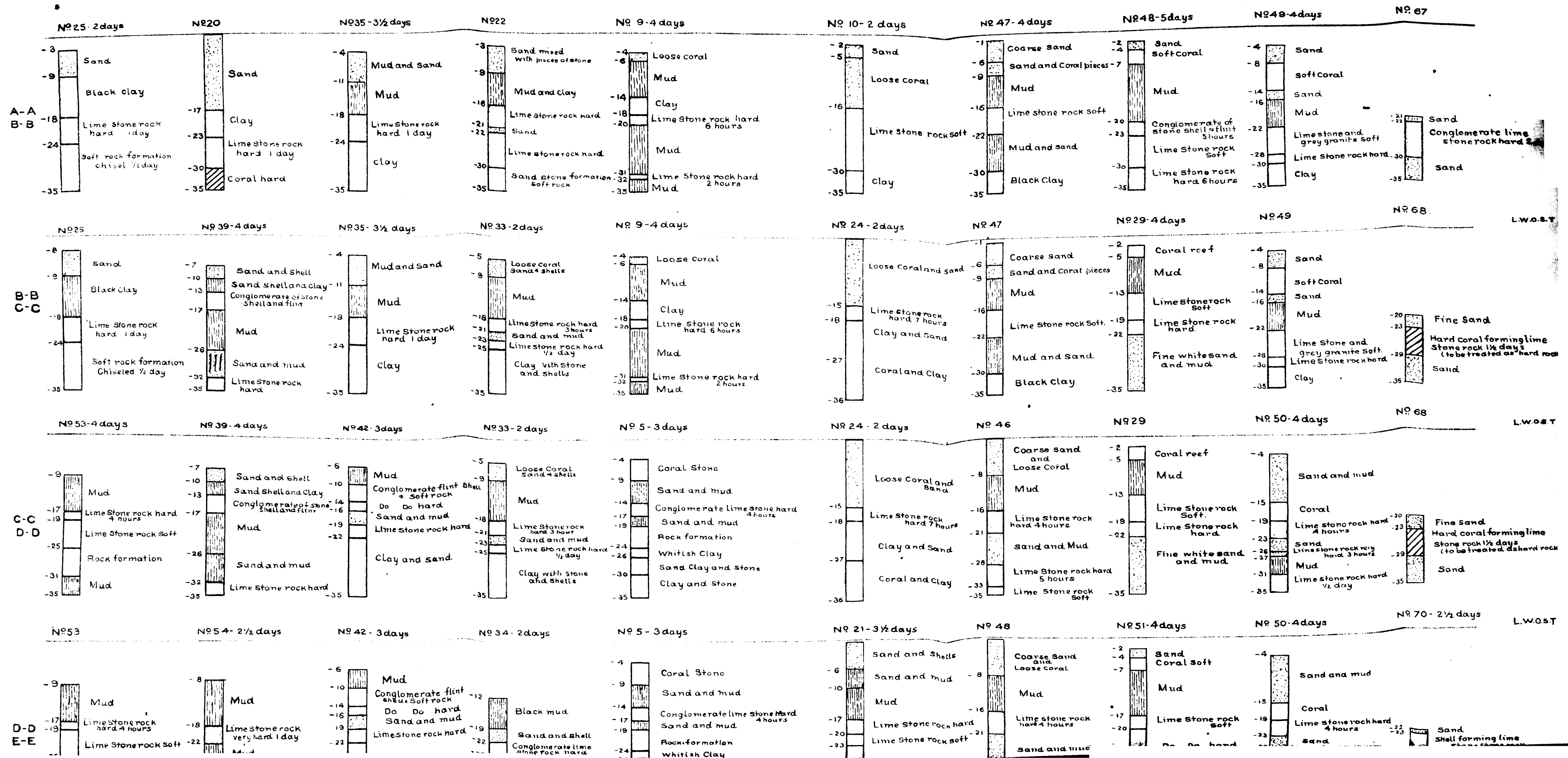
1922

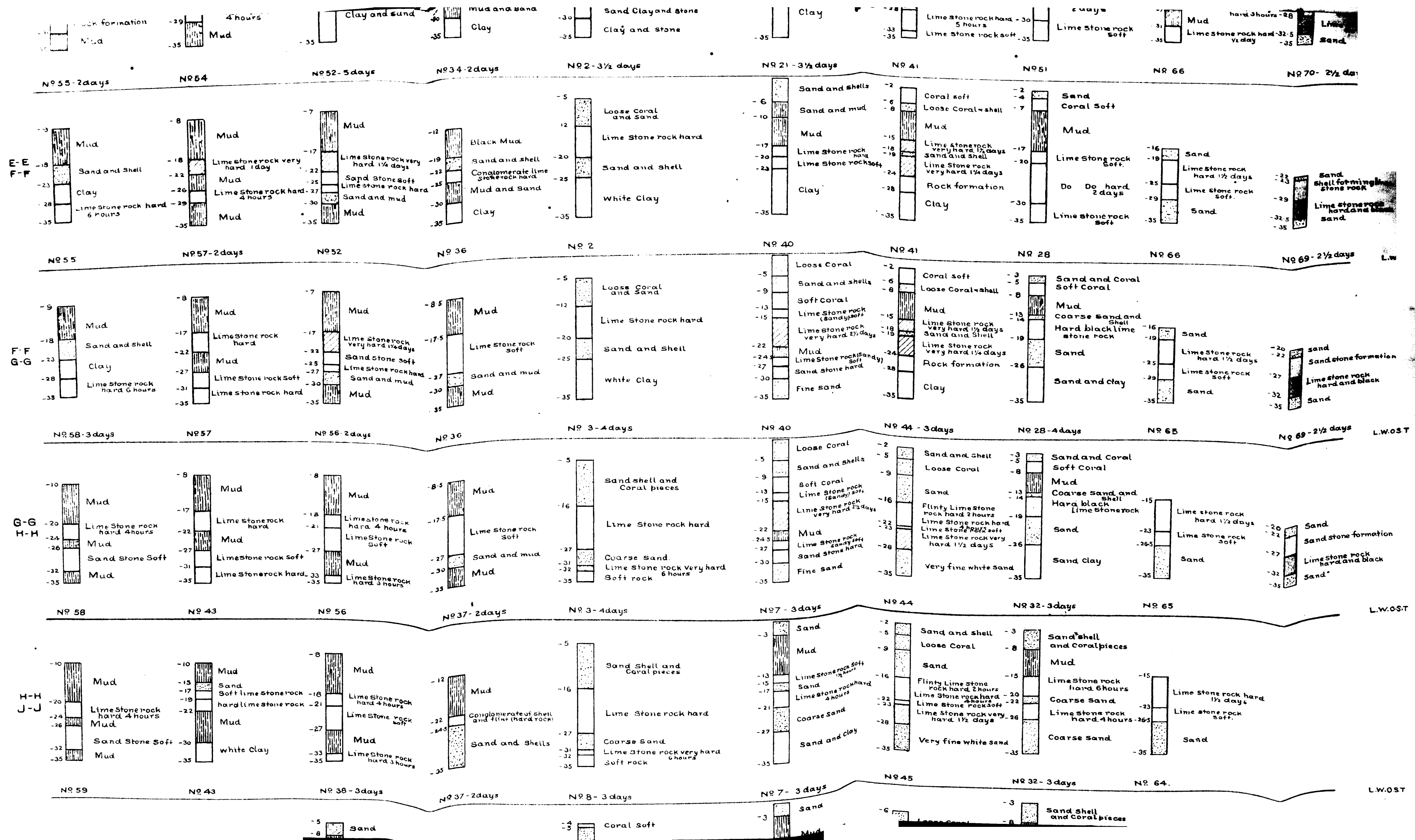


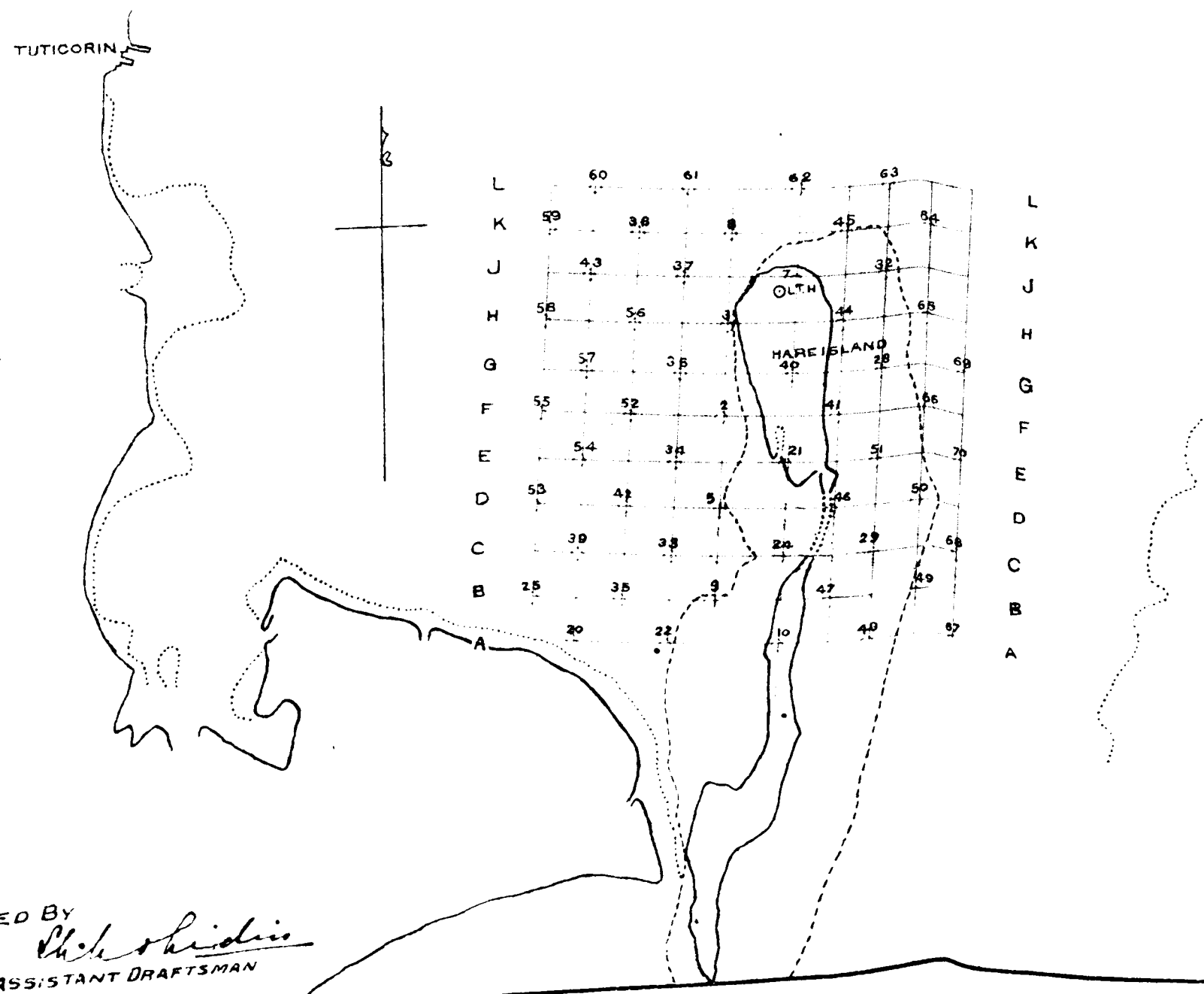
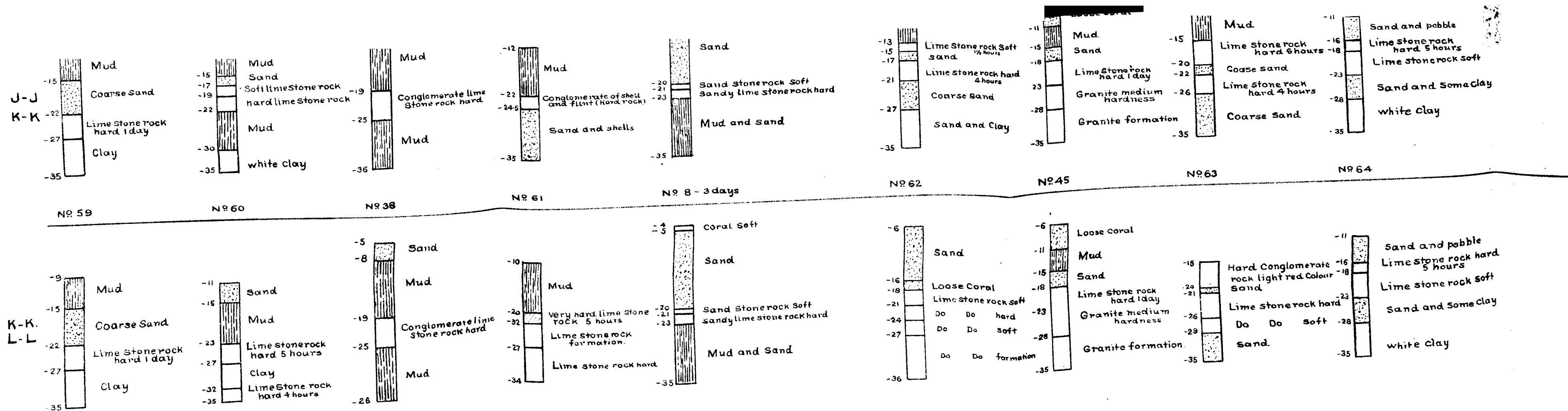


Does not exceed 30 of a knot per hour

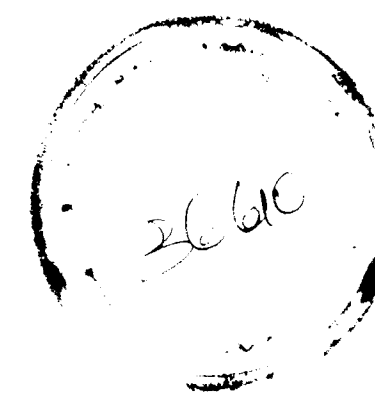
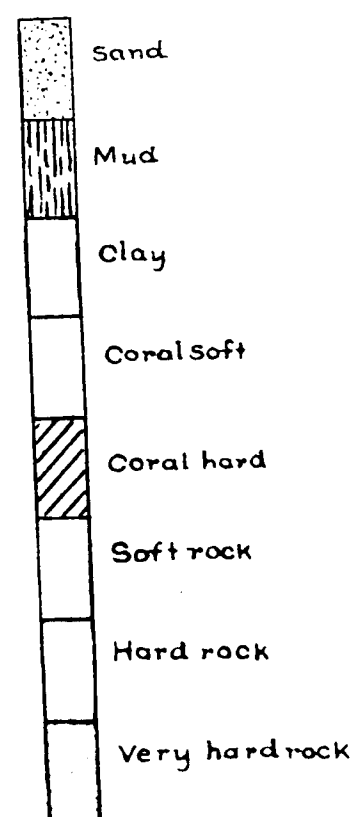
TUTICORIN HARBOUR PROJECT — RECORD OF BORINGS —







COLOUR SCHEME



TRACED BY
Ch. Chidias
 ASSISTANT DRAFTSMAN

ROBERT C. BRISTOW M.Inst.C.E.,
 Harbour Engineer to Govt of Madras.
 October 1922.

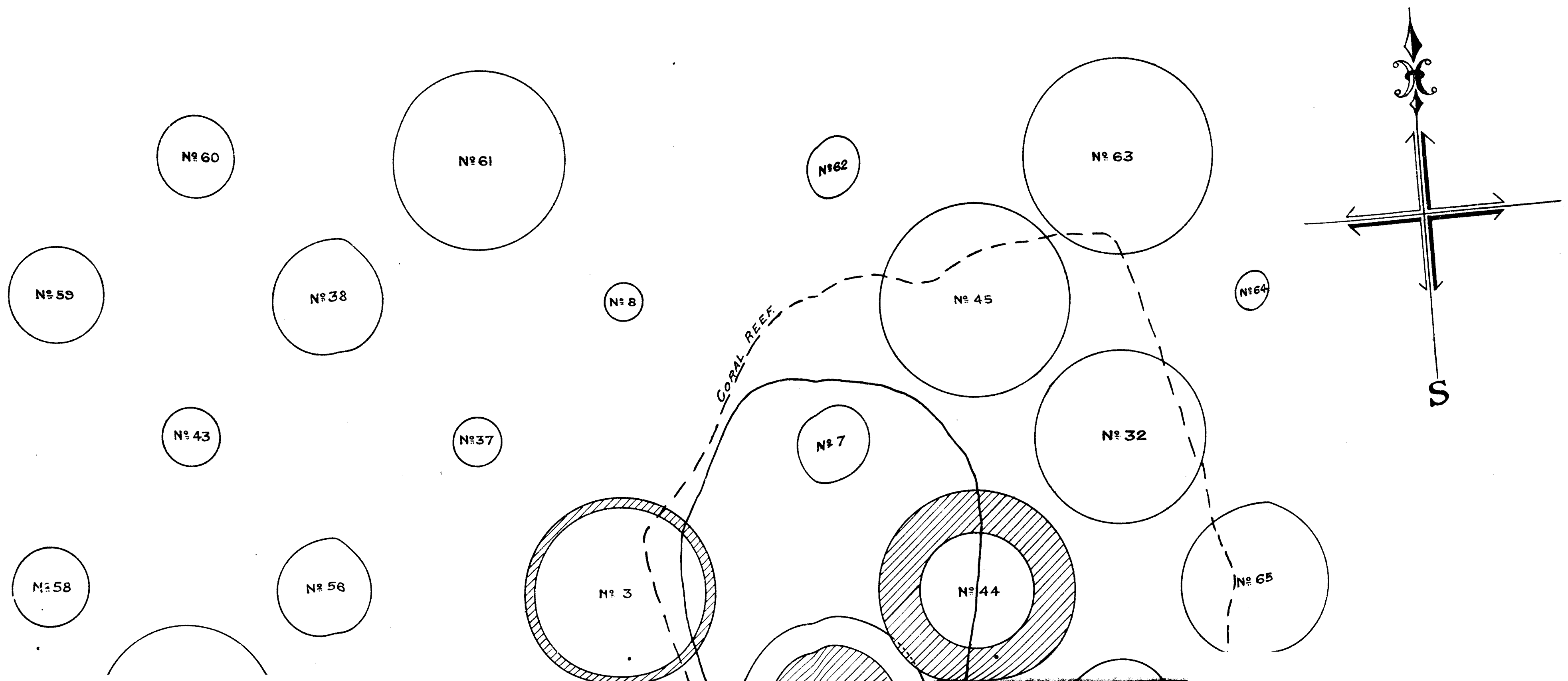
Robert Stevenson
 EXECUTIVE ENGINEER
 EAST COAST HARBOUR DIVISION.
 TUTICORIN.

W. Manabrooy

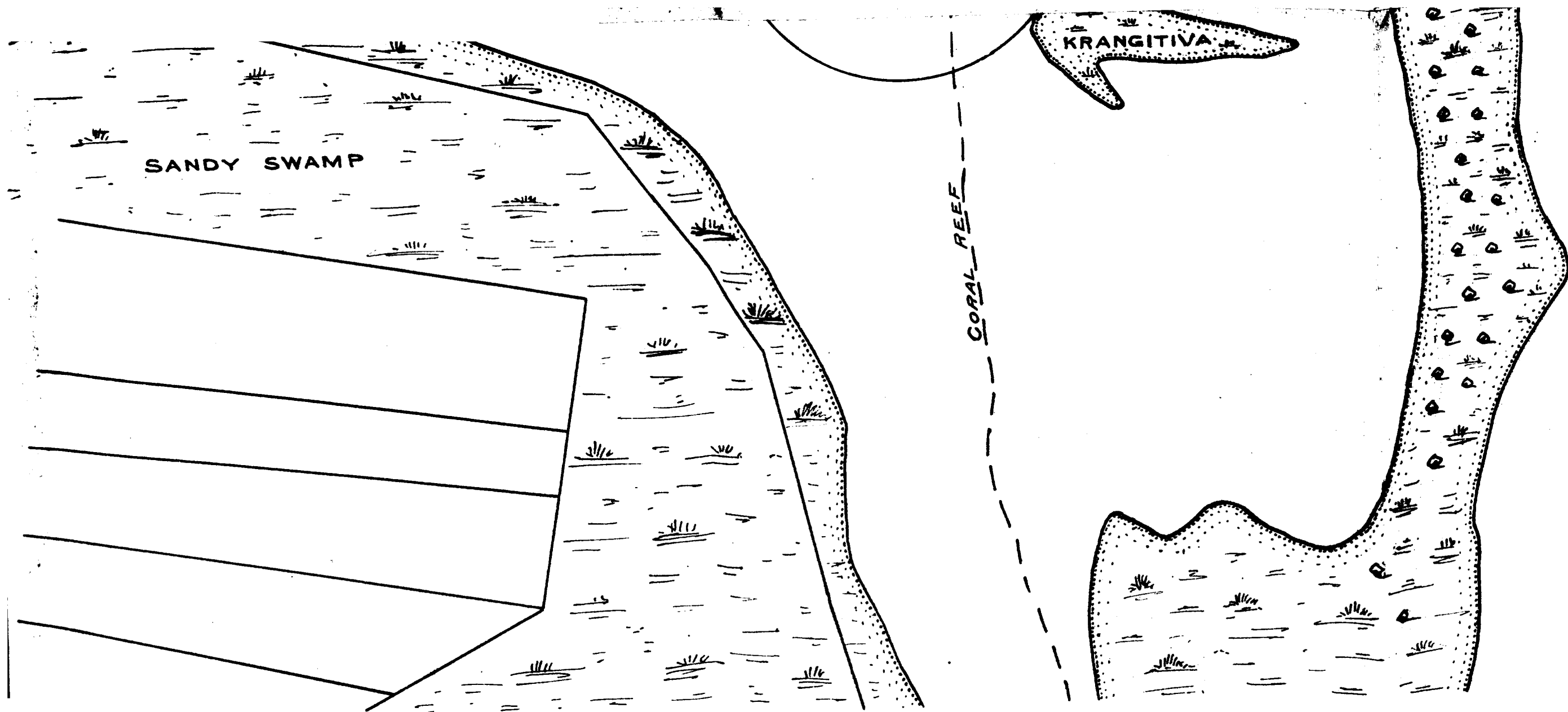
DRAWING

TUTICORIN HARBOUR WORKS

PLAN SHOWING BORINGS THE CIRCLES REPRESENT PROPORTIONATE AMOUNT OF HARD & VERY-HARD MATERIAL IN EACH.





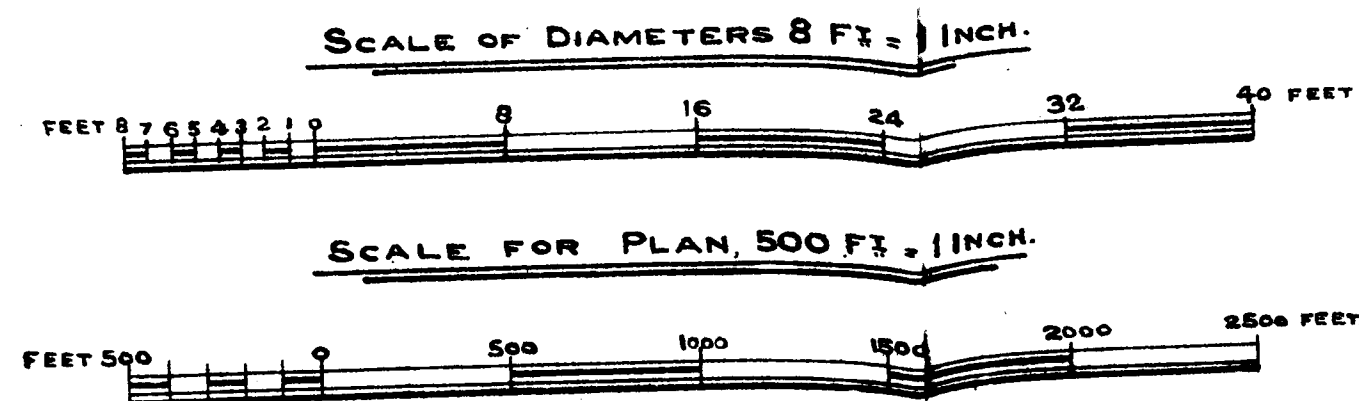


Note:- As the borings indicate material exists south of an alternative position. Turning Basin is shown No. 6. A final decision will be arrived at after experience of actual dredging in the canal.

REFERENCE.

□ Hard material.

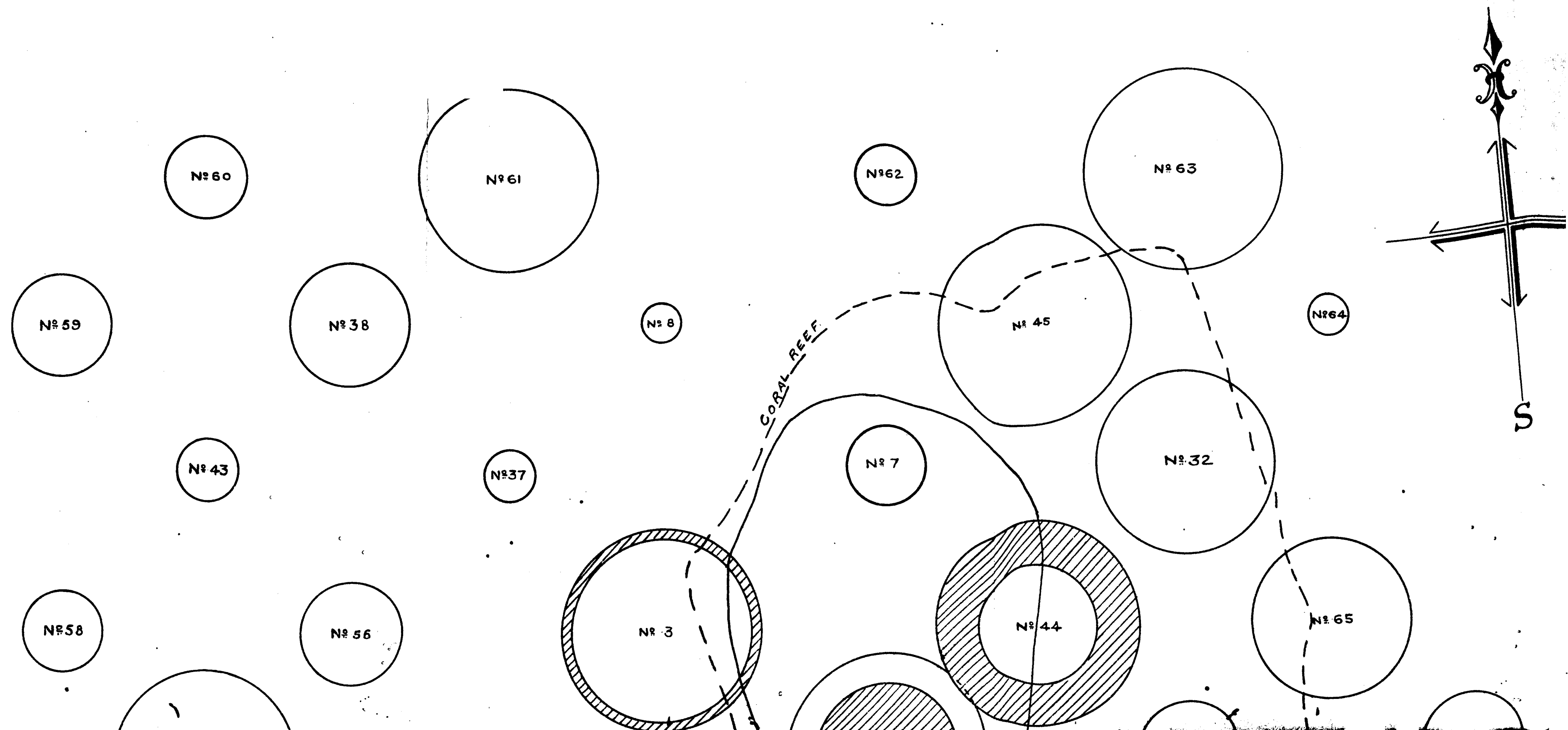
▨ Very Hard material.

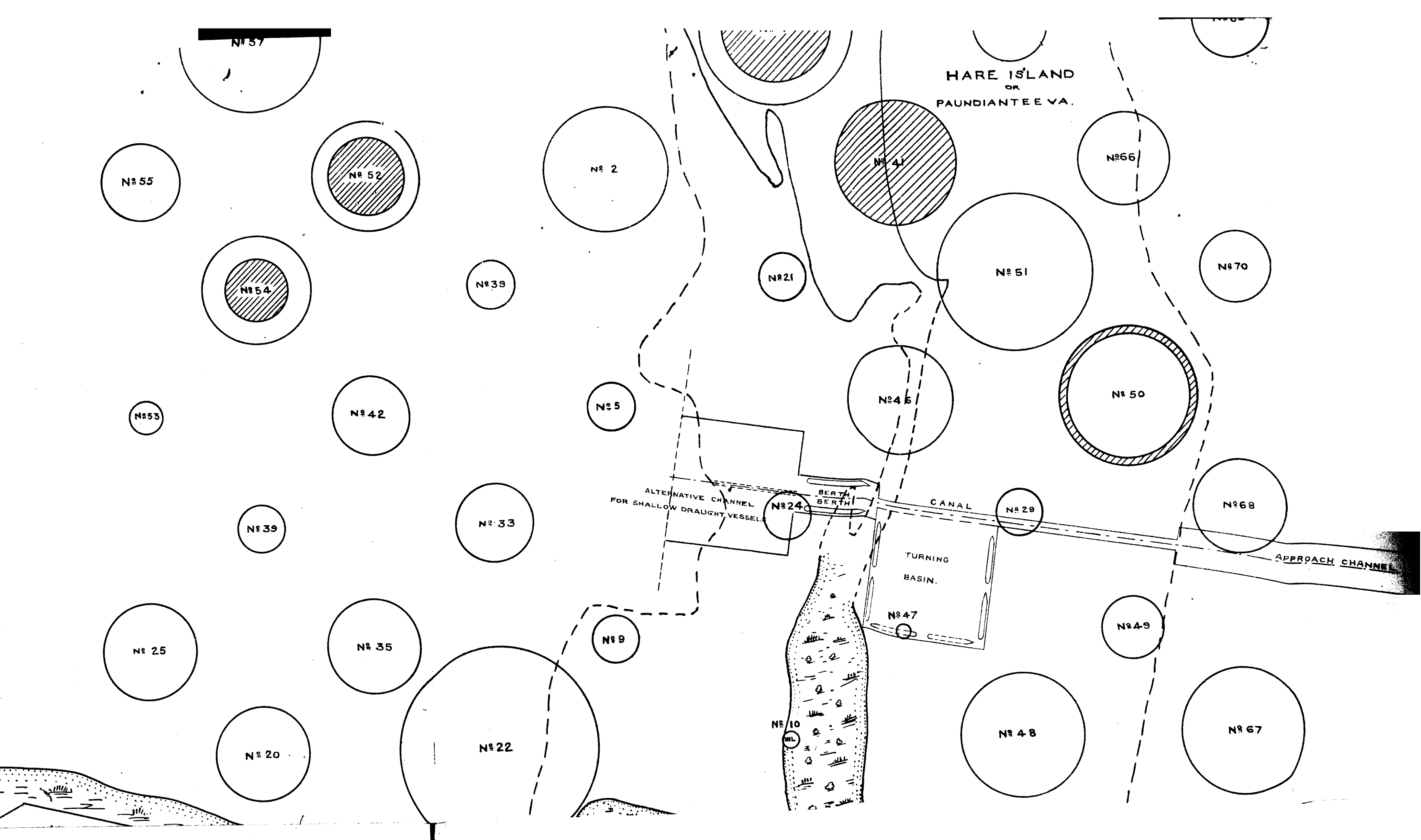


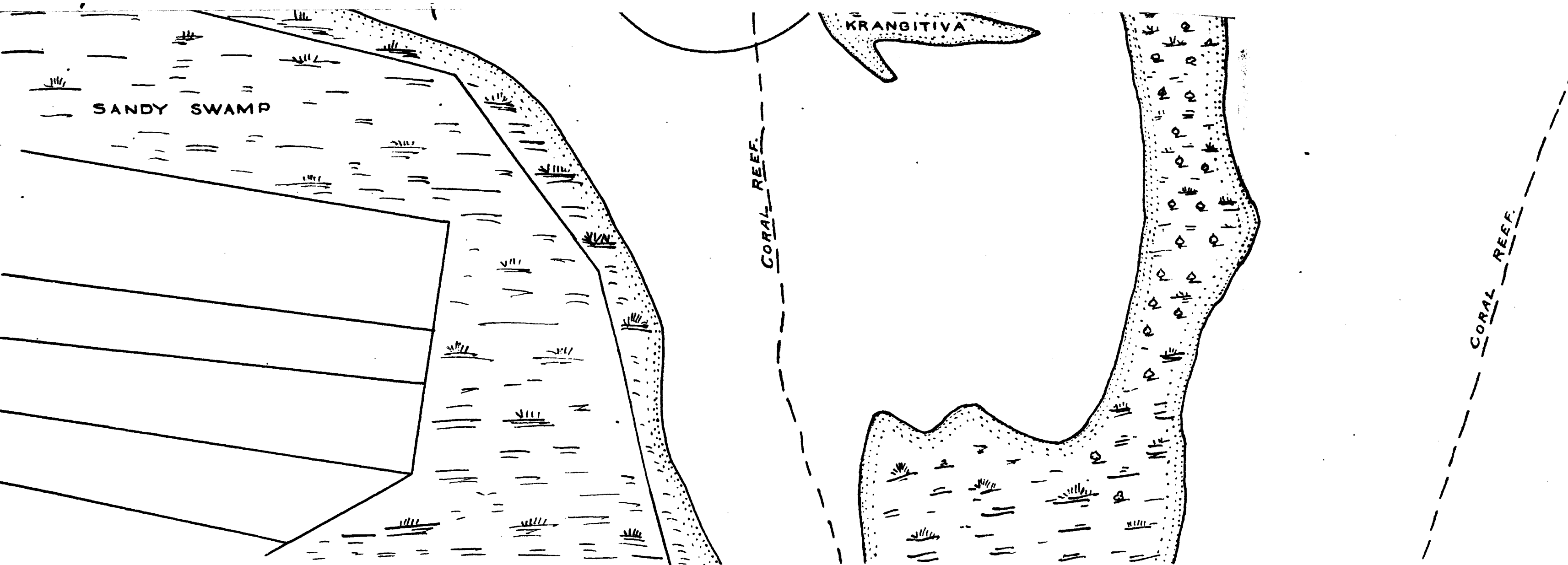
ROBERT C. BRISTOW. M. INST. C.E.
Harbour Engineer to Govt of Madras
November 1922.

TUTICORIN HARBOUR WORKS

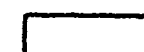
PLAN SHOWING BORINGS THE CIRCLES REPRESENT PROPORTIONATE AMOUNT OF HARD & VERY HARD MATERIAL IN EACH.

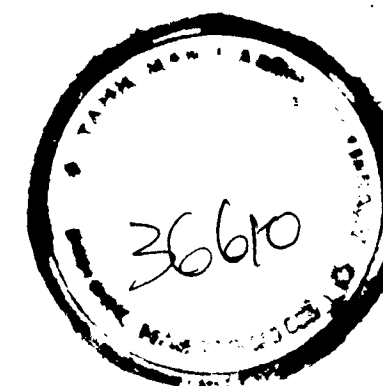
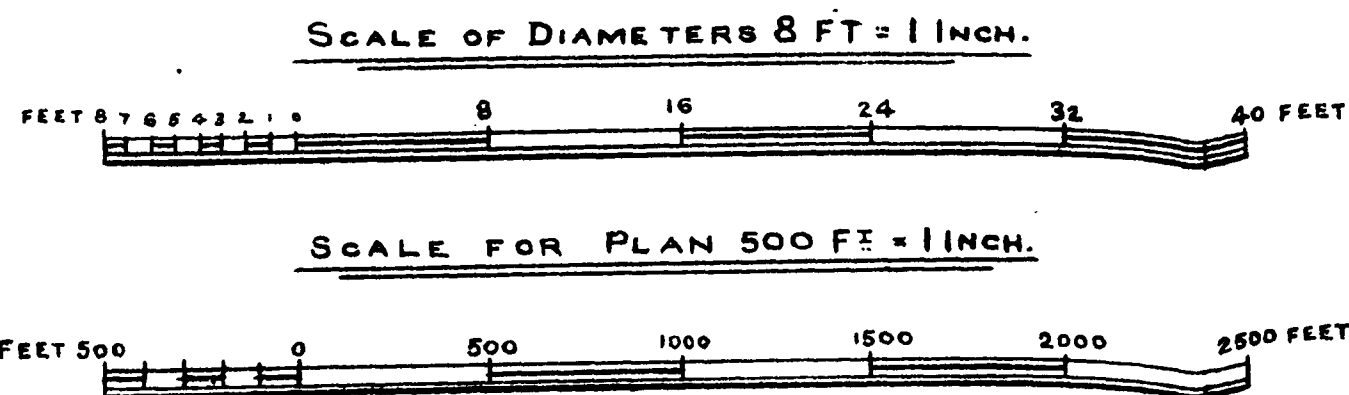






REFERENCE.

-  Hard material.
-  Very Hard material.
-  Proposed Canal, Turning basin, & Approach channel.
-  Alternative Proposal.



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