FINAL FIELD REPORT

SIDE SCAN SONAR OPERATIONS

14TH MAY TO 28TH SEPTEMBER, 1973

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CONTENTS

LIST OF DIAGRAMS AND SONAR RECORDS

SUMMARY

This was a year during which our newly acquired Klein Associates Model 400 Dual Channel Side Scan Sonar was used in an experimental and investigational role. This instrument lets us see for the first time what lies between the lines of the hydrographic survey and thus has definite potential in our survey work.

The sonar equipment proved to be somewhat prone to electronic failure, but most of these problems were solved and it performed well for most of its field assignments. During its field season the sonar was with four different field parties for periods of one to two weeks and was also utilized to the full on a two week study of an area of subaqueous sand waves in the Lower St. Lawrence. The sonar was used from large variety of vessels of all sizes and worked well with most of them.

The first field work was with the Lake St. Clair-Thames River party, then with the Navigational Ranges survey. Thereafter, the sonar worked on Lake Winnipeg and with the James Bay party.

The aim of the Sand Wave Study was to locate and observe subaqueous sand waves in the St. Lawrence River. With the side scan sonar available as a new hydrographic tool, it was hoped to obtain comprehensive information on the location, formation, layout and size of the sand waves. A bottom sampling program was undertaken to determine the material composing these underwater structures. The time available was limited, but detailed work was completed covering one major area of interest between Cap Gribane and Cap Brûlé with some additional reconnaissance work.

CHRONOLOGY

May 14	J. Weller transferred to Sonar from James Bay Party.
May 28	Boat and coxswain available. First trial run with Sonar.
May 30	First sonar breakdown.
June 4	Sonar repaired. Good records obtained in Hamilton Harbour.
June 5	Sonar breakdown. Waiting for parts.
June 13	Sonar repaired.
June 20	Working with Mini-fix on Lake Ontario towards Bronte.
June 22	Sonar breakdown.
June 29	Sonar repaired.
July 3	Sonar joined Thames River-Lake St. Clair party at Tilbury, Ontario.
July 4-13	Working in Thames River and Lake St. Clair.
July 20	Joined Navigational Ranges party at Brighton, Ontario.
July 23	Demonstration run with RPS on CSS VEDETTE for Mr. Shaw, the Deputy Minister for Dept. of Environment and Mr. McCulloch, Director, Central Region.
July 24-30	Working with Navigational Ranges party.
July 31	Sonar with VEDETTE en route to Lower St. Lawrence.
August 7-17	Sand Wave Study - see separate report following Narrative.
August 20	Sonar equipment returned to C.C.I.W.
August 30	Sonar en route to join Lake Winnipeg party at Grand Rapids, Man.
September 4-7	Working with Lake Winnipeg party.
September 4	Damaged tailfin of Towfish.
September 8	Sonar en route from Winnipeg to Fort George, Québec.
September 20-27	Sonar working with James Bay Party.
September 28	Sonar returned to C.C.I.W.

DESCRIPTION OF SONAR EQUIPMENT

As can be seen in Figure 1, the side scan sonar system is made up of four basic parts: the power supply; the recorder; the cable; and the towed transducer-body, along with connecting wires and recording paper.

The standard power supply is 24 Volts D.C. such as supplied by a pair of car batteries, but the model purchased for the Central Region, Canadian Hydrographic Service, has the optional extra power pack which permits the use of 110 Volts A.C. from a vessel's main supply. There is thus a choice of power source. It was found, however, that the recorder was prone to electronic problems, and the first question asked was invariably "How stable was the power supply?" To eliminate the possibility of power surges or voltage spikes on the line damaging the electronics of the equipment, the 24 Volt D.C. mode was generally used, and the pair of car batteries was found to be adequate for a full day's operation.

The recorder is an Alden recorder using Alfax wet paper, with a double helix type stylus giving two independent but matched graphs, one for the starboard side and one for the port. The other half of the writing mechanism is a metal band which rotates slowly so that the electric sparks that mark the paper do not also burn notches in the blade. The recording mechanism performed satisfactorily throughout the season except latterly when the writing blade drive motor stopped working, thus allowing notches to be burnt in the blade at the transmission marks and scale lines. It was found, however, that in hot, dry weather it was necessary to clean the helices frequently due to their becoming clogged with paper fragments thus giving a streaky graph. The recorder is fitted with a two minute fix marker in addition to the usual manual fix button. There are range lines appearing across the graph at 25 metre intervals, thus indicating the slope range of targets from the towfish. Ranges available are 75 metres, 150 metres and 300 metres on each side. By changing a plug-in circuit board these can be 100 m, 200 m, and 400 m. The front of the recorder carries two rows of control knobs for adjusting the graph so that the two sides may be tuned independently.

The cable is available in various lengths to order, with the standard length being 100 metres. The cable serves a double purpose, for in addition to being the tow cable it also contains the electric wiring for triggering the transducers and returning the echo to the recorder's amplifiers. The cable is armoured, but is is important not to kink it as this would shorten the cable's useful life. The cable has a Kellem Grip (known as the Chinese Finger) for attaching the towfish, and is fitted with a second Kellem Grip for the optional extra Recovery Device.

The most interesting part of the side scan sonar system is probably the towed transducer body, or towfish, which contains two arrays of Piezo-electric crystal transducers. These transducers have an output frequency of 100 KHz with the main beam being $3/4^{o}$ wide horizontally and 20^{o} wide vertically. These beams are depressed 10^{o} below the horizontal, thus directing most energy towards the bottom at a distance for long range use. At the 20^{o} beam width the power has fallen to 50% and continues to weaken as the beam widens, thus the least power is directed downwards where the bottom is closest with the best reflective angle, requiring the least power to return an echo. The most energy is directed out towards the distant bottom where attenuation due to distance travelled is greatest and the reflective angle is poorest. The upper part of the beam transmits upwards from the towfish towards the water surface which also returns an echo; this is useful because the water surface records as a thin line on the graph thus indicating the towing depth of the fish.

The towfish is normally closer to the surface than it is to the bottom so the first echo we receive will be from the water surface above, recording at the appropriate distance across the graph from the transmission mark. The bottom directly below the towfish is the next echo to be received, recording further across the graph, and the echo will continue to be recorded - darker or lighter depending on the strength of the echo - out to the maximum range.

Sharp peaks, large boulders and wrecks register in two ways on the side scan sonar graph. In addition to returning a strong echo due to the good reflective angle such targets also cast a "shadow" which appears as a white patch behind the dark echo.

One recorded line gives little useful information, but putting succeeding lines side by side gives a fairly good picture of the bottom and our sonar triggers up to 10 times per second depending on the range in use, with the recorder drawing the lines at 100 to 200 lines per inch depending on the paper speed.

The sonar transmits on both sides, so there will be two graphs to consider; however the two sides should be similar with the features on one side continuing across and appearing on the other side. The only occasion when the two graphs may be expected to be different is when the sonar is operated parallel with the shore with the bottom slope rising on one side and falling off on the other, in which case the graph will be stronger on one side, weaker on the other.

As has already been pointed out, the darker record indicates a stronger echo and the whiter parts little or no echo, thus a dark patch on the graph is created by a good echo though this may be either because the bottom is rising giving a better reflective plane, or it may be due to the bottom material changing, for example from mud to sand or sand to rock, giving a better reflective surface. In order to get a good idea of the bottom topography, we need to have at least 100% overlap so that everything is seen from both sides. This will show by the "shadow" changes whether a recorded feature is a shoal or an area of more reflective material. Quite often, of course, the two come together: the rocky patch in the sand may also be a rising shoal.

INTRODUCTION

After comparison and evaluation of the different models on the market and some experimental field work in the Killarney area of Georgian Bay in August 1972, a Klein Associates model 400 Dual Channel Side Scan Sonar was purchased for the Central Region of the Canadian Hydrographic Service. It was then decided that the first year should be spent using the equipment in an experimental and investigational role to determine how this equipment could best be used. Use of the side scan sonar lets the hydrographer see for the first time what lies between the lines of the hydrographic survey, and thus this new device obviously had definite potential as the tool of the future in our hydrographic survey work. However, in order to get the most use and the best work from any tool, it is necessary to get ideas from many sources on how to use the tool.

To this end a hydrographer was assigned to work full time with the sonar to become familiar with the equipment and its operation and then to travel with the sonar as its operator to visit as many of the Central Region's field survey parties as feasible. The main reason for this approach is that if we send a new piece of equipment into the field, better results will be obtained if we also send an operator. The operator will be able to get the equipment working quicker than the other field personnel who have never seen it before and who have a lot of other things to do, and the operator will be able to recognize when the machine is not performing as well as it should and will hopefully be able to rectify any malfunctions.

One reason for taking the sonar round the various field parties is that this way we see how the equipment performs in some of the very different areas that we have here in the Central Region, but the main reason for taking the sonar round the field parties rather than running a course on it at the CCIW is that this way each of the Party Chiefs and each of the field hydrographers gets the feel of the machine in operation in his own survey area in conjunction with his own survey programme under field operational conditions, and through their personal experience in the use of the machine and their observation of its strong points and weaknesses will be better able to understand the machine's possibilities and limitations.

This would give the widest possible scope for gleaning further ideas from a large percentage of our field hydrographers on the possible future utilization of the side scan sonar in our hydrographic survey work.

NARRATIVE

The sonar equipment proved to be somewhat prone to electronic failure and during the first two months it seldom performed satisfactorily, but most of the problems were solved and the sonar subsequestly worked well for most of its field assignments. During its field season, the sonar was with four different field survey parties for periods of one to two weeks and was also utilized to the full on a two week study of an area of sybaqueous sand waves in the Lower St. Lawrence, thus during the season the sonar was used in a variety of areas from a large variety of craft of all sizes, and it proved to work well on all except two boats. When working with the Botved type of launch, engine noise proved to be a problem with interference badly obscuring the graph. This interference, however, could be reduced to an acceptable level by having the recorder and operator in the bows of the launch. The other exception was the ship "NARWHAL", and here the problem seemed to be water turbulence attenuating the signal. This may have been due to the ship's propellor turbulence being so much deeper than with all the other craft, with the towfish thus being towed just at or above the turbelence level and the energy transmissions unable to penetrate to the bottom and back to the towfish.

Most of the early work with the sonar this season was done in the Hamilton Harbour, and this proved to be a most interesting area. Originally quite flat, areas of it have been dredged leaving a quite startling topography.

Figure 2 shows the original flat fairly soft bottom with depths of about 20 metres below the towfish. The features that show up so well are actually little more than marks on the sandy bottom. As can be seen from the ones that pass under the towfish from one side to the other, these features have a vertical dimension so small as to barely show. These are probably shallow grooves dug by ship's anchor cables as this area is used as an anchorage.

Figure 3 is over an area which has been frequently dredged. The original depth was about 15 metres, but it has been dredged at various times to depths of about 20-25 metres, except for the bits that were missed. The circular patches are craters left by the dredging, some directly below the towfish; others off to each side. Even the scour marks of the dredging are clearly visible. The slightly different levels of dredging show up quite clearly though the elevation difference is barely one metre. The echo from the water surface above the fish shows up well on this record, with the fish at a depth of about 5 metres.

Figure 4 shows the type of record given by bottom material changes off Bronte in Lake Ontario. The bottom here was mud, becoming bedrock. This is an area where Dr. Rukavina, a Sedimentologist with the Geolimnology Section of Lakes Research Division at CCIW, has done extensive bottom sampling.

Figure 5 is a record obtained last year near Killarney and shows how well rocky patches can show up. Note also the small patches of sand ripples between the rocks.

Figures 4 and 5 are both extreme examples. By looking at one isolated record, only limited conclusions can be reached on the topography of the bottom, which is the main concern. Even Figure 5 which looks so dramatic does not really tell very much on its own. It shows that the bottom is rugged below the towfish because the profile is there, and the features obviously continue out on both sides, but unfortunately clumps of weeds sometimes look very much like rocks on the graph with somewhat similar shadows - See Figure 9 - and the sonar cannot indicate the depth of any feature that is off the track, nor can it know which way the bottom is sloping. The weak graph may be due to bottom slope, but it may also be due to less reflective bottom materials. Some of the "shadows" cast by the rocky patches may be patches of soft mud. The length of a shadow depends on the height of an object, but it also depends on the slope and height of the area around the object, so to reach any reliable conclusions on the topography of the bottom more information is required. In a flat featureless region that has already been well sounded, one pass over an area with the side scan sonar would perhaps be sufficient because any features sudden enough to be missed by the regular sounding lines should show up on the sonar, and such a feature located by the sonar would then be examined as a shoal in the regular way. Usually, however, it is necessary to run overlapping lines to give the necessary double view of the entire area. Figure 6 is a companion to Figure 3. Note the changed shadow effects on the two graphs of the same area.

In Figures 3 and 6 the fish is being towed at about 4 knots at a depth of $2\frac{1}{2}$ metres below the surface. The two tracks are about 70 metres apart.

The Sonar's first field assignment was with the Lake St. Clair - Thames River party. The Thames River is very shallow, and the Towfish was "towed" from the bow of a Boston Whaler on a very short line so that it was directly below the boat at a depth of about one metre. This worked fairly well, and Figure 7 shows a typical section of the graph obtained. The feature that shows up so well was later examined by echo sounder as a "shoal" and seemed to be a sunken log in a deep hollow in the river bed. The sonar was used on Lake St. Clair for the location of the submerged crib protecting the end of a water intake pipe. The crib itself did not show up due to the broken nature of the bottom but the rubble covered pipeline was readily located and followed out to the end to pinpoint the crib. See Fig. 8.

On July 20th, the side scan sonar joined the Navigational Ranges party at Brighton, Ontario. On the 23rd, there was a special run to demonstrate the HAAPS, the RPS and the sonar installed on board the 49 ft. long survey vessel VEDETTE, and thereafter the sonar worked with the Navigational Ranges party on the ranges at Brighton, Cobourg, Port Hope and Oshawa. Figure 9 shows the type of record obtained on the Brighton range and demonstrates the frustrating effect of weeds on the sonar graph. Salt Point light is on a small island with the shoal extending from it, but a large percentage of the other echoes is due to weeds, which often caught on the towfish. Figure 10 shows the flat bottom and bottom material changes off Cobourg.

The sonar travelled with the VEDETTE to Québec, and from August 7th to 17th, was used extensively during the Sand Wave Study. This assignment is covered in a separate report following this Narrative, and Figure 13 is a typical record of the sand waves that were observed.

On September 3rd, the sonar equipment joined the Lake Winnipeg Survey party at Grand Rapids, Manitoba, but electronic problems again manifested themselves making it difficult to obtain usable graphs. Compounding the problem, the towfish struck bottom and tore off most of its tailfin necessitating emergency rebuilding using the materials at hand. The repaired towfish worked fairly satisfactorily for a day or two, though the recorder was becoming more difficult to adjust - perhaps due to the towfish not towing quite level.

On September 20th, with a new tailfin, the sonar joined the James Bay party at Fort George, Québec, and went on board the 252 ft. CCGS NARWHAL. Electronic problems were making it more difficult to obtain good graphs and the range was unaccountably down to about 70 metres, but the sonar was used during shoal searching on the launch SURGE and the graphs obtained were adequate to produce the sketch of the bottom topography as shown in Fig. 11. Compare this with the soundings obtained by the echo sounder. Even with the sonar working very poorly, the graph shows us a fairly clear picture of the bottom features between the sounding lines.

As previously noted, towing from the ship NARWHAL was not successful, which is thought to be due to the deeper water turbulence from the ship's propellors blanking out the sonar transmissions. Further experiments with large ships such as the BAFFIN will confirm or disprove this theory.

On September 28th, the sonar returned to C.C.I.W. with a detailed list of its mechanical and electronic troubles and the recommendation that it be returned to the manufacturer for a thorough overhaul. Some of the problems were due to water having entered the nosecone of the towfish, but others were more difficult to pinpoint. There are some comments on operating difficulties and fault finding in the appendix to this Narrative.

CONCLUSIONS AND RECOMMENDATIONS

Our experiences with the sonar this year have been mixed. To quote a classic Nursery Rhyme: "When it is good it is very, very good; but when it is bad, it is horrid". As can be seen from the sample records in this report, the quality of the recording can be exceptionally good and clear, but in light of the electronic difficulties experienced this past summer it is considered advisable to send an operator out with the equipment again next year. This is mainly because even when electronic problems manifest themselves, the sonar can often give a useful picture in shallow waters when encouraged by an experienced and patient operator. Also, the operator will be able to recognize when the equipment is not performing as well as it should and may be able to rectify any malfunctions. Electronic circuit boards are easily exchanged, but repairs to these boards should be attempted only by qualified technicians.

Sending the sonar round the various field parties seems to be the best way of utilizing the sonar at present, though no doubt in years to come the price will be considerably reduced and several of our field parties will have a sonar with them as part of their equipment for use in routine checks of all critical areas. Very shallow and shoal areas should be avoided when towing the towfish as its tailpiece is easily damaged and quite expensive.

Of all the areas visited by the sonar this season, the region that held most promise for utilization of the instrument to the full was James Bay. The bottom topography there being irregular seemed to be especially suitable for a side scanning device, and the features appearing on the sonar graph quite closely resembled the contour lines on the Field Sheet despite the operating difficulties we were having with the equipment at the time. This type of area is the one where the sonar can be most useful as the features that would show up best on the sonar - i.e. sudden peaks - are those most likely to be missed by the conventional sounding methods.

Due to the difficulties of determining the exact position of the towfish, both horizontally and vertically, it is not suggested that the Side Scan Sonar be used for precise depth or position measurements, but as a shoal locating aid and as a final check in critical areas the sonar has its place as the tool of the future in our hydrographic survey work. In its present state of development the sonar must not be used to let the hydrographic surveyor take short cuts in his work and shoals located with its aid should be examined in the usual manner, but used as a reconnaissance tool the side scan sonar can perhaps reduce our work by letting us better space our sounding lines to suit the observed terrain of the survey area. Coupled with its check sweeping of critical areas, the use of the side scan sonar can thus give us much greater confidence in the reliability of our charts and the safety of our chart users.

LOWER ST. LAWRENCE SAND WAVE STUDY

Dates: August 7 - 16, 1973

Personnel: A.J. Kerr
D. Monahan
R. Bryant
J. Weller
P. Millette

Chronology:

August 5	VEDETTE arrives Québec City.
August 6	A.J. Kerr and J. Weller board VEDETTE and live on board with the two crew members. D. Monahan, R. Bryant and P. Millette travel to hotel at St. Laurent on Ile d'Orleans.
August 7	VEDETTE proceeds to St. Francois, Ile d'Orleans, to pick up Messrs. Monahan, Bryant and Millette and then commences survey of sand waves with Side Scan Sonar.
August 10	R. Bryant departs for Burlington.
August 11	Reconnaissance run with sonar via Coudres Passage to St. Joseph-de-la-Rive.
August 12	Return run to St. Francois.
August 16	A.J. Kerr and D. Monahan depart.
August 17	P. Millette departs to PORTE DAUPHINE.
August 20-21	VEDETTE on Revisory Survey of Québec Harbour.
August 21	J. Weller departs to PORTE DAUPHINE.
August 22	VEDETTE departs for C. Leadman at Sorel, P.Q.

LOWER ST. LAWRENCE SAND WAVE STUDY

NARRATIVE

The purpose of this survey was to locate and observe the sand waves in this section of the St. Lawrence River. The existence of underwater sand waves as large as 6 or even 8 metres in height in water depths of around 15 to 35 metres has long been known, but with the deeper draft vessels navigating in the area and the associated necessary dredging programme, the need to know more about the composition, formation and movement of the sand waves became increasingly important. Heretofore, all work has been done with conventional echo sounders indicating only the depth of the bottom directly below the launch, but with the side scan sonar available as a new hydrographic tool it was hoped to obtain information on the bottom features out on both sides of the survey vessel, and with this complete coverage coupled with complete overlap really comprehensive information on the location, formation, size and layout of the sand waves could perhaps be obtained. It was also planned to take bottom samples to determine the material composing these underwater sand waves.

The time available for the study was very limited - a period of only ten (10) working days - and during this time two of the personnel lived on board the survey vessel VEDETTE with the two crew members, and the other two or three men living in a hotel ashore joining the VEDETTE each day. The VEDETTE tied up at the dock at St. Francois each evening, with all personnel eating ashore. The local restaurant facilities proved to be quite varied.

Reconnaissance lines with the sonar were run the first day from Ile Madame to Cap Gribane to locate the most promising areas for further study. Two spots were then settled on for further study - one at each end of the region - and on subsequent days, lines were run in these areas at a spacing of 100 metres. Using the side scan sonar on the 150 metre range, this would give good overlap to ensure the necessary double coverage of the entire area.

On the 9th of August, two pairs of small range beacons were constructed to give lines across a sand wave field, and these ranges were run each day after that to observe any day to day changes in the sand waves. Running these ranges gave a lot of trouble due to the exceptionally strong currents and unfortunately it proved impossible to keep on course at the reduced launch speed necessary to ensure good echo returns for the side scan sonar, with additional complications due to the towed transducer body being twenty metres away from the R.P.S. receiver antenna.

A Dietz La Fond bottom grab was used to do the sampling, and extensive programmes of bottom sampling were carried out on two days. By anchoring in the sand wave field and letting out more anchor line a few metres at a time, samples were obtained from various points across the sand wave to determine whether or not the crest of the wave is composed of the same material as the trough.

The positioning system used was the Motorola RPS which performed well up to a distance of 24,000 metres, which was the furthest required. There was one day when one of the two transponders was responding poorly, but with this exception the RPS worked well until the same transponder suddenly died a few days later. For the remaining two days of the survey, Langley Muir who was working in the same area with the PORTE DAUPHINE on the Tides and Currents survey very kindly lent one of his transponders. Without this help the sand wave programme could not have been completed. The depth, position and time data were all recorded on the HAAPS equipment, though "just in case" selected positions were also recorded in the conventional manner. The magnetic tapes from the HAAPS have since been processed and the survey data were all successfully recorded. It has been discovered though that due to the sampling rate being once every two seconds instead of every half second, a lot of the sand wave crests did not record correctly on the magnetic tape, being "deep" by up to 1½ metres on occasion, so the sounding rolls had to be scaled by the conventional method. The troughs, however, usually recorded correctly and the position data was all right.

On August 11th and 12th, reconnaissance lines using both the side scan sonar and the echo sounder were run from the study area up to St. Joseph-de-la-Rive through Coudres Passage and across the north end of Isle-aux-Coudres. This was scheduled partially to investigate the existence of sand waves, but also to help in the planning of subsequent hydrographic surveys in the area. The records of the sonar and echo sounder indicate that the bottom is fairly uniform with no sand waves northeast of Cap Gribane until reaching Coudres Passage where there are large sand waves in deep water.

During the course of the study, an area was found near the main shipping lane with depths somewhat less than the charted 4½ fathoms, and this information was passed on to the M.O.T. at Québec City before the VEDETTE left the vicinity so that an immediate Notice to Mariners could be promulgated in the interests of safe navigation.

Figure 12 shows the study areas and reconnaissance lines, and Figure 13 is a typical example of the sonar records obtained of the sand waves. The sand wave formations as found in the area between Cap Brûlé and Cap Gribane are shown in Figure 14. It proved very difficult to co-relate the sonar graphs here, with adjacent lines often bearing little resemblence to each other. This is due to the fish (like the launch) proceeding crabwise in the strong current, with this problem being further compounded by the difficulties of steering a straight course in these circumstances. Minor course alterations of the towing vessel are not generally transmitted to the towed body, but larger course alterations distort the sonar's recorded graph quite seriously and, moreover, these distortions are not easily recognized.

Further study is being done on the sonar records obtained in the Lower St. Lawrence, and David Monahan, a Geologist at Headquarters in Ottawa, is studying the bottom samples obtained during the sand wave study and a paper combining the geological and hydrographic aspects of the study is in preparation.

APPENDIX 1

SONAR OPERATING DIFFICULTIES

SIDE SCAN SONAR OPERATING DIFFICULTIES

Any difficulties encountered in working with the Side Scan Sonar such as the Klein or E.G.&G. models can be classified under one of three main headings: Operational, Mechanical, or Electronic. The Mechanical faults generally are quite obvious as they manifest themselves as physical damage to the paper or as streaky or patchy printing and are fairly simple to pinpoint and remedy. Operational and Electronic problems are not so simple to differentiate and are often difficult to even recognize as being malfunctions. This is where previous experience with the machine is invaluable as it helps the operator recognize whether or not the equipment is performing as well as it should be.

Operational and Electronic problems fall into two groups: those that affect both channels, and those that affect only one side of the record.

As a general rule, with identical settings on both rows of knobs the record produced should be the same on both sides. If the picture quality is markedly different on the two sides, alter the course of the towing vessel and tow back along the same track in the opposite direction. If the record quality difference is due to external causes such as wind and waves or a shelving bottom, the poorer picture will now be on the other side. The cause may even be the turbulence of the towing vessel's own wake, and if so, towing from the other side of the vessel will cause the picture to change. One other possibility is that the towed transducer body is tangled in its own safety line and towing on its side or even upside down. Pull the towfish in and check for this.

If the unequal picture is unaffected by the foregoing procedures, the fault is probably an electronic one and is usually very simply remedied by replacing the faulty electronic circuit board. There are six boards in the recorder (three pairs) which may be involved here, and the method is to swap the boards a pair at a time until the fault changes to the other side of the paper record, thus identifying the faulty board. Replace this board with one from the spare parts kit. Attach a label to the faulty board with details of the trouble for future reference.

If this fails to locate a fault which affects only one side of the record, the malfunction may lie in the towfish circuit boards which require to be changed by a technician. Stand the fish on the workshop floor and carefully remove the nosecone (six slotted screws) thus exposing the pair of circuit boards. Note whether or not there is any evidence of water having entered the nosecone, as it should be perfectly watertight. Swap over the circuit boards. If the fault changes sides on the paper record, replace the delinquent board, and attach a label with details of the malfunction. With great care not to damage the plastic surface and O-ring, replace the nosecone.

If a fault develops on both sides of the paper record simultaneously, the problem - if electronic - will be with the Trig-Scale board, which also controls the two minute event marks and scale lines. The Helix board controls the speed of rotation of the helix drum and thus the range scales. The Paper Drive is self-explanatory.

Paper Damage

The paper may be cut lengthways by a damaged helix. Often this will be due to one end of the helix being bent up, but there may be a break in the helix. Cuts across the paper by the helix indicate that the writing blade is too close to it. Raise the blade by turning the thumb wheels at each end of the blade as required. In very hot dry weather, the paper may dry so rapidly that it shrinks and stretches between the helix drum and the paper drive rollers. This can be minimized by keeping the plastic covers in place. If the paper tears at the edges, the roll is probably not seated well in its holder or is sticking. Check to see that it moves freely and that the plastic ends of the previous roll were removed. If the paper is being marked so as to burn holes, which may be black or yellow in appearance, it indicates that the gain is set too high. If the event marks are burning or cutting the paper, the intensity is set too high.

White Streaks or Patches

White streaks or patches on the sonar paper record - particularly noticeable on the event marks - have one of two causes: either the helix has scraps of paper adhering to it, or the helix and writing blade are not in close enough contact. Clean the helix or adjust the blade height with the thumb wheels at each end of the blade as required. There is another type of white streak that is a very bad sign. On changing to the short range, white lines may appear on the record that correspond to where the range lines were on the longer range, or a white line may develop around the dark transmission marks. This indicates that the writing blade is no longer moving and has become burnt or worn in the areas that it does most work, i.e., transmission and range lines. If this fault is not rectified as soon as it develops the edge of the blade will become unuseable. With the recorder running and its top open, check to make sure that the blade is being slowly moved by the drive unit at the left hand side. The blade may have cut a channel in its two bearing plates and may be sticking there.

Interference

Anything operating on a frequency close to that of the Sonar - 100 KHz. - or a harmonic thereof may produce an interference pattern on the record. The echo sounder is the most common source here with the interference appearing as a fairly open pattern of short lines with the same length and intensity over the whole of the record. This interference can generally be eliminated or reduced to an acceptable level by making the tow much longer.

Engine or V-drive noise can be reduced or eliminated by moving the recorder further away from the engine. If this has no effect, the noise may be in the power supply. If using the vessel's power change to batteries and leave the ground clip disconnected. Try moving the batteries to a different location on the boat.

Another source of interference is the use of a radio transmitter in the vicinity. The solution is to cease transmission or to move the radio (if a portable) away from the recorder.

Interference may also be due to waves on the water surface. This gives a mottled appearance, mostly quite near the transmission marks, though in the case of the waves having the same speed and direction as the launch, i.e., virtual standing waves, the effect may extend further and obscure bottom features.

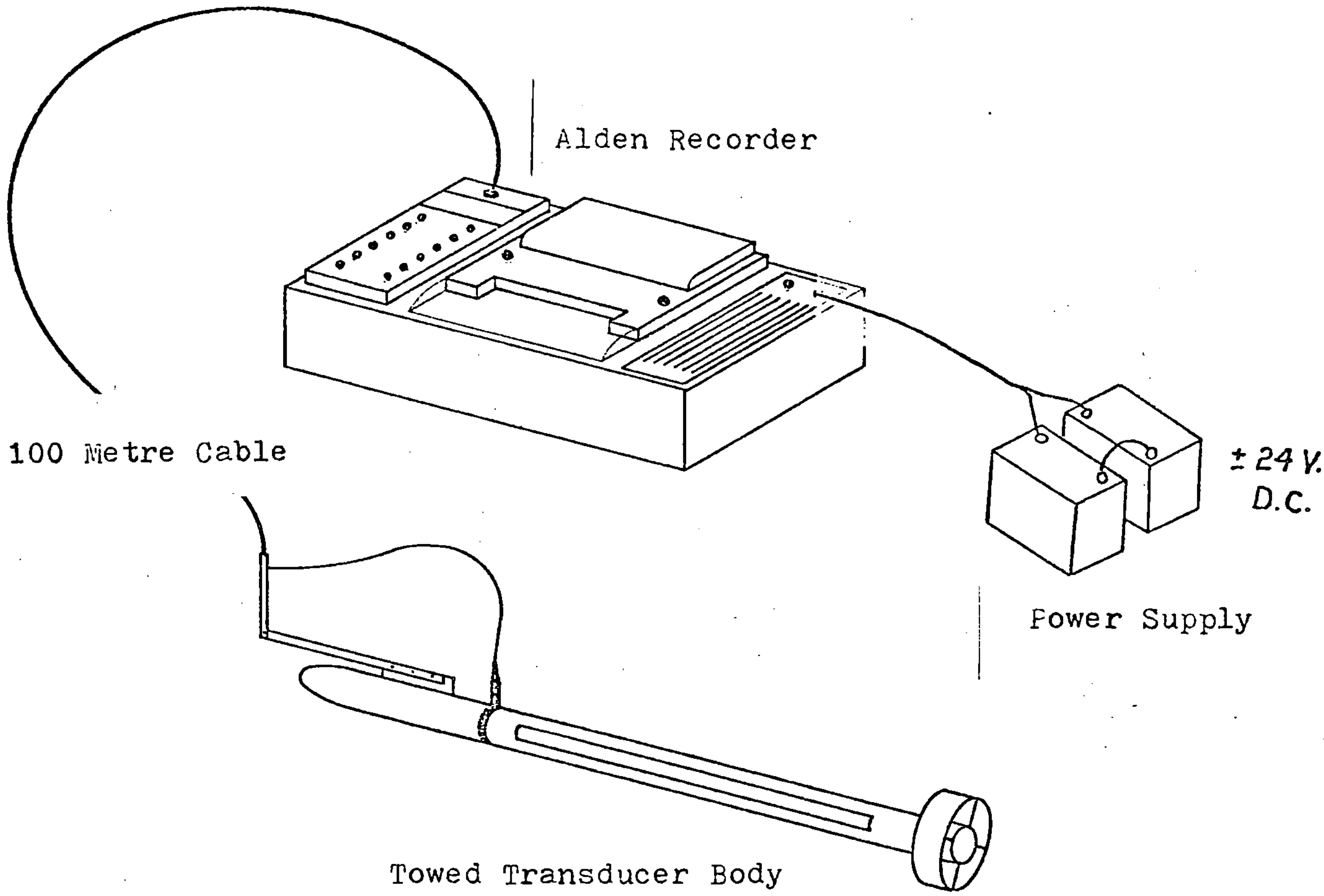
Blanking Out

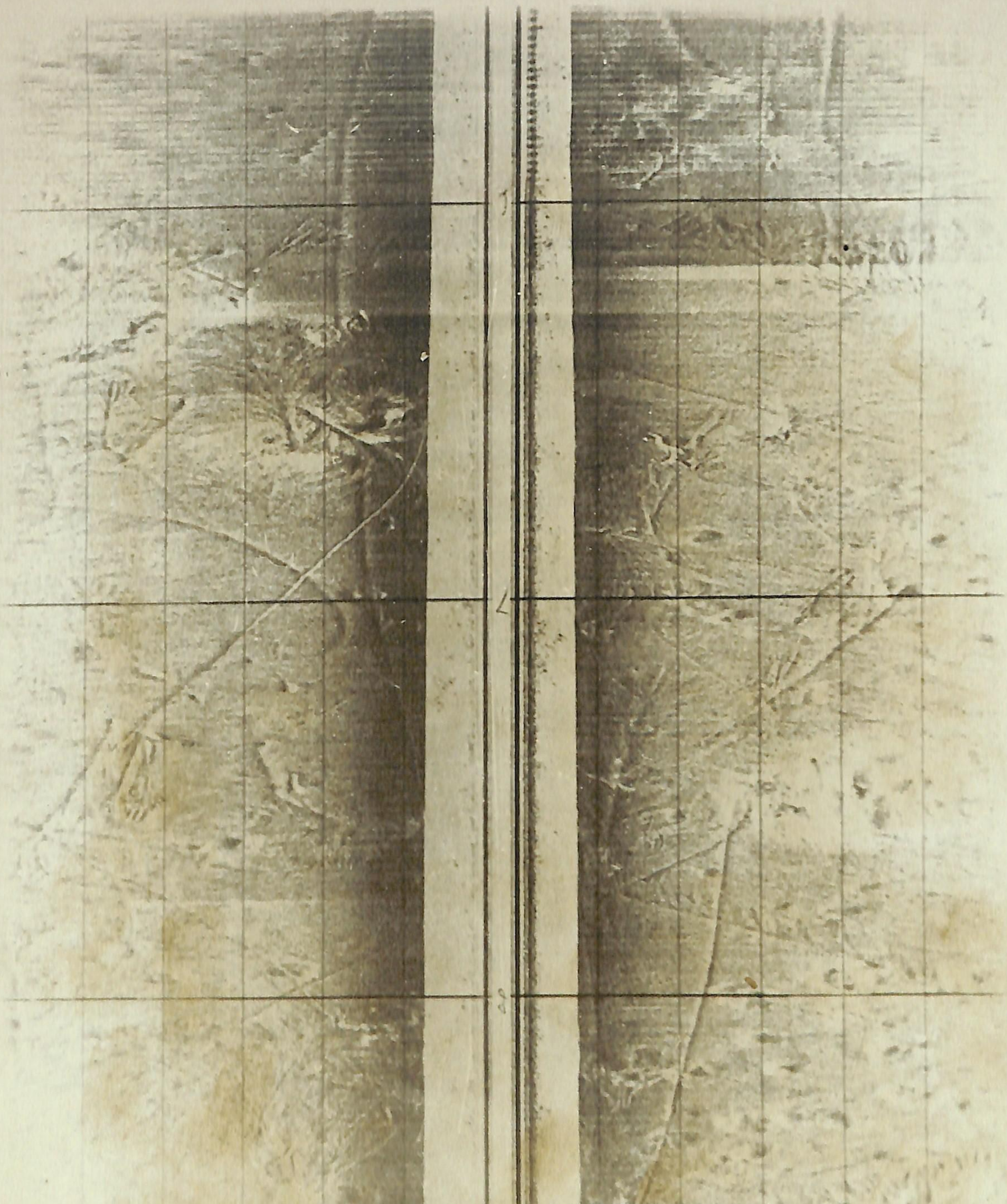
The towing speed is quite important, with the best speeds being between 3 and 8 knots. At 100 lines per inch paper speed, 3.9 knots gives a record where the scale distance lengthways is the same as across the paper. Above 9 knots the record tends to blank out. There is a critical speed around 5 knots where the towfish moves erratically, giving a layered or rippled effect to the record. This is remedied by raising or lowering the towing speed slightly.

APPENDEX 2

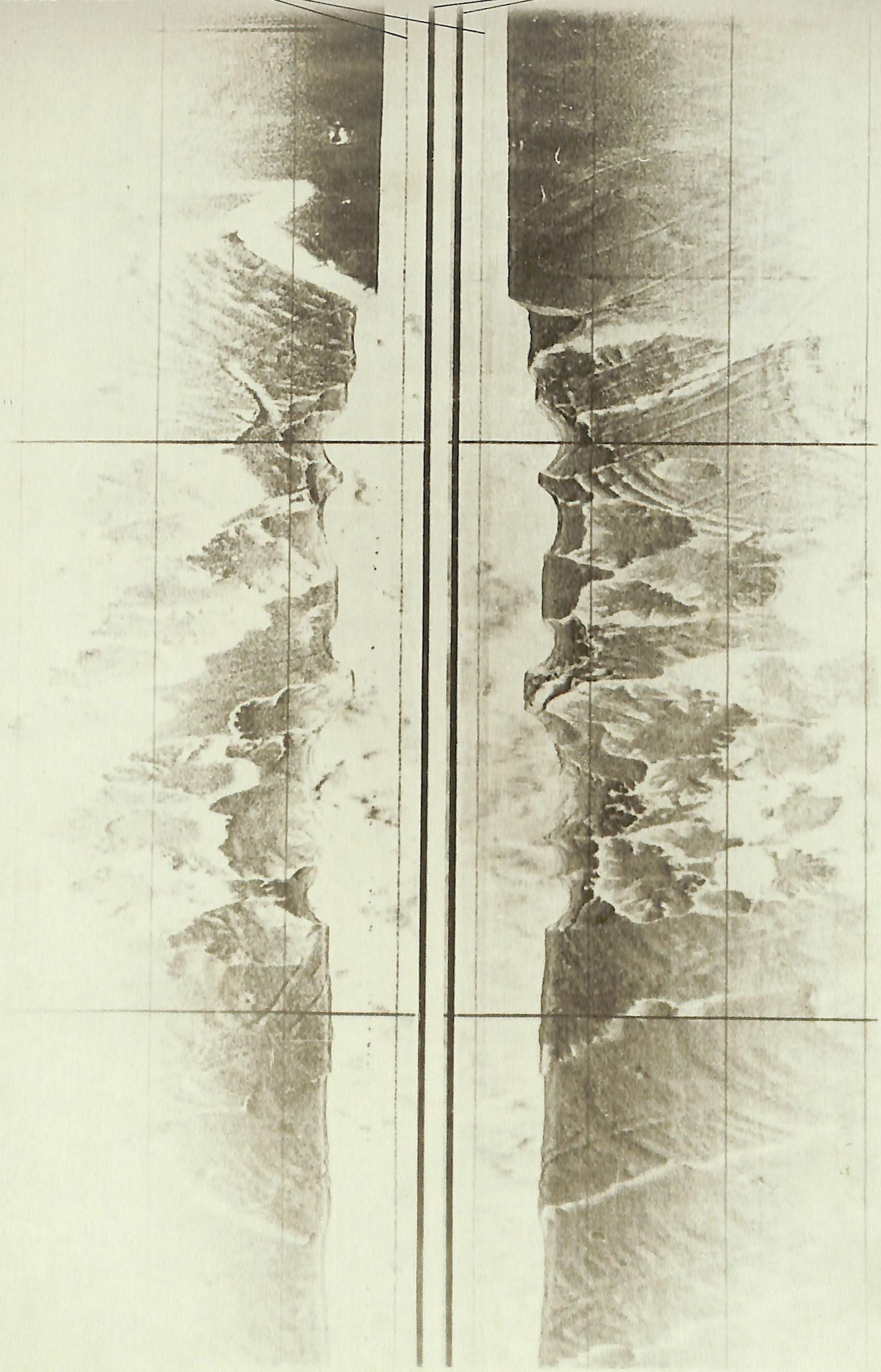
DIAGRAMS AND SONAR RECORDS

Klein Associates Model 400 Dual Channel Side Scan Sonar

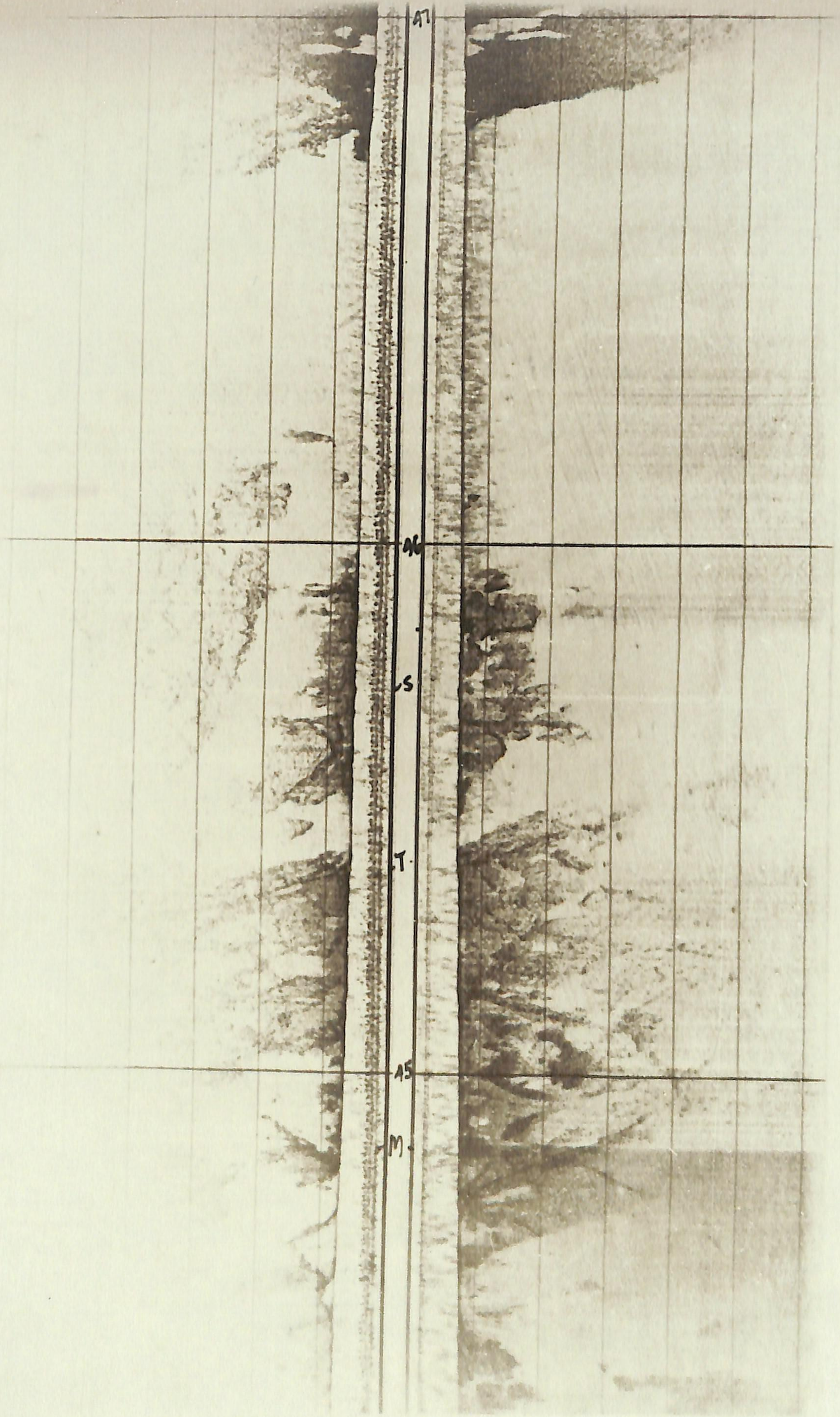




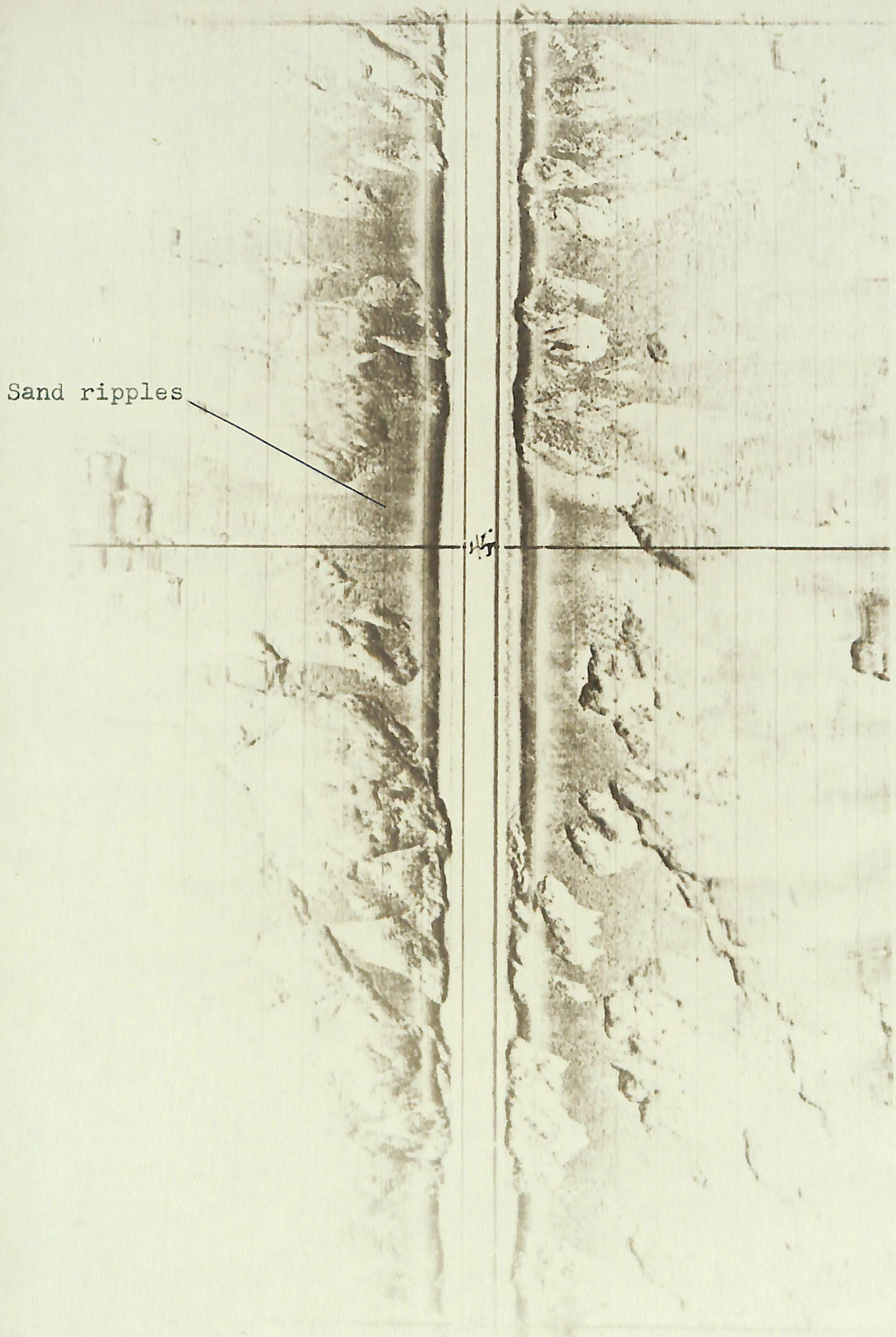
Hamilton Harbour, showing flat fairly soft bottom.



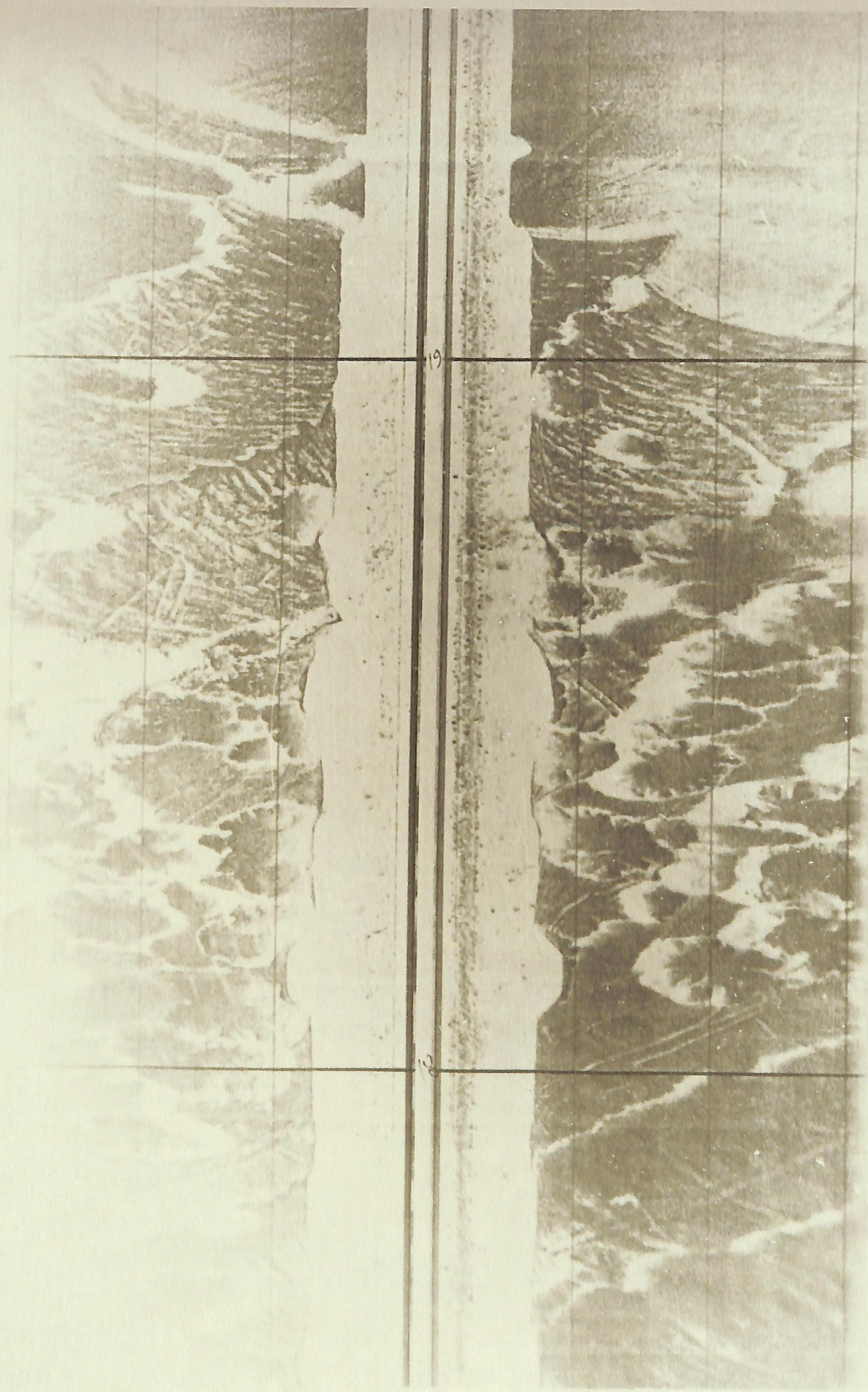
Hamilton Harbour dredged area.



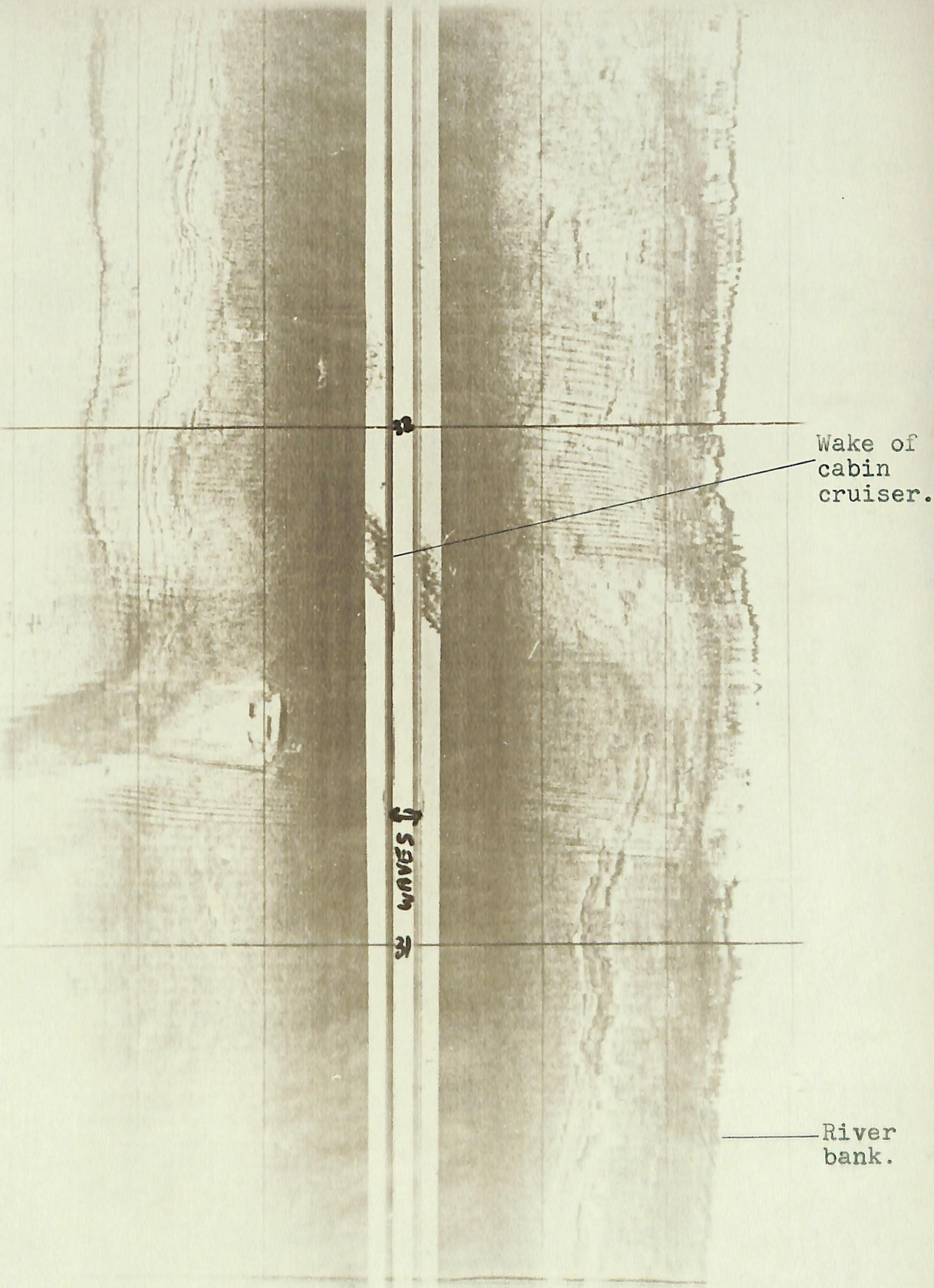
Lake Ontario near Bronte, Bottom changing from mud to bedrock.



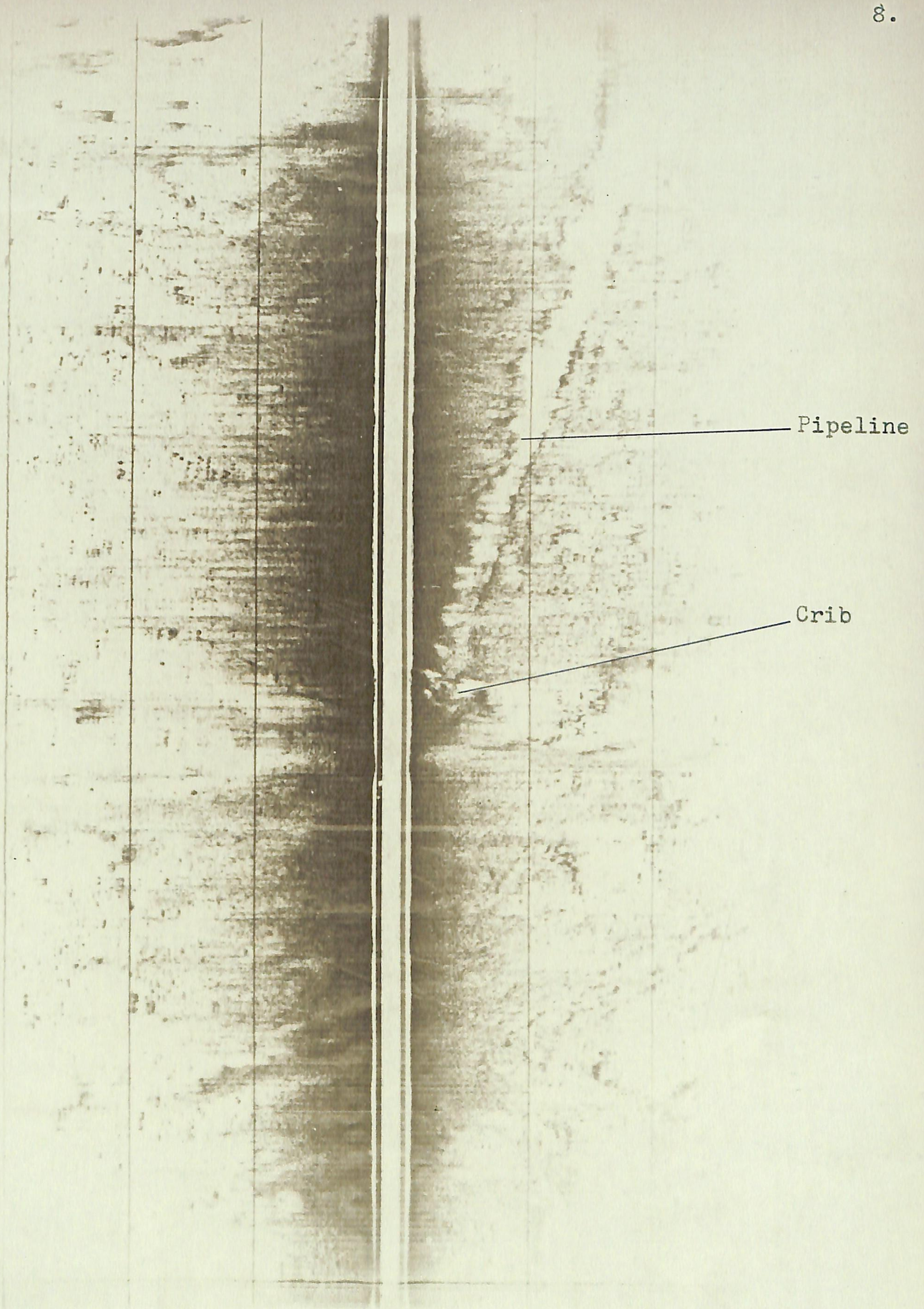
Georgian Bay near Killarney, showing rocky bottom with sand patches.



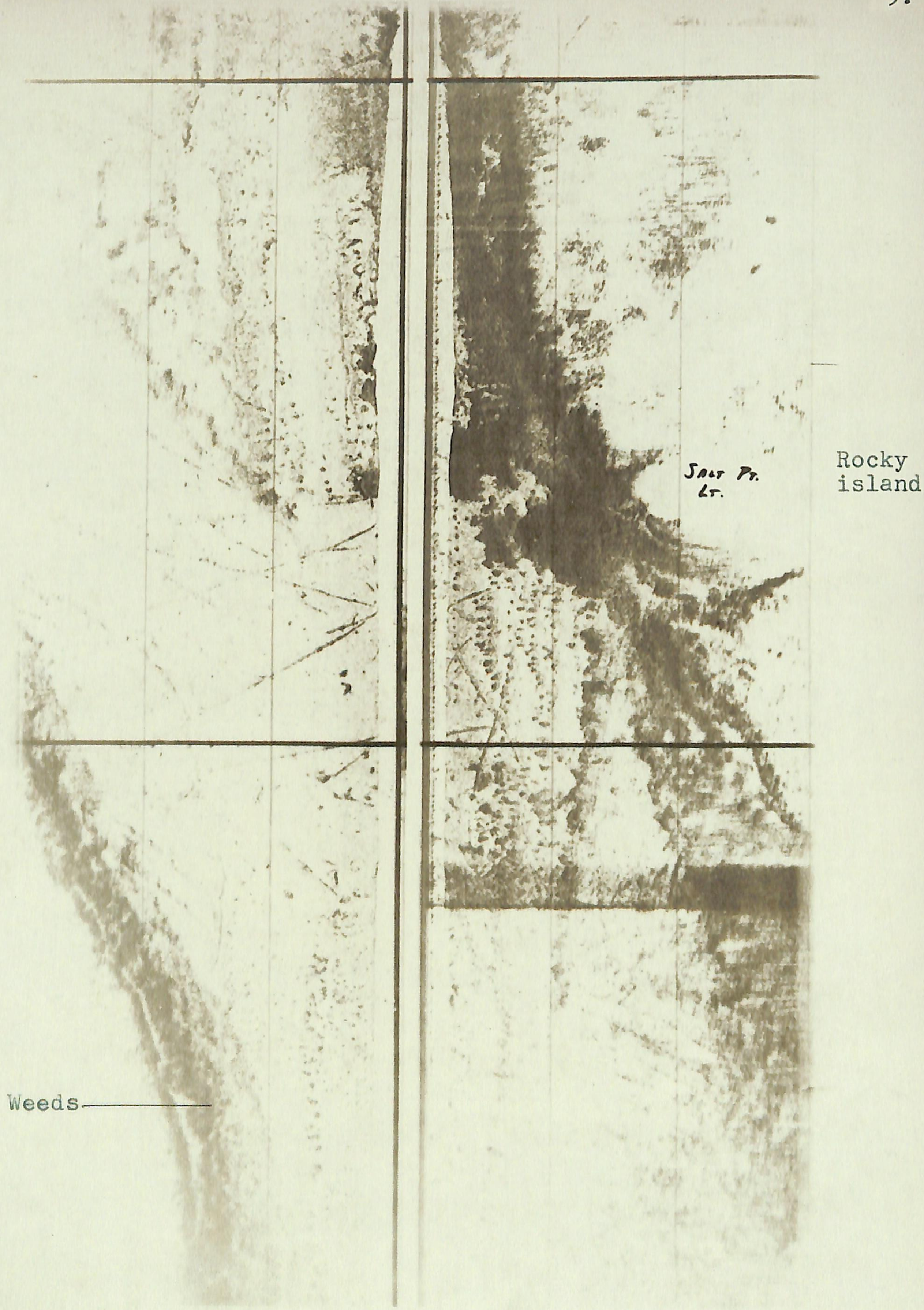
Hamilton Harbour dredged area



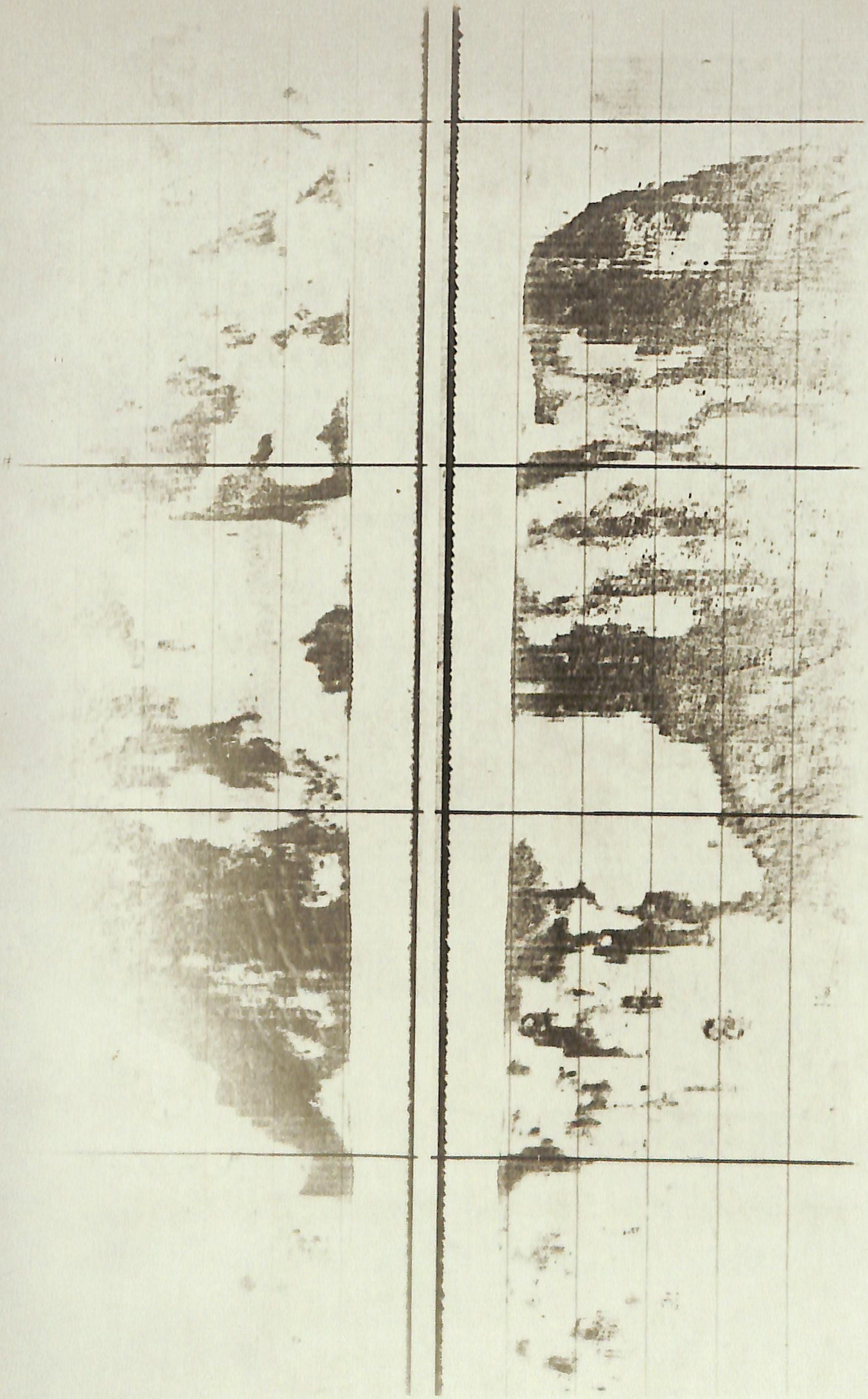
Thames River at Jeannette Creek.



Lake St. Clair. Water intake located by rubble covered pipeline.

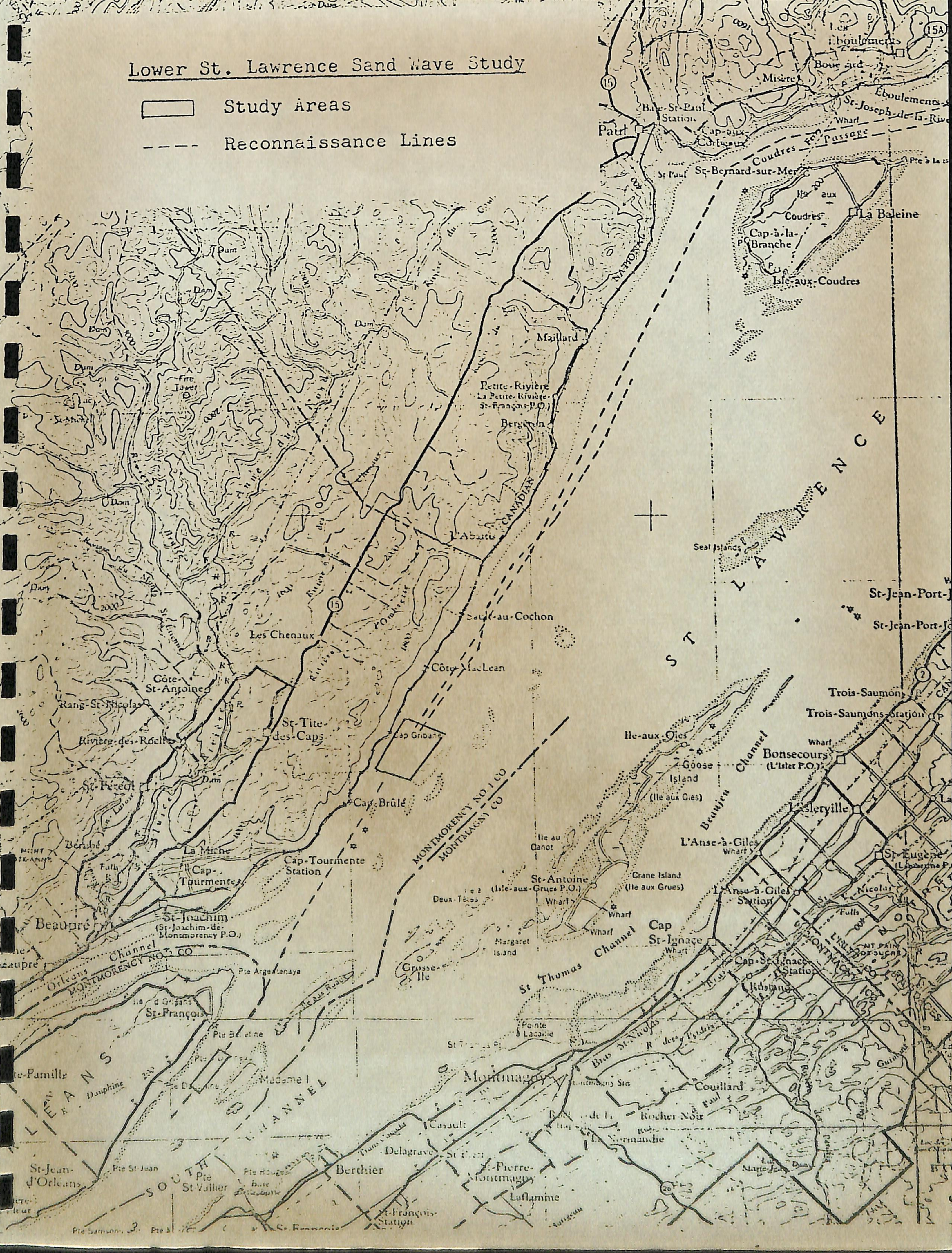


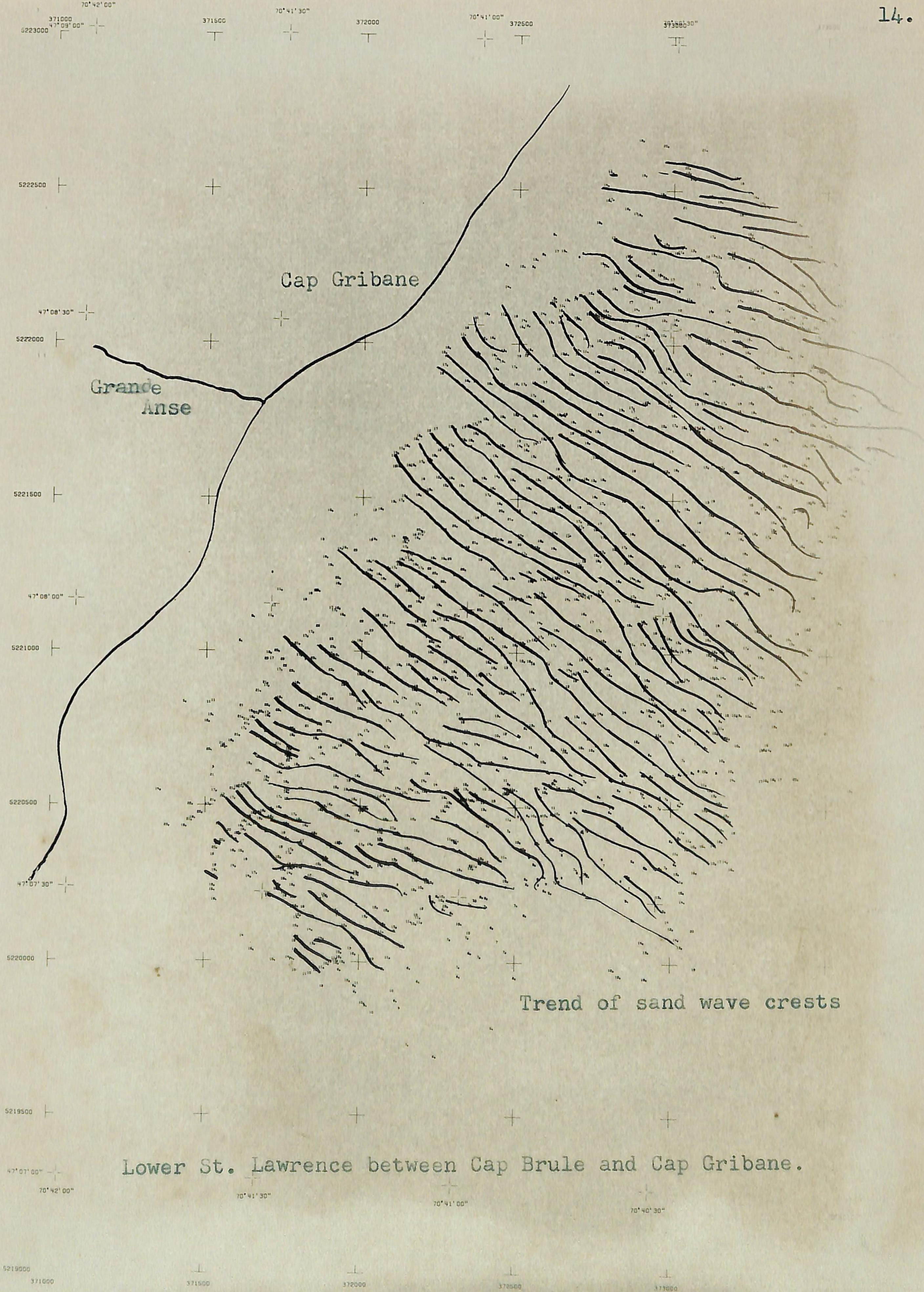
Brighton Ranges showing weed effects.



Cobourg Ranges with bottom material changes.


Rocky Patches
Sand Ripples
Shoal, other than rock
Scale 1:10,000


Lower St. Lawrence Sand Wave Study
Study Areas
Reconnaissance Lines
Cap Gribane
St-Tite-des-Caps
Cap-Brûlé
Côte-MacLean
Saut-au-Cochon
L'Abatis
Les Chenaux
Côte-St-Antoine
Rang-St-Nicolas
St-Ferréol
Cap-Tourmente
Cap-Tourmente Station
St-Joachim
(St-Joachim-de-Montmorency P.O.)
Beaupré
Orléans Channel
MONTMORENCY NO.2 CO
MONTMORENCY NO.1 CO
MONTMAGNY CO
CANADIAN
NATIONAL
Petite-Rivière
Maillard
Baie-St-Paul
Isle-aux-Coudres
La Baleine
Cap-à-la-Branche
St-Bernard-sur-Mer
Coudres Passage
St-Joseph-de-la-Rive
S T L A W R E N C E
Seal Islands
St-Jean-Port-Joli
Trois-Saumons
Trois-Saumons Station
Ile-aux-Oies
Goose Island
Beaujeu Channel
Bonsecours
(L'Islet P.O.)
L'Isletville
L'Anse-à-Giles
L'Anse-à-Giles Station
Crane Island
(Ile aux Grues)
St-Antoine
(Isle-aux-Grues P.O.)
Deux-Têtes
Margaret Island
Grosse-Ile
Cap St-Ignace
Cap-St-Ignace Station
St Thomas Channel
St-François
Pte Argentenay
Montmagny
Coulliard
Rocher Noir
Cassult
Delagrave
Berthier
St-Pierre-Montmagny
Luflamme
St-François Station
St-Jean d'Orléans
Pte St Jean
Pte St Vallier
SOUTH CHANNEL
Madame I
Dauphine



Lower St. Lawrence between Cap Brule and Cap Gribane.