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DETERMINATION OF WATER QUALITY PARAMETERS IN THE MASSACHUSETTS BAY (1970-1973)

by

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and

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Cambridge, Massachusetts 02139

Report No. MITSG 74-8
November 21, 1973

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Report No. MITSG 74-8
Index No. 74-308 Cbk

ABSTRACT

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SHEILA L. FRANKEL
and
BRYAN R. PEARCE

Field measurements and samples were taken on various dates from November 1970 to August 1973. These measurements include total suspended sediment, turbidity, dissolved oxygen, temperature, depth and salinity. The samples were returned to the Parsons Laboratory for NO_2^-, NO_3^-, $PO_4^{\equiv}$ and Si determination. Methods of determination have been specified and all data have been correlated to position and date. Studies in progress and future investigations are discussed. Trends in data, specifically spacial distribution, time variance and temperature dependence, are presented. All the data taken to date support the conclusion that the Massachusetts Bay coastal area is a nitrogen limiting system.

ACKNOWLEDGEMENTS

This study constitutes a part of a series of investigations in a major environmental research program on the "Sea Environment in Massachusetts Bay and Adjacent Waters". This program consists of theoretical and field investigations and is under the administrative and technical direction of Dr. Arthur T. Ippen, Institute Professor, Department of Civil Engineering and of Dr. Erik L. Mollo-Christensen, Professor, Department of Meteorology as co-principal investigators. Support of the program is provided in part by the Sea Grant Office of NOAA, Department of Commerce, Washington, D.C. through Grant No. NG-43-72, in part by the Henry L. and Grace Doherty Charitable Foundation, Inc., in part by NOAA/NOMES, Department of Commerce, Washington, D.C. through Grant No. 04-3-022-10, and in part by the Department of Natural Resources, Commonwealth of Massachusetts through Project No. DMR-73-1.

The project which is the subject of this report was conducted by staff members of the Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics and was administered under Project Nos. DSR 80344, 80575, and 81100 at M.I.T.

This report was prepared by Ms. Sheila L. Frankel, DSR Staff Chemist, and Dr. Bryan R. Pearce, Research Associate, Department of Civil Engineering. The advice and guidance of Dr. Arthur T. Ippen is hereby gratefully acknowledged.

Many people were involved in the collection of field data. Major participants, in addition to the authors, were Mr. Douglas A. Briggs, Mr. Edward F. McCaffrey, Mr. William Leimkuhler, Mr. George Christodoulou, Mr. Robert F. Paquette and Mr. Cortis Cooper, who also gave assistance in computer programming.

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CHAPTER 1

INTRODUCTION

The M.I.T. Massachusetts Bay Project is funded by an institutional grant from the Sea Grant Office, National Oceanographic and Atmospheric Administration, Department of Commerce, Washington, D.C. The Commonwealth of Massachusetts contributed funding to the project for the year 1972-1973.

The goal of the project is the comprehensive understanding of the physical environment of the waters in Massachusetts Bay with primary emphasis on the definition of pollution problems and the development of a predictive hydrodynamic model of the water environment. The essential inputs to such a model require the measurement and definition of all dynamic factors, such as winds, tide, currents, temperature, salinity, water quality, sediment transport, etc., on a continuous time scale and with variations through the seasons. The following methods are employed:

1. Salinity and temperature sections, surface mixing layer observations
2. Velocity measurements by drogues and current meters in cooperation with AOML
3. Vertcial cross sections of water chemistry
4. Vertical cross sections of suspended sediments

These goals and methods remain in effect but with modifications that have resulted from the temporary merger with the New England Offshore Mining Environment Study. The data taking for 1972-73 was modified, making it suitable for the more detailed study of the impact of the NOAA-NOMES Project as well as the existing Massachusetts Bay

Project. Since the NOMES Project ended July 1, 1973, studies have now returned to encompass the whole Bay and concentration on the NOMES area has been discontinued.

Figure 1 is a chart of the Massachusetts Bay Area and Figure 2 is a picture of the research vessel used for field studies.

The water chemistry sampling was started under separate sponsorship in 1970 and continued to date under the Sea Grant Project. It is intended that this field collection program must be carried out with the other baseline measurements as long as possible. Fifteen stations were sampled concurrently with phytoplankton measurements for the NOMES Project. Samples were taken at two week intervals over the vertical cross section and analyzed at the Parsons Water Quality Laboratory (Figure 3). Depending on the time of year, samples are analyzed for all or part of the following parameter list: NO_2^-, NO_3^-, NH_3, $PO_4^{\equiv}$, Si. These studies will continue and will typically include one Bay section, encompassing the entire bay, and two day cruises per month.

Systematic measurements of suspended sediment and turbidity in Massachusetts Bay have begun. It is intended to continue these measurements. The extended time span will provide statistically useful data including seasonal variations. This information will lead to a pattern of suspended load concentration and turbidity measurements varying with time and position in both lateral directions along with the vertical. Vertical profiles are important in that they will show the effects of the various currents at different depths (above and below the thermocline) and also the effects of waves and tidal action and turbulence on the concentration of the suspended matter.

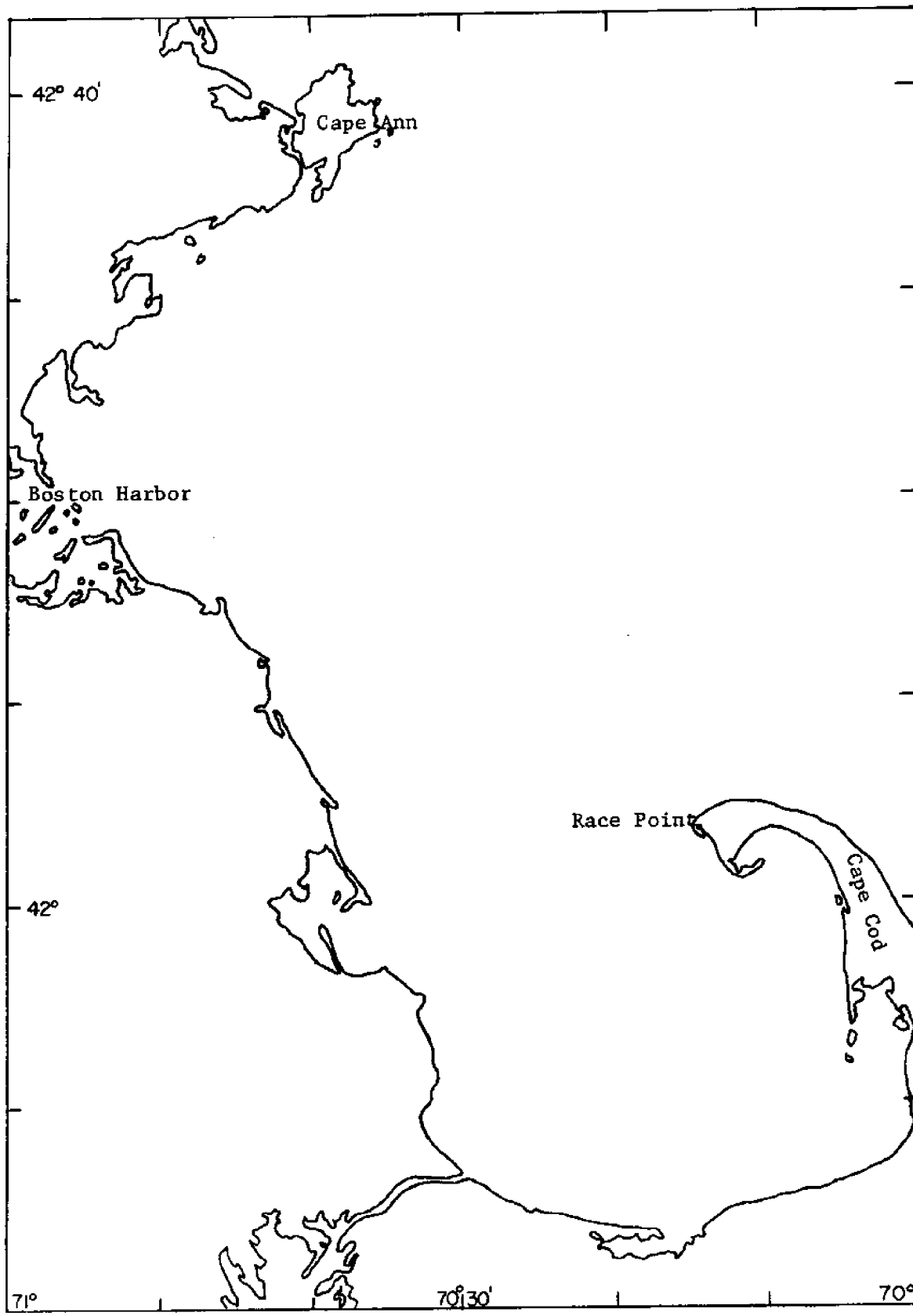


Figure 1 Massachusetts Bay Area

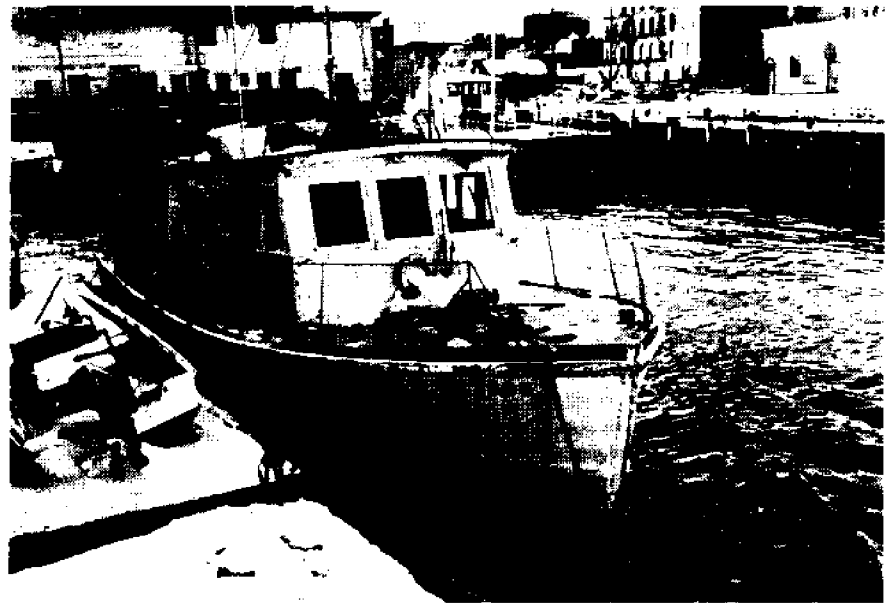


Figure 2 M.I.T. Research Vessel R. R. Shrock

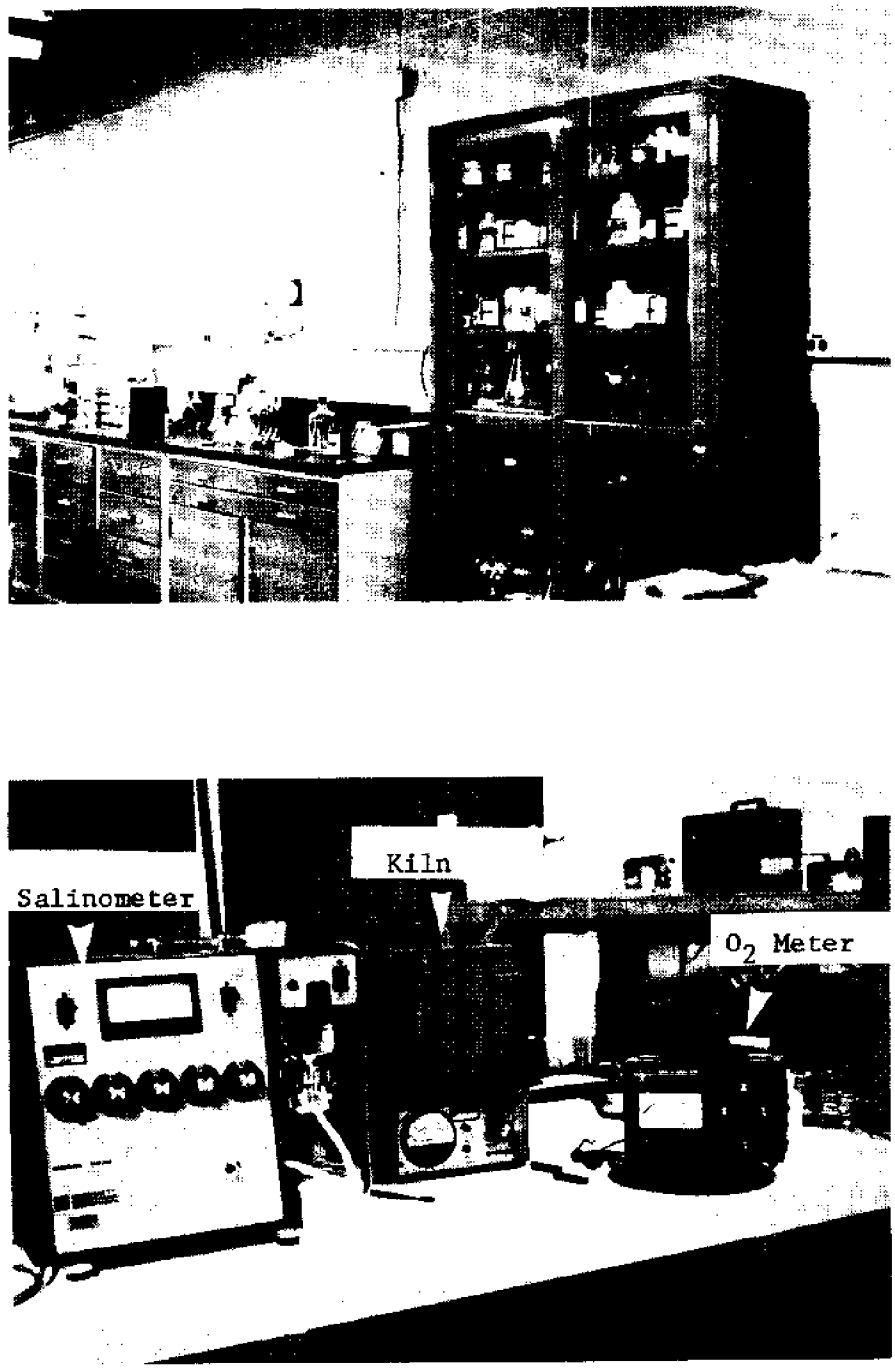


Figure 3 Chemistry Laboratory and Various Instruments Utilized

After an in-depth review of the methods of suspended load measurement, it was decided that the only reliable method would be by filtration.

Using water pumped on board, the turbidity will be monitored. This turbidity measurement will show correlation with suspended load. However, it is felt that the actual turbidity itself is an important factor, since one concern is the light depletion below the surface, which is caused by suspended matter.

The turbidity measurements will be made in conjunction with the routine chemistry and conductivity, temperature, depth surveys.

Presented here is a data progress report of those abiotic controls studied.

The following nutrients were analyzed: $PO_4^{\equiv}$, NO_2^-, NO_3^-, SiO_2, NH_3, and dissolved oxygen. Physical parameters measured include turbidity, suspended sediments and per cent organic material, salinity, temperature, depth, tide and currents.

Nutrient availability in the Bay is an important indication of environmental suitability to support living systems. Dynamic interaction of the following five processes govern the overall rate of production of biomass (Stumm and Morgan, 1967).

1. Uptake of soluble nutrients by phytoplankton and bacteria
2. Loss of nutrients as soluble organic compounds from phytoplankton followed by slow regeneration of nutrients
3. Sedimentation of plankton and other nutrient containing detritus

4. Migration of inorganic nutrients from the sediments and the decay of littoral vegetation
5. Restoration of soluble nutrients to the phytosynthetic zone from the sediments by vertical currents.

The nature of these nutrients can be determined by chemical analysis. The nutrients which are among those necessary to phytoplankton growth, i.e., N, P, Si (for diatoms), are studied. N is usually a critical limiting nutrient for production and is found in coastal waters as NH_3 or in other more oxidized states as NO_3^- or NO_2^-. Nitrogen is a necessary constituent of amino acids, proteins and of nucleic acids such as RNA and DNA. Deficiencies in nitrogen can severely limit growth. Phosphorus is important as it is a component of energy transfer compounds such as ATP of the nucleic acids and of phospholipids. The ratio of nitrogen to phosphorus varies from 3:1 to 30:1 (by atoms) in unicelular marine algae. The ratio varies according to the kind of algae and the availability of both nutrients (Ryther & Dunston, 1971). Figure 4 (Riley & Skirrow, 1965, p. 550) shows the relative changes of cell composition of phytoplankton owing to nitrogen and phosphorus depletion in sea water.

Silicon is a basic structual element in the cell walls of diatoms and is an important parameter to consider. Dissolved O_2 is a measurement of phytoplankton productivity and its availability is important to marine life.

Temperature is a natural regulatory factor in biomass production. As all chemical reactions are temperature dependent, so are the enzyme catalyzed biochemical reactions that govern the metabolic activity of

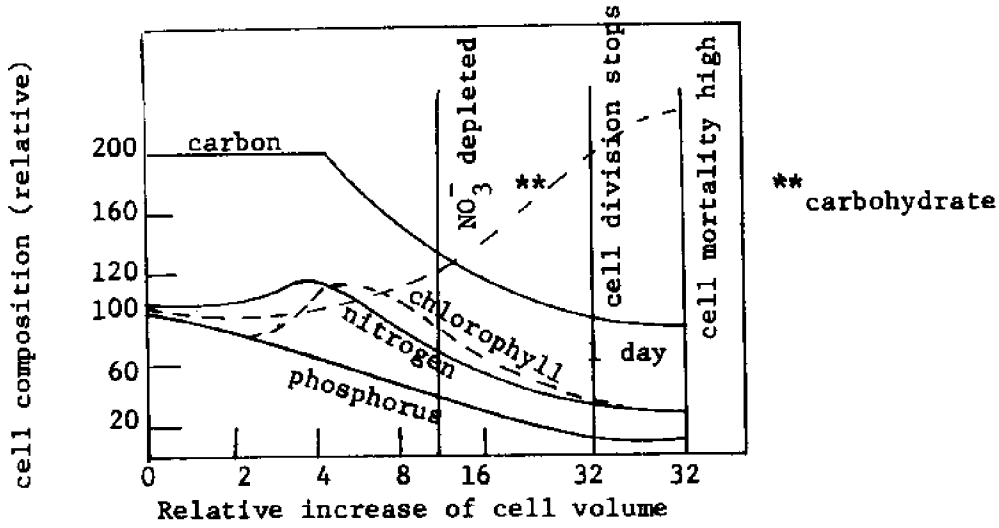


Figure 4 Relative Changes of Cell Composition of Phytoplankton Owing to Nitrogen Phosphorus Depletion in Sea Water

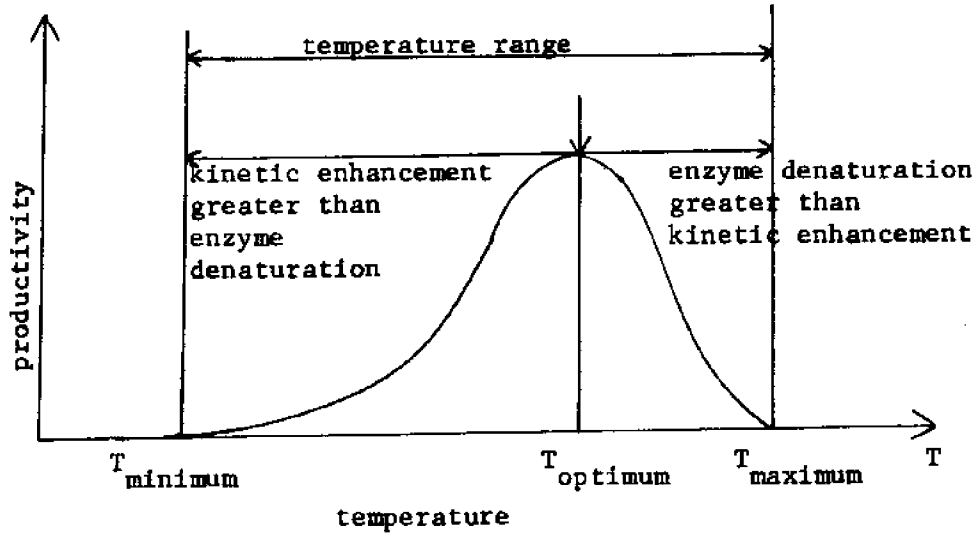


Figure 5 Productivity as a Function of Temperature for Phytoplankton

phytoplankton. Enzyme catalysis is extremely sensitive to temperature changes. As one would expect, in the winter, phytoplankton production is minimal while in summer it is maximal. In spring and fall production is dependent on changes in temperature. Therefore, vertical temperature measurements indicate the favorable layers of production. This is illustrated by Figure 5 (Alician Quinlan - private communication).

Salinity affects biological activity because a change in salinity causes a change in ionic strength of the environmental medium and a change in gas solubility. Figure 6 illustrates the gas solubility as a function of salinity. As salinity increases, gas solubility decreases, in particular that of CO_2. This means less available CO_2 for phytoplankton photosynthetic production. This effect is coupled with the influence of ionic strength differentials set up across the cell walls. Water flows through the cell walls to higher ionic strength and causes internal concentration problems. Physiological processes operate within a limit of ionic strength. If there is not a balance of extracellular and intracellular ionic strengths, especially if net flow of water is inward, the cell could burst. Thus, there must be a pumping process of water into or out of the cell. What is important is the amount of energy consumption necessary for this process. If too much energy is applied to this process, not enough energy for reproduction and growth will be left.

Necessary, of course, to understanding marine ecosystems, is the measurement of the amount of sediment both organic and inorganic in aquatic layers. This gives a crude indication of the amount of biomass

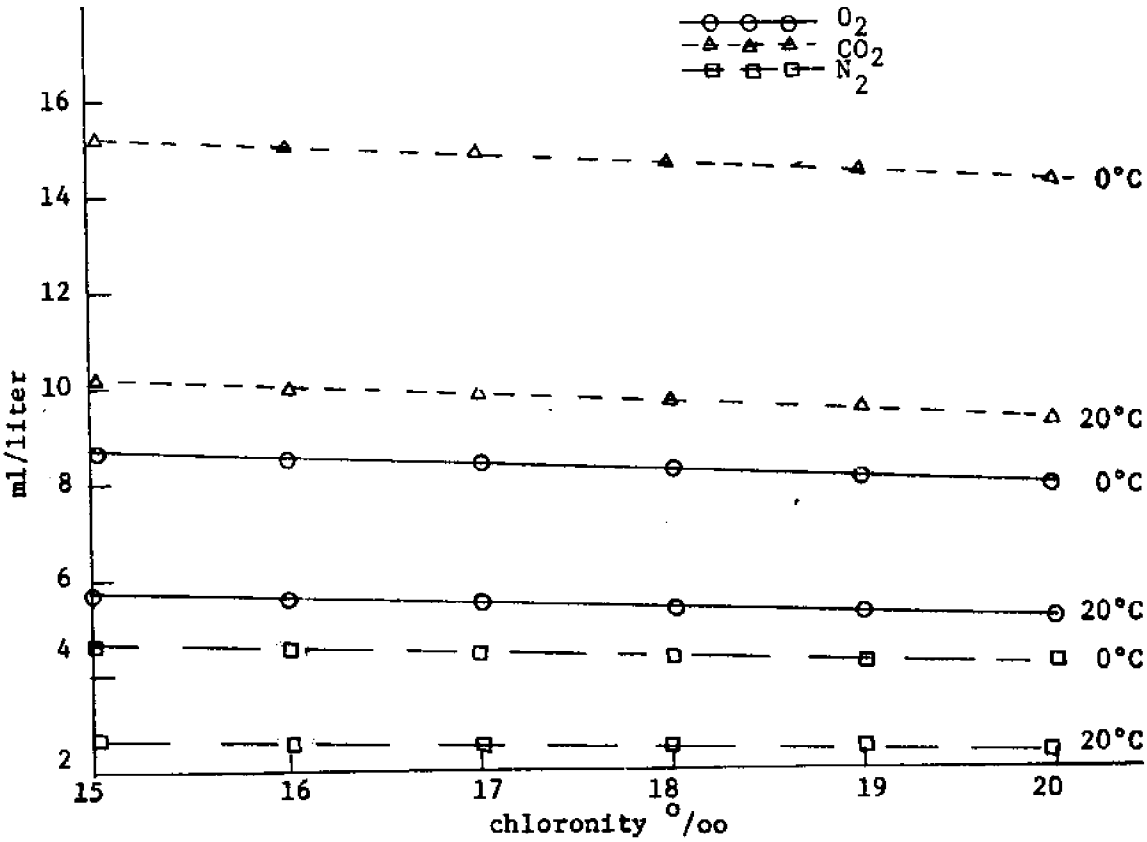


Figure 6 Solubility of Gases vs Chlorinity

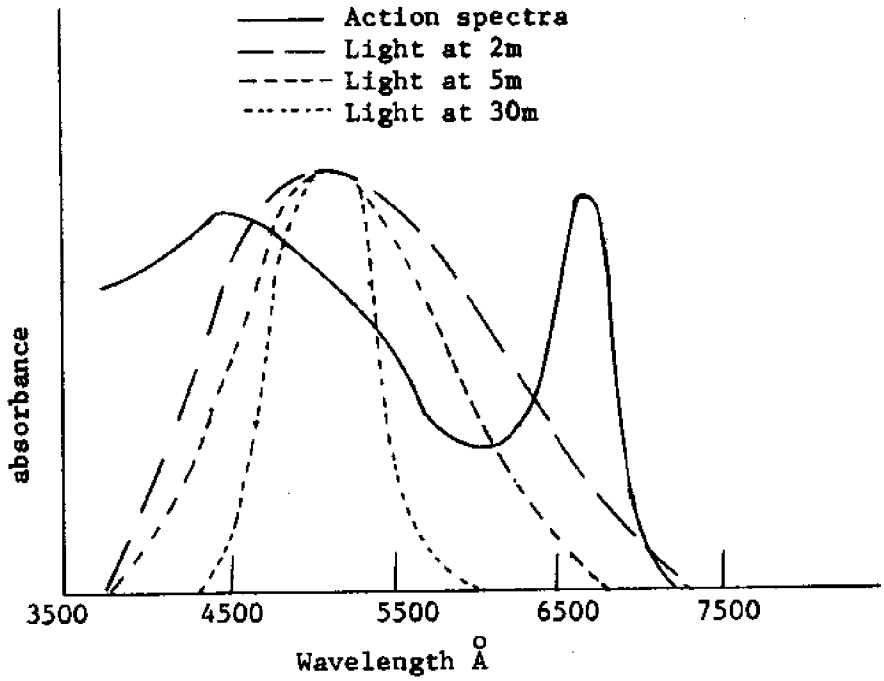


Figure 7 Spectra for Sunlight in Seawater and Idealized Action Spectrum for Marine Phytoplankton

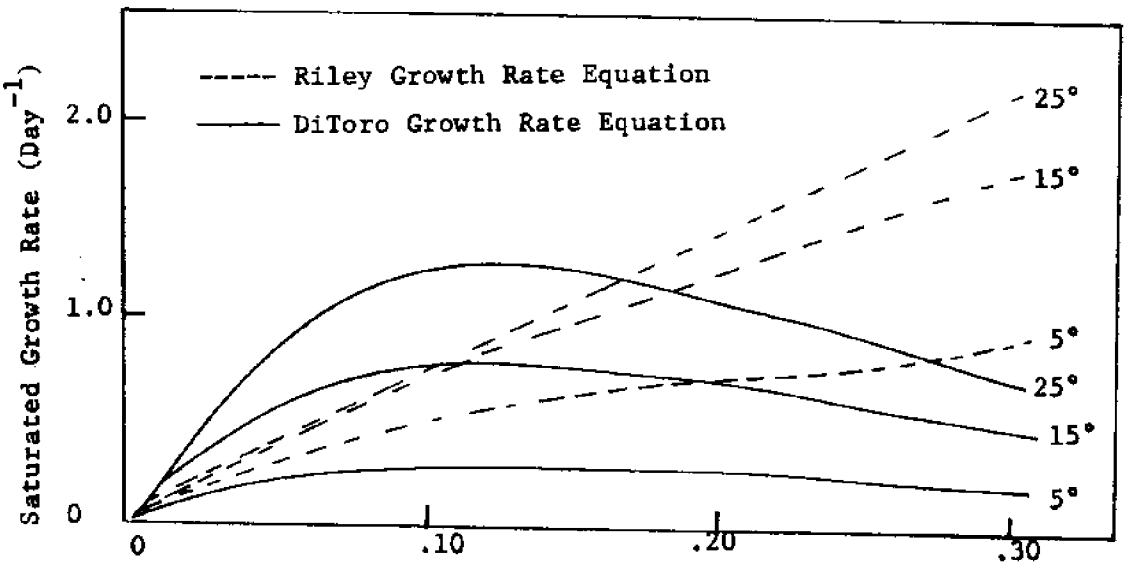
1. Spectral Distribution and Intensity of Light in Seawater Varies with Depth
2. Action Spectrum (Normalized Rate of Photosynthesis vs Wavelength) Shows Photosynthesis Pigments Most Efficient near Wavelengths Least Readily Absorbed by Seawater

in the layers and also of the availability of inorganic material, such as trace elements, necessary to the production of biomass.

The percentage of inorganic materials in suspended sediment is indicative also of the amount of fine clays and silt which originate from fresh water inputs such as rivers. In shallow waters, suspended sediment can be a measure of the stirring up of sediment layers on the bottom.

Since radiation is the only source of energy available for production of biomass, light is a growth limiting factor. As can be seen in Figures 7 (Riley and Skirrow, 1965, p. 529) and 8 (DiToro et. al., 1970), the spectral distribution and intensity of light in seawater varies with depth. These peaks are shown for clear coastal seawater and demonstrate where the photosynthetic process is most efficient, i.e., near the chlorophyl a and carotenoid absorption peaks. Since white light is rapidly absorbed by seawater and little penetrates to lower depths, it is important to consider the turbidity of the layers. The more turbid the water, the less light is likely to penetrate and thus smaller biomass production will occur.

Monitoring of the above parameters can contribute not only to the understanding of the Mass Bay environment but also to the maintenance of a clean and healthy ecosystem. If an aquatic ecosystem is to flourish, the requirements already stated are a necessary, though perhaps not sufficient, condition. Due to gaps in the understanding of the oceans, there may be further necessary conditions as yet not found. By careful measurement of abiotic controls, the best and worst areas in the bay can be located and studied. Two benefits



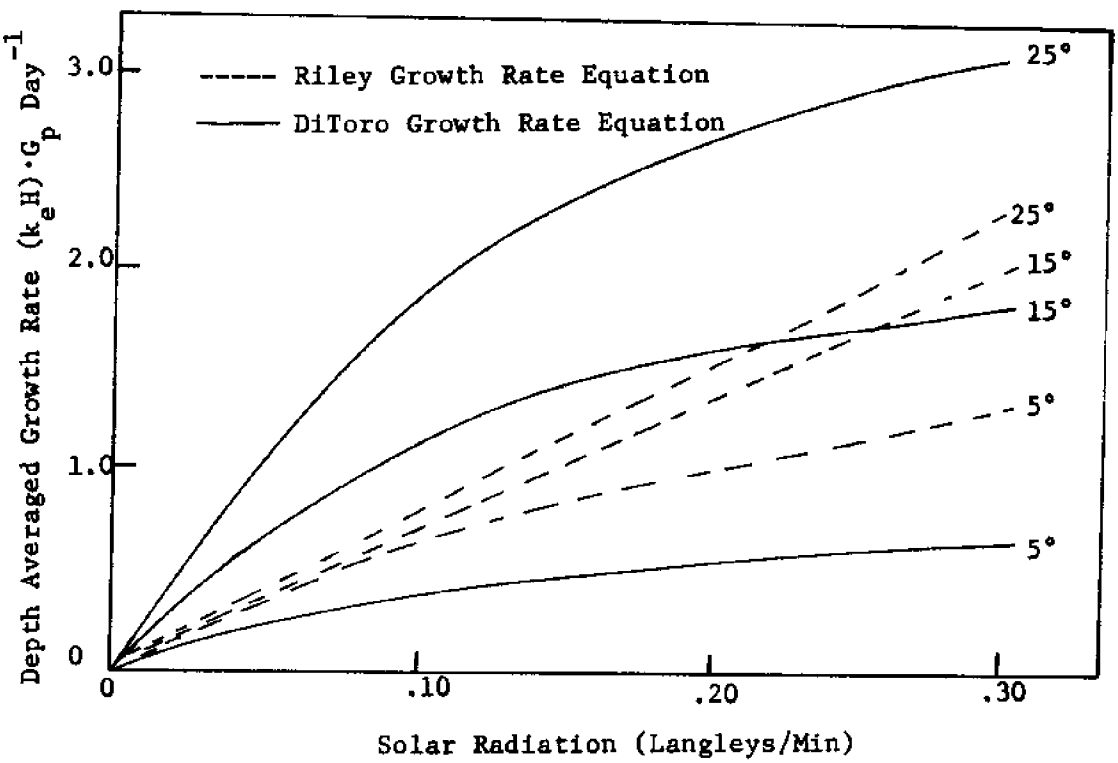


Figure 8 Comparison of Phytoplankton Growth Rates as a Function of Incident Solar Radiation Intensity and Temperature

(Langley = cal/cm^2)

can be derived from such studies. First, observing the effect of human and natural influences on these controls could lead to an ability to predict the biological behavior of the bay. Perhaps pollution, as an example, could alter any or all of the above abiotic controls thus damaging the necessary life sustaining systems. Second, anomalies in these observations could lead to new discoveries, either biological or physical.

Misuse threatens the oceans which are the source of a large portion of our food supply and the greatest source of atmospheric oxygen. Since, despite their importance, the natural waters of the world remain in large part a mystery, the importance of studies of this kind cannot be overemphasized.

CHAPTER 2

METHODS OF SAMPLING AND PRESERVATION

The nutrient samples taken from February to May, 1973 were obtained using a Van Dorn sampling bottle. No bottles were used as sample containers. $CHCl_3$ was used as a preservative. Mercuric chloride ($HgCl_2$) is generally recognized to be a superior preservative to chloroform. We, however, fully realizing the impact of mercury poisoning in our natural water systems, agree completely with the Environmental Protection Agency that the use of mercuric chloride should be avoided if at all feasible. The sample bottles were then kept at 4°C until analyzed. Although $CHCl_3$ was recommended as a preservative by EPA and Technicon Corp., it has been found that it is somewhat unsatisfactory for absolute data. We were, however, able to obtain relative data on the fluctuations of nutrient levels in the Bay area. Our studies were especially concentrated in the NOMES Project Area. Since May, 1973, studies on proper preservation techniques for nutrient samples have been conducted at the Parsons Laboratory. Of concern in the fact that poisoning causes lysing of cells and thus is not completely satisfactory as a preservative. Current studies are examining the effect, on samples, of filtering and then quick freezing them. Our results are not as yet conclusive but they seem to indicate that more reliable data can be obtained when samples are frozen rather than poisoned. (This will be discussed in Chapter 4 of this report).

Our more recent data is drawn from samples that are preserved

by quick freezing with dry ice, on board, immediately after sampling. Sampling in these cases was done using a Little Giant submersible pump which was attached to the M.I.T. C.T.D. The sampling connectors and pump impeller constitute an all P.V.C. sampling system. The sampling system is flushed completely at each sample location before sampling procedures are begun at that depth and location.

Suspended sediment samples are taken and filtered either on board or immediately upon arrival at the lab. They are filtered through 0.45μ millipore filters (HAWP). If samples are not filtered immediately, they are kept at 4°C.

Salinity, depth and temperature data are obtained using the M.I.T. C.T.D. Turbidity of samples is taken on board ship immediately after sampling.

Dissolved O_2 is done in situ using a model 54 Yellow Springs dissolved oxygen meter which was calibrated against our own portable Winkler apparatus and checked with saturated seawater.

Ammonia samples will be taken by freezing without filtering. Filtering delays the preservation of samples and since rapid loss of NH_3 accompanies the warming of the samples, immediate freezing is necessary. De Gobbis (J. of L. & O., 1973) found that the best method of freezing samples is to use large polyethylene bottles. The larger the sample bottle is, the smaller the surface to volume ratio and therefore the smaller the likelihood of ammonia loss from the samples.

CHAPTER 3

INSTRUMENTS UTILIZED AND METHODS FOR ANALYSIS

To measure so many parameters accurately and efficiently, a great number of instruments and methods must be employed. The different methodologies and varied instrumentation will be discussed in this chapter.

3.1 The C.T.D.

The C.T.D. is a conductivity, temperature and depth instrument which is used during the Massachusetts Bay study to measure temperature and conductivity over the depth of the water column. This instrument was developed by the Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics for oceanographic studies with funds provided by the Massachusetts Bay/Sea Grant Program. The C.T.D. provides vertical profiles of temperature versus depth and conductivity versus depth and was designed for computer compatibility. The C.T.D. is shown in Figure 9. The sensors are a Standard Controls Company pressure transducer Model #210-80-040-06; Rosemont Engineering Company, Model #171CG platinum resistance thermometer and a Plessey Company, Model #2600-3 conductivity transformer.

The output signal from each sensor is provided in F.M. format by voltage control oscillators. These signals can then be recorded with a clock signal on an 8-track Precision Instrument magnetic tape recorder and then reduced to digital format (which is converted to hard copy output on IBM 360/70) or on board graphic output can be provided by a three channel discriminator circuit and a Houston

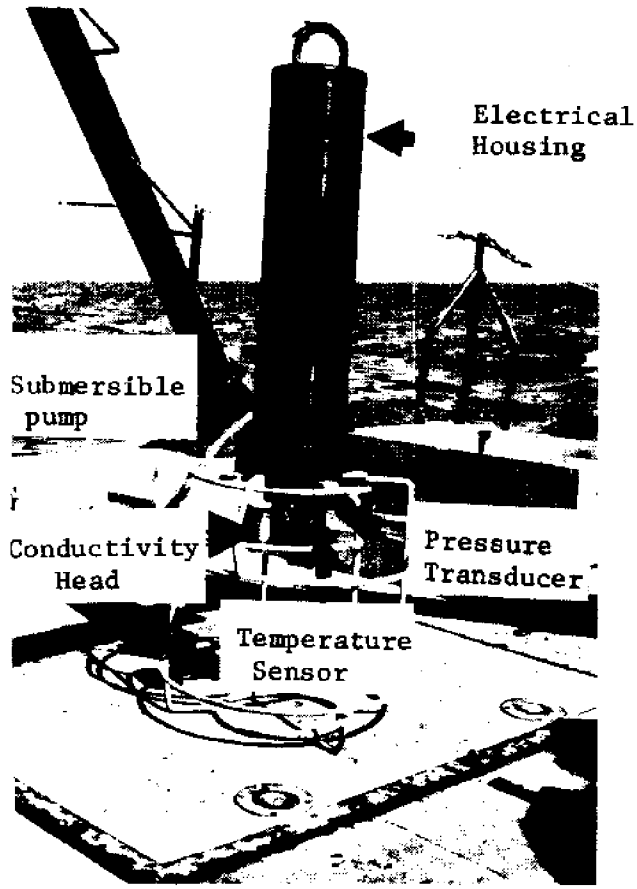


Figure 9 The M.I.T. Conductivity, Temperature, Depth Instrument

Instrument x-y plotter. The accuracy of the sensors is 0.01°C for temperature, 0.5 feet for depth and 0.02 MM/CM for conductivity. The system is linear to 0.01 percent for all sensors and the temperature element has a time constant of 0.31 seconds. A listing of sample C.T.D. data is shown in Appendix C.

3.2 Suspended Solids

Total suspended sediment is measured by filtering on board immediately after sampling. Previously (February, 1973 - March, 1973) Millipore matched weight preweighed 37 mm filters had been used in the Millipore fluid sampling kit. The kit contained disposable plastic filter holders, a special stainless steel holder, tubing, connectors and accessories necessary to do pressurized filtering on fluid samples. Use of that particular set-up was soon dropped due to inaccurate weights received from Millipore and contamination of filtering lines.

Apparatus now used for filtering was put together by the Massachusetts Bay Sea Grant group at M.I.T. A portable set-up (Figure 10) includes 5 Millipore glass filtering funnels and 5 polyethylene containers. A vacuum pump is used at approximately 15 in/Hg. The pump is capable of lowering the pressure to 5 in/Hg.

All weights are taken using a Mettler Co. Semi-micro Balance with accuracy to ± .01 mg. Millipore .45μ mixed cellulose ester filters (47 mm) are preweighed on that balance before each cruise. Two filters are used during the filtering process; the bottom filter being a blank.

The sets of filters are washed with 250 ml of deionized water immediately after filtering. They are then returned to the laboratory

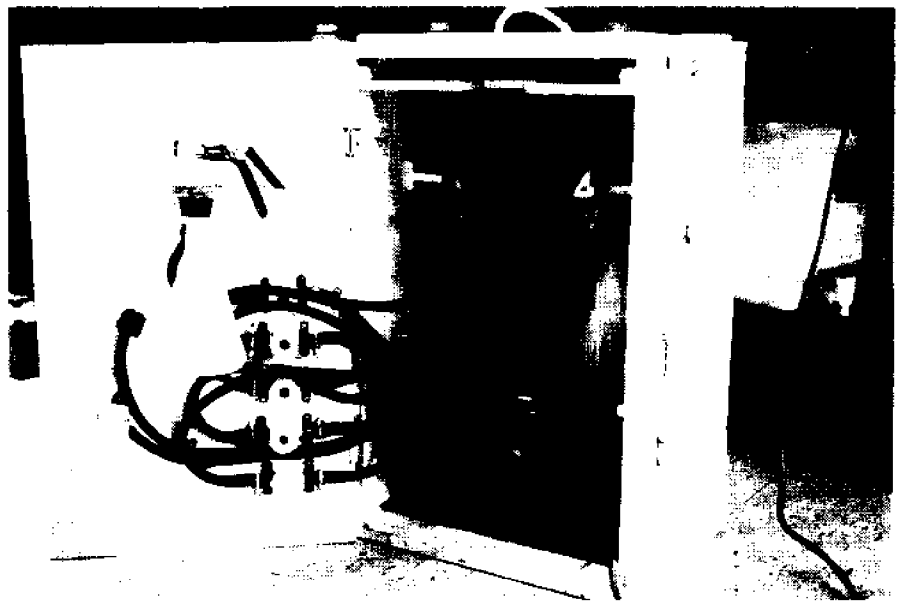


Figure 10 Portable Filtering Apparatus

after the cruise and allowed to air dry for 2 to 3 days. The filters are covered while drying to protect them from particles in the air. After the filters have had sufficient drying time, they are weighed separately. The total suspended solids are then calculated taking into account the added weight, if any, to the blank, as well as the added weight to the top filter. That is,

$$\text{Total Suspended Solid} = (\Delta \text{ weight}_{\text{top filter}} - \Delta \text{ weight}_{\text{bottom filter}})$$

After the determination of the total suspended solids in milligrams per liter of seawater, the filters are cut in half. Half of the top filter is saved for analysis of grain size distribution. The other half of the filter and corresponding half of the blank are used in determining the percentage of organic material in the solids. The half filters are weighed and then soaked in ethyl alcohol so that they can be rolled and placed into a small platinum crucible. All the platinum crucibles used have been preheated, cooled and weighed. Platinum crucibles have virtually no weight change due to their lack of reactivity. A blank half is always fired along with a top half. The platinum crucibles are first heated to rid the filters of any excess moisture. Then the platinum crucibles are placed in porcelain crucibles with covers which are put in a kiln. They are fired at 500°C for one hour. At this temperature all organic material would burn off leaving only inorganic material. No higher temperature is used because at 550°C, calcium carbonate would begin to decompose. It would then be followed by inorganic compounds as temperatures increased. After an hour the crucibles are removed from the kiln and placed in a

dessicator for 30 minutes to cool. They are then weighed.

To calculate the percent organic matter:

1) Subtract weight of empty crucible and blank correlation (average weight of 1/2 of control filters),

2) Multiply by 2 = actual ash content of filter,

3) $\%\ \text{organic} = \frac{\text{total suspended matter (corrected ash) x 100}}{\text{total suspended matter}}$.

The method employed was found to be the best existant method for measuring total suspended solids. This method is presently in use by Dr. K. O. Emery at Woods Hole Oceanographic Institute, Woods Hole, Massachusetts.

3.3 Turbidity

Turbidity, which is taken immediately on board, is measured on a Hach 2100 A Turbidimeter. The method essentially is the comparison of the intensity of light scattered by a sample with the intensity of light scattered by a standard reference suspension. The higher the intensity of light, the higher the turbidity. Formazin polymer is used as the reference suspension for water as its reproducibility is better than others tested. The Environmental Protection Agency recommends only the Hach Turbidimeter because it is the only commercial instrument available with the following necessary specifications (EPA, pp. 308-319).

1. The turbidimeter shall consist of a nephelometer with light source for illuminating the sample and one or more photo-electric detectors with a readout device to indicate the intensity of light scattered at right angles to the path of the incident light. The turbidimeter should be so designed that little stray light reaches

the detector in the absence of turbidity and should be free from significant drift after a short warm-up period.

2. The sensitivity of the instrument should permit detection of turbidity differences of 0.02 unit or less in waters having turbidities less than 1 unit. The instrument should measure from 0 to 40 units turbidity. Several ranges will be necessary to obtain both adequate coverage and sufficient sensitivity for low turbidities.

3. The sample tubes to be used with the available instrument must be of clear, colorless glass. They should be kept scrupulously clean, both inside and out, and discarded when they become scratched or etched. They must not be handled at all where the light strikes them, but should be provided with sufficient extra length, or with a protective case, so that they may be handled.

4. Differences in physical design of turbidimeters will cause differences in measured values for turbidity even though the same suspension is used for calibration. To minimize such differences, the following design criteria should be observed:

   4.1 Light source: Tungsten lamp operated at not less than 85% of rated voltage or more than rated voltage.

   4.2 Distance traversed by incident light and scattered light within the sample tube: Total not to exceed 10 cm.

   4.3 Angle of light acceptance of the detector: Centered at 90° to the incident light path and not to exceed ± 30° from 90°.

   4.4 Maximum turbidity to be measured: 40 units.

3.4 Nutrient Data

Nutrient data is analyzed by a Technicon Monitor IV Auto Analyzer. A Sampler IV was added to the setup to insure uniformity of sample times and no contamination. (See Figures 11, 12, 13). An automated method is superior to a manual colorimetric method for several reasons which will be covered in the following.

Ion analysis is accomplished through the use of one of the fundamental equations of analytical photometry: Beer's Law ($I = I_o e^{-acb}$). Calibration curves for concentration are also based on fundamental laws:

$$\text{Concentration of Unknown} = \frac{\text{Absorbance of Unknown}}{\text{Absorbance of Standard}} \times \text{Concentration of Standard}$$

$T = I/I_o$

I = Light exiting flow cell

I_o = Incident light (before entering flow cell)

$A = -\log T = \log \frac{1}{T} = \log I_o/I = abc$ = absorbance

a = absorptivity

b = sample thickness (light path length)

c = concentration (moles/liter)

absorptivity = mode of expression of relationship between light energy, sample concentration and thickness

$abc = \log I_o/I$

$$a = \frac{\log I_o/I}{bc}$$

b = cm

c = moles/l

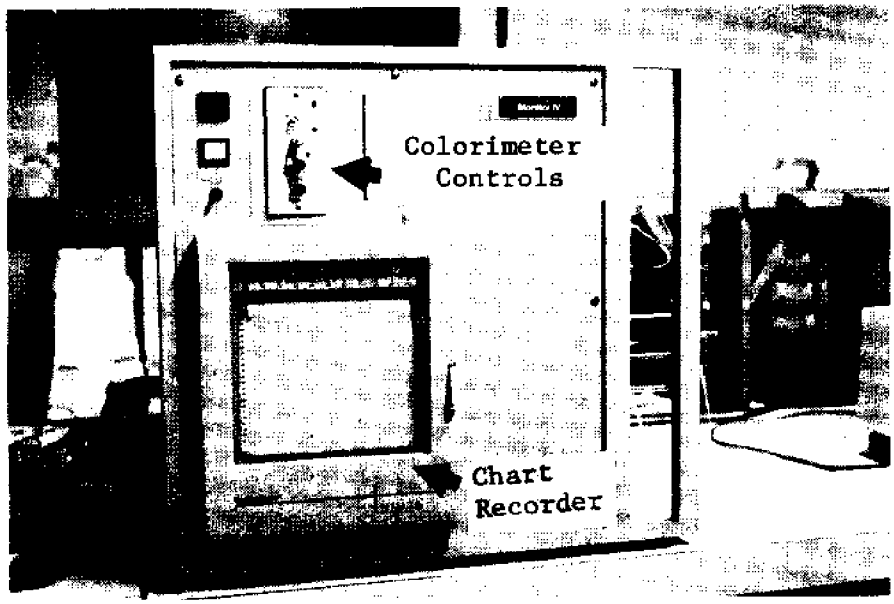


Figure 11 Technicon Monitor IV Auto Analyzer

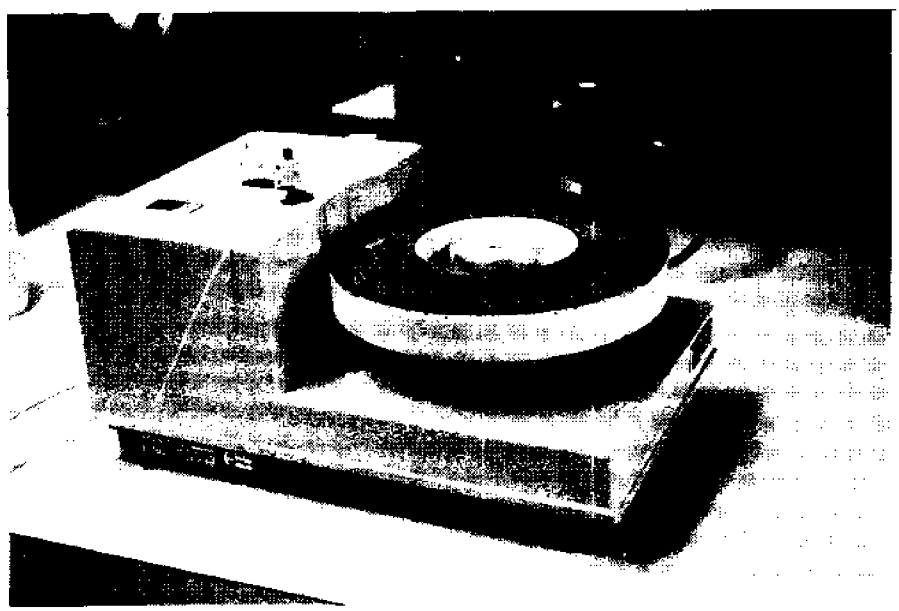


Figure 12 Sampler IV Accessory to Auto Analyzer

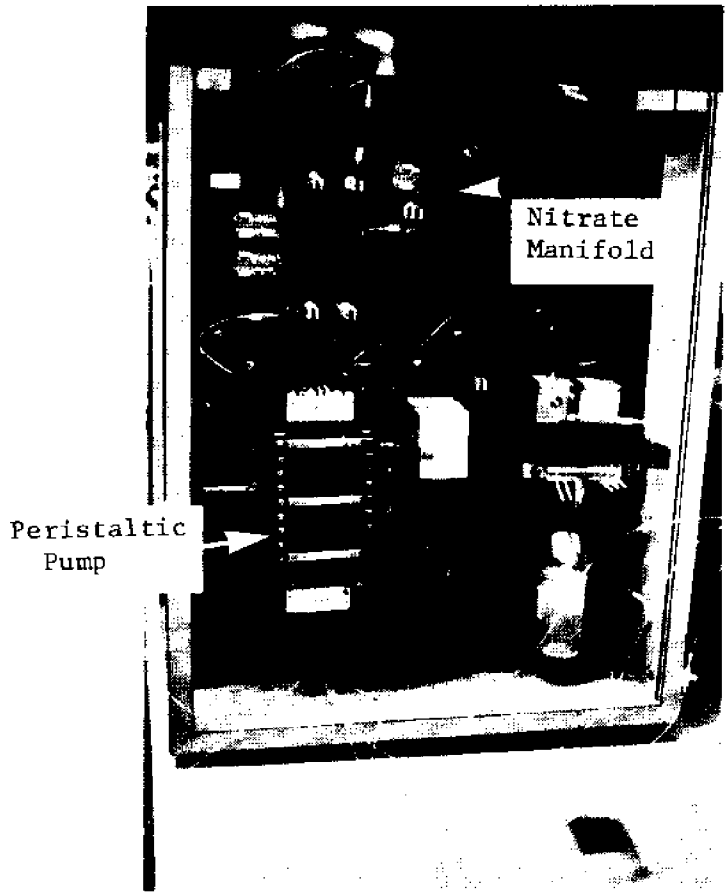
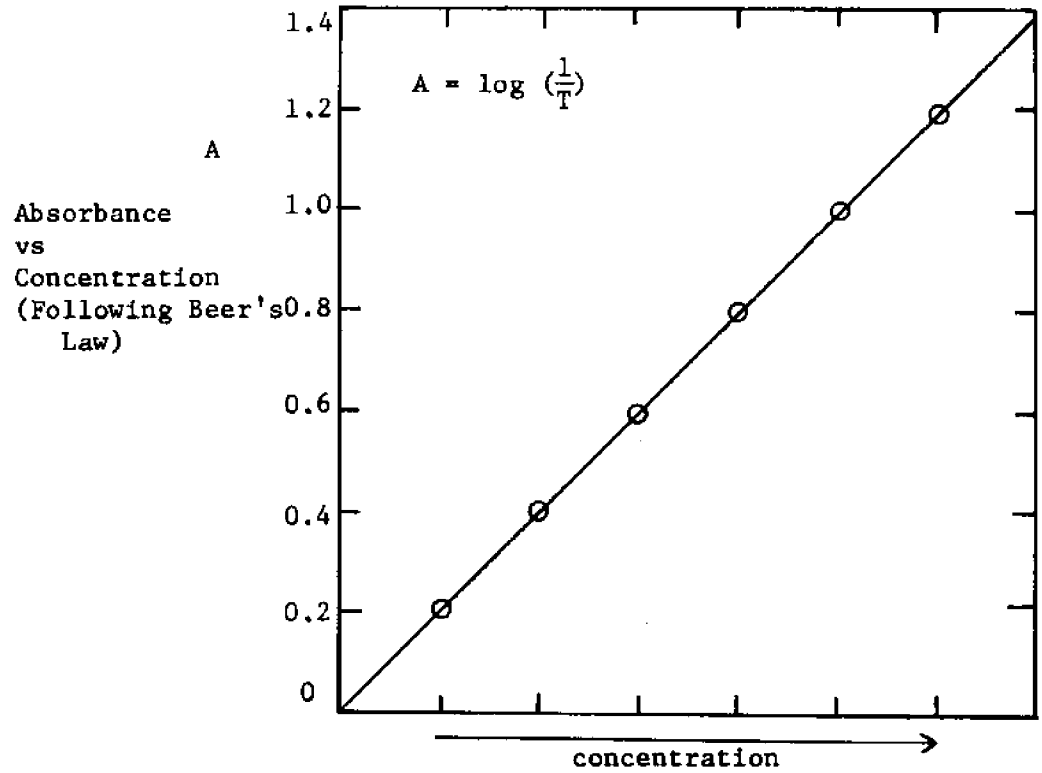


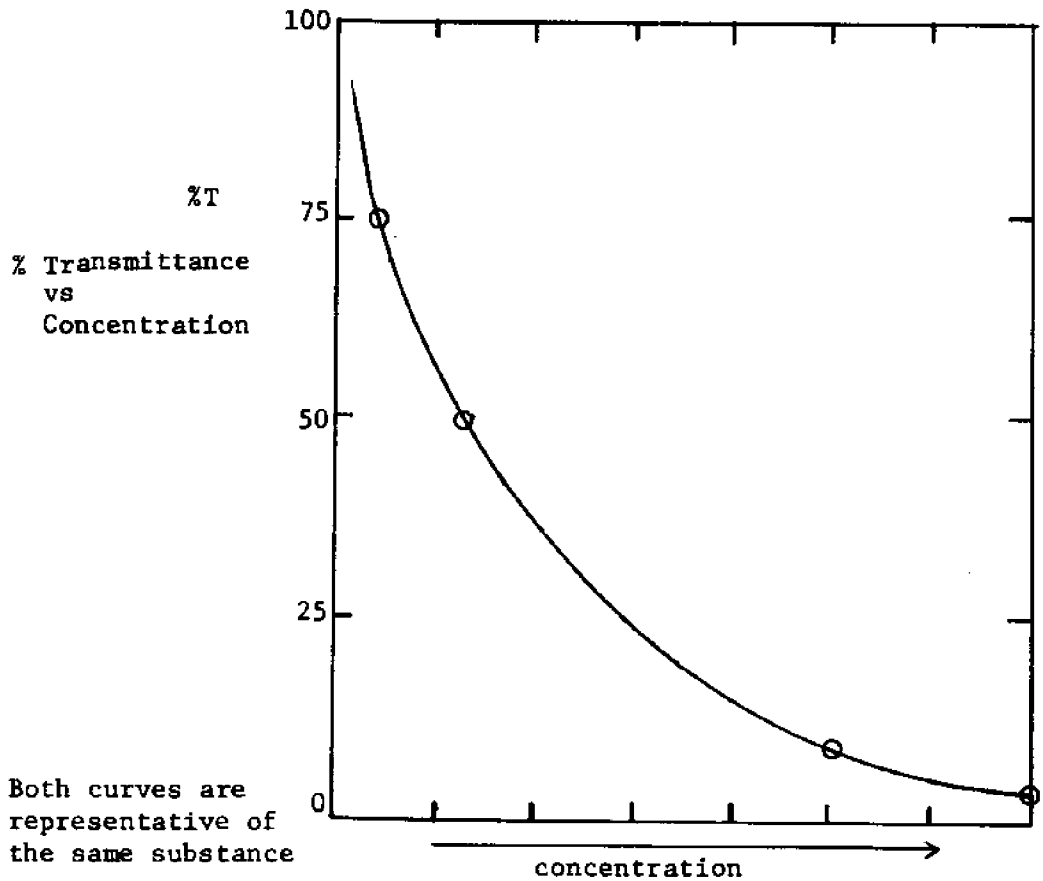
Figure 13 Front View of Auto Analyzer with Nitrate Manifold

If Beer's Law is to apply, light coming through the filter must be monochromatic (Technicon filters are used) and distance travelled by the light must be fixed (a Technicon 50 ml flowcell is used and the path length is constant). As can be seen by the above equation, if a longer path length is used absorbance is increased and as a result sensitivity is increased. In all our determinations an extra long flow cell is used to obtain maximum sensitivity.

When Beer's Law is followed (refer to Figure 14) a graph of absorbance versus concentration shows the plotted points form a straignt line. Because of slight non-linearities which can be introduced through ambient light, improper filters and chemical errors (temperature variation, impurities, uncontrolled Ph, interferences and non-linearity of chemical reactions at very low concentrations) calibration curves are drawn for every ion measured and for each determination. A computer program set up to analyze the data uses a least squares determination to draw the best straight line through known standard points in order to calibrate the instrument. Built into the program are allowances for electrical and chemical drift over the time required for analysis. Refer to Figure 14a for computer program. Values of absorbance are input to the program which then prints out the corrected concentrations of the ions in micromoles/liter.

The analyzer, to a large extent, eliminates random human error. A reference beam in the colorimeter is averaged with a sample beam (see Figures 15 and 16). The air bubbles introduced into the sample tubes insure sample integrity from one sample to the next and also increase thorough mixing within each sample module (see Figure 17). All of the





Both curves are representative of the same substance

Figure 14 Calibration Curves

```
DIM Y[4],E[4],M[3],B[3],S[60],D[60],A[60],X[60]
LET F=5
 GOSUB 2000
 FOR W=1 TO 100
 LET F=2
 PRINT "ENTER DATE OF TEST"
 INPUT D1,D2,D3
 GOSUB 2000
 PRINT "NOTE:NO2 DATA MUST BE RUN IMMEDIATELY PRECEEDING NO2-NO3"
 GOSUB 2000
 PRINT "IF PO4 WRITE 1; NO2, 2;  NO2-NO3, 3;  SIO4, 4"
 INPUT Z
 GOSUB 2000
 PRINT "ENTER STANDARDS IN PAIRS(CONC 1ST,%ABS 2ND)BEGNG WITH SMALST"
  PRINT "IF MIS-ENTRY WRITE 111 AND START AGAIN"
 LET I=1
 FOR I=1 TO 3
 INPUT E[I],Y[I]
 IF E[I]=111 OR Y[I]=111 THEN 70
 NEXT I
 LET M1=E[1]+E[2]+E[3]
 LET M2=Y[1]+Y[2]+Y[3]
 LET C1=(E[1]*Y[1]+E[2]*Y[2]+E[3]*Y[3])
 LET C2=(E[1]↑2+E[2]↑2+E[3]↑2)
 LET C=(4*C1-M1*M2)/(4*C2-M1*M1)
 LET B=(C2*M2-M1*C1)/(4*C2-M1*M1)
 LET D=((Y[1]-C*E[1]-B)↑2+(Y[2]-C*E[2]-B)↑2+(Y[3]-C*E[3]-B)↑2+B↑2)/4
   LET D=SQR(D)
  GOSUB 2000
  PRINT "ENTER DRIFT, THEN # OF SAMPLES"
  INPUT G,N
  GOSUB 2000
  PRINT "ENTER SAMPLE PTS AS STATION,DEPTH,%ABS"
  PRINT " IF MIS-ENTRY WRITE 111 AND START AGAIN"
  LET I=1
  FOR I=1 TO N
  INPUT S[I],D[I],A[I]
  IF S[I]=111 OR D[I]=111 OR A[I]=111 THEN 125
  LET A[I]=A[I]-(I/N)*G
  IF Z#3 THEN 180
  LET K=(A[I]-B)/C
  LET X[I]=K-X[I]
  GOTO 185
  LET X[I]=(A[I]-B)/C
  NEXT I
  LET F=10
  GOSUB 2000
  PRINT "                    WATER RESOURCES"
  PRINT "                       M.I.T."
  PRINT "                 R.M. PARSONS LABORATORY"
  LET F=4
  GOSUB 2000
  LET F=2
  PRINT "THE FOLLOWING DATA IS INTERPOLATED FROM A LINE"
  PRINT "OF THE FORM Y=";C;"X+";B
  PRINT "ARRIVED AT BY THE METHOD OF LEAST SQUARES"
  PRINT "WITH AN ERROR OF";D
```

Figure 14A Computer Program for Nutrient Analyses

```
GOSUB 2000
PRINT "THE DATE OF SAMPLING WAS";D1;"/";D2;"/";D3
GOSUB 2000
IF Z#1 THEN 250
PRINT "THE ION BEING TESTED FOR IS PO4"
IF Z#2 THEN 260
PRINT "THE ION BEING TESTED FOR IS NO2"
IF Z#3 THEN 270
PRINT "THE ION BEING TESTED FOR IS NO3"
IF Z#4 THEN 280
PRINT " THE ION BEING TESTED FOR IS SIO4"
GOSUB 2000
PRINT "THE DRIFT IS";G
LET F=4
GOSUB 2000
PRINT TAB(20)"AUTO ANALYZER DATA OUTPUT"
LET F=2
GOSUB 2000
PRINT "STATION       DEPTH            ZABS          UMOLE/L"
PRINT
FOR I=1 TO N
IF SGN(X[I])=-1 OR SGN(A[I])=-1 THEN 310
GOTO 311
LET A[I]=X[I]=0
PRINT S[I],D[I],A[I],X[I]
NEXT I
LET F=10
GOSUB 2000
NEXT W
 REM SUBROUTINE  SPACES LINES
 FOR P=1 TO F
 PRINT
 NEXT P
 RETURN
 END
```

Figure 14A Continued

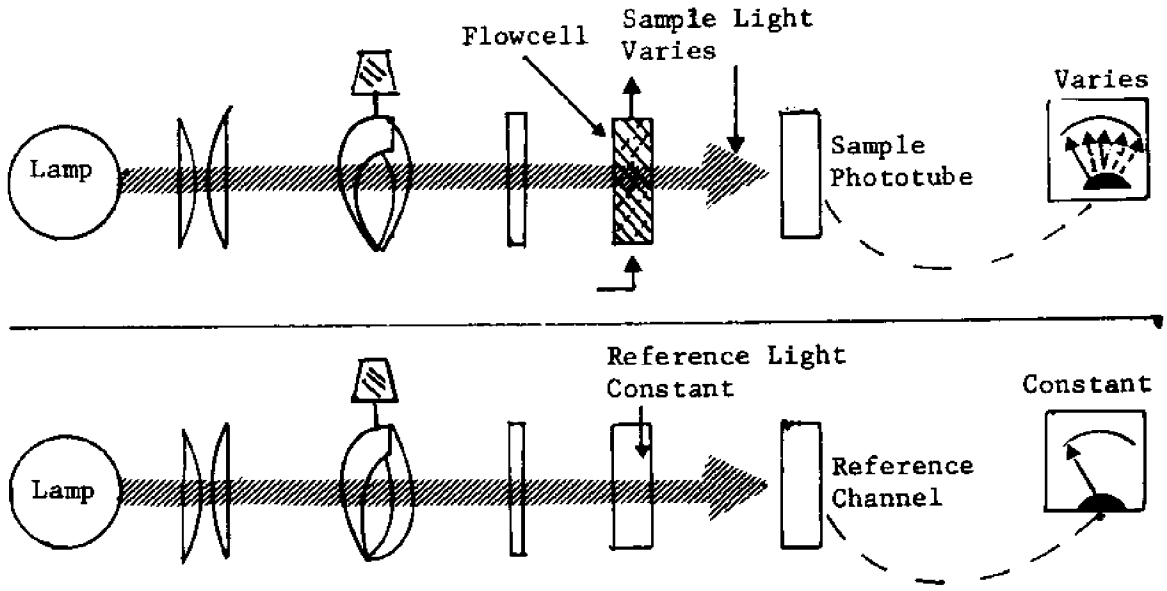


Figure 15 Sample in Flowcell Upsets Balanced Condition

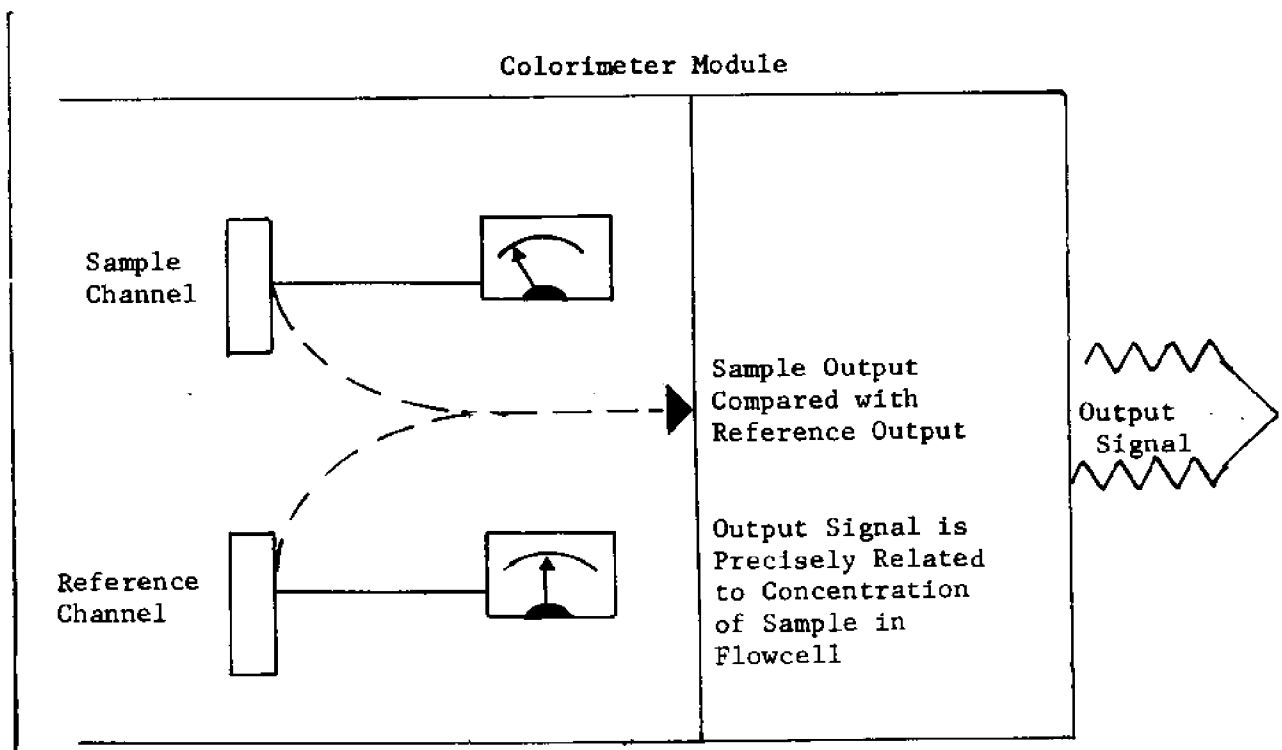


Figure 16 Electrical Output Signal of Colorimeter

Air Bubbles Ensure
Sample-to-Sample
Integrity

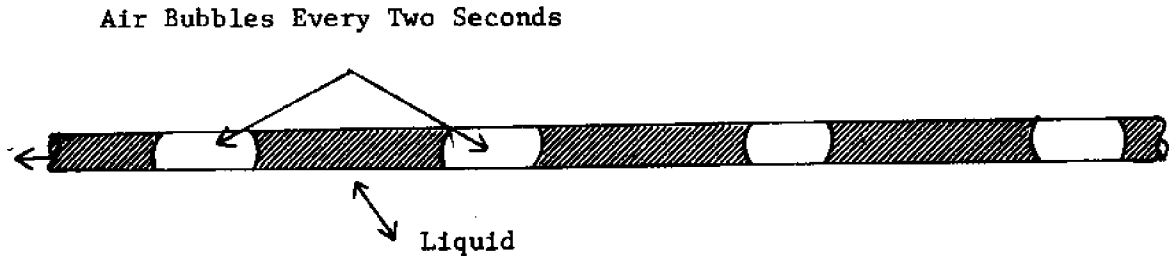


Figure 17 Air Segmentation of Liquid Stream

Every two seconds, an air bubble forces its way into the flowing liquid stream. As a consequence, the liquid stream leaving the connector is segmented (Figure 17).

These air bubbles, by their scrubbing action against the inner walls of the tube, isolate individual liquid slugs, and thus ensure sample integrity.

reagents used in the determinations are made with chemically pure compounds and deionized water. Standards are made up with analytically pure chemicals which are weighed to four decimal places on a semi-micro mettler balance, with deionized water, and put into acid washed glassware. They are kept refrigerated and preserved with $CHCl_3$ to insure maintenance of purity. They are replaced every month. All reagents are filtered before use to exclude any impurities or unwanted suspended matter. For some determinations, heating is required. An automatic adjustable heater within the monitor is used. Technicon chemical methodologies, which are all pretested, are used. Sample methodologies which have been used are included in Appendix D. Proper pump tube sizes are used which insure that samples spend the exact amount of time in the system developing correct color for maximum absorbance.

The color in each sample is induced by chemically forming a colored complex with the specific ion being analyzed. Each of these complexes absorbs light differently, i.e., they have their absorption maxima at different wave lengths. The color is then proportional to the concentration of the ion. By Beer's Law, absorbance is directly proportional to concentration as has already been shown. One gets a typical output on the recorder as shown in Figure 18, which is then analyzed by the use of the Parsons Laboratory computer.

Instrument accuracy, according to Technicon Corp., is approximatly ± 1%, which is the accuracy of the recorder. Technicon claims, since all manipulations to the sample are identical, there is no variance in data. We have found that our standards can be reproduced to within the accuracy stated by technicon.

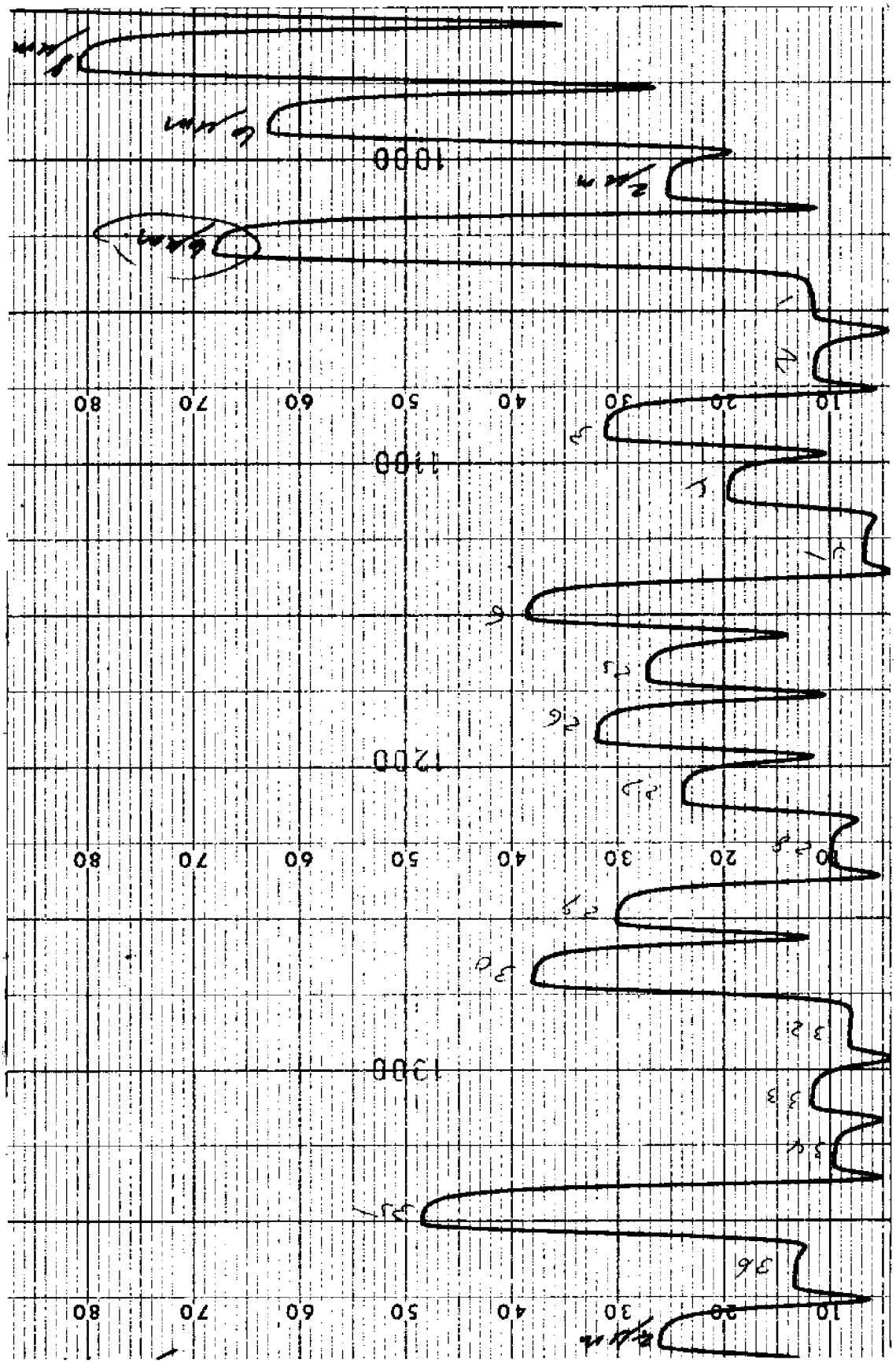


Figure 18 NO_3^- - NO_2^- Output for June 2, 1973 Cruise

CHAPTER 4

DATA AND DATA INTERPRETATION

4.1 Introduction

In Appendix A, data is presented from November 22, 1970 to November 25, 1973. These measurements were taken as routine chemical data from one Massachusetts Bay area by Prof. John M. Edmond. (M.I.T. Department of Earth and Planetary Sciences). The nutrient data was spectroscopically obtained using a Beckman D.U. In Appendix B, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics data is presented organized chronologically by cruise.

Even though it is of general interest to present all the data taken in the surrounding bay area, much of it is varied since there are numerous effluents entering the bay from many different points. Nutrient enrichment from the different sewage treatment plants vary from town to town, as amounts of nutrients depend on population and industrial waste.

An effort has been made, however, to take representative data and present it in varied ways to show specific trends. For example, concentration of nutrients versus distance from the harbor is plotted and indicates the harbor as a huge source of sediment and nutrient concentration. Another series of plots, concentration versus time for stations throughout the bay, show the time for the spring bloom and levels of concentration of nutrients over other periods. A third set of plots indicates variations of nutrient concentration with temperature during a particular season.

Studies that are already in progress and those that may be initiated will be discussed. One of the studies that will be continued will be that of proper sample preservation.

4.2 Studies in Progress

To insure reliability of nutrient concentrations from samples, we are continuing a major study for the correct preservation of samples. Included are plots of filtered data versus unfiltered data (Figures 19, 20, 21). Identical samples were taken, one frozen immediately and the other filtered and then frozen. The samples were then defrosted and analyzed simultaneously. The nitrite (NO_2^-) data yielded a mean, $\bar{x}$, of - 0.04. The standard deviation, δ, = 0.16 where

$$\bar{x} = \frac{\Sigma x_i}{N} \qquad N = \text{number of sample points}$$

$$\delta = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{N - 1}} \qquad x_i = x_{\text{filtered}} - x_{\text{unfiltered}}$$

From this data it can be concluded, so far in the study, that filtering seems to have no effect on the nitrite concentration.

When the sample analysis and plot of nitrate are carried out, the results show an $\bar{x} = 0.97$ and a $\delta = .259$ which leads one to the conclusion that filtering has a large effect on the nitrate concentration. On the average, a filtered sample is 0.97 μmole higher in concentration than an unfiltered sample. There could be two explanations. Leaching out of nitrates from the cellulose mixed ester Millipore filters could be a problem or turbidity could be effecting the readings from the colorimeter. Two experiments were performed to test the above explanations.

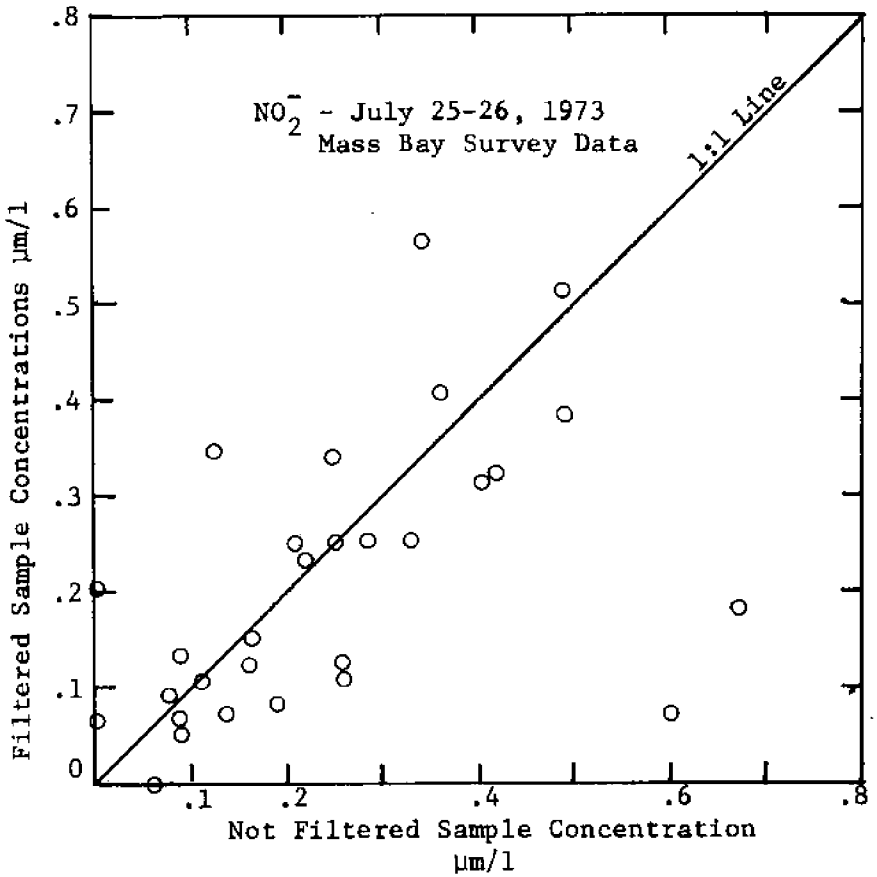


Figure 19 Filtered Sample Concentrations as a Function of Unfiltered Sample Concentrations

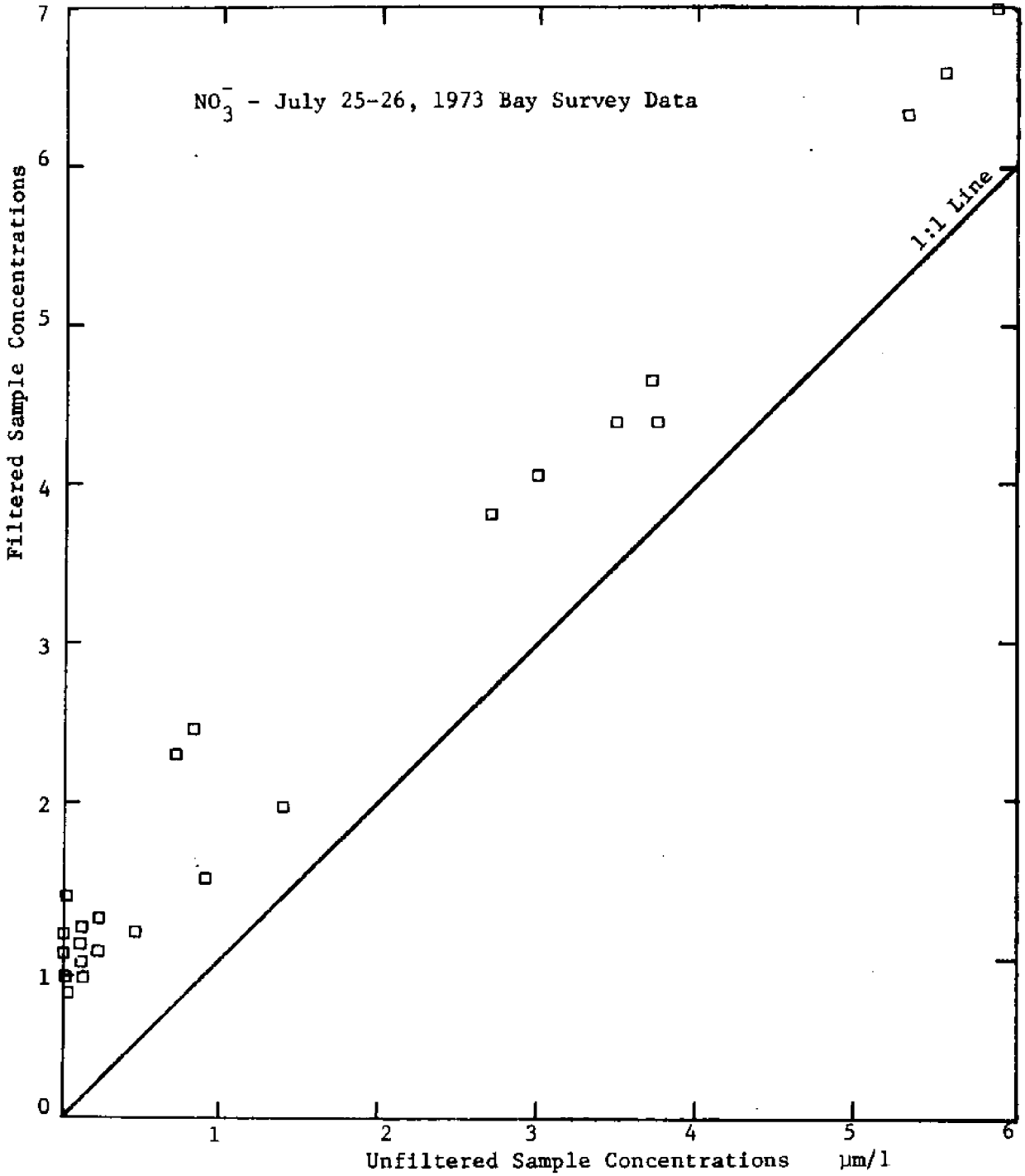


Figure 20 Filtered Water Samples as a Function of Unfiltered Samples

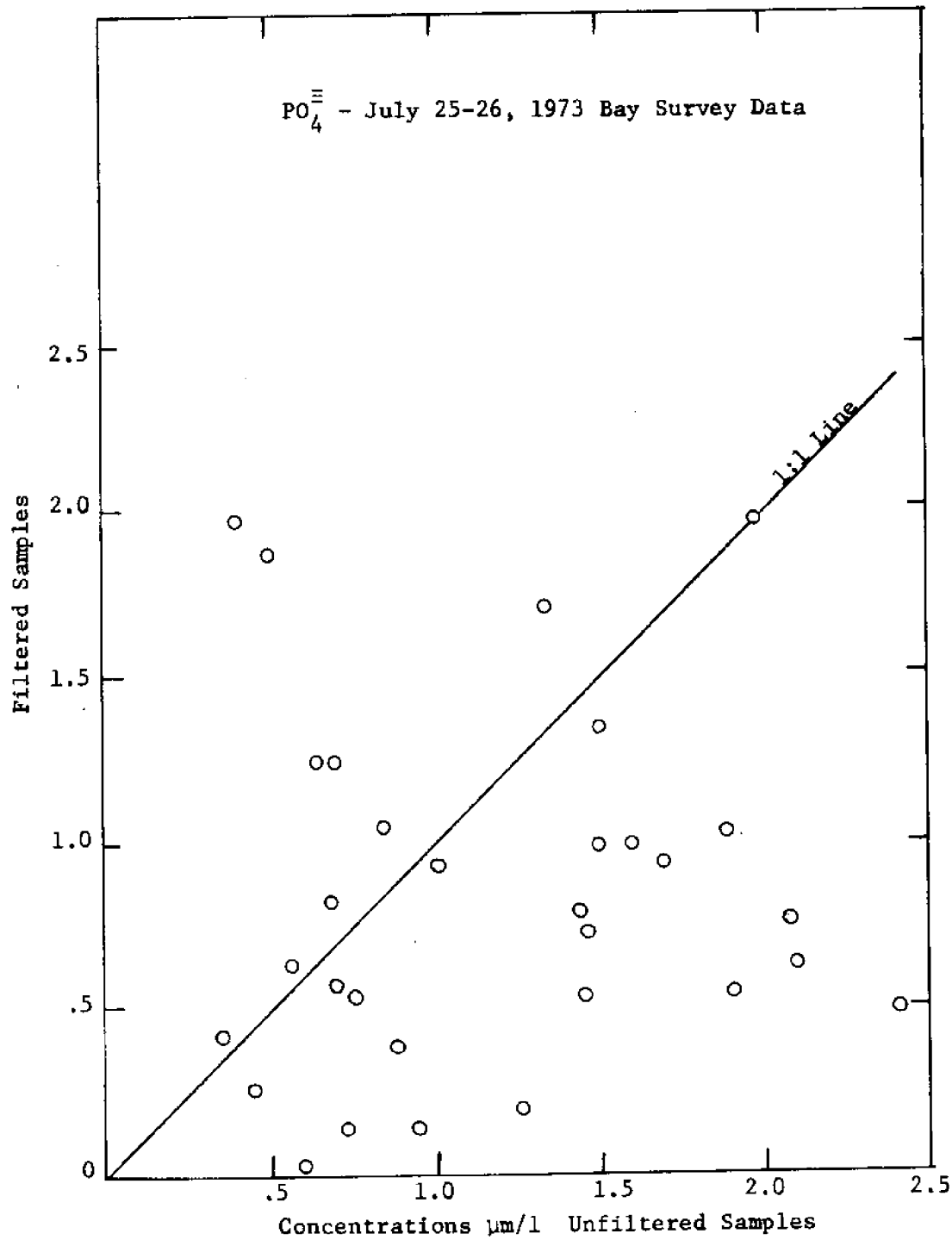


Figure 21 Filtered Samples as a Function of Unfiltered Samples

Standard solutions of nitrate were made up using artificial seawater. These solutions were then used to calibrate the auto-analyzer. Further solutions were then made up using not only artificial seawater, but artificial seawater made turbid with kaolinite. The standards were then run again on the analyzer, but this time they had a turbidity of .67 F.T.U. No effect was observed. To further test the effects of turbidity, four 6 micromolar standards were made up, each with a different turbidity ranging from 5.5 F.T.U. to .38 F.T.U. Again no effect was observed, as can be seen in Figure 22.

Since the turbidity seemed to afford no answer to the problem, the Millipore filters were tested. Standards were again made up with artificial seawater and used to calibrate the analyzer. Then 500 ml of a 6 micromolar standard was made up with a turbidity of .68 F.T.U. It was run on the analyzer unfiltered and then after having been filtered through two Millipore filters. As can be seen in Figure 23, the filtered sample is approximately 0.9 μm higher than the unfiltered sample. Similar results were obtained when 100 ml of the 2 μm standard with no turbidity was filtered and run. the 2 μm standard was 1.2 μm higher after having been filtered. Ordinary deionized water and then artificial seawater were run through the analyzer both filtered and unfiltered. The filtered sample always showed from .9 to 1.3 μm higher, which the July 25-26 data in Figure 20 also showed. All indications then seem to support the idea that the Millipore filters leach nitrates in significant enough amounts to effect the concentrations of the sea water samples. Alghough it is desirable to filter all the samples before analyzing for nutrients, it can be seen that it can be

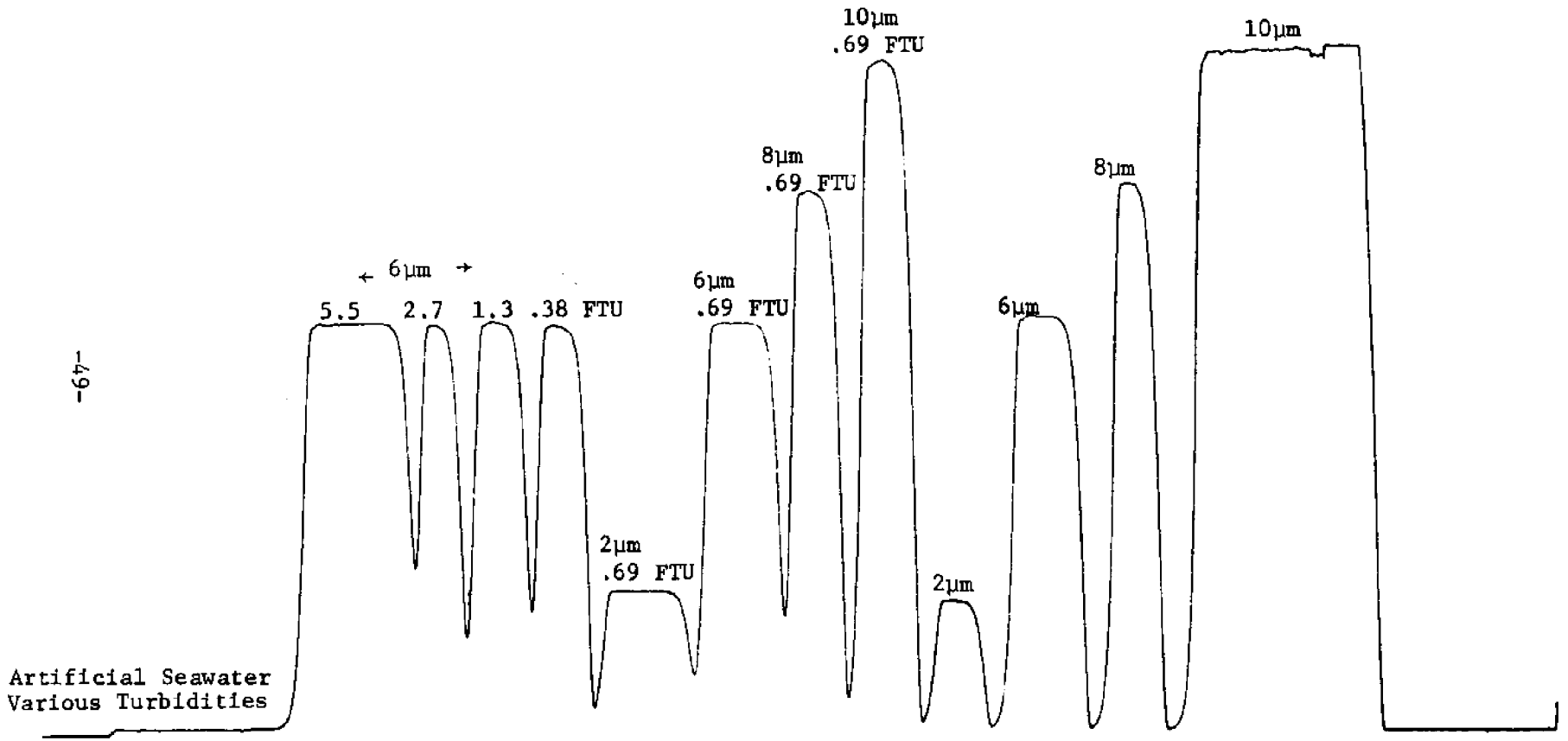


Figure 22 Output for test of turbidity effects on NO_3^- concentrations

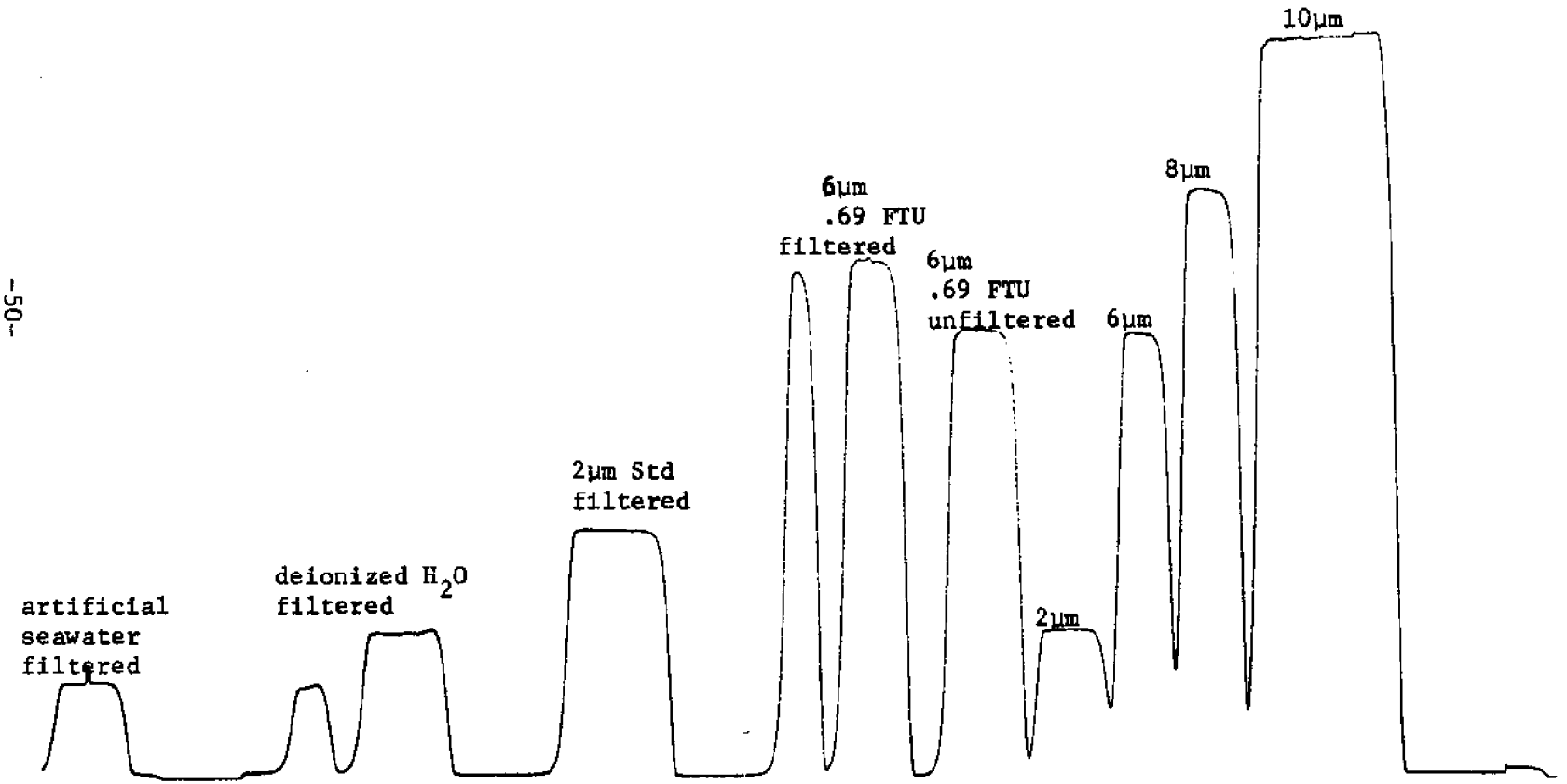


Figure 23 Output for test of filtering effects on NO_3^- concentrations

more detrimental to filter through Millipore than to not filter at all.

The phosphate plots were far less conclusive than the other nutrients, with a mean of $\bar{x}$ =-.31 and standard deviation δ = .737. The data seems to be extremely spurious. Further tests need to be made but the randomness of the data may also be indicative of the fact that along the Massachusetts Bay coastline there are several sources of sewage effluent which would supply large amounts of phosphate in both the soluble and particulate phases. Since our analysis does not distinguish between the soluble and particulate phosphates, this could produce large variations in our data. A plot of the difference between filtered and unfiltered data ($x_{unfiltered} - x_{filtered}$) versus total suspended solids is not conclusive using the data presently at hand, but it does seem to indicate a trend. As the concentration of the suspended solids increases the difference between the filtered and unfiltered sample seems to increase also (see Figure 24). Further investigation and many more data points will be needed to obtain anything conclusive.

We have dissolved oxygen data and will increase our O_2 data acquisition to obtain a better idea of the O_2:nutrient ratios that exist in the Bay area. Ammonia and pH measurements will also be included in the future with the parameters presently being analyzed. Lastly to be able to roughly assess the biomass production, analysis for chlorophyll a will be carried out on-board ship using our Turner fluorometer. If progress in the understanding of the ongoing processes in the Bay area is to be made, increased sampling, analysis and interpretation must be continued.

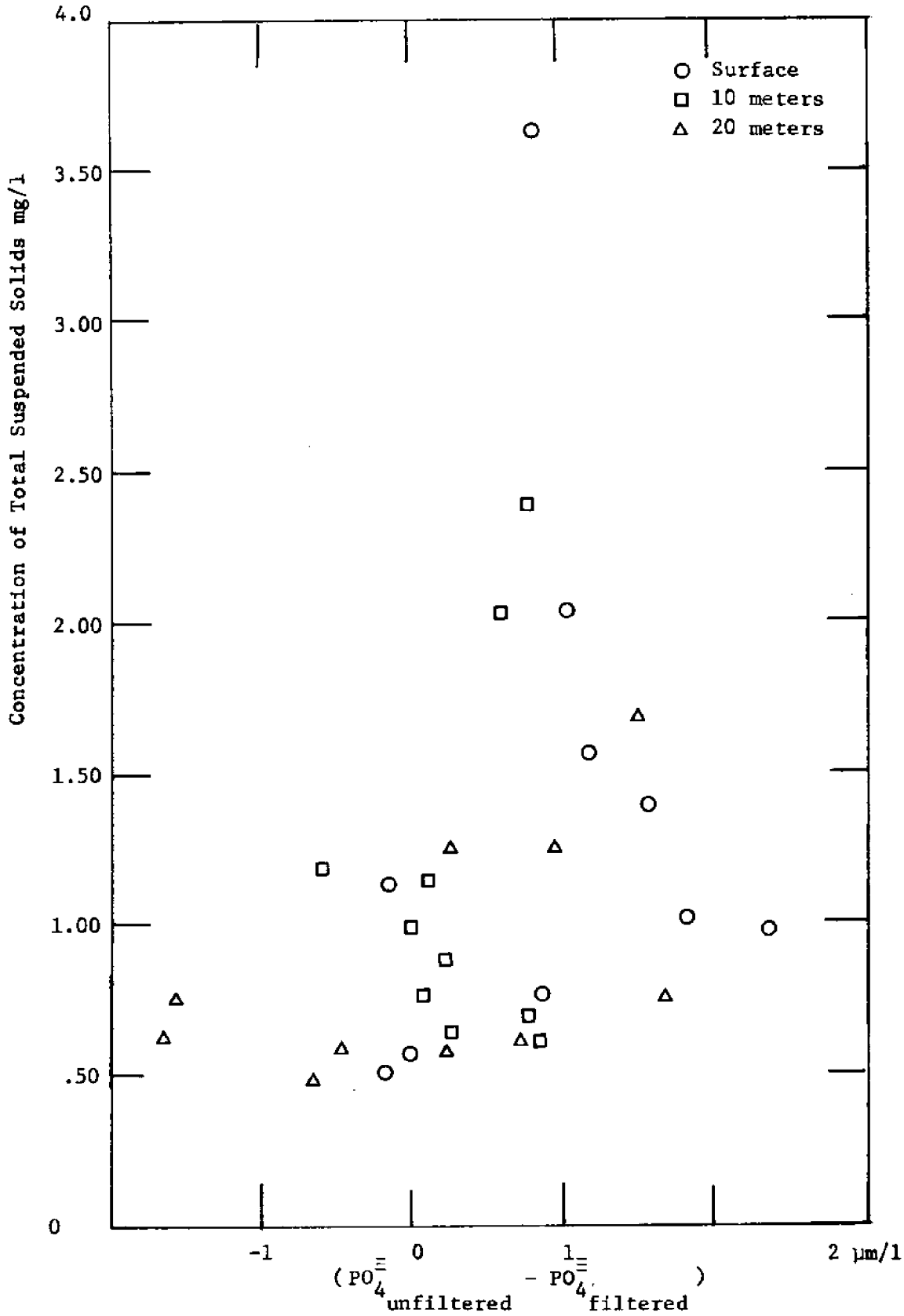


Figure 24 The Total Suspended Solids as a Function of the Difference of Phosphate Filtered and Unfiltered Samples

4.3 Trends in Data

4.3.1 Spatial Distribution of NO_3^-, $PO_4^{\equiv}$ and Suspended Solids

The fact that increased concentrations of nutrients and suspended solids flow from sewage effluents in the harbor outward, seems to be supported by the following sets of graphs. Figure 25 is a chart of the harbor area with the sampling positions correlated to number as indicated. In the following graphs (Figures 26-28) the concentrations of NO_3^-, $PO_4^{\equiv}$, and suspended solids are plotted against these numbers. The inner harbor is represented as 0. As could be expected, generally the higher concentration of nutrients and sediments originates in the harbor. It looks very much as if the effluent on the harbor is the major source of man's contribution to the environmental waters. One must look to the possible problems that could occur from these contributions given so freely out of our sewage systems.

4.3.2 Time Variant Trends in Nutrient Concentrations

The time variant trends in the nutrient concentrations can be seen in the plots presented in Figures 31 through 36. To facilitate the coordination of Data taking activities by the various groups working on the NOMES Project, a rectangular grid of stations was set up as shown in Figure 29. Figure 30 shows specifically the location of the three stations chosen as examples of the temporal changes in nutrient concentration patterns. These three stations were chosen mainly because it is at these stations that the most comprehensive data has been taken over the time period. In addition, the A1 station is representative of one of the stations closest to land and A4 of one of the stations

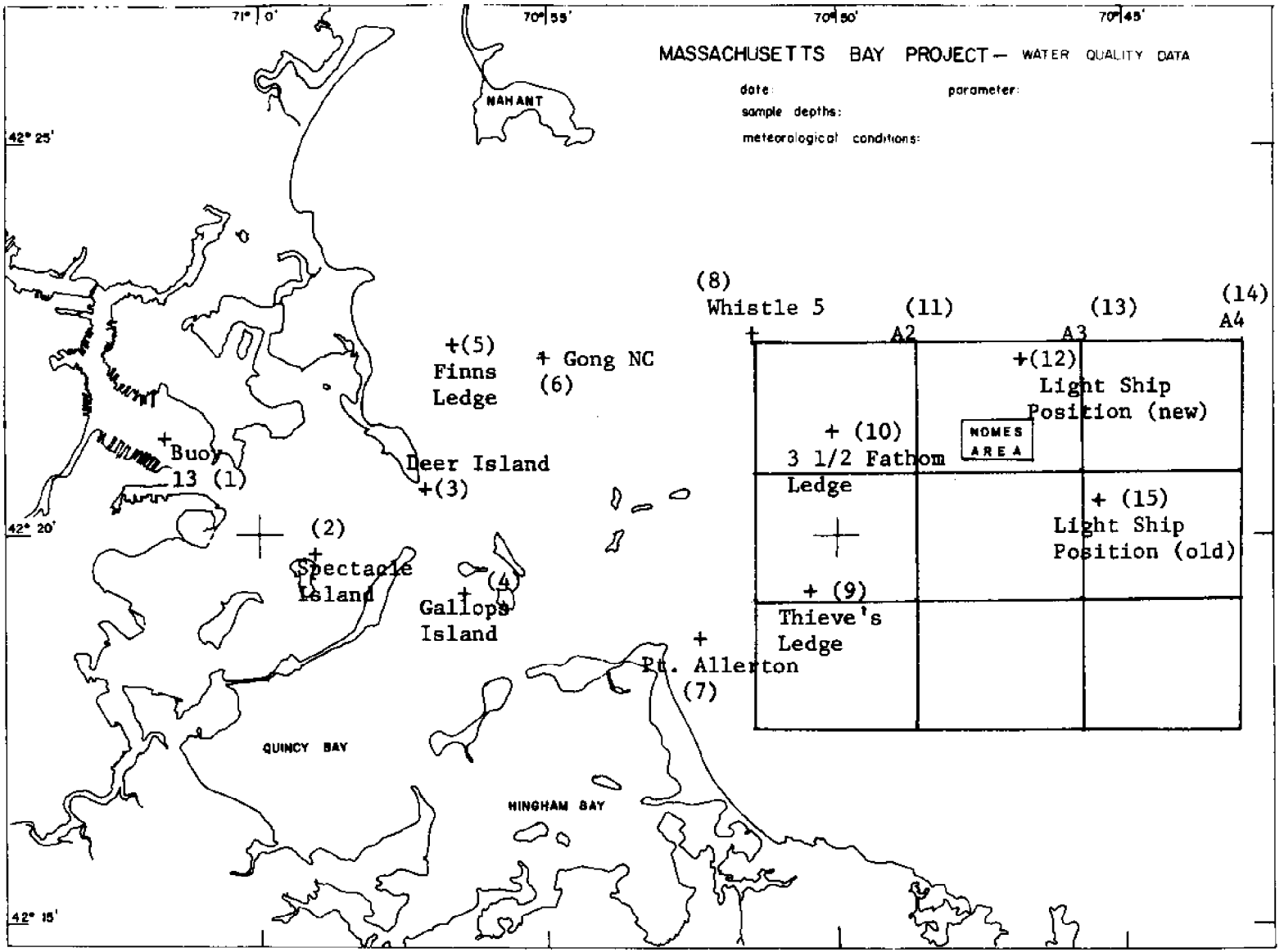


Figure 25 Chart of Positions for Concentration vs Distance

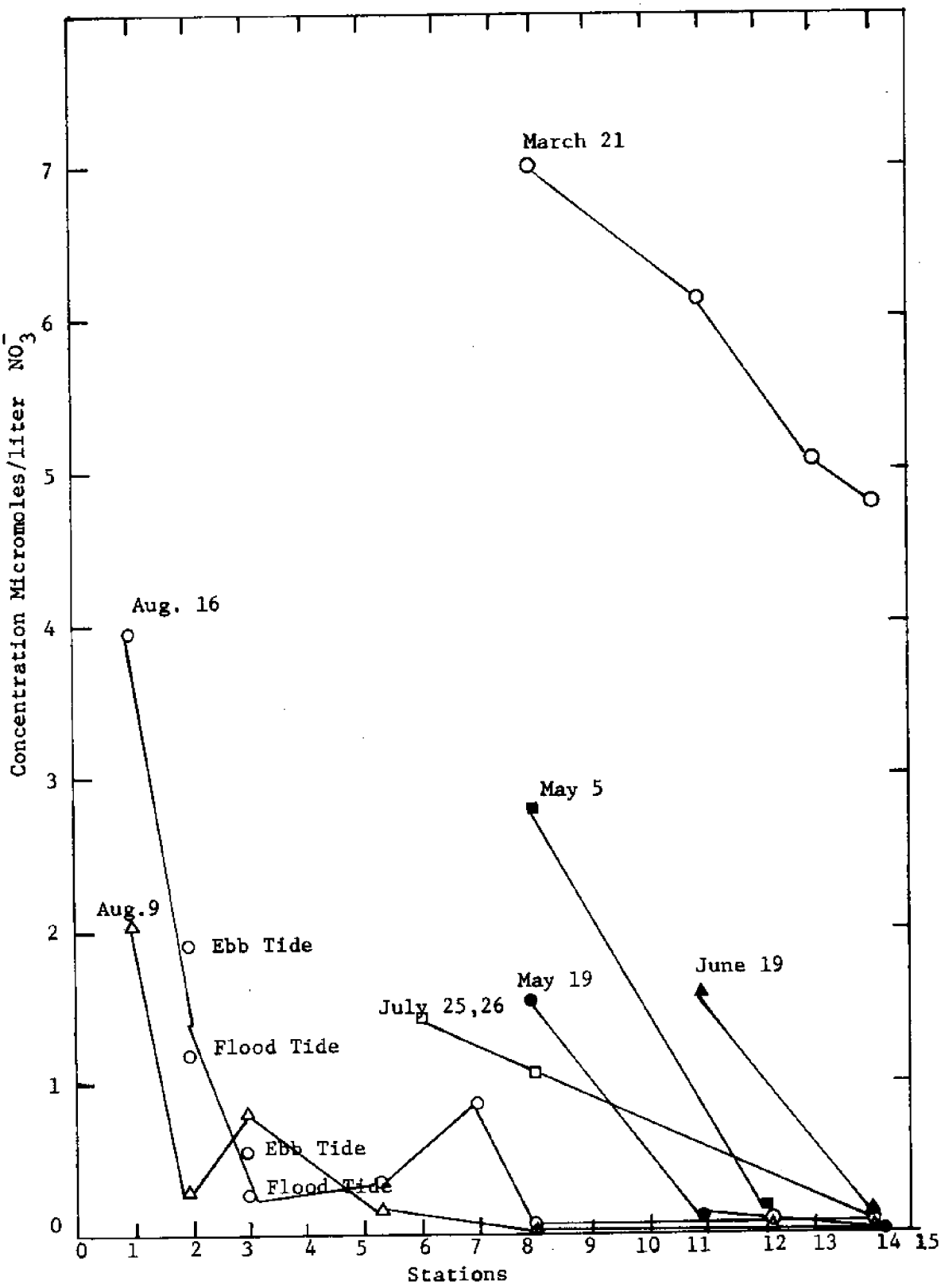


Figure 26 Concentration of NO_3^- as a Function of Increasing Distance from Boston Harbor (General Trends Seem to Indicate that Even at Different Times of the Year, the Concentrations Decrease with Increasing Distance from Harbor)

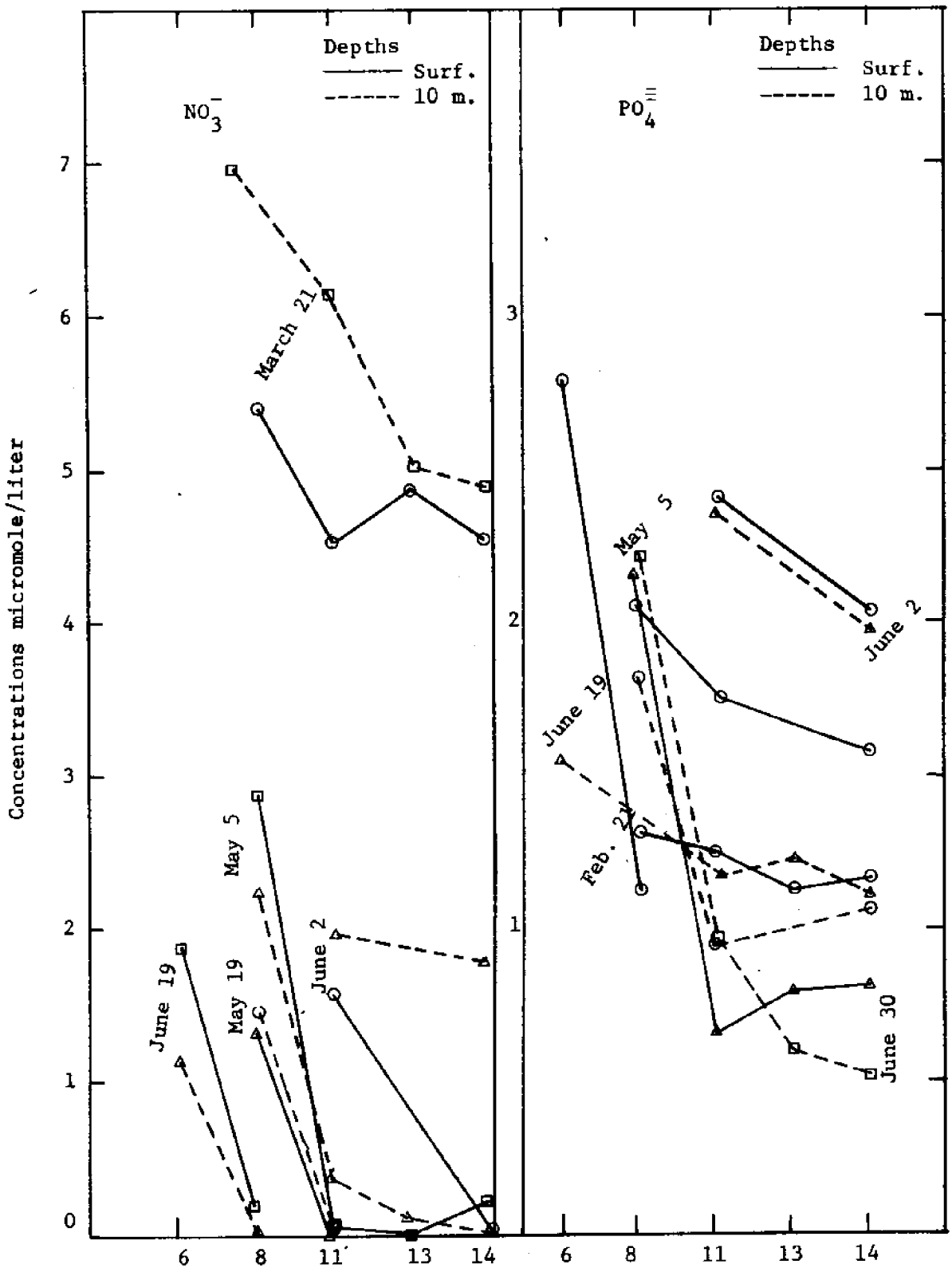


Figure 27 NO_3^- Concentrations as a Function of Increasing Distance from Boston Harbor

Figure 27A $PO_4^{\equiv}$ Concentrations as a Function of Increasing Distance from Boston Harbor

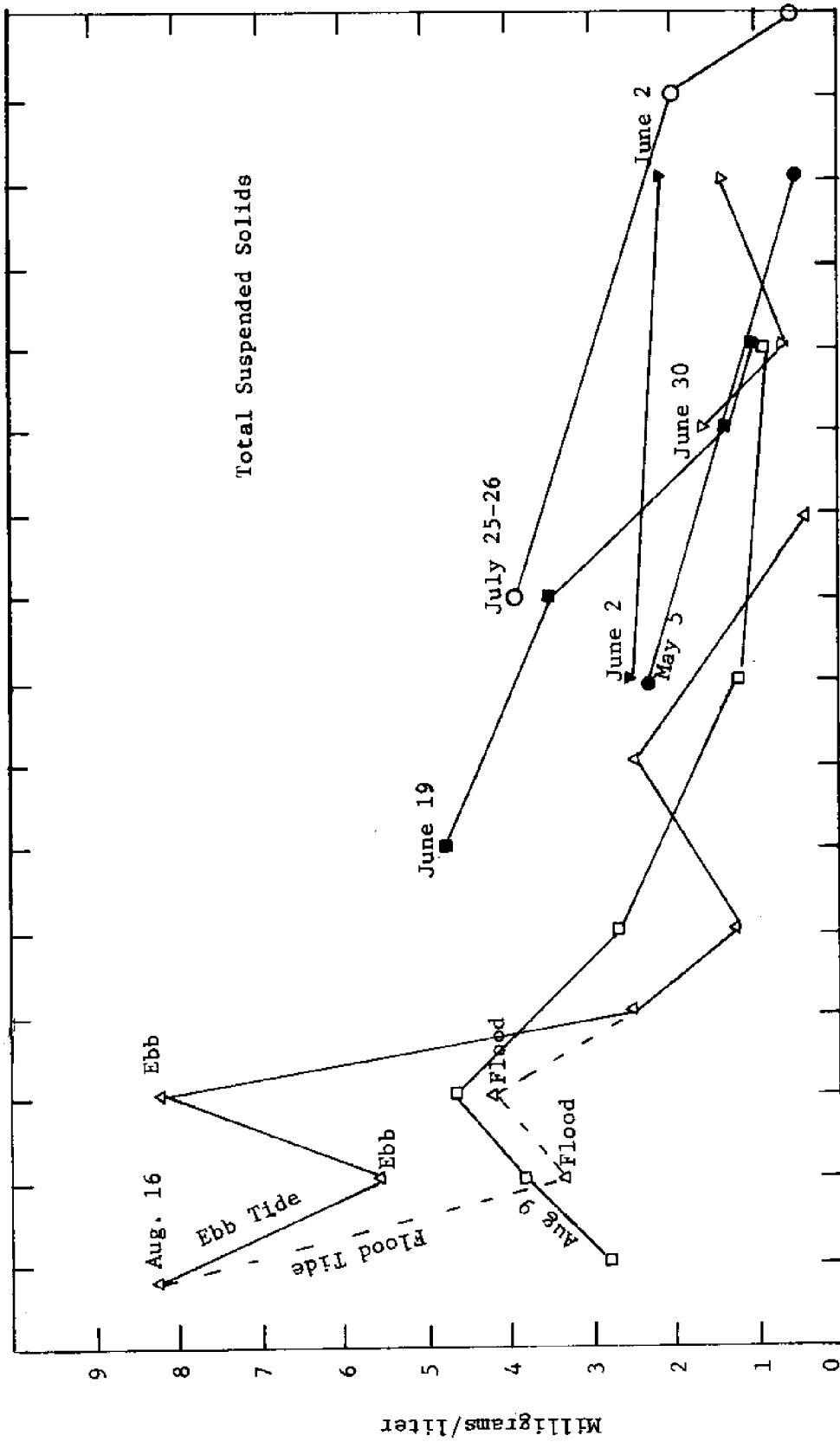
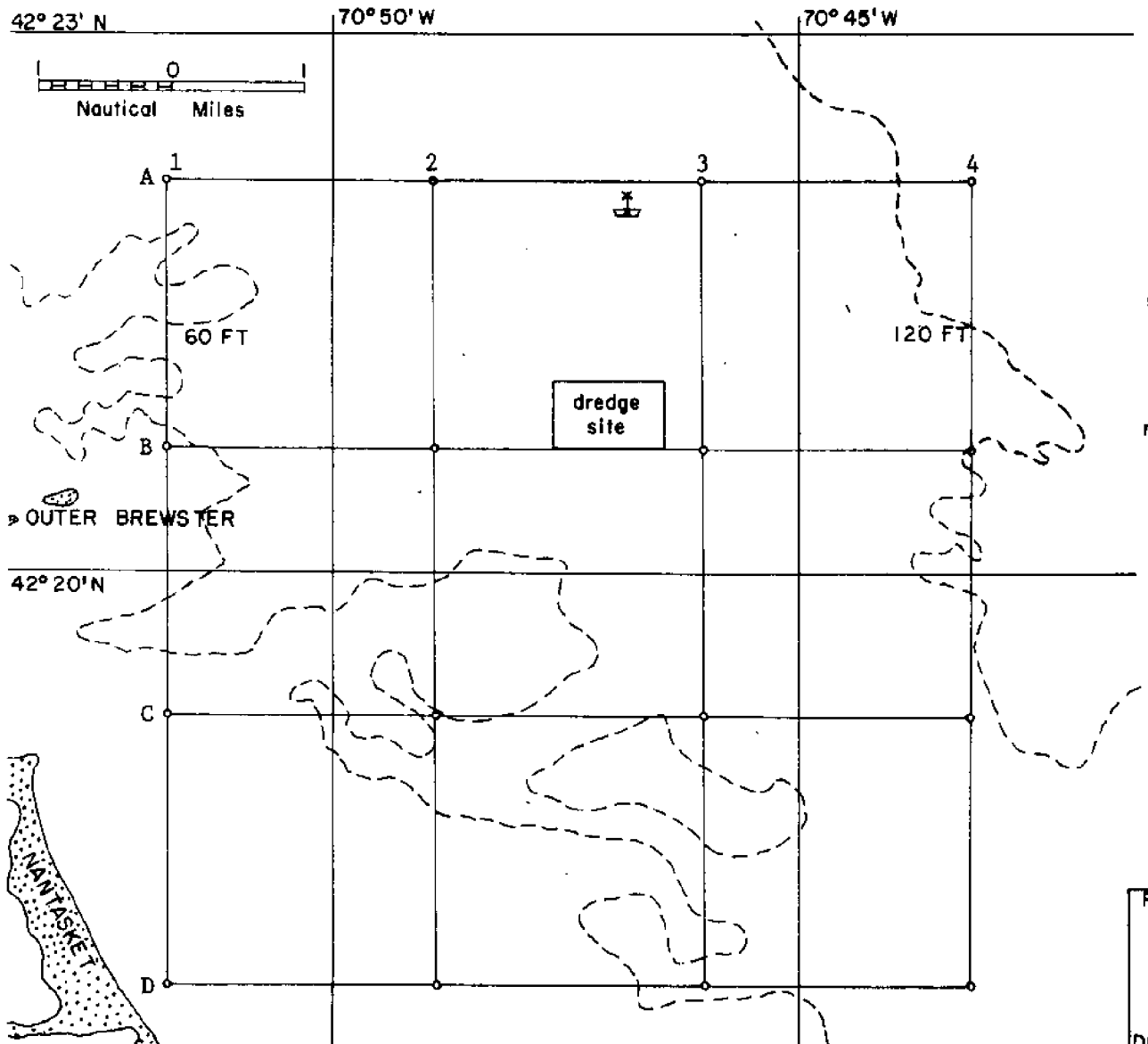


Figure 28 Total Suspended Solids Plotted against Relative Distance from the Harbor



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date:

parameter:

sample depths:

meteorological conditions:

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING

Figure 29 The NOMES Sampling Station Grid

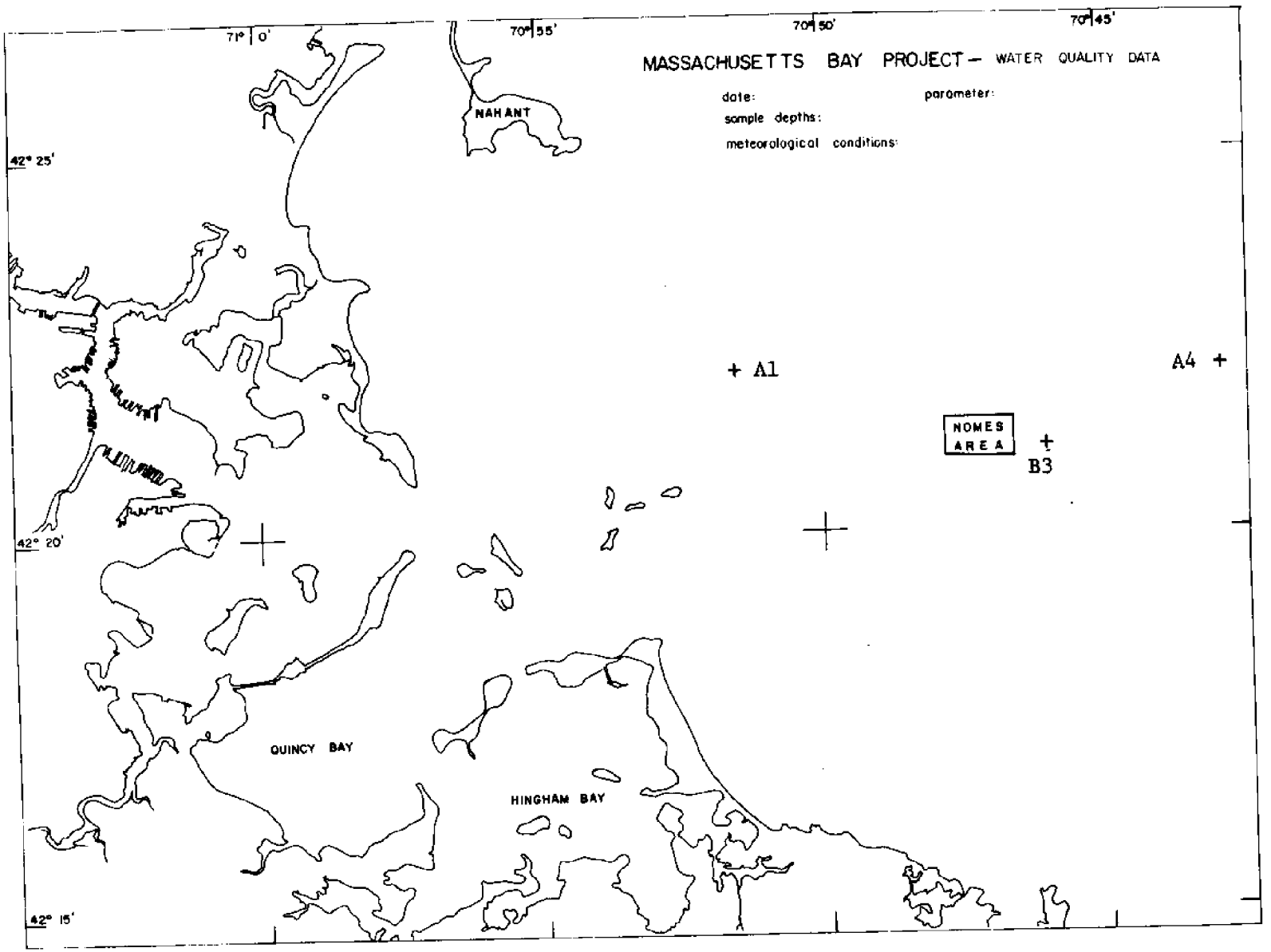


Figure 30 Locations of Stations A1, A4 and B3 of NOMES Grid

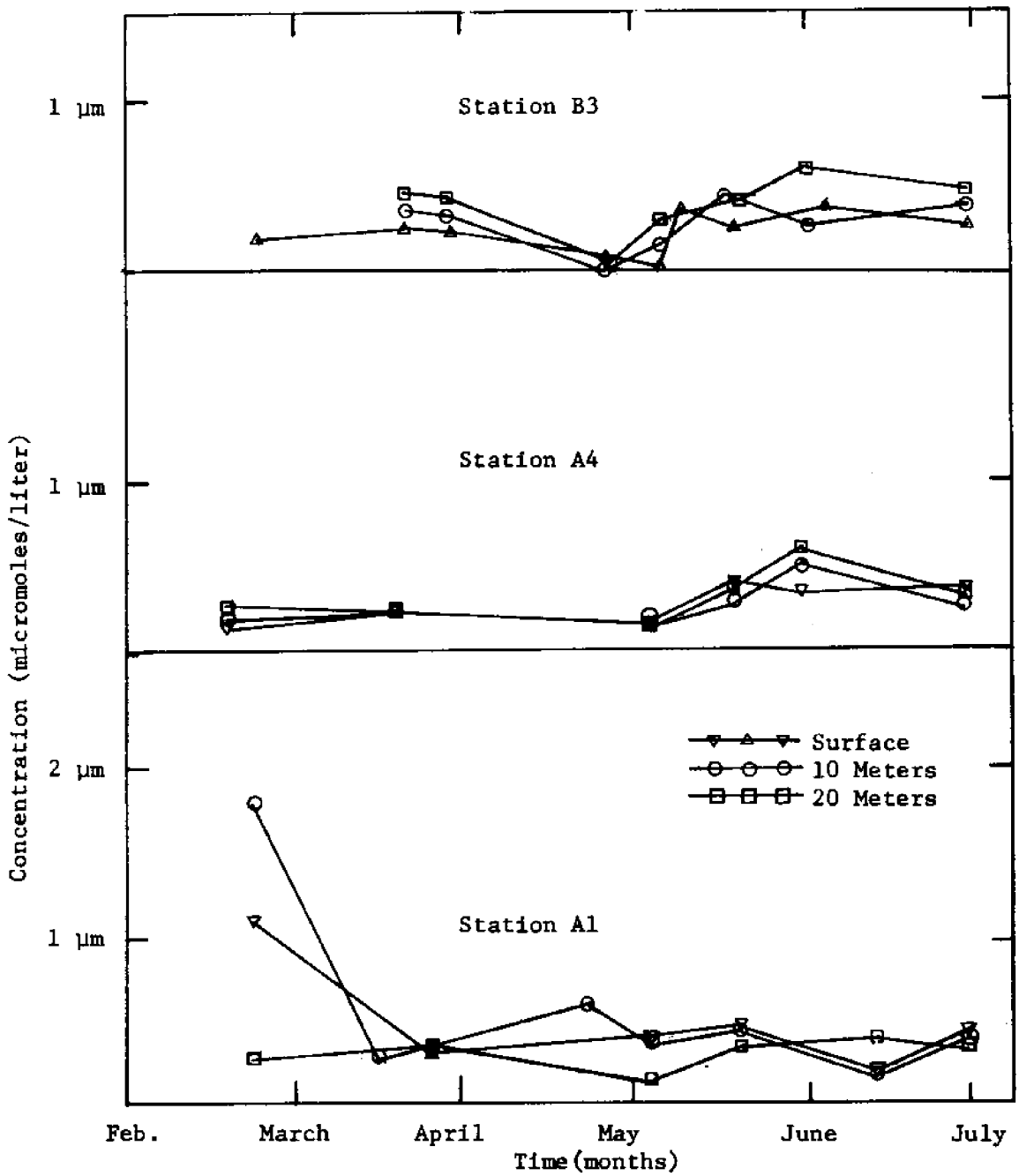


Figure 31: Concentration of NO_2^- as a function of time over stations A1, A4, and B3.

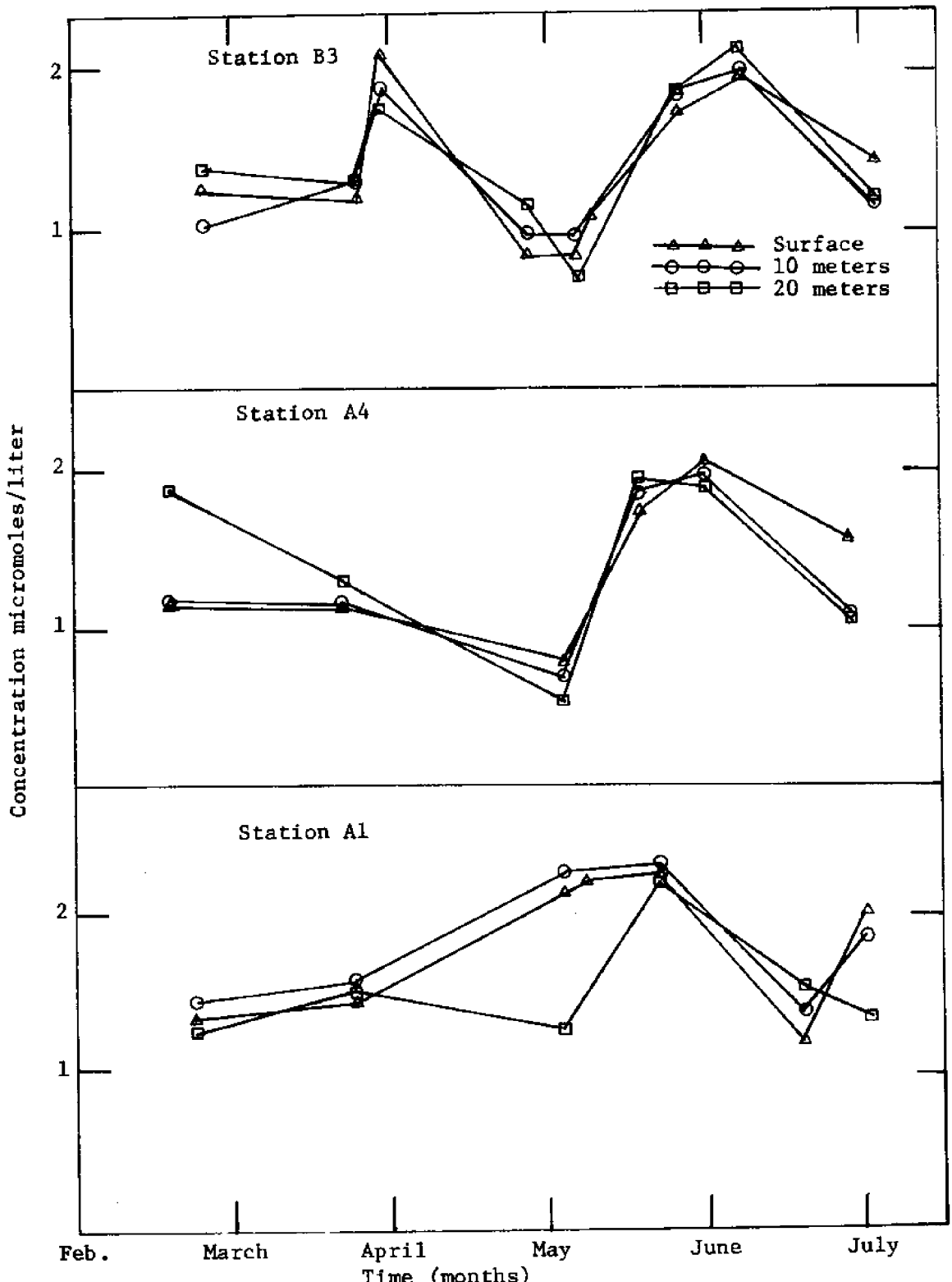


Figure 32 Concentration of $PO_4^{\equiv}$ versus Time in Months over Stations A1, A4 and B3

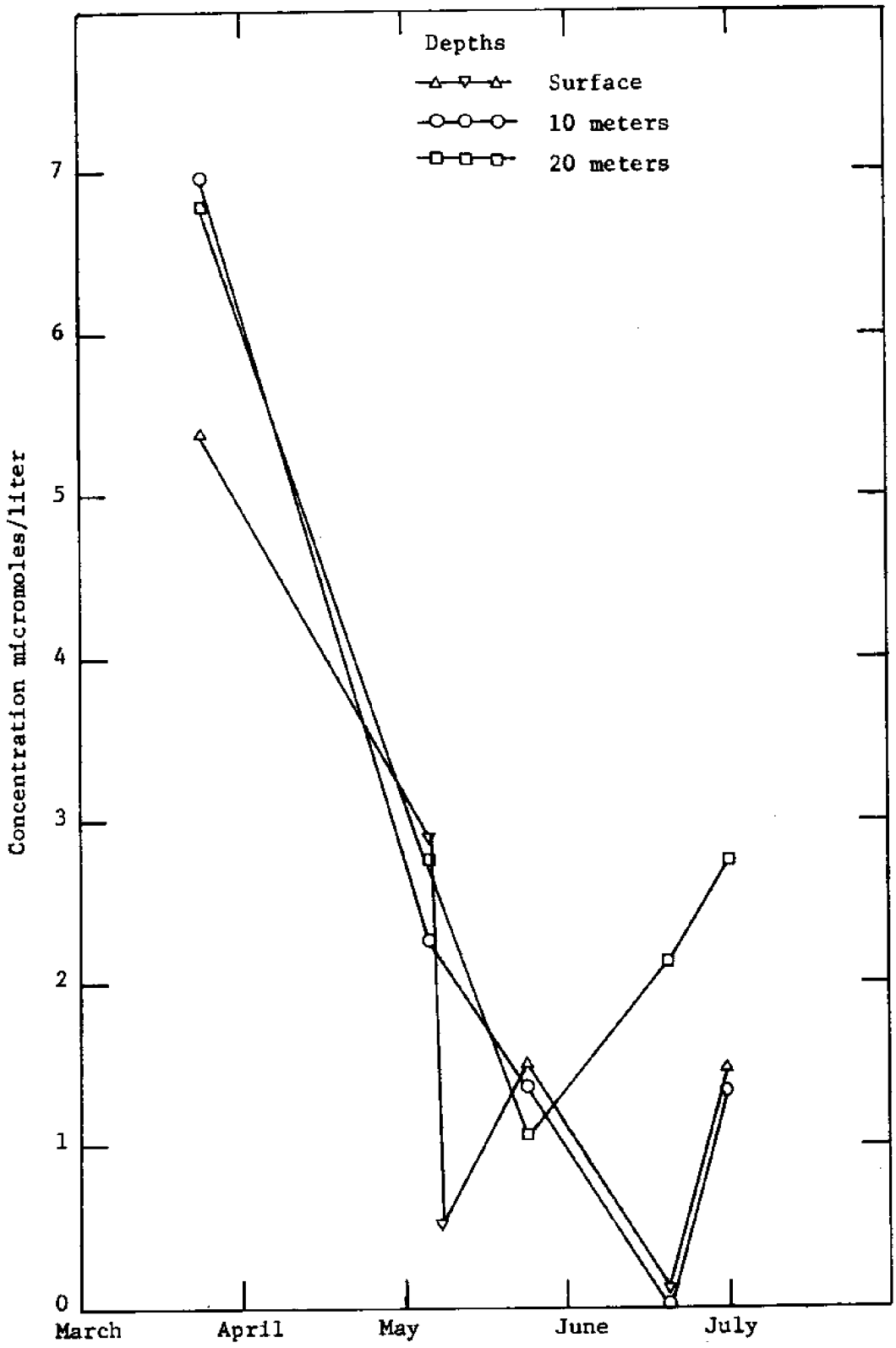


Figure 33 NO_3^- Concentration vs Time for Station A1

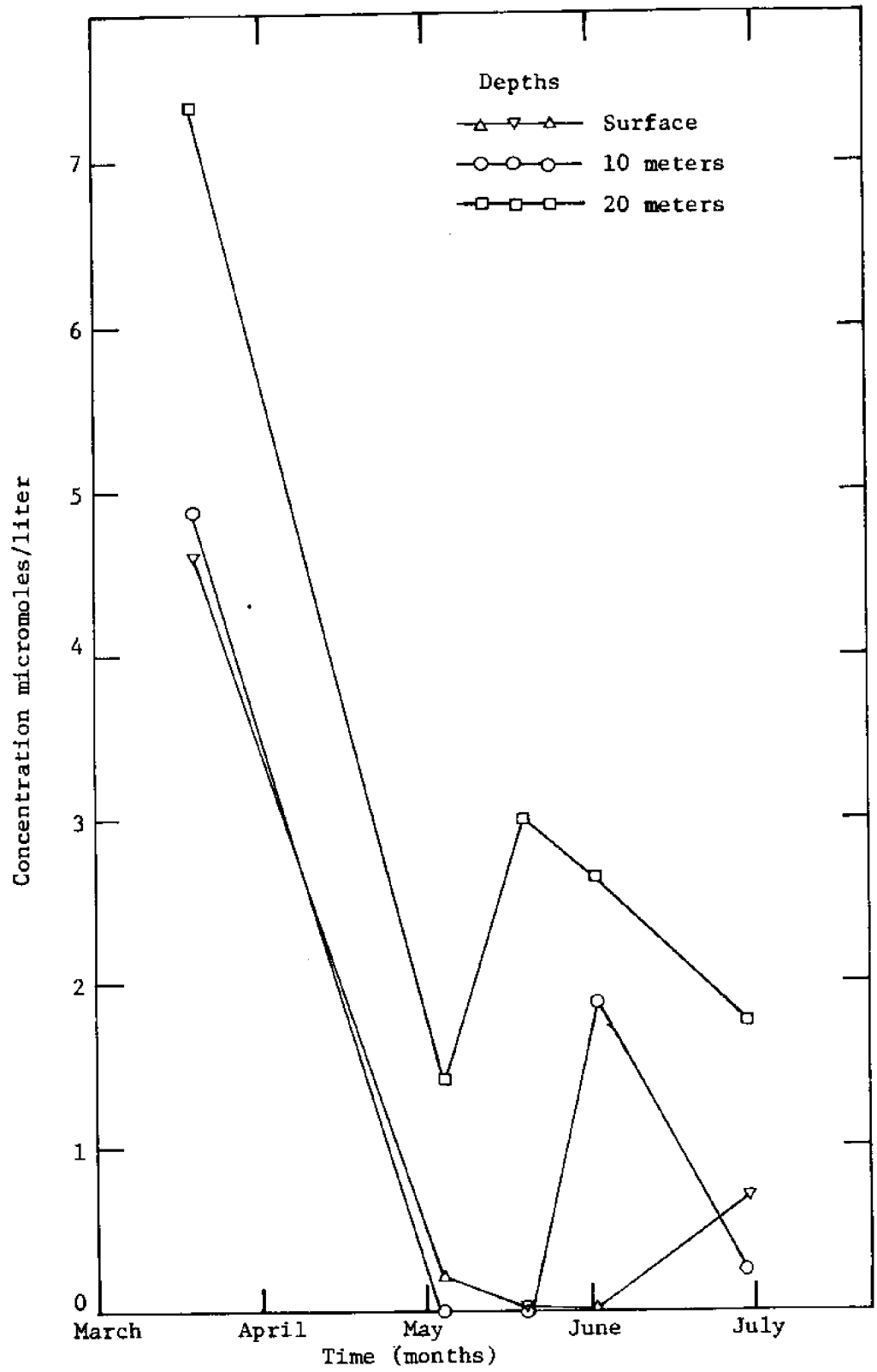


Figure 34 NO_3^- Concentration versus Time for Station A4

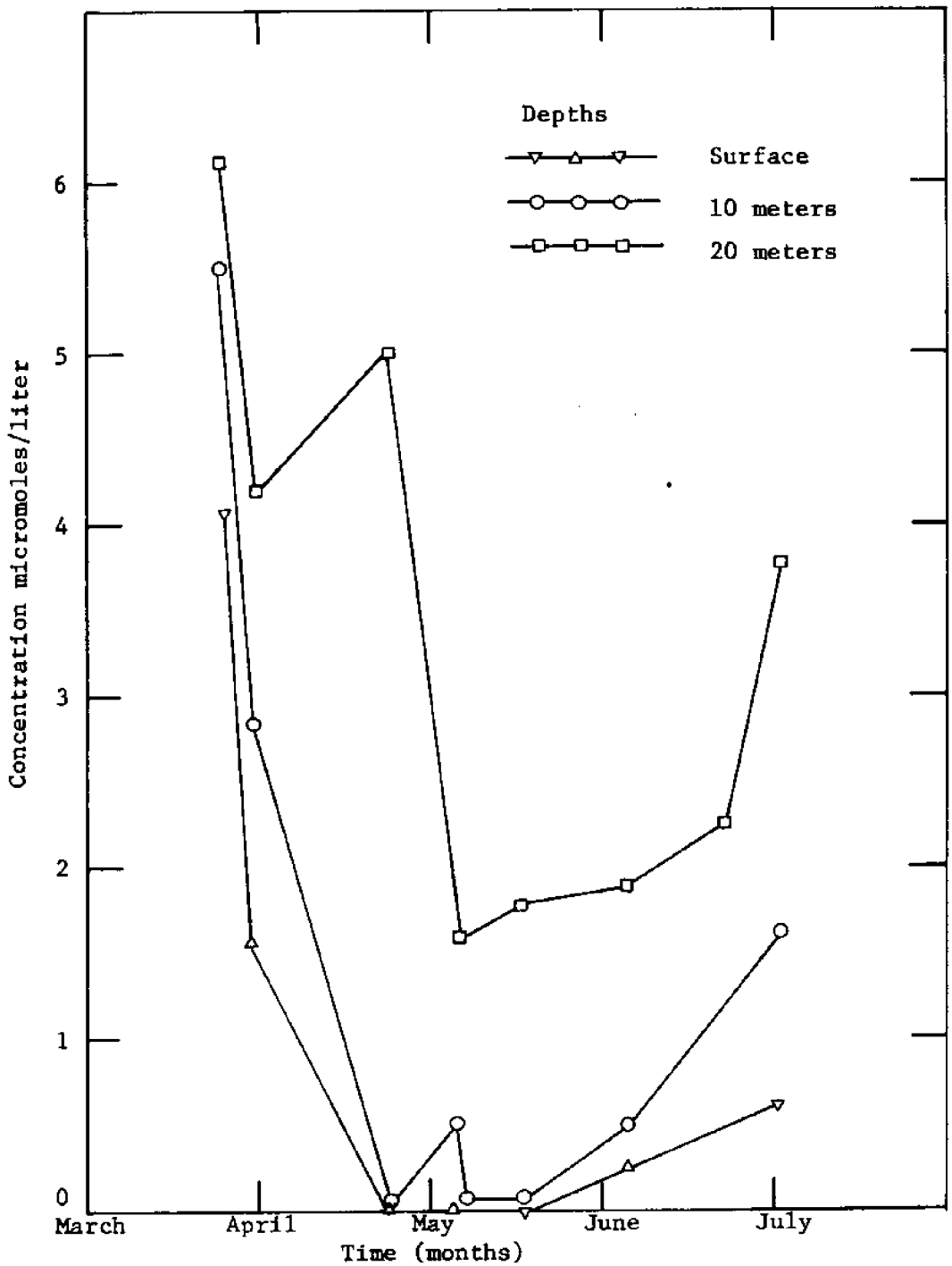


Figure 35 NO_3^- Concentrations vs. Time for Dredge Site B3

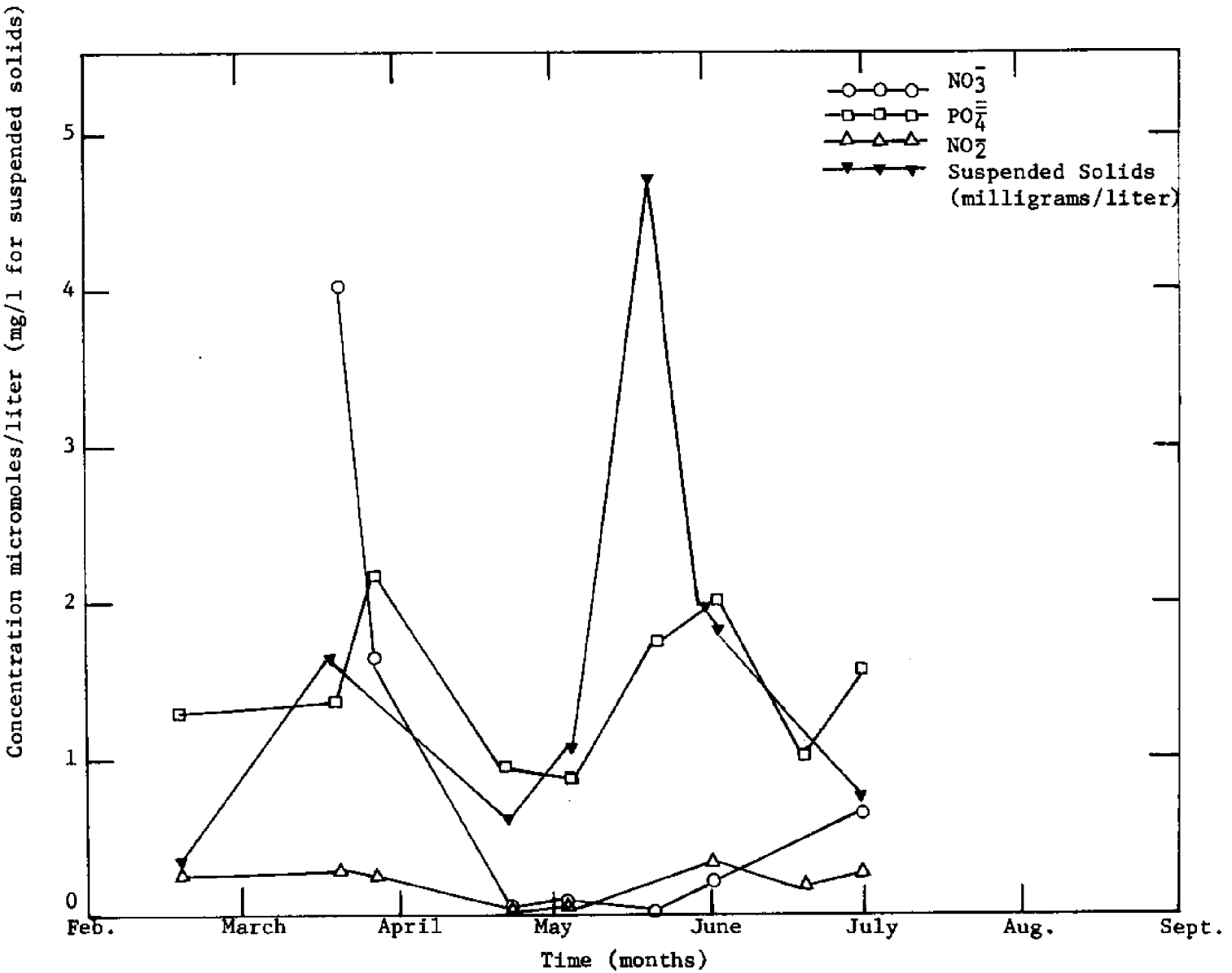


Figure 36 A Plot of Concentration of Various Nutrients and Total Suspended Solids vs. Time for Station B3

farthest from land.

Normal spring blooms can most clearly be seen in the nitrate plots (Figures 33, 34, and 35) since nitrogen seems to be the limiting growth factor. This is discussed in the conclusion of this paper. The nitrogen, therefore, in the winter months, reaches a peak concentration and then drops to zero at the time of the spring bloom in April. The growing phytoplankton population completely consumes the limiting nitrogen nutrients. Phosphate is in excess even during the bloom (Figure 32). Since phosphate is not the limiting nutrient, one could not expect its concentration to fall to negligible amounts during the bloom. The nutrient concentrations that would normally occur in the bay could very well be increased by sewage effluents in the harbor. Thus, excess phosphate remains, even during peak phytoplankton growth. Nitrites (Figure 31), however, seem to fall in concentration as do the nitrates.

4.3.3 Phytoplankton Dependence on Temperature

The last series of plots indicating a trend are those that graphically demonstrate the temperature dependence of phytoplankton growth. During the summer months, there exists a sharp thermocline (sudden drop of temperature) where the temperature can vary from 4°C to 21°C. Four degrees centigrade is the average temperature for deep seawater year round. Referring to the graphs of the July 25-26 cruise (Figures 37 and 38), one notices that, in the case of nitrate, the limiting growth factor, concentrations vary from almost 0 at surface temperatures, all the way to 7 1/2 micromoles below the thermocline. Nitrite varies between 0 to .70 micromoles per liter. Naturally

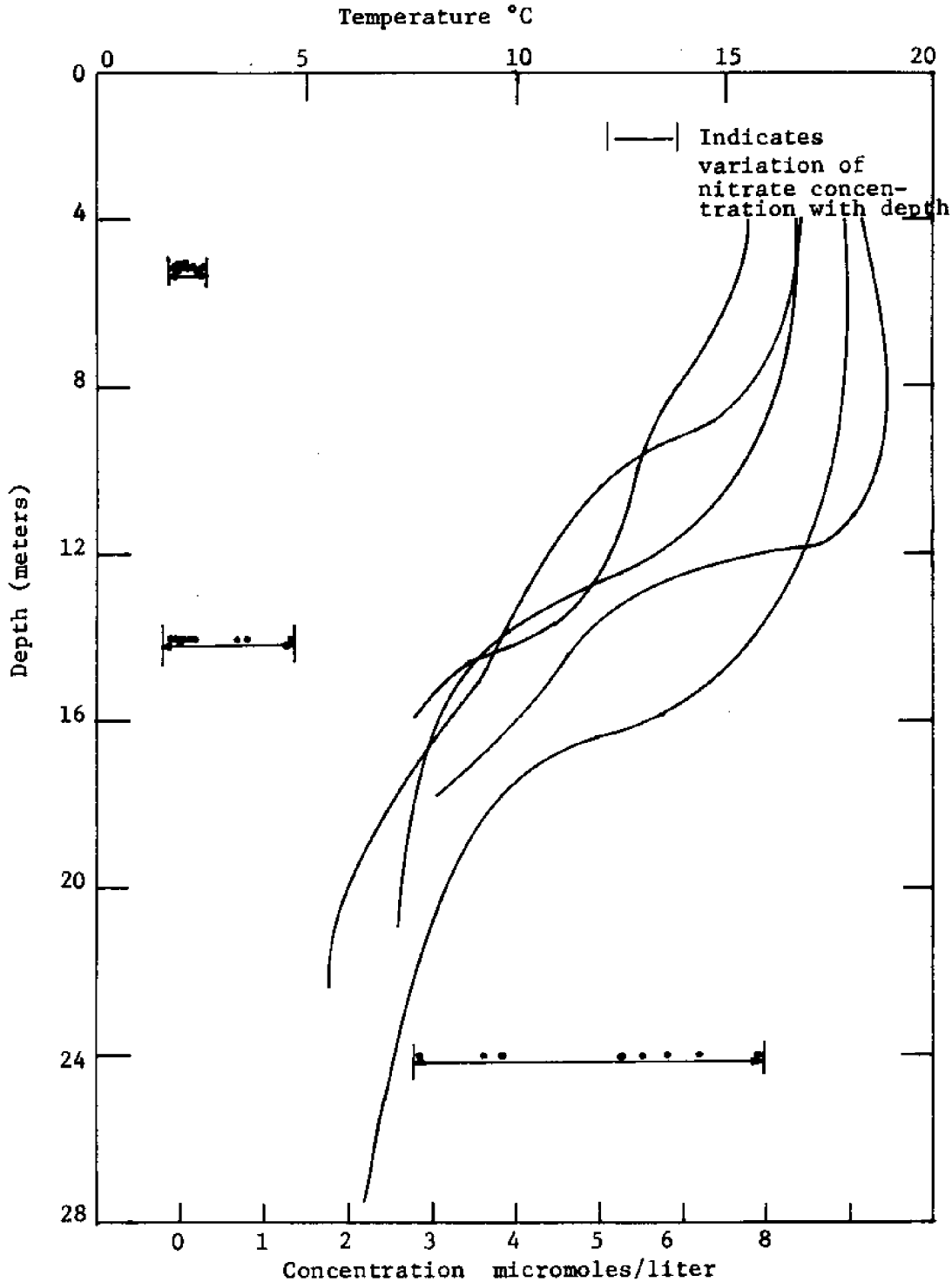


Figure 37 NO_3^- Concentration as a Function of Depth (The Data is Taken from the July 25-26 Bay Survey The Thermoclines Presented are Five Stations Representative of the 19 Covered. The NO_3^- Data is Taken from the 10 Chemistry Stations.)

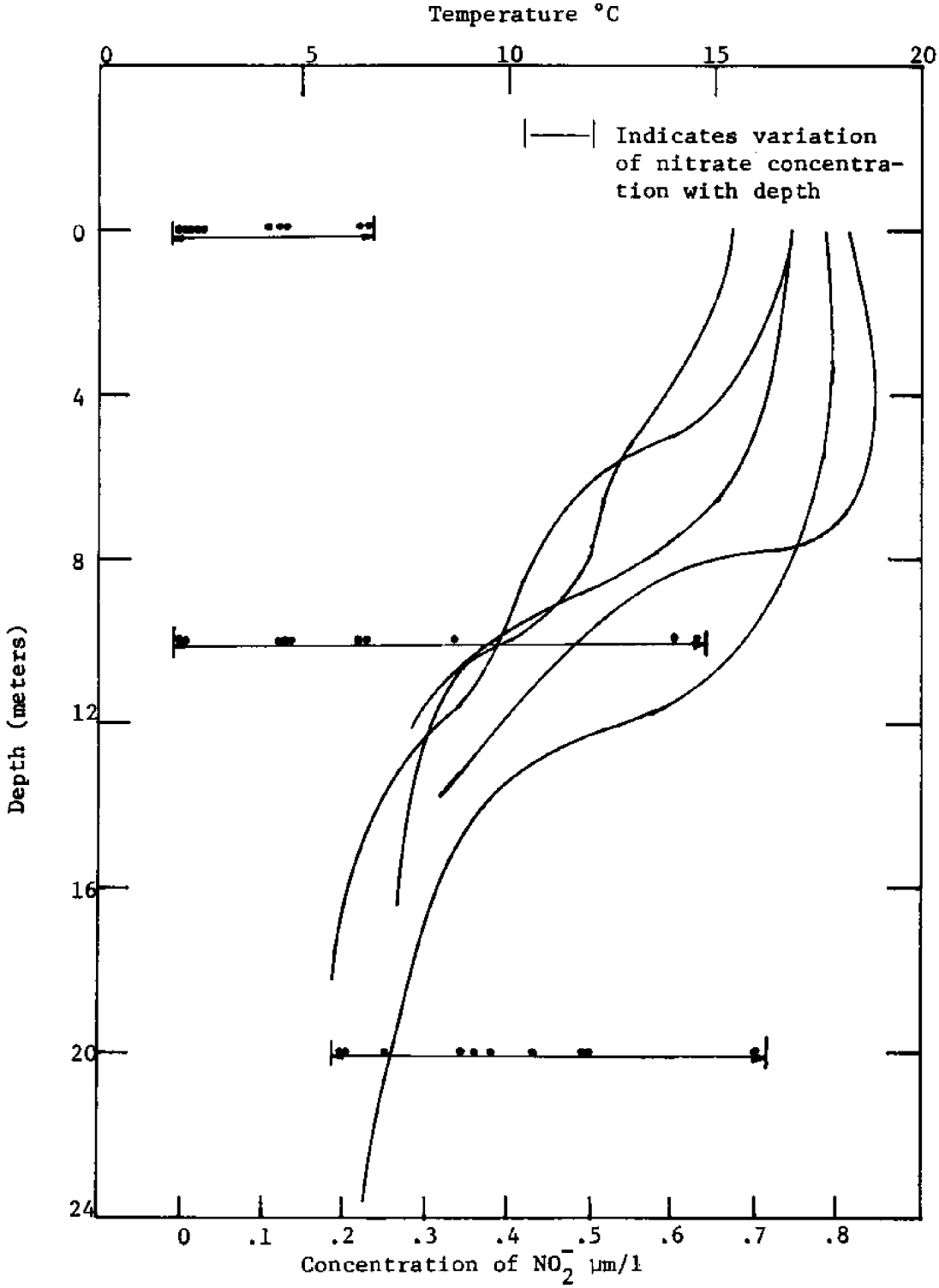


Figure 38 NO_2^- Concentration as a Function of Depth. (The Data is Taken from the July 25-26 Mass Bay Survey. The Thermoclines Presented are Five Stations Representative of the 19 Covered.)

concentration of nutrients would be higher in the layers of the ocean too cold to support life. Where there is no phytoplankton growth, the existent nutrient concentration is neither used nor depleted. With colder weather, the thermocline in the Mass Bay area begins to recede. By the end of September, it has disappeared in the inner harbor where the water is more shallow and by the end of November it has disappeared throughout all the depths. Phytoplankton growth ceases for the winter and nutrient concentrations increase regardless of depth. Representative plots of some of the data at different times of the year support the above. From the graphs in Figures 39 and 39A one can see that on March 21, 1973 there is no thermocline, the water temperature is very low, the nutrient concentrations are higher than in the summer and invariant to depth.

Included in Appendix C are representative C.T.D. plots showing the thermocline at different times of the year, a new computer program, and output for that data. Temperature, salinity, depth and σ_t are tabulated (where $\sigma_t = (\rho_{\text{salt water}} - 1) \times 10^3$)

ρ = density

Temperature, depth and salinity are then plotted on a graph. (Refer to Appendix C). All C.T.D. data in the future will be treated in this manner. It is important to continually develop new ways to clarify data and insure its reliability.

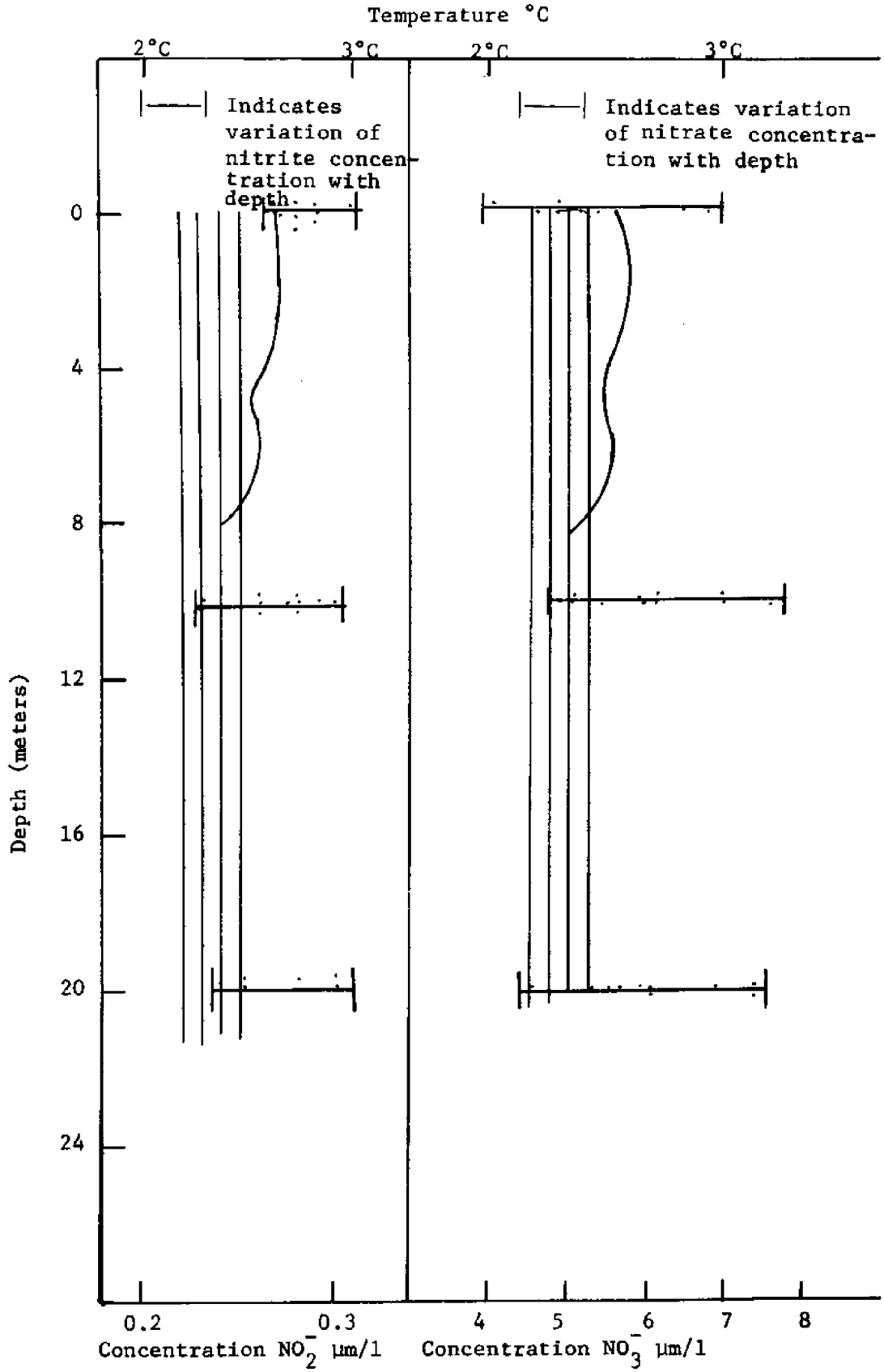


Figure 39 Concentration of NO_2^- as a Function of Depth

Figure 39A Concentration of NO_3^- as a Function of Depth

Data Presented Here is from March 21 Cruise. Five Thermoclines are Representative of Area where Data was Taken (i.e., NOMES Area - Fig. 17)

CHAPTER 5

CONCLUSIONS

Important to the maintenance of a healthy and aesthetic aquatic environment is the balance between photosynthetic production (P = rate of production of organic material) and respiration (R = rate of destruction of organic material). This balance can be characterized in terms of a simplified stoichiometric chemical equation

$$106\ CO_2 + 15\ NO_3^- + HPO_4^{2-} + 122\ H_2O + 18\ H^+ + (\text{trace elements} + \text{energy})$$

(P ↓ ↑ R)

$$C_{106}H_{263}O_{110}N_{16}P_1 + 138\ O_2$$

(Algae protoplasm)

(Ralph Mitchell Water Pol'n Micro Biol. p. 14)

In Figure 40, this equation is represented pictorially and the results of an inbalance in this steady state is indicated.

Typically, one finds that the ratio between nitrogen and phosphorus in plytoplankton is 16:1. This same ratio of nutrients (soluble nitrates and phosphates) is found in the deep waters of the Western Atlantic as reported by Stumm (pp. 15 & 16 of Mitchell). This ratio of 16:1 may, however, be typical only of the ocean as a whole and may be used generally as a rule of thumb. But as Ryther and Dunstan state, "since 98% of the ocean's volume lies below the depth of photosynthesis and plant growth, such mean values have little relevance....for discussion of the upper euphotic layer of the oceans". Over the ocean's surface there appears to be many different ratios of these elements. Ryther

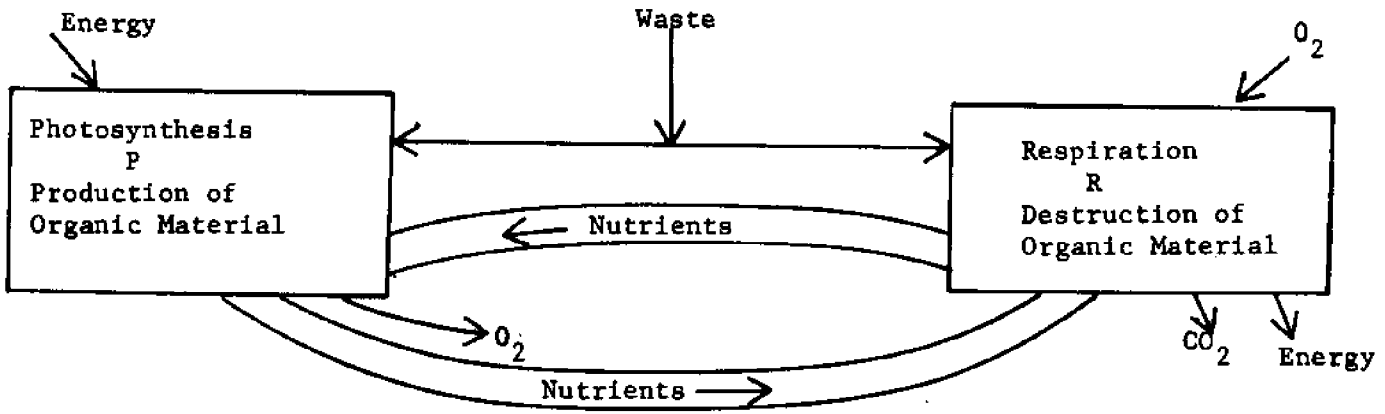


Figure 40 Balance between Photosynthesis and Respiration. A disturbance of the P-R Balance Results from Vertical or Longitudinal Separation of P and R Organisms. An Unbalance between P and R Functions Lead to Pollutional Effects of One Kind or Another. Depletion of O_2 if P < R or Mass Development of Algae if Production Rates Become Larger than the Rates of Algal Destruction by Consumer and Decomposes Organisms (R < P) (Mitchell, p. 15)

and Dunstan found that nitrogen is one critical limiting factor to algal growth and eutrophication in coastal marine waters. They propose two reasons for nitrogen being the limiting factor. First, in deep waters, since vertical transport of nutrients from beneath the thermocline is infrequent, the one principal enrichment of nutrients to the euphotic layer is achieved by a recycling process. It was found, however, that the regeneration of phosphorus which accompanies the decomposition and mineralization of phytoplankton is much more rapid than nitrogen. Therefore, nitrogen is used as soon as it is produced while there is usually an excess of phosphorus. (See Table 1).

Secondly, they have found that in coastal waters which are subjected to enormous amounts of sewage effluent there exist phytoplankton which have much lower ratios of nitrogen to phosphorus. Ryther and Dunstan conclude from data provided to them that one can calculate the N:P ratio by atoms in domestic wastes that have undergone primary sewage treatment to be 5.8:1. If the waste has undergone secondary treatment the ratio would be 5.4:1. They found in the two coastal areas they studied (Great South Bay - Mouches Bay and New York Bight) two green types of alga had developed. The N:P ratio in this type of phytoplankton was about 6.6:1, much lower than usual, thus giving support to the possibility that nitrogen was a limiting growth factor in coastal environments enriched in nutrients by sewage effluent. Typically the coastal waters contain a fairly high concentration of soluble phosphates but a rather low concentration of nitrates since they are absorbed and used immediately. During blooms the nitrate concentrations

Days	NH_3 + NO_2^-+NO_3^- (ug atoms P/Liter)	$PO_4^{\equiv}$ (ug atoms P/Liter)	N:P (by atoms)	Excess P (ug atoms P/Liter)
0	0.00	0.80	0.0	0.80
7	0.86	0.79	1.1	0.70
17	2.81	0.84	3.3	0.56
30	3.08	1.05	2.8	0.74
48	3.86	0.98	3.9	0.59
87	4.14	1.04	4.1	0.63

TABLE 1: Regeneration of Nitrogen and Phosphorous Accompanying the Decomposition of Mixed Plankton

(Ryther and Dunstan, Table 1)

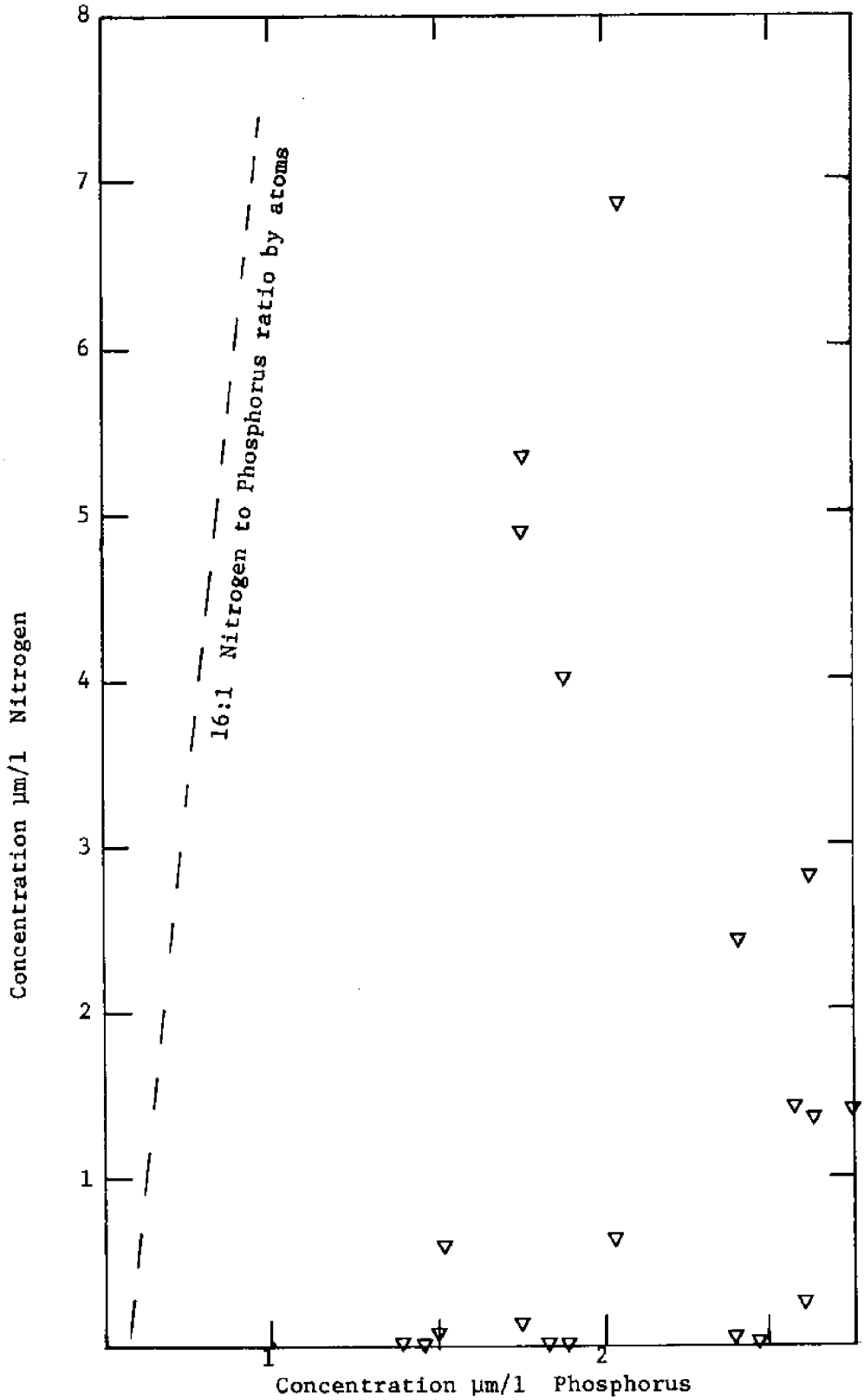


Figure 41 A Plot of Nitrogen Concentrations Versus Phosphorus Concentrations over the Period of March through June. This Demonstrates that the Ratio Falls Far below the Average 16:1 Line.

would drop to almost negligible amounts.

Referring to Figure 41, where typical Massachusetts Bay Environment Data is plotted against an average line of ratio 16:1 of N:P, it can easily be seen that the N:P ratio is far less than 16. Since the ratio is far less than 16 and since during the spring bloom when phytoplankton production is at its highest, the nitrate concentration drops to 0 (refer to pages 62 to 64 for representative data). One can, using this data, state that nitrogen is also the growth limiting factor in Massachusetts Bay coastline waters. Phosphate, as can be seen on page 61, is still present in excess even in the bloom season. Since nitrogen is the limiting growth factor, it can be seen then that further addition of phosphate is not the critical polluting factor leading either to increase of algal growth or eutrophication. The critical factor would be the nitrogen input.

The main source (Mitchell, p. 45) of nitrogen and phosphorus compounds in coastal and estuarine waters is municipal sewage. All of the sewage of roughly half of the population of the United States is emptied into our coastal waters. Sewage contains large amounts of nigroten compounds since a major nitrogen source is the end product of metabolism in humans. Ammonia is present in abundance along with nitrate, nitrite and urea. The first three compounds mentioned are directly utilized by all plankton and urea by many, although not all.

The nutrient loadings pouring out of our sewage disposal plants could cause eutrophication (undesirable increased algal growth). For instance, nitrates could increase algal growth in the immediate harbor area and further out. Furthermore, unusual algal growth like the red

tide are being examined in the light of the excess nutrient inputs from sewage effluents.

In conclusion, we believe that additional data must be accumulated to support new investigations which should be carried on to ascertain the influence of these increased concentrations to the biological community of Massachusetts Bay. Thus, the continuing and ultimate goal of this project is to formulate a hydrodynamic and ecological model of the Massachusetts Bay Area. This model must have as its foundation a comprehensive understanding of the two dominant processes that govern nutrient concentrations; namely the hydrodynamic transport processes that control the spacial distribution of nutrient material from the harbor seaward and the ecological interactions that control the temporal patterns of biological productivity.

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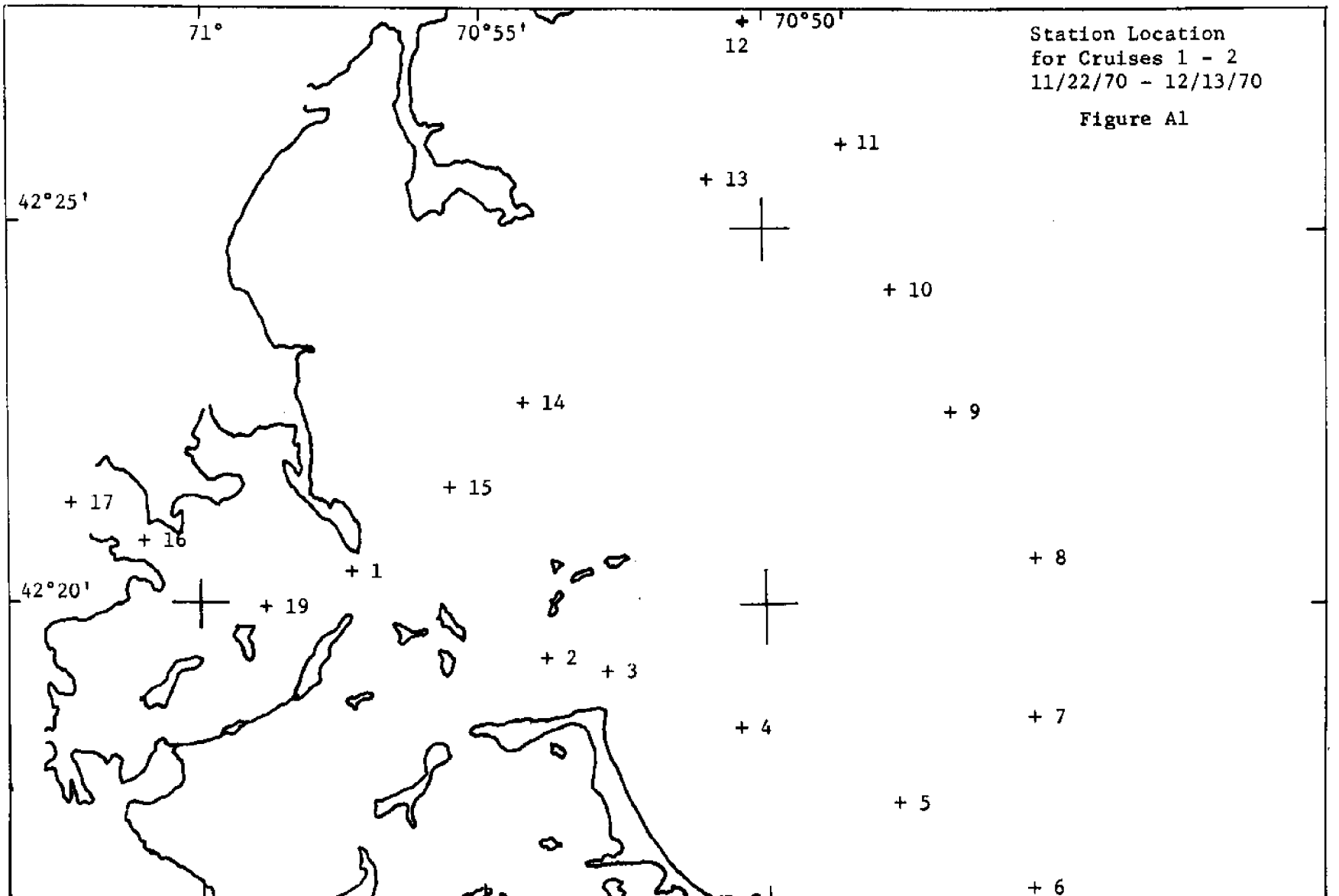
APPENDIX A

ROUTINE CHEMICAL DATA
FROM
MASSACHUSETTS BAY

NOVEMBER 22, 1970 - NOVEMBER 25, 1972

John M. Edmond
Department of
Earth & Planetary
Sciences


71°
70°55'
70°50'
42°25'
42°20'
12
+ 11
+ 13
+ 10
+ 14
+ 9
+ 15
+ 17
+ 16
+ 1
+ 8
+ 19
+ 2
+ 3
+ 4
+ 7
+ 5
+ 6
Station Location
for Cruises 1 - 2
11/22/70 - 12/13/70
Figure A1

CRUISE 1

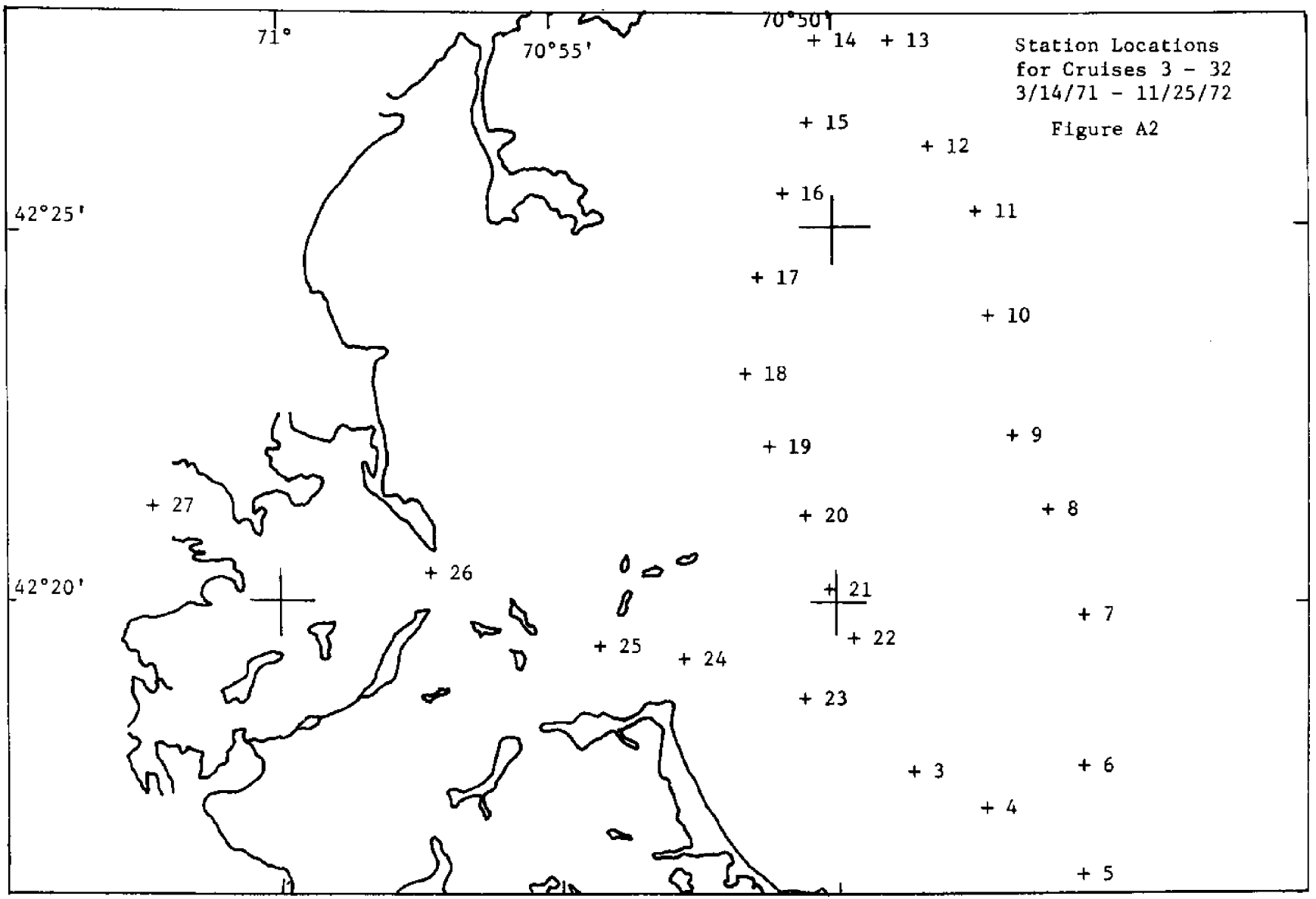
November 22, 1970

Station	Time	D (meters)	T °C	S °/00	O_2 ml/l
9	11:33	5		31.890	4.07
		10		31.890	4.41
		15		31.931	5.32
		17		31.968	6.00
		22		32.011	6.02
		27		32.015	6.04
3	12:40	5		31.526	5.94
		15		31.757	6.05
		25		31.810	6.16
15	13:06	4		30.701	5.82
		12		31.003	5.65
		19		31.398	5.70
1	13:22	4		30.382	4.93
		9		30.700	5.27
		14		30.817	5.90

CRUISE 2

December 13, 1970

1	13:45	2		31.189	6.08
		6.5		31.394	6.65
		11.5		31.536	6.52
		16		31.506	6.73
		21		31.480	6.54
19	14:08	1	4.7	30.937	6.19
		7		30.988	6.15
		10		31.523	6.53
16	14:30	2	4.8	29.62	5.55
		8.5		30.879	6.06
		15		30.812	6.28
17	14:50	2	5.1	30.16	4.90
		8.5		30.943	5.52
		15		31.149	6.00



Station Locations
for Cruises 3 - 32
3/14/71 - 11/25/72

Figure A2

CRUISE 3

March 14, 1970

Station	Time	D (meters)	T °C	$S^0/00$	$PO_4^{\equiv}$ µm/l	Si µm/l
1	09:15	0		30.697	0.340	0.314
2	09:30	0	2.4	30.571	0.34	0
3	09:45	0	2.3	30,746	0	0.98
4	09:55	0	2.0	28.60	0.09	0
5	10:05	0	2.0	29.35	0.09	0
6	10:20	0	2.0	28.36	0	0
7	10:30	0	2.1	30.963	0.21	0
8	10:42	0	2.5	31.731	0	0
9	10:52	0	2.3	31.812	0	0
10	11:10	0	2.8	30.727	0	0
11	11:27	0	2.8	31.660	0	0
12	11:37	0	2.7	30.595	0	0
13	11:50	0	2.7	31.385	0	0
14	12:00	0	2.5	31.403	0	0
15	12:14	0	2.7	31.367	0	0
16	12:24	0	2.4	31.408	0	0
17	12:39	0	2.7	31.591	0	0.11
		32		31.782	0	0
18	13:05	0	3.1	31.023	0.72	0.31
		25		31.785	-	-
19	13:17	0	3.0	30.776	0.76	0.07
		24		31.814	-	-
20	13:30	0	3.1	30.744	1.01	0.24
		30		31.823	-	-
21	13:43	0	3.5	30.420	0.63	-
		27		31.847	-	-
22	13:50	0	3.5	30.989	0.47	-
		26		31.815	0.04	-
23	14:06	0	3.8	30.920	0.50	-
		17		31.641	0.13	-
24	14:28	0	2.8	30.864	0.55	-
		13		31.647	-	-
25	14:42	0	2.4	30.520	1.14	-
		17		30.889	0.59	-
26	15:00	0	3.3	29.33	1.10	-
		20		30.16	1.65	-
27	15:45	0	4.0	15.45	4.35	-
		11		30.26	1.78	-

CRUISE 4

March 29, 1971

Station	D (meters)	T °C	S °/00	O_2 ml/l	$PO_4^{\equiv}$ µm/l	Si µm/l
1	1	3.4	30.20	-	2.25	0.79
	9		30.08	-	1.37	0.53
	18		30.708	-	1.15	0.66
2	2	3.3	30.711	-	0.93	0.35
	5		30.959	-	1.01	0.46
	9		31.006	6.13	1.01	0.39
3	1	3.2	31.016	-	1.24	0.35
	6		30.999	-	1.10	0.27
	12		30.844	-	1.15	0.22
4	1	3.3	31.181	-	0.93	0.13
	7.5		31.040	7.99	0.93	0.12
	17		31.150	-	1.01	0.31
5	1	3.1	31.078	-	0.93	0.38
	7.5		30.993	8.48	0.93	0.46
	17		31.126	-	0.79	0.55
6	1	3.1	30.968	-	0.71	0.25
	12		30.999	8.33	0.88	0.22
	23		31.035	-	1.01	0.56
7	1	3.1	31.142	-	0.71	0.75
	10		31.257	8.42	0.75	1.01
	22		30.883	-	0.79	0.65
8	1	3.0	31.367	-	0.71	0.54
	10		31.194	7.99	0.62	0.71
	20		31.464	-	0.75	0.55
	29		31.568	-	0.75	-
9	1		31.356	-	0.71	0.41
	11		31.323	9.09	0.57	0.38
	21		31.453	-	0.75	0.34
	30		31.472	-	0.88	0.25
10	1	2.9	31.466	-	3.75	0.27
	9		31.501	-	0.04	0.07
	18		31.386	8.98	0.88	0.21
	27		31.555	-	0.75	0.46
	36		31.427	-	0.75	0.45
11	1	3.0	31.204	-	0.75	0.48
	8		31.304	-	0.53	0.42
	17		31.139	7.81	0.84	0.45
	26		31.610	-	0.93	0.45
	35		31.620	-	0.66	0.51
12	0	2.9	31.188	-	0.66	0.52
	11		31.224	7.68	0.93	0.48
	22		31.304	-	0.79	0.49
	33		31.474	-	0.97	0.48

CRUISE 4 (continued)

March 39, 1971

Station	D (meters)	T °C	S $^{0}/_{00}$	O_2 ml/1	$PO_4^{\equiv}$ µm/1	Si µm/1
13	0	3.2	31.275	-	2.16	0.51
	9		31.206	-	2.96	0.38
	18		31.572	-	2.51	0.42
	27		31.578	-	2.65	0.48
	35		31.616	-	3.18	0.44
14	1	-	30.03	-	3.62	0.36
	21		30.03	7.93	3.44	0.40
15	1	-	30.625	-	2.69	0.36
	9		30.074	8.85	3.31	0.40
	27		30.422	-	3.84	0.28

CRUISE 5

April 27, 1971

Station	Time	D (meters)	T °C	S °/00	O_2 ml/l	$PO_4^{\equiv}$ µm/l	Si µm/l
1	09:25	3	6.0	30.22	7.21	1.65	0
		12		30.11	7.70	1.71	0
15	09:45	2	6.2	29.51	7.32	1.34	0.35
		7.5		30.35	7.51	1.44	0
		12		30.679	7.69	0.77	0
14	10:05	2.5	6.2	30.34	7.49	1.65	0.05
		9.5		30.39	7.66	1.52	0.05
		18		30.986	-	0.46	0
13	10:40	3	5.8	30.21	8.19	0.88	0.84
		19		30.677	8.13	0.62	0
		36		31.439	7.65	0.57	0
12	11:00	4	6.0	30.359	7.92	0.83	0
		15		30.384	8.24	0.57	0.17
		26		31.167	7.90	0.41	0
10	11:35	2.5	6.1	30.401	8.15	0.72	0.35
		14		30.803	8.31	0.57	0
		22.5		31.309	8.38	0.31	0
		32.5		31.129	7.82	1.13	0
8	11:50	4		30.634	7.92	0.46	0.12
		17		31.043	8.63	0.26	1.81
		32		31.458	7.78	1.03	0
7	12:20	2	6.0	30.395	8.21	0.67	0.05
		12		30.664	7.30	0.57	0
		21		31.134	7.91	1.24	0.30
9	12:45	2	6.0	30.517	-	0.83	0
		13		30.521	9.73	0.52	0
		25.5		31.027	7.15	1.44	0
4	13:25	2.5	7.0	30.506	8.23	1.29	0
		11		30.470	7.95	1.03	0
2	13:40	2	7.2	30.330	7.64	0.93	0
		10		30.523	7.31	1.44	0

CRUISE 7

July 6, 1971

Station	Time	D (meters)	T °C	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l	Si µm/l
3	08:55	0	14.5	0.79	0.07	1.14
		10		0.84	0.06	1.30
4	09:12	0	14.9	0.29	0.03	0.58
		12		0.76	0.17	4.48
5	09:28	0	16.9	0.24	0.01	0.45
		18		0.82	0.08	3.90
6	10:06	0	16.7	0.22	0.04	0.36
		9		0.25	0	0.58
		28		0.31	0.21	0.11
7	10:33	0	17.5	0.17	0.06	0.38
		12		0.31	0	3.34
		36		0.92	0.38	8.94
9	10:54	0	17.1	0.24	0.02	0.46
		10		0.33	0	3.57
		35		0.85	0.36	7.40
Halfway to 9a E.MC Buoy	11:16	0	16.2	0.26	0.01	2.04
		5		0.27	0	0.97
		11		0.42	0.01	2.45
		50		0.98	0.43	8.72
E,MC 9b Buoy	11:44	0	16.3	0.16	0.01	0.56
		7		0.42	0	0.92
		13		0.22	0.12	3.51
		64		0.98	0.43	9.57
13	12:24	0	16.9	0.29	0	0.97
		12		0.45	0	2.52
		46		0.90	0.38	9.31
14	12:59	0	16.9	0.18	0.03	9.60
		15		0.45	0.05	6.47
		31		0.74	0.22	6.62
15	13:28	0	15.4	0.32	0.03	2.10
		7.5		0.24	0.03	4.94
		33		0.98	0.32	16.06
N.Channel 15a	14:01	0	14.8	0.83	0.07	2.97
		16		0.72	0.12	7.49
		21		0.79	0.19	7.54
#4 Bell 15b	14:19	0	14.1	0.89	0.13	2.65
		13		0.73	0.13	4.64
1	14:37	0		4.73	0.41	7.44
		9		1.79	0.12	2.32
		19		0.89	0.09	1.98

CRUISE 8

July 13, 1971

Station	Time	D (meters)	T °C	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l	Si µm/l
14	09:02	0	13.3	1.25	0.13	1.36
		7.5		0.87	0.13	0.70
13	09:21	0	12.9	1.22	0.15	1.21
		13		1.35	0.14	1.06
12	09:39	0	11.3	1.04	0.11	0.78
		12		0.74	0.09	1.34
		16		1.07	0.15	3.00
11	10:16	0	13.0	0.70	0.79	0.55
		10		1.23	0.14	1.60
		15		1.41	0.19	2.81
		27		2.17	1.18	11.59
10	10:39	0	13.2	0.85	0.08	0.69
		11		1.33	0.12	2.14
		22.5		1.11	0.22	2.89
9	11:00	0	14.8	0.77	0.10	0.41
		8		1.42	0.05	0.31
		16.5		1.30	0.38	3.71
		33		1.60	0.47	6.03
8	11:25	0	16.0	0.58	0.06	0.42
		4.5		0.63	0.05	3.45
		21		1.50	0.41	9.91
		43		4.21	3.19	15.40
7	11:58	0	16.1	0.79	0.90	1.78
		15		1.25	0.46	4.33
		30		1.47	0.60	8.32
		45		1.55	0.61	9.26
6	13:10	0	16.1	0.66	0.06	1.20
		6		0.54	0.07	1.41
		10		0.38	0.06	1.55
		27		0.89	0.46	4.41
5	13:41	0	15.1	1.93	0.15	1.11
		10		1.86	0.08	2.14
		30		1.82	0.28	4.82
4	14:06	0	15.0	0.51	0.09	0.67
		7		2.76	0.06	0.49
		32		1.48	0.10	2.05
3	14:33	0	13.7	0.88	0.11	0.62
		16		1.14	0.09	0.74
2	14:46	0	14.6	1.11	0.08	0.66
		13		0.90	0.12	0.42
1	15:00	0		3.33	0.27	4.09
		18		0.84	0.10	0.49

CRUISE 9

July 20, 1971

Station	Time	D (meters)	T °C	NO_2^- µm/l	Si µm/l
14	08:47	0	12.4	0.13	1.84
		9		0.11	2.12
13	09:07	0	11.4	0.16	4.57
		13		0.30	3.73
12	09:21	0	14.1	0.12	4.7
		16		0.27	2.65
11	09:54	0	14.8	0.13	1.04
		9		0.11	1.62
		28		0.39	6.92
10	10:14	0	14.7	0.11	1.34
		4		0.19	2.48
		16		0.17	3.69
		23		0.37	6.07
9	10:35	0	14.2	0.15	1.02
		10		-	1.78
		32		0.60	9.76
8	10:52	0	14.4	0.13	0.90
		9		0.11	2.92
		12		0.39	2.52
		42		0.46	7.54
7	11:19	0	14.6	0.85	1.58
		15		0.39	3.77
		20		0.57	4.97
		50		0.44	8.20
6	11:48	0	13.5	0.41	0.92
		6		0.81	0.99
		10		-	1.64
		40		-	6.24
5	12:20	0	13.5	0.20	1.37
		6		0.14	1.53
		20		0.39	1.83
4	12:44	0	14.1	0.14	0.94
		31		0.47	8.17
3	13:14	0	12.5	0.12	1.45
		20		0.20	2.28
2	13:29	0	12.5	0.15	2.23
		13		0.10	1.40
1	13:44	0	12.4	0.51	6.06
		13		0.31	3.70

CRUISE 10

July 27, 1971

Station	Time	D (meters)	T °C	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l	Si µm/l
3	09:06	0	13.9	0.88	0.17	1.21
		7.5		0.40	0.16	0.93
4	09:20	0	13.2	0.83	0.17	1.68
		12		0.81	0.11	1.42
5	09:36	0	11.5	0.43	0.08	1.06
		16		0.99	0.09	3.81
6	10:08	0	13.1	0.42	0.15	0.58
		10		0.35	0.14	1.36
		26		1.22	0.65	5.27
7	10:27	0	13.2	0.40	0.31	0.72
		11		0.47	0.21	1.68
		22.5		1.03	0.43	4.61
9	10:44	0	13.1	0.38	0.20	0.75
		12		0.28	0.16	0.64
		32		0.91	0.23	3.46

CRUISE 11

August 3, 1971

Station	Time	D (meters)	T °C	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l	Si µm/l
3	08:47	0	15.5	1.90	0.21	3.32
		10		2.63	0.14	4.24
4	09:02	0	14.6	0.84	0.10	1.70
		13		0.76	0.14	2.47
5	09:19	0	15.8	1.12	0.09	1.01
		16		1.14	0.16	3.54
6	09:50	0	15.7	1.10	0.10	1.22
		19		1.40	0.20	4.07
7	10:10	0	16.2	0.84	0.13	1.46
		16		0.89	0.14	2.12
		23		0.84	0.21	3.28
9	10:31	0	18.0	0.23	0.04	0.81
		10		0.36	0.04	1.67
		37		0.89	0.30	3.91
9a	10:50	0	18.2	0.21	0.04	0.74
		10		0.26	0.03	1.33
		20		0.81	0.24	4.13
		40		1.20	0.27	6.80
9b	11:13	0	17.8	0.21	0.05	0.58
		8		0.29	0.03	1.26
		20		0.54	0.06	2.49
		50		1.03	0.23	8.14
13	11:46	0	18.5	0.30	0.04	0.59
		5		0.28	0.03	0.52
		15		0.49	0.05	2.65
		35		0.97	0.27	4.43
14	12:15	0	18.3	0.50	0.08	0.85
		6		0.47	0.03	1.09
		20		0.74	0.17	3.32
15	12:41	0	17.8	0.73	0.06	0.85
		10		0.51	0.04	1.51
		30		0.81	0.27	4.03
15a	13:06	0	14.8	1.70	0.13	2.63
		10		0.64	0.04	1.68
		20		0.88	0.11	2.69
15b	13:24	0	13.4	2.51	0.19	4.29
		12		1.58	0.17	3.82
1	13:38	0	13.7	3.78	0.32	5.79
		9		1.60	0.18	3.29

CRUISE 12

August 10, 1971

Station	Time	D (meters)	T °C	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l	Si µm/l
3	09:36	0	15.7	1.47	0.34	3.59
		8.5		1.35	0.30	3.14
4	09:51	0	15.4	1.47	0.29	3.63
		8.5		1.42	0.23	3.23
5	10:05	0	14.5	1.05	0.22	2.27
		14		1.17	0.27	5.26
6	10:40	0	15.3	0.77	0.15	1.08
		9		1.02	0.18	2.96
		19		1.04	0.25	4.51
7	11:00	0	15.3	0.50	0.12	0.86
		15		0.64	0.12	3.02
		30		1.02	0.27	6.13
9	11:16	0	15.4	0.38	0.12	0.84
		15		0.48	0.10	0.37
		32		1.05	0.37	8.35
9a	11:40	0	17.0	0.14	0.09	0.82
		9		0.66	0.11	2.85
		19		0.87	0.24	4.14
		39		1.04	0.22	8.22
9b	12:00	0	16.6	0.17	0.05	0.74
		10		0.38	0.04	1.28
		25		0.92	0.27	0.99
		50		1.04	0.20	8.57
13	12:30	0	16.7	0.15	0.03	0.64
		15		0.34	0.04	1.43
		40		0.95	0.23	5.62
14	12:55	0	15.7	0.20	0.06	0.56
		15		0.67	0.13	3.50
15		0	14.5	0.39	0.08	1.03
		10		0.33	0.08	1.16
		31		1.04	0.19	7.27
15a	13:43	0	14.4	1.19	0.21	3.01
		19		0.67	0.09	3.20
15b	13:55	0	14.1	0.74	0.13	2.01
		10		0.63	0.08	2.60
1	14:09	0	12.9	2.07	0.20	5.45
		16		0.59	0.10	2.73

CRUISE 13

August 27, 1971

Station	Time	D (meters)	T °C	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l	Si µm/l
3	09:57	0	15.1	1.98	0.17	3.44
		6		1.69	0.10	3.28
4	10:14	0	15.1	1.76	0.08	2.98
		8.5		1.79	0.10	2.79
5	10:28	0	15.6	0.75	0.07	0.97
		14		1.32	0.06	5.15
6	11:02	0	16.5	0.60	0.06	1.92
		10		1.39	0.05	5.32
		20		1.27	0.07	7.67
15a	12:06	0	13.9	2.26	0.05	3.47
		20		1.00	0.06	4.52
15b	12:20	0	13.7	2.03	0.17	2.65
		10		1.11	0.07	3.67
1	12:33	0	14.5	3.73	0.13	4.68
		10		1.99	0.11	3.24

CRUISE 14

September 1, 1971

Station	Time	D (meters)	T °C	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l	Si µm/l
3	09:20	0	16.0	2.24	0.63	5.97
		4		1.94	0.57	5.68
4	09:36	0	15.5	1.32	0.41	3.64
		10		1.37	0.37	3.96
5	09:51	0	15.5	1.09	0.37	2.78
		15		1.39	0.67	6.63
6	10:23	0	15.9	0.76	0.28	2.45
		12		0.76	-	2.97
		25		1.36	0.54	9.06
7	10:43	0	16.3	0.50	0.29	2.29
		19		0.88	0.38	3.44
9	11:04	0	16.7	0.21	0.30	1.33
		12		0.67	0.29	2.67
		25		1.11	0.46	7.88
9a	11:27	0	16.9	0.18	0.35	1.38
		10		0.45	0.33	1.16
		20		0.95	0.41	6.90
		43		1.06	0.23	9.74
9b	11:48	0	16.2	0.23	0.30	1.37
		12		0.38	0.20	2.03
		26		0.64	0.25	3.78
		50		1.11	0.21	7.97
13	12:31	0	16.5	0.23	0.22	0.78
		10		0.39	0.24	0.94
		20		0.80	0.26	5.58
		34		0.94	0.20	7.51
14	13:05	0	16.4	0.36	0.21	0.97
		10		0.51	0.22	1.38
		30		1.00	0.21	7.95
15	13:32	0	16.5	0.36	0.18	1.32
		17		0.97	0.25	4.20
		27		1.24	0.25	9.55
15a	13:58	0	16.5	0.50	0.26	1.53
		17		1.44	0.24	6.04
15b	14:10	0	16.2	0.97	0.24	2.12
		10		1.39	0.35	2.75
1	14:23	0	16.3	5.39	0.58	11.33
		8		2.50	0.41	4.42

CRUISE 15

October 19, 1971

Station	Time	D (meters)	T °C	O_2 ml/1	$PO_4^{\equiv}$ µm/1	NO_2^- µm/1
6	10:55	0	13.9	6.63		0.24
		11		6.16		0.06
9	11:47	0	14.1	7.52		0
		11		7.94		0
		16		7.60		0
		23		5.98		0.04
12	12:45	0	13.1	6.25		0.12
		10		5.80		0.01
		20		5.54		0
1	13:30	0	12.7	6.12		0.89
		10		5.84		0.88

CRUISE 16

October 30, 1971

9	13:20	0	14.2	9.53	0.86	0.53
		10		8.40	-	-
		26		5.97	0.56	0.42
7	13:40	0	14.4	9.84	1.05	0.81
		10		7.88	0.87	1.02
		30		5.32	0.64	0.85
6	14:10	0	15.1	9.67	0.29	0.78
		10		8.02	0.37	0.92
		25		5.40	1.29	1.35
11	14:40	0	15.2	7.62	1.36	1.22
		15		6.90	1.08	2.01
		45		5.69	2.15	1.43

CRUISE 17

November 6, 1971

Station	Time	D (meters)	T °C	O_2 ml/l	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l
6	10:30	0	12.4	6.00	1.08	0.50
		13		-	0.24	0.36
8	10:55	0	12.4	-	0.82	0.34
		12		-	0.61	0.43
9	11:30	0	12.2	7.30	0.11	0.90
		12		-	0.34	0.40
		25		-	0	0.44
14	12:32	0	12.2	6.22	0	0.98
		23		5.35	0	0.49
1	13:15	0	11.9	2.87	0.37	0.65
		20		6.01	1.37	1.42

CRUISE 18

November 13, 1971

6	10:50	0	9.4	7.09	1.84	0.95
		15		7.20	1.84	1.04
9	11:30	0	9.4	7.84	0.79	0.49
		10		7.43	0.97	0.49
		30		6.80	0.87	0.59
14	12:45	0	9.2	6.80	1.08	0.87
		25		5.77	1.22	0.68
1	14:00	0	9.0	5.97	2.41	1.72
		12		6.00	2.49	1.45

CRUISE 19

Station	Time	D (meters)	T °C	O_2 ml/l	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l
6	10:40	0	8.8	7.48	0.99	0.08
		19		7.51	1.05	0.07
8	11:00	0	9.0	8.63	1.03	0.08
		16		8.63	1.04	0.11
9	11:25	0	9.1	-	1.12	0.19
		28		6.90	1.48	0.03
14	12:15	0	9.1	8.92	1.28	0.02
		18		7.19	1.14	0.04
1	12:55	0	9.2	3.14	2.76	1.09
		15		-	1.72	0.85

CRUISE 20

December 21, 1971

3	08:45	0	5.5	7.67	1.83	0.22
		10		-	2.25	0.17
14	09:30	0	5.2	9.53	2.35	0.29
		13		8.88	2.19	0.44
15	10:35	0	5.6	9.84	2.07	0.50
		11		8.81	2.05	0.74
1	10:45	0	4.6	9.89	2.93	1.07
		11		9.26	2.86	1.30

CRUISE 21

January 15, 1972

Station	Time	D (meters)	T °C	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l
6	09:45	0	4.5	2.26	0.70
		26		2.57	1.03
8	10:05	0	5.0	1.98	0.80
		25		2.01	0.62
9	10:25	0	4.9	1.96	0.56
		35		2.05	0.82
14	11:20	0	4.7	2.09	0.92
		18		1.83	0.59
1	12:00	0	5.0	3.25	1.47
		20		2.72	1.02

CRUISE 22

January 22, 1972

6	09:55	0	3.5	1.91	0.19
		17		1.63	0.11
8	10:30	0	3.5	1.74	0.65
		17		1.83	0.23
9	10:55	0	3.6	1.41	0.45
		25		1.53	0.10
14	11:35	0	3.4	1.96	0.49
		17		1.85	0.08
1	12:15	0	3.2	2.30	0.43
		18		2.16	0.33

CRUISE 23

February 12, 1972

Station	Time	D (meters)	T °C	S °/00	O_2 ml/l	$PO_4^{\equiv}$ m/l	NO_2^- m/l
6	09:45	0	1.5		9.41	1.26	0.25
		22			9.44	1.33	0.08
8	10:15	0	2.2		9.38	1.11	0.21
		21			9.36	1.05	0.12
9	10:40	0	1.8		9.11	0.99	0.44
		33			9.28	1.15	0.05
14	14:00	0	2.6		9.30	1.18	0.86
		16			9.56	1.14	0.54
1	14:40	0	1.8		8.41	2.63	0.97
		14			8.94	1.85	0.32

CRUISE 24

March 18, 1972

9	10:00	0	4.8		8.51	1.59	0.28
		20			9.04	1.13	0.11
1	11:30	0	3.5		8.83	1.45	0.14
		12			9.20	1.53	0.05

CRUISE 25

June 3, 1972

6	10:00	0	11.0	31.033		1.99	0.09
		16		32.106		2.99	0.25
8	10:20	0	12.0	30.826		2.17	0.21
		16		32.009		2.23	0.41
9	10:45	0	11.6	30.971		2.24	0.14
		10		32.653		2.46	0.20
		27		33.592		2.60	0.21
14	11:30	0	12.2	-		2.84	0.53
		19		32.461		2.85	0.46
1	12:05	0	11.2	30.731		2.88	0.18
		14		30.893		2.95	0.57

CRUISE 26

June 10, 1972

Station	Time	D (meters)	T °C	O_2 ml/l	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l
14	09:45	0	10.5	4.62	1.07	0.10
		22		5.96	1.59	0.08
1	10:50	0	10.0	5.83	2.05	0.14
		17		6.49	0.75	0.16

CRUISE 27

July 28, 1972

6	10:07	0	17.9		0.39	0.46
		18			1.18	0.76
8	10:45	0	18.8		0.17	0.25
		17			0.63	0.36
9	11:30	0	19.0		0.13	0.43
		25			0.83	1.46
Dredge Site	12:15	0	19.5		0.06	0.43
		25			0.88	0.58
14	13:15	0	19.8		0.38	0.25
		22			1.98	0.64

CRUISE 28

August 26, 1972

Station	Time	D (meters)	T °C	S $^{0}/_{00}$	$PO_4^{\equiv}$ µm/l	NO_2^{-} µm/l
6	09:35	0	20.0	31.644	0.871	0.65
		18		32.056	1.22	0.60
8	10:00	0	20.0	31.646	1.04	0.52
		18		32.070	1.43	0.50
9	10:46	0	21.0	31.618	1.25	0.47
		30		32.210	1.47	0.69
Dredge Site	13:00	0	22.0	31.576	1.28	0.43
		25		32.143	1.52	0.75
14	13:40	0	21.0	31.712	1.90	0.64
		25		32.262	1.42	0.71
1	14:35	0	20.0	30.428	2.82	1.08

CRUISE 29

September 9, 1972

6	10:10	0	21.0	31.394	1.16	0.67
		16		31.764	0.68	0.60
8	10:55	0	22.1	31.423	0.71	0.46
		16		31.771	0.72	0.36
9	11:30	0	22.3	31.680	0.91	0.22
		18		31.873	0.71	0.20
		28		31.874	0.80	0.29
Dredge Site	12:15	0	22.4	31.449	2.00	0.36
		22		32.026	0.97	0.40
14	13:05	0	22.2	31.185	1.99	0.65
		24		31.891	1.31	0.46
1	13:50	0	22.0	30.194	2.77	0.59
		18		31.452	1.72	0.40

CRUISE 30

September 16, 1972

Station	Time	D (meters)	T °C	S °/00	$PO_4^{\equiv}$ µm/l	NO_2^- µm/l
6	10:50	0	25.5	31.303	1.40	0.63
		21		32.103	1.02	0.69
8	11:25	0	26.2	31.358	1.59	0.26
		21		32.009	1.16	0.42
9	11:50	0	26.1	31.377	1.43	0.23
		16		31.871	0.75	0.52
		32		32.290	1.04	0.58
Dredge Site	12:25	0	26.3	31.314	1.50	0.48
		23		31.944	1.02	0.48
14	13:00	0	26.3	32.211	1.88	0.87
		24		32.048	2.95	0.98
1	13:40	0	26.3	30.745	2.90	0.96
		11		30.883	2.73	0.90

CRUISE 31

October 14, 1972

1	09:15	0	12.7	30.712	2.91	0.94
		11		31.373	2.85	1.01
6	10:45	0	12.3	31.756	2.60	0.13
		24		-	2.78	0.17
Dredge Site	11:45	0	13.0	31.794	2.63	0.08
		12		31.827	2.61	0.23
		24		32.202	2.84	0.20
9	12:05	0	12.9	31.811	3.00	0.17
		15		31.857	2.69	0.21
		32		32.547	2.72	0.31

CRUISE 32

November 25, 1972

Station	D (meters)	T °C	S $^{0}/_{00}$	O_2 ml/l	$PO_4^{\equiv}$ µm/l	NO_2^{-} µm/l
6	0	8.7	31.637	8.95	2.04	0.50
	5	5.7	31.608	6.07	1.60	0.56
	22	5.9	31.958	6.04	1.97	0.42
8	0	6.2	31.865	5.50	2.51	0.44
	5	6.4	31.985	6.52	1.63	0.53
	18	6.7	32.189	5.54	2.06	0.40
9	0	6.6	32.274	6.25	1.60	0.44
	5	6.6	32.277	6.92	2.36	0.38
	34	6.7	32.365	6.62	1.68	1.13
Dredge Site	0	6.7	32.192	5.30	2.36	0.44
	5	6.7	32.193	6.00	1.48	0.43
	28	6.9	32.323	6.42	1.51	0.32
14	0	6.1	31.499	6.79	2.97	0.79
	5	6.1	31.771	6.52	2.46	0.52
	26	6.6	32.214	6.05	2.32	0.40
1	0	5.8	31.950	-	2.76	0.65
	5	5.8	31.020	-	2.18	0.74
	21	5.9	30.633	-	2.83	0.48

APPENDIX B

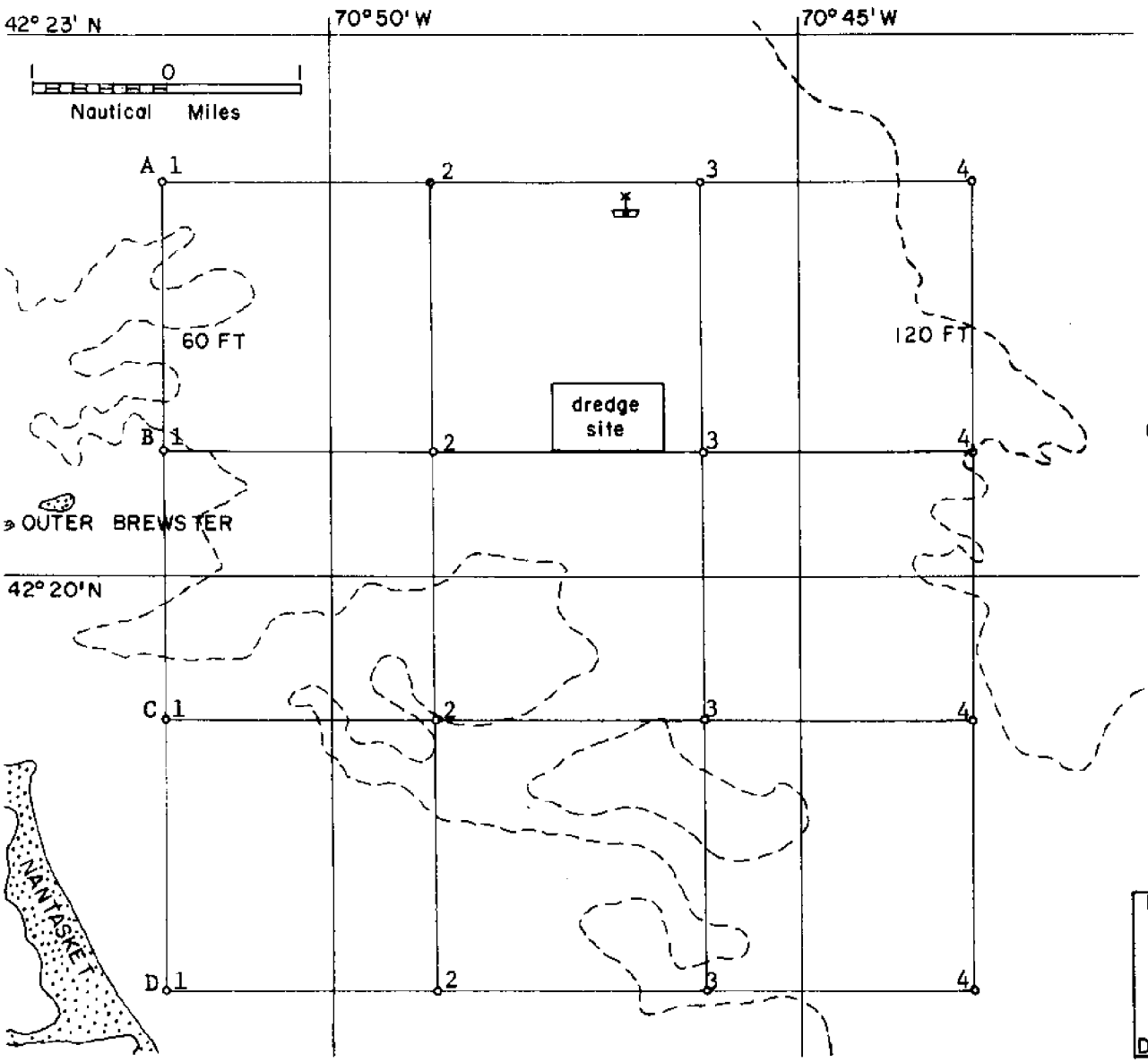
CHEMICAL DATA

MASSACHUSETTS BAY AREA

RALPH M. PARSONS LABORATORY

FOR WATER RESOURCES AND HYDRODYNAMICS

Sheila Frankel
Staff Chemist
Department of
Civil Engineering



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date:

parameter:

sample depths:

meteorological conditions:

R. M. PARSONS LABORATORY
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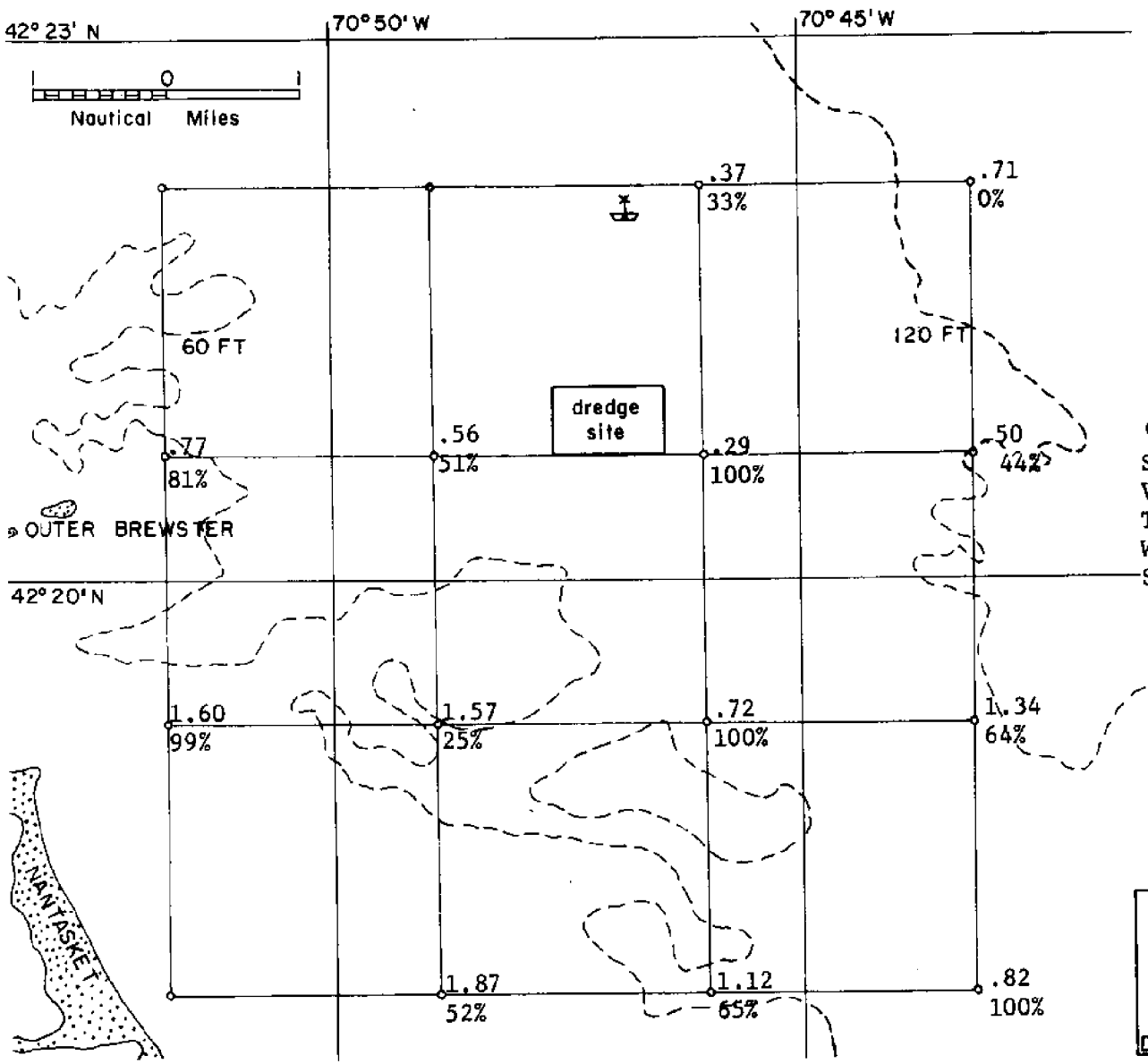
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING

FIGURE B1 - STATION NUMBERS FOR NOMES GRID



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: February 17, 1973

parameter: Suspended Sediment

sample depths: 1st number - total sediment mg/l
2nd number - % organic

meteorological conditions:
Sky: Partly Cloudy
Visibility: 13 miles
Temperature: 38° F
Wind: 190°, 11 Knots
Sea: 3-5 Feet

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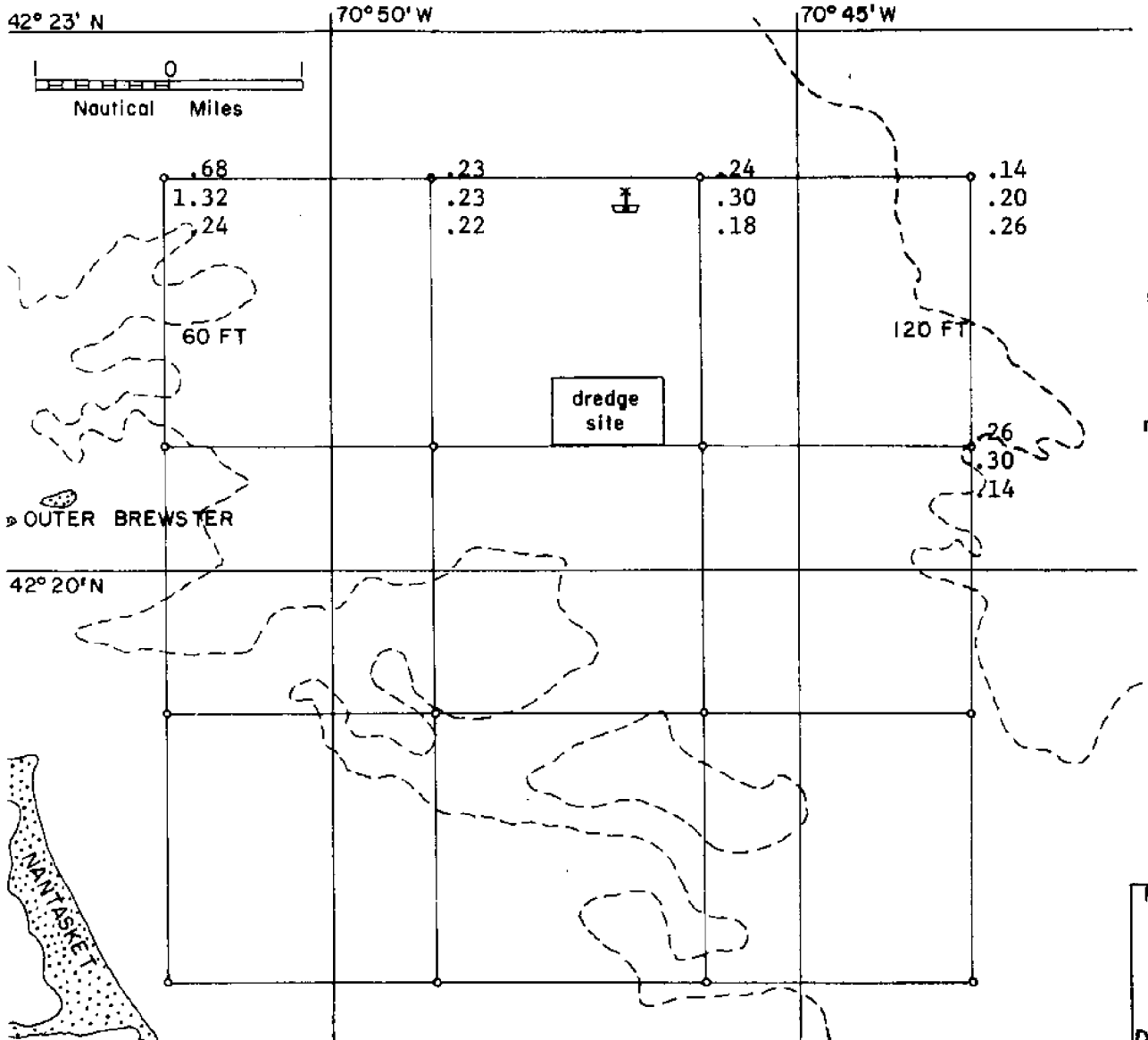

NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: February 21, 1973

parameter: NO_2^- µm/1

sample depths:
1st No. - Surface
2nd No. - 5 meters
3rd No. - 10 meters

meteorological conditions:
Sky: Clear
Visibility: 12 Miles
Temperature: 40° F
Wind: 210°, 10 Knots
Sea: 2-3 Feet

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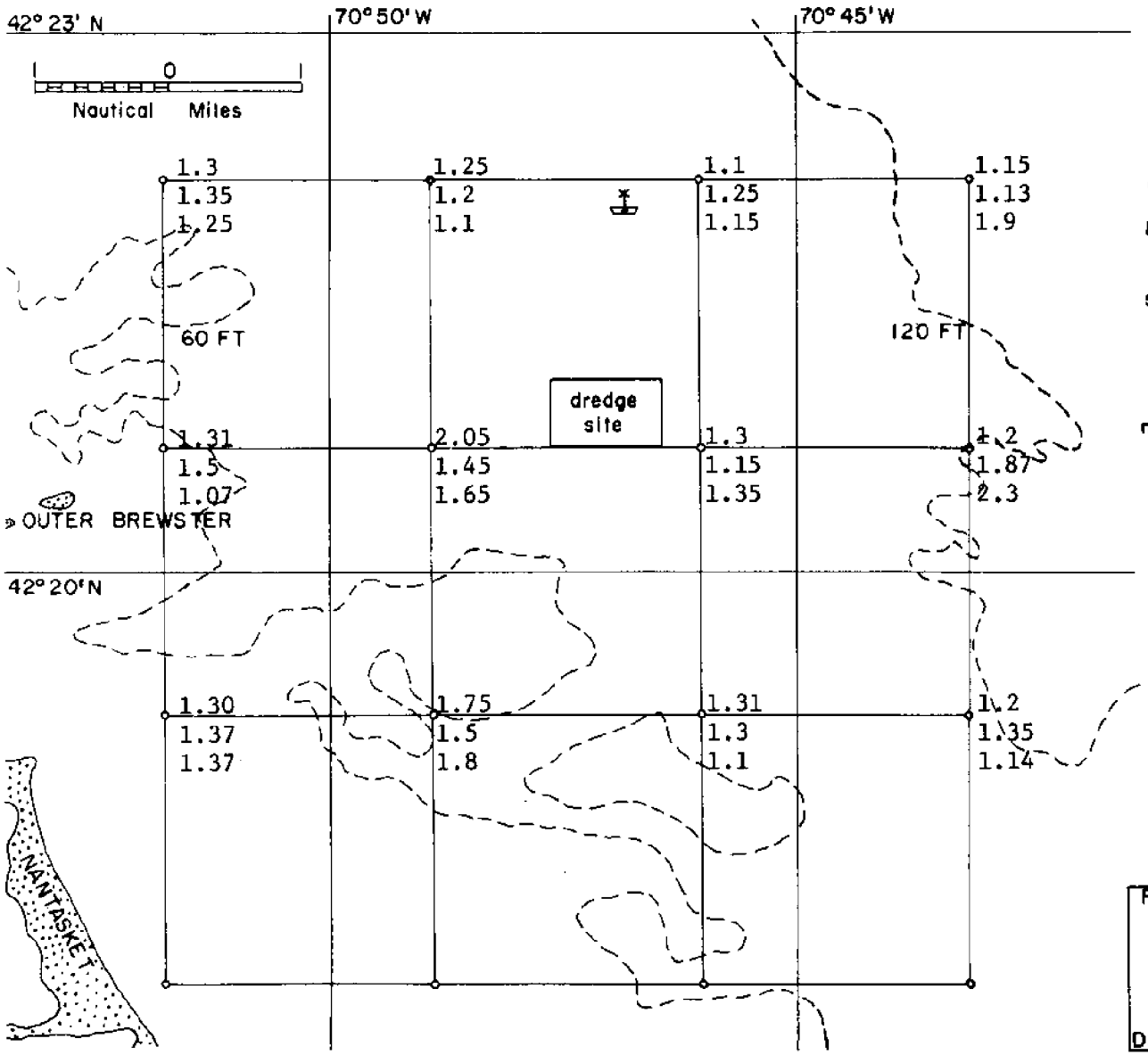

NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: February 21, 1973

parameter: $PO_4^{\equiv}$ µm/1

sample depths:

1st No. - 1 meter
2nd No. - 5 meters
3rd No. - 10 meters

meteorological conditions:

Sky: Clear
Visibility: 12 Miles
Temperature: 40° F
Wind: 210°, 10 Knots
Sea: 2-3 Feet

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AND HYDRODYNAMICS
M. I. T.
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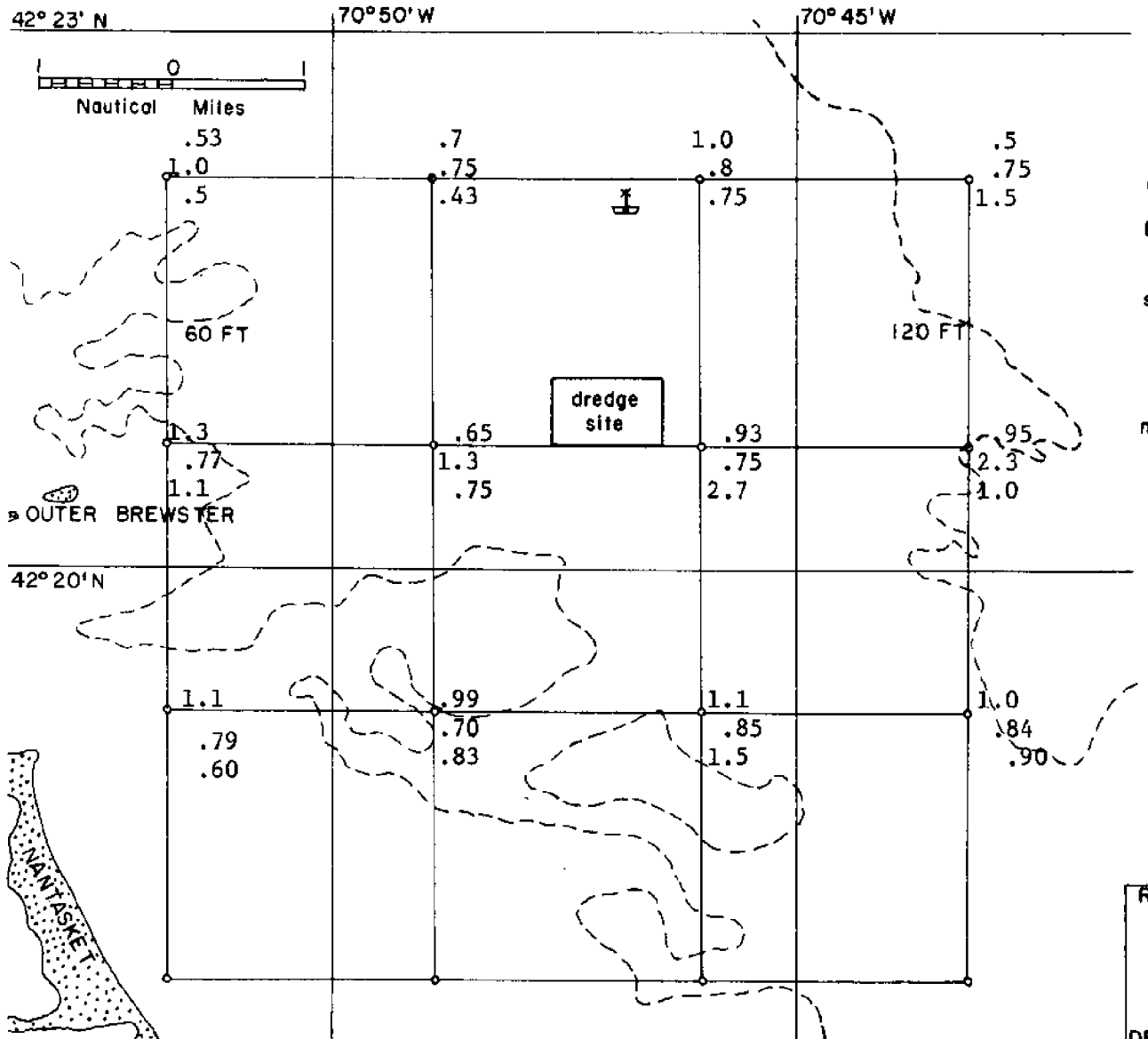

NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: February 21, 1973

parameter: Turbidity (F.T.U.)

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Clear
Visibility: 12 Miles
Temperature: 40°F
Wind 210°, 10 Knots
Sea: 2-3 Feet

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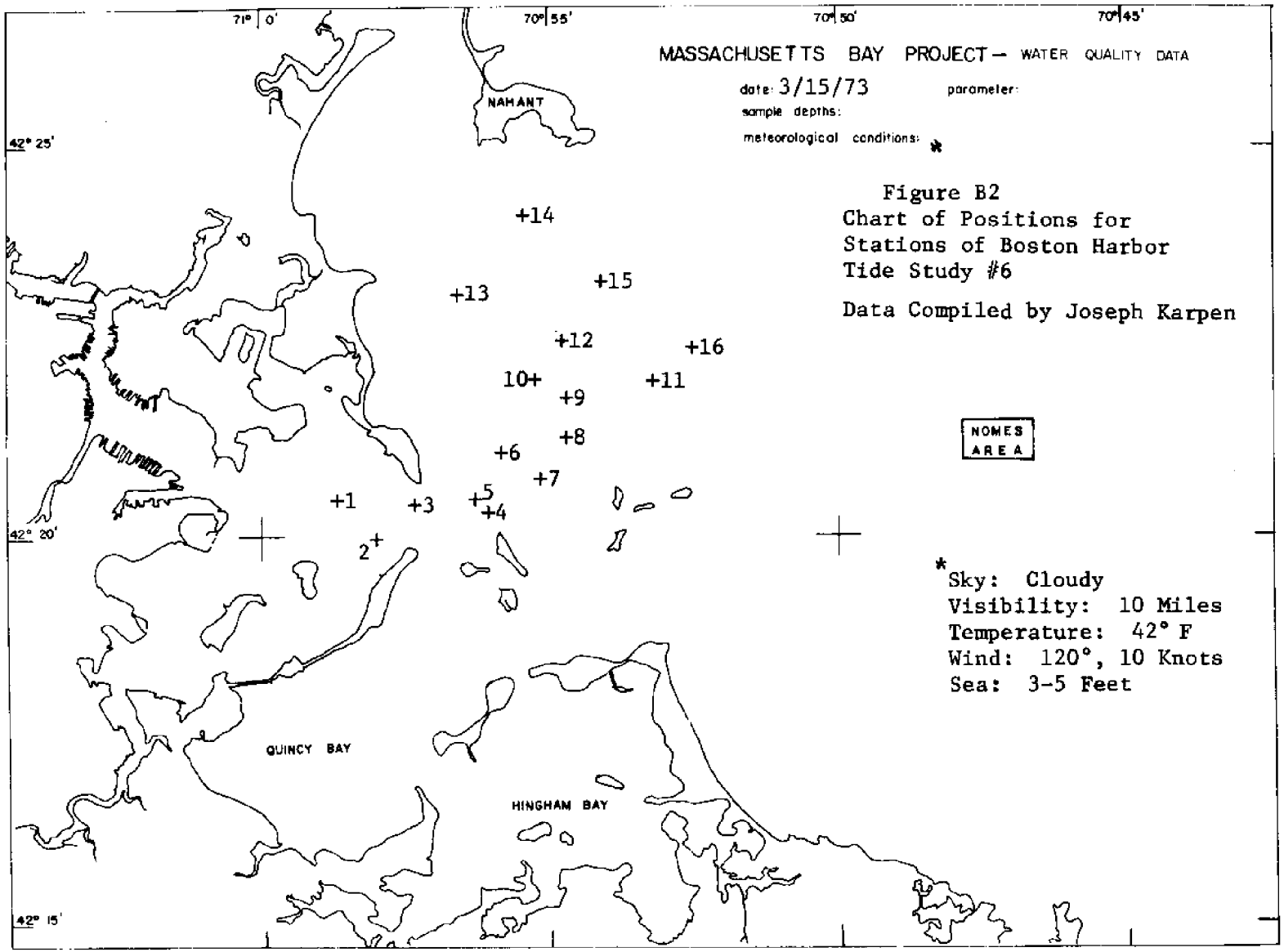


Figure B2
Chart of Positions for
Stations of Boston Harbor
Tide Study #6

Data Compiled by Joseph Karpen

BOSTON HARBOR TIDE STUDY #6

15 March 1973

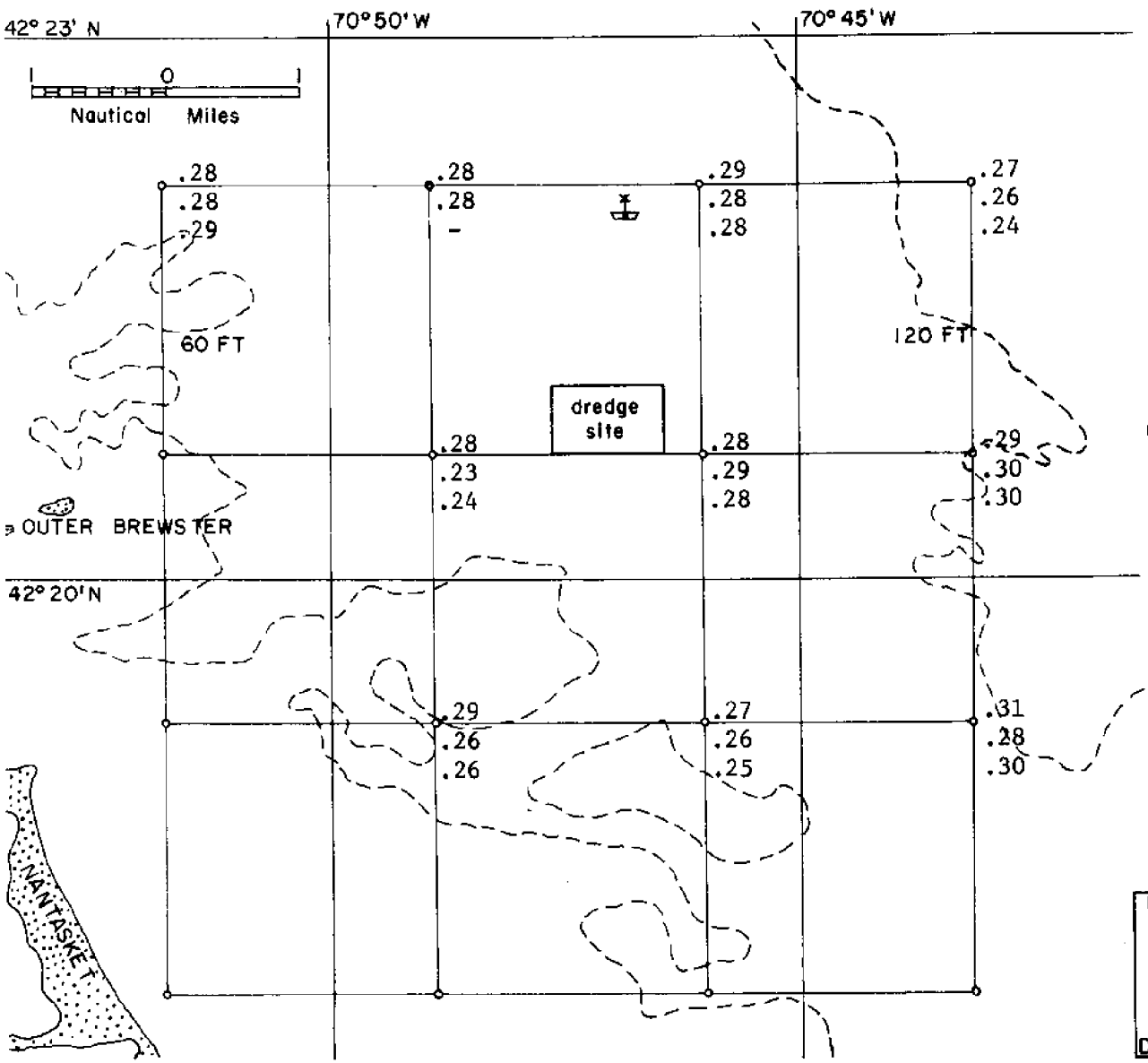
Station *	Salinity [1]	NO_2^- Conc. [2]	Surf. Temp. [3]	Time
1	29.574	.308	6.0	12:15
2	29.019	.361	6.0	12:27
3	30.460	.300	4.9	12:33
4	30.347	.339	5.0	12:40
5	31.478	.348	4.8	12:43
6	30.660	.276	4.5	12:46
7	30.319	.325	5.0	12:48
8	30.340	.356	5.0	12:52
9	30.789	.303	4.4	12:54
10	-	.277	4.5	12:58
11	30.801	.300	4.4	13:09
12	30.924	.309	4.2	13:16
13	-	-	-	-
14	31.160	.182	4.0	13:35
15	31.004	.285	4.0	14:00
16	30.768	.270	4.4	14:15

1 Salinity in parts per thousand

2 NO_2^- Conc. in µm/l

3 Temp. in degrees centigrade

* All samples are bucket grab surface samples



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: March 21, 1973

parameter: NO_2^- µm/1

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Cloudy
Visibility: 13 Miles
Temperature: 34° F
Wind: 040°, 10 Knots, Gust 19 Knots
Sea: 5-8 Feet

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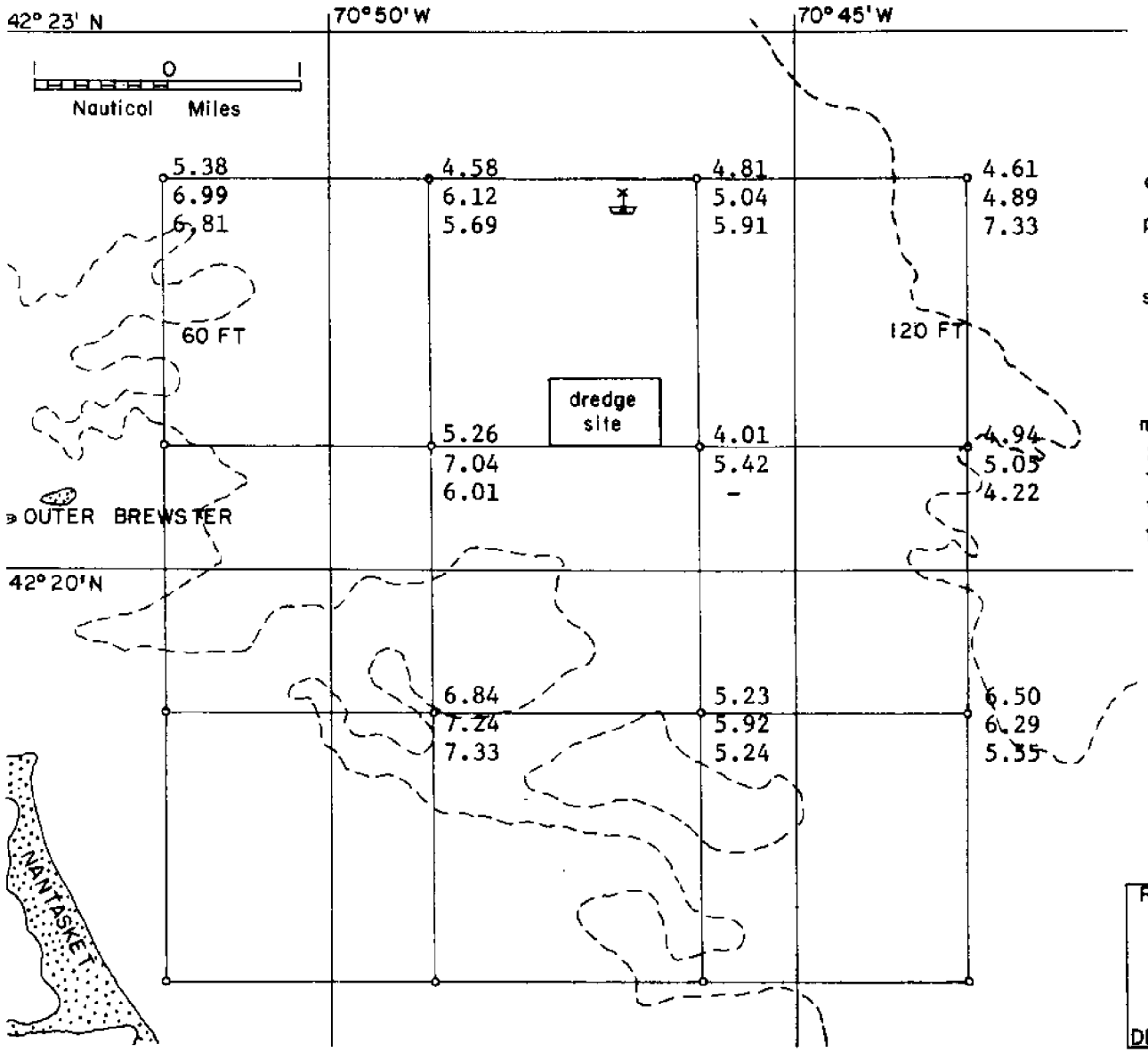

NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: March 21, 1973

parameter: NO_3^- µm/l

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Cloudy
Visibility: 13 Miles
Temperature: 34°F
Wind: 040°, 10 Knots, Gust 19 Knots
Sea: 5-8 Feet

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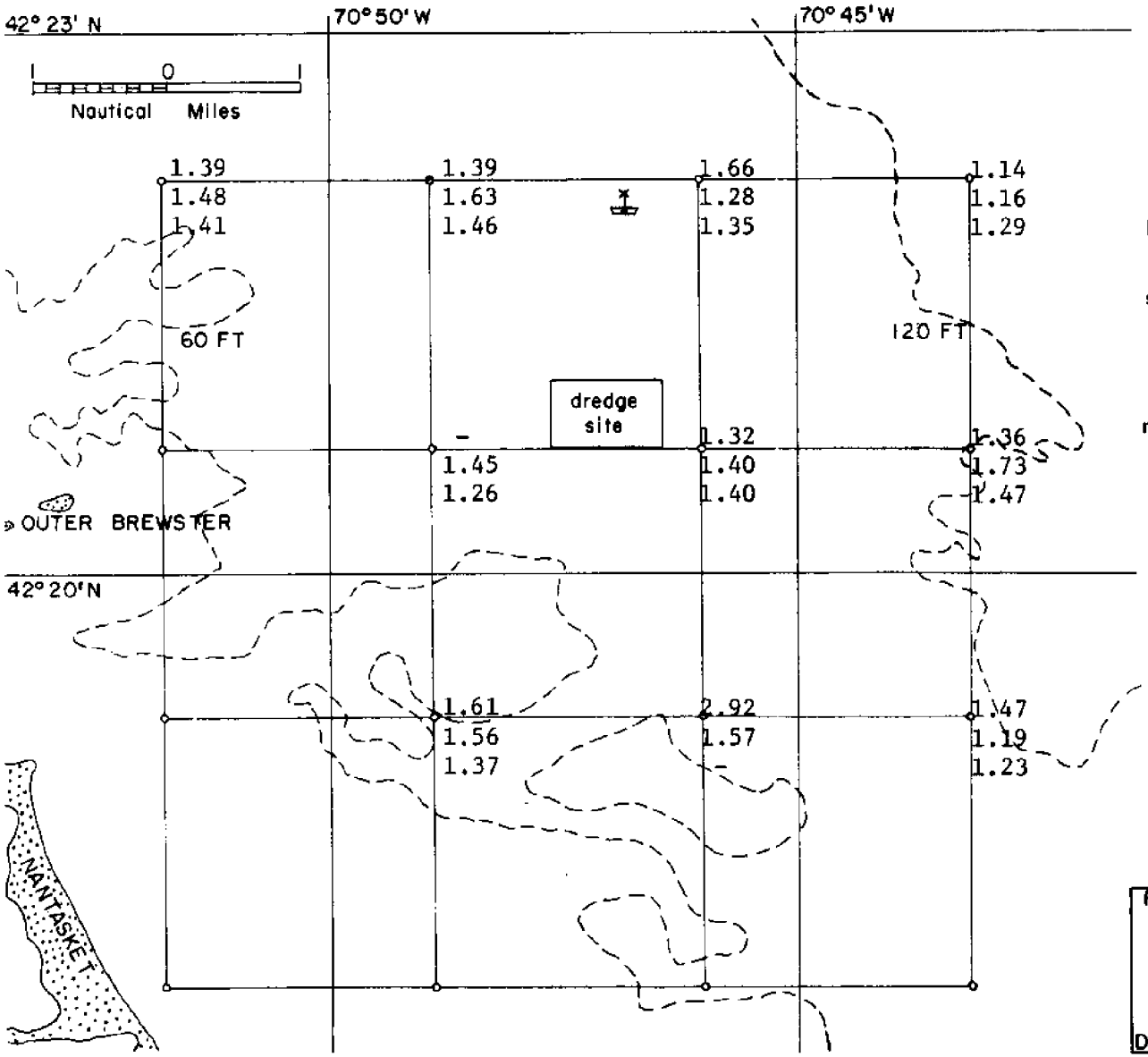

NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: March 21, 1973

parameter: $PO_4^{\equiv}$ µm/l

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Cloudy
Visibility: 13 Miles
Temperature: 34° F
Wind: 040°, 10 Knots, Gust 19 Knots
Sea: 5-8 Feet

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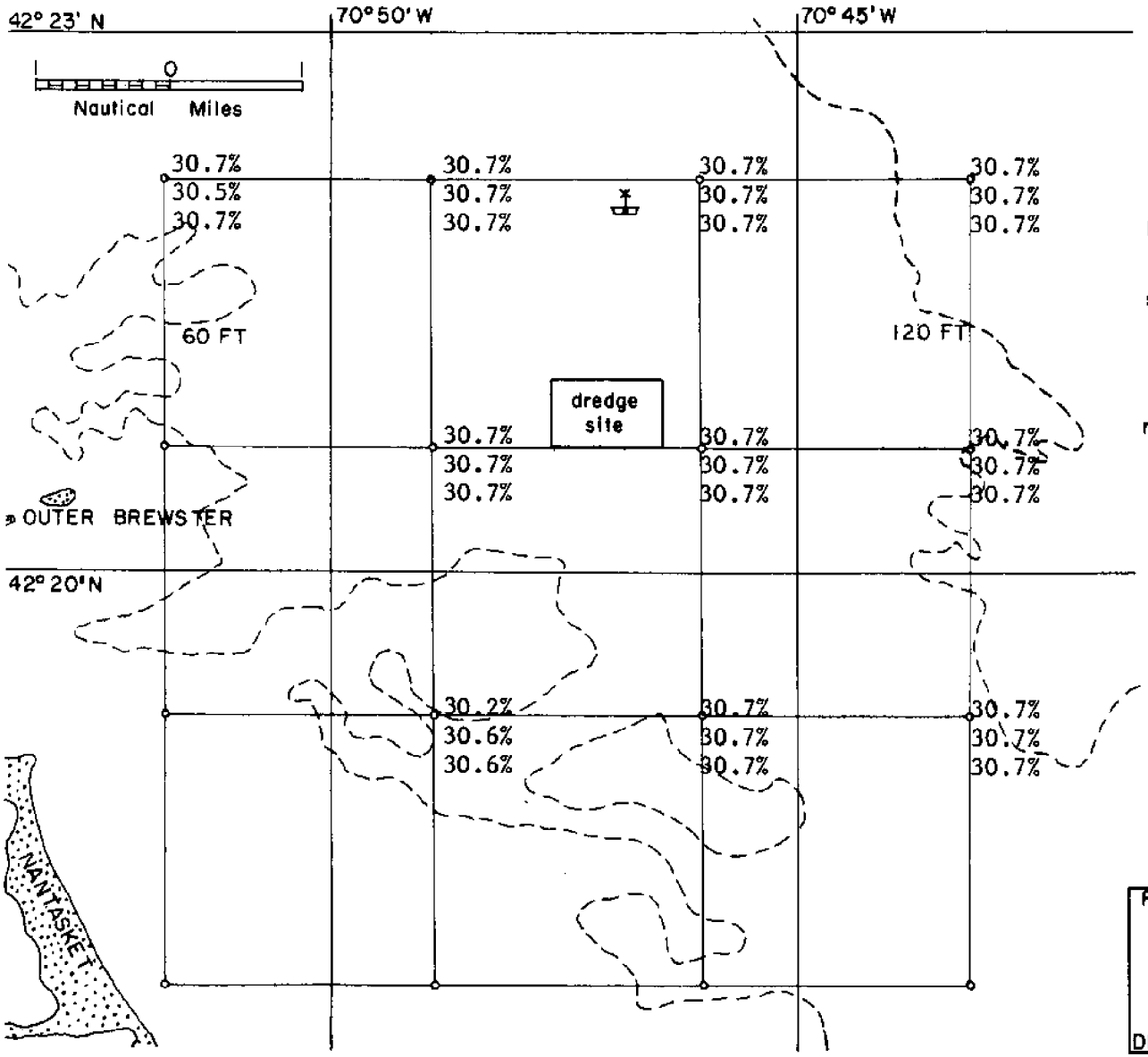

NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: March 21, 1973

parameter: Salinity

sample depths:

1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Cloudy
Visibility: 13 Miles
Temperature: 34°F
Wind: 040°, 10 Knots, Gust 19 Knots
Sea: 5-8 Feet

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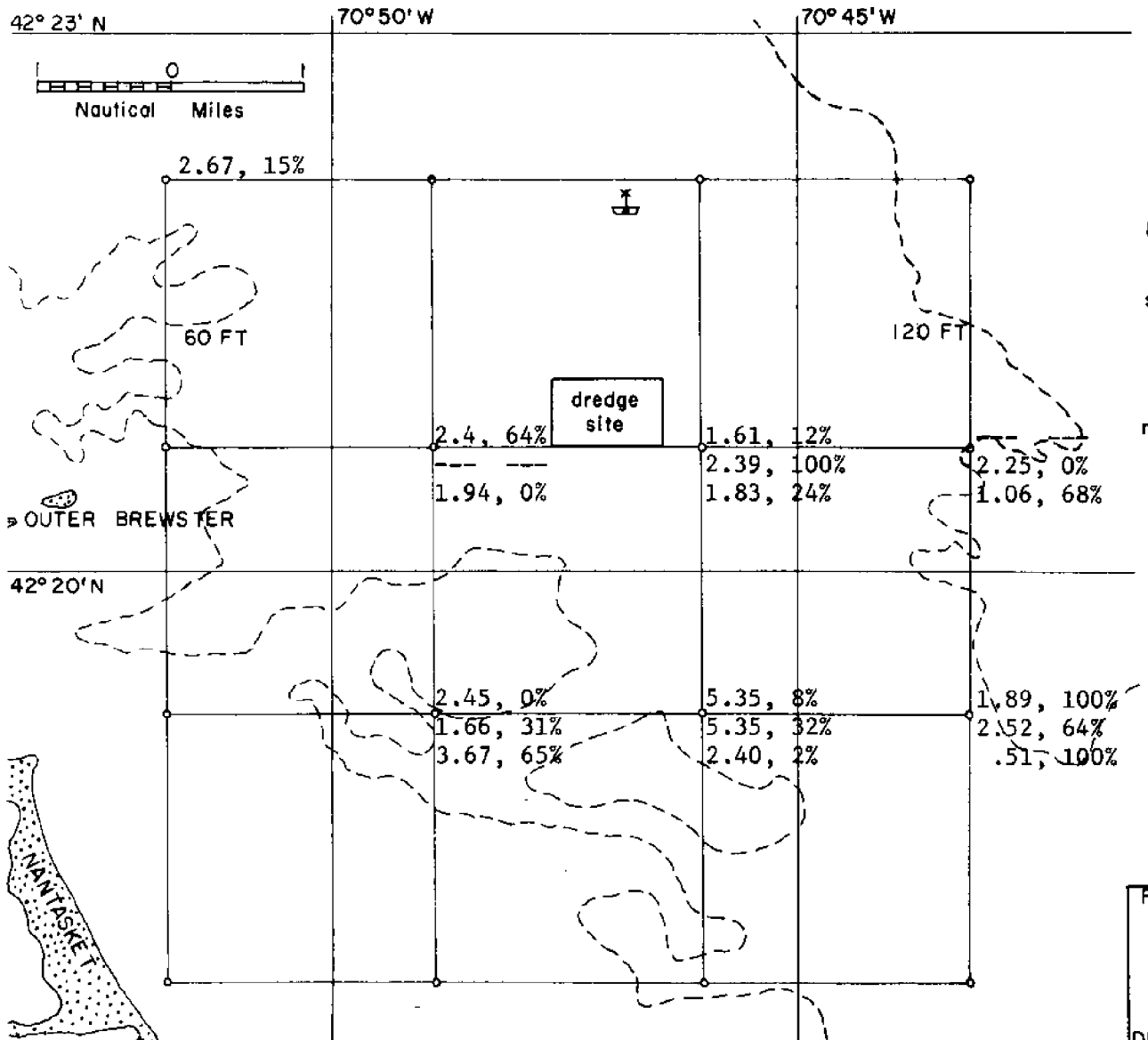
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: March 21, 1973

parameter: Total Suspended Sediment
mg/1 and % Organic

sample depths:
1st Nos. - Surface
2nd Nos. - 10 meters
3rd Nos. - 20 meters

meteorological conditions:
Sky: Cloudy
Visibility: 13 Miles
Temperature: 34° F
Wind: 040°, 10 Knots, Gust
19 Knots
Sea: 5-8 Feet

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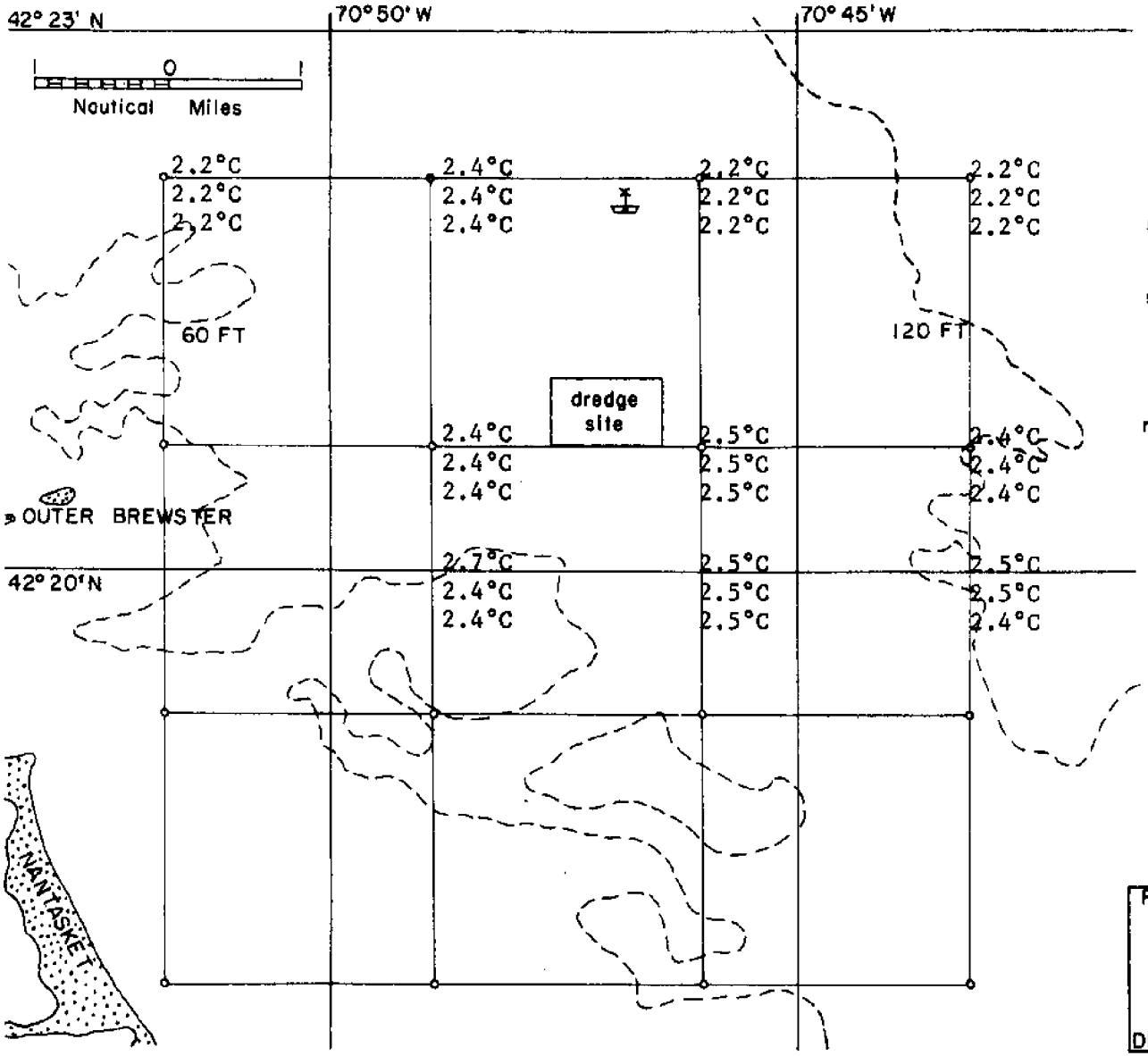
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: March 21, 1973

parameter: Temperature

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Cloudy
Visibility, 13 Miles
Temperature: 34° F
Wind: 040°, 10 Knots, Gust 19 Knots
Sea: 5-8 Feet

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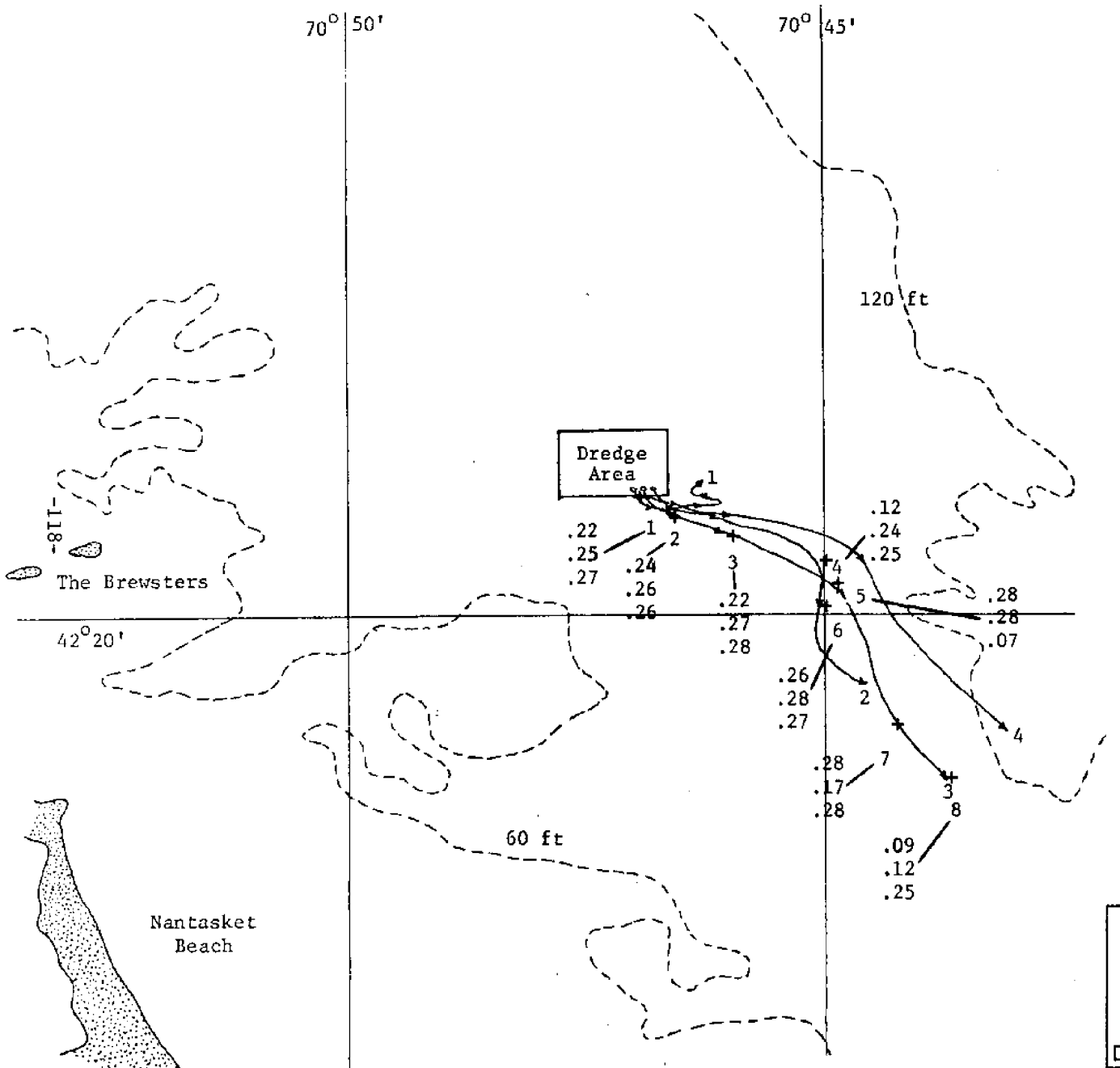
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT

DROGUE STUDY

date: 28&29 March 1973
parameter: NO_2^- µm/l
drogue depths:

1st No. - Surface
2nd No. - 10 Meters
3rd No. - 20 Meters

meteorol. cond.:

Sky: Cloudy
Visibility: 8 Miles
Temperature: 36°F
Wind: 120°, 8 Knots
Sea: 3-5 Feet, Swell to 10 Feet

1 0 1
Nautical Miles

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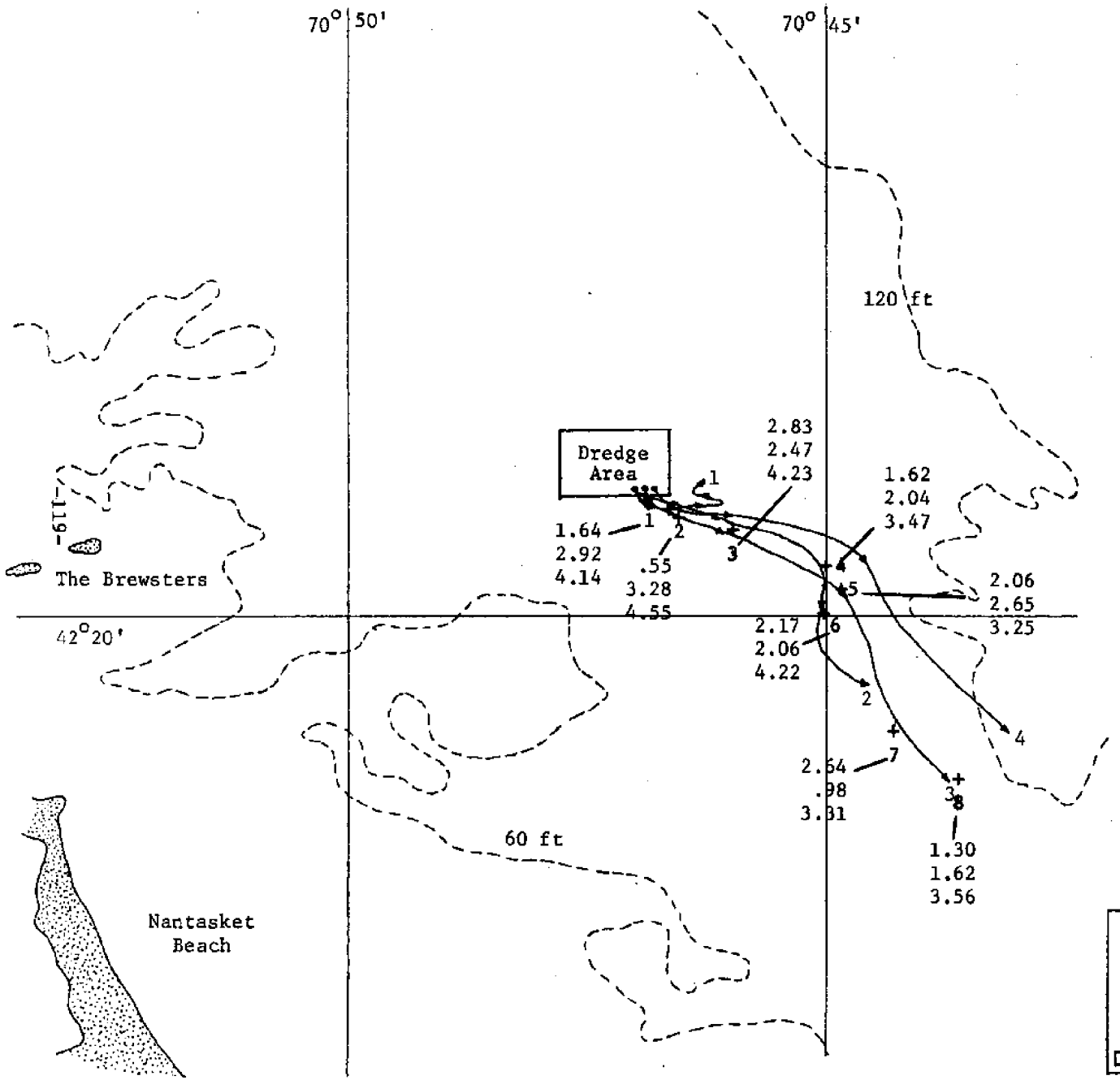
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA - NOMES PROJECT

DROGUE STUDY

date: 28&29 March 1973
parameter: NO_3^- µm/l
drogue depths:

1st No. - Surface
2nd No. - 10 Meters
3rd No. - 20 Meters

meteorol. cond.:

Sky: Cloudy
Visibility: 8 Miles
Temperature: 36°F
Wind: 120°, 8 Knots
Sea: 3-5 Feet, Swell to 10 Feet

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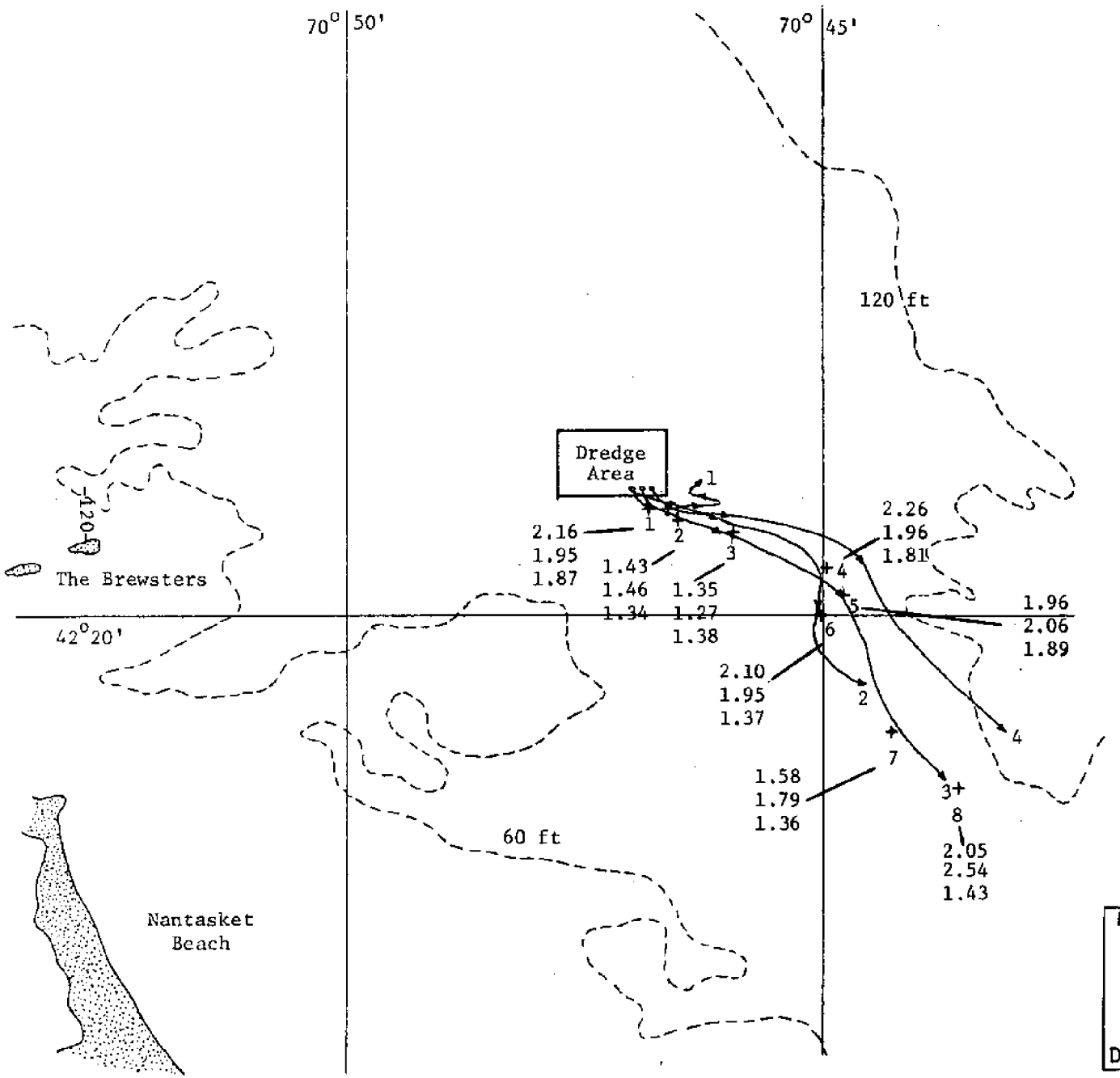
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT

DROGUE STUDY

date: 28&29 March 1973
parameter: $PO_4^{\equiv}$ µm/l
drogue depths:

1st No. - Surface
2nd No. - 10 Meters
3rd No. - 20 Meters

meteorol. cond.:

Sky: Cloudy
Visibility: 8 Miles
Temperature: 36°F
Wind: 120°, 8 Knots
Sea: 3-5 Feet, Swell to 10 Feet

0
Nautical Miles

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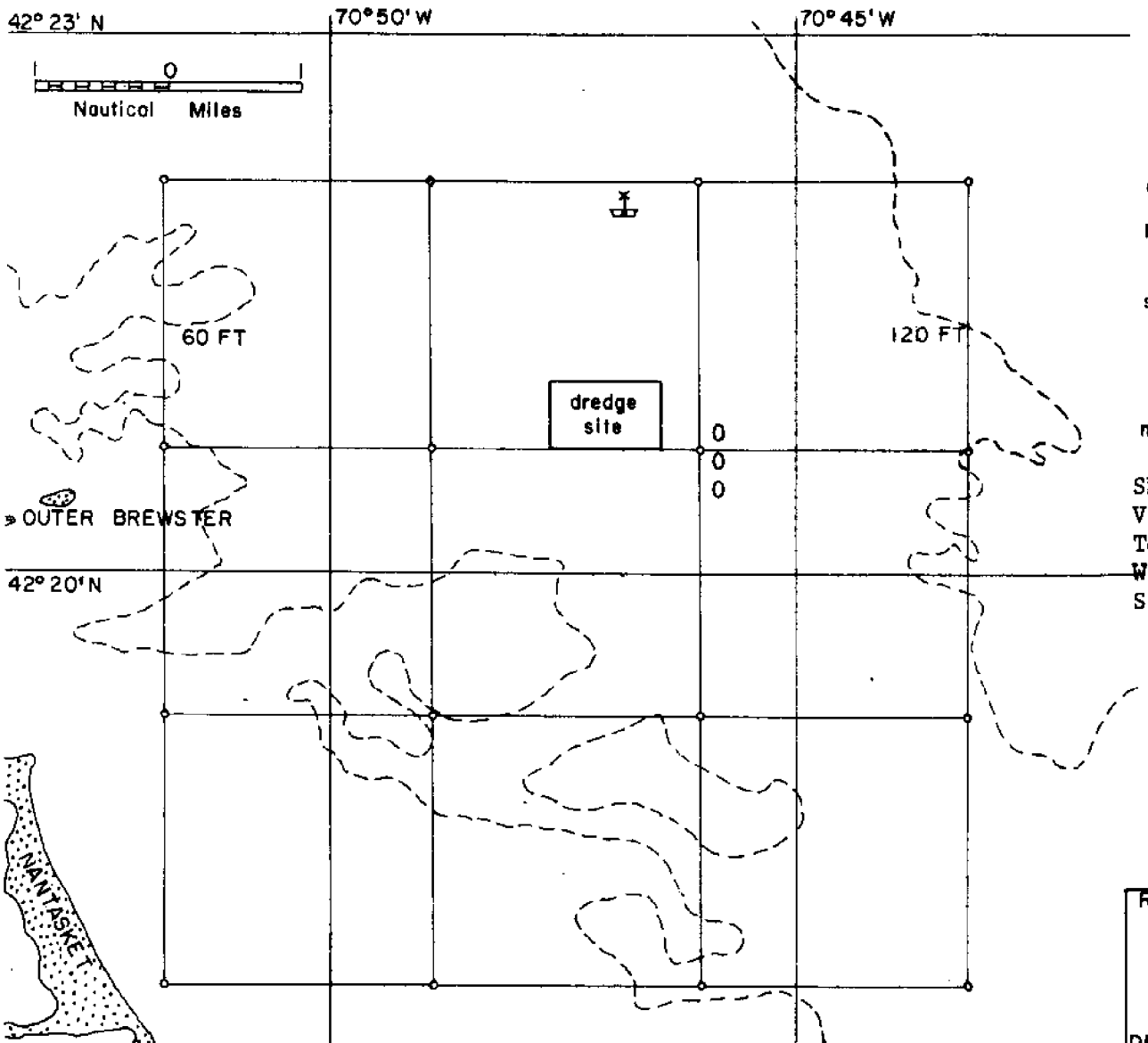
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: April 25, 1973

parameter: NO_2^-

sample depths:

1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Overcast
Visibility: 13 Miles
Temperature: 50° F
Wind: 110°, 9 Knots
Sea: 3-5 Feet

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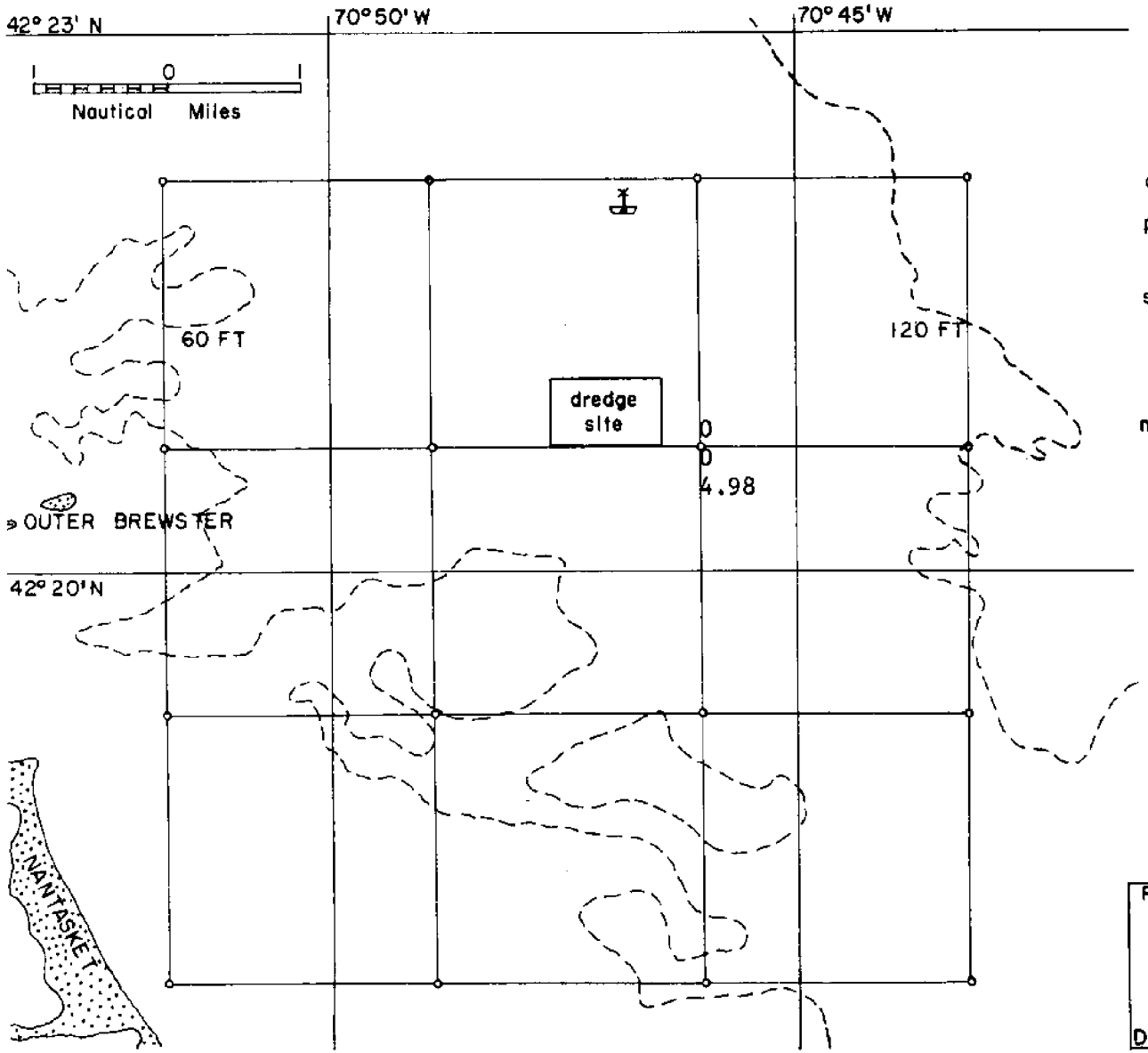
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: April 25, 1973

parameter: NO_3^-

sample depths:

1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Overcast
Visibility: 13 Miles
Temperature: 50°F
Wind: 110°, 9 Knots
Sea: 3-5 Feet

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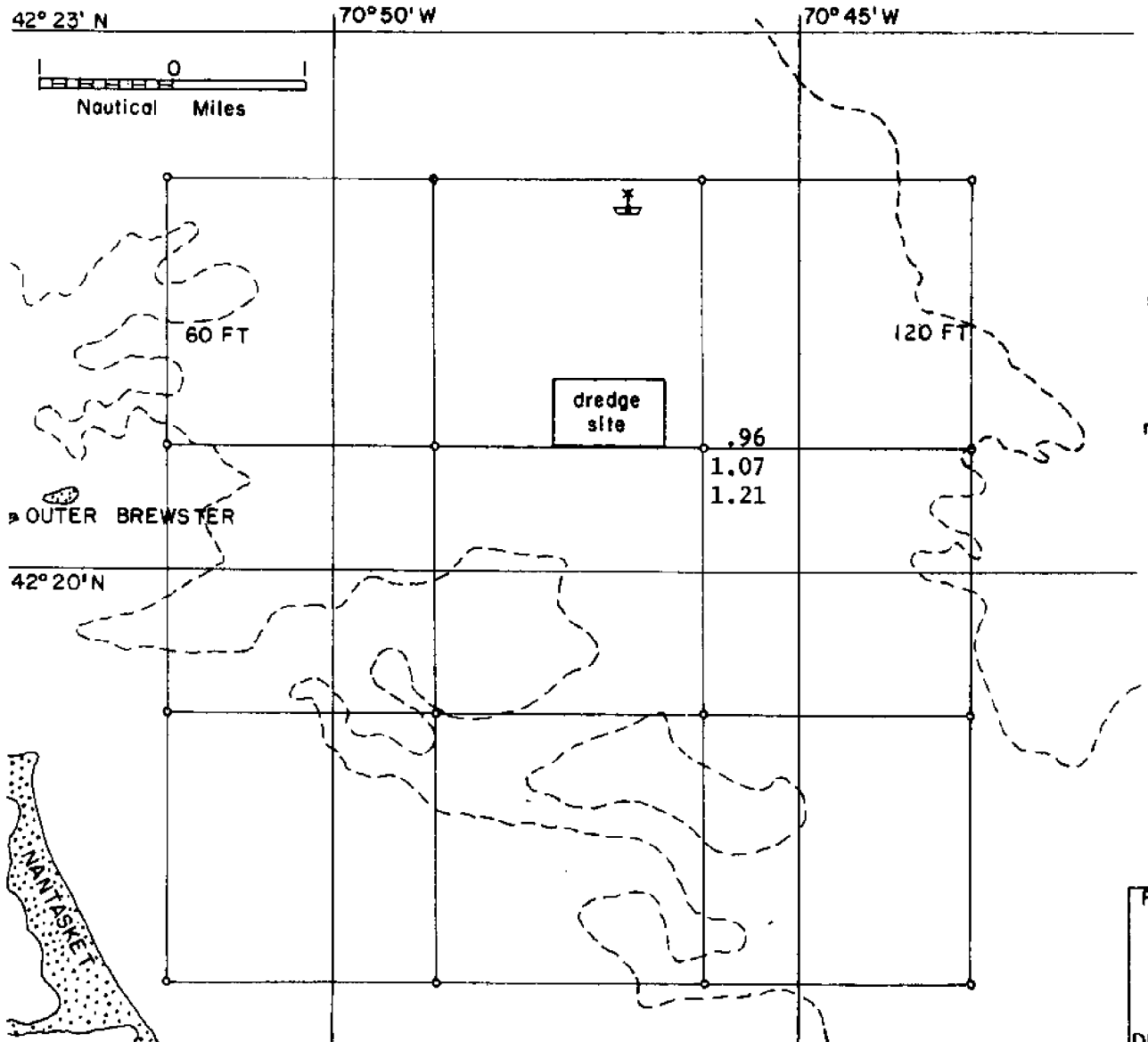

NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: April 25, 1973

parameter: $PO_4^{\equiv}$ µm/1

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Overcast
Visibility: 13 Miles
Temperature: 50° F
Wind: 110°, 9 Knots
Sea: 3-5 Feet

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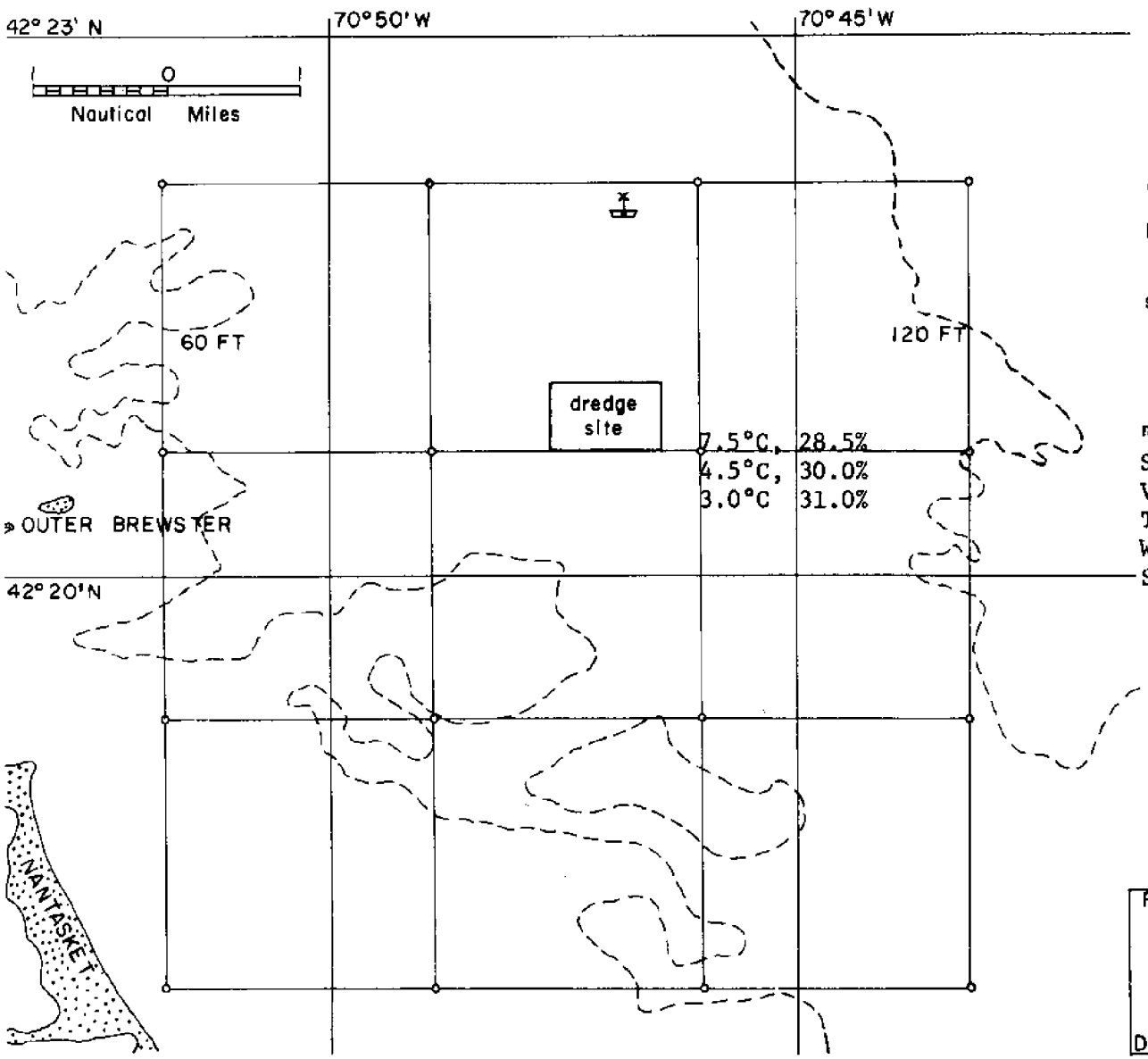
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

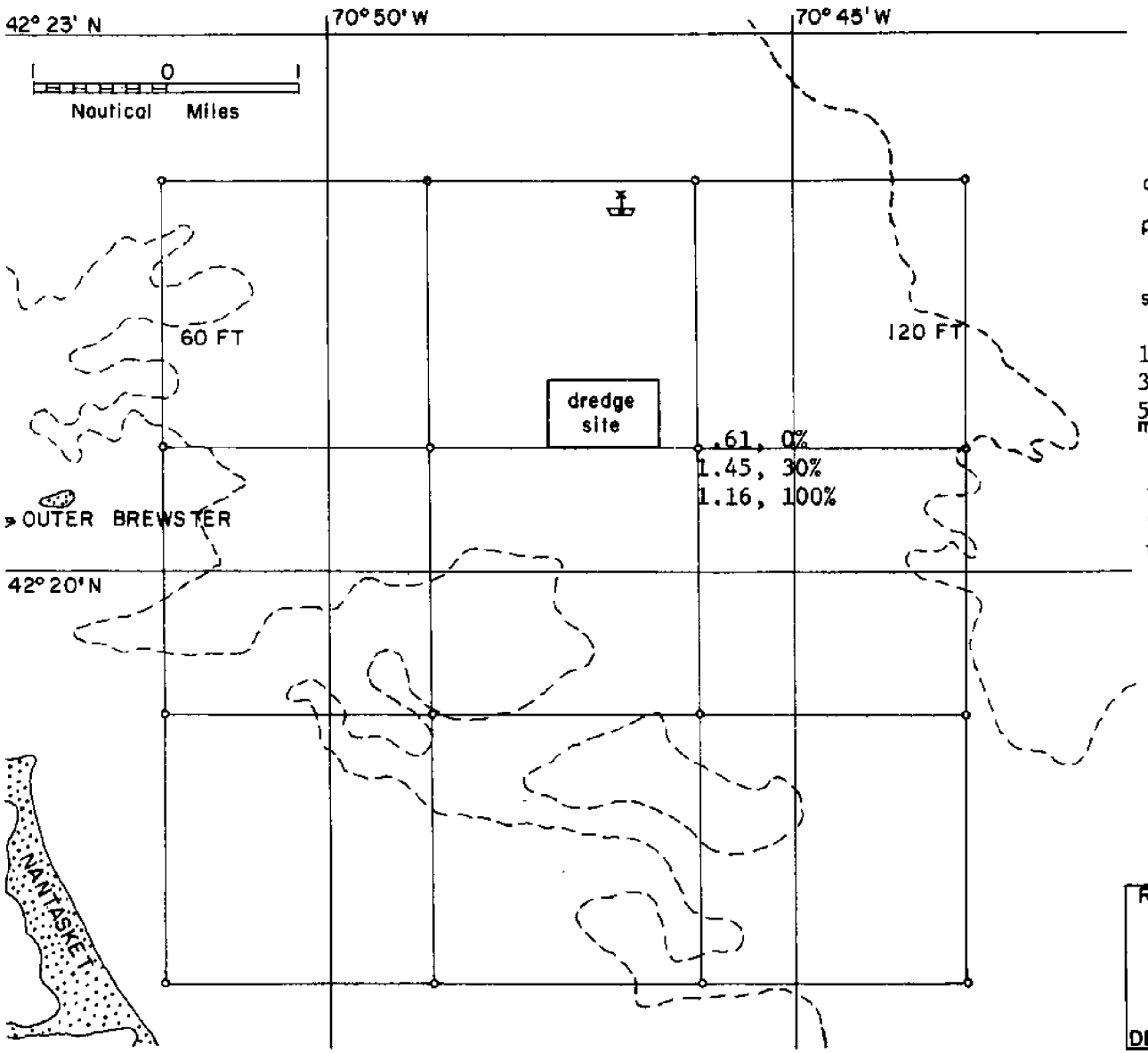
date: April 25, 1973

parameter: Salinity Temperature

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Overcast
Visibility: 13 Miles
Temperature: 50° F
Wind: 110°, 9 Knots
Sea: 3-5 Feet

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: April 25, 1973

parameter: Total Suspended Sediment, % Organic

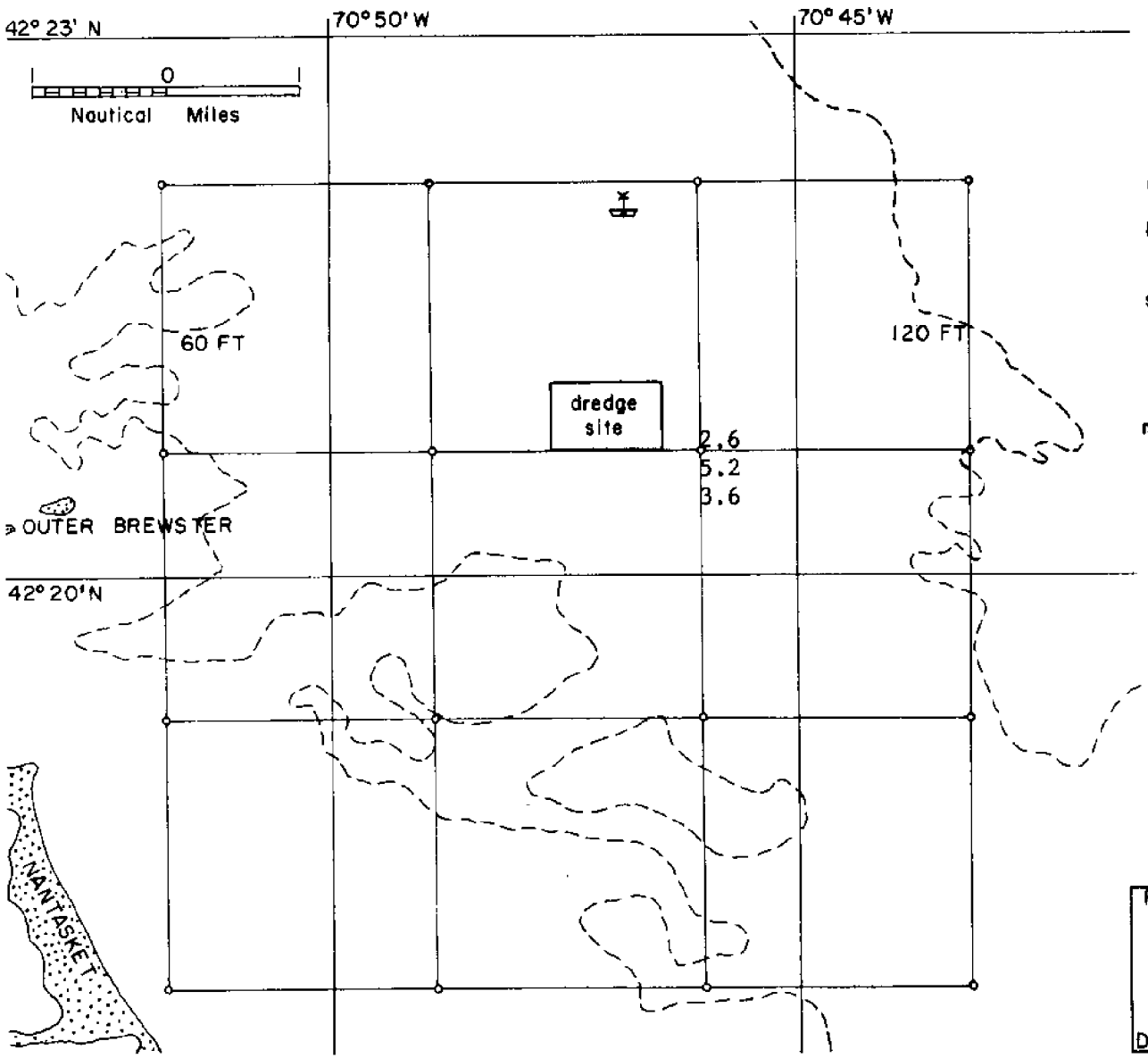
sample depths:

1st No., 2nd No., - Surface
3rd No., 4th No., - 10 meters
5th No., 6th No., - 20 meters

meteorological conditions:

Sky: Overcast
Visibility, 13 Miles
Temperature: 50° F
Wind: 110°, 9 Knots
Sea: 3-5 Feet

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: April 25, 1973

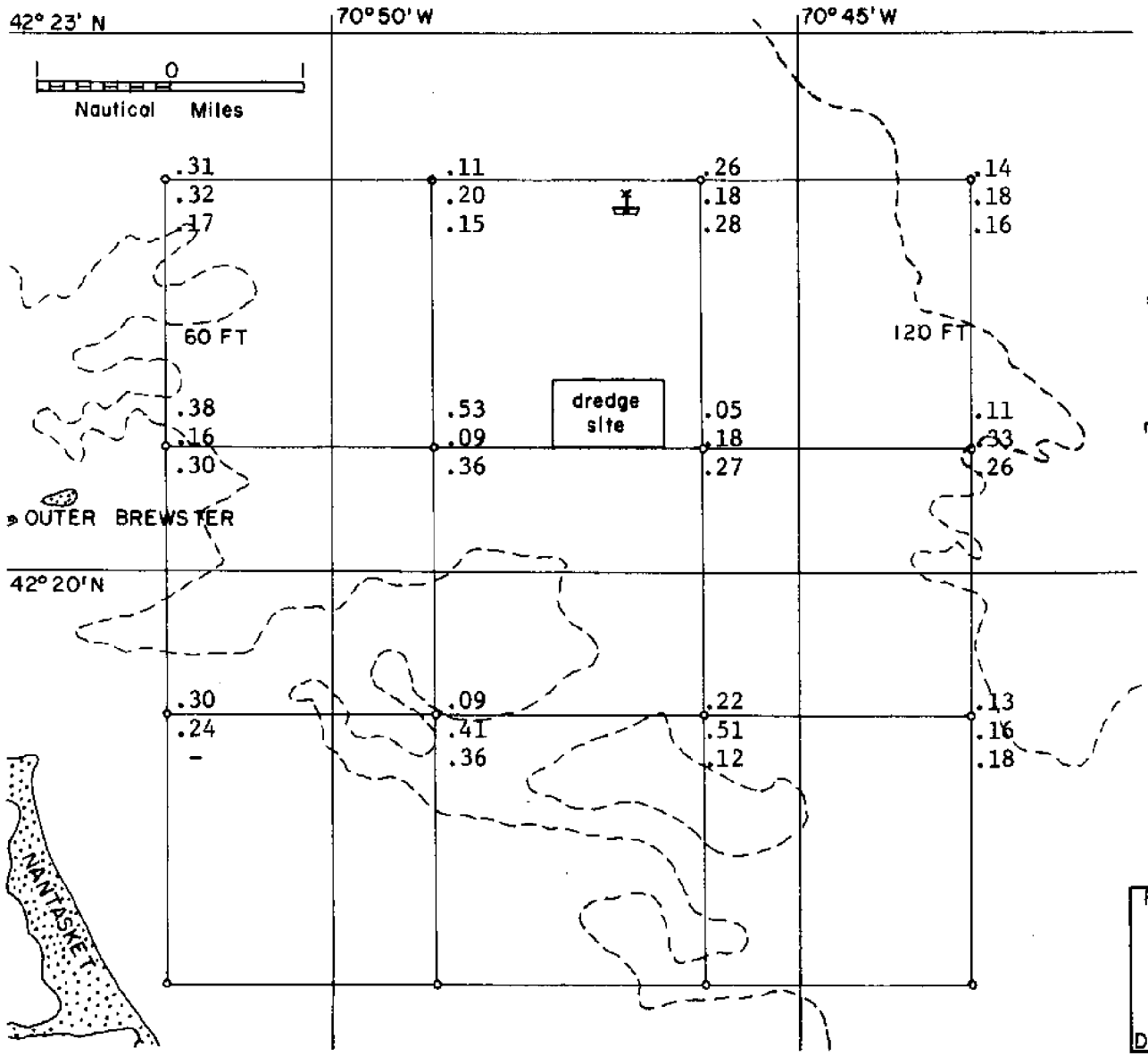
parameter: Turbudity (F.T.U.)

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Overcast
Visibility: 13 Miles
Temperature: 50° F
Wind: 110°, 9 Knots
Sea: 3-5 Feet

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: May 5, 1973

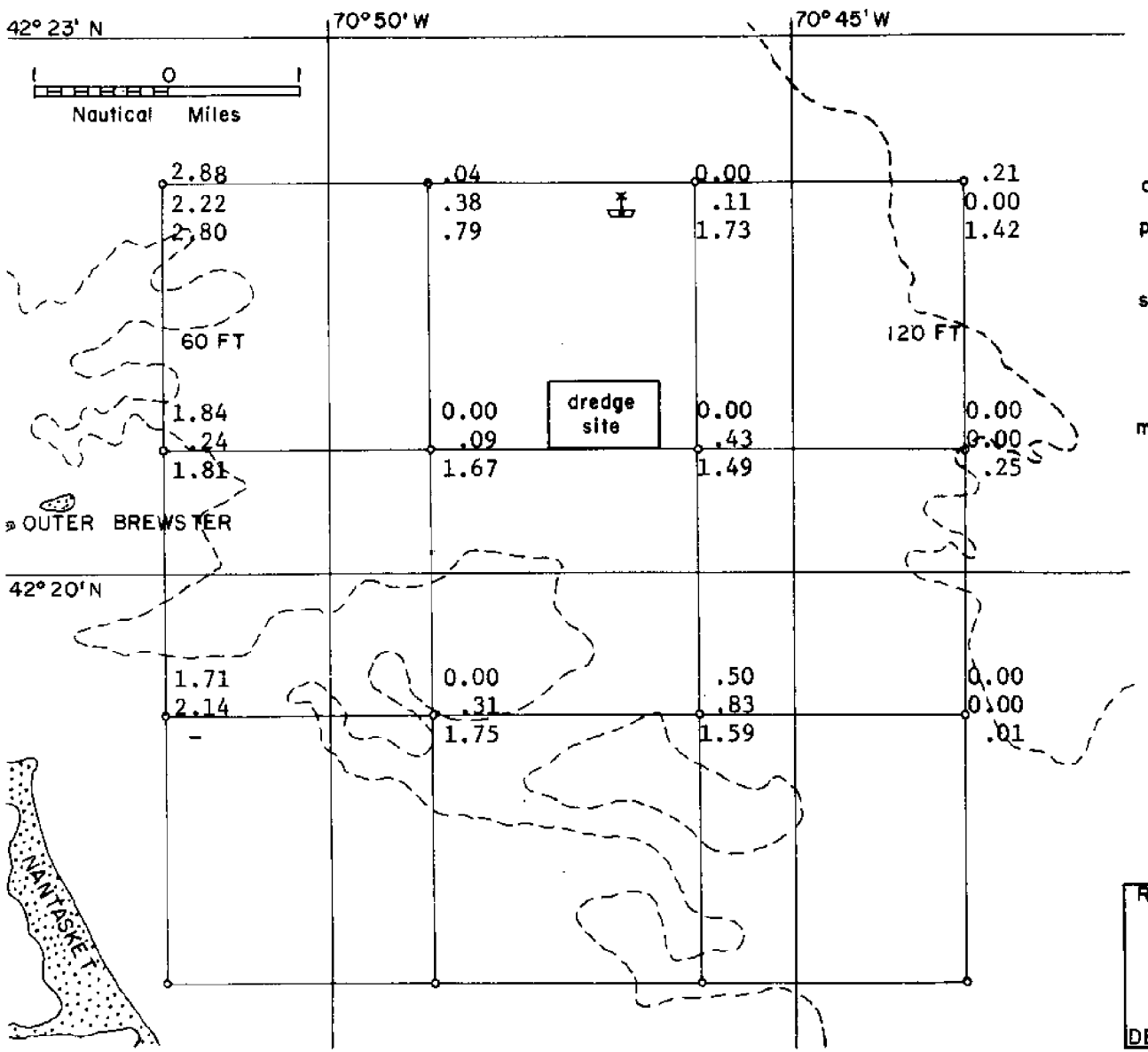
parameter: NO_2^- µm/1

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Cloudy
Visibility: 12 Miles
Temperature: 53° F
Wind: 310°, 3 Knots
Sea: < 1 Foot

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: May 5, 1973

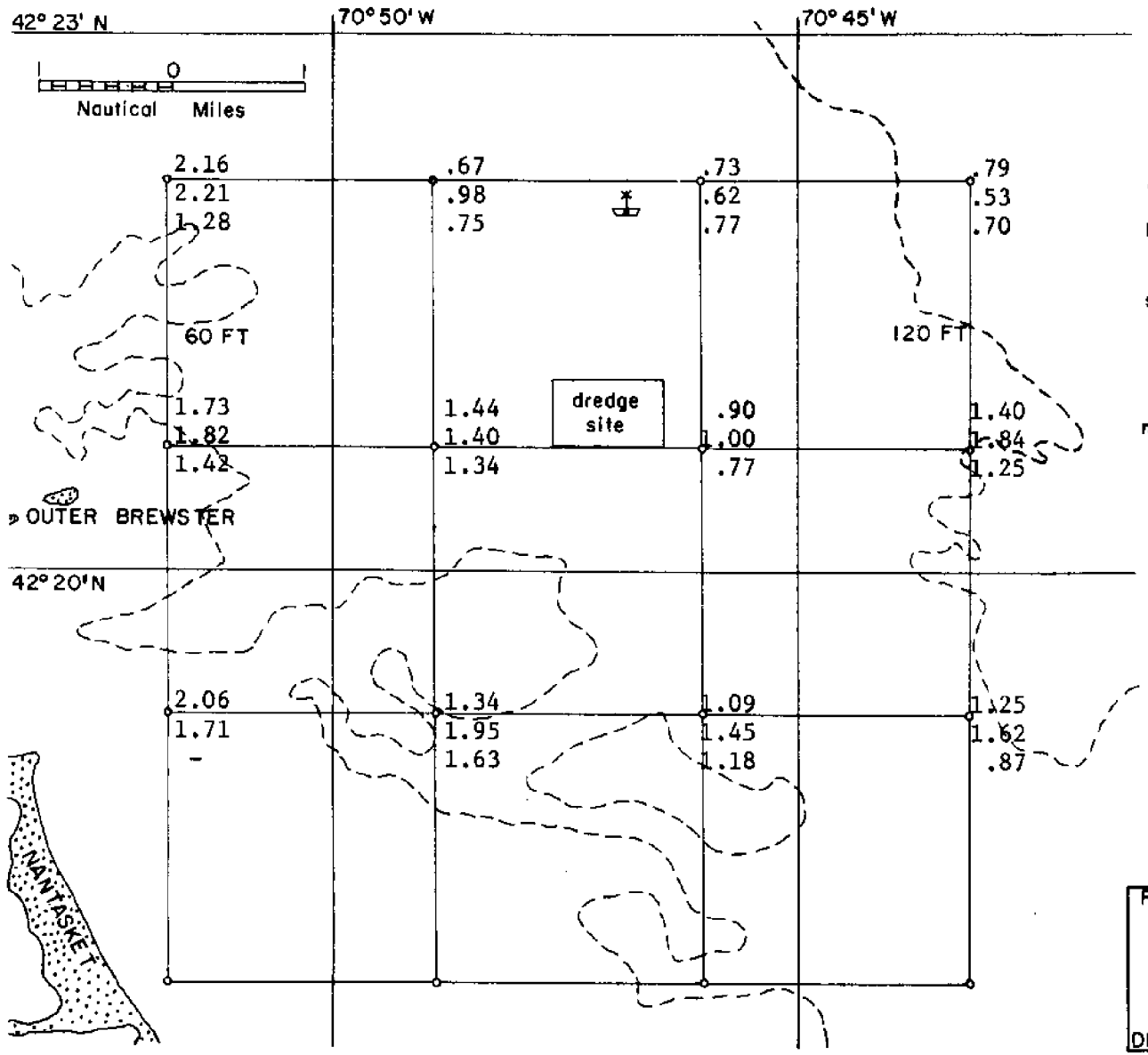
parameter: NO_3^- µm/l

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Cloudy
Visibility: 12 Miles
Temperature: 53°F
Wind: 310°, 3 Knots
Sea: < 1 Foot

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

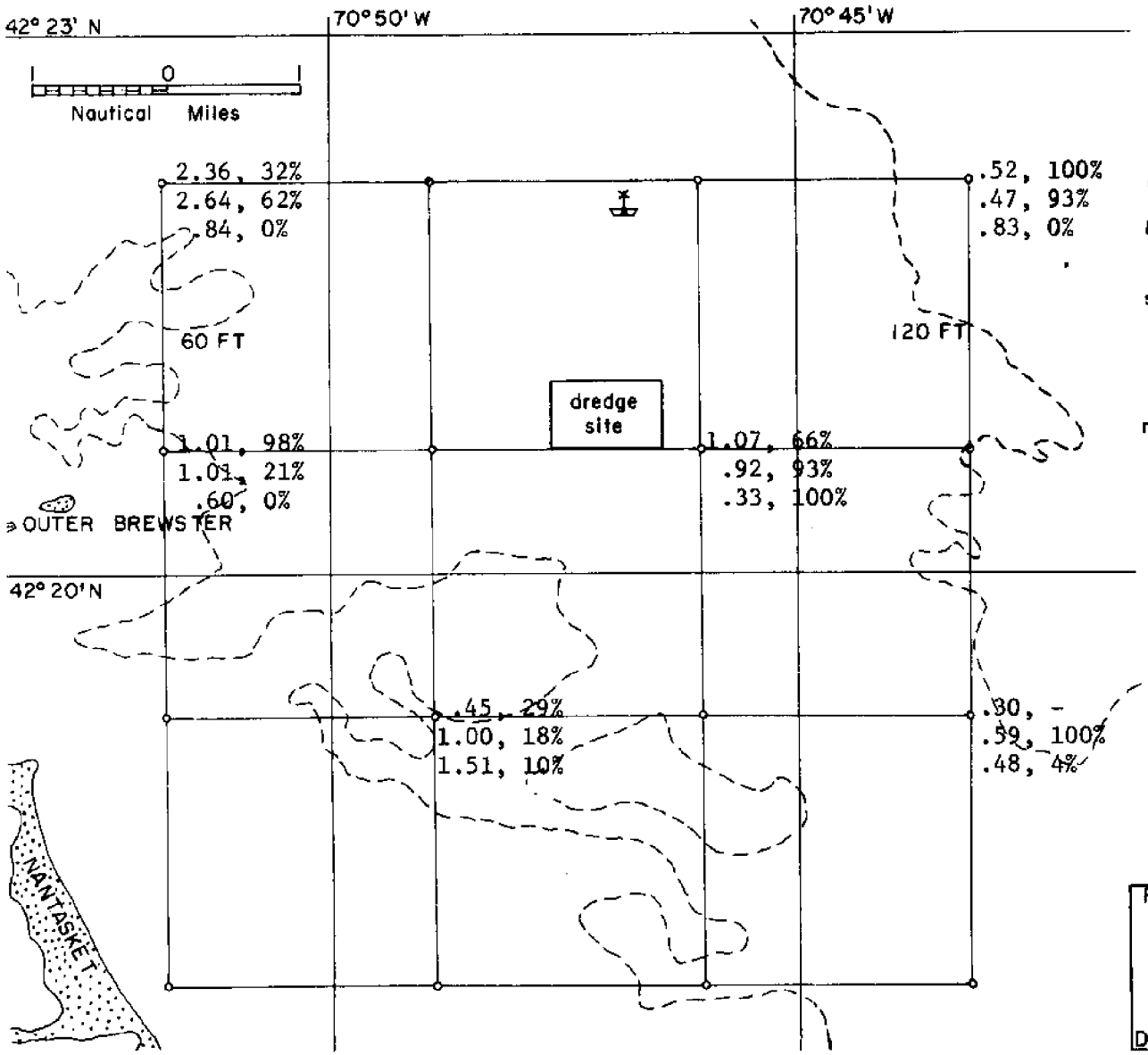
date: May 5, 1973

parameter: $PO_4^{\equiv}$ µm/l

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Cloudy
Visibility: 12 Miles
Temperature: 53° F
Wind: 310°, 3 Knots
Sea: < 1 Foot

R. M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

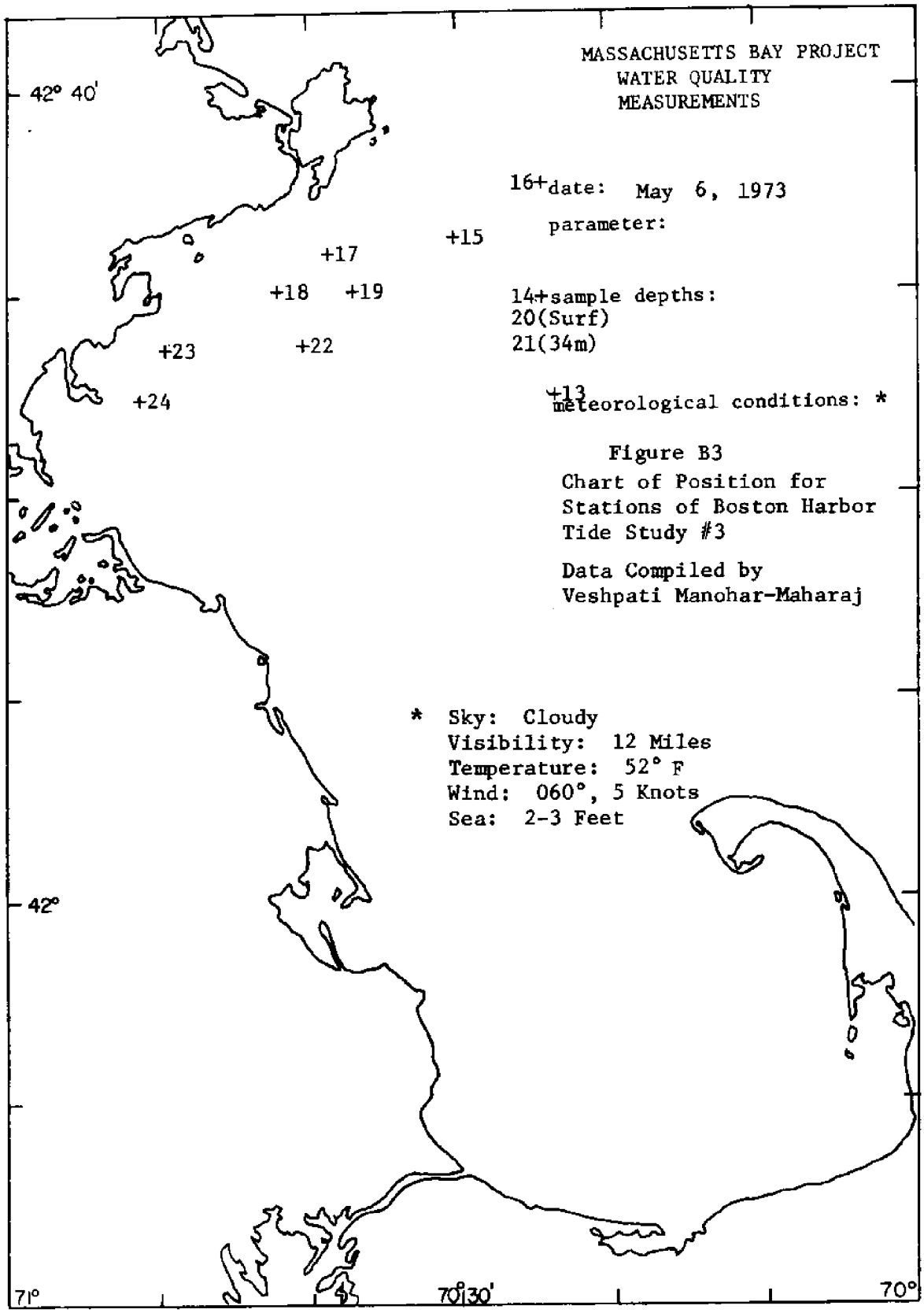
date: May 5, 1973

parameter: Total Suspended Sediment
mg/l and % Organic

sample depths:
1st Nos. – Surface
2nd Nos. – 10 meters
3rd Nos. – 20 meters

meteorological conditions:
Sky: Cloudy
Visibility: 12 Miles
Temperature: 53°F
Wind: 310°, 3 Knots
Sea: < 1 Foot

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING


MASSACHUSETTS BAY PROJECT
WATER QUALITY
MEASUREMENTS
42° 40'
16+
date: May 6, 1973
parameter:
+15
+17
+18
+19
14+sample depths:
20(Surf)
21(34m)
+23
+22
+24
+13
meteorological conditions: *
Figure B3
Chart of Position for
Stations of Boston Harbor
Tide Study #3
Data Compiled by
Veshpati Manohar-Maharaj
* Sky: Cloudy
Visibility: 12 Miles
Temperature: 52° F
Wind: 060°, 5 Knots
Sea: 2-3 Feet
42°
71°
70°30'
70°

6 May 1973

$PO_4^{\equiv}$

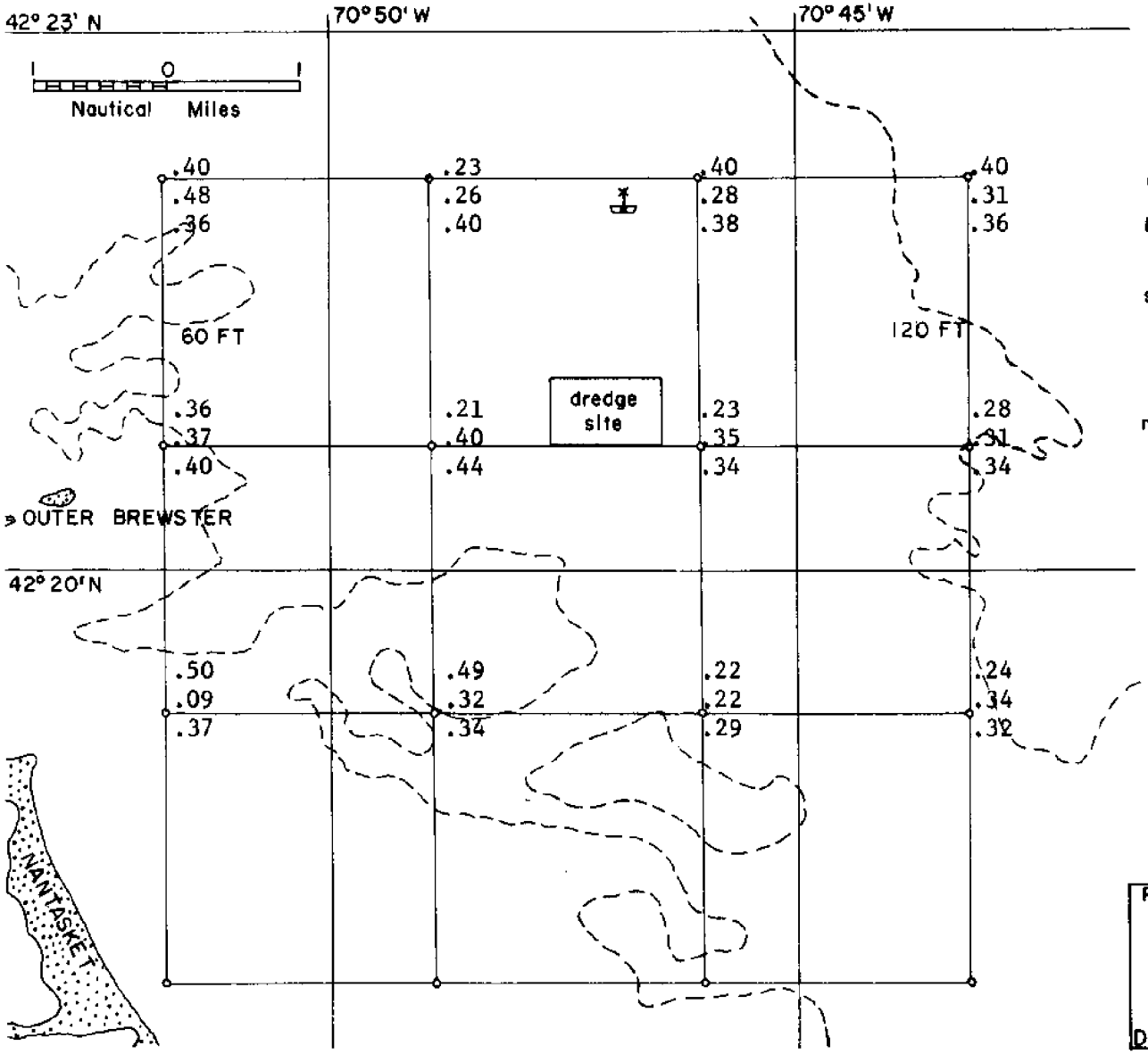
Station	Depth	% ABS	Micromole/l
13	3.4	29.55	1.21
14	3.4	26.1	1.03
15	3.4	24.45	.94
16	3.4	25.2	.98
17	3.4	25.75	1.01
18	3.4	26.3	1.04
19	3.4	25.85	1.02
20	3.4	25.9	1.02
21	3.4	25.45	.99
22	3.4	48.5	2.20
23	3.4	32.05	1.34
24	3.4	29.1	1.19

NO_2^-

13	3.4	21.5	.27
14	3.4	11.5	.10
15	3.4	25	.33
16	3.4	30	.41
17	3.4	13	.13
18	3.4	19	.23
19	3.4	15.5	.17
20	3.4	14	.14
21	3.4	13.5	.13
22	3.4	15.5	.17
23	3.4	21.5	.27
24	3.4	24	.31

NO_3^-

13	3.4	12.1	.46
14	3.4	14.3	.86
15	3.4	16.5	.86
16	3.4	15.1	.64
17	3.4	9.8	.35
18	3.4	8.5	.11
19	3.4	9.8	.31
20	3.4	10.1	.37
21	3.4	5.8	0
22	3.4	7.4	6.10
23	3.4	8.8	.10
24	3.4	5.5	0



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

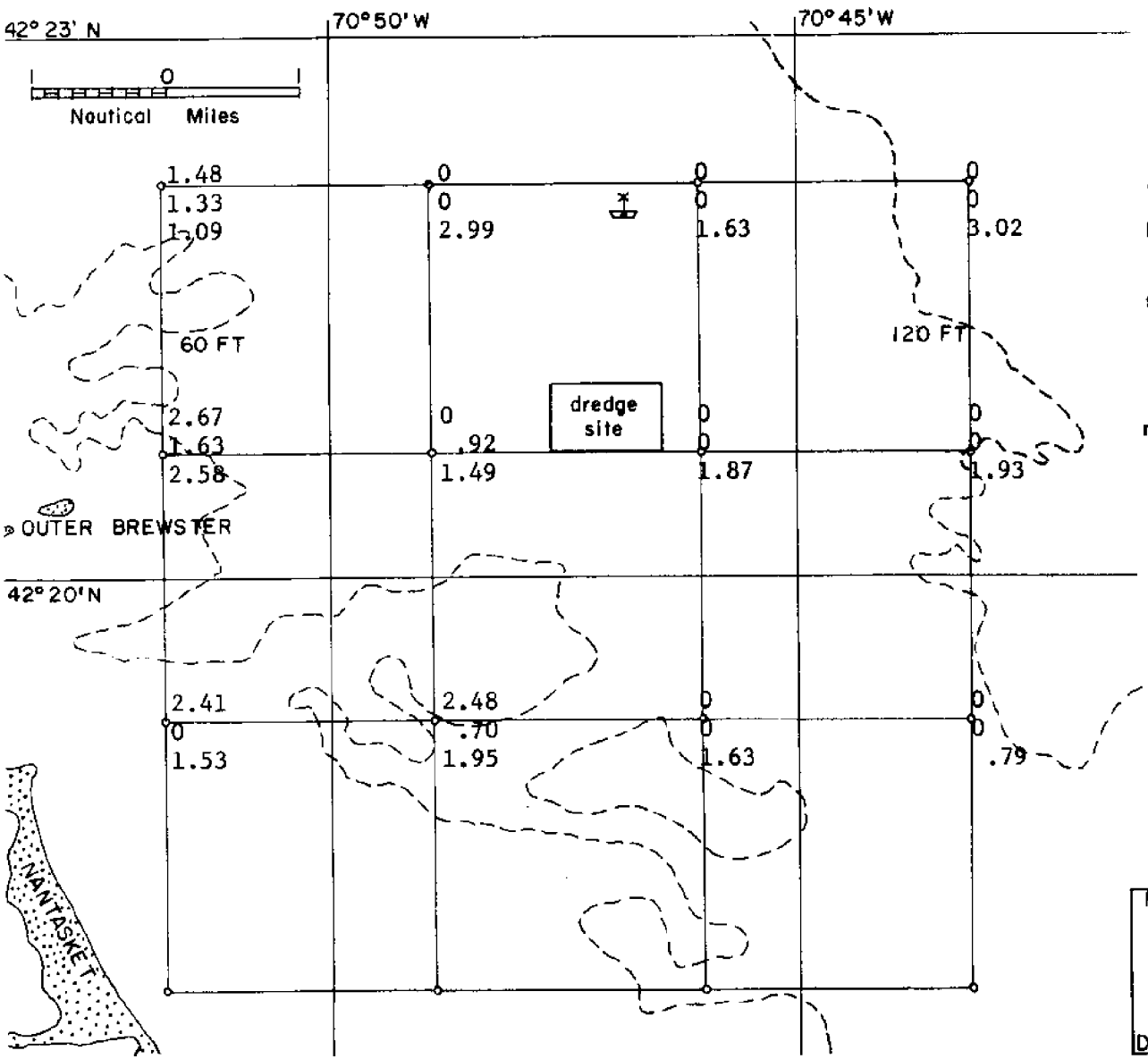
date: May 19, 1973

parameter: NO_2^- µm/l

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Partly Cloudy
Visibility: 25 + Miles
Temperature: 62° F
Wind: 320°, < 1 Knot
Sea: < 1 Foot

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: May 19, 1973

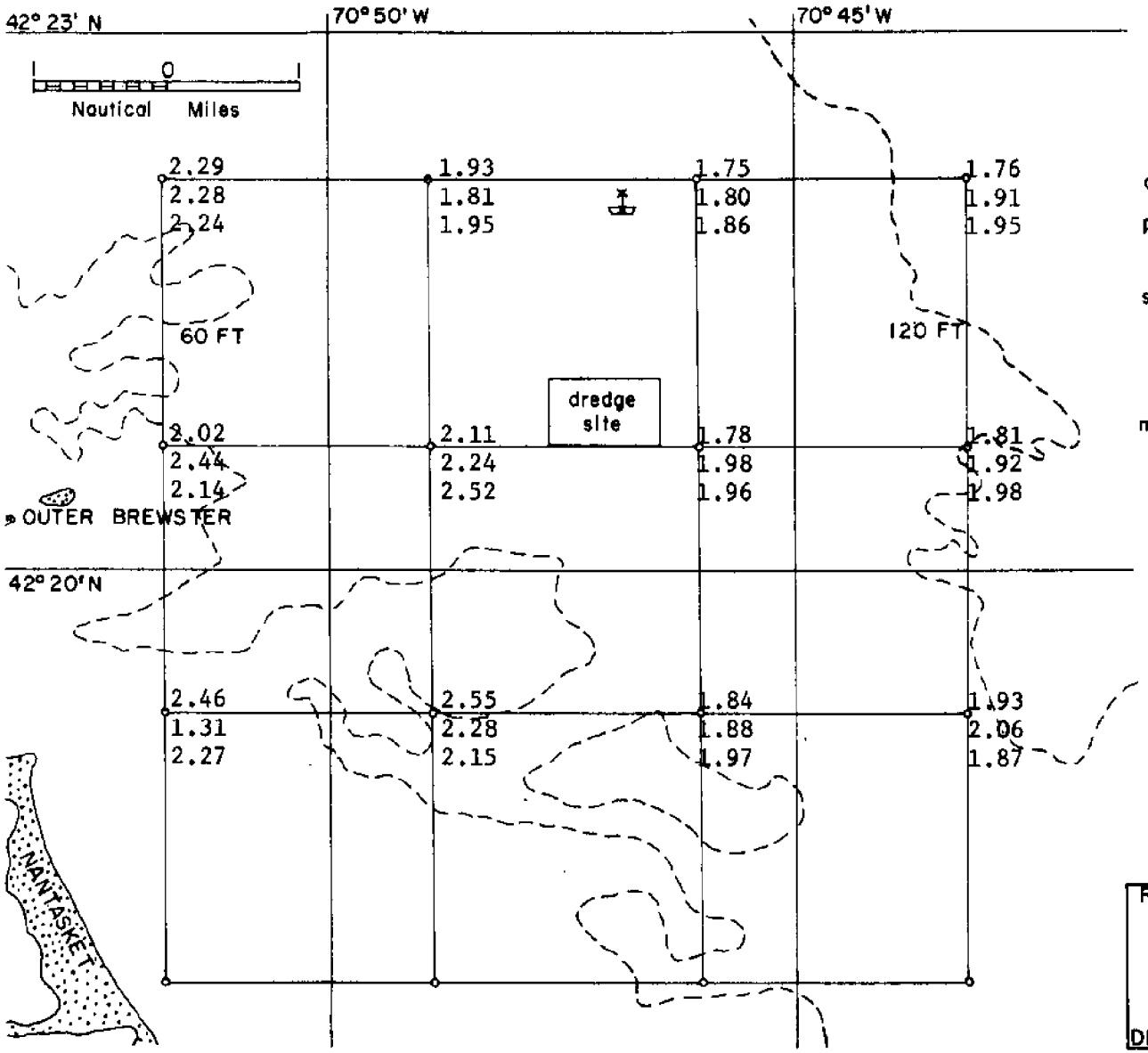
parameter: NO_3^- µm/1

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Partly Cloudy
Visibility: 25 + Miles
Temperature: 62° F
Wind: 320°, < 1 Knot
Sea: < 1 Foot

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

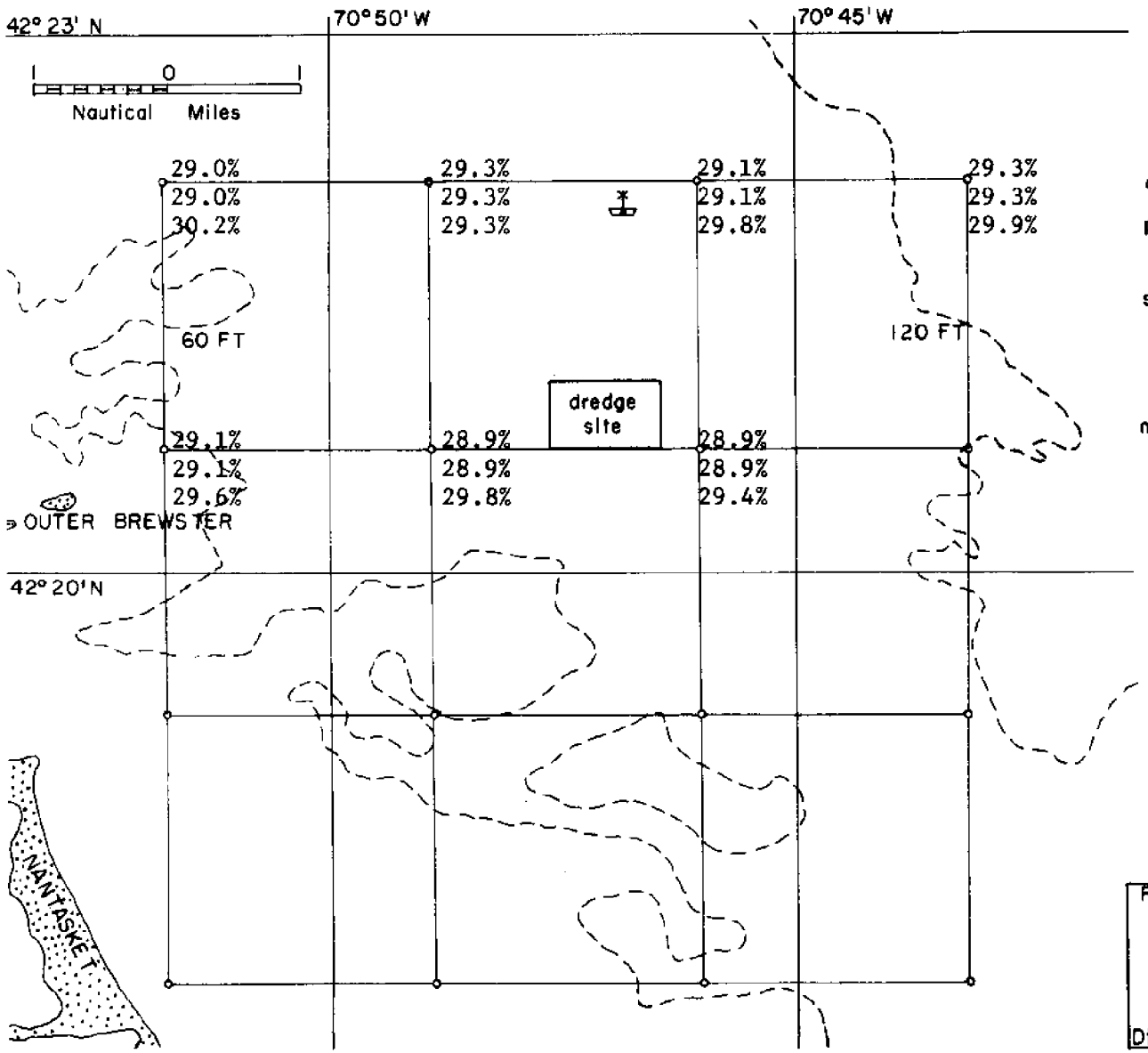
date: May 19, 1973

parameter: $PO_4^{\equiv}$ µm/l

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Partly Cloudy
Visibility: 25 + Miles
Temperature: 62° F
Wind: 320°, < 1 Knot
Sea: < 1 Foot

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: May 19, 1973

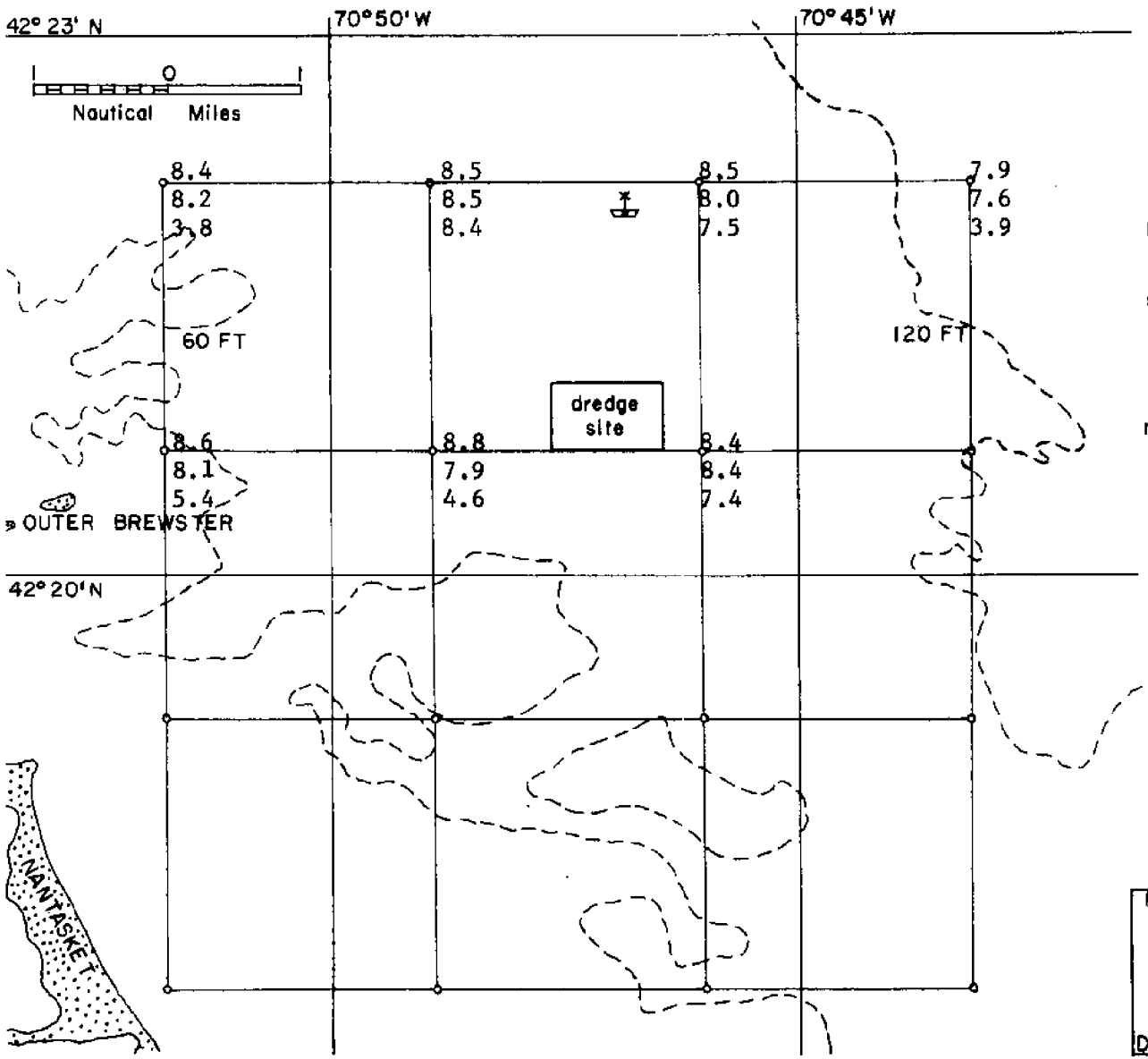
parameter: Salinity

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Partly Cloudy
Visibility: 25 + Miles
Temperature 62° F
Wind: 320°, < 1 Knot
Sea: < 1 Foot

R. M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: May 19, 1973

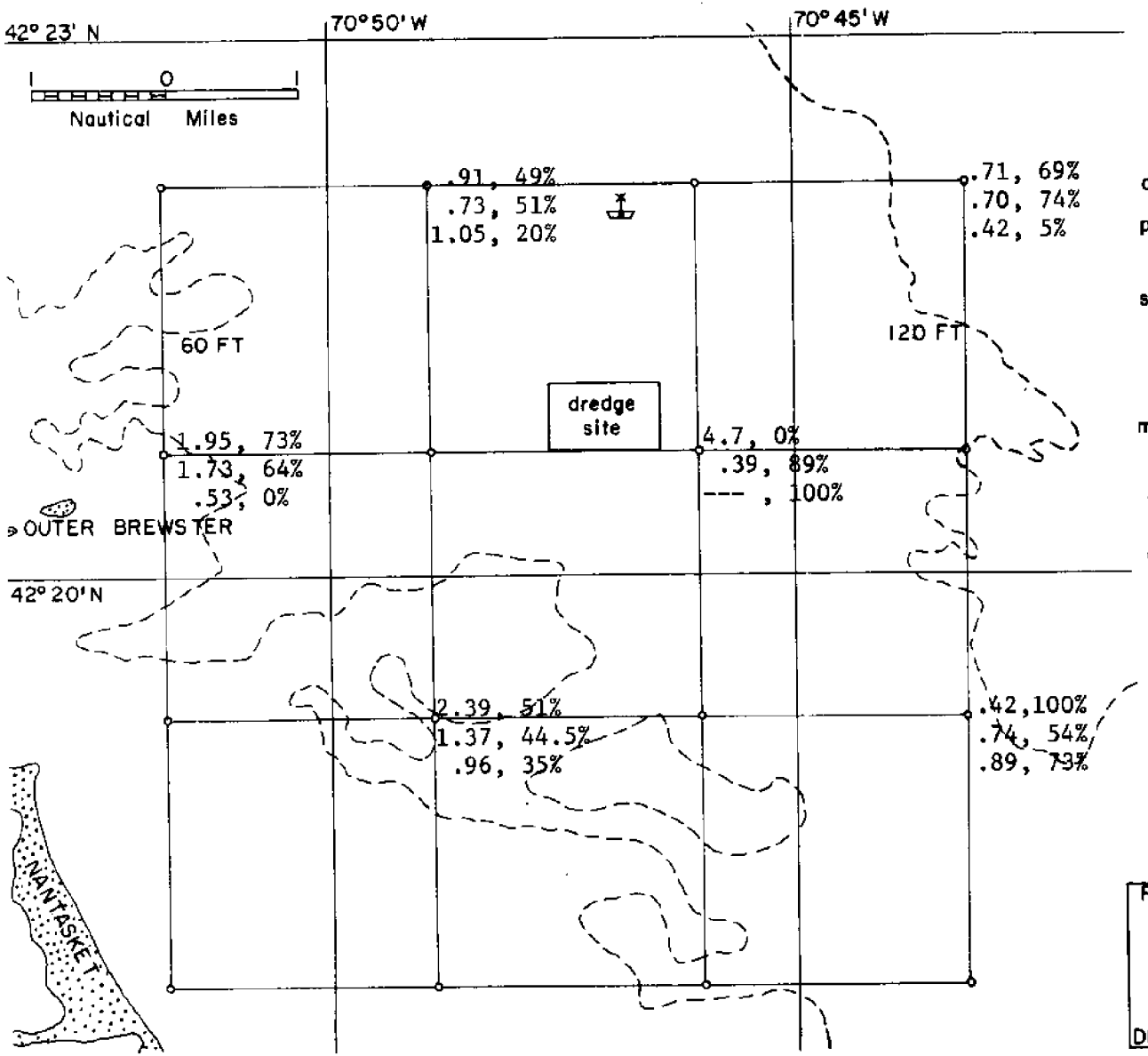
parameter: Temperature

sample depths:
1st No. - Surface
2nd No. - 10 meters
3nd No. - 20 meters

meteorological conditions:

Sky: Partly Cloudy
Visibility: 25 + Miles
Temperature: 62° F
Wind: 320°, < 1 Knot
Sea: < 1 Foot

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: May 19, 1973

parameter: Total Suspended Sediment
mg/l and % Organic

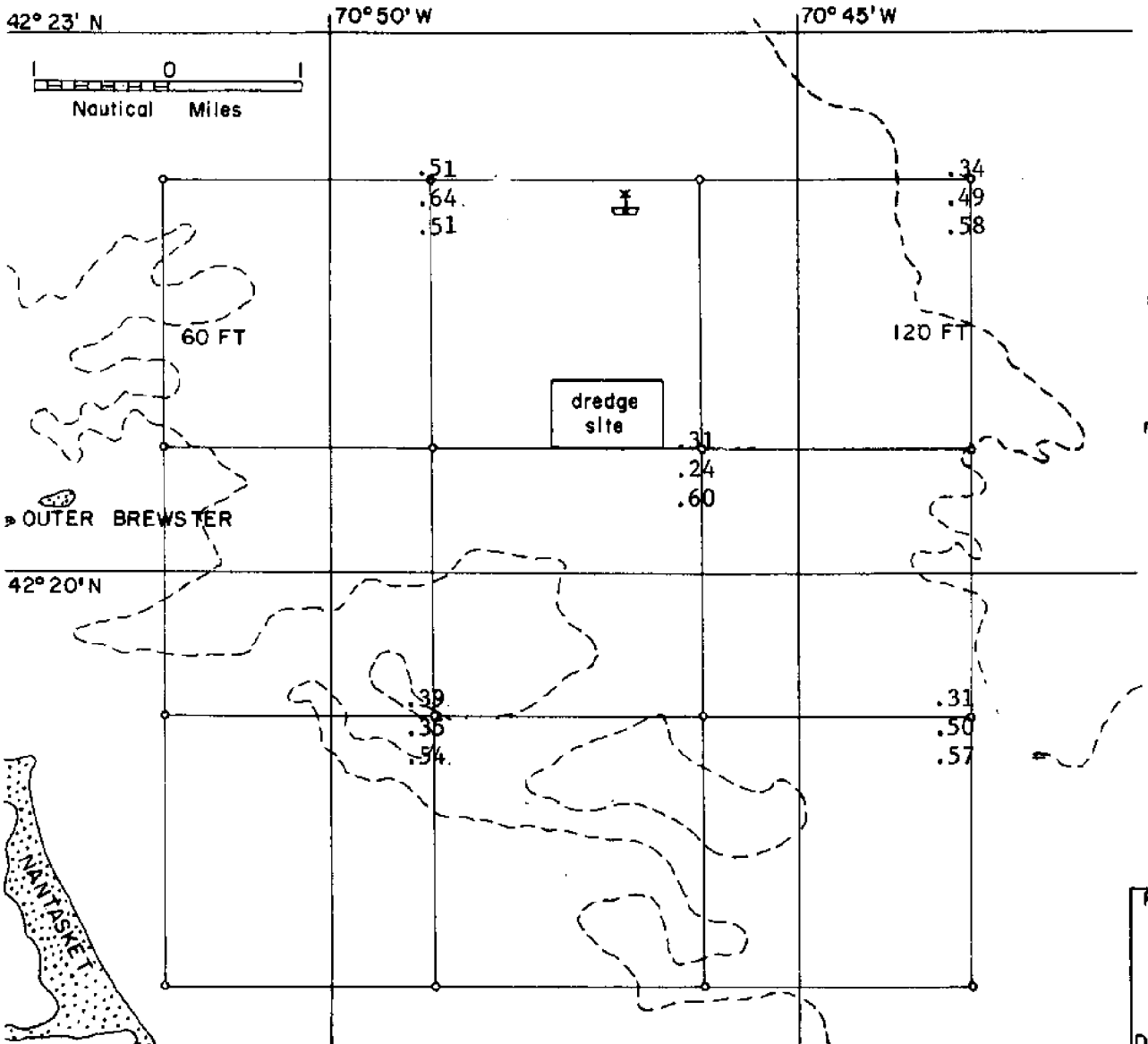
sample depths:

1st Nos. - Surface
2nd Nos. - 10 meters
3rd Nos. - 20 meters

meteorological conditions:

Sea: Partly Cloudy
Visibility: 25 + Miles
Temperature: 62° F
Wind: 320°, < 1 Knot
Sea: < 1 Foot

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: June 2, 1973

parameter: NO_2^-

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

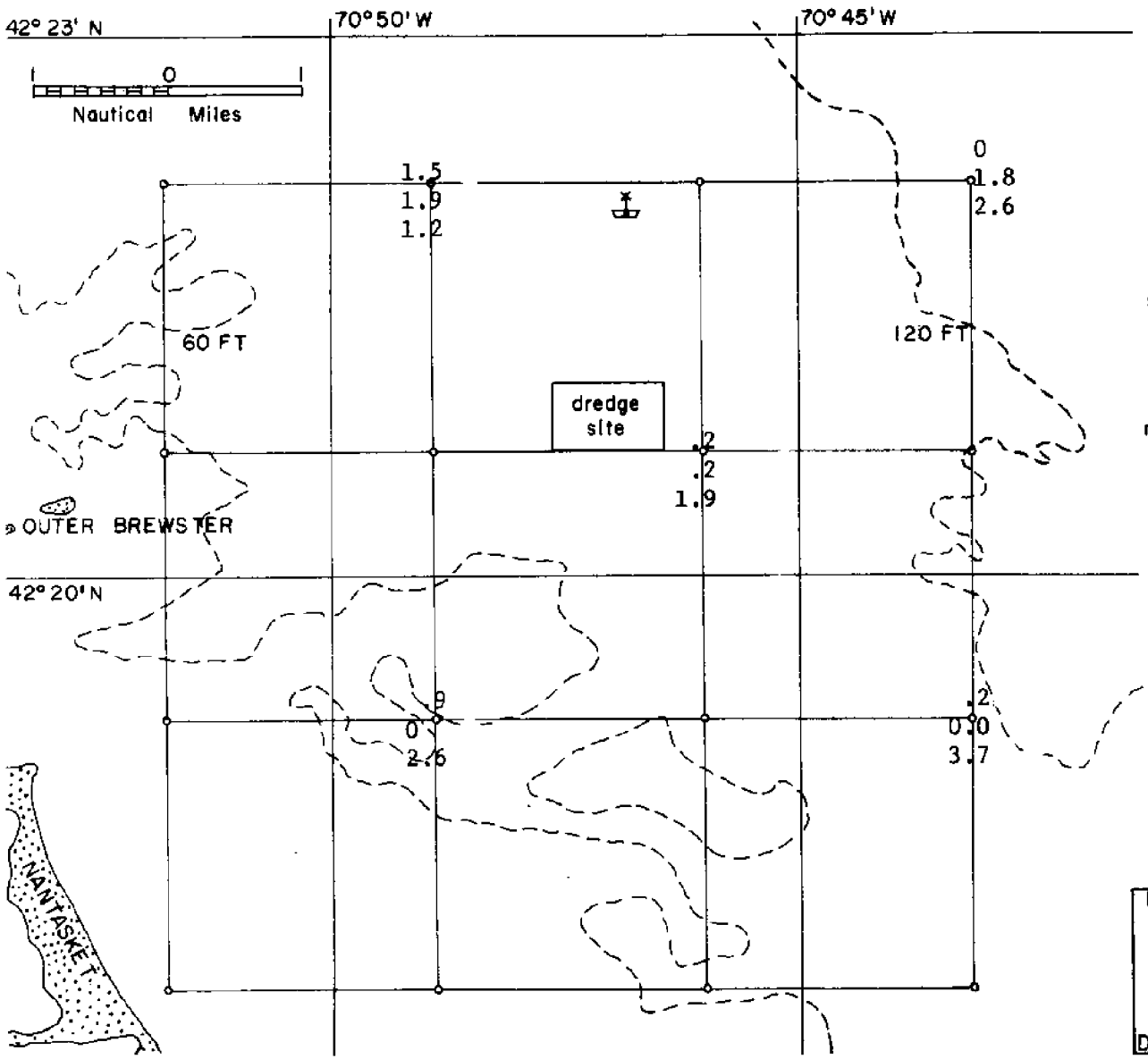
meteorological conditions:
Sky: Clear
Visibility: 15 + Miles
Temperature: 70° F
Wind: 340°, 7 Knots
Sea: 3-5 Feet

Control Station

Longitude 70°35' W
Latitude 42°30' N

Surface - no data
10 meters - .22
20 meters - .22

R. M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: June 2, 1973

parameter: NO_3^-

sample depths:
1st No. - surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

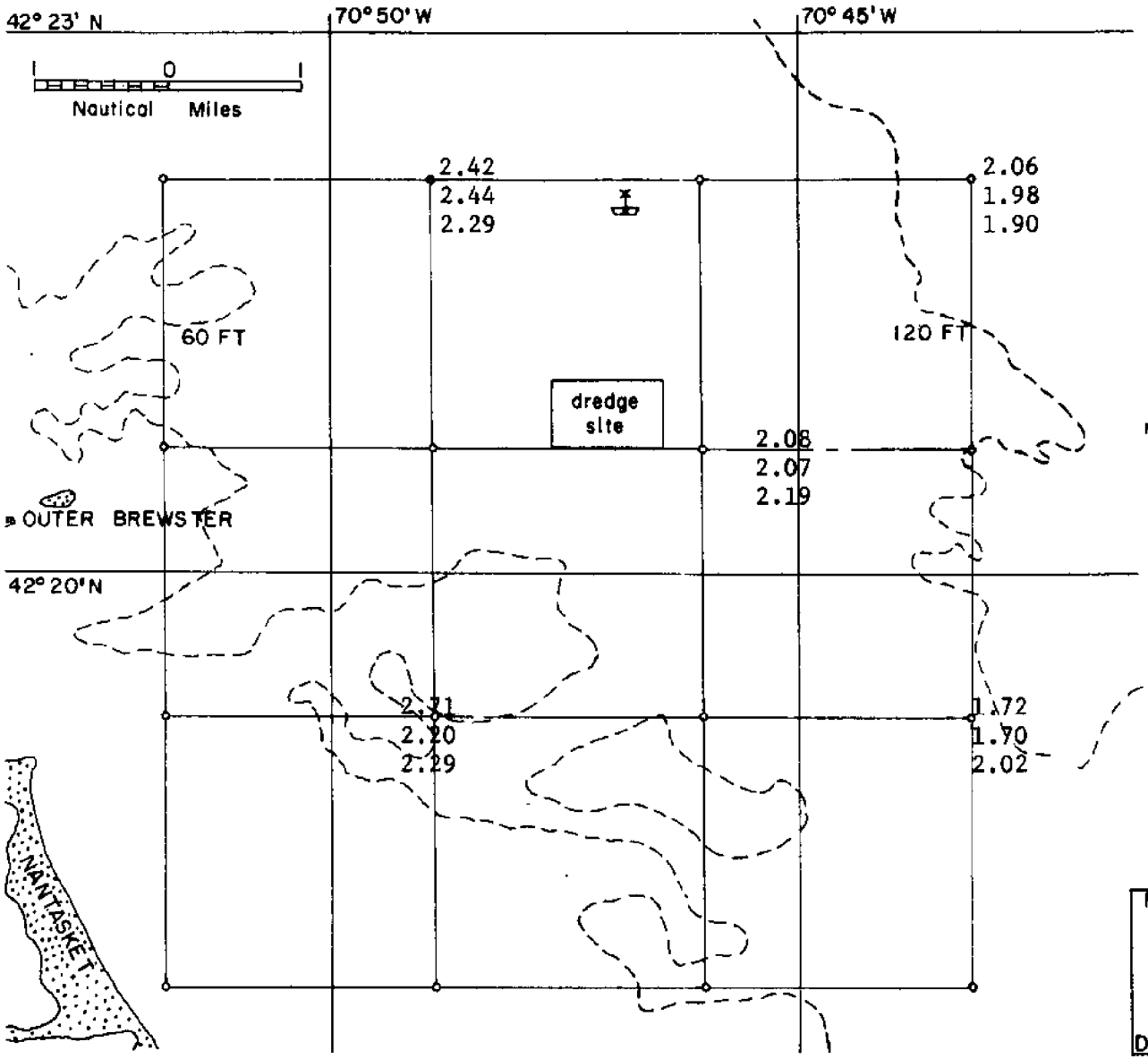
Sky: Clear
Visibility: 15 + Miles
Temperature: 70° F
Wind: 340°, 7 Knots
Sea: 3-5 Feet

Control Station

Longitude 70° 35' W
Latitude 42° 30' N

Surface - no data
10 meters - .0
20 meters - .1

R. M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: June 2, 1973

parameter: $PO_4^{\equiv}$

sample depths:

1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

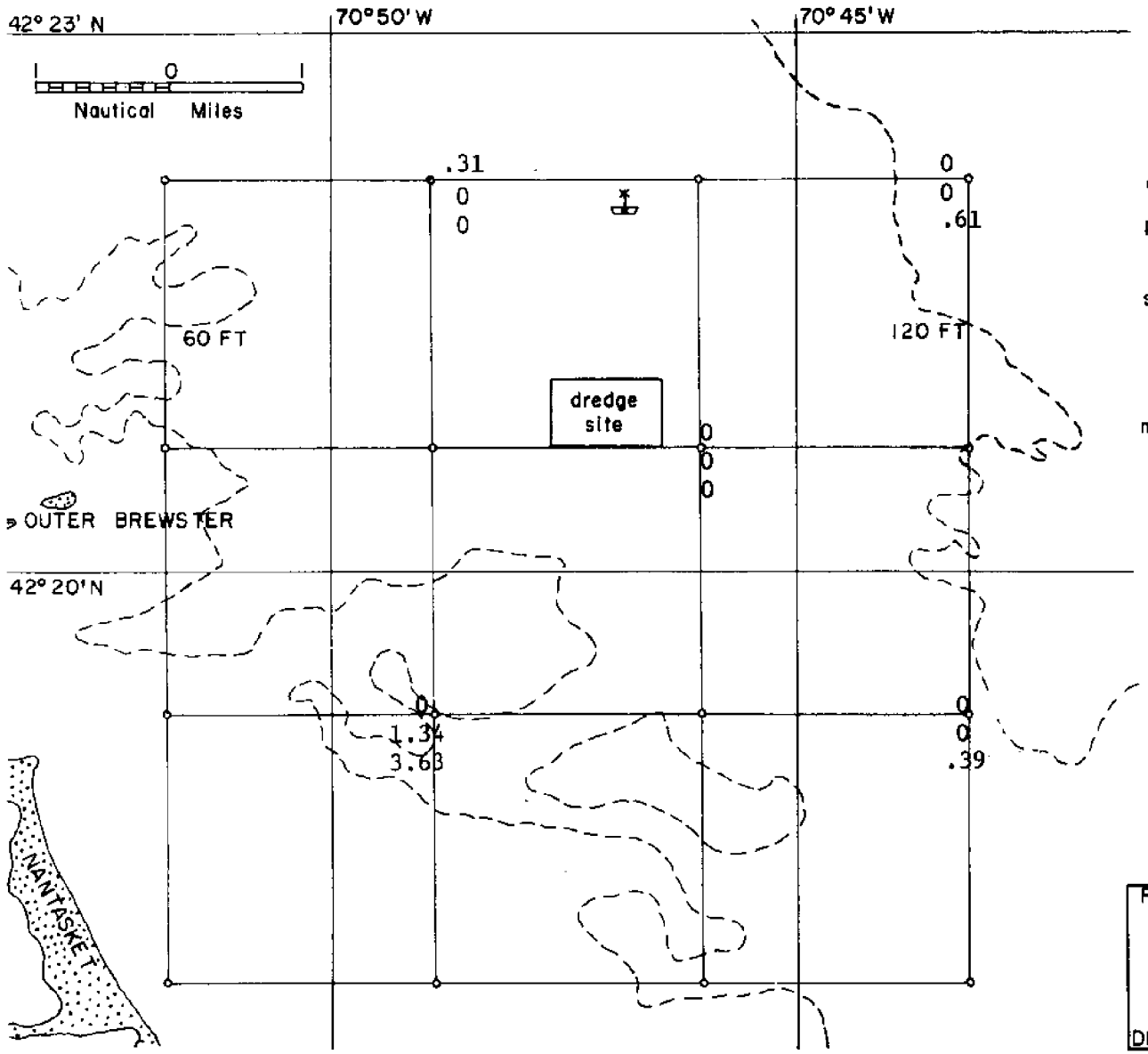
meteorological conditions:

Sky: Clear
Visibility: 15 + Miles
Temperature: 70°F
Wind: 340°, 7 Knots
Sea: 3-5 Feet

Control Station
Longitude 70°35' W
Latitude 42°30' N

Surface - no data
10 meters - 1.65
20 meters - 1.69

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: June 2, 1973

parameter:
S_1O_3

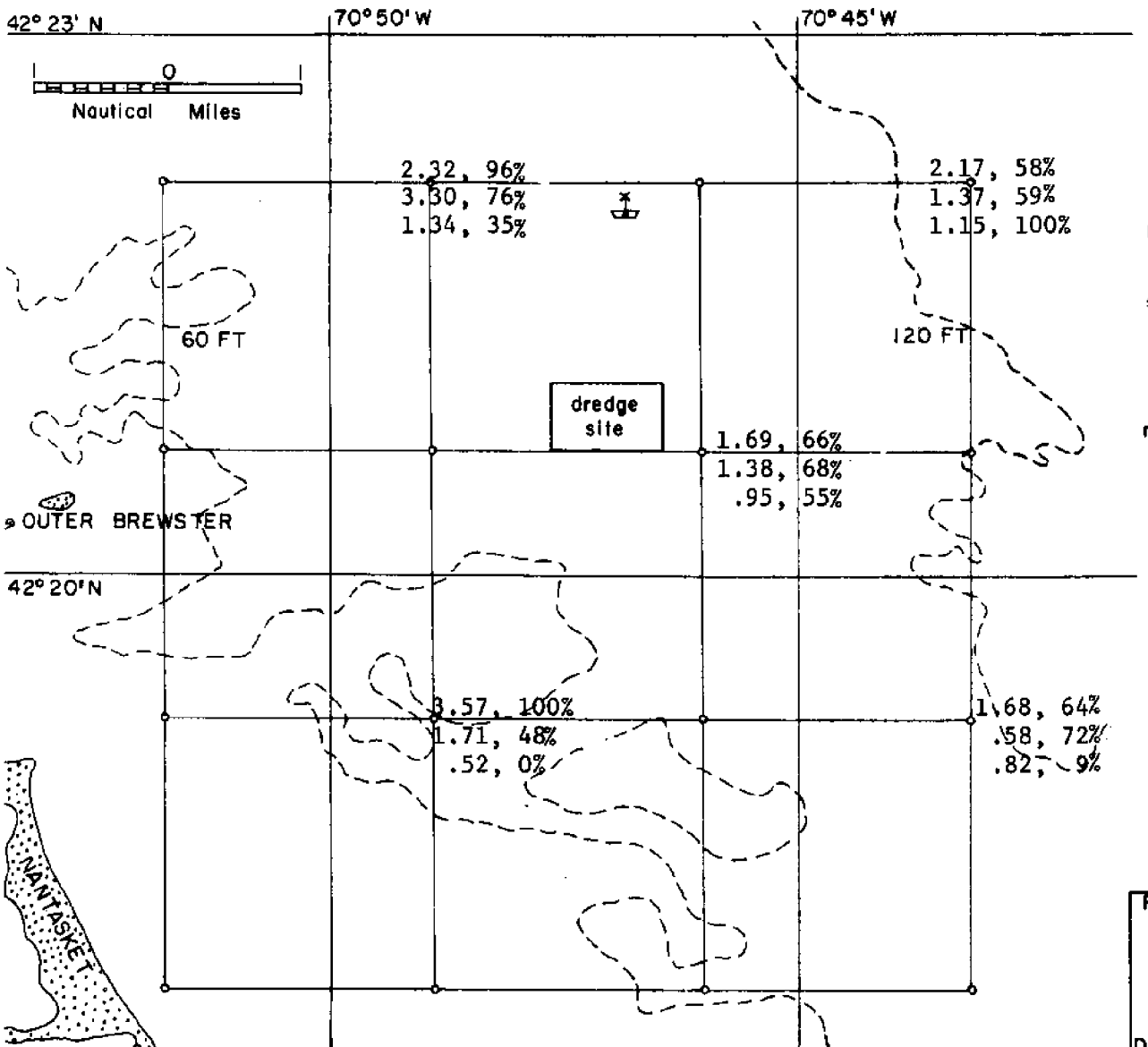
sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Clear
Visibility: 15 + Miles
Temperature: 70° F
Wind: 340°, 7 Knots
Sea: 3-5 Feet

Control Station
Longitude 70°35' W
Latitude 42°30' N

Surface - 0
10 meters - 0
20 meters - 0

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: June 2, 1973

parameter:
Suspended Sediment mg/l
% Organic Sediment

sample depths:
1st Nos. - Surface
2nd Nos. - 10 meters
3rd Nos. - 20 meters

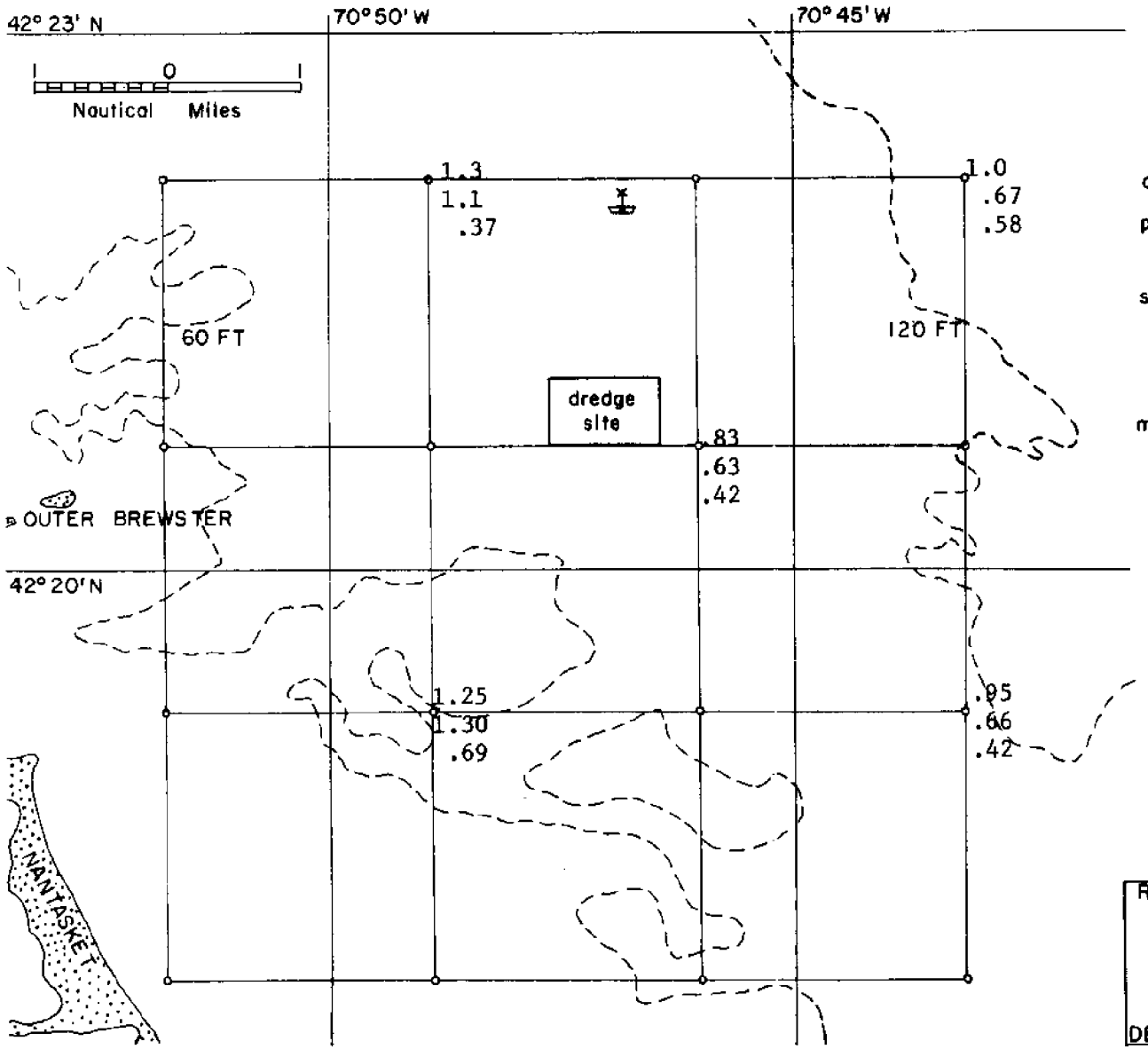
meteorological conditions:
Sky: Clear
Visibility: 15 + Miles
Temperature: 70° F
Wind: 340°, 7 Knots
Sea: 3-5 Feet

Control Station

Longitude 70°35' W
Latitude 42°30' N

Surface - 1.82, 0%
10 meters - .73, 100%
20 meters - 1.27, 66

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: June 2, 1973

parameter:
Turbidity (F.T.U.)

sample depths:

1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

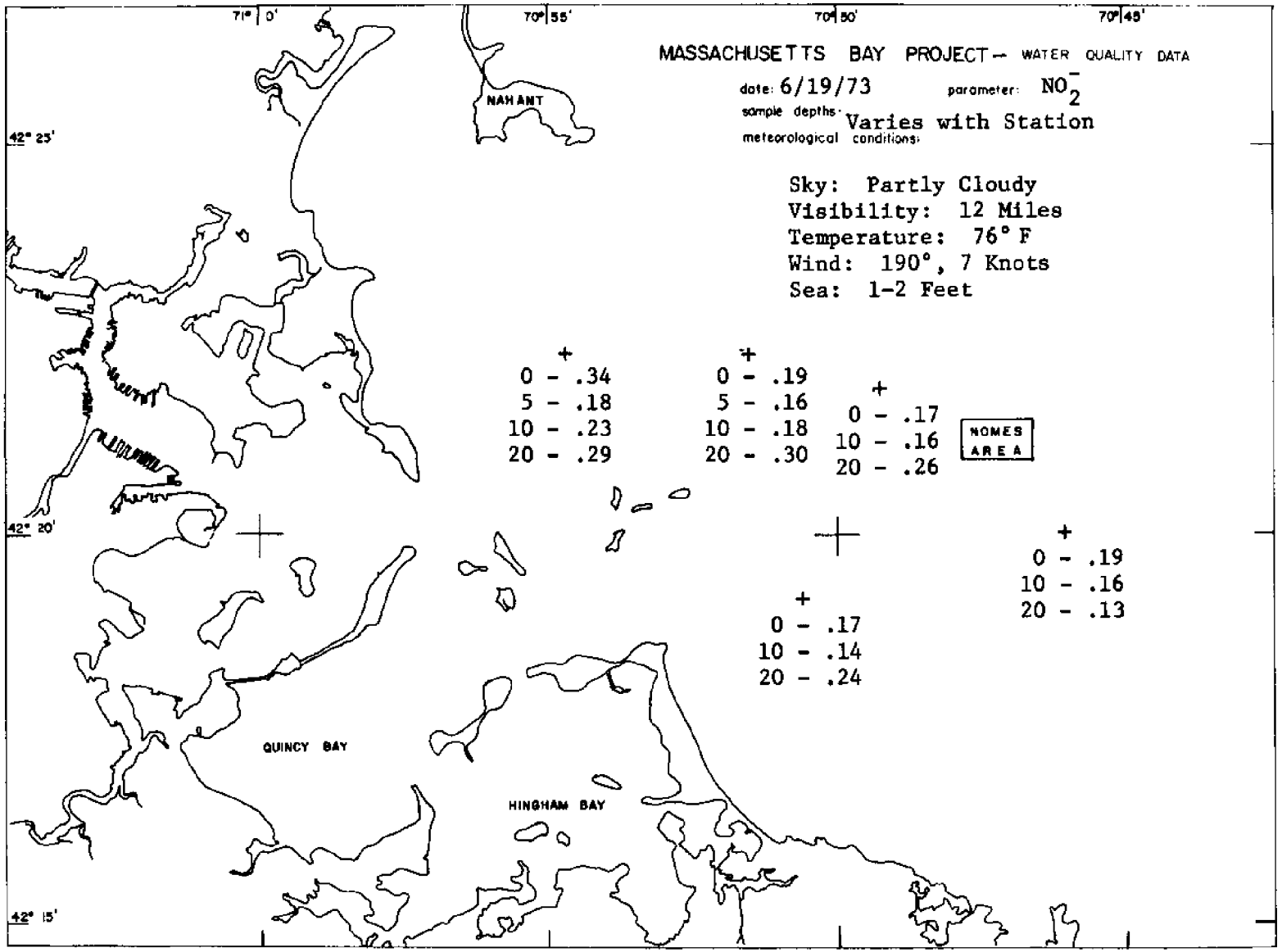
Sky: Clear
Visibility: 15 + Miles
Temperature 70° F
Wind: 340°, 7 Knots
Sea: 3-5 Feet

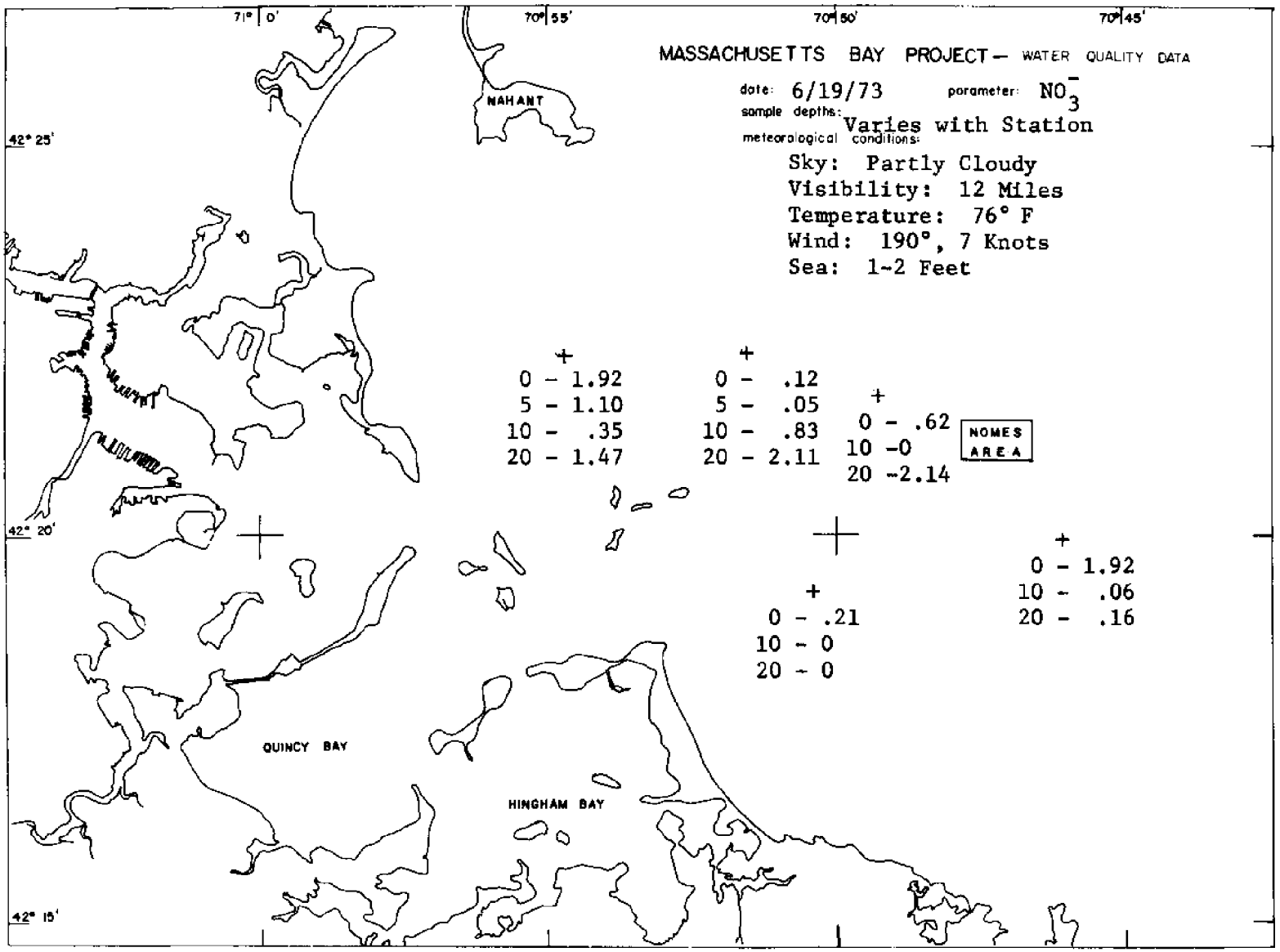
Control Station

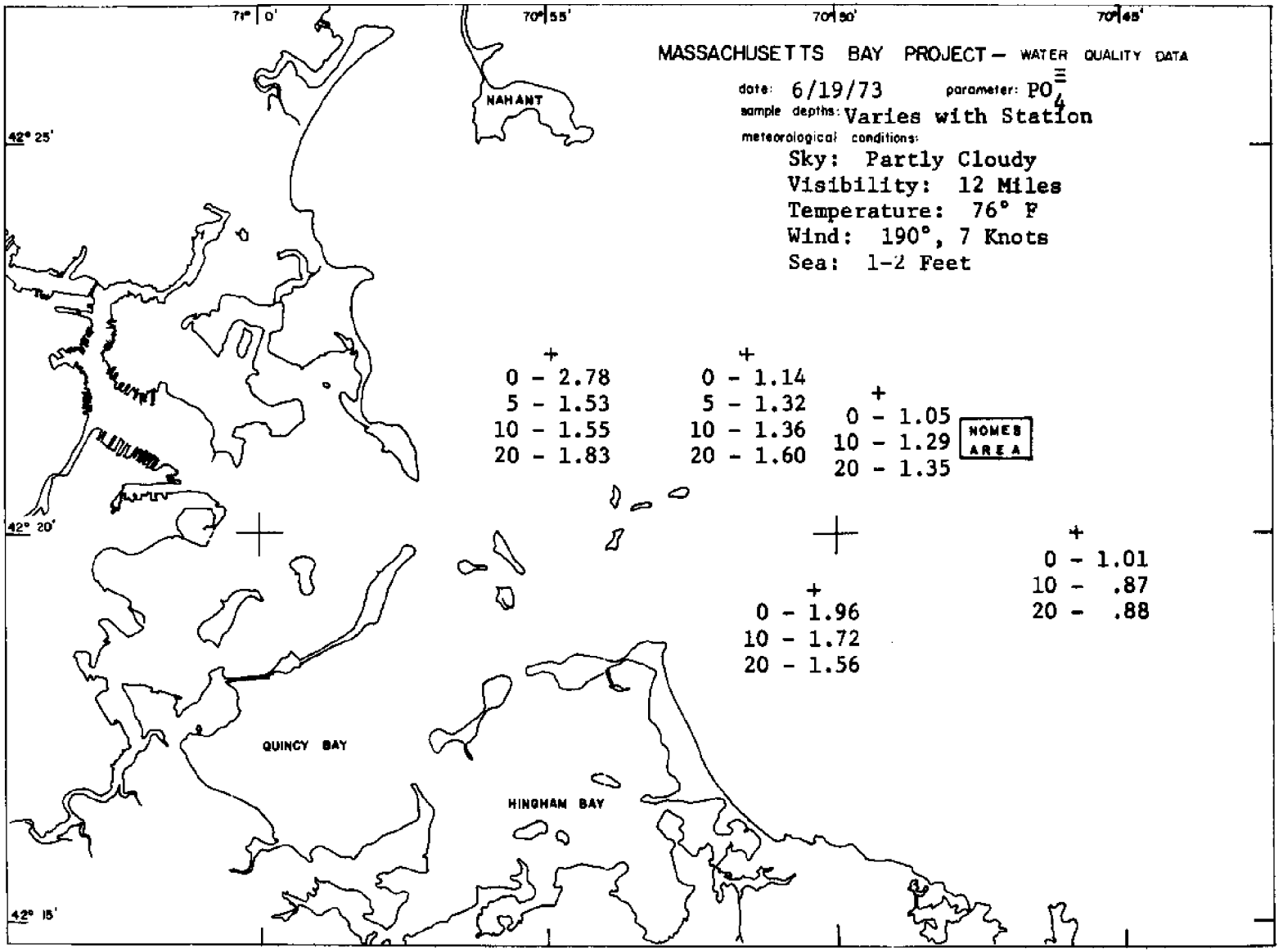
Longitude 70°35' W
Latitude 42°30' N

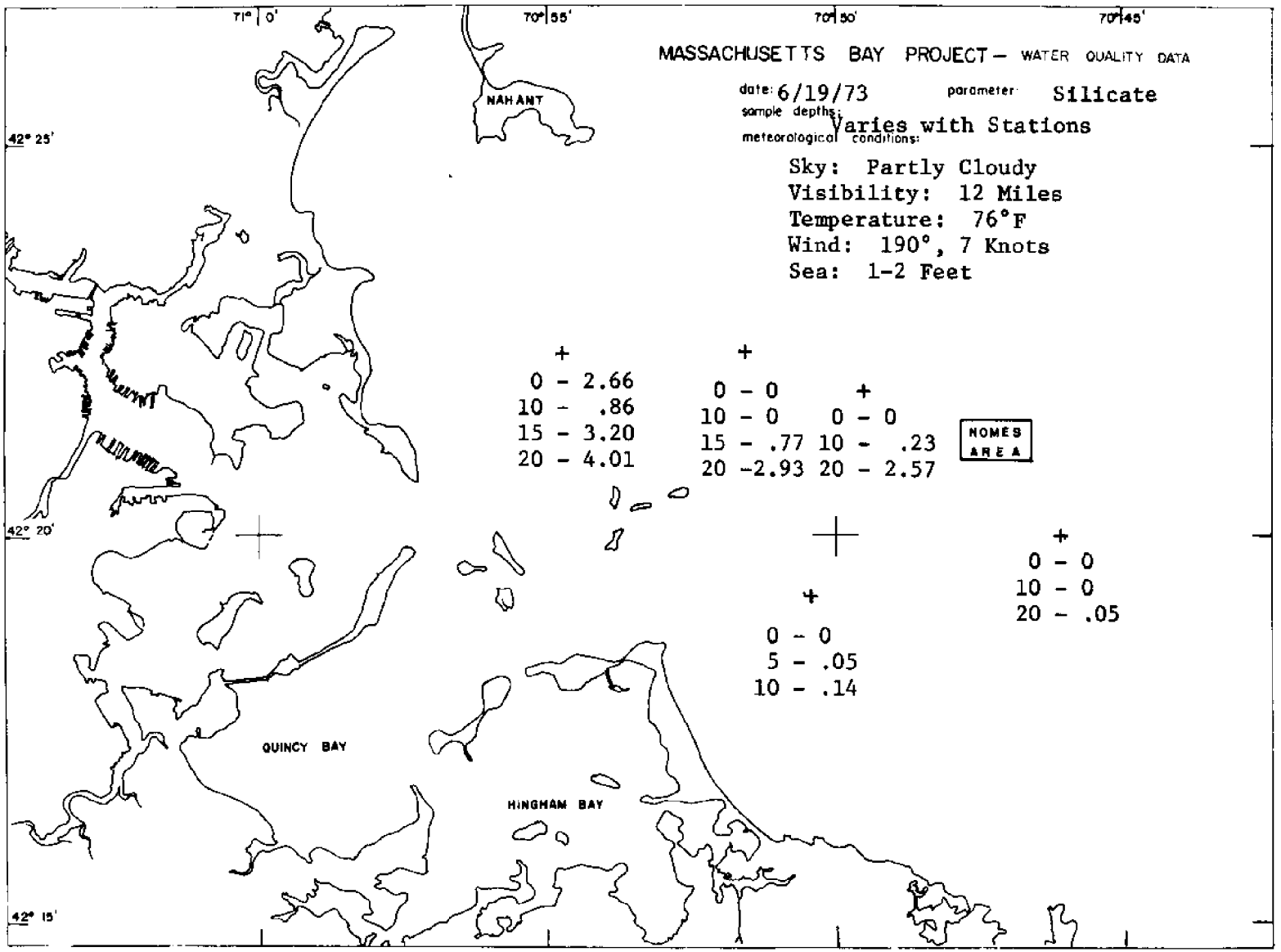
Surface - .37
10 meters - .40
20 meters - .35

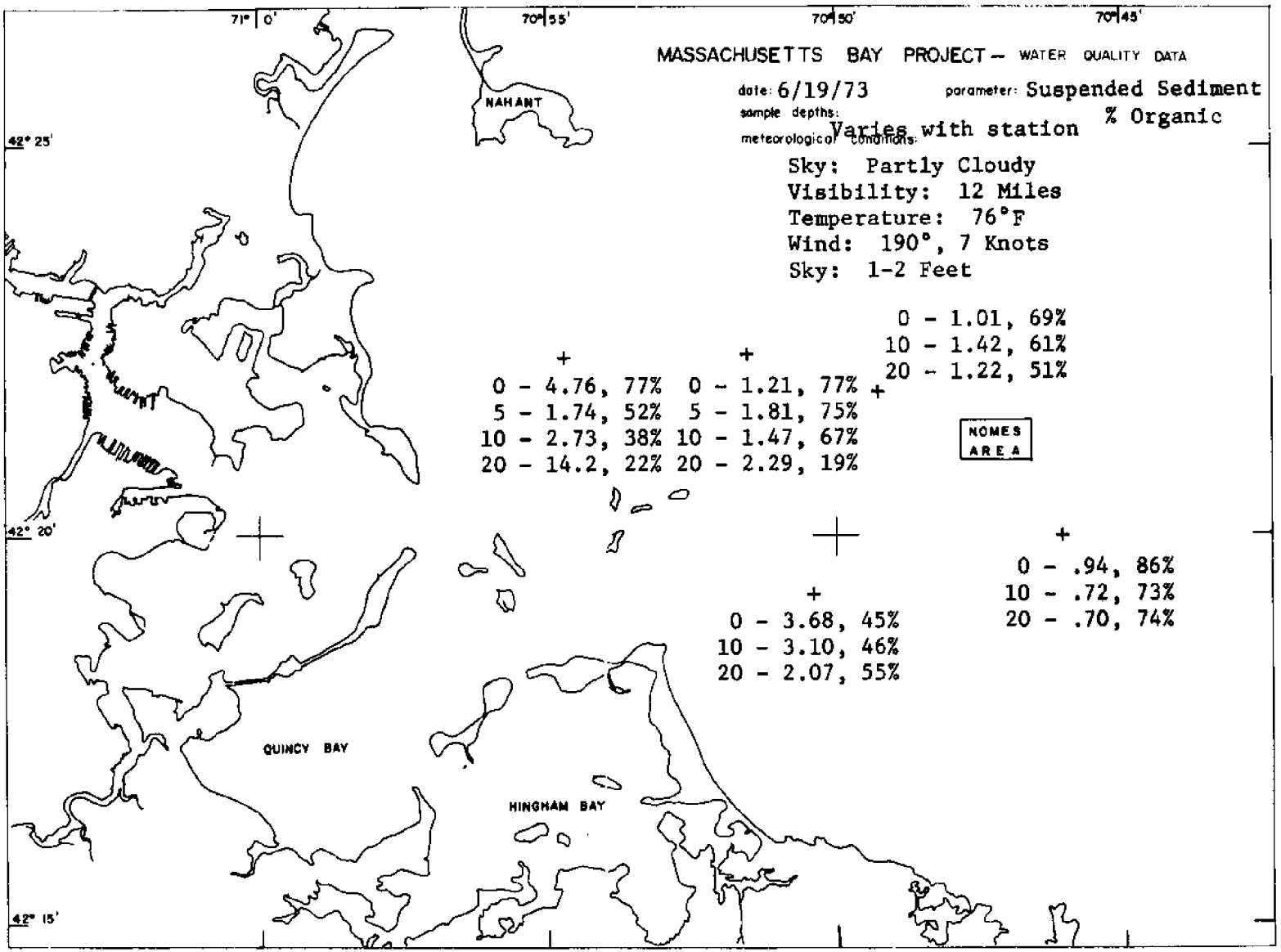
R. M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING

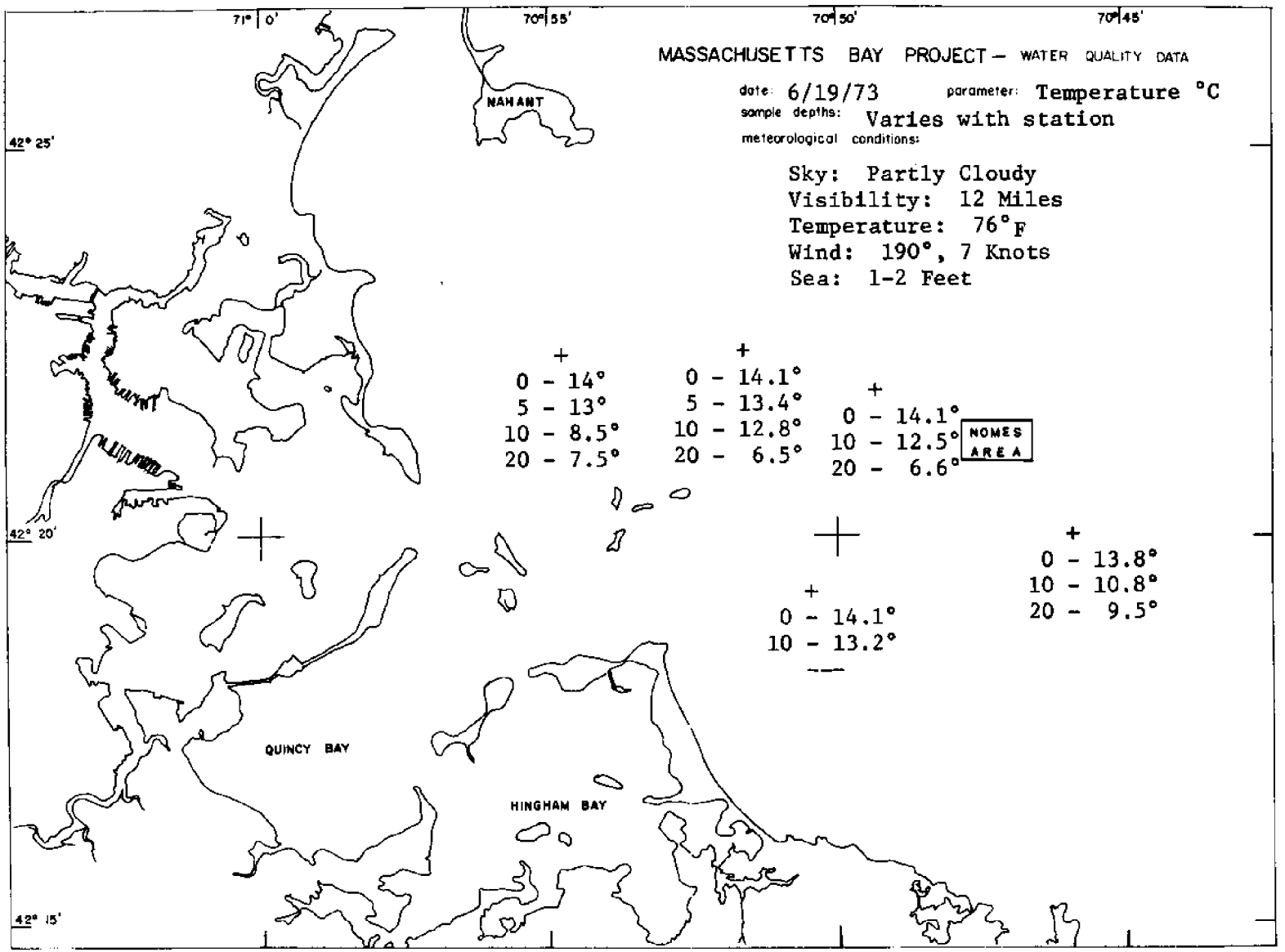

MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: 6/19/73
parameter: NO_2^-
sample depths: Varies with Station
meteorological conditions:
Sky: Partly Cloudy
Visibility: 12 Miles
Temperature: 76° F
Wind: 190°, 7 Knots
Sea: 1-2 Feet
0 - .34
5 - .18
10 - .23
20 - .29
0 - .19
5 - .16
10 - .18
20 - .30
0 - .17
10 - .16
20 - .26
NOMES AREA
0 - .17
10 - .14
20 - .24
0 - .19
10 - .16
20 - .13
NAHANT
QUINCY BAY
HINGHAM BAY
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'

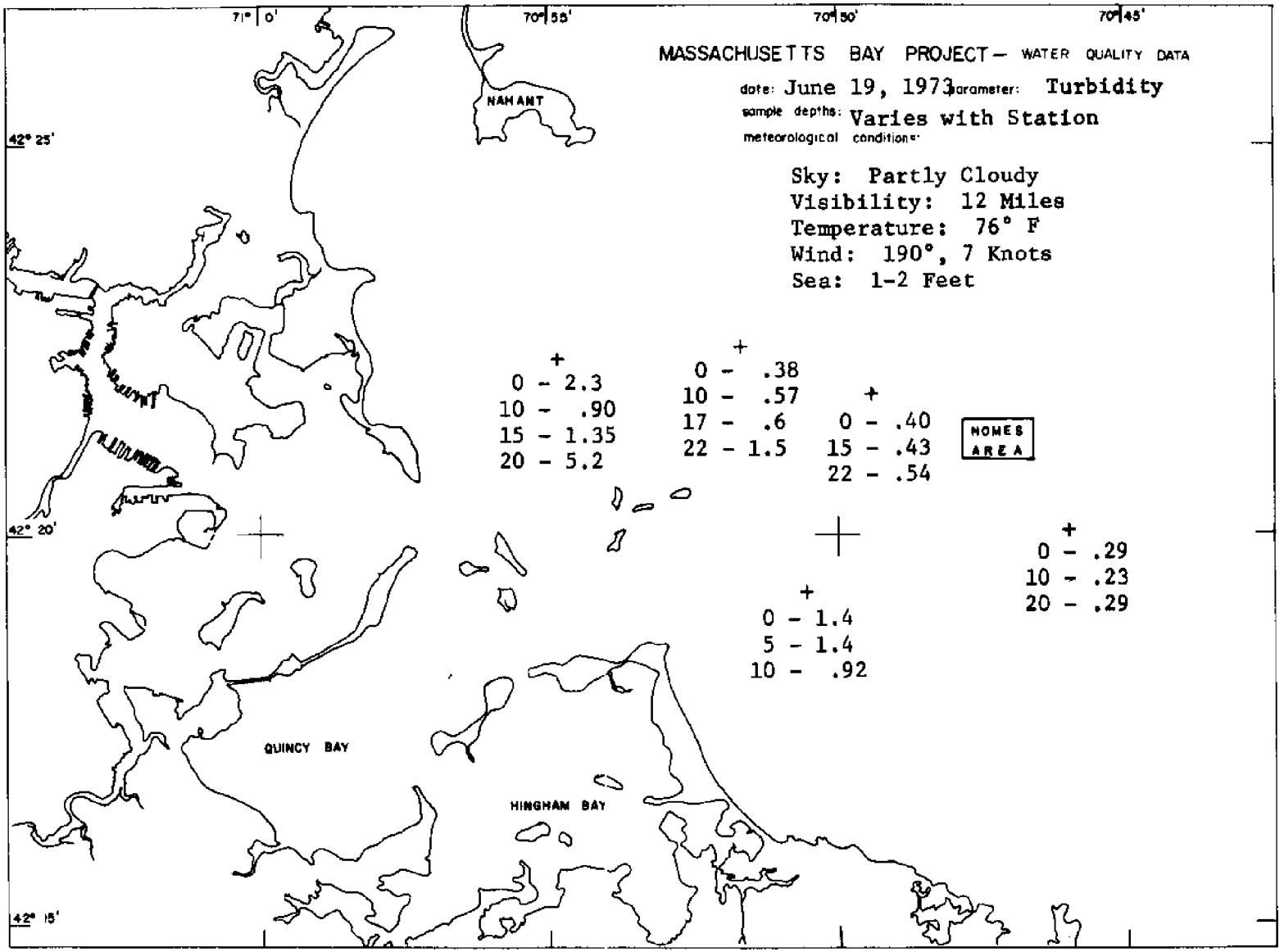

MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: 6/19/73
parameter: NO_3^-
sample depths: Varies with Station
meteorological conditions:
Sky: Partly Cloudy
Visibility: 12 Miles
Temperature: 76° F
Wind: 190°, 7 Knots
Sea: 1-2 Feet
0 - 1.92
5 - 1.10
10 - .35
20 - 1.47
0 - .12
5 - .05
10 - .83
20 - 2.11
0 - .62
10 -0
20 -2.14
NOMES AREA
0 - .21
10 - 0
20 - 0
0 - 1.92
10 - .06
20 - .16
NAHANT
QUINCY BAY
HINGHAM BAY
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'

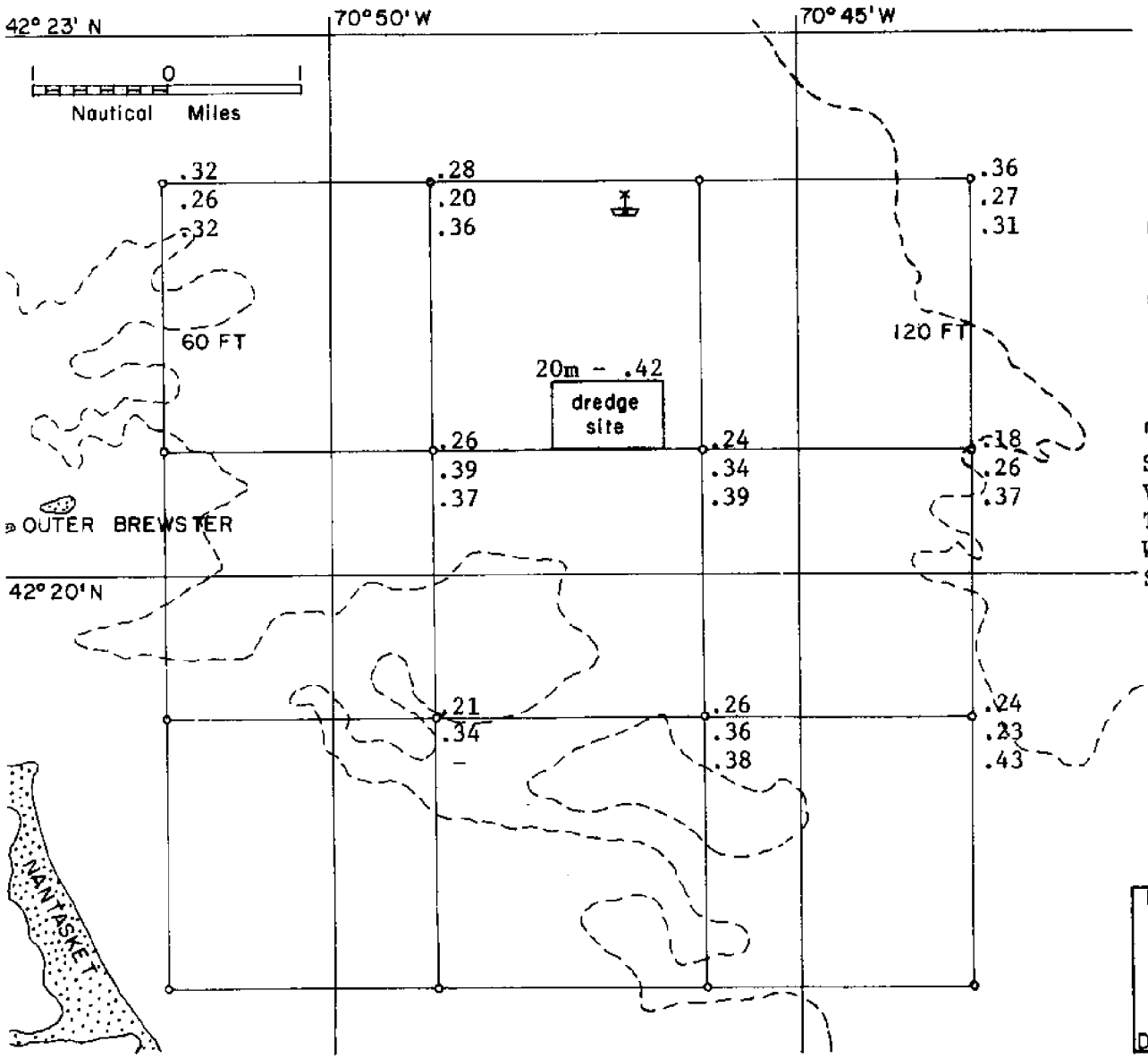

MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: 6/19/73
parameter: $PO_4^{\equiv}$
sample depths: Varies with Station
meteorological conditions:
Sky: Partly Cloudy
Visibility: 12 Miles
Temperature: 76° F
Wind: 190°, 7 Knots
Sea: 1-2 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
QUINCY BAY
HINGHAM BAY
0 - 2.78
5 - 1.53
10 - 1.55
20 - 1.83
0 - 1.14
5 - 1.32
10 - 1.36
20 - 1.60
0 - 1.05
10 - 1.29
20 - 1.35
NOMES AREA
0 - 1.96
10 - 1.72
20 - 1.56
0 - 1.01
10 - .87
20 - .88


MASSACHUSETTS BAY PROJECT – WATER QUALITY DATA
date: 6/19/73
parameter: Silicate
sample depths: Varies with Stations
meteorological conditions:
Sky: Partly Cloudy
Visibility: 12 Miles
Temperature: 76°F
Wind: 190°, 7 Knots
Sea: 1-2 Feet
0 - 2.66
10 - .86
15 - 3.20
20 - 4.01
0 - 0
10 - 0
15 - .77
20 -2.93
0 - 0
10 - .23
20 - 2.57
NOMES AREA
0 - 0
5 - .05
10 - .14
0 - 0
10 - 0
20 - .05
NAHANT
QUINCY BAY
HINGHAM BAY
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'


71° 0'
70° 55'
70° 50'
70° 45'
MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: 6/19/73
parameter: Suspended Sediment
sample depths: Varies with station
% Organic
meteorological conditions:
Sky: Partly Cloudy
Visibility: 12 Miles
Temperature: 76°F
Wind: 190°, 7 Knots
Sky: 1-2 Feet
NAHANT
42° 25'
42° 20'
42° 15'
0 - 4.76, 77%
5 - 1.74, 52%
10 - 2.73, 38%
20 - 14.2, 22%
0 - 1.21, 77%
5 - 1.81, 75%
10 - 1.47, 67%
20 - 2.29, 19%
0 - 1.01, 69%
10 - 1.42, 61%
20 - 1.22, 51%
NOMES AREA
0 - 3.68, 45%
10 - 3.10, 46%
20 - 2.07, 55%
0 - .94, 86%
10 - .72, 73%
20 - .70, 74%
QUINCY BAY
HINGHAM BAY


MASSACHUSETTS BAY PROJECT – WATER QUALITY DATA
date: 6/19/73
parameter: Temperature °C
sample depths: Varies with station
meteorological conditions:
Sky: Partly Cloudy
Visibility: 12 Miles
Temperature: 76°F
Wind: 190°, 7 Knots
Sea: 1-2 Feet
0 - 14°
5 - 13°
10 - 8.5°
20 - 7.5°
0 - 14.1°
5 - 13.4°
10 - 12.8°
20 - 6.5°
0 - 14.1°
10 - 12.5°
20 - 6.6°
NOMES AREA
0 - 14.1°
10 - 13.2°
0 - 13.8°
10 - 10.8°
20 - 9.5°
NAHANT
QUINCY BAY
HINGHAM BAY
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'


MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: June 19, 1973 parameter: Turbidity
sample depths: Varies with Station
meteorological conditions:
Sky: Partly Cloudy
Visibility: 12 Miles
Temperature: 76° F
Wind: 190°, 7 Knots
Sea: 1-2 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
QUINCY BAY
HINGHAM BAY
0 - 2.3
10 - .90
15 - 1.35
20 - 5.2
0 - .38
10 - .57
17 - .6
22 - 1.5
0 - .40
15 - .43
22 - .54
NOMES AREA
0 - 1.4
5 - 1.4
10 - .92
0 - .29
10 - .23
20 - .29



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: June 30, 1973

parameter: NO_2

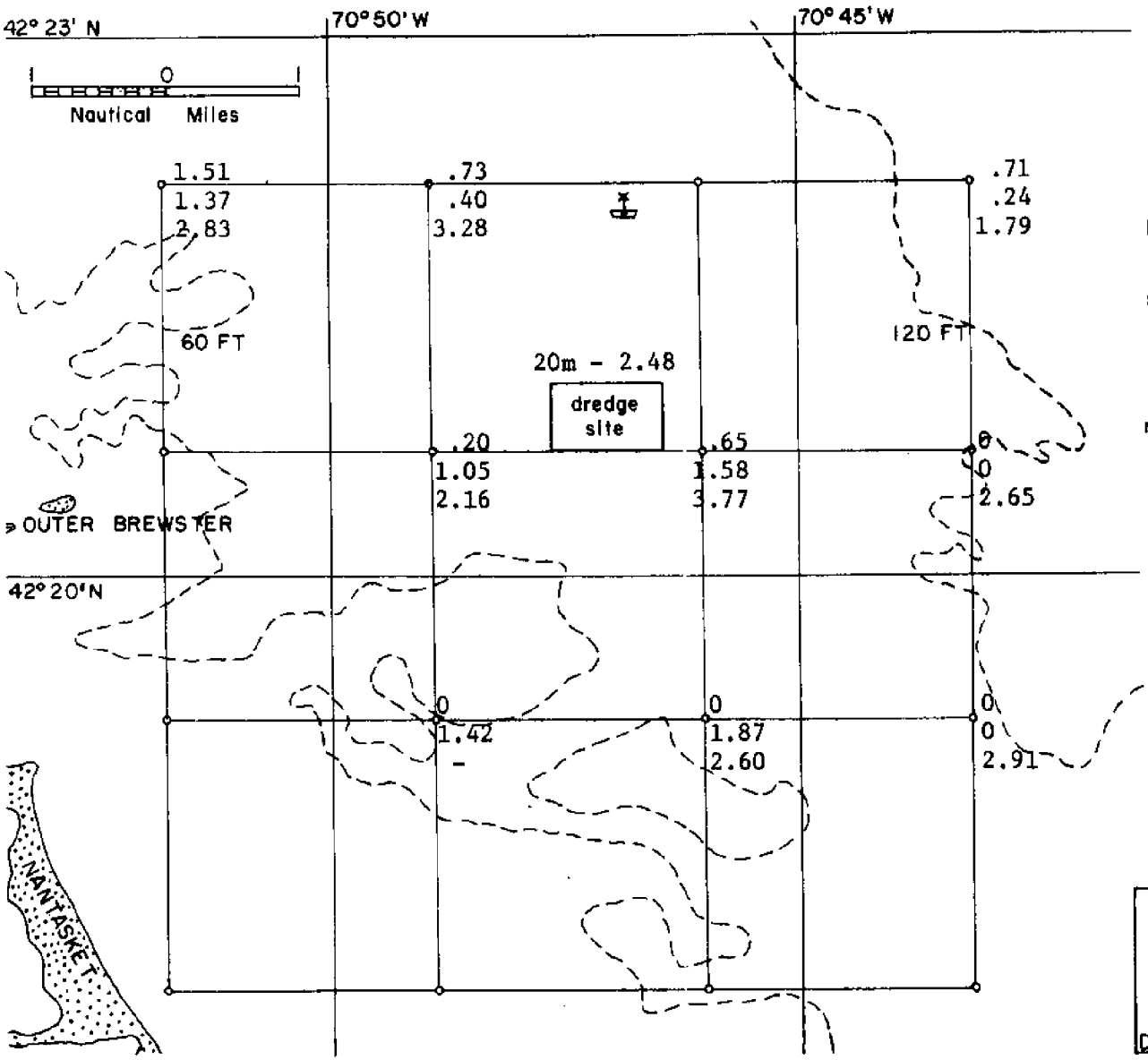
sample depths:

1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Overcast
Visibility: 10 Miles
Temperature: 73° F
Wind: 160°, 7 Knots
Sea: 2-3 Feet

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

date: June 30, 1973

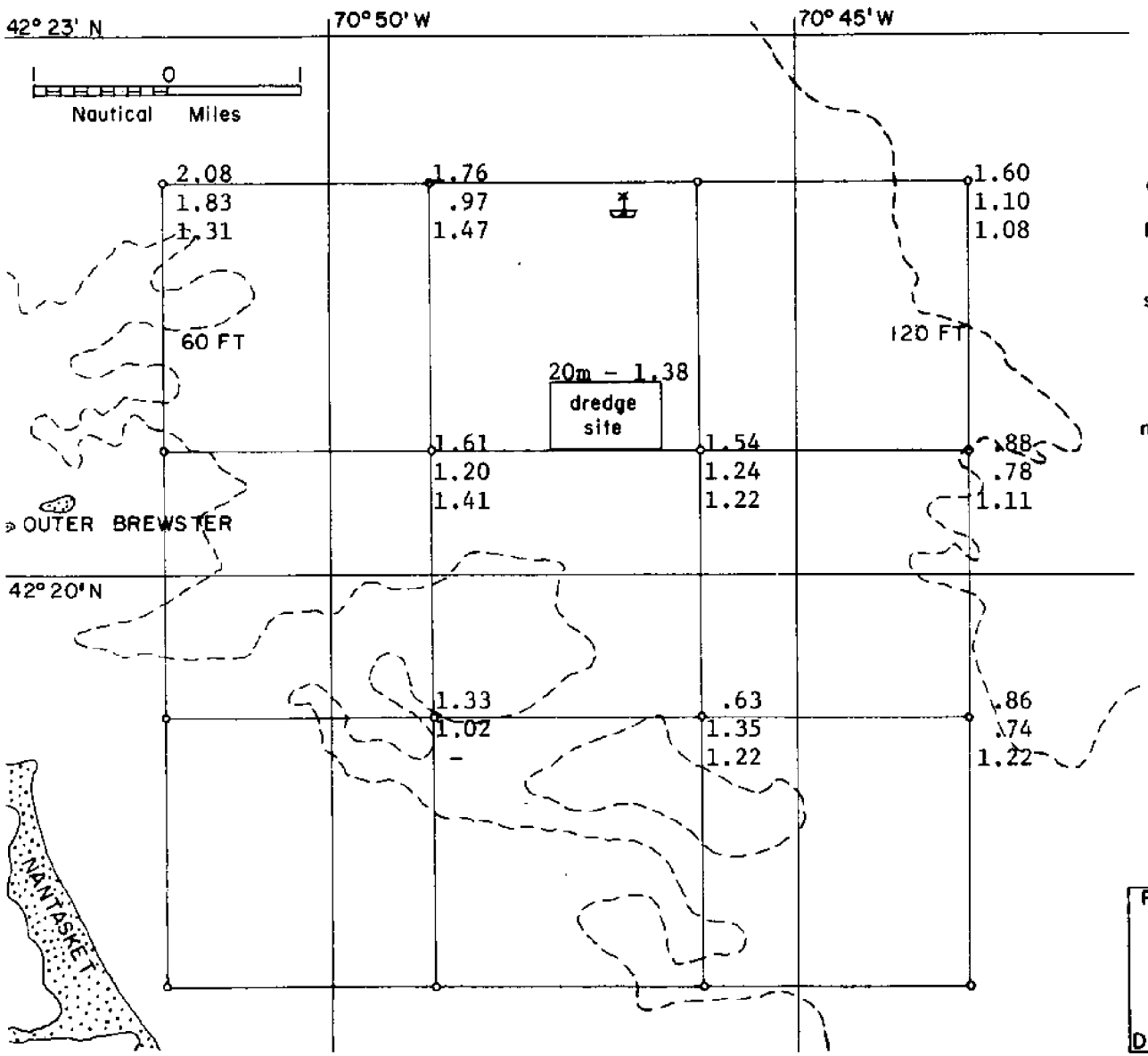
parameter: NO_3^-

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:

Sky: Overcast
Visibility: 10 Miles
Temperature: 73° F
Wind: 160°, 8 Knots
Sea: 2-3 Feet

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

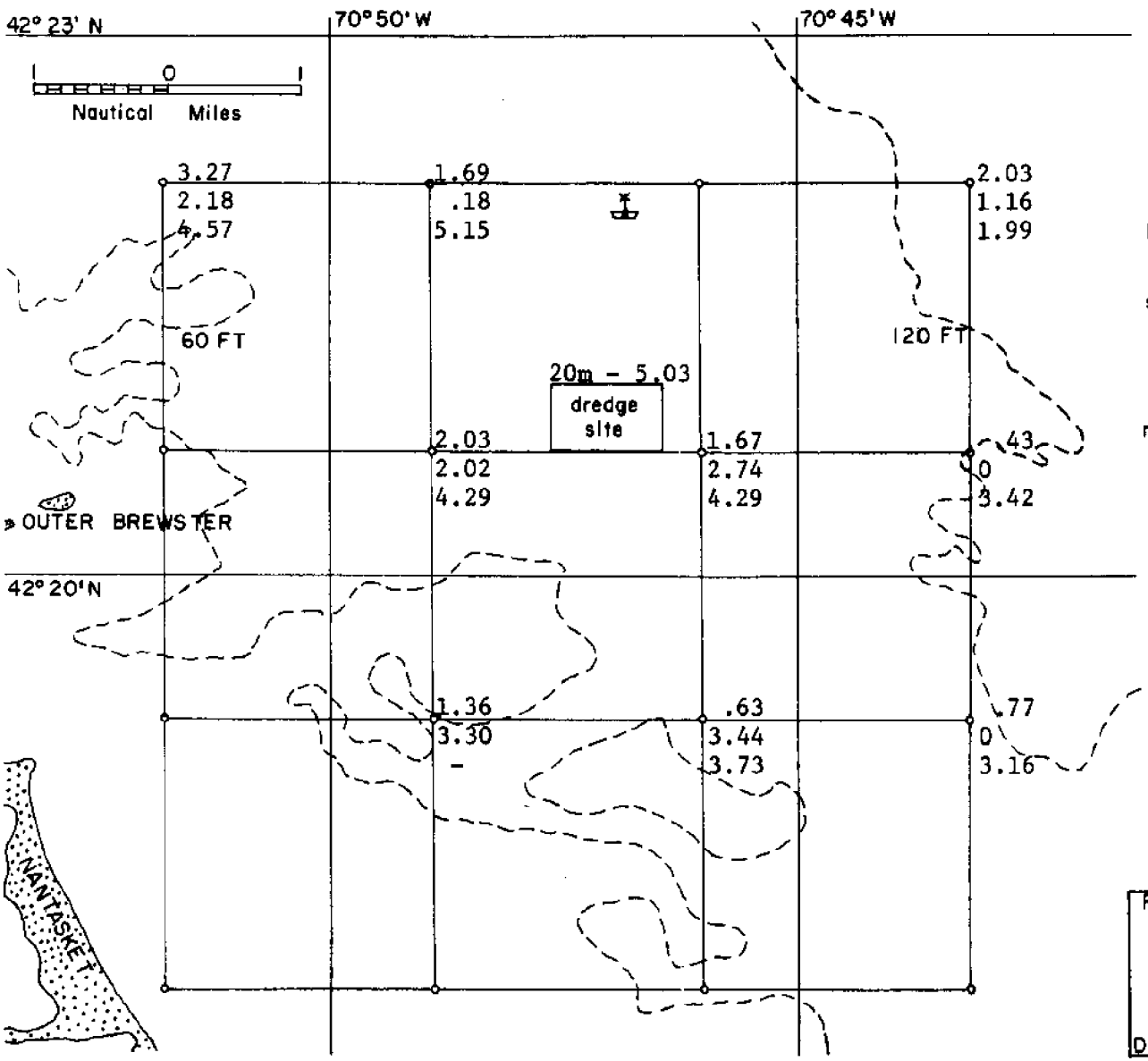
date: June 30, 1973

parameter:
$PO_4^{\equiv}$

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Overcast
Visibility: 10 Miles
Temperature: 73° F
Wind: 160°, 8 Knots
Sea: 2-3 Feet

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

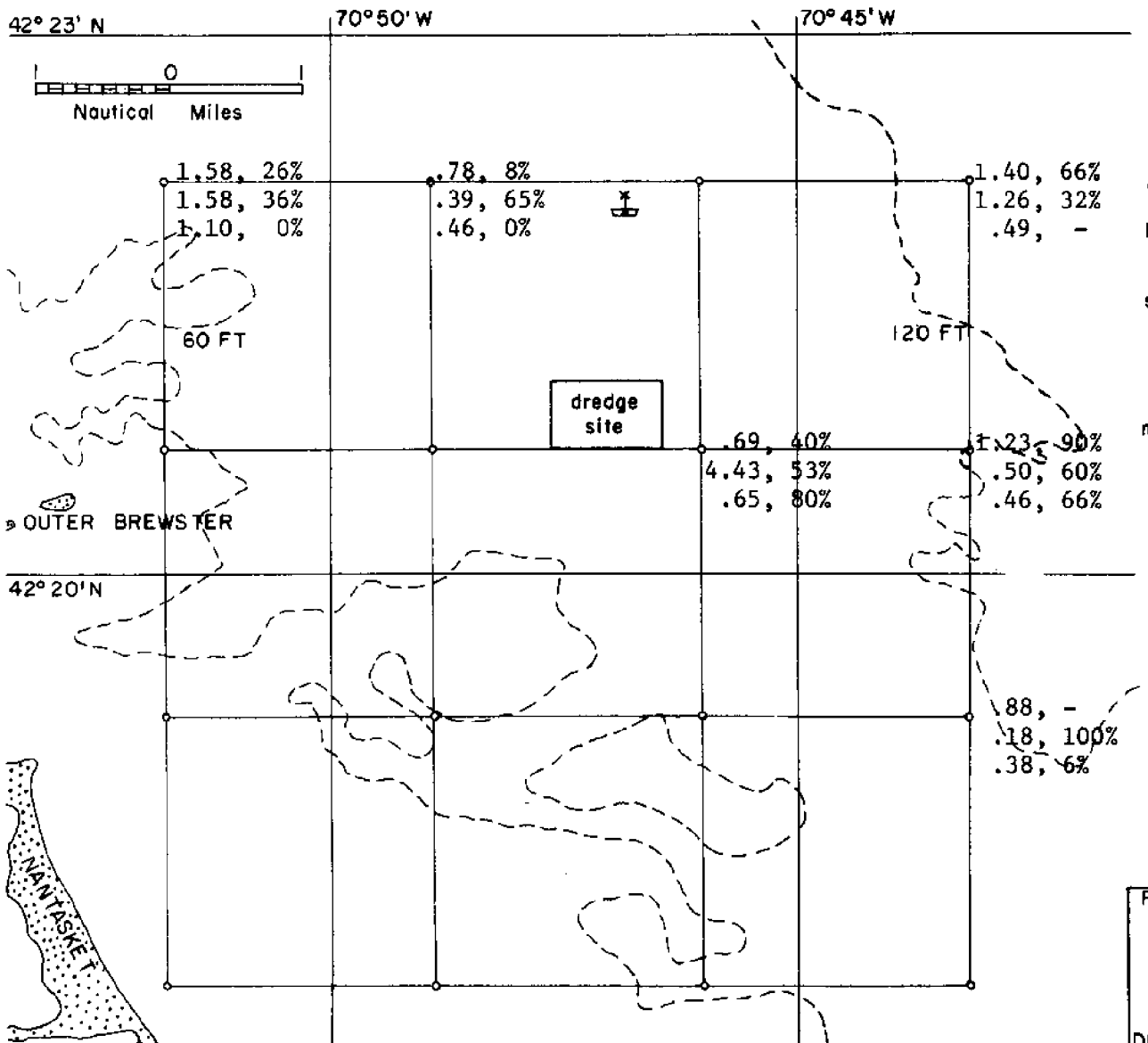
date: June 30, 1973

parameter:
Silicate

sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters

meteorological conditions:
Sky: Overcast
Visibility: 10 Miles
Temperature: 73° F
Wind: 160°, 7 Knots
Sea: 2-3 Feet

R.M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING



NOAA – NOMES PROJECT
WATER QUALITY
MEASUREMENTS

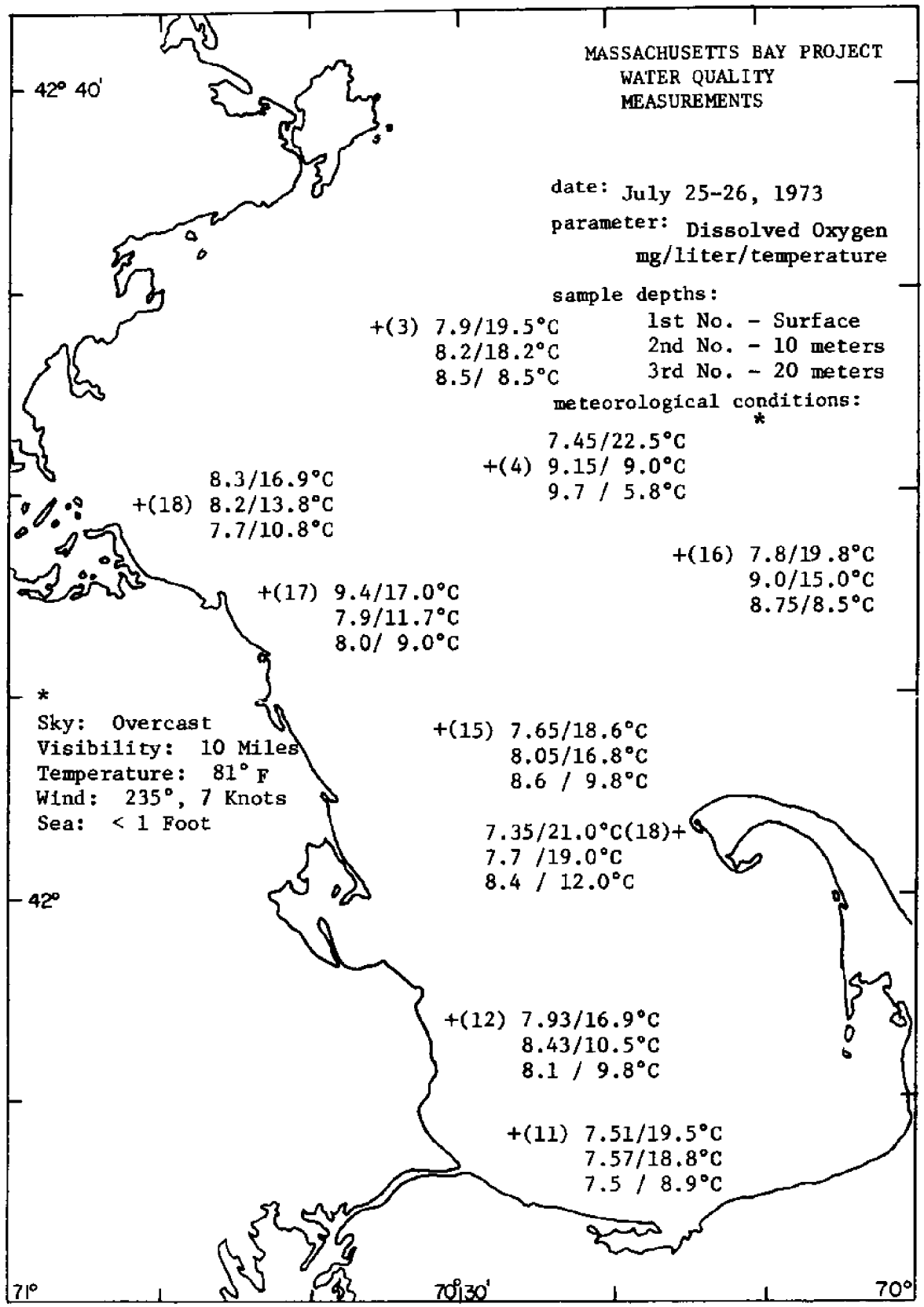
date: June 30, 1973

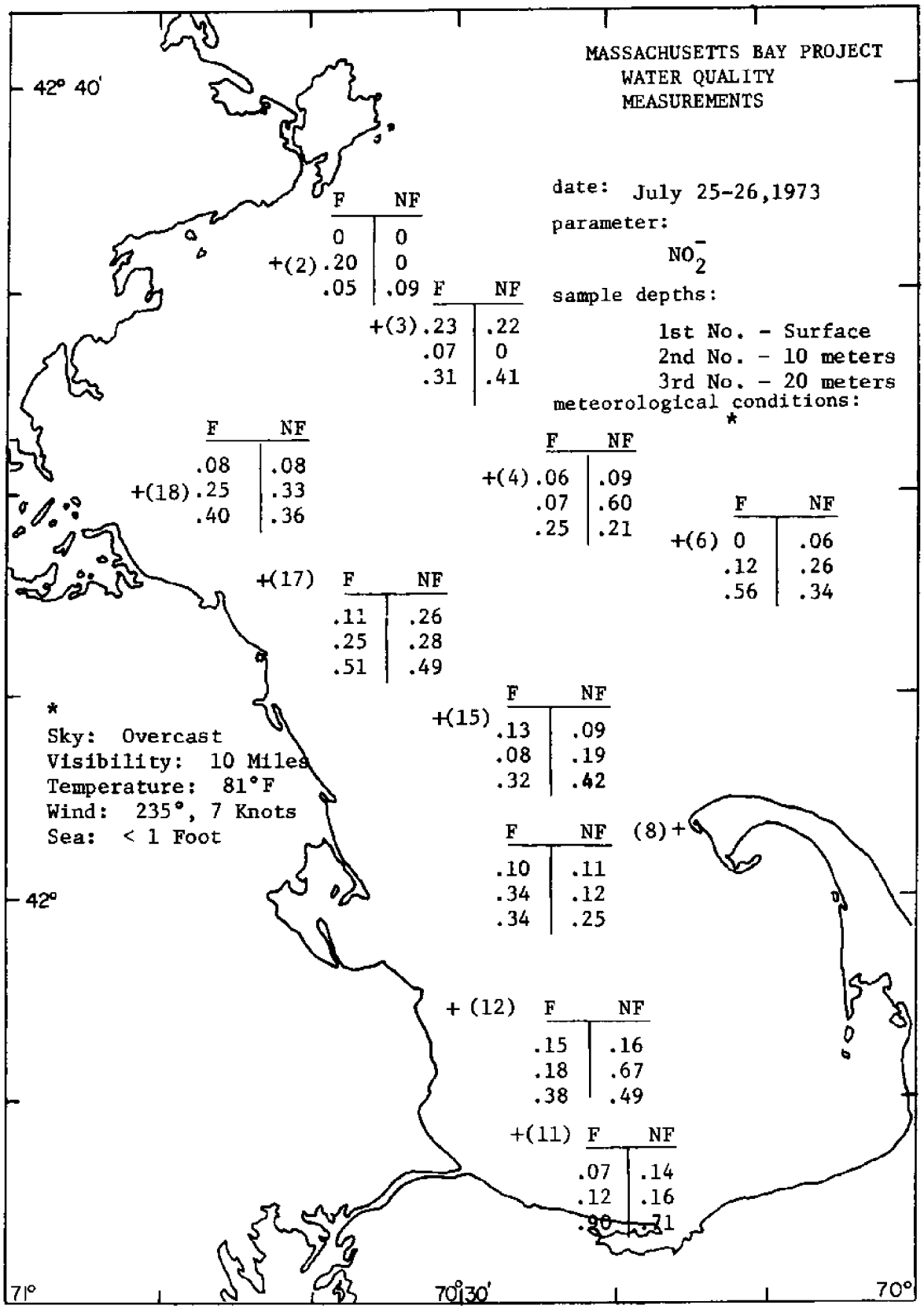
parameter: Total Suspended Sediment and % Organic Sediment

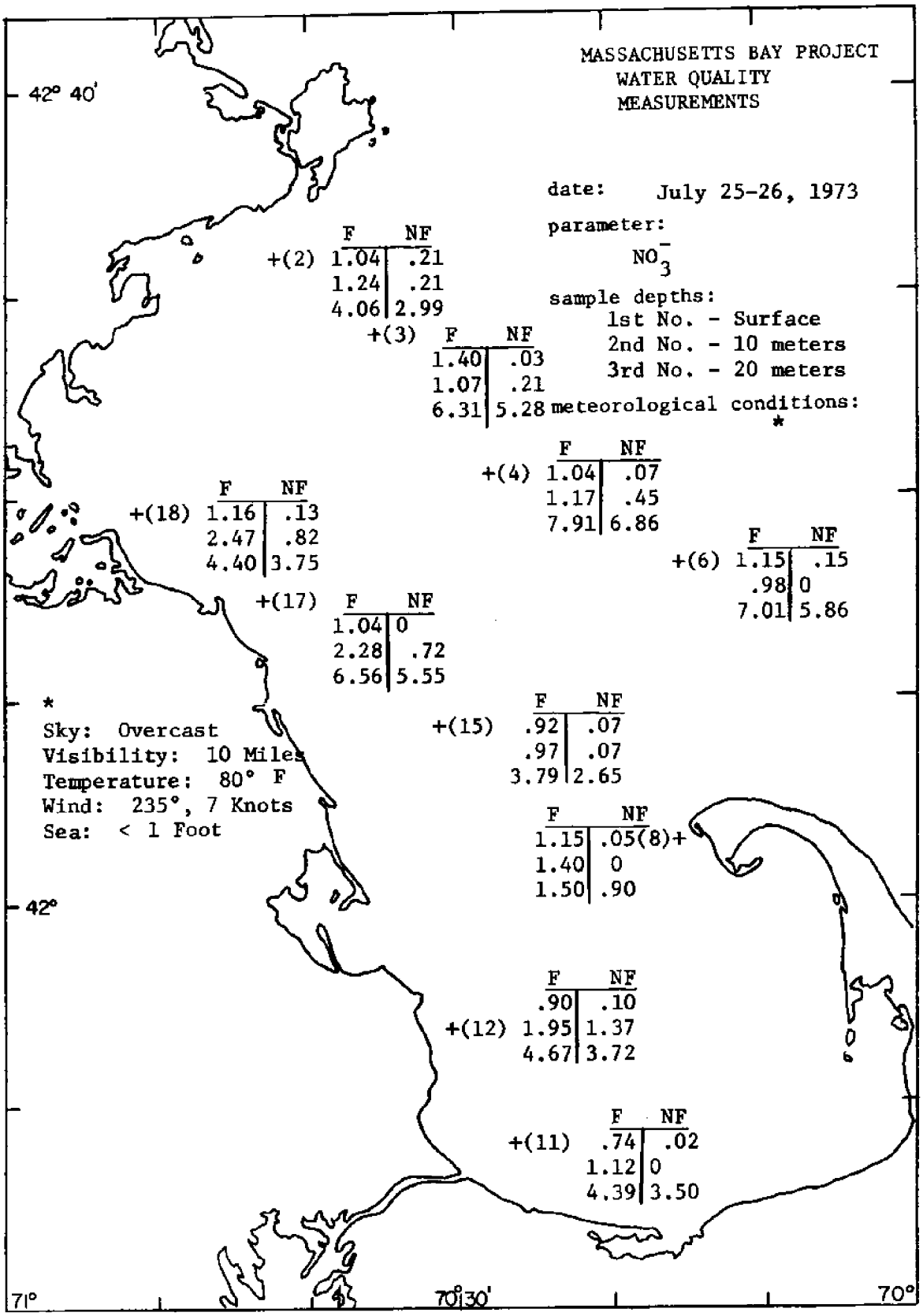
sample depths:
1st Nos. - Surface
2nd Nos. - 10 meters
3rd Nos. - 20 meters

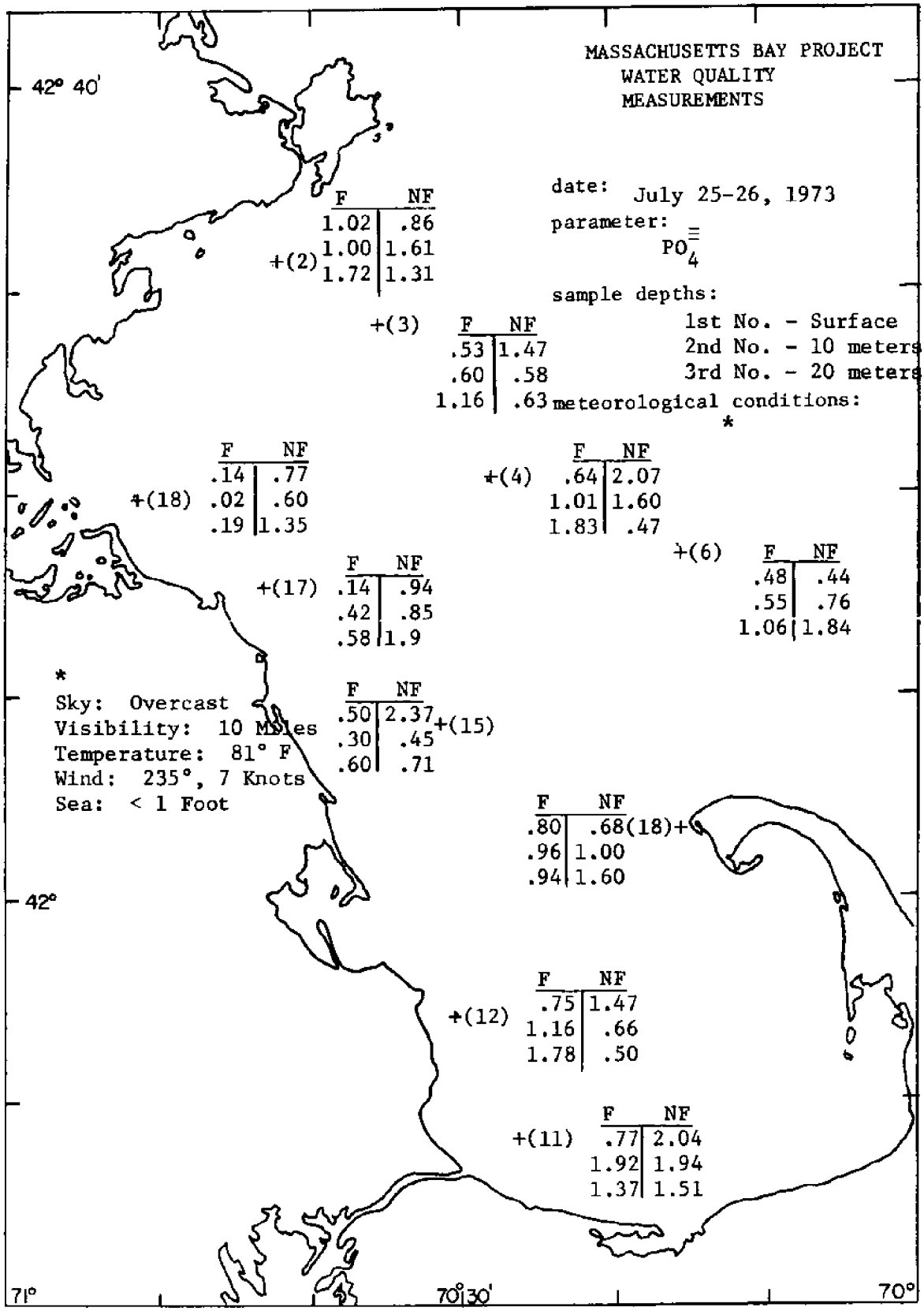
meteorological conditions:
Sky: Overcast
Visibility: 10 Miles
Temperature: 73° F
Wind: 160°, 8 Knots
Sea: 2-3 Feet

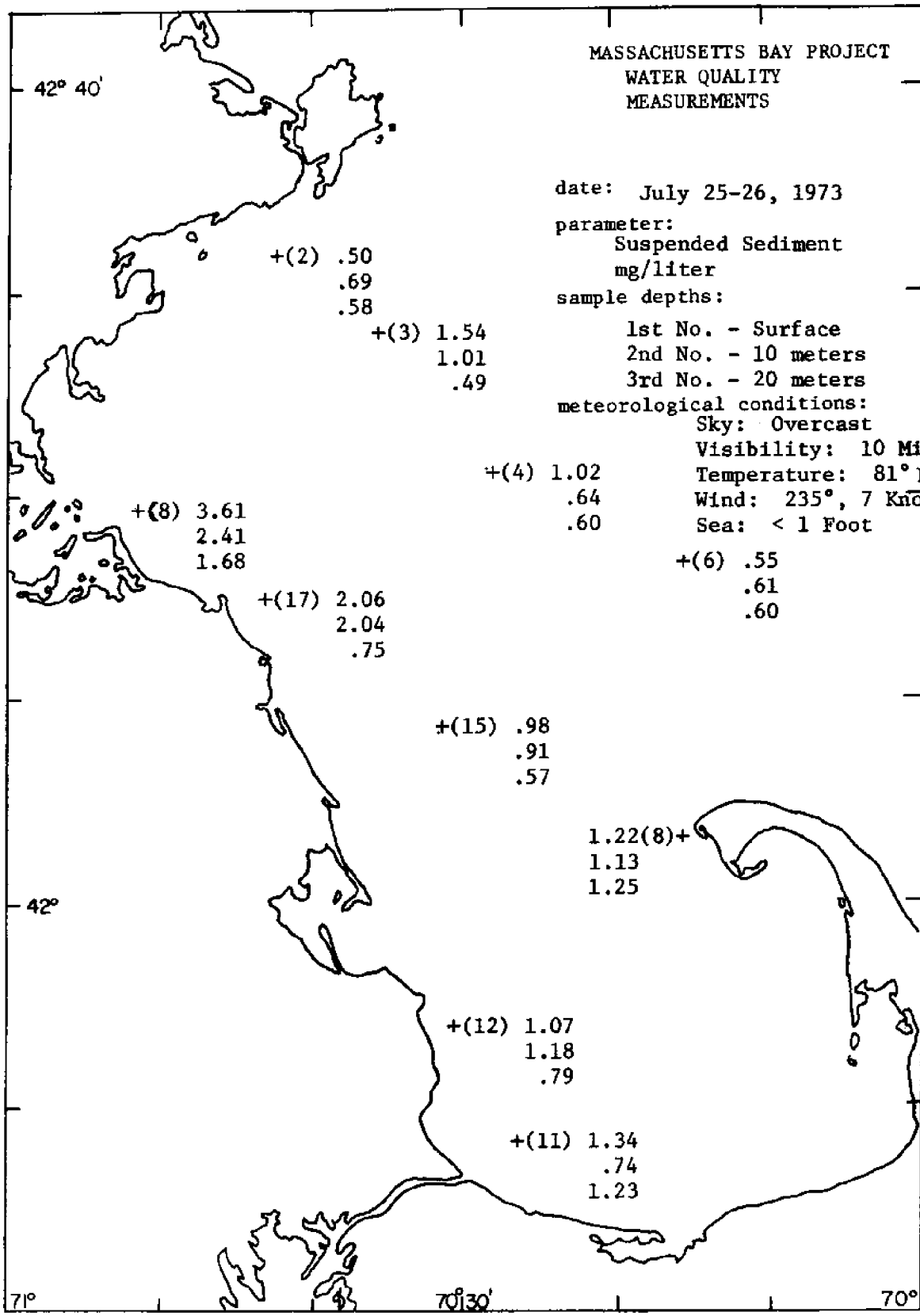
R. M. PARSONS LABORATORY
FOR WATER RESOURCES
AND HYDRODYNAMICS
M. I. T.
DEPT. OF CIVIL ENGINEERING

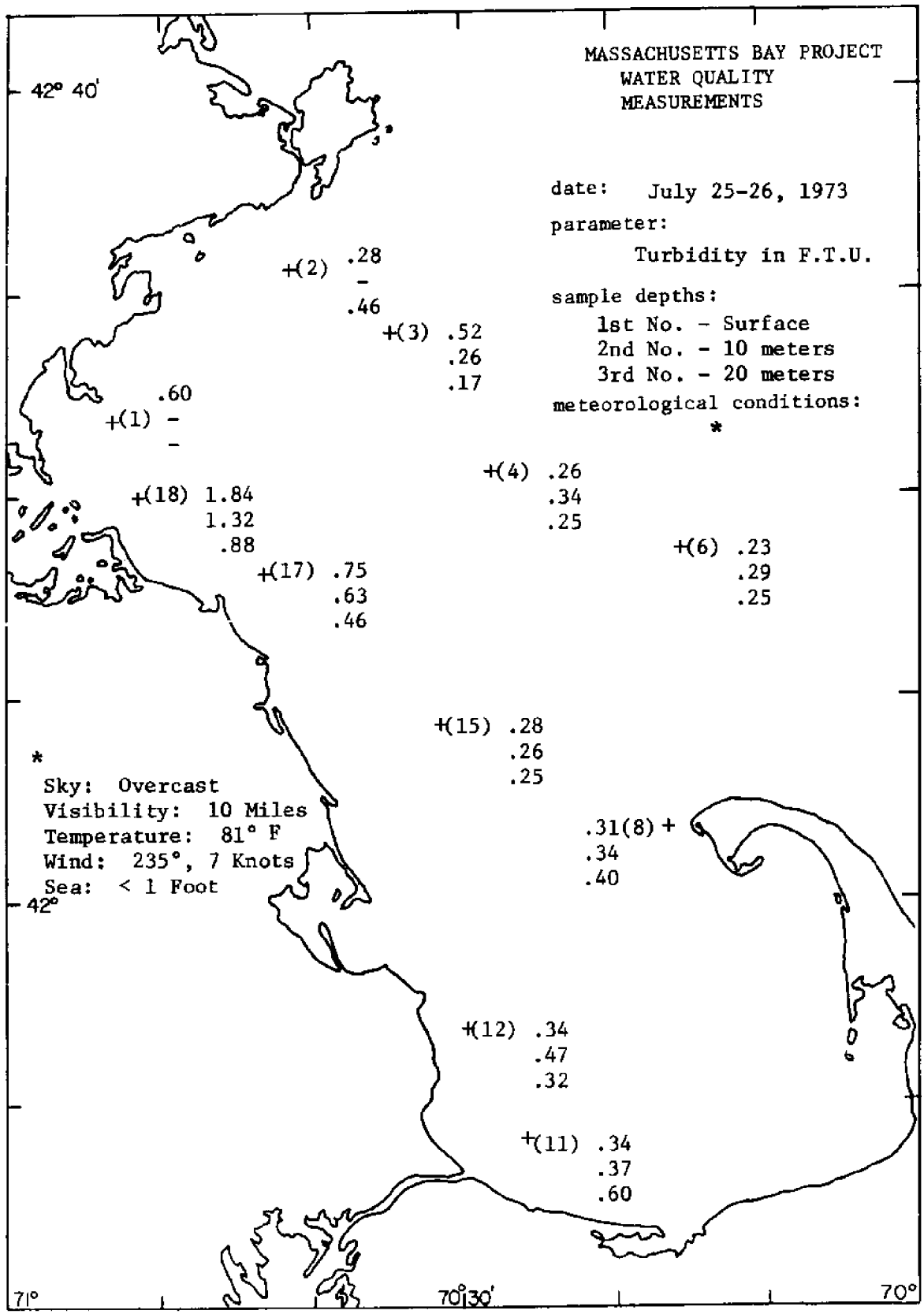

MASSACHUSETTS BAY PROJECT
WATER QUALITY
MEASUREMENTS
date: July 25-26, 1973
parameter: Dissolved Oxygen
mg/liter/temperature
sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters
meteorological conditions:
*
Sky: Overcast
Visibility: 10 Miles
Temperature: 81° F
Wind: 235°, 7 Knots
Sea: < 1 Foot
+(3) 7.9/19.5°C
8.2/18.2°C
8.5/ 8.5°C
7.45/22.5°C
+(4) 9.15/ 9.0°C
9.7 / 5.8°C
8.3/16.9°C
+(18) 8.2/13.8°C
7.7/10.8°C
+(16) 7.8/19.8°C
9.0/15.0°C
8.75/8.5°C
+(17) 9.4/17.0°C
7.9/11.7°C
8.0/ 9.0°C
+(15) 7.65/18.6°C
8.05/16.8°C
8.6 / 9.8°C
7.35/21.0°C(18)+
7.7 /19.0°C
8.4 / 12.0°C
+(12) 7.93/16.9°C
8.43/10.5°C
8.1 / 9.8°C
+(11) 7.51/19.5°C
7.57/18.8°C
7.5 / 8.9°C
42° 40'
42°
71°
70°30'
70°

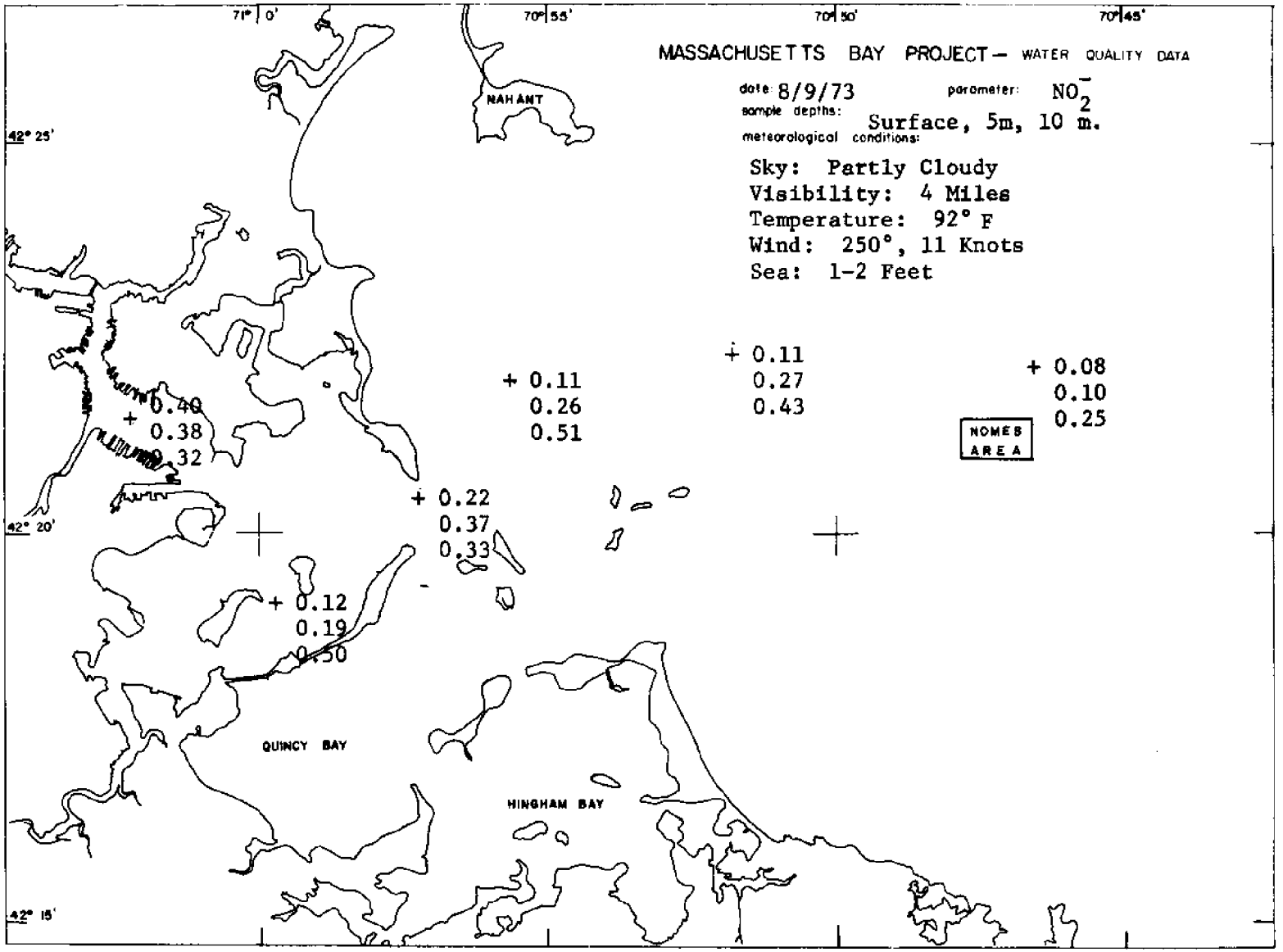

MASSACHUSETTS BAY PROJECT
WATER QUALITY
MEASUREMENTS
date: July 25-26,1973
parameter:
NO_2^-
sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters
meteorological conditions:
*
Sky: Overcast
Visibility: 10 Miles
Temperature: 81°F
Wind: 235°, 7 Knots
Sea: < 1 Foot
42° 40'
42°
71°
70°30'
70°
+(2) F NF
0 0
.20 0
.05 .09
+(3) F NF
.23 .22
.07 0
.31 .41
F NF
.08 .08
+(18) .25 .33
.40 .36
+(4) F NF
.06 .09
.07 .60
.25 .21
+(6) F NF
0 .06
.12 .26
.56 .34
+(17) F NF
.11 .26
.25 .28
.51 .49
+(15) F NF
.13 .09
.08 .19
.32 .42
(8)+ F NF
.10 .11
.34 .12
.34 .25
+(12) F NF
.15 .16
.18 .67
.38 .49
+(11) F NF
.07 .14
.12 .16
.90 .71

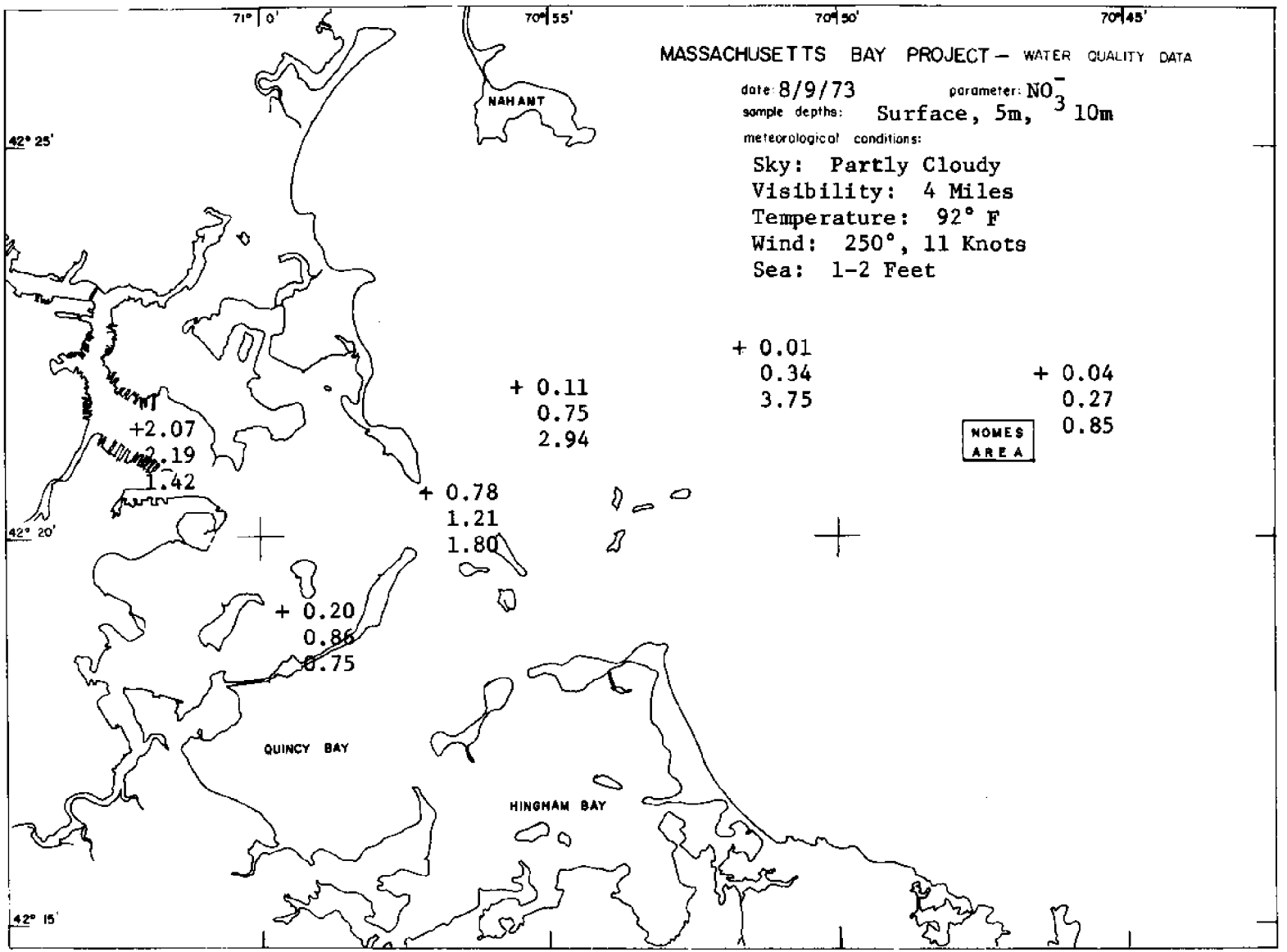

MASSACHUSETTS BAY PROJECT
WATER QUALITY
MEASUREMENTS
date: July 25-26, 1973
parameter:
NO_3^-
sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters
meteorological conditions:
*
+(2)
F NF
1.04 .21
1.24 .21
4.06 2.99
+(3)
F NF
1.40 .03
1.07 .21
6.31 5.28
+(4)
F NF
1.04 .07
1.17 .45
7.91 6.86
+(6)
F NF
1.15 .15
.98 0
7.01 5.86
+(18)
F NF
1.16 .13
2.47 .82
4.40 3.75
+(17)
F NF
1.04 0
2.28 .72
6.56 5.55
+(15)
F NF
.92 .07
.97 .07
3.79 2.65
+(8)
F NF
1.15 .05
1.40 0
1.50 .90
+(12)
F NF
.90 .10
1.95 1.37
4.67 3.72
+(11)
F NF
.74 .02
1.12 0
4.39 3.50
* Sky: Overcast
Visibility: 10 Miles
Temperature: 80° F
Wind: 235°, 7 Knots
Sea: < 1 Foot
42° 40'
42°
71°
70° 30'
70°

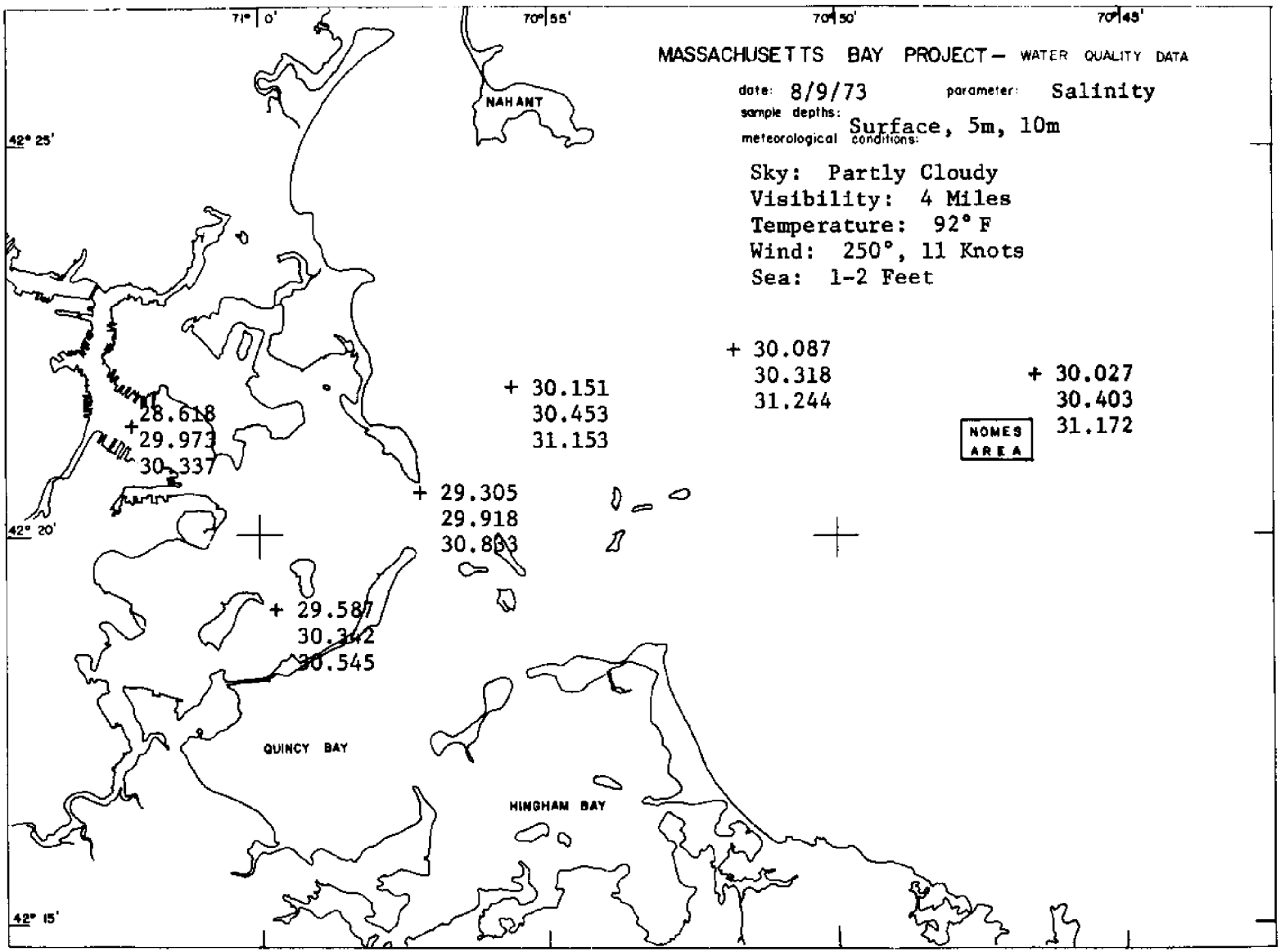

MASSACHUSETTS BAY PROJECT
WATER QUALITY
MEASUREMENTS
date: July 25-26, 1973
parameter: $PO_4^{\equiv}$
sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters
meteorological conditions:
*
42° 40'
42°
71°
70° 30'
70°
+(2)
F NF
1.02 .86
1.00 1.61
1.72 1.31
+(3)
F NF
.53 1.47
.60 .58
1.16 .63
+(4)
F NF
.64 2.07
1.01 1.60
1.83 .47
+(6)
F NF
.48 .44
.55 .76
1.06 1.84
+(11)
F NF
.77 2.04
1.92 1.94
1.37 1.51
+(12)
F NF
.75 1.47
1.16 .66
1.78 .50
+(15)
F NF
.50 2.37
.30 .45
.60 .71
+(17)
F NF
.14 .94
.42 .85
.58 1.9
+(18)
F NF
.14 .77
.02 .60
.19 1.35
F NF
.80 .68(18)+
.96 1.00
.94 1.60
* Sky: Overcast
Visibility: 10 Miles
Temperature: 81° F
Wind: 235°, 7 Knots
Sea: < 1 Foot

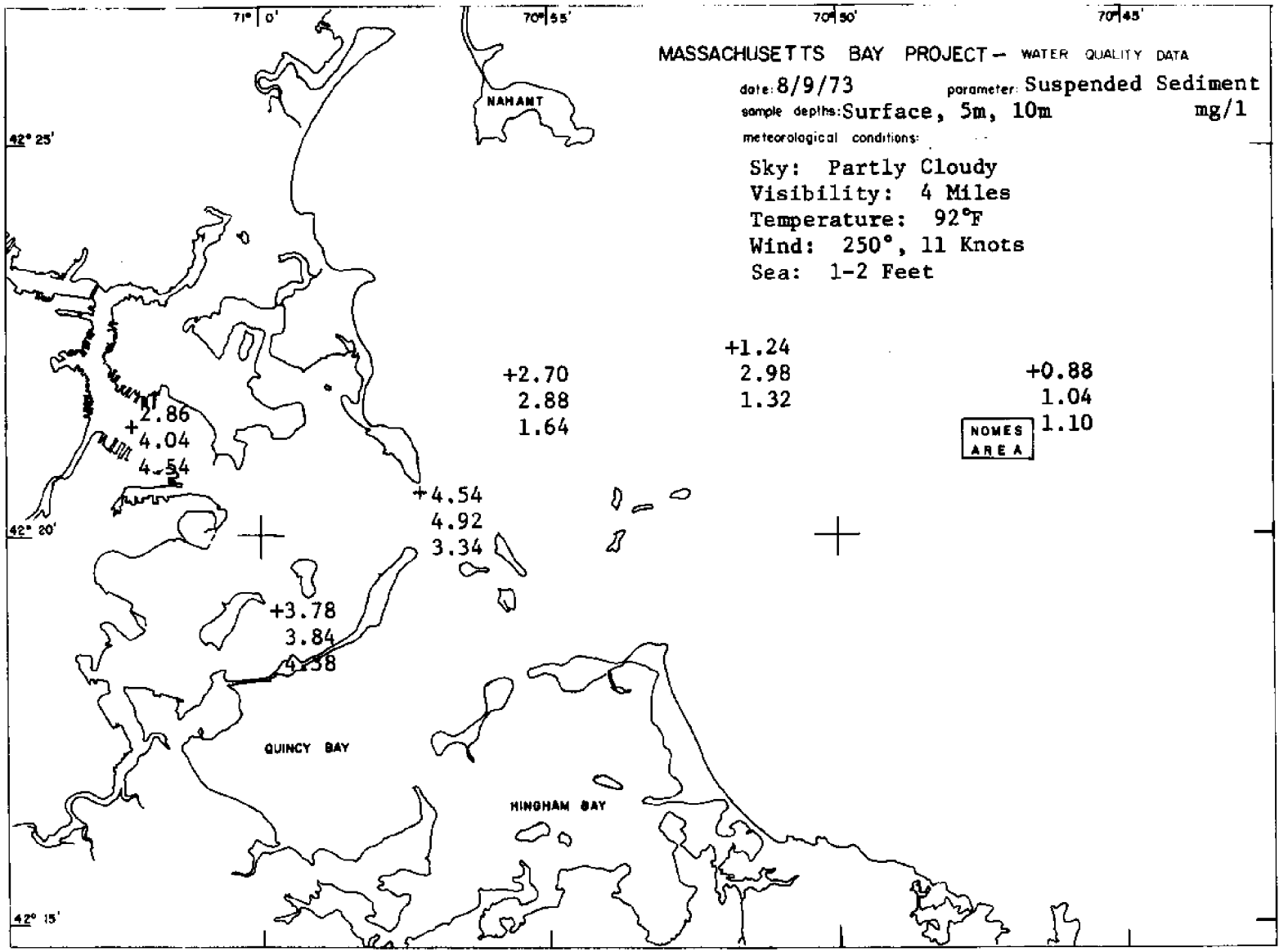

MASSACHUSETTS BAY PROJECT
WATER QUALITY
MEASUREMENTS
date: July 25-26, 1973
parameter:
Suspended Sediment
mg/liter
sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters
meteorological conditions:
Sky: Overcast
Visibility: 10 Miles
Temperature: 81° F
Wind: 235°, 7 Knots
Sea: < 1 Foot
42° 40'
+(2) .50
.69
.58
+(3) 1.54
1.01
.49
+(4) 1.02
.64
.60
+(6) .55
.61
.60
+(8) 3.61
2.41
1.68
+(17) 2.06
2.04
.75
+(15) .98
.91
.57
1.22(8)+
1.13
1.25
42°
+(12) 1.07
1.18
.79
+(11) 1.34
.74
1.23
71°
70°30'
70°

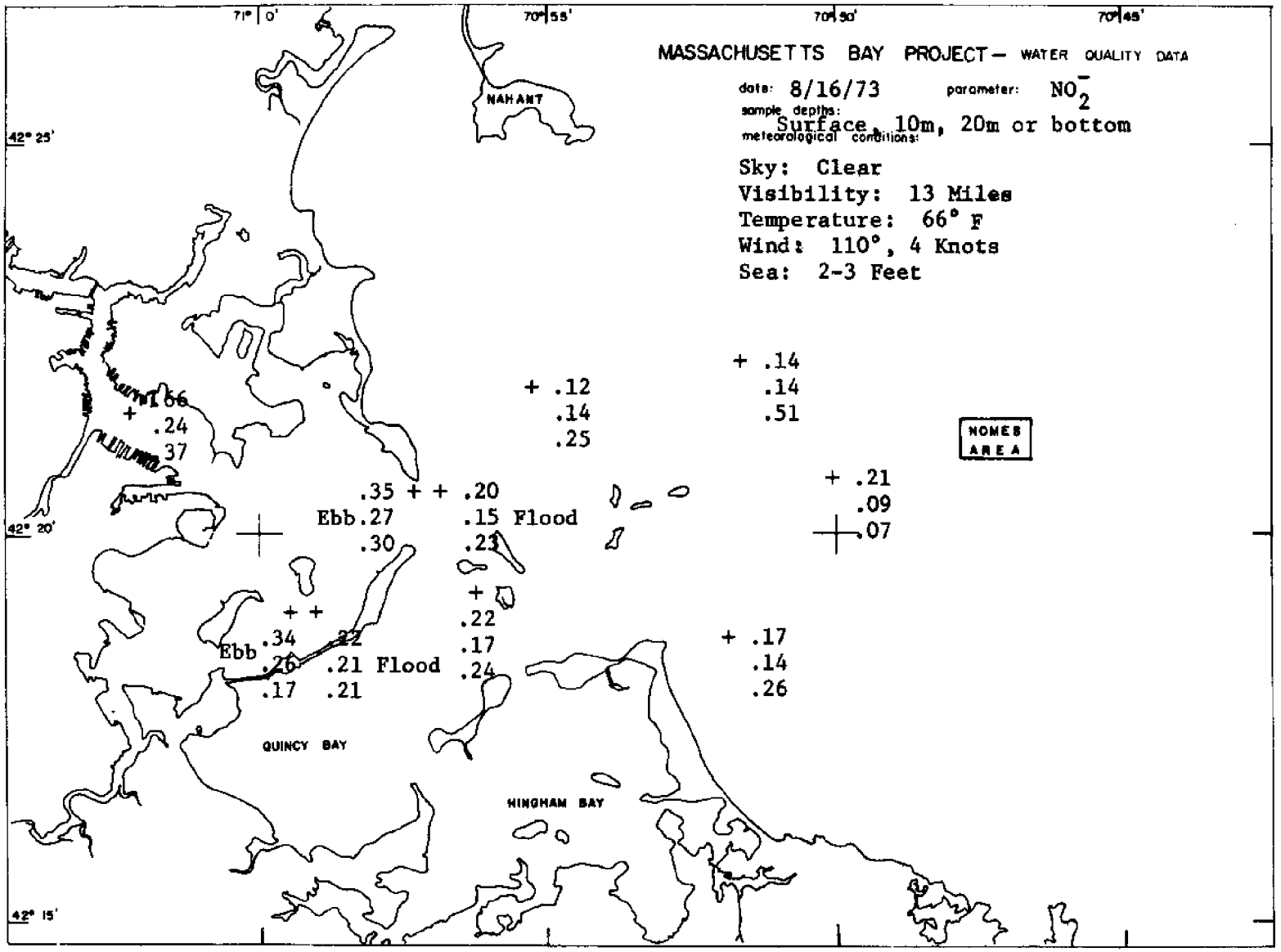

MASSACHUSETTS BAY PROJECT
WATER QUALITY
MEASUREMENTS
date: July 25-26, 1973
parameter:
Turbidity in F.T.U.
sample depths:
1st No. - Surface
2nd No. - 10 meters
3rd No. - 20 meters
meteorological conditions:
*
42° 40'
+(2) .28
-
.46
+(3) .52
.26
.17
.60
+(1) -
-
+(4) .26
.34
.25
+(18) 1.84
1.32
.88
+(6) .23
.29
.25
+(17) .75
.63
.46
+(15) .28
.26
.25
*
Sky: Overcast
Visibility: 10 Miles
Temperature: 81° F
Wind: 235°, 7 Knots
Sea: < 1 Foot
42°
.31(8) +
.34
.40
+(12) .34
.47
.32
+(11) .34
.37
.60
71°
70°30'
70°

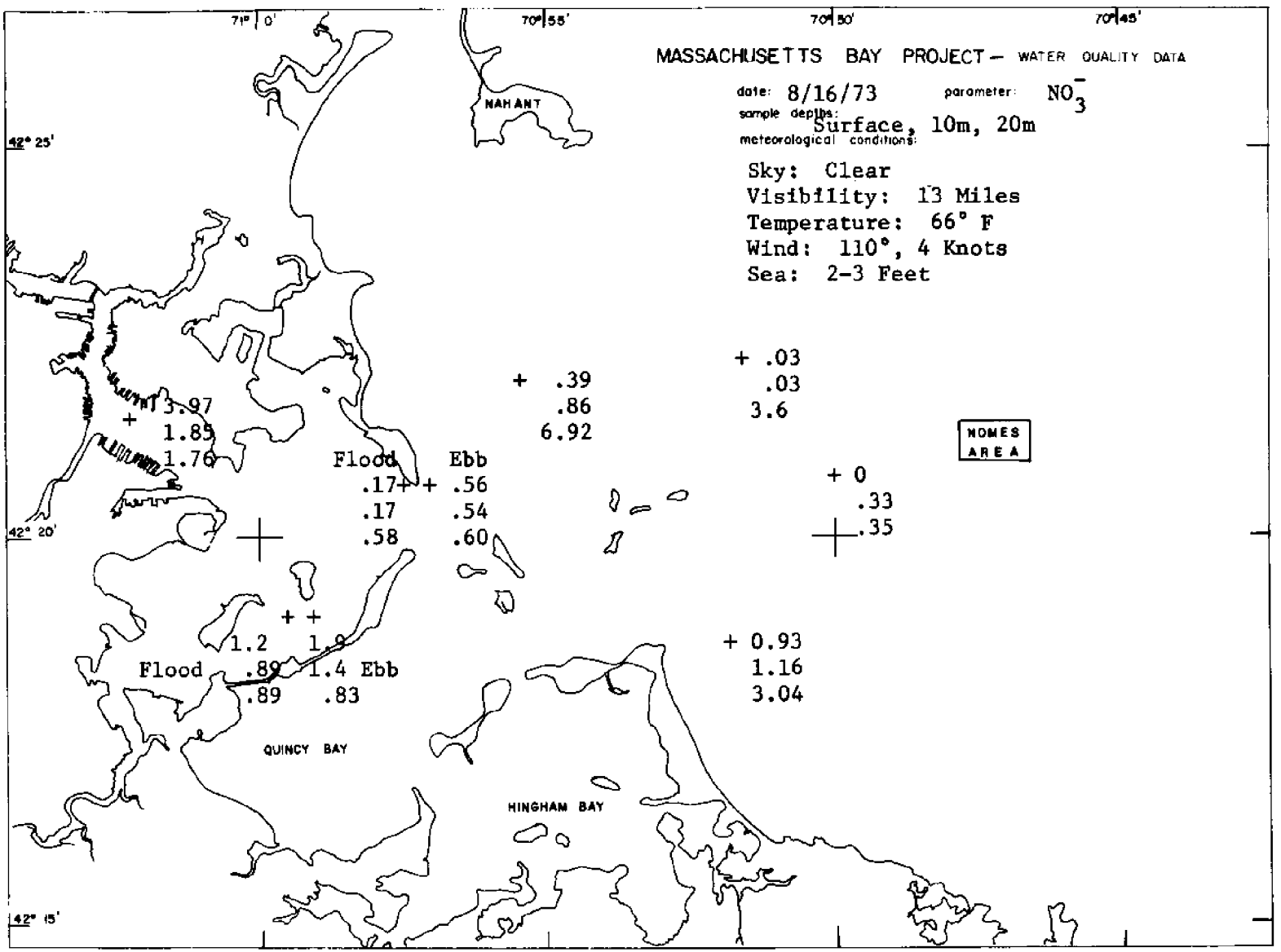

MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: 8/9/73
parameter: NO_2^-
sample depths: Surface, 5m, 10 m.
meteorological conditions:
Sky: Partly Cloudy
Visibility: 4 Miles
Temperature: 92° F
Wind: 250°, 11 Knots
Sea: 1-2 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
QUINCY BAY
HINGHAM BAY
+ 0.40
+ 0.38
0.32
+ 0.11
0.26
0.51
+ 0.22
0.37
0.33
+ 0.12
0.19
0.50
+ 0.11
0.27
0.43
+ 0.08
0.10
0.25
NOMES AREA

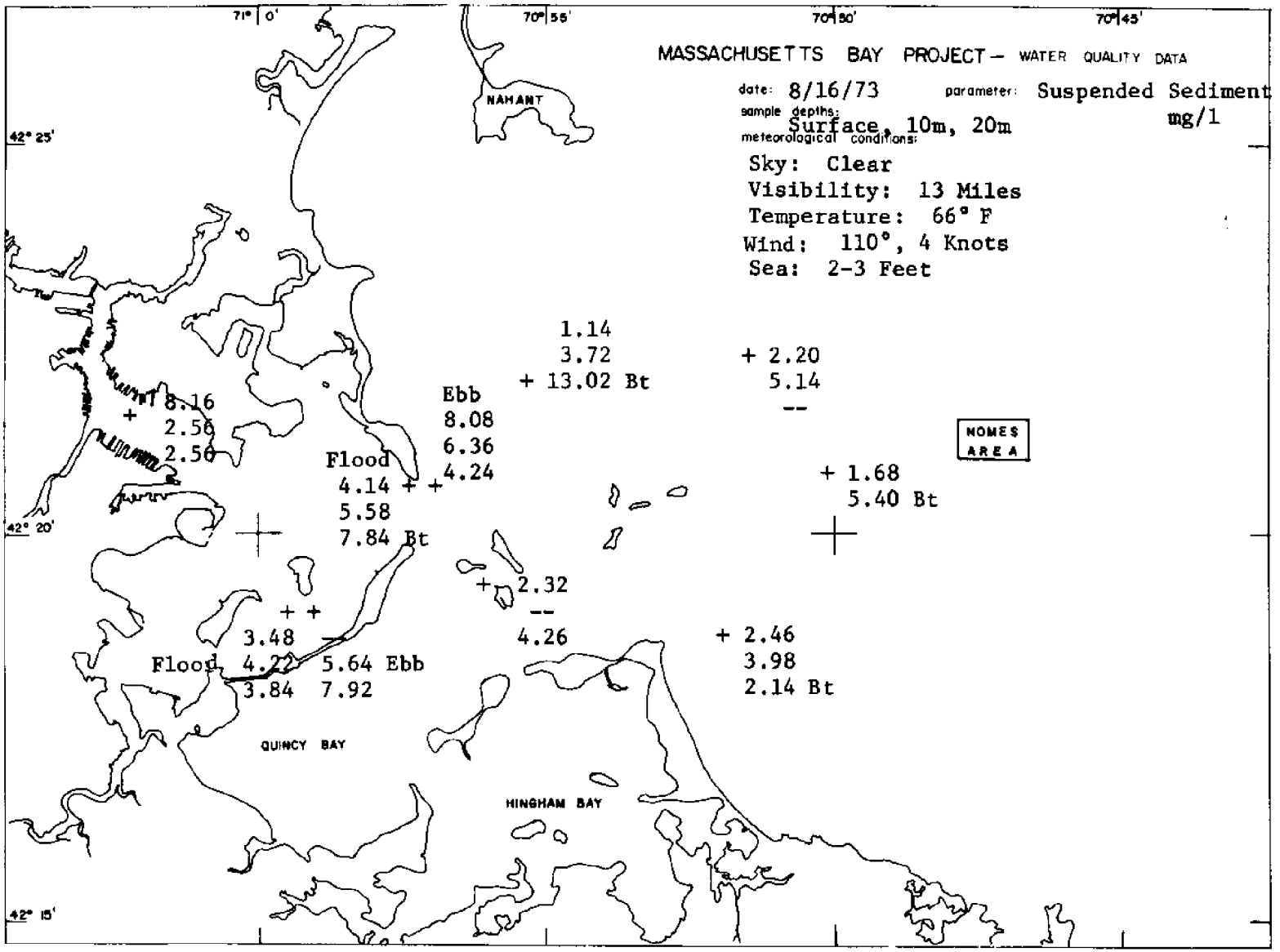

MASSACHUSETTS BAY PROJECT – WATER QUALITY DATA
date: 8/9/73
parameter: NO_3^-
sample depths: Surface, 5m, 10m
meteorological conditions:
Sky: Partly Cloudy
Visibility: 4 Miles
Temperature: 92° F
Wind: 250°, 11 Knots
Sea: 1-2 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
+2.07
2.19
1.42
+ 0.11
0.75
2.94
+ 0.78
1.21
1.80
+ 0.20
0.86
0.75
+ 0.01
0.34
3.75
+ 0.04
0.27
0.85
NOMES AREA
QUINCY BAY
HINGHAM BAY

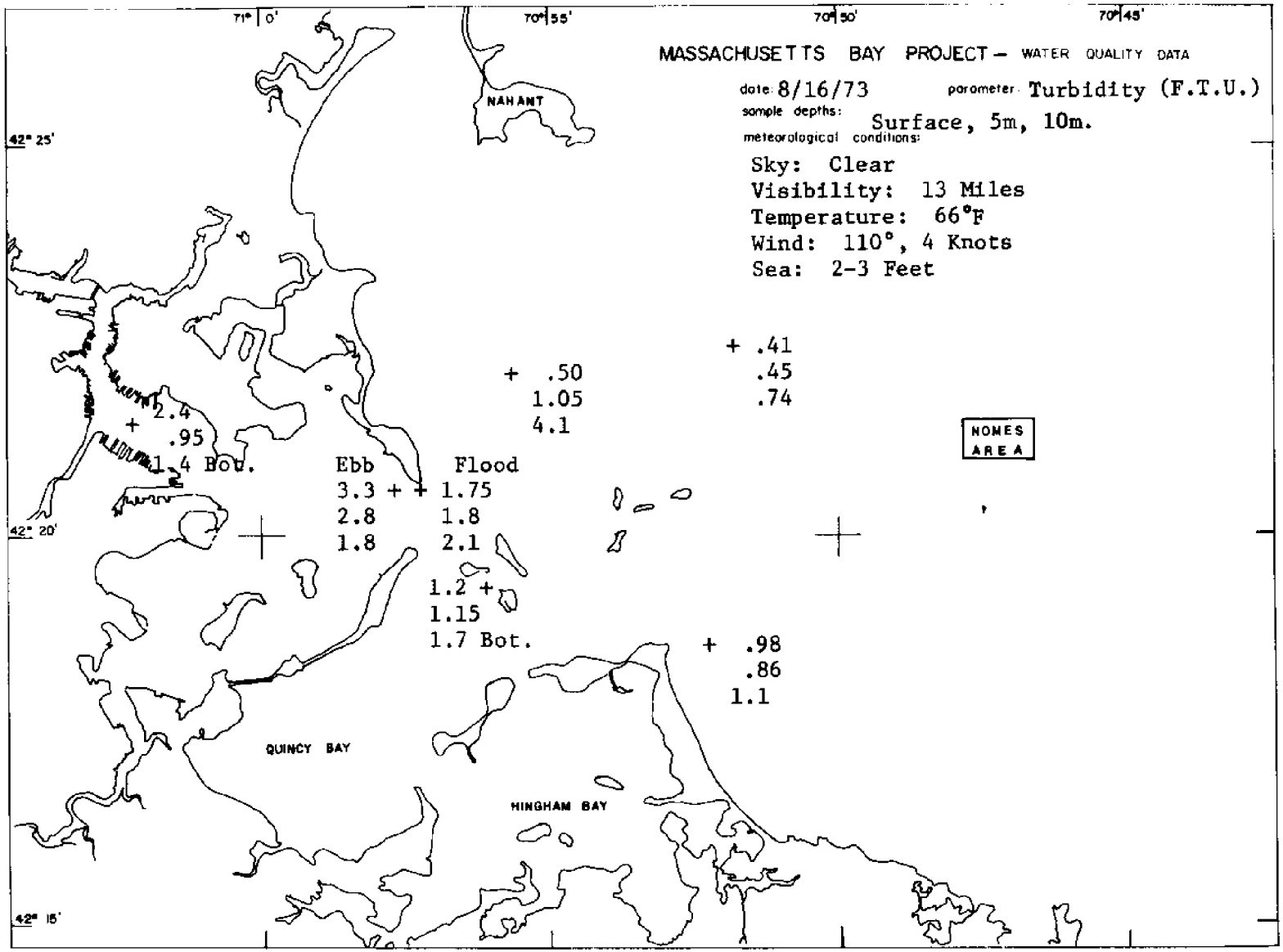

MASSACHUSETTS BAY PROJECT – WATER QUALITY DATA
date: 8/9/73
parameter: Salinity
sample depths: Surface, 5m, 10m
meteorological conditions:
Sky: Partly Cloudy
Visibility: 4 Miles
Temperature: 92° F
Wind: 250°, 11 Knots
Sea: 1-2 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
+ 28.618
+ 29.973
30.337
+ 30.151
30.453
31.153
+ 30.087
30.318
31.244
+ 30.027
30.403
31.172
NOMES AREA
+ 29.305
29.918
30.803
+ 29.587
30.342
30.545
QUINCY BAY
HINGHAM BAY


MASSACHUSETTS BAY PROJECT – WATER QUALITY DATA
date: 8/9/73
parameter: Suspended Sediment
sample depths: Surface, 5m, 10m
mg/1
meteorological conditions:
Sky: Partly Cloudy
Visibility: 4 Miles
Temperature: 92°F
Wind: 250°, 11 Knots
Sea: 1-2 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
+2.70
2.88
1.64
+1.24
2.98
1.32
+0.88
1.04
1.10
NOMES AREA
2.86
+4.04
4.54
+4.54
4.92
3.34
+3.78
3.84
4.38
QUINCY BAY
HINGHAM BAY


MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: 8/16/73
parameter: NO_2^-
sample depths: Surface, 10m, 20m or bottom
meteorological conditions:
Sky: Clear
Visibility: 13 Miles
Temperature: 66° F
Wind: 110°, 4 Knots
Sea: 2-3 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
NOMES AREA
QUINCY BAY
HINGHAM BAY
.14
.14
.51
.12
.14
.25
.24
.37
.35
.20
Ebb .27
.15 Flood
.30
.23
.21
.09
.07
.22
.17
.24
.34
.22
Ebb .26
.21 Flood
.17
.21
.17
.14
.26


MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: 8/16/73
parameter: NO_3^-
sample depths: Surface, 10m, 20m
meteorological conditions:
Sky: Clear
Visibility: 13 Miles
Temperature: 66° F
Wind: 110°, 4 Knots
Sea: 2-3 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
3.97
1.85
1.76
Flood
Ebb
.17
.17
.58
.56
.54
.60
+ .39
.86
6.92
+ .03
.03
3.6
NOMES AREA
+ 0
.33
.35
1.2
1.9
Flood .89 1.4 Ebb
.89 .83
+ 0.93
1.16
3.04
QUINCY BAY
HINGHAM BAY


MASSACHUSETTS BAY PROJECT — WATER QUALITY DATA
date: 8/16/73
parameter: Suspended Sediment
mg/l
sample depths: Surface, 10m, 20m
meteorological conditions:
Sky: Clear
Visibility: 13 Miles
Temperature: 66° F
Wind: 110°, 4 Knots
Sea: 2-3 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
QUINCY BAY
HINGHAM BAY
NOMES AREA
1.14
3.72
+ 13.02 Bt
+ 2.20
5.14
--
Ebb
8.08
6.36
4.24
8.16
2.56
2.56
Flood
4.14
5.58
7.84 Bt
+ 1.68
5.40 Bt
+ 2.32
--
4.26
3.48
Flood 4.22
3.84
5.64 Ebb
7.92
+ 2.46
3.98
2.14 Bt


MASSACHUSETTS BAY PROJECT – WATER QUALITY DATA
date 8/16/73
parameter Turbidity (F.T.U.)
sample depths: Surface, 5m, 10m.
meteorological conditions:
Sky: Clear
Visibility: 13 Miles
Temperature: 66°F
Wind: 110°, 4 Knots
Sea: 2-3 Feet
71° 0'
70° 55'
70° 50'
70° 45'
42° 25'
42° 20'
42° 15'
NAHANT
QUINCY BAY
HINGHAM BAY
NOMES AREA
+ .41
.45
.74
+ .50
1.05
4.1
2.4
+ .95
1.4 Bot.
Ebb
3.3 +
2.8
1.8
Flood
+ 1.75
1.8
2.1
1.2 +
1.15
1.7 Bot.
+ .98
.86
1.1

APPENDIX C

SALINITY, TEMPERATURE, DEPTH DATA

SECTION C.1

TABULATION OF SALINITY, TEMPERATURE, DEPTH AND σ_t FOR ALL DATA

Special thanks to Hugh F. Mulligan Department of Botany University of New Hampshire, for March 21 - May 19, 1973 salinity and temperature data.

CTD STATION 13

GEOGRAPHIC POSITION
42-22-12 NORTH
70-46-00 WEST

DATE-TIME 03 21 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.20	30.70	24.77
1	2.20	30.70	24.77
2	2.20	30.70	24.77
3	2.20	30.70	24.77
4	2.20	30.70	24.77
5	2.20	30.70	24.77
6	2.20	30.70	24.77
7	2.20	30.70	24.77
8	2.20	30.70	24.77
9	2.20	30.70	24.77
10	2.20	30.70	24.77
11	2.20	30.70	24.77
12	2.20	30.70	24.77
13	2.20	30.70	24.77
14	2.20	30.70	24.77
15	2.20	30.70	24.77
16	2.20	30.70	24.77
17	2.20	30.70	24.77
18	2.20	30.70	24.77
19	2.20	30.70	24.77
20	2.20	30.70	24.77

CTD STATION 14

GEOGRAPHIC POSITION
42-22-12 NORTH
70-43-15 WEST

DATE-TIME 03 21 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.20	30.70	24.77
1	2.20	30.70	24.77
2	2.20	30.70	24.77
3	2.20	30.70	24.77
4	2.20	30.70	24.77
5	2.20	30.70	24.77
6	2.20	30.70	24.77
7	2.20	30.70	24.77
8	2.20	30.70	24.77
9	2.20	30.70	24.77
10	2.20	30.70	24.77
11	2.20	30.70	24.77
12	2.20	30.70	24.77
13	2.20	30.70	24.77
14	2.20	30.70	24.77
15	2.20	30.70	24.77
16	2.20	30.70	24.77
17	2.20	30.70	24.77
18	2.20	30.70	24.77
19	2.20	30.70	24.77
20	2.20	30.70	24.77

CTD STATION 22

GEOGRAPHIC POSITION
42-20-42 NORTH
70-49-00 WEST

DATE-TIME 03 21 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.40	30.70	24.78
1	2.40	30.70	24.78
2	2.40	30.70	24.78
3	2.40	30.70	24.78
4	2.40	30.70	24.78
5	2.40	30.70	24.78
6	2.40	30.70	24.78
7	2.40	30.70	24.78
8	2.40	30.70	24.78
9	2.40	30.70	24.78
10	2.40	30.70	24.78
11	2.40	30.70	24.78
12	2.40	30.70	24.78
13	2.40	30.70	24.78
14	2.40	30.70	24.78
15	2.40	30.70	24.78
16	2.40	30.70	24.78
17	2.40	30.70	24.78
18	2.40	30.70	24.78
19	2.40	30.70	24.78
20	2.40	30.70	24.78

CTD STATION 23

GEOGRAPHIC POSITION
42-20-42 NORTH
70-46-00 WEST

DATE-TIME 03 21 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.30	30.70	24.78
1	2.30	30.70	24.78
2	2.30	30.70	24.78
3	2.30	30.70	24.78
4	2.30	30.70	24.78
5	2.30	30.70	24.78
6	2.30	30.70	24.78
7	2.30	30.70	24.78
8	2.30	30.70	24.78
9	2.30	30.70	24.78
10	2.30	30.70	24.78
11	2.30	30.70	24.78
12	2.30	30.70	24.78
13	2.30	30.70	24.78
14	2.30	30.70	24.78
15	2.30	30.70	24.78
16	2.30	30.70	24.78
17	2.30	30.70	24.78
18	2.30	30.70	24.78
19	2.30	30.70	24.78
20	2.30	30.70	24.78

CTD STATION 24

GEOGRAPHIC POSITION
42-20-42 NORTH
70-53-15 WEST

DATE-TIME 03 21 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.40	30.70	24.78
1	2.40	30.70	24.78
2	2.40	30.70	24.78
3	2.40	30.70	24.78
4	2.40	30.70	24.78
5	2.40	30.70	24.78
6	2.40	30.70	24.78
7	2.40	30.70	24.78
8	2.40	30.70	24.78
9	2.40	30.70	24.78
10	2.40	30.70	24.78
11	2.40	30.70	24.78
12	2.40	30.70	24.78
13	2.40	30.70	24.78
14	2.40	30.70	24.78
15	2.40	30.70	24.78
16	2.40	30.70	24.78
17	2.40	30.70	24.78
18	2.40	30.70	24.78
19	2.40	30.70	24.78
20	2.40	30.70	24.78

CTD STATION 32

GEOGRAPHIC POSITION
42-19-12 NORTH
70-49-00 WEST

DATE-TIME 03 21 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.70	30.20	24.38
1	2.70	30.20	24.38
2	2.70	30.20	24.38
3	2.70	30.20	24.38
4	2.60	30.20	24.38
5	2.60	30.20	24.38
6	2.60	30.40	24.54
7	2.40	30.50	24.62
8	2.40	30.60	24.70
9	2.40	30.60	24.70
10	2.40	30.60	24.70
11	2.40	30.60	24.70
12	2.40	30.60	24.70
13	2.40	30.60	24.70
14	2.40	30.60	24.70
15	2.40	30.60	24.70
16	2.40	30.60	24.70
17	2.40	30.60	24.70
18	2.40	30.60	24.70
19	2.40	30.60	24.70
20	2.40	30.60	24.70

CTD STATION 11

GEOGRAPHIC POSITION
42-22-12 NORTH
70-51-50 WEST

DATE-TIME 03 21 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.20	30.70	24.77
1	2.20	30.50	24.61
2	2.20	30.80	24.85
3	2.20	30.80	24.85
4	2.20	30.70	24.77
5	2.20	30.70	24.77
6	2.20	30.70	24.77
7	2.20	30.70	24.77
8	2.20	30.70	24.77
9	2.20	30.70	24.77
10	2.20	30.70	24.77
11	2.20	30.70	24.77
12	2.20	30.70	24.77
13	2.20	30.70	24.77
14	2.20	30.70	24.77
15	2.20	30.70	24.77
16	2.20	30.70	24.77
17	2.20	30.70	24.77
18	2.20	30.70	24.77
19	2.20	30.70	24.77
20	2.20	30.70	24.77

CTD STATION 12

GEOGRAPHIC POSITION
42-22-12 NORTH
70-49 00 WEST

DATE-TIME 03 21 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.20	30.70	24.77
1	2.20	30.70	24.77
2	2.20	30.70	24.77
3	2.20	30.70	24.77
4	2.20	30.70	24.77
5	2.20	30.70	24.77
6	2.20	30.70	24.77
7	2.20	30.70	24.77
8	2.20	30.70	24.77
9	2.20	30.70	24.77
10	2.20	30.70	24.77
11	2.20	30.70	24.77
12	2.20	30.70	24.77
13	2.20	30.70	24.77
14	2.20	30.70	24.77
15	2.20	30.70	24.77
16	2.20	30.70	24.77
17	2.20	30.70	24.77
18	2.20	30.70	24.77
19	2.20	30.70	24.77
20	2.20	30.70	24.77

CTD STATION 12

GEOGRAPHIC POSITICN
42-22-12 NORTH
70-49-00 WEST

DATE-TIME 03 31 73 - CO GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	2.80	29.80	24.06
1	2.50	29.80	24.06
2	2.50	30.10	24.30
3	2.50	30.10	24.30
4	2.50	30.10	24.30
5	2.40	30.10	24.30
6	2.40	30.10	24.30
7	2.40	30.10	24.30
8	2.40	30.10	24.30
9	2.40	30.10	24.30
10	2.20	30.60	24.69
11	2.20	30.60	24.69
12	2.20	30.60	24.69
13	2.20	30.60	24.69
14	2.20	30.60	24.69
15	2.20	30.60	24.69
16	2.20	30.60	24.69
17	2.20	30.60	24.69
18	2.20	30.60	24.69
19	2.20	30.60	24.69
20	2.20	30.60	24.69

CTD STATION 14

GEOGRAPHIC POSITION
42-20-42 NORTH
70-51-50 WEST

DATE-TIME 04 17 73 - CO GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	4.00	29.10	23.52
1	4.00	29.10	23.52
2	4.00	29.10	23.52
3	3.70	29.10	23.51
4	3.50	29.40	23.75
5	3.50	29.40	23.75
6	3.50	29.40	23.75
7	3.50	29.40	23.75
8	3.00	29.40	23.75
9	3.00	29.40	23.75
10	3.00	29.40	23.75
11	3.00	29.40	23.75
12	3.00	29.40	23.75
13	3.10	29.40	23.75
14	3.10	29.40	23.75
15	3.10	29.40	23.75
16	3.00	29.40	23.75
17	3.00	29.40	23.75
18	3.00	29.40	23.75
19	3.00	29.40	23.75
20	3.00	29.40	23.75

CTD STATION 11

GEOGRAPHIC POSITION
42-22-12 NORTH
70-51-50 WEST

DATE-TIME 04 23 73 --00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	5.50	29.20	23.58
2	5.50	29.20	23.58
4	5.30	29.20	23.58
6	5.20	29.20	23.58
8	5.10	29.30	23.67
10	4.20	29.80	24.08
12	3.60	30.00	24.24
14	3.10	30.20	24.39
16	2.60	30.20	24.38
18	2.40	30.60	24.70
20	2.40	30.40	24.54
22	2.40	30.60	24.70
24	2.40	30.60	24.70
26	2.40	30.60	24.70

CTD STATION 12

GEOGRAPHIC POSITION
42-22-12 NORTH
70-49-00 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.00	29.10	23.48
2	6.00	29.10	23.48
4	5.80	29.20	23.57
6	5.50	29.20	23.58
8	5.00	29.20	23.59
10	3.30	29.30	23.67
12	2.80	30.10	24.31
14	2.80	30.10	24.31
16	2.70	30.40	24.55
18	2.60	30.40	24.54
20	2.40	30.50	24.62
22	2.40	30.50	24.62
24	2.40	30.50	24.62

CTD STATION 13

GEOGRAPHIC POSITION
42-22-12 NORTH
70-46-00 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.00	29.30	23.64
2	5.80	29.30	23.65
4	5.70	29.30	23.65
6	5.50	29.30	23.66
8	5.30	29.30	23.66
10	5.00	29.40	23.75
12	4.70	29.40	23.75
14	4.20	29.50	23.84
16	2.70	30.10	24.30
18	2.50	30.10	24.30
20	2.50	30.30	24.46
22	2.50	30.40	24.54
24	2.50	30.40	24.54
26	2.50	30.50	24.62

CTD STATION 14

GEOGRAPHIC POSITION
42-22-12 NORTH
70-43-15 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.10	29.10	23.48
2	6.00	29.10	23.48
4	5.90	29.10	23.49
6	5.10	29.10	23.51
8	4.80	29.40	23.75
10	4.40	29.40	23.76
12	3.70	29.50	23.84
14	3.10	29.80	24.07
16	3.10	29.80	24.07
18	3.00	30.00	24.23
20	2.80	30.10	24.31
22	2.70	30.20	24.38
24	2.70	30.40	24.55
26	2.60	30.40	24.54

CTD STATION 21

GEOGRAPHIC POSITION
42-20-42 NORTH
70-51-50 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.40	29.00	23.39
2	6.40	29.00	23.39
4	6.30	29.00	23.39
6	5.00	29.20	23.59
8	4.30	29.20	23.60
10	3.80	29.70	24.00
12	2.60	30.00	24.22
14	2.60	30.20	24.38
16	2.60	30.30	24.46
18	2.60	30.30	24.46
20	2.50	30.30	24.46
22	2.50	30.30	24.46
24	2.50	30.30	24.46
26	2.50	30.40	24.54

CTD STATION 22

GEOGRAPHIC POSITION
42-20-42 NORTH
70-49-00 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.50	29.10	23.46
2	6.50	29.10	23.46
4	6.20	29.30	23.64
6	5.40	29.30	23.66
8	5.20	29.40	23.75
10	4.90	29.60	23.91
12	3.90	30.10	24.32
14	2.90	30.20	24.39
16	2.90	30.30	24.47
18	2.60	30.40	24.54
20	2.60	30.40	24.54
22	2.60	30.40	24.54
24	2.50	30.40	24.54
26	2.50	30.40	24.54

CTD STATION 23

GEOGRAPHIC POSITION
42-20-42 NORTH
70-46-00 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	5.60	29.30	23.66
2	5.50	29.40	23.74
4	5.40	29.40	23.74
6	5.20	29.40	23.75
8	5.10	29.40	23.75
10	5.10	29.40	23.75
12	4.60	29.40	23.75
14	3.60	29.40	23.75
16	2.80	29.70	23.98
18	2.60	30.00	24.22
20	2.50	30.30	24.46
22	2.40	30.30	24.46
24	2.40	30.50	24.62
26	2.40	30.60	24.70

CTD STATION 24

GEOGRAPHIC POSITION
42-20-42 NORTH
70-53-15 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	5.80	29.40	23.73
2	5.80	29.40	23.73
4	5.40	29.40	23.74
6	5.10	29.40	23.75
8	5.00	29.40	23.75
10	4.80	29.40	23.75
12	3.60	29.60	23.92
14	3.10	29.90	24.15
16	2.80	30.00	24.23
18	2.70	30.10	24.30
20	2.60	30.10	24.30
22	2.50	30.20	24.38
24	2.40	30.30	24.46
26	2.40	30.60	24.70

CTD STATION 31

GEOGRAPHIC POSITION
42-19-12 NORTH
70-51-50 WEST

DATE-TIME 04 23 73 - CO GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.00	28.90	23.32
2	5.90	29.10	23.49
4	5.70	29.40	23.73
6	5.50	29.40	23.74
8	4.90	29.40	23.75
10	4.70	29.50	23.83
12	4.50	29.50	23.84
14	4.40	29.50	23.84
16	4.30	29.50	23.84

CTD STATION 32

GEOGRAPHIC POSITION
42-19-12 NORTH
70-49-00 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.20	29.10	23.48
2	6.10	29.10	23.48
4	5.50	29.20	23.58
6	5.40	29.20	23.58
8	5.20	29.20	23.58
10	5.20	29.40	23.75
12	4.80	29.50	23.83
14	4.00	29.90	24.16
16	3.30	30.10	24.31
18	2.80	30.10	24.31
20	2.80	30.10	24.31
22	2.70	30.10	24.30
24	2.50	30.10	24.30
26	2.50	30.10	24.30

CTD STATION 33

GEOGRAPHIC POSITION
42-19-12 NORTH
7C-46-00 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.30	29.30	23.63
2	6.10	29.30	23.64
4	5.40	29.30	23.66
6	4.80	29.30	23.67
8	3.90	29.40	23.76
10	3.30	29.40	23.75
12	2.90	29.70	23.99
14	2.80	30.00	24.23
16	2.80	30.00	24.23
18	2.80	30.00	24.23
20	2.60	30.00	24.22
22	2.60	30.20	24.38
24	2.60	30.30	24.46
26	2.60	30.40	24.54

CTD STATION 34

GEOGRAPHIC POSITION
42-19-12 NORTH
70-43-15 WEST

DATE-TIME 04 23 73 - 00 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	6.10	29.40	23.72
2	5.70	29.50	23.81
4	5.50	29.50	23.82
6	5.40	29.50	23.82
8	5.30	29.50	23.82
10	5.20	29.50	23.83
12	4.90	29.50	23.83
14	4.50	29.50	23.84
16	3.80	29.70	24.00
18	3.50	30.10	24.32
20	2.80	30.10	24.31
22	2.70	30.20	24.38
24	2.70	30.20	24.38
26	2.60	30.30	24.46

CTD STATION 23

GEOGRAPHIC POSITION
42-20-42 NORTH
70-49-00 WEST

DATE-TIME 04 25 73 1600 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.35	31.50	25.35
1	7.35	31.50	25.35
2	7.35	31.50	25.35
3	7.32	31.50	25.35
4	7.30	31.50	25.36
5	7.30	31.40	25.28
6	7.05	31.20	25.13
7	6.85	31.10	25.06
8	6.10	30.60	24.69
9	5.45	30.10	24.30
10	5.00	29.80	24.07
11	4.62	29.60	23.91
12	4.50	29.50	23.84
13	4.05	29.30	23.68
14	3.72	29.20	23.59
15	3.50	29.00	23.43
16	3.50	28.90	23.35
17	3.42	28.90	23.35
18	3.35	28.90	23.35
19	3.20	28.90	23.35
20	3.10	28.90	23.35
21	3.10	28.90	23.35
22	3.10	28.90	23.35
23	3.10	28.90	23.35
24	3.10	28.90	23.35
25	3.10	28.90	23.35
26	3.10	28.90	23.35

CTD STATION 11

GEOGRAPHIC POSITION
42-22-12 NORTH
70-51-50 WEST

DATE-TIME 05 05 73 1400 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.80	28.90	23.23
1	7.60	28.90	23.25
2	7.60	28.90	23.25
3	7.60	28.90	23.25
4	7.60	28.90	23.25
5	7.60	28.90	23.25
6	7.60	28.90	23.25
7	7.60	28.90	23.25
8	7.60	28.90	23.25
9	7.60	28.90	23.25
10	7.60	28.90	23.25
11	7.10	29.20	23.52
12	6.30	29.10	23.47
13	6.20	29.30	23.64
14	5.10	29.60	23.91
15	5.00	29.90	24.15
16	5.00	29.90	24.15
17	4.90	29.90	24.15
18	4.90	29.90	24.15
19	4.70	29.90	24.16
20	4.70	29.90	24.16
21	4.70	30.00	24.24
22	4.40	30.00	24.24
23	4.40	30.00	24.24
24	4.40	30.00	24.24
25	4.40	30.00	24.24

CTD STATION 12

GEOGRAPHIC POSITION
42-22-12 NORTH
70-49-00 WEST

DATE-TIME 05 05 73 1500 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.90	29.30	23.55
1	7.60	28.90	23.25
1	7.90	29.30	23.55
2	7.90	29.30	23.55
3	7.90	29.30	23.55
4	7.90	29.30	23.55
5	7.90	29.00	23.31
6	7.60	29.00	23.33
7	7.20	29.00	23.35
8	7.20	29.10	23.43
9	6.80	29.10	23.45
10	6.80	29.10	23.45
11	6.80	29.10	23.45
12	6.30	29.10	23.47
13	6.20	29.10	23.48
14	5.90	29.50	23.81
15	5.90	29.50	23.81
16	5.50	29.50	23.82
17	5.00	29.50	23.83
18	5.00	29.50	23.83
19	5.00	29.50	23.83
20	4.10	29.60	23.92
21	4.10	29.60	23.92
22	4.10	29.80	24.08
23	4.10	29.80	24.08
24	4.10	29.80	24.08
25	4.10	29.80	24.08

CTD STATION 13

GEOGRAPHIC POSITION
42-22-12 NORTH
70-46-00 WEST

DATE-TIME 05 05 73 1600 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.20	29.00	23.35
1	7.20	29.00	23.35
2	7.20	29.00	23.35
3	7.20	29.00	23.35
4	7.20	29.00	23.35
5	7.20	29.00	23.35
6	7.20	29.00	23.35
7	7.20	29.00	23.35
8	7.10	29.00	23.36
9	5.80	29.40	23.73
10	5.80	29.40	23.73
11	5.50	29.40	23.74
12	5.50	29.40	23.74
13	5.50	29.40	23.74
14	5.00	29.40	23.75
14	5.00	29.40	23.75
15	5.00	29.80	24.07
16	4.60	29.80	24.08
17	4.60	29.80	24.08
18	4.60	29.80	24.08
19	4.50	29.80	24.08
20	4.50	29.80	24.08
21	4.50	29.80	24.08
22	4.20	29.80	24.08
23	4.20	29.80	24.08
25	4.20	29.80	24.08

CTD STATION 14

GEOGRAPHIC POSITION
42-22-12 NORTH
70-43-15 WEST

DATE-TIME 05 05 73 1700 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.20	29.00	23.35
1	7.20	29.00	23.35
2	7.20	29.00	23.35
3	7.20	29.00	23.35
4	7.20	29.00	23.35
5	7.20	29.00	23.35
6	7.20	29.00	23.35
7	7.20	29.00	23.35
8	6.90	29.00	23.37
9	6.90	29.00	23.37
10	6.50	29.20	23.54
11	6.50	29.20	23.54
12	6.20	29.20	23.56
13	6.20	29.20	23.56
14	5.60	29.20	23.58
15	5.00	29.40	23.75
16	5.00	29.40	23.75
17	5.00	29.40	23.75
18	4.40	29.90	24.16
19	4.40	29.90	24.16
20	4.40	29.90	24.16
21	4.40	29.90	24.16
22	4.40	29.90	24.16
23	3.90	29.90	24.16
24	3.90	30.20	24.40
25	3.90	30.20	24.40

CTD STATION 21

GEOGRAPHIC POSITION
42-20-42 NORTH
70-51-50 WEST

DATE-TIME 05 05 73 2000 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.90	28.80	23.15
1	7.90	28.80	23.15
2	7.90	28.80	23.15
3	7.90	28.80	23.15
4	7.90	28.80	23.15
5	7.90	28.80	23.15
6	7.90	28.80	23.15
7	7.90	28.80	23.15
8	7.60	28.80	23.17
9	7.40	29.10	23.42
10	7.40	29.10	23.42
11	7.40	29.10	23.42
12	7.40	29.10	23.42
13	7.40	29.10	23.42
14	7.40	28.90	23.26
15	7.40	29.00	23.34
16	7.20	29.00	23.35
17	6.60	29.00	23.38
18	5.80	29.30	23.65
19	5.40	29.30	23.66
20	4.90	29.60	23.91
21	4.90	29.80	24.07
22	4.90	29.80	24.07
23	4.90	29.80	24.07
24	4.90	29.80	24.07
25	4.90	29.80	24.07

CTD STATION 22

GEOGRAPHIC POSITION
42-20-42 NORTH
70-49-00 WEST

CATE-TIME 05 05 73 1900 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.10	29.20	23.46
1	8.10	29.20	23.46
2	7.60	29.20	23.49
3	7.60	29.20	23.49
4	7.60	29.20	23.49
5	7.60	29.20	23.49
6	7.60	29.20	23.49
7	7.40	29.20	23.50
8	7.00	29.20	23.52
9	7.00	29.20	23.52
10	6.20	29.20	23.56
11	6.20	29.50	23.80
12	5.50	29.50	23.82
13	5.50	29.50	23.82
14	5.50	29.50	23.82
15	5.10	29.50	23.83
16	4.70	29.50	23.83
17	4.70	29.90	24.16
18	4.30	29.90	24.16
19	4.30	29.90	24.16
20	4.30	29.90	24.16
21	4.30	29.90	24.16
22	4.30	29.90	24.16
23	4.00	29.90	24.16
24	4.00	29.90	24.16
25	4.00	29.90	24.16

CTD STATION 23

GEOGRAPHIC POSITION
42-20-42 NORTH
70-46-00 WEST

DATE-TIME 05 05 73 1500 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.90	29.20	23.47
1	7.90	29.20	23.47
2	7.90	29.20	23.47
3	7.90	29.20	23.47
4	7.90	29.20	23.47
5	7.90	29.20	23.47
6	7.90	29.20	23.47
7	7.90	29.20	23.47
8	7.60	29.20	23.49
9	7.60	29.20	23.49
10	7.60	29.20	23.49
11	7.20	29.20	23.51
12	7.20	29.20	23.51
13	6.90	29.20	23.53
14	6.60	29.20	23.54
15	5.90	29.20	23.57
16	5.50	29.60	23.90
17	5.30	29.60	23.90
18	5.30	29.60	23.90
19	5.00	29.60	23.91
20	4.70	29.90	24.16
21	4.10	30.00	24.24
22	3.70	30.00	24.24
23	3.70	30.20	24.40
24	3.70	30.20	24.40
25	3.70	30.20	24.40

CTD STATION 24

GEOGRAPHIC POSITION
42-20-42 NORTH
70-53-15 WEST

DATE-TIME 05 05 73 1700 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.30	29.00	23.35
1	7.30	29.00	23.35
2	7.30	29.00	23.35
3	7.30	29.00	23.35
4	7.30	29.00	23.35
5	7.30	29.00	23.35
6	7.30	29.00	23.35
7	7.30	29.00	23.35
8	7.10	29.00	23.36
9	6.90	29.00	23.37
10	6.60	29.00	23.38
11	6.40	29.40	23.71
12	6.40	29.40	23.71
13	6.20	29.40	23.72
14	6.20	29.40	23.72
15	6.20	29.40	23.72
16	6.20	29.40	23.72
17	5.40	29.40	23.74
18	5.10	29.40	23.75
19	5.10	29.40	23.75
20	4.40	29.80	24.08
21	4.40	29.80	24.08
22	4.40	29.80	24.08
23	4.40	29.80	24.08
24	4.40	29.80	24.08
25	4.40	29.80	24.08

CTD STATION 32

GEOGRAPHIC POSITION
42-19-12 NORTH
70-49-00 WEST

DATE-TIME 05 05 73 2100 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.30	29.20	23.44
1	8.30	29.20	23.44
2	8.00	29.20	23.46
3	8.00	29.20	23.46
4	8.00	29.20	23.46
5	7.60	29.20	23.49
6	7.40	29.20	23.50
7	7.40	29.20	23.50
8	7.40	29.20	23.50
9	7.40	29.20	23.50
10	7.40	29.20	23.50
11	7.40	29.20	23.50
12	7.40	29.20	23.50
13	7.40	29.20	23.50
14	7.40	29.20	23.50
15	7.40	29.20	23.50
16	6.80	29.20	23.53
17	6.40	29.20	23.55
18	6.10	29.20	23.56
19	6.10	29.20	23.56
20	6.10	29.20	23.56
21	4.90	29.50	23.83

CTD STATION 33

GEOGRAPHIC POSITION
42-19-12 NORTH
70-46-00 WEST

DATE-TIME 05 05 73 1800 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.30	28.60	22.96
1	7.90	29.10	23.39
2	7.90	29.10	23.39
3	7.90	29.10	23.39
4	7.50	29.10	23.41
5	7.50	29.10	23.41
6	7.50	29.10	23.41
7	7.50	29.10	23.41
8	7.20	29.10	23.43
9	7.20	29.10	23.43
10	7.00	29.10	23.44
11	7.00	29.10	23.44
12	6.20	29.10	23.48
13	6.20	29.40	23.72
14	6.20	29.40	23.72
15	6.20	29.40	23.72
16	5.70	29.40	23.73
17	5.70	29.40	23.73
18	5.00	29.40	23.75
19	5.00	29.40	23.75
20	5.00	29.40	23.75
21	5.00	29.40	23.75
22	4.60	29.60	23.91
23	4.10	29.60	23.92
24	4.10	29.80	24.08
25	3.70	29.80	24.08

CTD STATION 34

GEOGRAPHIC POSITION
42-19-12 NORTH
70-43-15 WEST

DATE-TIME 05 05 73 1800 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.80	29.00	23.31
1	7.50	29.00	23.33
2	7.20	29.00	23.35
3	7.00	29.00	23.36
4	7.00	29.00	23.36
5	7.00	29.00	23.36
6	7.00	29.00	23.36
7	7.00	29.00	23.36
8	7.00	29.00	23.36
9	7.00	29.20	23.52
10	6.60	29.20	23.54
11	6.60	29.20	23.54
12	6.50	29.30	23.63
13	6.10	29.40	23.72
14	5.80	29.40	23.73
15	5.80	29.40	23.73
16	5.80	29.40	23.73
17	5.80	29.40	23.73
18	5.40	29.40	23.74
19	5.40	29.40	23.74
20	5.10	29.40	23.75
21	5.10	29.60	23.91
22	5.10	29.60	23.91
23	4.70	29.60	23.91
24	4.70	29.60	23.91
25	4.70	29.70	23.99

CTD STATION 42

GEOGRAPHIC POSITION
42-17-42 NORTH
70-49-00 WEST

DATE-TIME 05 05 73 1900 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.30	29.00	23.28
1	8.30	29.00	23.28
2	8.30	29.00	23.28
3	7.90	29.00	23.31
4	7.90	29.00	23.31
5	7.90	29.00	23.31
6	7.90	29.00	23.31
7	7.90	29.00	23.31
8	7.90	29.00	23.31
9	7.90	29.00	23.31
10	7.90	29.00	23.31
11	7.90	29.00	23.31
12	7.50	29.00	23.33
13	7.50	29.00	23.33
14	7.10	29.30	23.60
15	6.40	29.30	23.63
16	6.40	29.30	23.63
17	6.40	29.30	23.63
18	6.40	29.30	23.63

CTD STATION 11

GEOGRAPHIC POSITION
42-22-12 NORTH
70-51-50 WEST

DATE-TIME 05 19 73 1300 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.40	29.00	23.27
2	8.40	29.00	23.27
3	8.40	29.00	23.27
4	8.40	29.00	23.27
5	8.40	29.00	23.27
6	8.40	29.00	23.27
7	8.40	29.00	23.27
8	8.40	29.00	23.27
9	8.40	29.00	23.27
10	8.20	29.00	23.29
11	8.20	29.00	23.29
12	6.30	29.00	23.39
13	5.50	29.00	23.42
14	5.30	29.00	23.42
15	5.30	29.70	23.98
16	5.30	29.70	23.98
17	4.80	29.70	23.99
18	4.00	29.70	24.00
19	3.80	29.70	24.00
20	3.80	30.20	24.40
21	3.80	30.20	24.40

CTD STATION 12

GEOGRAPHIC POSITION
42-22-12 NORTH
70-49 00 WEST

DATE-TIME 05 19 73 1400 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.50	29.30	23.51
1	8.50	29.30	23.51
2	8.50	29.30	23.51
3	8.50	29.30	23.51
4	8.50	29.30	23.51
5	8.50	29.30	23.51
6	8.50	29.30	23.51
7	8.50	29.30	23.51
8	8.50	29.30	23.51
9	8.50	29.30	23.51
10	8.50	29.30	23.51
11	8.50	29.30	23.51
12	8.50	29.30	23.51
13	8.40	29.30	23.51
14	8.40	29.30	23.51
15	8.40	29.70	23.84
16	8.40	29.70	23.84
17	8.40	29.70	23.84
18	8.40	29.70	23.84
19	8.40	29.70	23.84
20	8.40	29.70	23.84
21	8.10	29.70	23.86
22	7.70	29.70	23.88
23	7.30	30.00	24.15
24	6.00	29.70	23.97
25	5.00	29.80	24.07

CTD STATION 13

GEOGRAPHIC POSITION
42-22-12 NORTH
70-46-00 WEST

DATE-TIME 05 19 73 1600 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.50	29.10	23.35
1	8.50	29.10	23.35
2	8.50	29.10	23.35
3	8.50	29.10	23.35
4	8.50	29.10	23.35
5	8.50	29.10	23.35
6	8.00	29.10	23.38
7	8.00	29.10	23.38
8	8.00	29.10	23.38
9	8.00	29.10	23.38
10	8.00	29.10	23.38
11	8.00	29.10	23.38
12	7.70	29.10	23.40
13	7.70	29.10	23.40
14	7.70	29.10	23.40
15	7.70	29.10	23.40
16	7.50	29.10	23.41
17	7.50	29.10	23.41
18	7.50	29.10	23.41
19	7.50	29.80	23.98
20	7.50	29.80	23.98
21	5.30	29.80	24.07
22	5.30	29.80	24.07
23	4.90	29.80	24.07
24	3.50	30.00	24.24
25	3.50	30.00	24.24
26	3.50	30.00	24.24

CTD STATION 14

GEOGRAPHIC POSITION
42-22-12 NORTH
70-43-15 WEST

DATE-TIME 05 19 73 1600 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.90	29.30	23.55
1	7.90	29.30	23.55
2	7.90	29.30	23.55
3	7.90	29.30	23.55
4	7.90	29.30	23.55
5	7.60	29.30	23.57
6	7.60	29.30	23.57
7	7.60	29.30	23.57
8	7.60	29.30	23.57
9	7.60	29.30	23.57
10	7.60	29.30	23.57
11	7.30	29.30	23.59
12	7.30	29.30	23.59
13	7.30	29.30	23.59
14	7.30	29.30	23.59
15	7.30	29.30	23.59
16	4.80	29.40	23.75
17	4.80	29.70	23.99
18	4.10	29.90	24.16
19	4.10	29.90	24.16
20	3.90	29.90	24.16
21	3.70	29.90	24.16
22	3.70	29.90	24.16
23	3.70	29.90	24.16
24	3.50	29.90	24.16
25	3.50	30.20	24.40
26	3.50	30.20	24.40

CTD STATION 24

GEOGRAPHIC POSITION
42-20-42 NORTH
70-53-15 WEST

DATE-TIME 05 19 73 1700 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	7.90	29.30	23.55
1	7.90	29.30	23.55
2	7.90	29.30	23.55
3	7.90	29.30	23.55
4	7.90	29.30	23.55
5	7.50	29.30	23.57
6	7.50	29.30	23.57
7	7.50	29.30	23.57
8	7.50	29.30	23.57
9	7.50	29.30	23.57
10	7.50	29.30	23.57
11	7.50	29.30	23.57
12	7.50	29.30	23.57
13	7.50	29.30	23.57
14	7.50	29.30	23.57
15	7.20	29.30	23.59
16	6.50	29.30	23.63
17	6.50	29.30	23.63
18	6.00	29.30	23.64
19	5.50	29.80	24.06
20	5.00	29.80	24.07
21	4.50	29.80	24.08
22	4.00	29.80	24.08
23	4.00	29.80	24.08
24	4.00	30.10	24.32
25	4.00	30.10	24.32
26	3.90	30.10	24.32

CTD STATION 34

GEOGRAPHIC POSITION
42-19-12 NORTH
70-43-15 WEST

DATE-TIME 05 19 73 1700 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.00	29.20	23.46
1	8.00	29.20	23.46
2	8.00	29.20	23.46
3	8.00	29.20	23.46
4	8.00	29.20	23.46
5	8.00	29.20	23.46
6	7.70	29.20	23.48
7	7.70	29.20	23.48
8	7.70	29.20	23.48
9	7.70	29.20	23.48
10	7.70	29.20	23.48
11	7.40	29.20	23.50
12	7.40	29.20	23.50
13	7.40	29.20	23.50
14	7.40	29.20	23.50
15	7.40	29.20	23.50
16	7.40	29.20	23.50
17	7.40	29.20	23.50
18	7.00	29.20	23.52
19	7.00	29.20	23.52
20	6.80	29.50	23.77
21	6.30	29.90	24.12
22	5.80	29.90	24.13
23	4.80	29.90	24.15
24	4.00	29.90	24.16
25	4.00	29.90	24.16
26	4.00	29.90	24.16

CTD STATION 32

GEOGRAPHIC POSITION
42-19-12 NORTH
70-49-50 WEST

DATE-TIME 05 19 73 1800 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.40	28.80	23.11
1	8.20	28.80	23.13
2	8.20	28.80	23.13
3	8.20	28.80	23.13
4	8.10	28.80	23.13
5	8.10	28.80	23.13
6	8.10	28.80	23.13
7	8.10	28.80	23.13
8	8.10	28.80	23.13
9	8.10	28.80	23.13
10	7.90	28.80	23.15
11	7.90	28.80	23.15
12	7.90	29.10	23.39
13	7.90	29.10	23.39
14	7.70	29.10	23.40
15	7.40	29.10	23.42
16	6.90	29.40	23.69
17	6.60	29.40	23.70
18	6.60	29.40	23.70
19	6.40	29.40	23.71
20	6.10	29.40	23.72
21	5.60	29.60	23.90
22	5.60	29.60	23.90
23	5.60	29.60	23.90
24	5.20	29.80	24.07
25	5.20	29.80	24.07
26	4.90	29.80	24.07

CTD STATION 33

GEOGRAPHIC POSITION
42-19-12 NORTH
70-46-00 WEST

DATE-TIME 05 19 73 1800 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.50	28.80	23.10
1	8.50	28.80	23.10
2	8.50	28.80	23.10
3	8.50	28.80	23.10
4	8.50	28.80	23.10
5	8.50	29.00	23.27
6	8.50	29.00	23.27
7	8.50	29.00	23.27
8	8.50	29.00	23.27
9	8.50	29.00	23.27
10	8.50	29.00	23.27
11	8.50	29.00	23.27
12	8.50	29.00	23.27
13	8.10	29.00	23.29
14	8.10	29.00	23.29
15	8.10	29.40	23.62
16	7.40	29.40	23.66
17	6.00	29.40	23.72
18	5.50	29.70	23.98
19	5.50	29.70	23.98
20	4.80	29.70	23.99
21	4.50	29.70	24.00
22	4.50	29.70	24.00
23	4.50	29.70	24.00
24	4.40	29.70	24.00
25	4.00	29.70	24.00
26	4.00	29.70	24.00

CTD STATION 31

GEOGRAPHIC POSITION
42-19-12 NORTH
70-51-50 WEST

DATE-TIME 05 19 73 1900 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.40	29.00	23.27
1	8.40	29.00	23.27
2	8.40	29.00	23.27
3	8.20	29.00	23.29
4	7.90	29.00	23.31
5	7.90	29.00	23.31
6	7.90	29.00	23.31
7	7.90	29.00	23.31
8	7.90	29.00	23.31
9	7.60	29.00	23.33
10	7.60	29.00	23.33
11	7.60	29.00	23.33
12	7.20	29.00	23.35
13	7.10	29.20	23.52
14	6.90	29.20	23.53

CTD STATION 21

GEOGRAPHIC POSITION
42-20-42 NORTH
7C-51-5C WEST

DATE-TIME 05 19 73 2000 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.60	29.10	23.34
1	8.60	29.10	23.34
2	8.60	29.10	23.34
3	8.60	29.10	23.34
4	8.60	29.10	23.34
5	8.40	29.10	23.35
6	8.40	29.10	23.35
7	8.40	29.10	23.35
8	8.40	29.10	23.35
9	8.10	29.10	23.38
10	8.10	29.10	23.38
11	8.10	29.10	23.38
12	8.10	29.10	23.38
13	8.10	29.10	23.38
14	7.80	29.10	23.40
15	7.80	29.10	23.40
16	6.90	29.10	23.45
17	6.90	29.60	23.85
18	5.90	29.60	23.89
19	5.40	29.60	23.90
20	5.90	29.60	23.89
21	5.90	29.60	23.89
22	4.90	29.60	23.91
23	4.90	29.60	23.91
24	4.90	29.60	23.91

CTD STATION 22

GEOGRAPHIC POSITION
42-20-42 NORTH
70-49-00 WEST

DATE-TIME 05 19 73 2000 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	8.80	28.90	23.16
1	8.80	28.90	23.16
2	8.70	28.90	23.17
3	8.70	28.90	23.17
4	8.50	28.90	23.18
5	8.10	28.90	23.21
6	8.10	28.90	23.21
7	8.10	28.90	23.21
8	8.10	28.90	23.21
9	8.10	28.90	23.21
10	7.90	28.90	23.23
11	7.90	28.90	23.23
12	7.90	28.90	23.23
13	7.90	28.90	23.23
14	7.70	29.10	23.40
15	6.00	29.60	23.89
16	5.10	29.60	23.91
17	5.10	29.60	23.91
18	4.90	29.60	23.91
19	4.60	29.80	24.08
20	4.60	29.80	24.08
21	4.40	29.80	24.08
22	3.80	29.90	24.16
23	3.80	29.90	24.16
24	3.80	29.90	24.16
25	3.80	29.90	24.16
26	3.80	29.90	24.16

CTD STATION 12

GEOGRAPHIC POSITION
42-22-12 NORTH
70-49-00 WEST

DATE-TIME 06 02 73 1300 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	10.70	28.00	22.25
1	10.60	28.00	22.26
2	10.60	28.00	22.26
3	10.50	28.50	22.67
4	10.40	28.50	22.68
5	10.40	28.00	22.28
6	10.40	28.70	22.85
7	10.10	-8.20	-6.99
8	9.80	28.20	22.51
9	9.40	28.70	22.95
10	9.00	28.70	22.98
11	8.20	29.40	23.61
12	7.40	29.40	23.66
13	6.90	29.40	23.69
14	6.30	29.40	23.71
15	5.90	29.40	23.73
16	5.50	29.40	23.74
17	5.30	29.40	23.74
18	5.10	30.10	24.31
19	5.00	30.10	24.31
20	4.80	29.90	24.15

CTD STATION 14

GEOGRAPHIC POSITION
42-22-12 NORTH
70-43-15 WEST

DATE-TIME 06 02 73 1400 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	10.40	28.40	22.60
1	10.40	28.40	22.60
2	10.40	28.40	22.60
3	10.40	28.40	22.60
4	10.30	28.40	22.62
5	10.10	28.40	22.64
6	9.90	28.40	22.66
7	9.70	28.40	22.68
8	9.60	28.40	22.69
9	9.30	28.50	22.80
10	9.00	28.50	22.82
11	8.30	28.50	22.88
12	7.50	29.20	23.49
13	6.90	29.40	23.69
14	6.30	29.40	23.71
15	6.20	29.40	23.72
16	6.10	29.40	23.72
17	5.90	29.40	23.73
18	5.60	29.80	24.06
19	5.10	29.80	24.07
20	5.10	29.90	24.15

CTD STATION 23

GEOGRAPHIC POSITION
42-20-42 NORTH
70-46-00 WEST

DATE-TIME 06 02 73 1900 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	12.30	27.50	21.64
1	12.30	27.50	21.64
2	12.30	27.50	21.64
3	12.30	27.50	21.64
4	12.30	27.50	21.64
5	12.10	27.50	21.67
6	12.00	27.50	21.68
7	11.70	27.90	22.04
8	11.50	27.90	22.07
9	11.20	27.90	22.11
10	10.90	27.90	22.14
11	9.40	27.90	22.30
12	8.00	29.00	23.30
13	7.50	28.20	22.69
14	6.90	28.60	23.04
15	6.40	29.00	23.39
16	6.00	29.00	23.40
17	5.80	29.00	23.41
18	5.20	29.40	23.75
19	5.20	29.40	23.75
20	5.20	29.40	23.75

CTD STATION 34

GEOGRAPHIC POSITION
42-19-12 NORTH
70-43-15 WEST

DATE-TIME 06 02 73 1900 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	12.40	28.20	22.19
1	12.10	28.20	22.23
2	11.70	28.20	22.28
3	11.70	28.20	22.28
4	11.70	28.20	22.28
5	11.70	28.20	22.28
6	11.70	28.10	22.20
7	11.70	28.10	22.20
8	11.70	28.10	22.20
9	11.70	28.10	22.20
10	11.70	28.10	22.20
11	11.40	28.10	22.24
12	11.00	28.10	22.29
13	9.90	28.90	23.06
14	8.80	28.90	23.16
15	8.10	28.90	23.21
16	7.30	29.40	23.67
17	6.50	29.40	23.71
18	5.80	29.10	23.49
19	5.30	30.00	24.23
20	4.80	30.00	24.23

CTD STATION 32

GEOGRAPHIC POSITION
42-19-12 NORTH
70-49-00 WEST

DATE-TIME 06 02 73 2000 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T
0	11.40	27.60	21.84
1	11.10	27.70	21.96
2	10.80	27.70	22.00
3	10.80	28.20	22.40
4	10.80	28.20	22.40
5	10.70	28.20	22.41
6	10.50	28.30	22.51
7	10.20	28.30	22.55
8	9.80	28.30	22.59
9	9.60	28.30	22.61
10	9.40	28.30	22.63
11	9.10	28.30	22.65
12	8.70	28.30	22.69
13	7.40	28.30	22.78
14	6.10	28.30	22.84
15	5.60	29.30	23.66
16	5.10	29.80	24.07

CTD STATION W5

GEOGRAPHIC POSITION
42-22-54 NORTH
70-51-42 WEST

DATE-TIME C6 15 73 1700 GMT

DEPTH (M)	TEMP (C)
0	14.08
1	14.08
2	14.08
3	14.07
4	13.96
5	13.68
6	13.60
7	13.55
8	13.51
9	13.48
10	13.45
11	13.45
12	13.34
13	13.20
14	12.97
15	12.80
16	12.20
17	8.68
18	7.75
19	7.35
20	6.76
21	6.57
22	6.55
23	6.53
24	6.52
25	6.51

CTD STATION 81

GEOGRAPHIC POSITION
42 21 20 NORTH
70 49 00 WEST

DATE-TIME 06 19 73 1900 GMT

DEPTH (M)	TEMP (C)
0	14.10
1	14.10
2	14.09
3	13.39
4	13.27
5	13.23
6	13.28
7	13.21
8	13.21
9	13.08
10	12.52
11	12.00
12	11.84
13	11.48
14	10.95
15	10.62
16	10.29
17	9.82
18	8.95
19	7.65
20	6.65
21	6.55

CTD STATION BL

GEOGRAPHIC POSITION
42 20 20 NORTH
70 45 20 WEST

DATE-TIME 06 19 73 1900 GMT

DEPTH (M)	TEMP (C)
0	13.90
1	13.92
3	13.25
4	12.70
5	12.58
6	12.20
7	11.93
8	11.48
9	10.82
10	10.76
11	10.74
12	10.54
13	10.45
14	10.35
15	10.38
16	10.32
17	10.26
18	10.21
19	10.10
20	9.60
21	9.00
23	8.42

CTD STATION TL

GEOGRAPHIC POSITION
42-19-30 NORTH
70-50-00 WEST

DATE-TIME 06 19 73 2000 GMT

DEPTH (M)	TEMP (C)
0	14.10
1	14.10
2	14.10
3	14.10
4	14.10
5	14.02
6	13.96
7	13.84
8	13.72
9	13.62
10	13.55
11	13.42

CTD STATION AH

GEOGRAPHIC POSITION
41 56 48 NORTH
70 14 42 WEST

DATE-TIME 07 26 73 1300 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	CONC(UM/CM)
1	18.40	30.97	22.12	41.50
2	18.40	30.97	22.12	41.50
3	18.40	30.97	22.12	41.50
4	18.40	30.97	22.12	41.50
5	18.40	30.97	22.12	41.50
6	18.37	30.99	22.14	41.50
7	17.82	31.33	22.53	41.40
8	16.25	31.26	22.84	39.90
9	15.40	31.31	23.07	39.20
10	14.05	31.59	23.57	38.30
11	12.70	31.68	23.91	37.20
13	11.20	31.80	24.28	36.00
14	10.66	31.87	24.43	35.60
15	9.95	32.10	24.72	35.20
16	9.42	32.16	24.85	34.80
17	8.88	32.24	25.00	34.40
18	8.48	32.18	25.01	34.00
19	8.10	32.11	25.01	33.60
20	7.50	32.23	25.19	33.20
21	6.12	32.43	25.53	32.20
22	5.91	32.41	25.54	32.00
23	5.86	32.46	25.59	32.00
24	5.85	32.47	25.59	32.00
25	5.84	32.48	25.60	32.00

CTD STATION AI

GEOGRAPHIC POSITION
41 52 24 NORTH
70 21 00 WEST

DATE-TIME 07 26 73 1400 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	CONC(UM/CM)
1	18.65	31.20	22.23	42.00
2	18.65	31.20	22.23	42.00
3	18.65	31.20	22.23	42.00
4	18.65	31.20	22.23	42.00
5	18.60	31.24	22.27	42.00
6	16.52	31.31	22.82	40.20
7	15.52	31.31	23.04	39.30
8	13.70	31.60	23.65	38.00
9	13.00	31.62	23.80	37.40
10	12.30	31.64	23.95	36.80
11	11.73	31.64	24.06	36.30
12	11.13	31.67	24.18	35.80
13	10.05	31.60	24.32	34.80
14	9.10	31.42	24.32	33.80
15	7.90	31.76	24.77	33.10
16	7.33	31.96	25.00	32.80
17	6.82	32.00	25.10	32.40
18	6.78	31.92	25.05	32.30
19	6.45	32.12	25.25	32.20
20	6.07	32.15	25.31	31.90
21	5.96	32.14	25.32	31.80

CTD STATION AJ

GEOGRAPHIC POSITION
41 48 54 NORTH
70 27 36 WEST

DATE-TIME 07 26 73 1500 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	CONC(UM/CM)
0	18.38	31.07	22.20	41.60
1	18.38	31.07	22.20	41.60
2	18.38	31.07	22.20	41.60
3	18.38	31.07	22.20	41.60
4	18.38	31.07	22.20	41.60
5	18.38	31.07	22.20	41.60
6	18.38	31.07	22.20	41.60
7	18.38	31.07	22.20	41.60
8	18.38	31.07	22.20	41.60
9	16.08	30.95	22.65	39.40
10	12.55	32.19	24.33	37.60
11	11.75	31.72	24.11	36.40
12	11.04	31.55	24.11	35.60
13	10.00	31.55	24.28	34.70
14	8.96	31.75	24.60	34.00
15	7.85	31.70	24.73	33.00
16	7.12	31.83	24.93	32.50
17	6.80	32.01	25.12	32.40
18	6.72	31.98	25.10	32.30
19	6.71	31.99	25.11	32.30

CTD STATION AK

GEOGRAPHIC POSITION
41 55 18 NORTH
70 29 36 WEST

DATE-TIME 07 26 73 1600 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	COND(UM/CM)
0	16.70	31.00	22.54	40.00
1	16.69	31.01	22.55	40.00
2	16.65	31.04	22.58	40.00
3	16.60	31.07	22.62	40.00
4	16.32	31.12	22.72	39.80
5	16.00	31.11	22.78	39.50
6	15.88	31.02	22.74	39.30
7	15.62	31.05	22.82	39.10
8	14.20	31.19	23.23	38.00
9	11.70	31.38	23.86	36.00
10	9.95	31.59	24.33	34.70
11	9.33	31.63	24.45	34.20
12	8.18	31.61	24.61	33.20
13	7.95	31.71	24.73	33.10
14	7.72	31.82	24.84	33.00
15	7.50	31.80	24.86	32.80
16	7.42	31.87	24.93	32.80
17	7.21	31.96	25.02	32.70
18	7.13	31.92	25.01	32.60
19	7.02	31.92	25.01	32.50
20	6.88	31.94	25.05	32.40
21	6.76	31.94	25.07	32.30
22	6.72	31.98	25.10	32.30

CTD STATION AL

GEOGRAPHIC POSITION
42-00-12 NORTH
70-29-18 WEST

CATE-TIME 07/26/73 1700 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	COND(UM/CM)
0	18.40	30.06	21.43	40.40
1	18.40	30.06	21.43	40.40
2	18.40	30.06	21.42	40.40
3	18.35	30.09	21.46	40.40
4	18.33	30.11	21.48	40.40
5	18.31	30.12	21.50	40.40
6	18.29	30.14	21.51	40.40
7	18.11	30.10	21.53	40.20
8	16.80	30.23	21.93	39.20
9	13.80	30.41	22.71	36.80
10	13.25	30.48	22.87	36.40
11	12.40	30.70	23.20	35.90
12	11.85	30.77	23.36	35.50
13	11.15	30.76	23.48	34.90
14	10.62	30.81	23.61	34.50
15	9.85	31.07	23.94	34.10
16	8.55	31.17	24.22	33.10
17	7.92	31.10	24.25	32.50
18	7.70	31.08	24.27	32.30
19	7.10	31.19	24.43	31.90
20	6.70	31.23	24.51	31.60
21	6.35	31.22	24.55	31.30
22	6.20	31.24	24.59	31.20

CTD STATION AM

GEOGRAPHIC POSITION
42 05 48 NORTH
70 31 18 WEST

DATE-TIME 07 26 73 1800 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	COND(UM/CM)
0	18.52	30.55	21.77	41.10
1	18.51	30.56	21.78	41.10
2	18.51	30.56	21.78	41.10
3	18.50	30.56	21.79	41.10
4	18.48	30.58	21.80	41.10
5	18.46	30.51	21.75	41.00
6	18.35	30.51	21.78	40.90
7	16.10	30.68	22.43	39.10
8	13.65	30.90	23.12	37.20
9	11.15	31.45	24.01	35.60
10	9.95	31.80	24.48	34.90
11	9.20	31.74	24.56	34.20
12	8.41	31.41	24.42	33.20
13	7.70	31.94	24.94	33.10
14	7.32	31.97	25.01	32.80
15	7.05	32.00	25.08	32.60
16	6.65	32.27	25.34	32.50
17	6.45	32.12	25.25	32.20
18	6.29	32.05	25.21	32.00
19	6.18	32.15	25.31	32.00
20	6.11	32.22	25.37	32.00
21	6.10	32.12	25.29	31.90

CTD STATION AN

GEOGRAPHIC POSITION
42 09 48 NORTH
70 31 12 WEST

DATE-TIME 07 26 73 1900 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	CONC(UM/CM)
0	17.98	30.62	21.95	40.70
1	17.92	30.66	22.00	40.70
2	17.90	30.68	22.02	40.70
3	17.90	30.68	22.02	40.70
4	17.85	30.63	21.99	40.60
5	17.80	30.58	21.97	40.50
6	17.70	30.58	21.99	40.40
7	17.65	30.61	22.03	40.40
8	17.60	30.65	22.07	40.40
9	17.42	30.62	22.08	40.20
10	16.60	30.73	22.36	39.60
11	15.70	30.81	22.62	38.90
12	15.40	30.87	22.73	38.70
13	12.90	31.14	23.45	36.80
14	10.75	31.50	24.12	35.30
15	9.40	31.56	24.39	34.20
16	8.92	31.68	24.56	33.90
17	8.60	31.65	24.58	33.60
18	8.40	31.73	24.67	33.50
19	7.60	31.71	24.77	32.80
20	7.15	31.80	24.90	32.50
21	7.00	31.83	24.94	32.40
22	6.90	31.81	24.94	32.30
23	6.74	31.85	25.00	32.20
24	6.42	31.93	25.10	32.00

CTD STATION AC

GEOGRAPHIC POSITION
42 14 00 NORTH
70 37 00 WEST

DATE-TIME 07 26 73 1900 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	CONC(UM/CM)
0	18.32	30.45	21.74	40.80
1	18.32	30.45	21.74	40.80
2	18.32	30.45	21.74	40.80
3	18.32	30.45	21.74	40.80
4	18.32	30.45	21.74	40.80
5	18.20	30.45	21.77	40.70
6	16.35	30.57	22.29	39.20
7	13.70	30.95	23.15	37.30
8	11.25	31.07	23.70	35.30
9	10.35	31.35	24.07	34.80
10	9.35	31.41	24.28	34.00
11	8.50	31.64	24.59	33.50
12	8.35	31.56	24.55	33.30
13	8.22	31.58	24.58	33.20
14	7.95	31.61	24.64	33.00
15	7.82	31.62	24.67	32.90
16	7.76	31.56	24.64	32.80
17	7.72	31.60	24.67	32.80
18	7.38	31.80	24.88	32.70
19	7.18	31.88	24.96	32.60
20	6.95	31.87	24.99	32.40
21	6.52	31.94	25.10	32.10
22	6.50	31.96	25.12	32.10
23	6.45	31.90	25.07	32.00
24	6.42	31.93	25.10	32.00
25	6.30	32.04	25.20	32.00
26	6.15	31.96	25.16	31.80
27	6.05	32.05	25.24	31.80
28	5.90	31.97	25.19	31.60

CTD STATION AP

GEOGRAPHIC POSITION
42 16 30 NORTH
70 42 24 WEST

DATE-TIME 07 26 73 2000 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	COND(UM/CM)
0	16.72	30.72	22.33	39.70
1	16.72	30.72	22.33	39.70
2	16.72	30.72	22.33	39.70
3	16.65	30.69	22.32	39.60
4	16.20	30.69	22.42	39.20
5	14.40	30.85	22.93	37.80
6	12.62	30.99	23.39	36.40
7	11.60	31.17	23.71	35.70
8	10.82	31.24	23.91	35.10
9	10.10	31.26	24.04	34.50
10	9.82	31.40	24.20	34.40
11	9.25	31.49	24.36	34.00
12	8.65	31.51	24.46	33.50
13	7.85	31.59	24.64	32.90
14	7.48	31.71	24.79	32.70
15	7.41	31.78	24.85	32.70
16	7.40	31.79	24.86	32.70
17	7.38	31.80	24.88	32.70
18	7.18	31.77	24.88	32.50
19	6.75	31.84	24.99	32.20
20	6.46	31.89	25.06	32.00
21	6.27	31.96	25.14	31.90

CTD STATION AQ

GEOGRAPHIC POSITION
42 19 30 NORTH
70 49 54 WEST

DATE-TIME 07 26 73 2100 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	CONC(UM/CM)
0	15.52	30.78	22.63	38.70
1	15.47	30.73	22.61	38.60
2	15.38	30.71	22.61	38.50
3	14.65	30.83	22.86	38.00
4	13.80	31.06	23.21	37.50
5	13.42	31.09	23.31	37.20
6	12.68	31.04	23.41	36.50
7	12.50	31.09	23.49	36.40
8	12.42	31.06	23.48	36.30
9	11.95	31.17	23.65	36.00
10	9.30	31.45	24.32	34.00
11	8.15	31.64	24.64	33.20
12	7.85	31.70	24.73	33.00
13	7.60	31.71	24.77	32.80

CTD STATION 18

GEOGRAPHIC POSITION
42-19-36 NORTH
70-49-54 WEST

DATE-TIME 09 15 73 1500 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	COND(UM/CM)
0	14.35	31.99	23.81	39.00
1	14.10	32.01	23.88	38.80
2	14.00	32.00	23.90	38.70
3	14.03	31.98	23.87	38.70
4	13.90	32.08	23.98	38.70
5	13.85	32.03	23.95	38.60
6	13.85	32.03	23.95	38.60
7	13.85	32.03	23.95	38.60
8	13.72	32.05	23.99	38.50
9	13.70	32.06	24.00	38.50
10	13.15	31.87	23.97	37.80
11	12.70	32.06	24.20	37.60

CTD STATION 01

GEOGRAPHIC POSITION
42-20-24 NORTH
70-57-12 WEST

DATE-TIME 09 19 73 1600 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	COND(UM/CM)
0	13.86	31.01	23.16	37.50
1	13.85	31.02	23.17	37.50
2	13.80	31.15	23.28	37.60
3	13.75	31.38	23.47	37.80
4	13.72	31.40	23.49	37.80
5	13.72	31.49	23.56	37.90
6	13.72	31.49	23.56	37.90
7	13.71	31.59	23.64	38.00
8	13.71	31.59	23.64	38.00
9	13.71	31.59	23.64	38.00
10	13.71	31.59	23.64	38.00
11	13.62	31.67	23.71	38.00
12	13.61	31.67	23.72	38.00
13	13.55	31.72	23.77	38.00
14	13.52	31.75	23.80	38.00
15	13.52	31.75	23.80	38.00
16	13.52	31.75	23.80	38.00

CTD STATION FL

GEOGRAPHIC POSITION
42-22-36 NORTH
70-55-18 WEST

DATE-TIME 09 19 73 1700 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	CONC(UM/CM)
0	13.65	31.74	23.76	38.10
1	13.62	31.76	23.79	38.10
2	13.52	31.85	23.87	38.10
3	13.35	31.89	23.94	38.00
4	13.35	31.80	23.87	37.90
5	13.32	31.83	23.90	37.90
6	13.32	31.82	23.90	37.90
7	13.35	31.80	23.87	37.90
8	12.75	32.02	24.16	37.60
9	12.55	32.10	24.26	37.50
10	12.05	32.14	24.38	37.10
11	11.80	32.36	24.60	37.10
12	10.50	32.62	25.03	36.20

CTD STATION W5

GEOGRAPHIC POSITION
42-22-54 NORTH
70-51-42 WEST

DATE-TIME 09 19 73 1700 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	COND(UM/CM)
0	13.69	32.17	24.09	38.60
1	13.66	32.19	24.11	38.60
2	13.62	32.13	24.07	38.50
3	13.45	32.18	24.15	38.40
4	13.42	32.21	24.17	38.40
5	13.32	32.11	24.11	38.20
6	13.18	32.13	24.16	38.10
7	13.05	32.24	24.27	38.10
8	12.95	32.23	24.28	38.00
9	13.00	32.09	24.17	37.90
10	12.95	32.14	24.21	37.90
11	12.92	32.16	24.23	37.90
12	12.90	32.18	24.25	37.90
13	12.85	32.22	24.29	37.90
14	12.65	32.29	24.39	37.80
15	11.80	32.26	24.52	37.00
16	10.65	32.68	25.05	36.40
17	10.55	32.57	24.98	36.20
18	10.15	32.63	25.10	35.90
19	9.50	32.70	25.27	35.40
20	9.00	32.75	25.38	35.00

CTD STATION BL

GEOGRAPHIC POSITION
42-22-40 NORTH
70-47-30 WEST

DATE-TIME 09 19 73 1800 GMT

DEPTH(M)	TEMP(C)	SALINITY(PPT)	SIGMA T	COND(UM/CM)
0	14.60	32.06	23.81	39.30
1	14.60	32.05	23.81	39.30
2	14.50	32.14	23.90	39.30
3	13.65	32.02	23.98	38.40
4	13.52	32.03	24.02	38.30
5	13.45	32.09	24.07	38.30
6	13.40	32.13	24.12	38.30
7	13.40	32.13	24.12	38.30
8	13.38	32.05	24.06	38.20
9	13.20	32.21	24.21	38.20
10	12.62	32.23	24.34	37.70
11	11.40	32.41	24.71	36.80
12	11.00	32.27	24.68	36.30
13	10.50	32.52	24.95	36.10
14	9.80	32.64	25.16	35.60
15	9.15	32.82	25.41	35.20
16	8.78	32.85	25.49	34.90
17	8.70	32.82	25.48	34.80
18	8.50	32.79	25.49	34.60
19	8.20	32.97	25.67	34.50
20	8.05	33.00	25.72	34.40
21	7.90	32.93	25.69	34.20
22	7.82	33.00	25.76	34.20
23	7.78	32.93	25.71	34.10
24	7.72	32.99	25.76	34.10
25	7.70	33.01	25.78	34.10
26	7.70	33.01	25.78	34.10
27	7.70	32.90	25.69	34.00

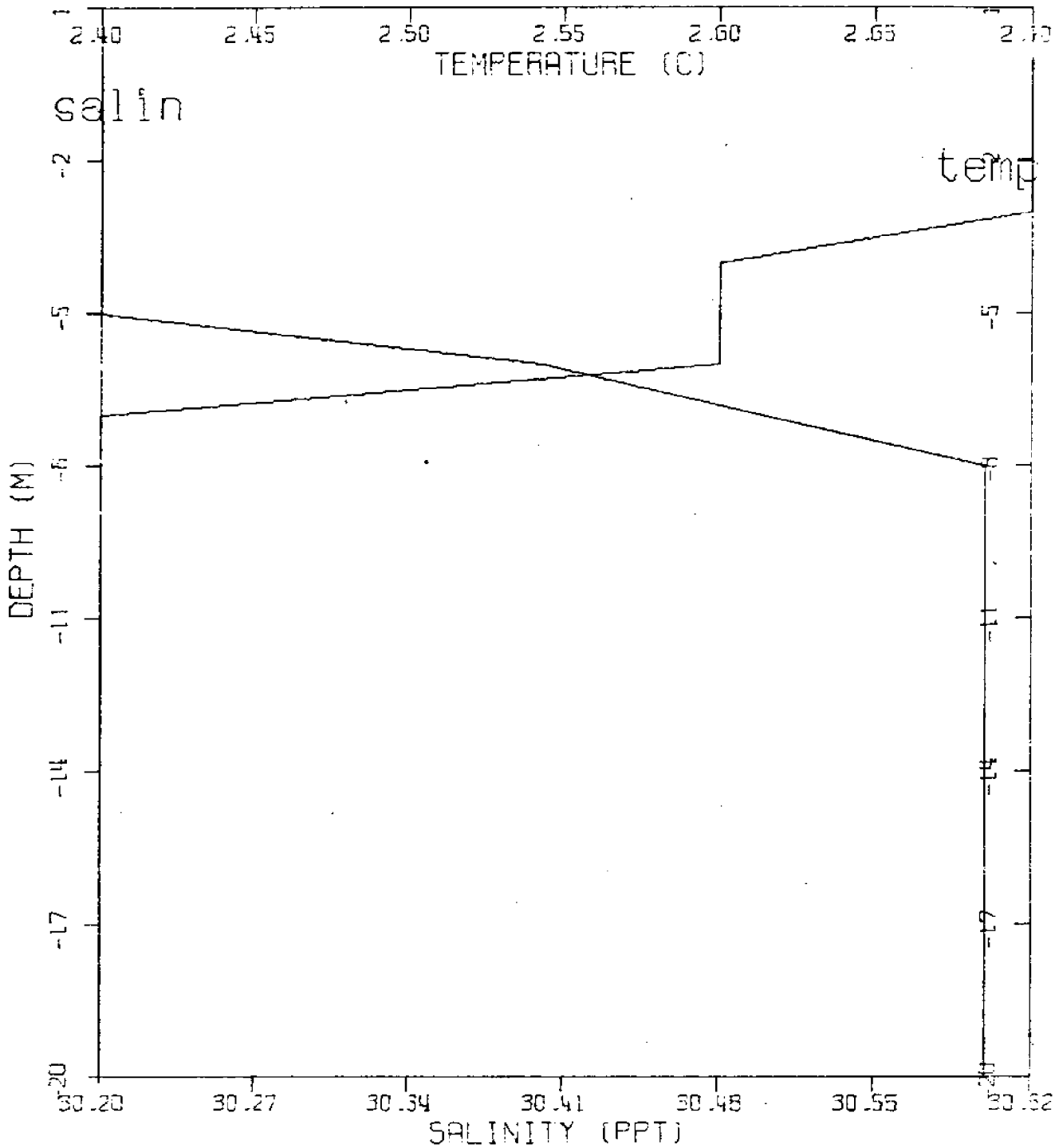
SECTION C.2

GRAPHICAL OUTPUT

SALINITY AND TEMPERATURE AS A FUNCTION OF DEPTH

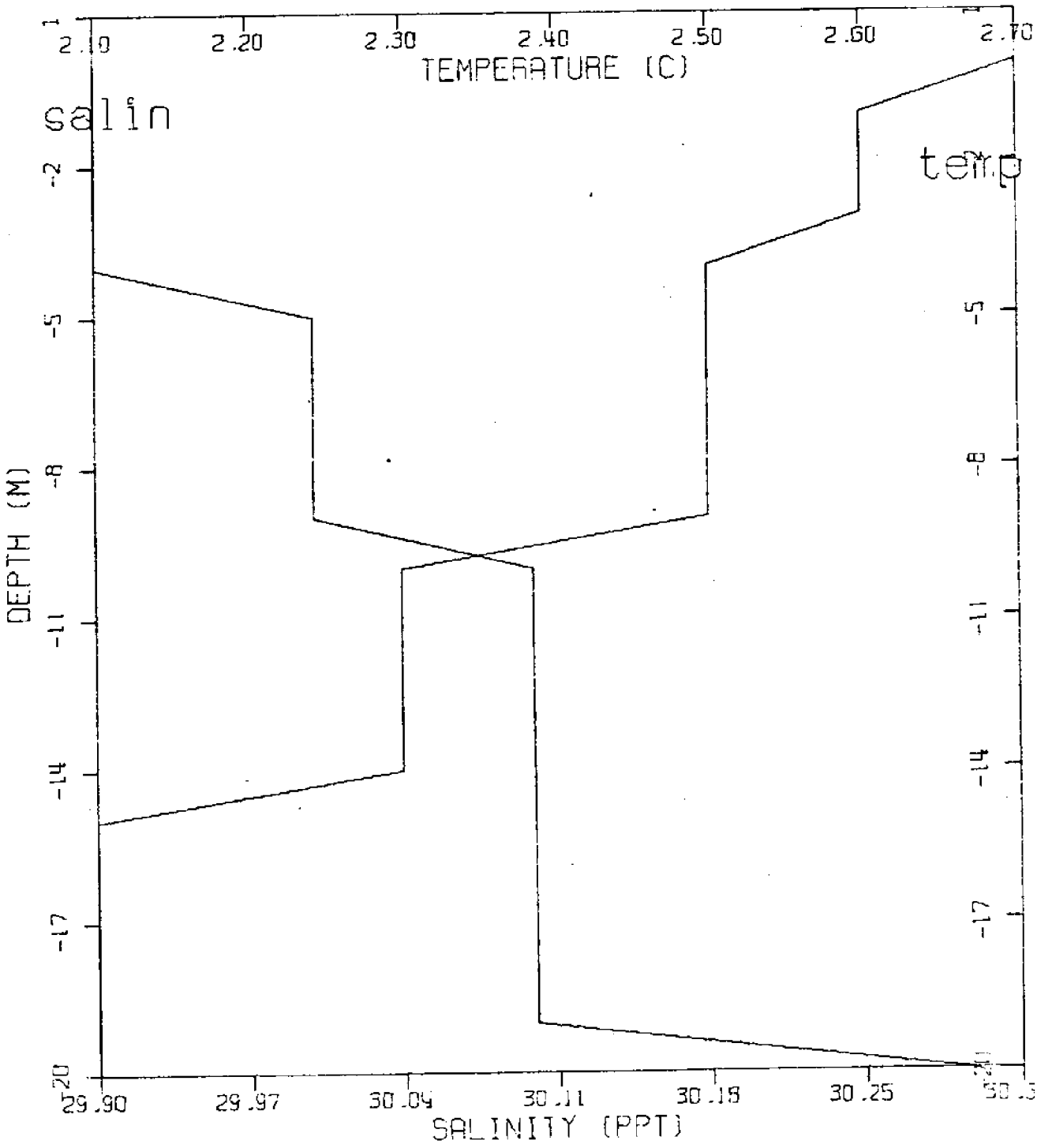
CTD Station 82 Position 42-19-12N
70-49-03W

Date 03 21 73 Time - 00 GMT



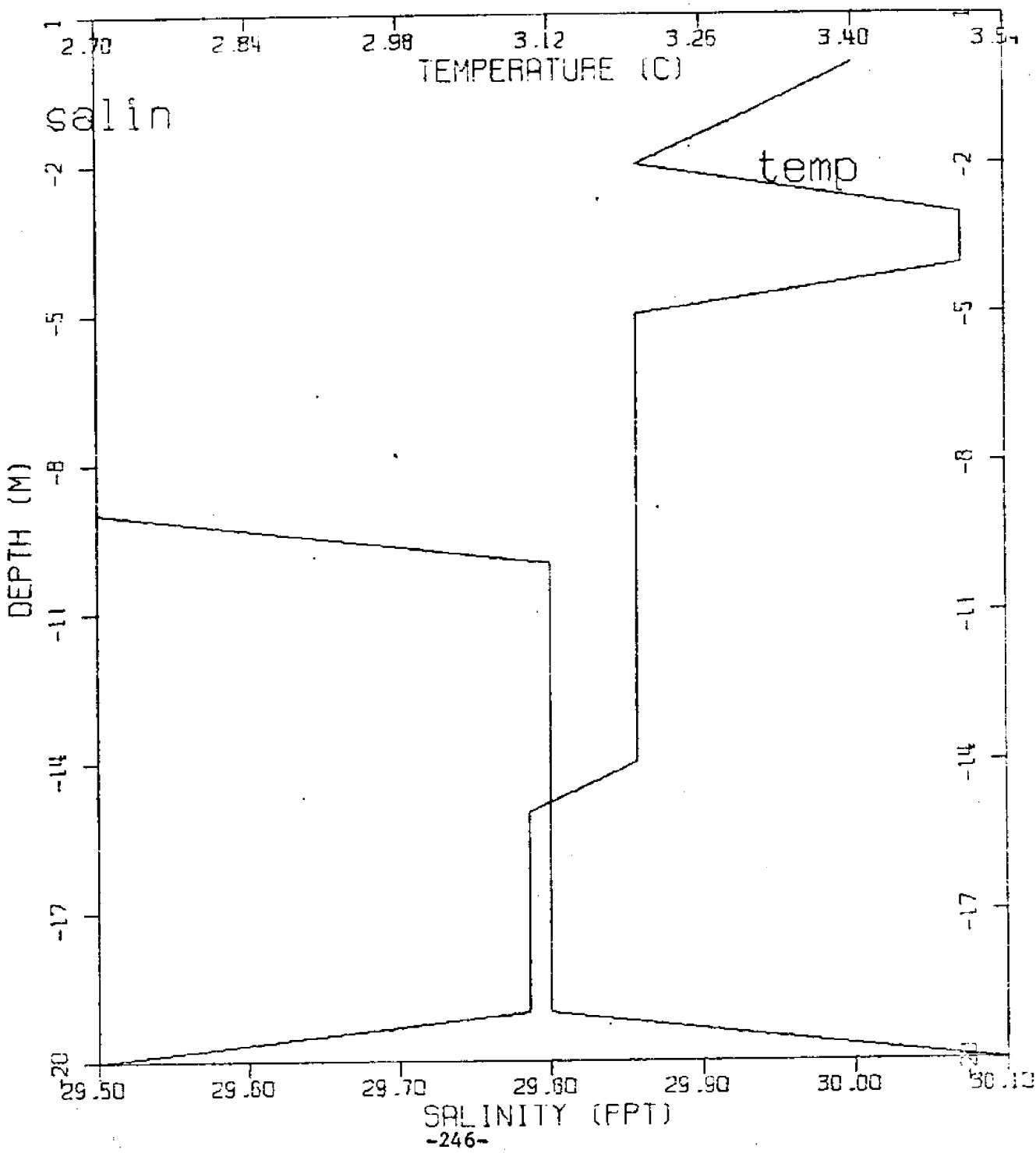
CTD Station 14 Position 42-22-12W 70-43-15N

Date 03 31 73 Time - 00 GMT



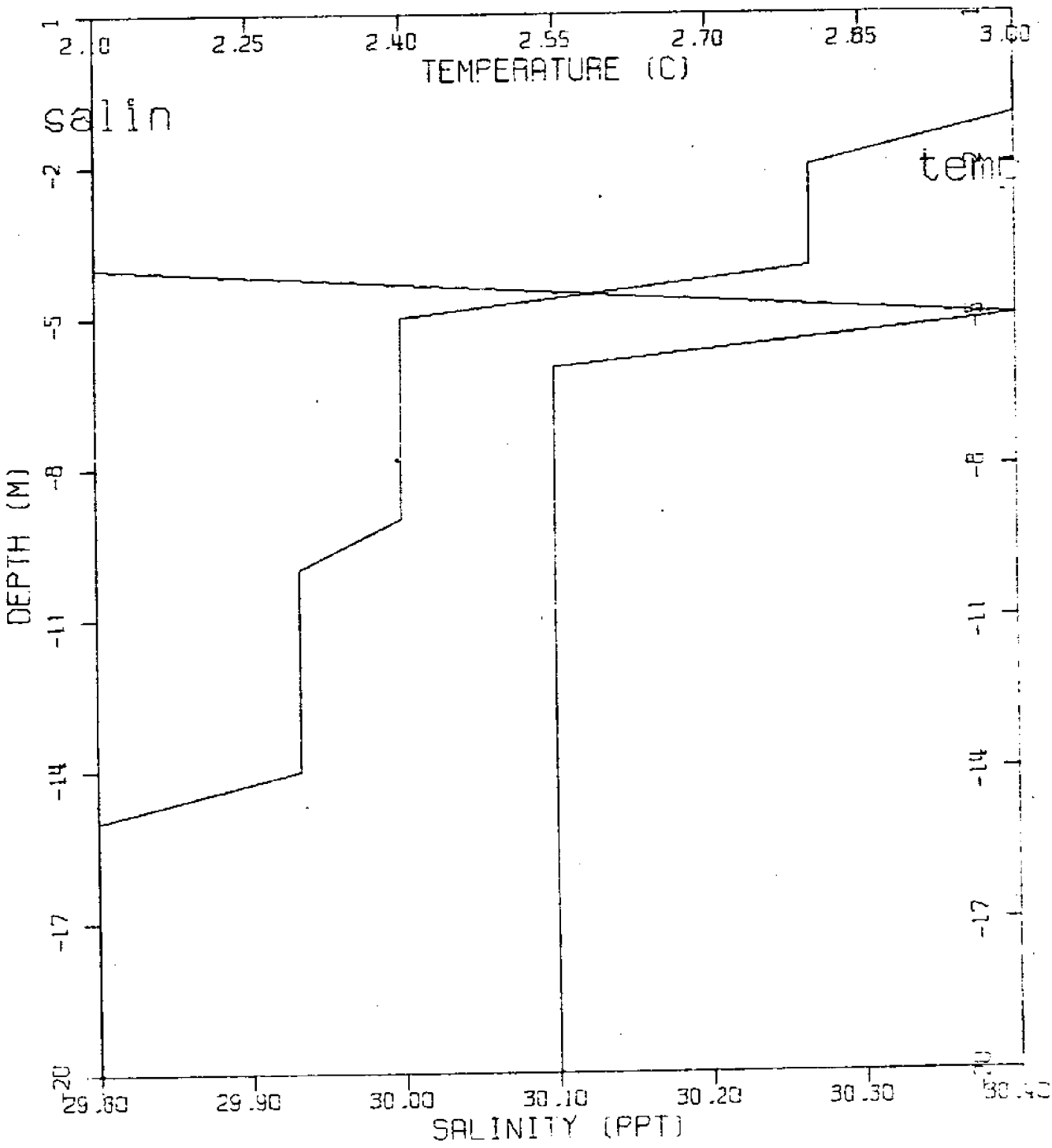
CTD Station 32 Position 42-19-12W 70-49-00N

Date 03 31 73 Time - 00 GMT



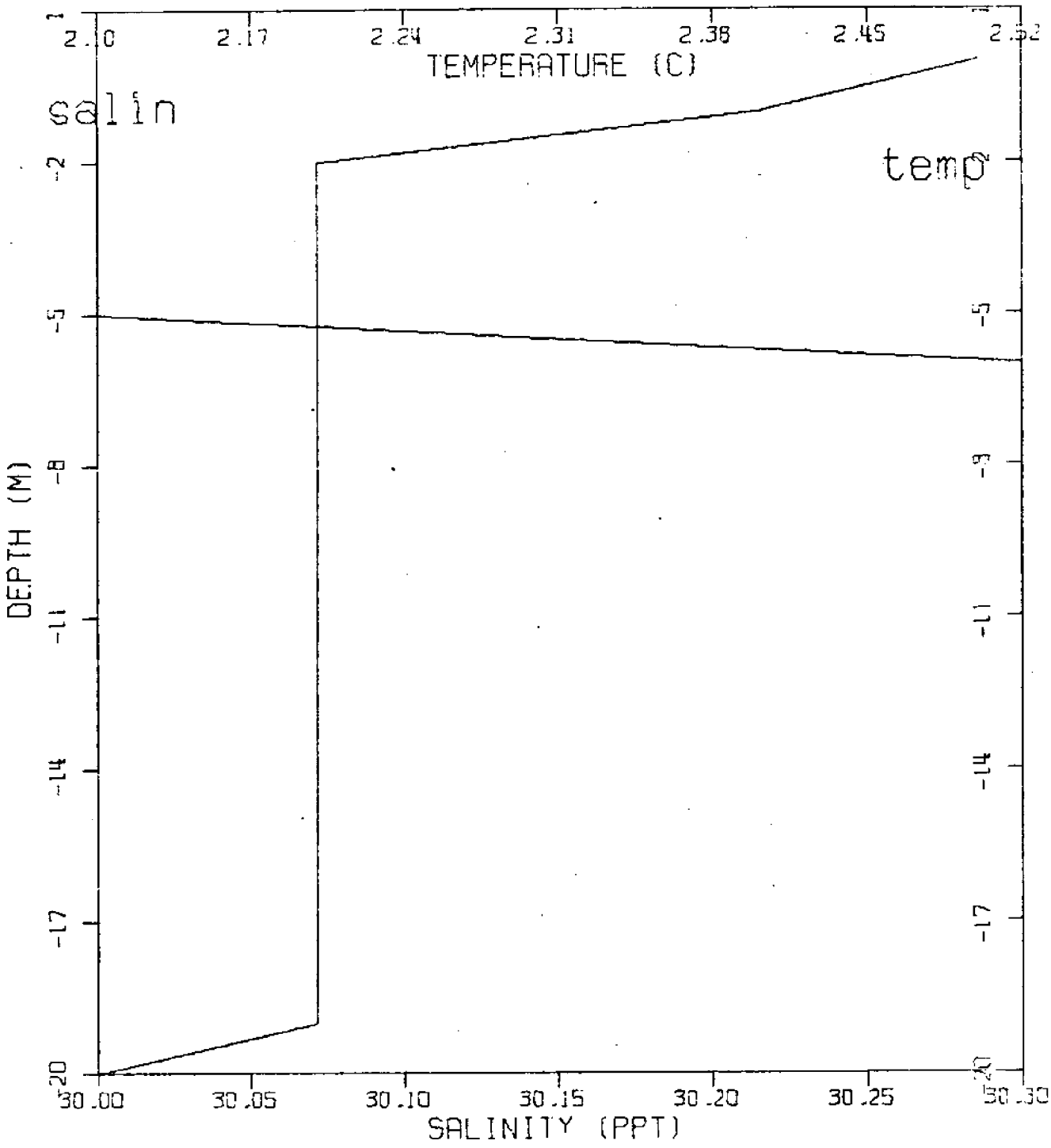
CTD Station 34 Position 42-19-12N 70-43-15W

Date 03 31 73 Time - 00 GMT



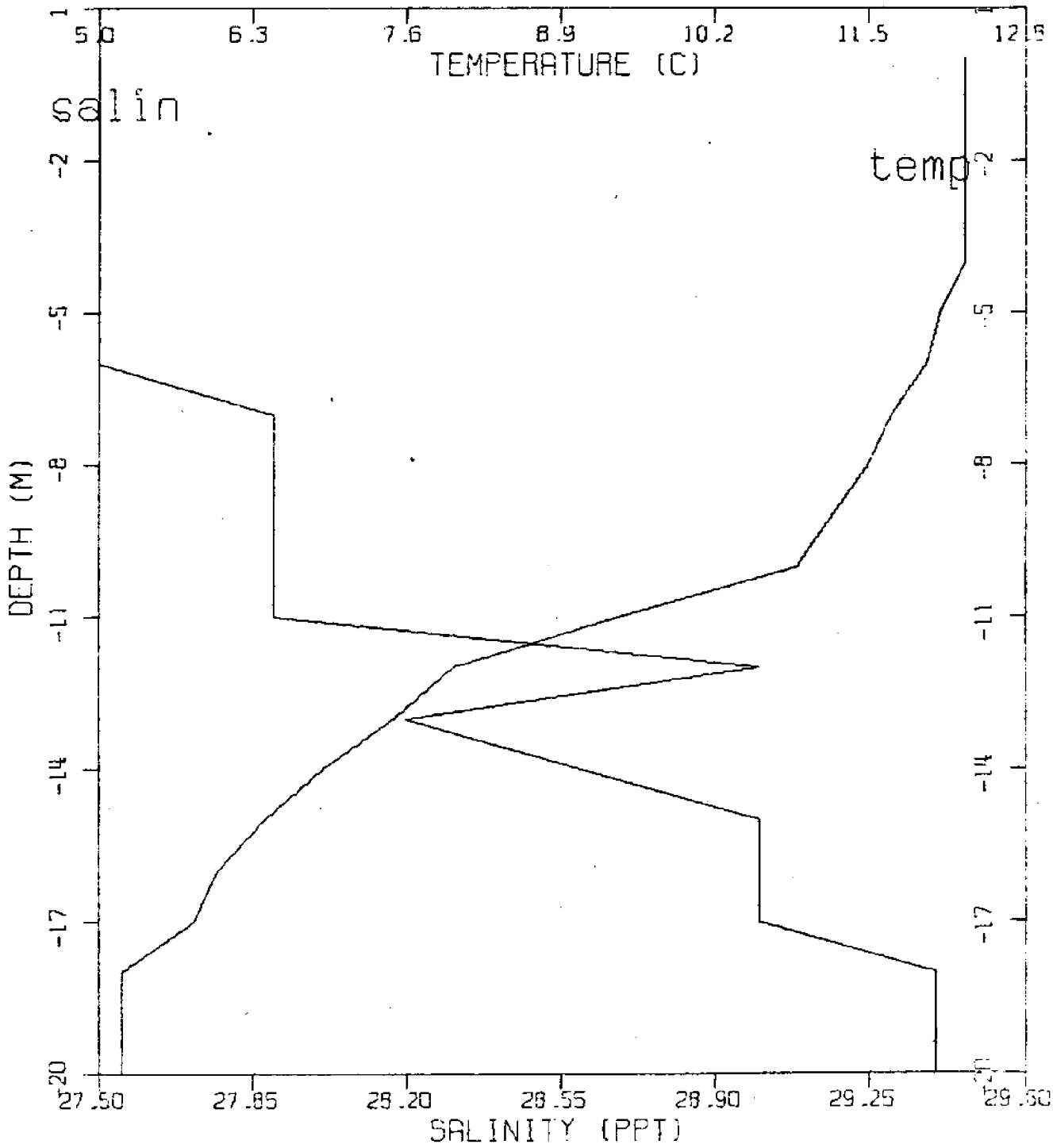
CTD Station 23 Position 42-20-42W
70-46-00N

Date 03 31 73 Time - 00 GMT



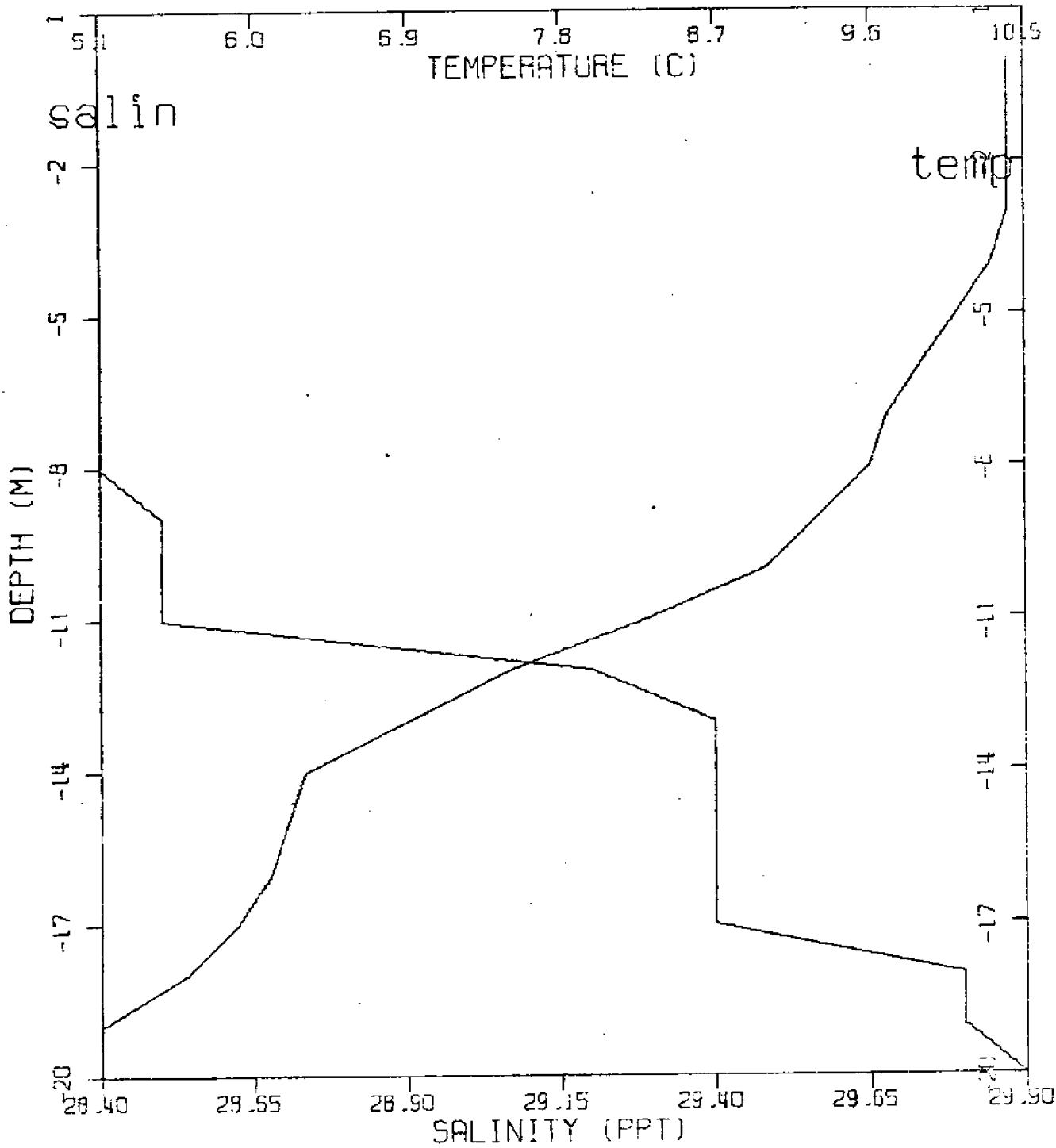
CTD Station 23 Position 42-20-42N
70-45-00W

Date 06 02 73 Time 1900 GMT



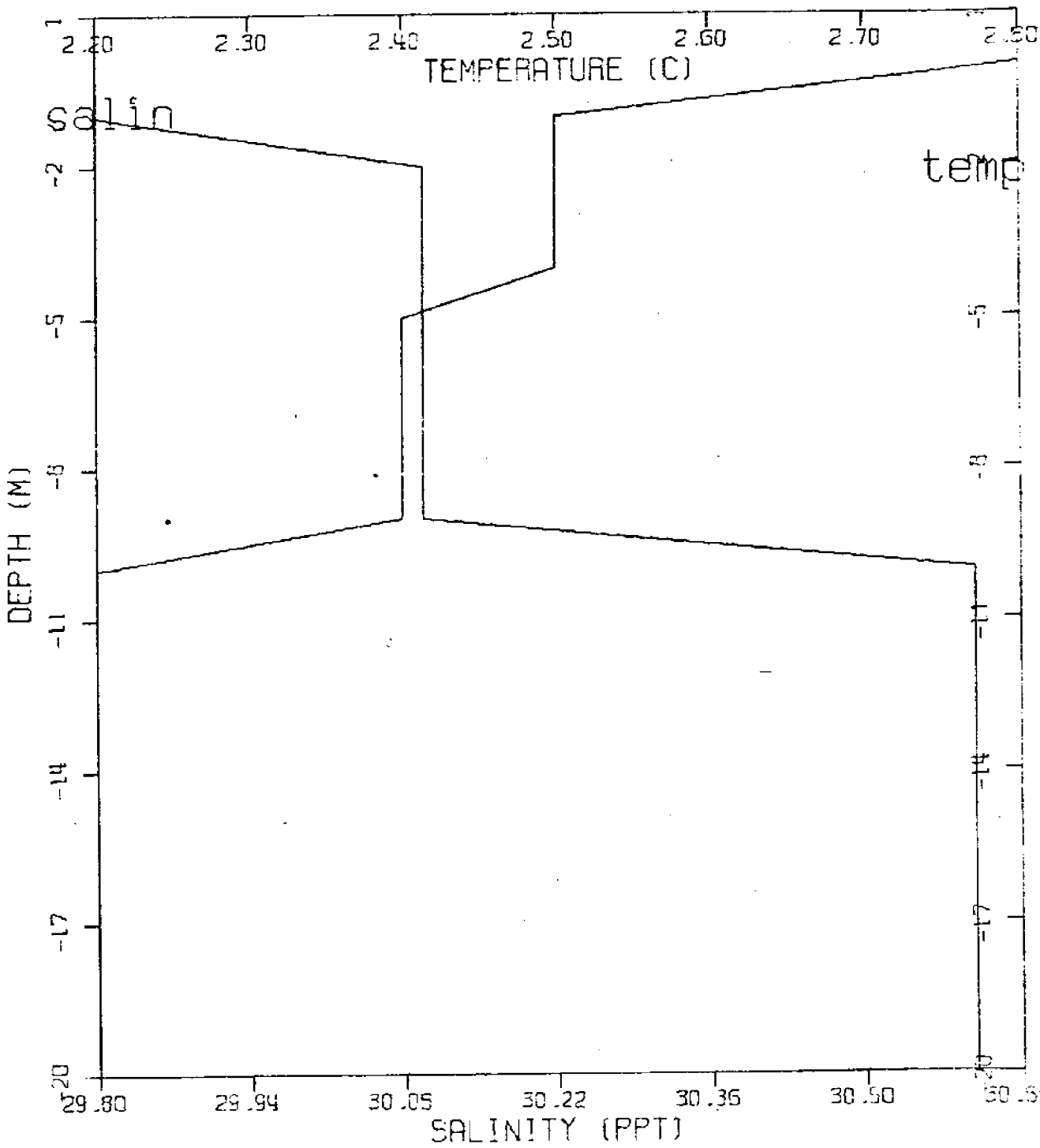
CTD Station 14 Position 42-33-12N
70-43-15W

Date 06 02 73 Time 1400 GMT



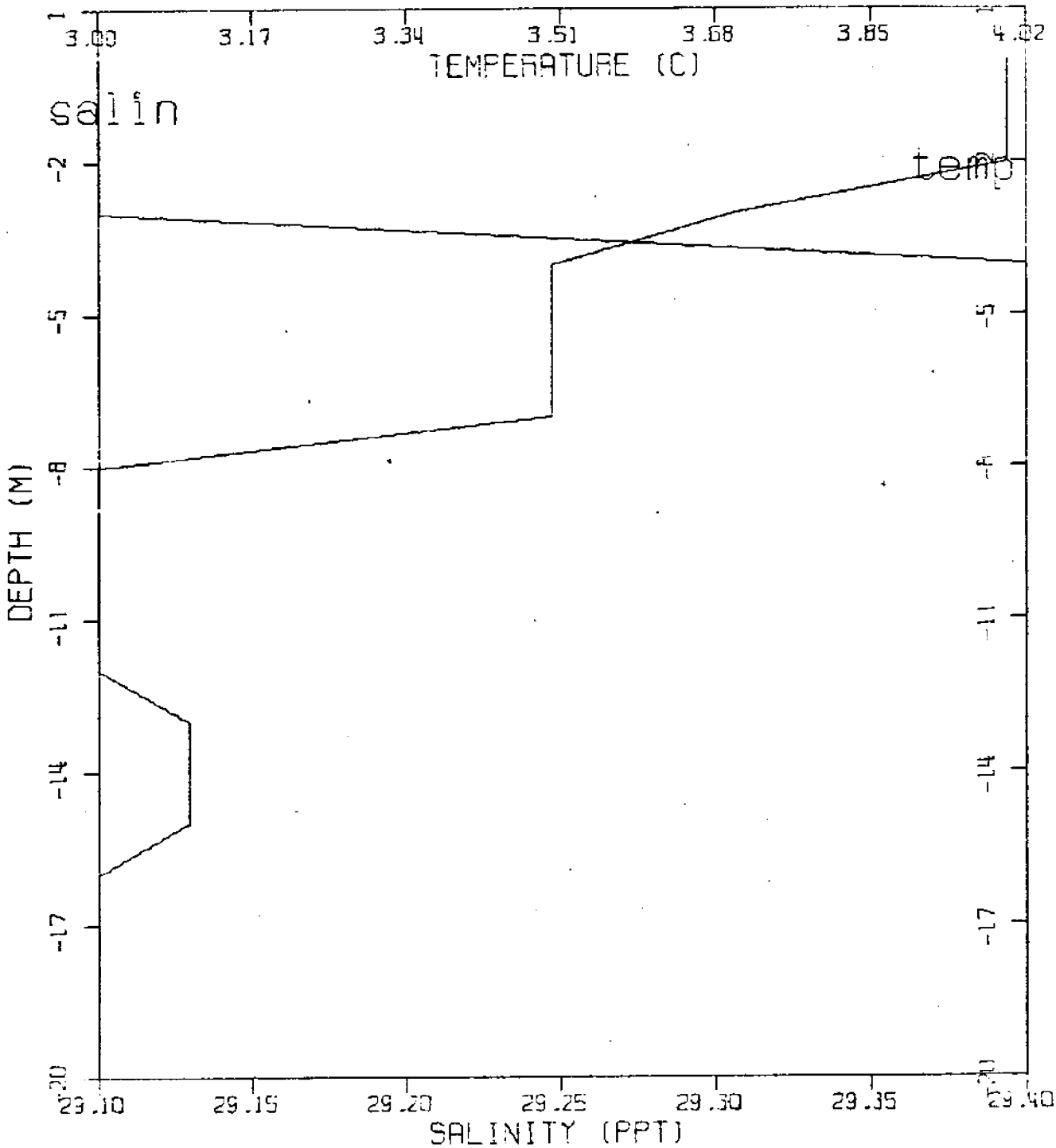
CTD Station 12 Position 42-22-12W 70-49-00N

Date 03 31 73 Time - 00 GMT



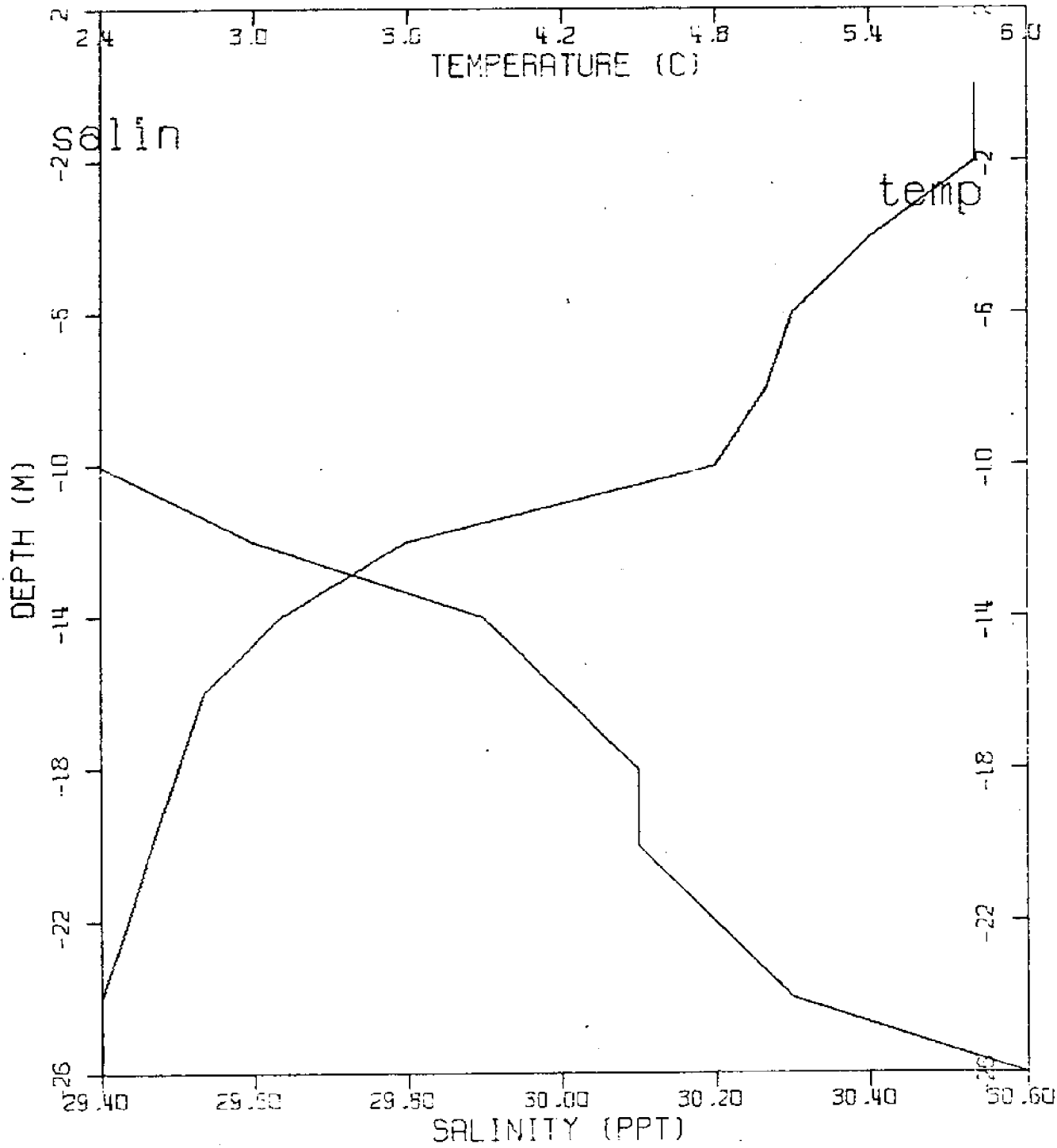
CTD Station 14 Position 42-20-42W 70-51-50N

Date 04 17 73 Time - 00 GMT



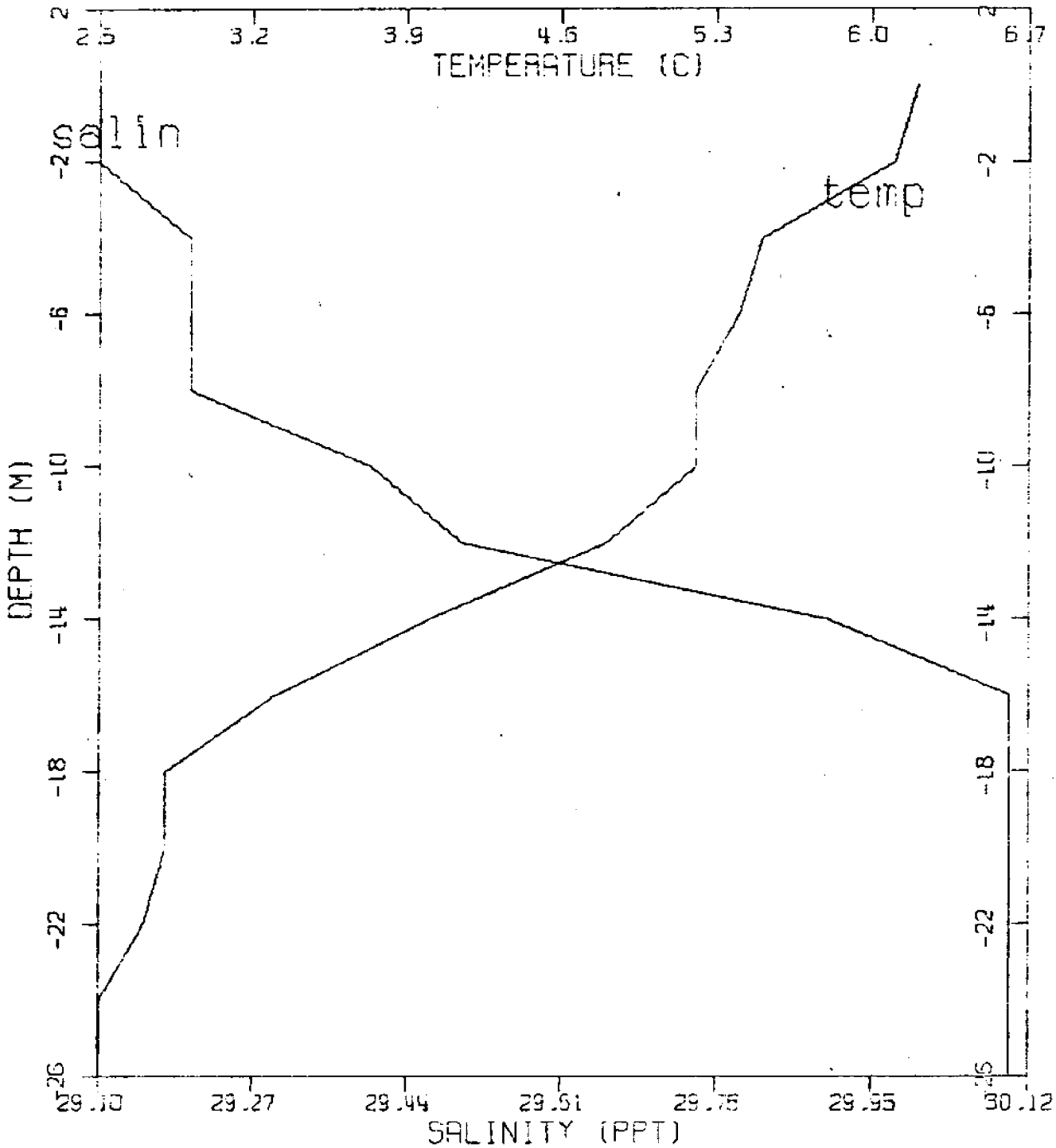
CTD Station 24 Position 42-20-42W
70-53-15N

Date 04 23 73 Time - 00 GMT



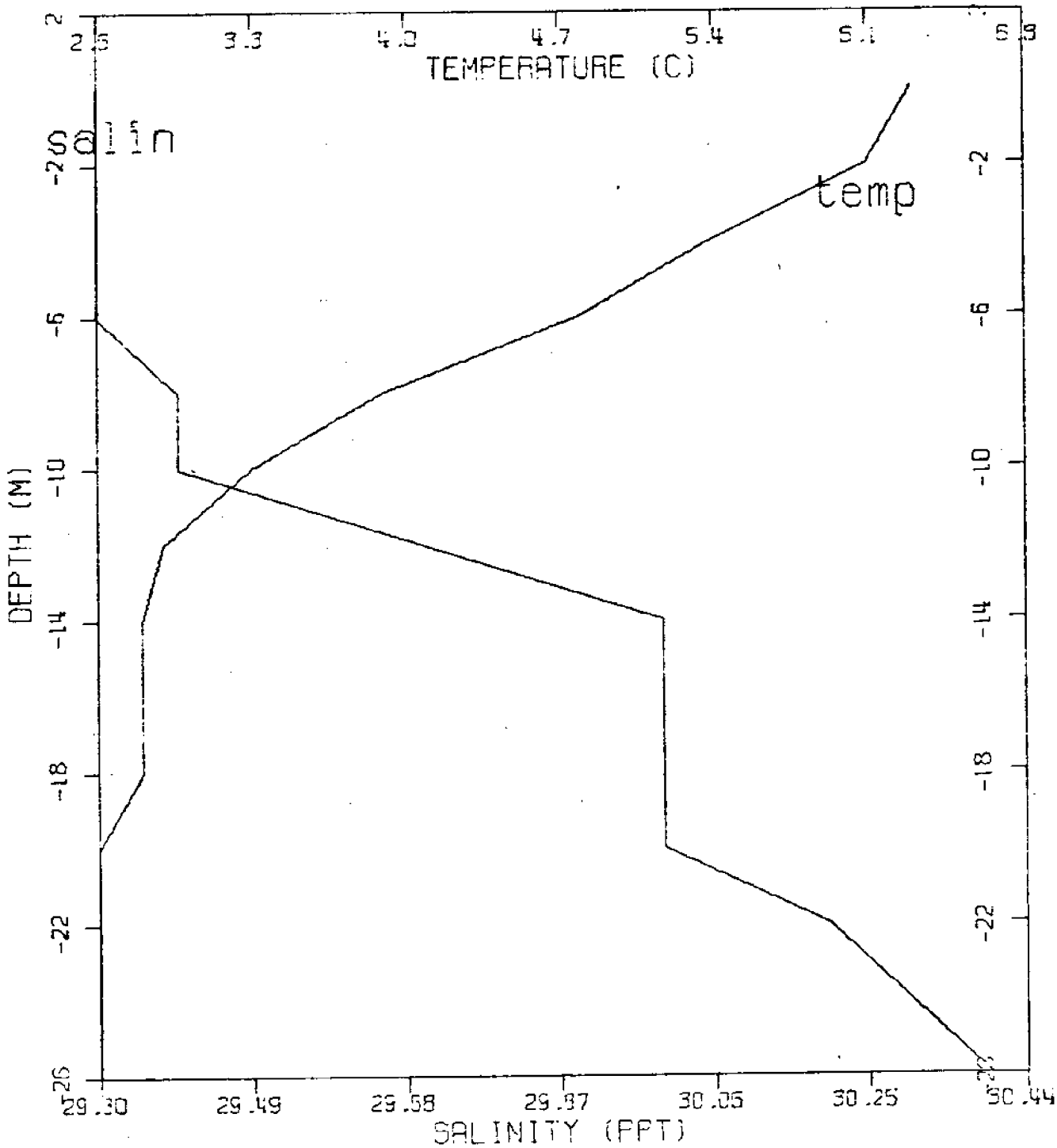
CTD Station 32 Position [illegible]

Date 04 23 73 Time - 00 GMT



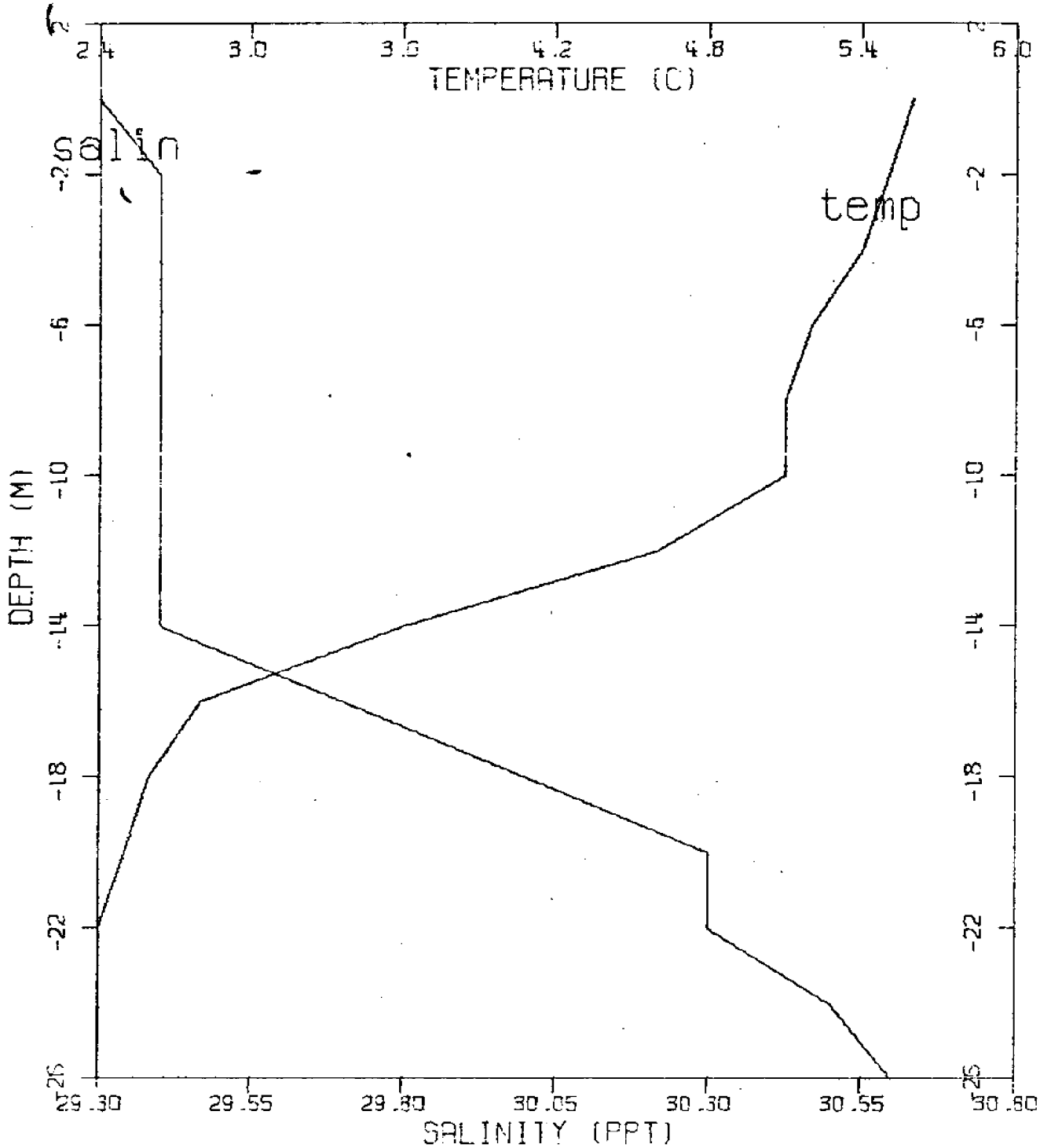
CTD Station 33 Position 42-19-12N
70-46-00W

Date 04 22 73 Time - 00 GMT



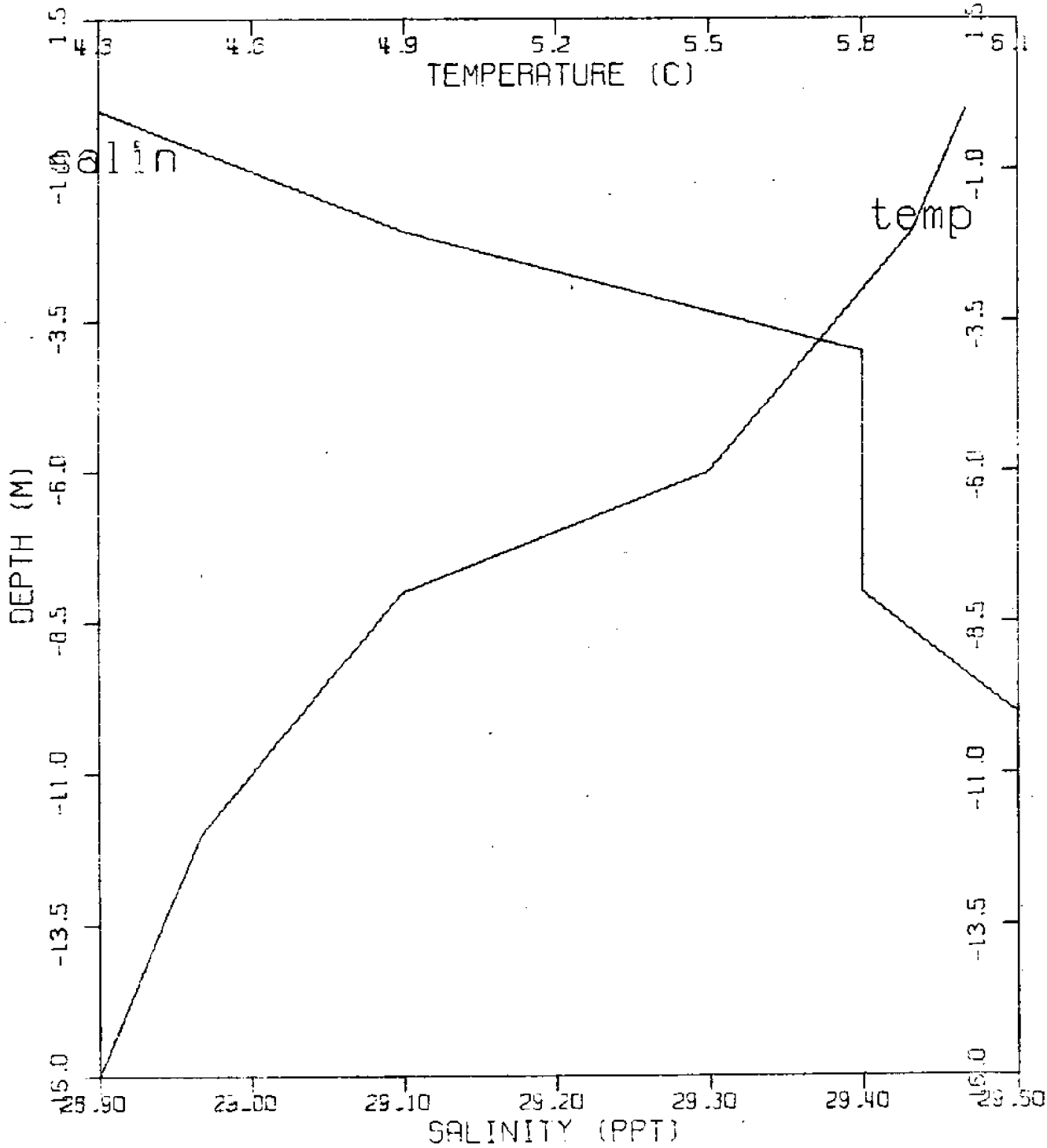
CTD Station 23 Position 42-20-42W
70-45-00N

Date 04 23 79 Time - 00 GMT



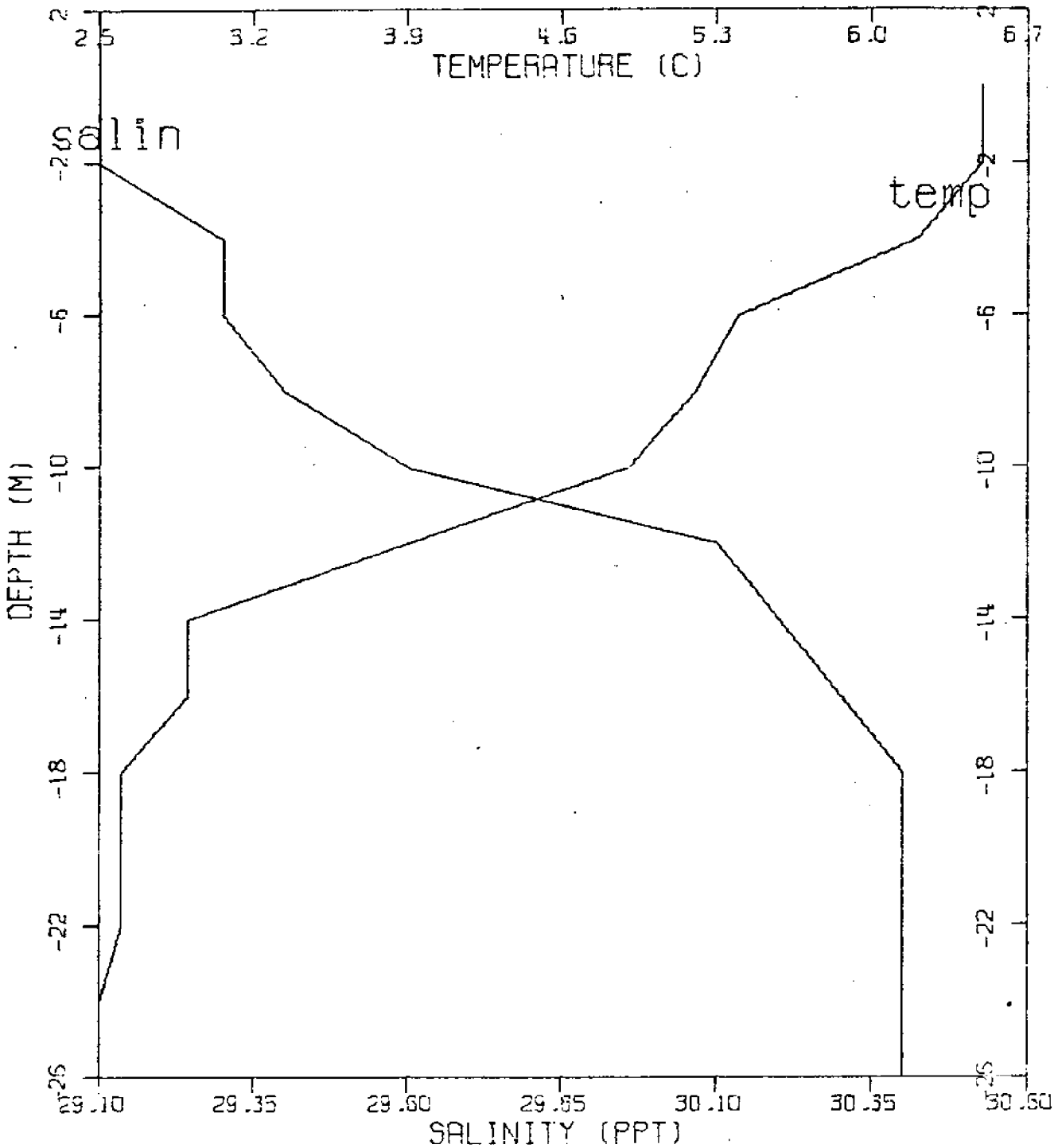
CTD Station 3i Position 42-13-12W 70-51-50N

Date 04 23 73 Time - 00 GMT



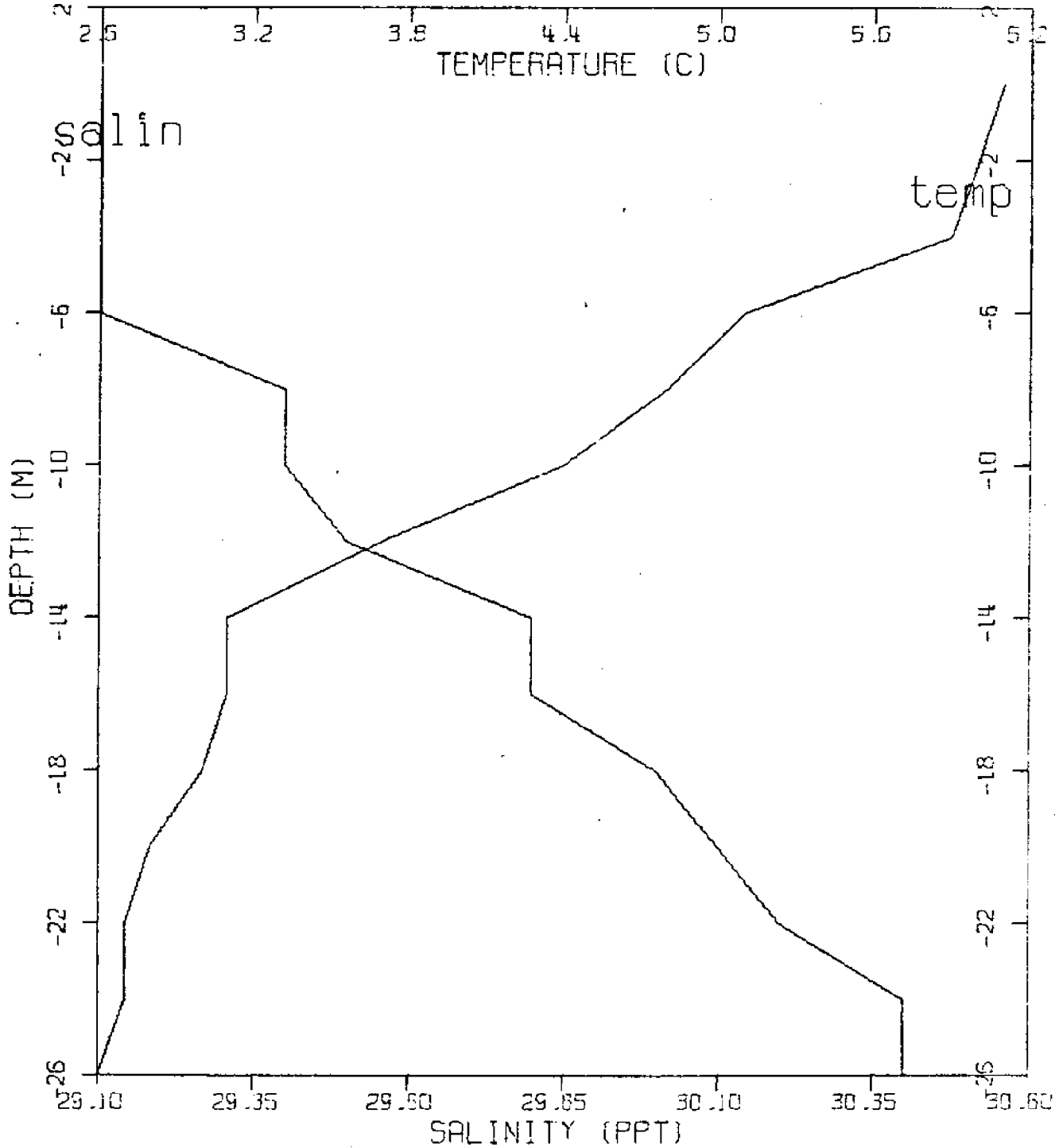
CTD Station 22 Position 42-20-42W
70-49-00N

Date 04 23 73 Time - 00 GMT



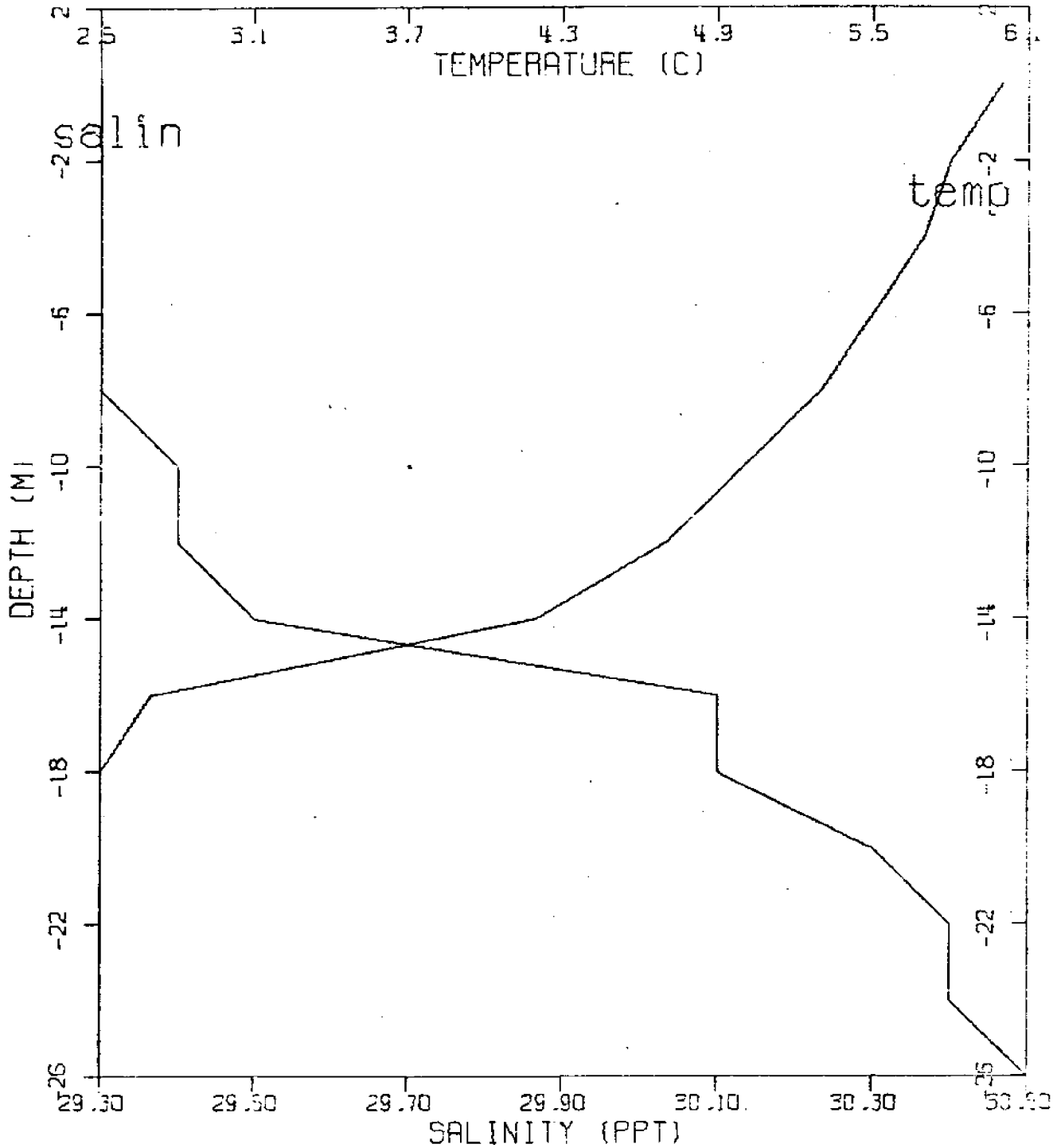
CTD Station 14 Position 42-22-12W 70-43-15N

Date 04 23 73 Time - 00 GMT



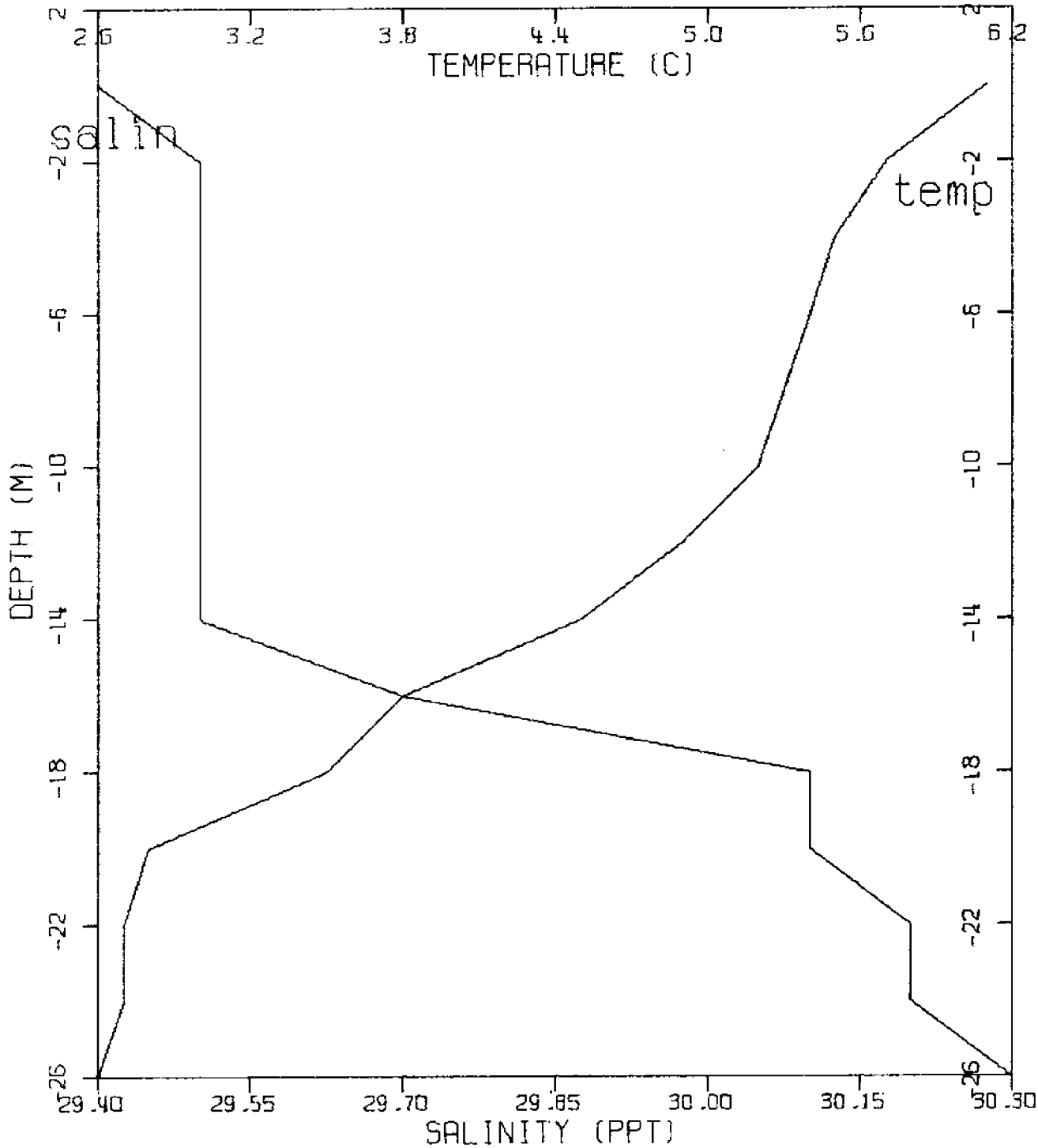
CTD Station 13 Position 42-22-12N 70-46-00W

Date 04 26 73 Time - 00 GMT



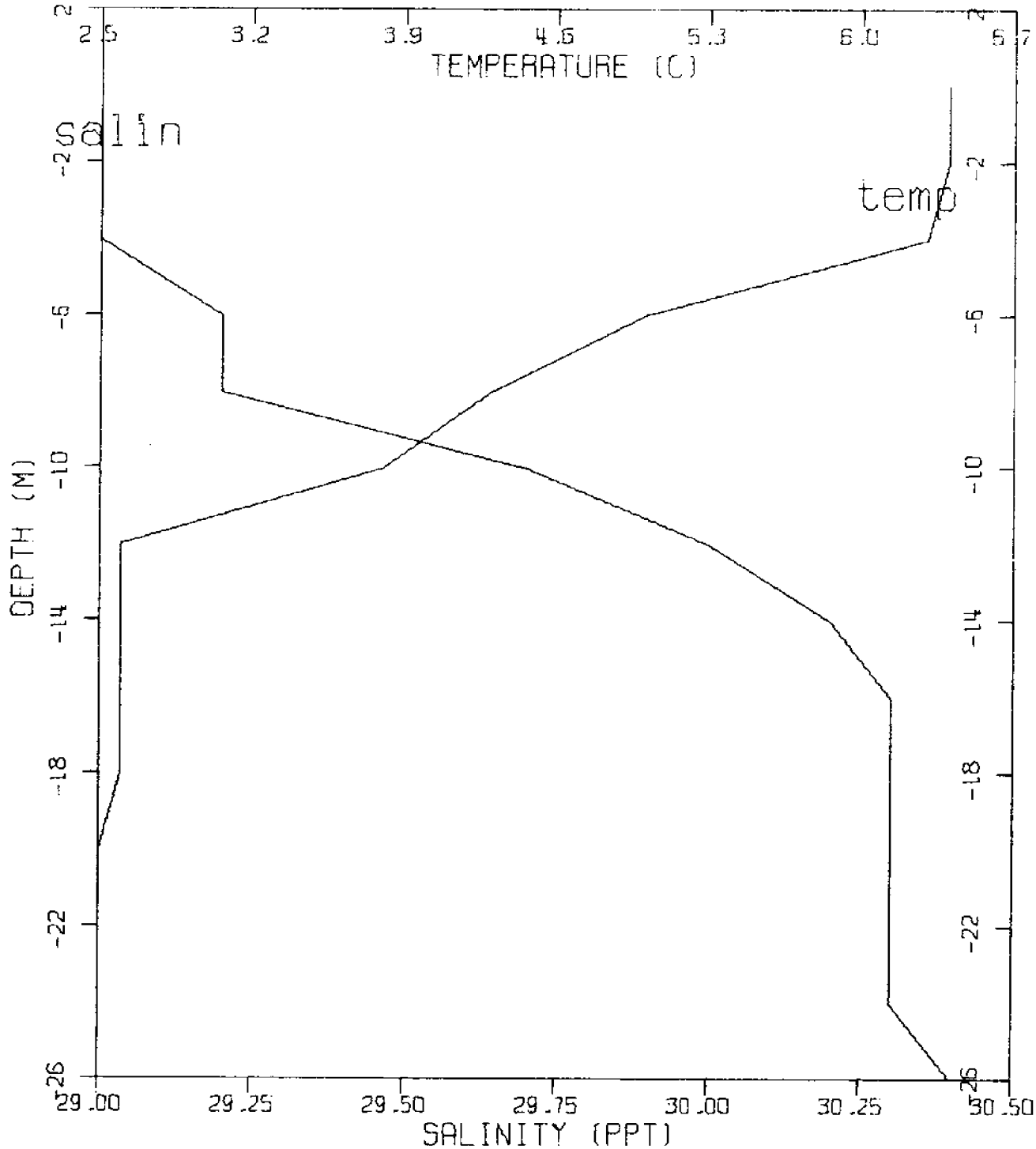
CTD Station 34 Position 42-19-12W 70-43-15N

Date 04 23 73 Time - 00 GMT



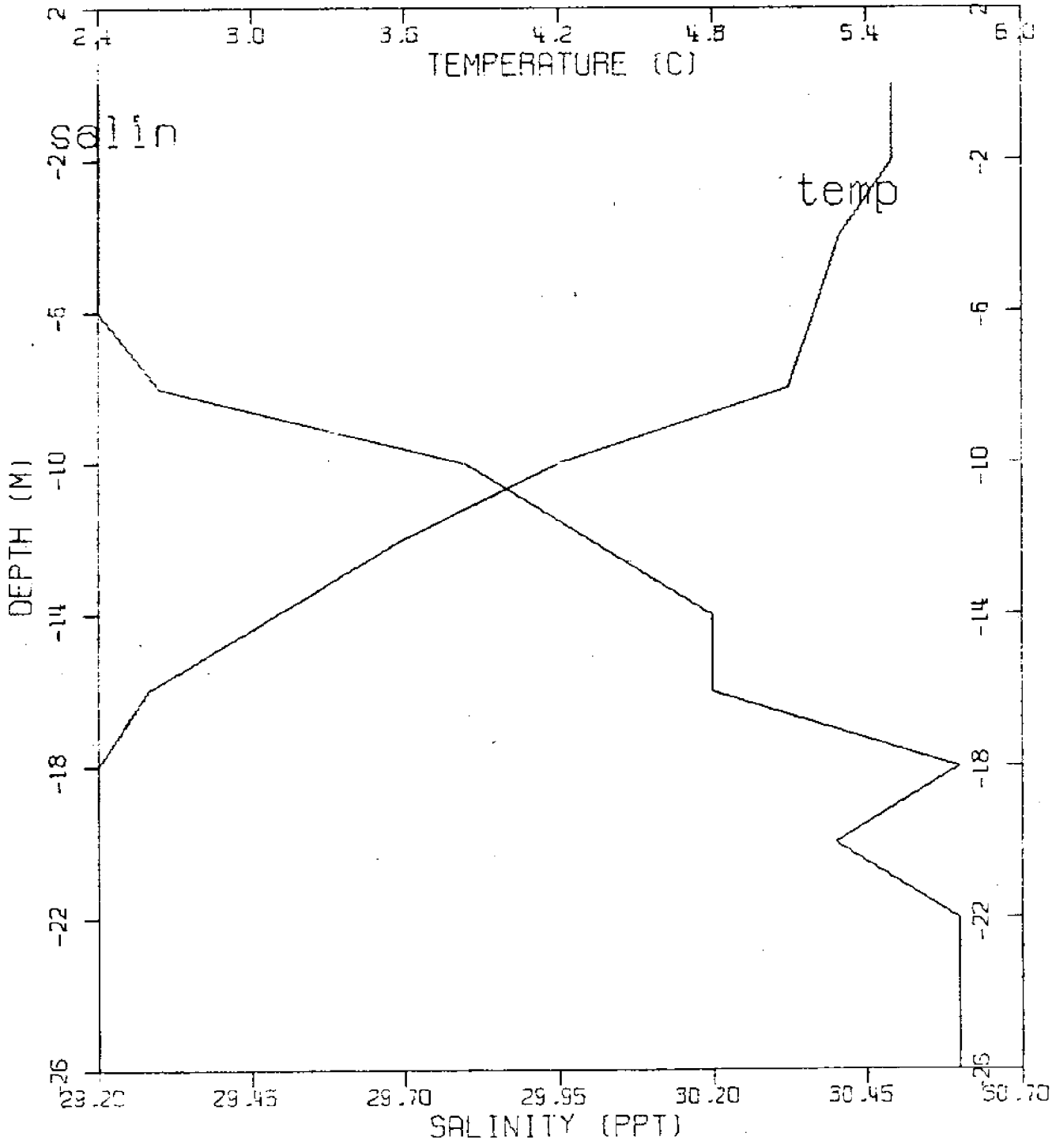
CTD Station 21 Position 42-20-42W 70-51-50N

Date 04 23 73 Time - 00 GMT



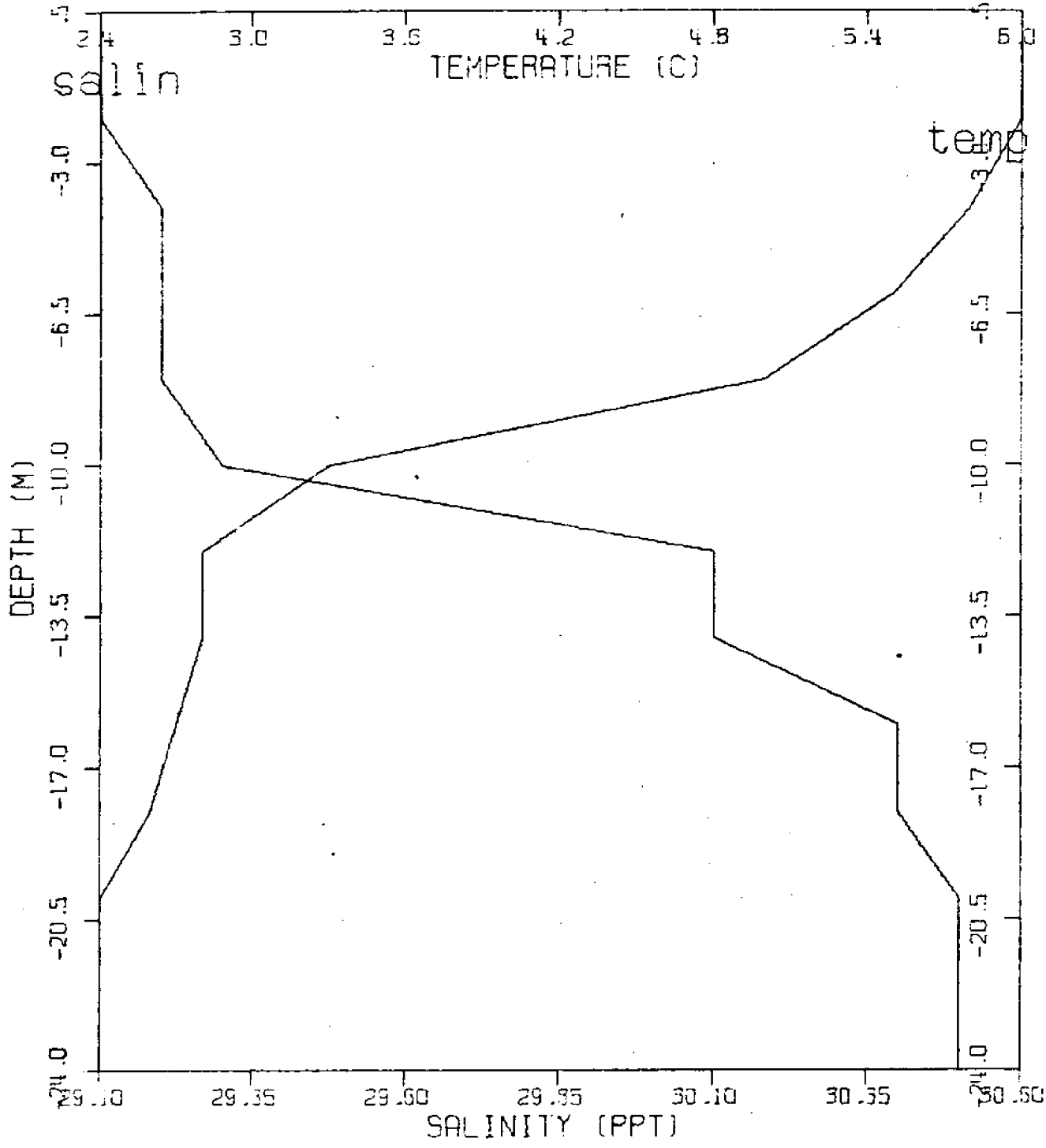
CTD Station 11 Position 42-22-12W
70-51-50N

Date 04 23 73 Time --00 GMT



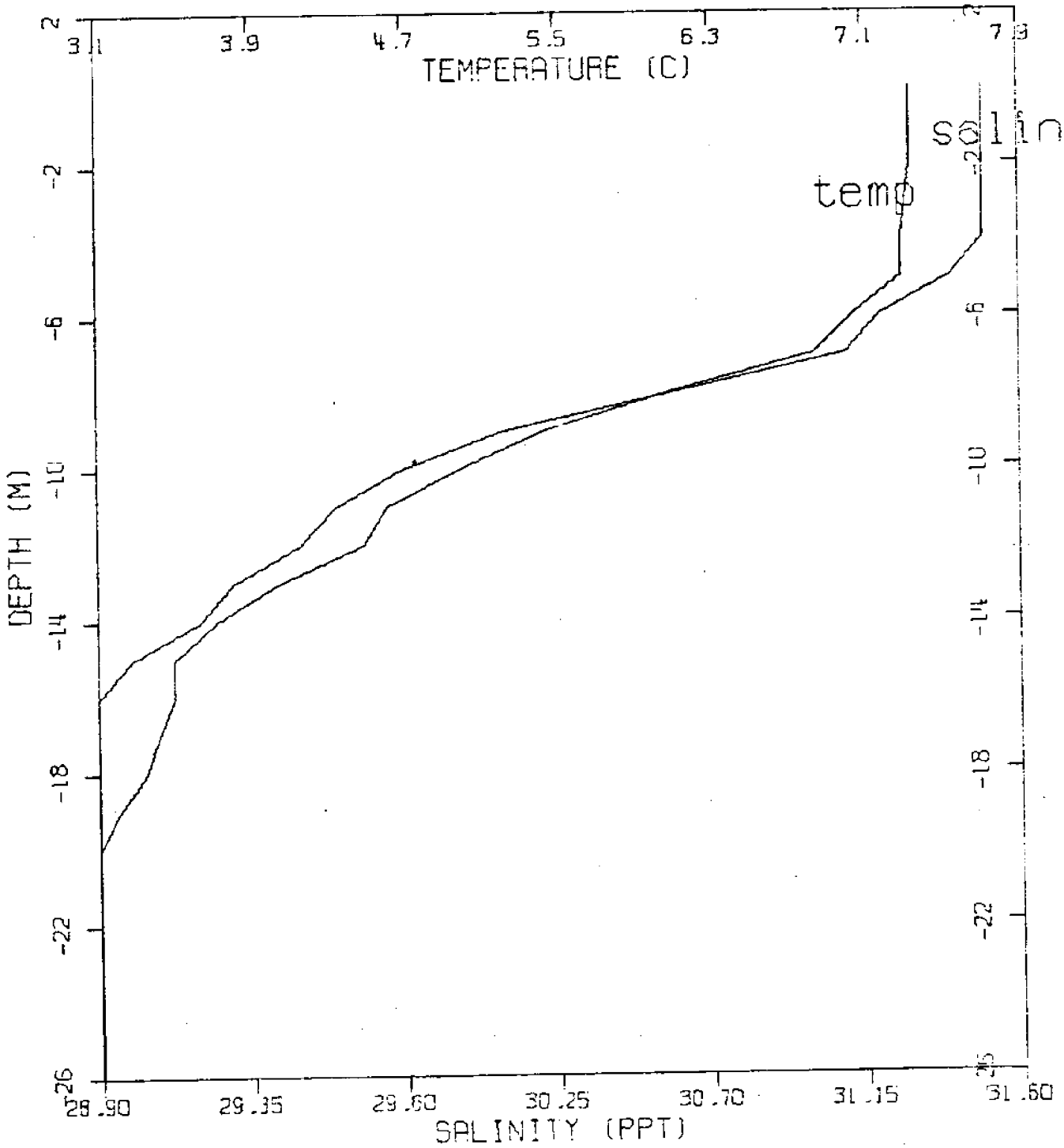
CTD Station 12 Position 42-22-12W 70-49-00N

Date 04 23 73 Time - 00 GMT



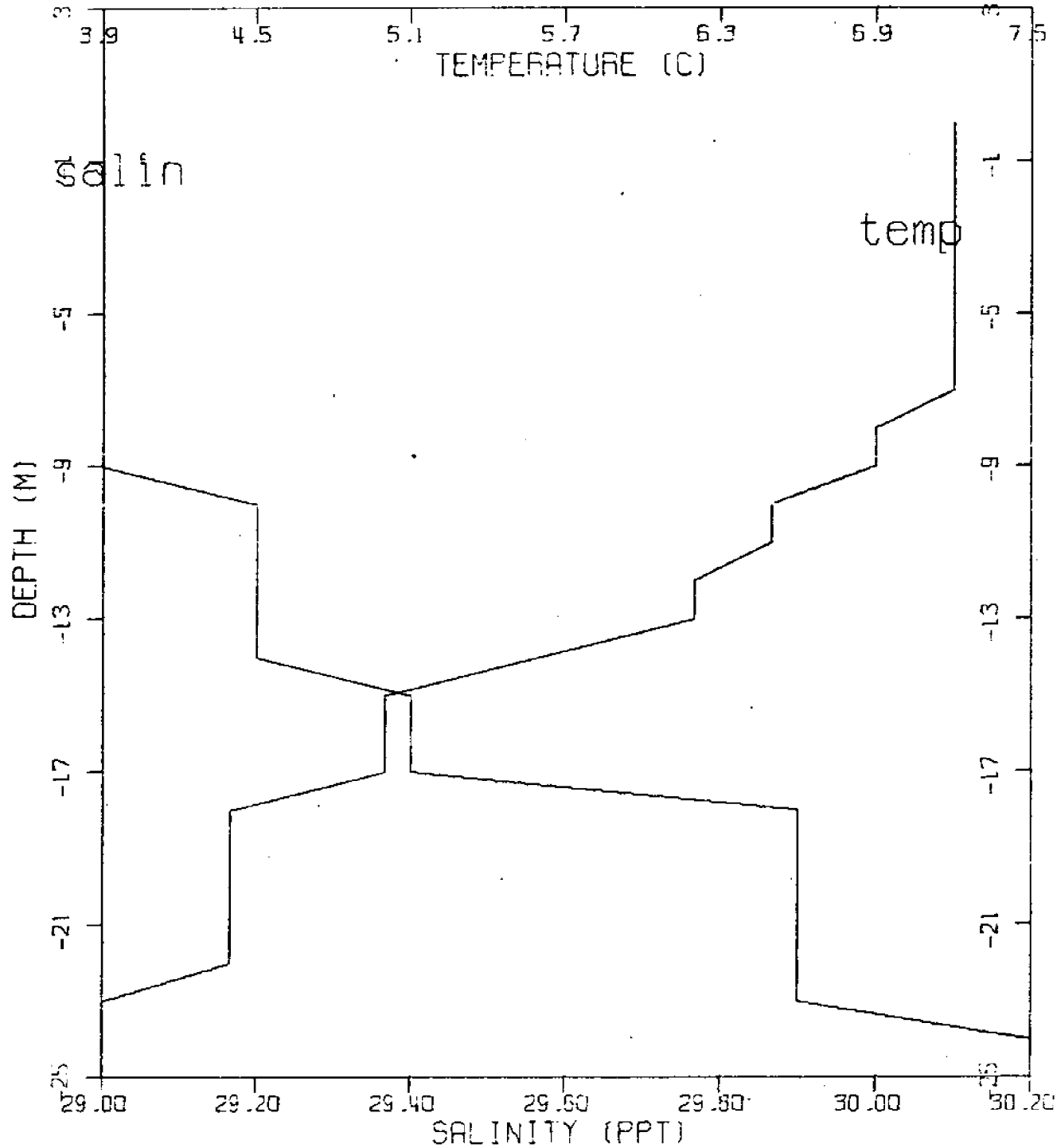
CTD Station 23 Position 42-20-42N 70-49-00N

Date 04 25 73 Time 1600 GMT



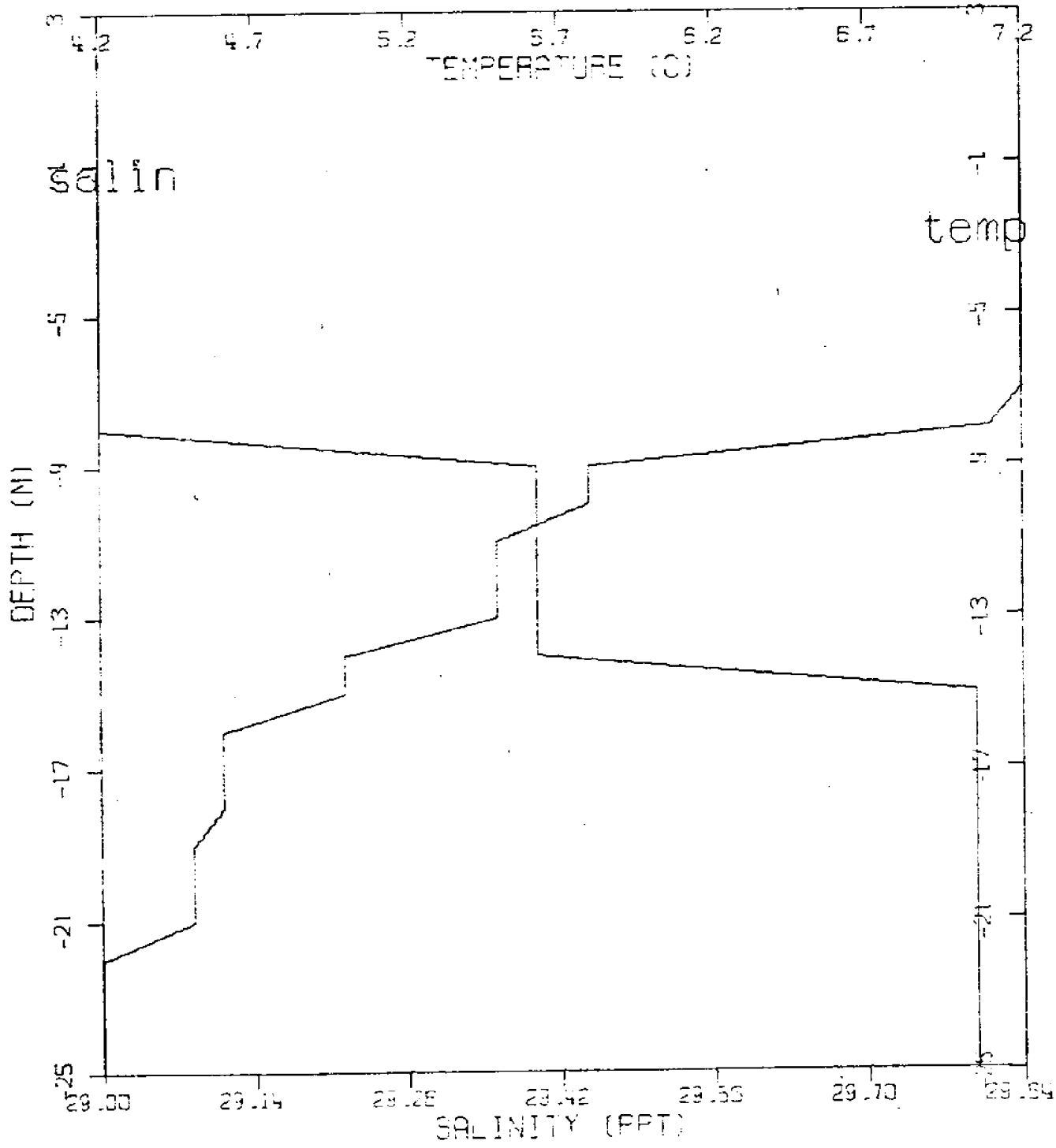
CTD Station 14 Position 42-22-12W
70-43-15N

Date 05 05 73 Time 1700 GMT



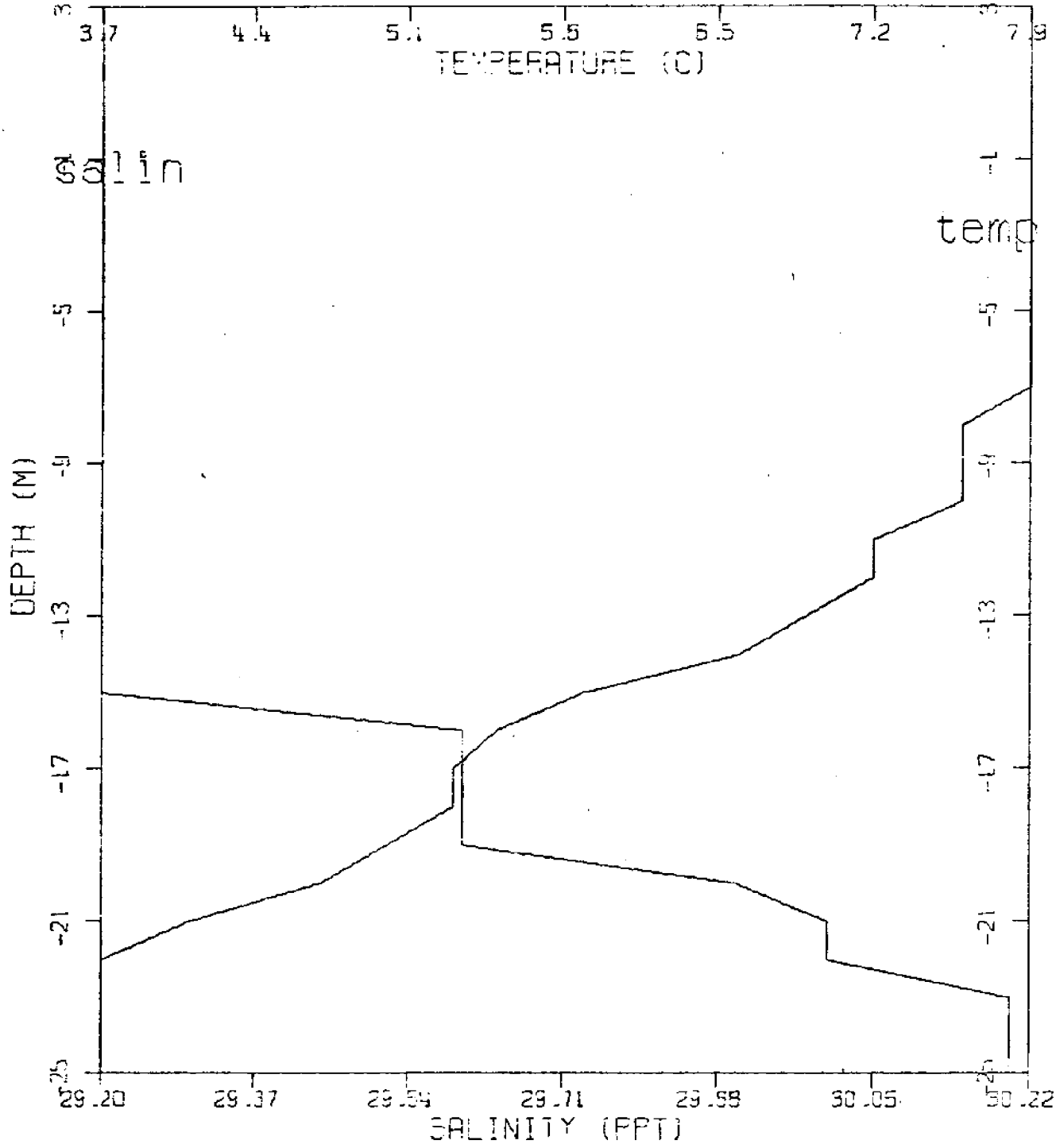
CTD Station 13 Position 43-22-12N
70-46-00W

Date 05 05 79 Time 1600 GMT



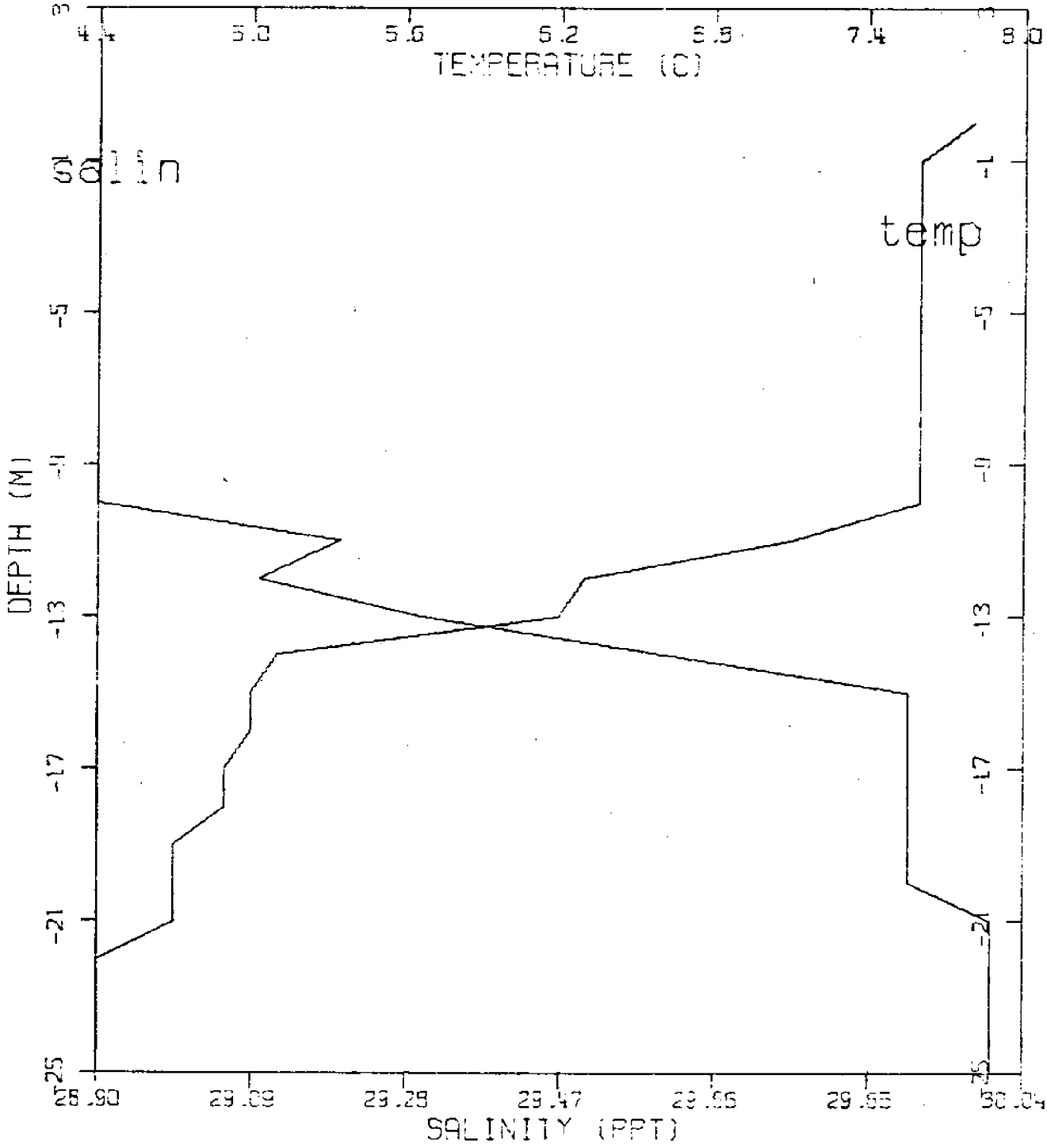
CTD Station 23 Position 42-20-42N
70-48-00W

Date 05 05 78 Time 1500 GMT



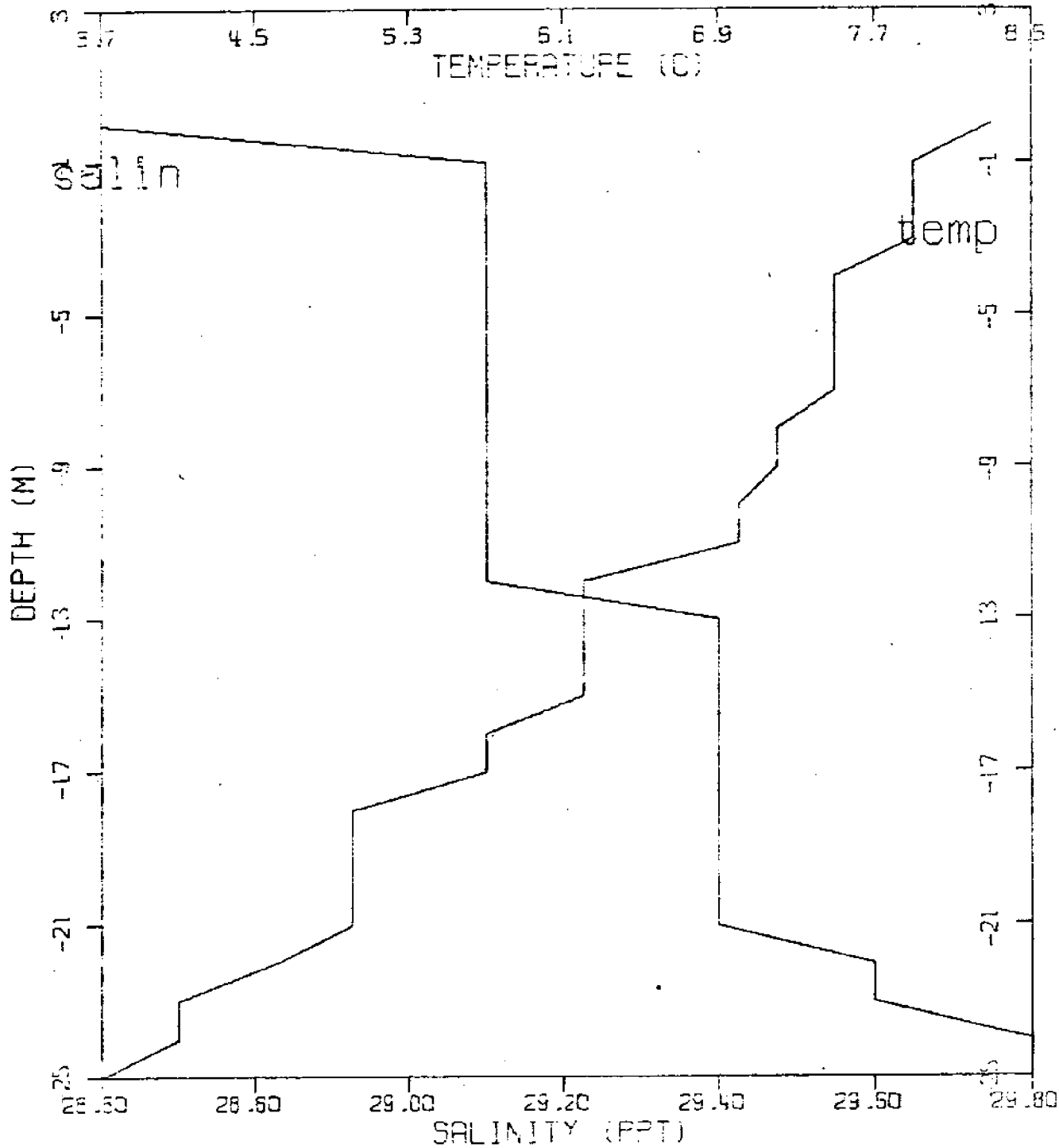
CTD Station 11 Position 42-22-12W
70-51-50N

Date 05 05 73 Time 1400 GMT



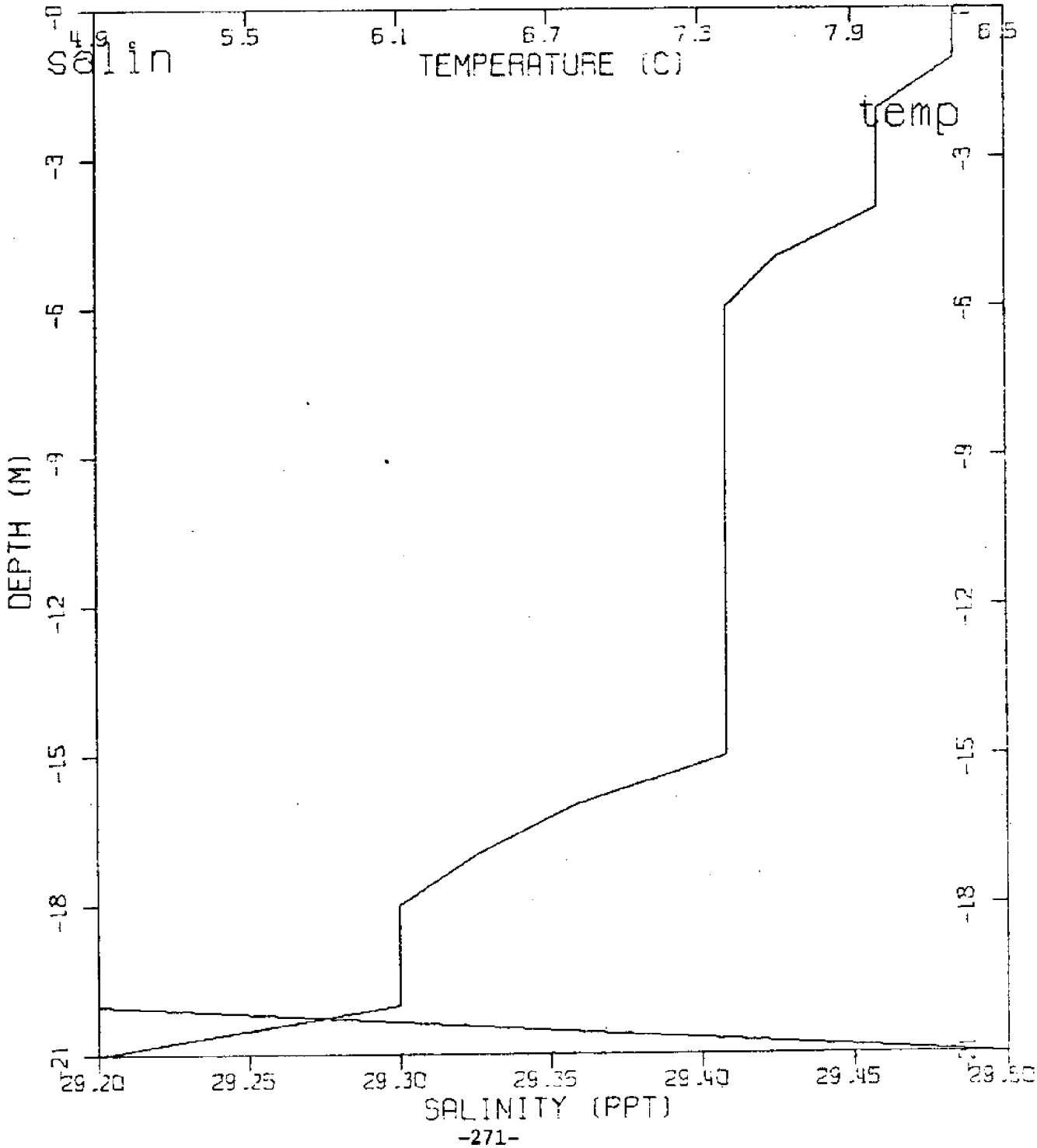
CTD Station 33 Position 42-19-13W 70-43-00N

Date 05 05 73 Time 1800 GMT



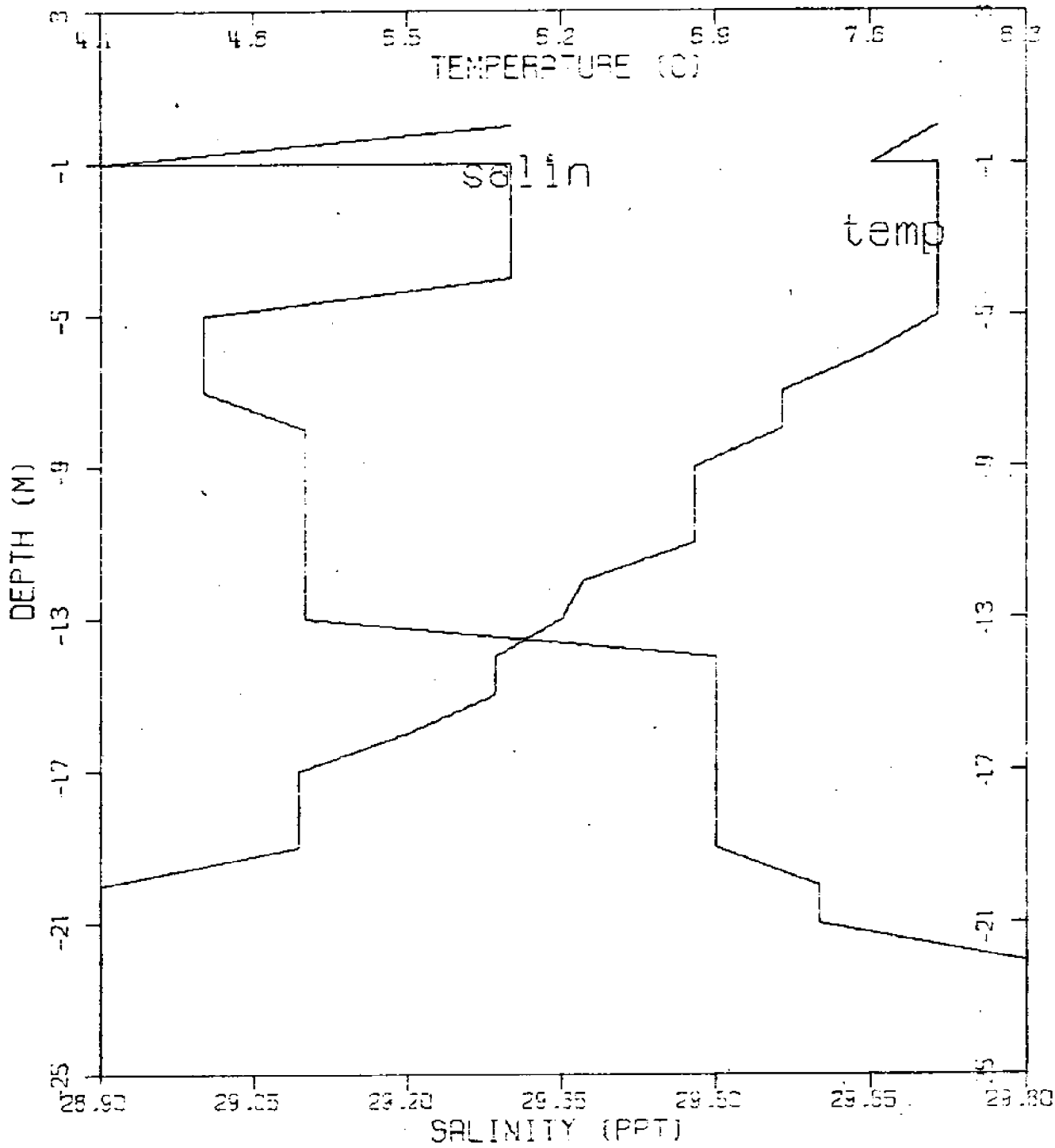
CTD Station 32 Position 42-19-12W 70-49-00N

Date 05 05 73 Time 2100 GMT



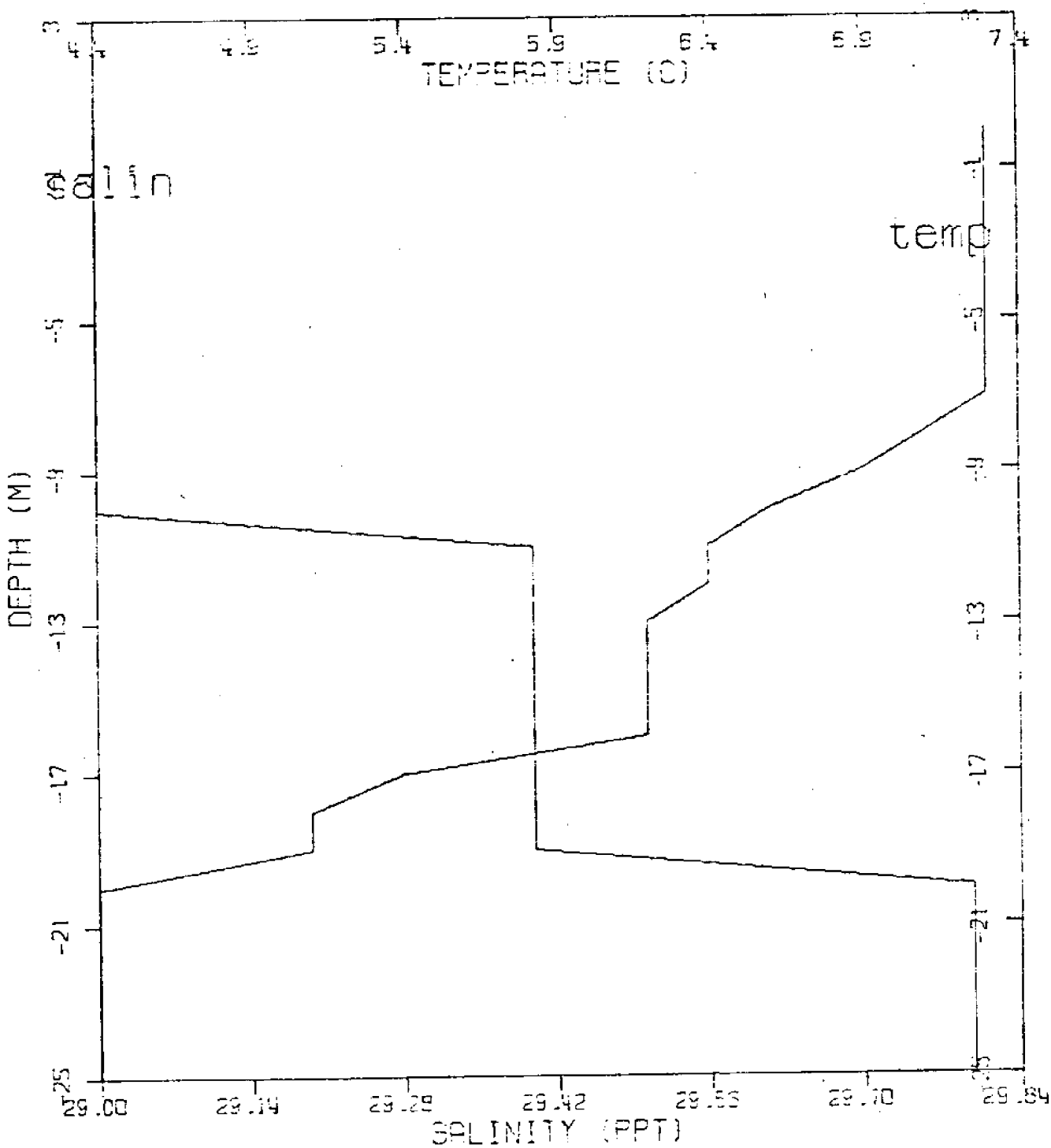
CTD Station 12 Position [illegible]

Date 05 05 78 Time 1530 GMT



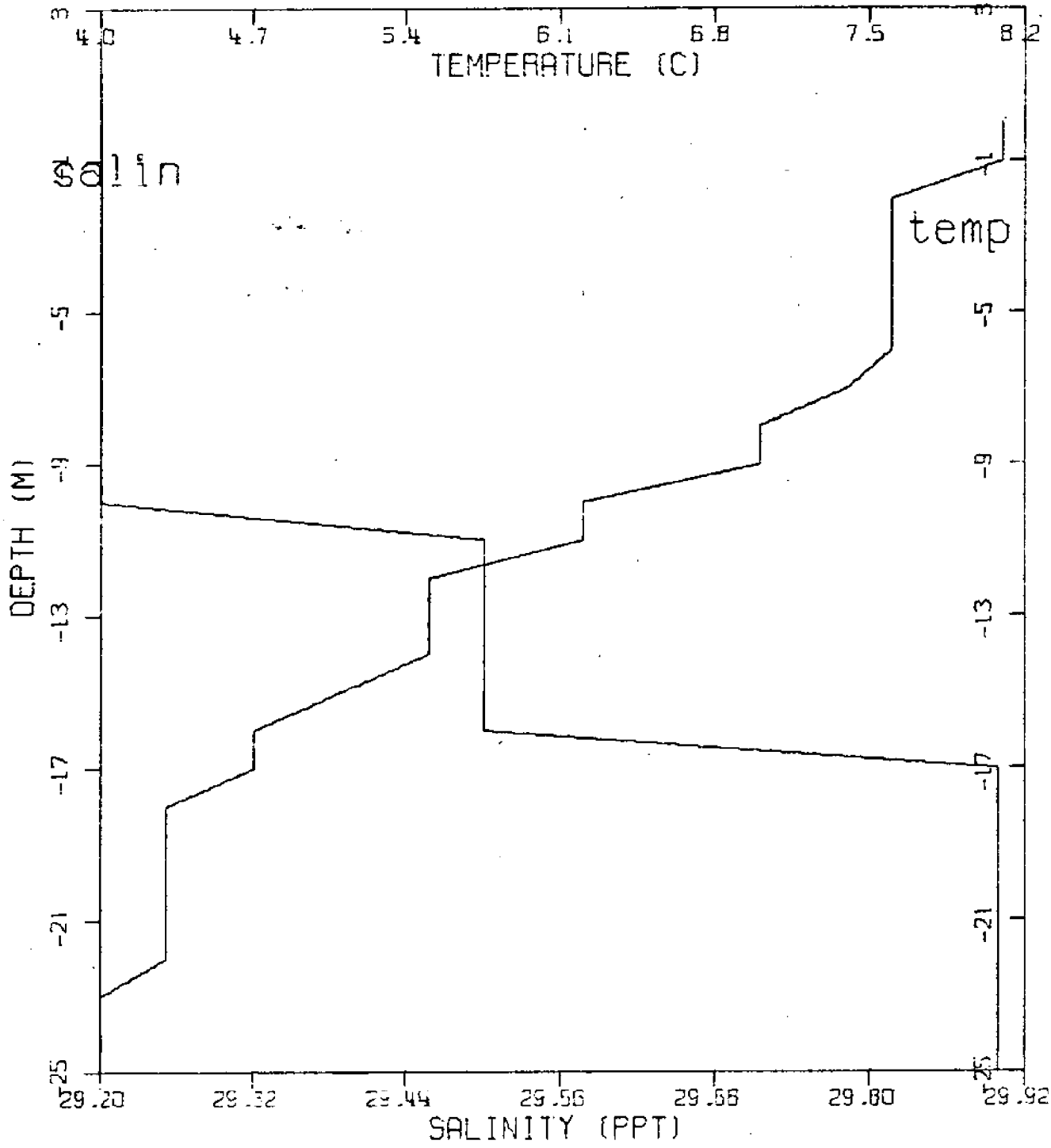
CTD Station 24 Position 42-20-42N
70-53-16W

Date 05 OE 73 Time 1700 GMT



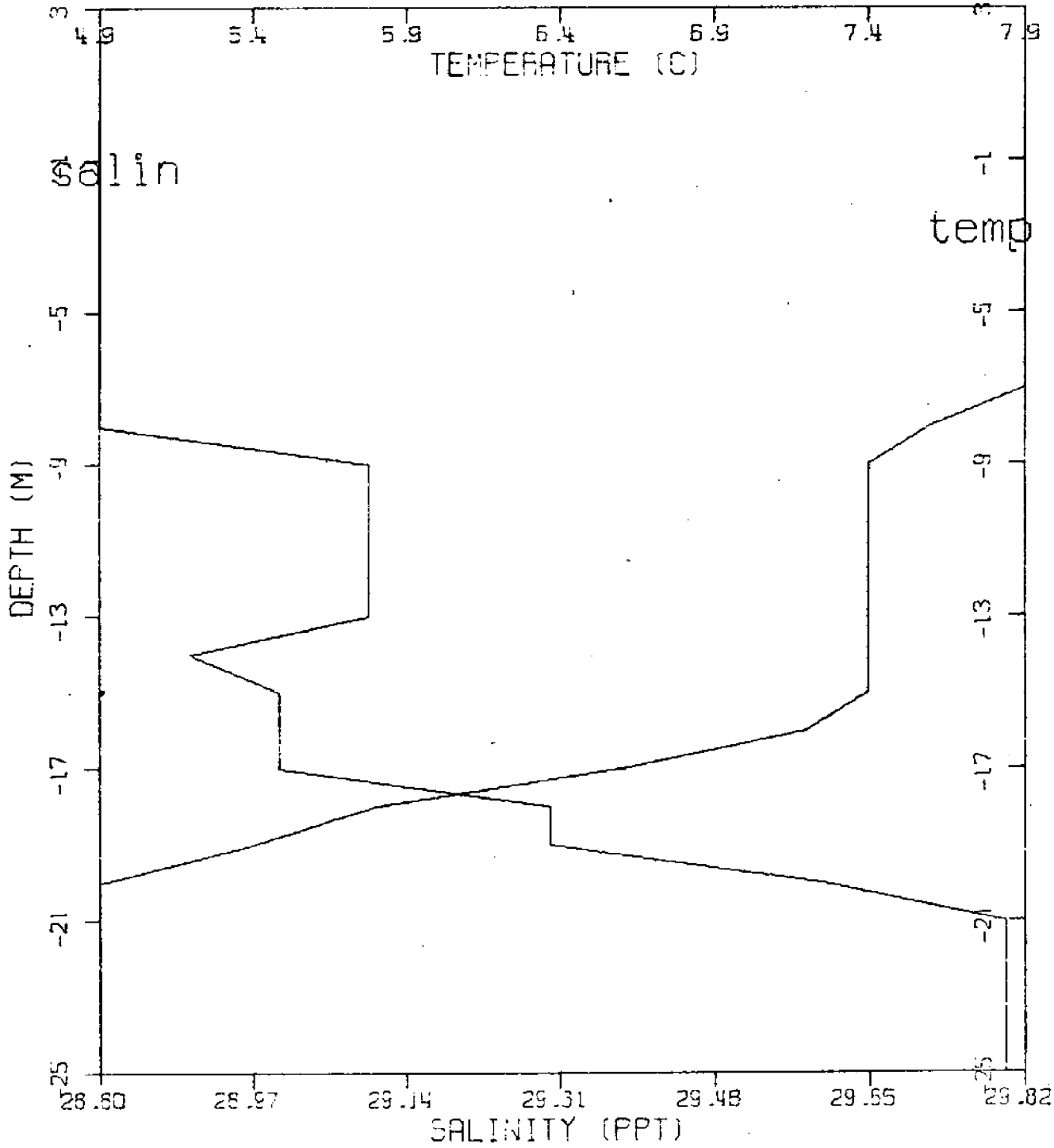
CTD Station 22 Position 42-20-42W 70-49-00N

Date 05 05 73 Time 1900 GMT



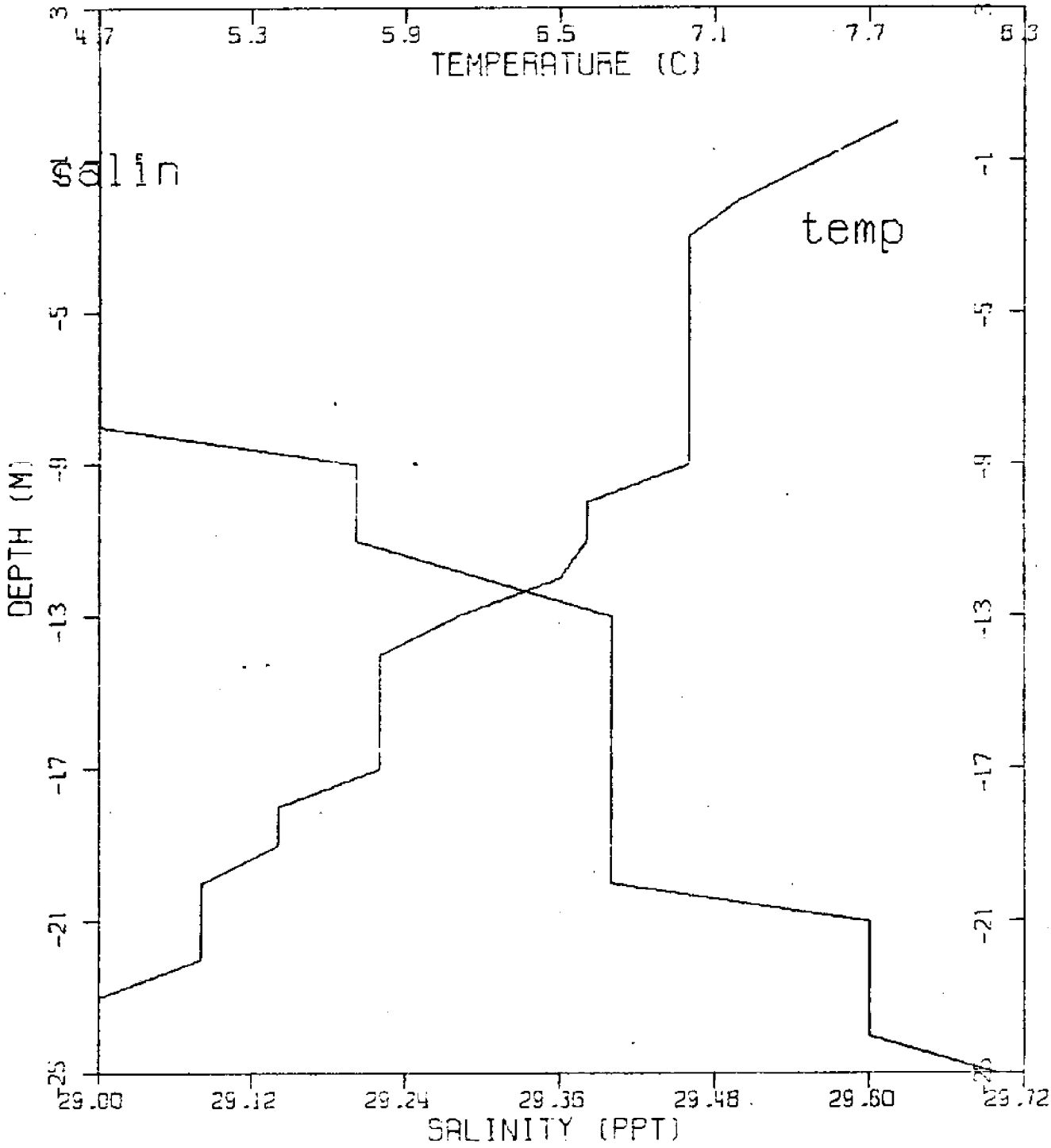
CTD Station 21 Position 42-20-42W 70-51-50N

Date 05 05 73 Time 2000 GMT



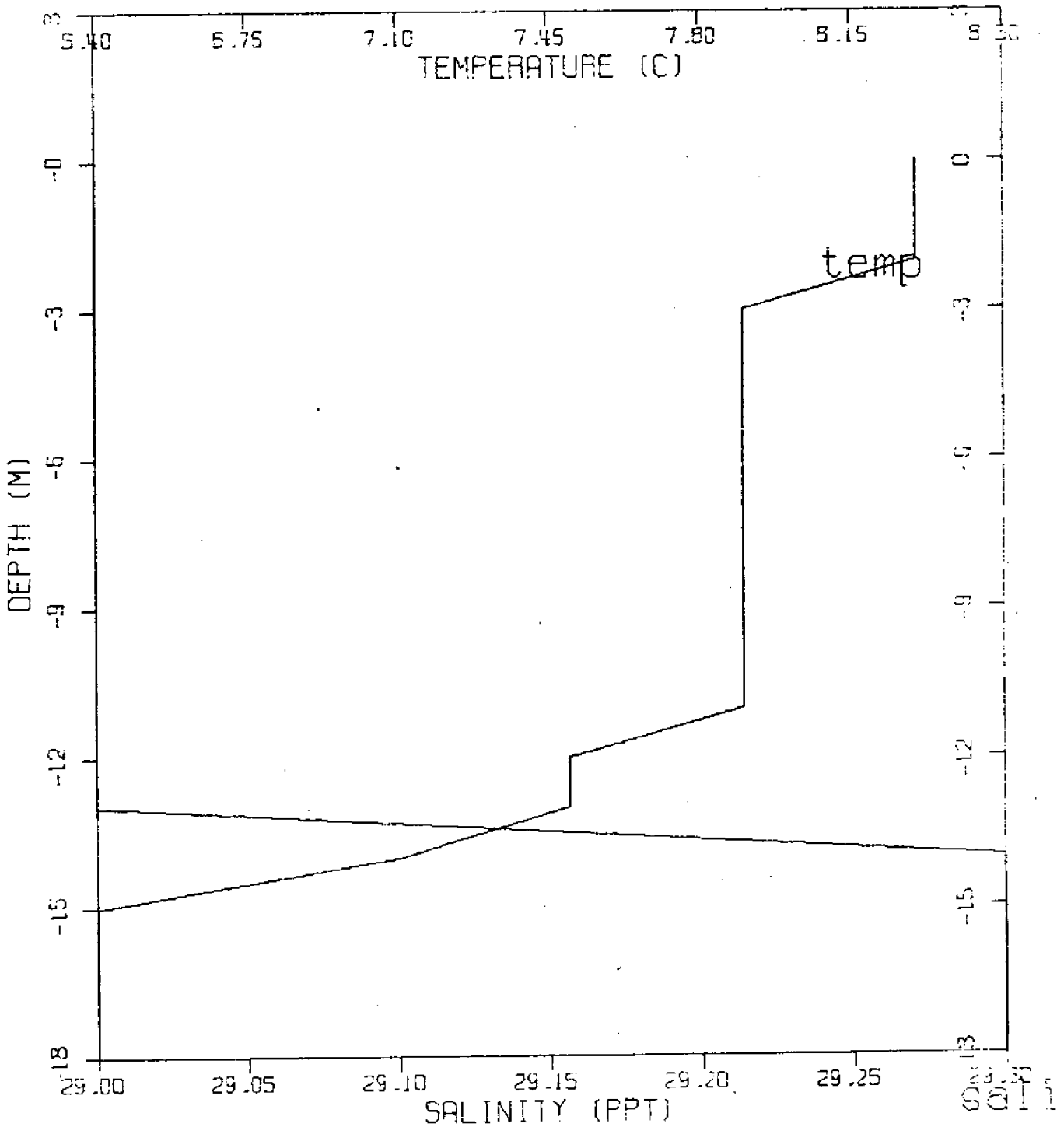
CTD Station 34 Position 42-19-12W 70-43-15N

Date 05 05 73 Time 1800 GMT



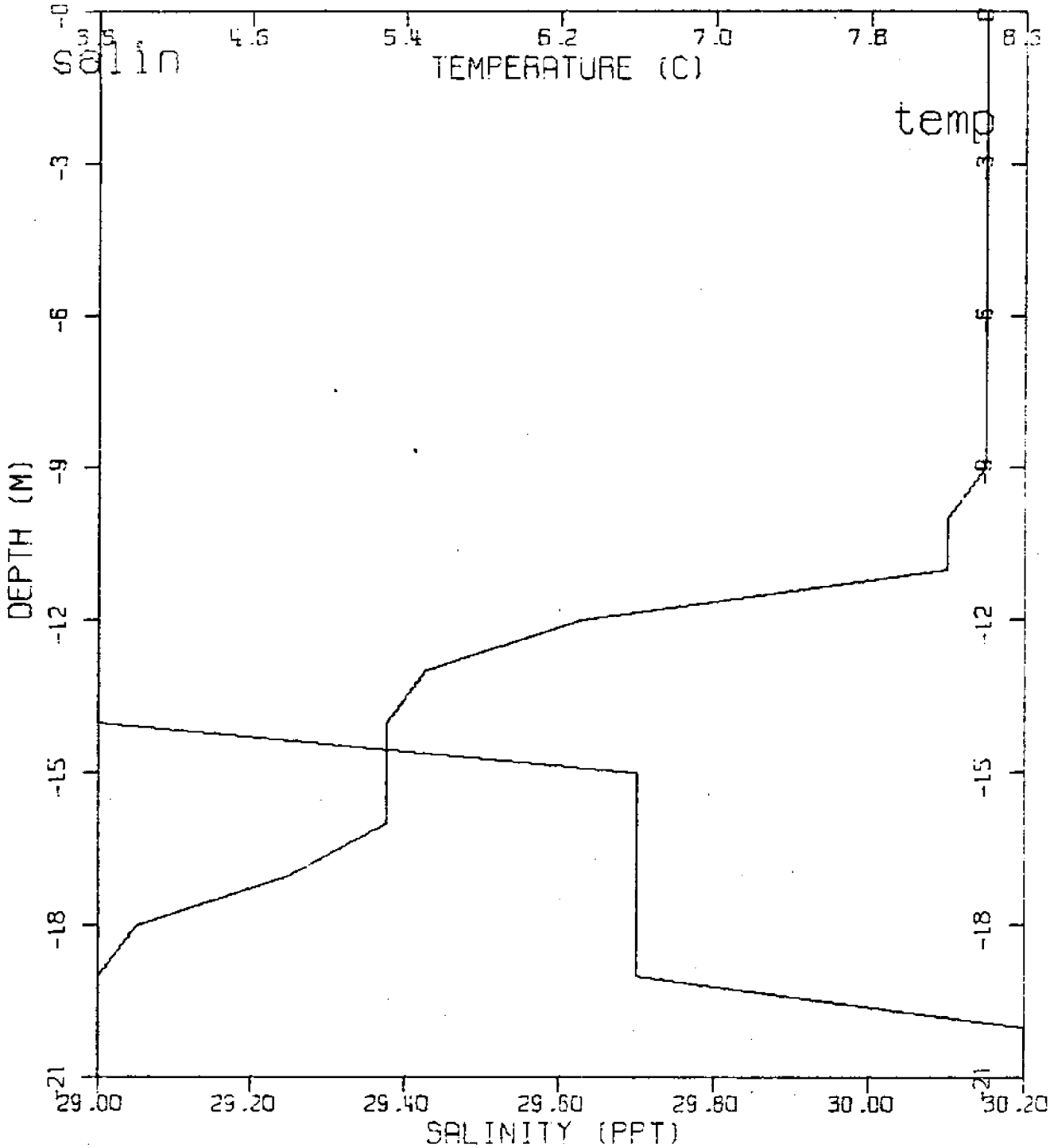
CTD Station 42 Position 42-17-42N 70-49-00N

Date 05 05 73 Time 1900 GMT



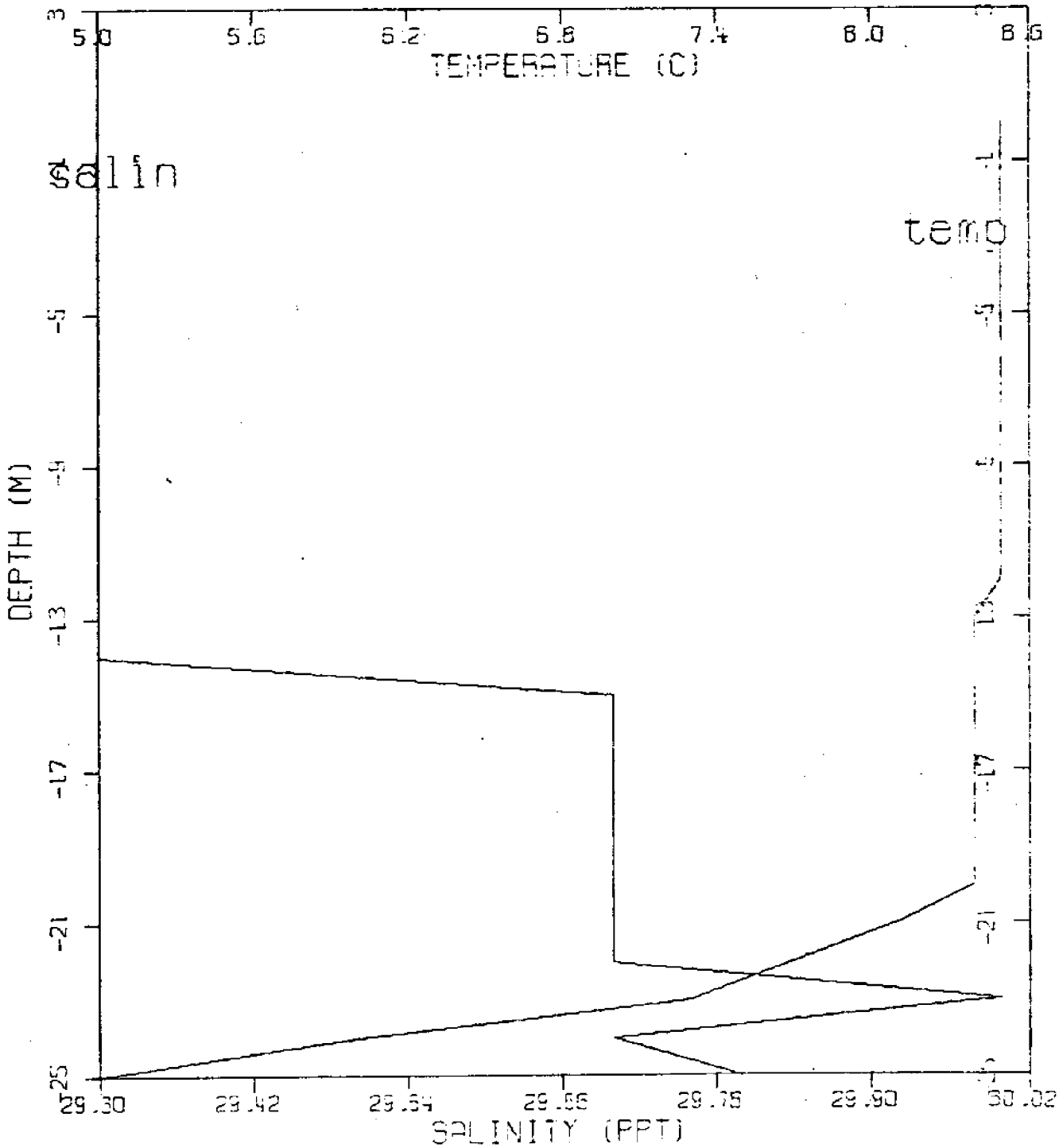
CTD Station 11 Position 42-22-12W
70-51-50N

Date 05 19 73 Time 1300 GMT



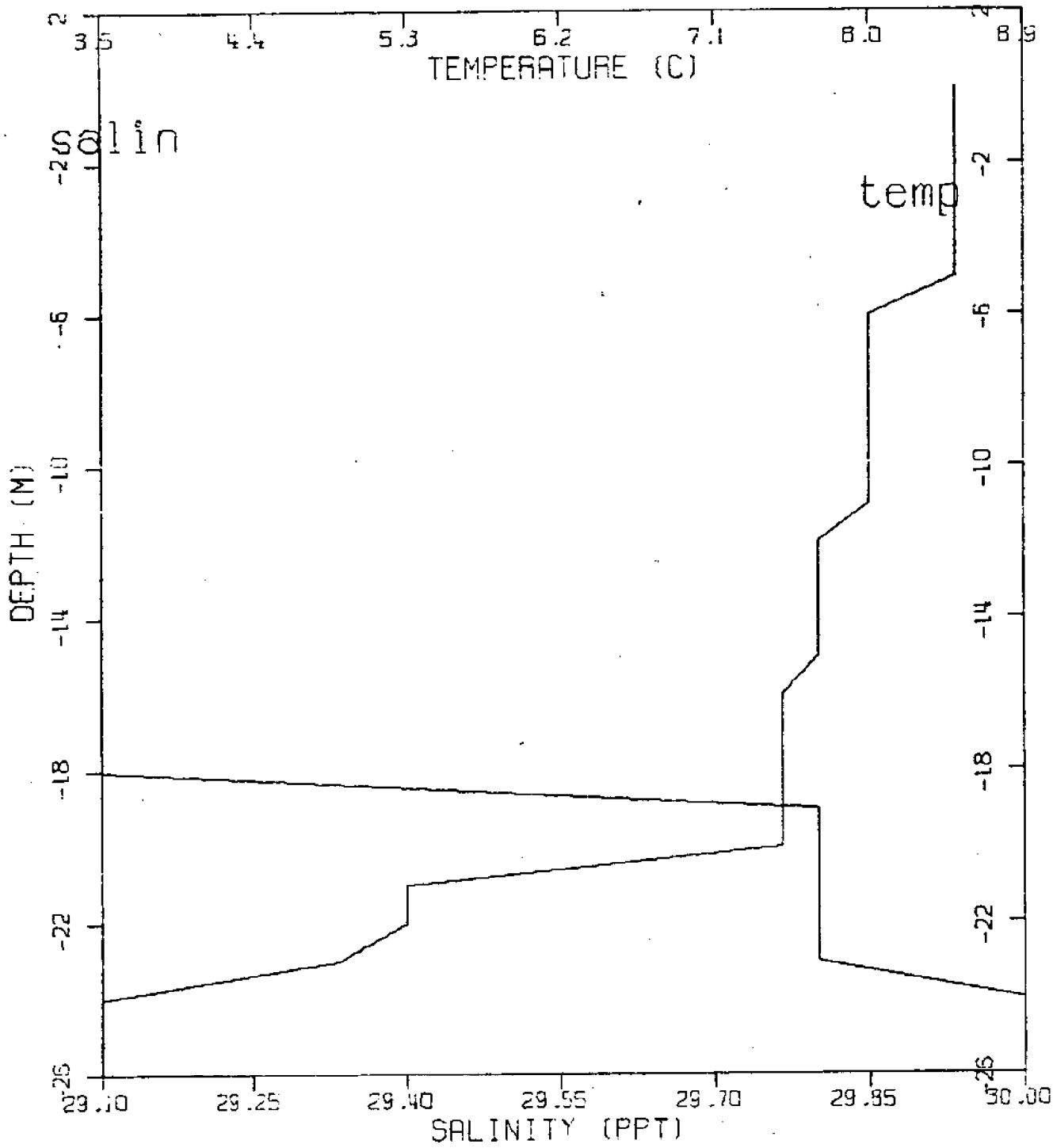
CTD Station 12 Position 42-22-13N
70-49 00W

Date 05 19 73 Time 1400 GMT



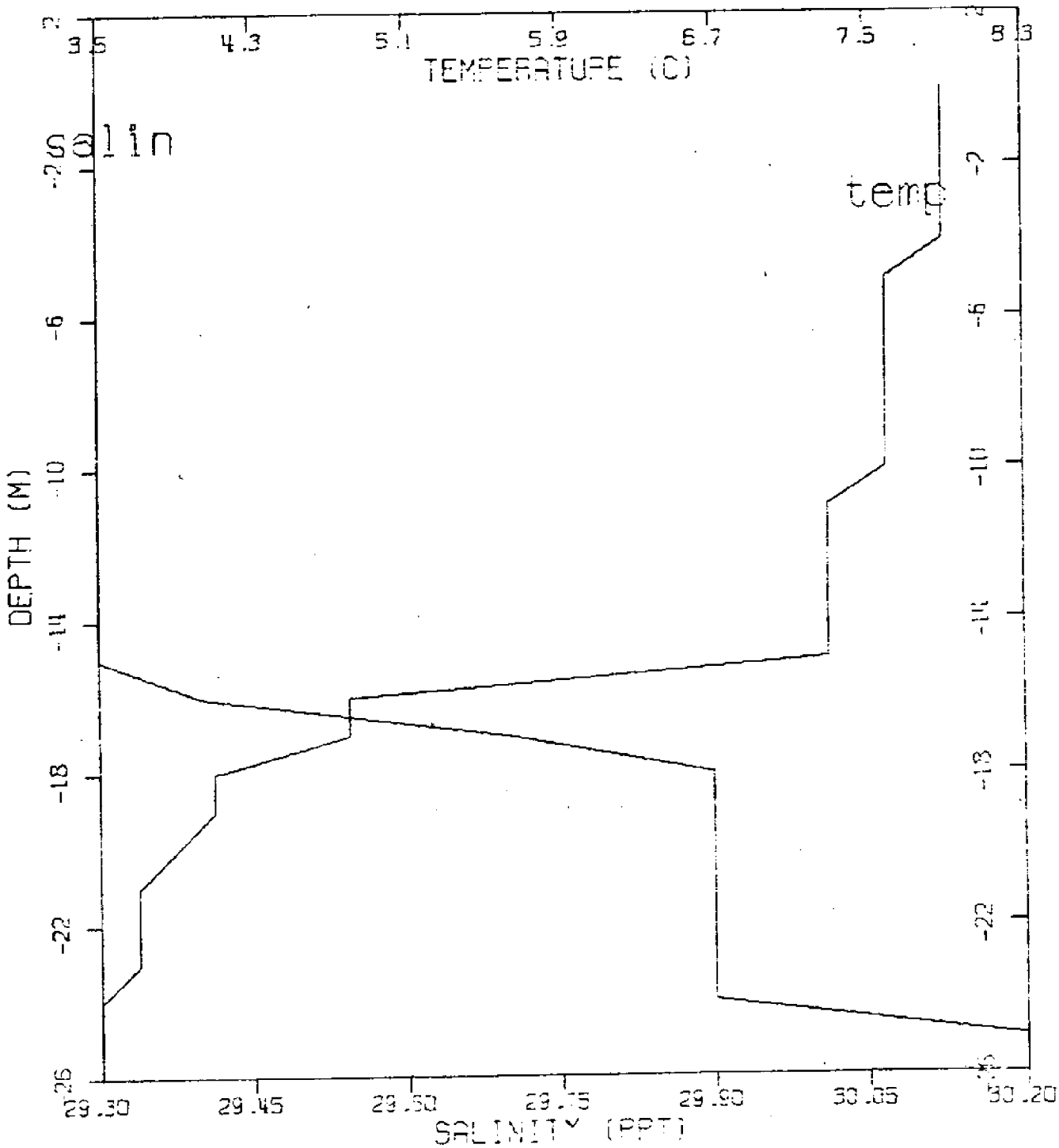
CTD Station 13 Position 42-22-12N 70-46-00N

Date 05 19 73 Time 1600 GMT



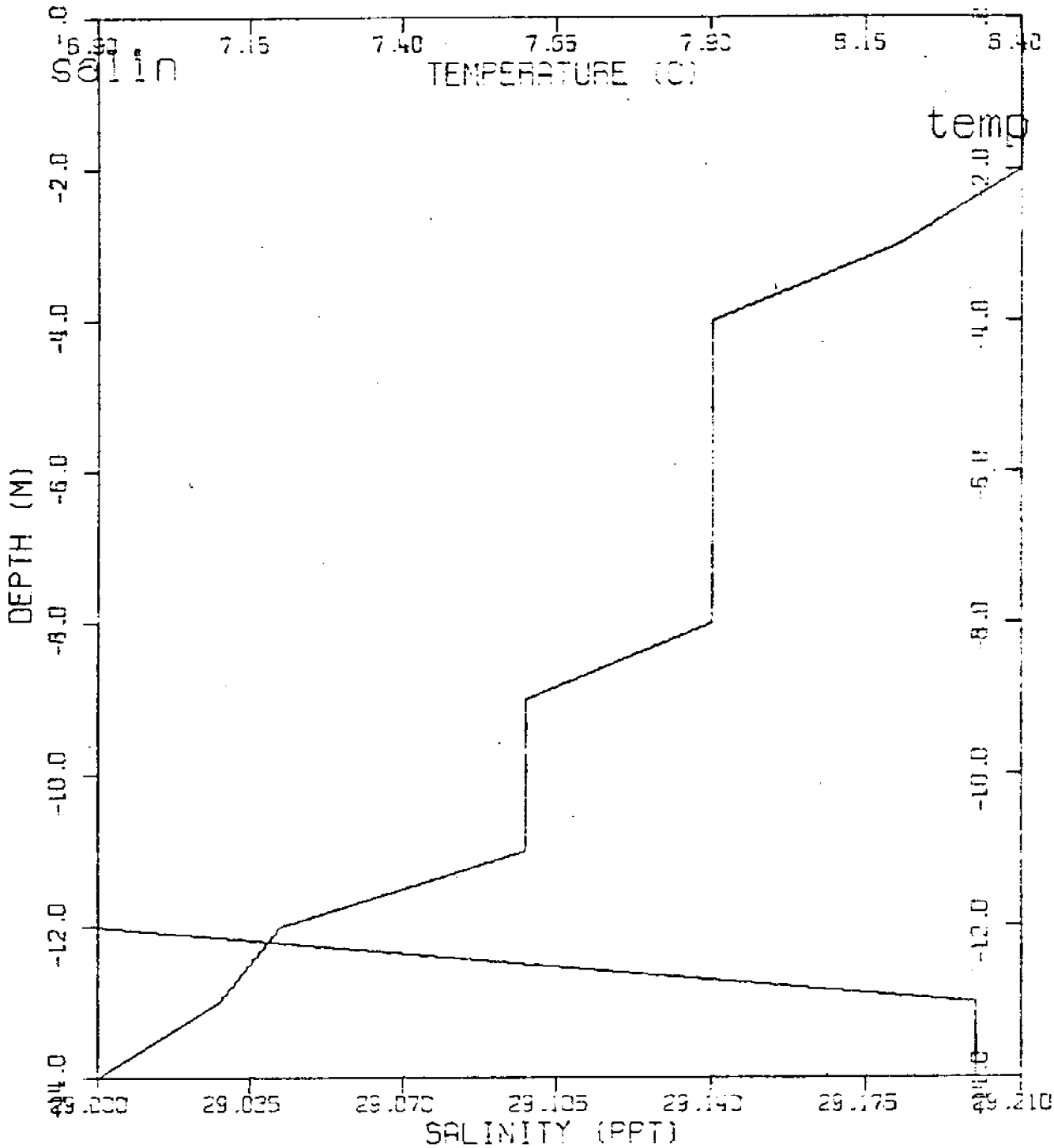
CTD Station 14 Position 42-22-12N
70-43-18W

Date 05 19 73 Time 1600 GMT



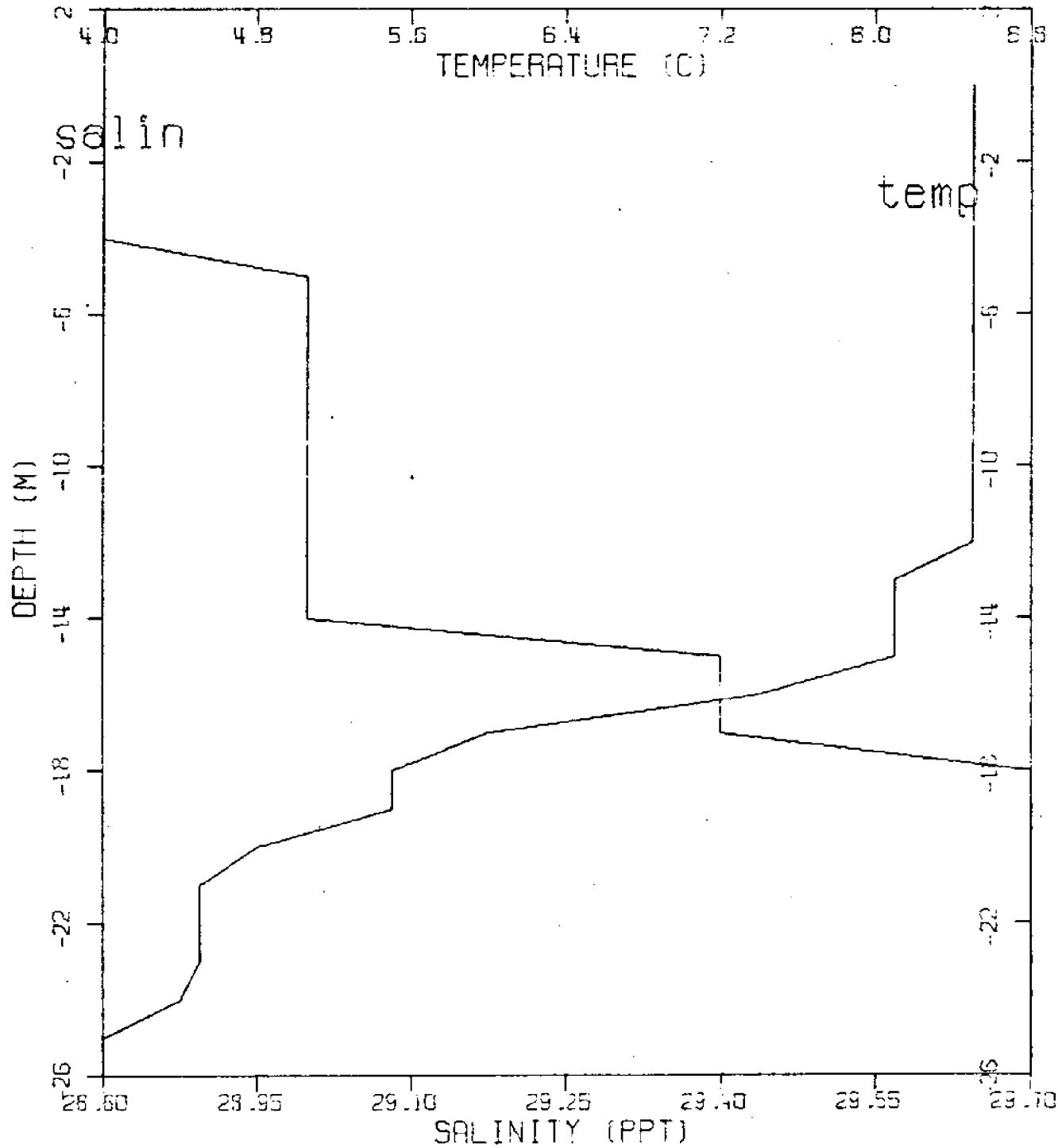
CTD Station 31 Position 42-19-12N 70-51-50W

Date 05 19 73 Time 1900 GMT



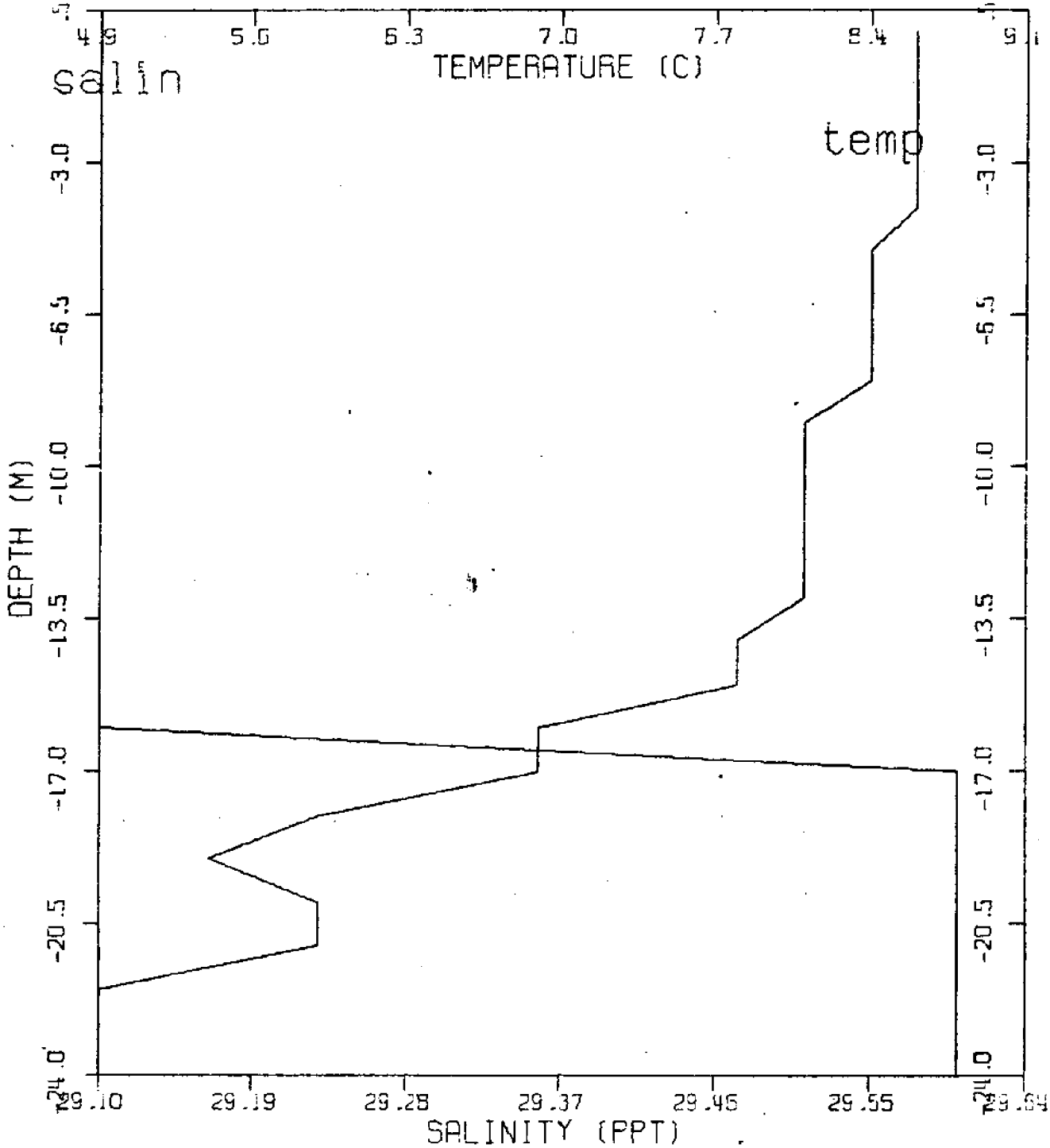
CTD Station 33 Position 42-19-12N
70-45-00W

Date 05 19 73 Time 1800 GMT



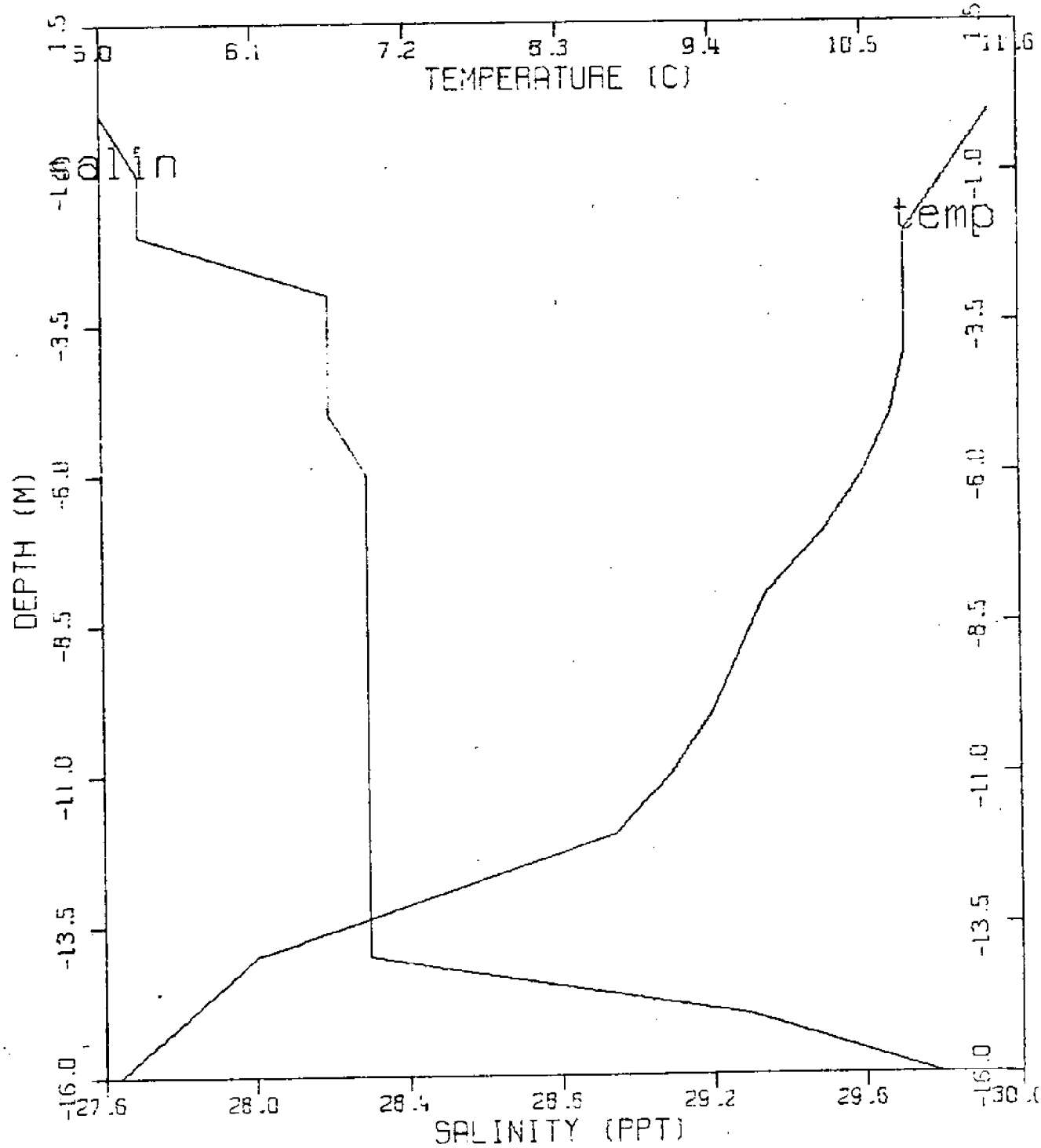
CTD Station 21 Position 42-20-42N
70-51-50W

Date 05 19 73 Time 2000 GMT



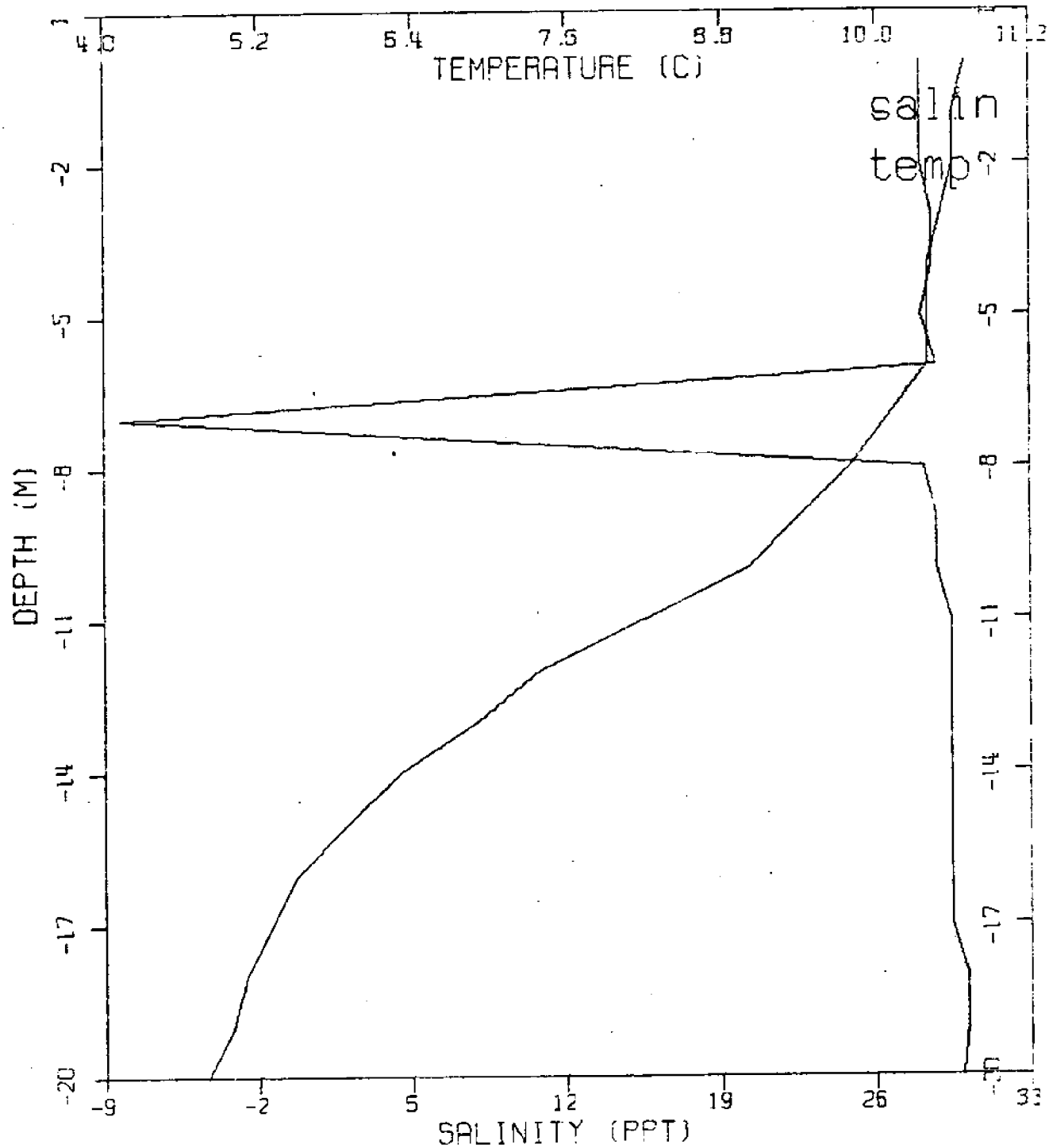
CTD Station 32 Position 42-19-12W 70-49-00N

Date 06 02 73 Time 2000 GMT



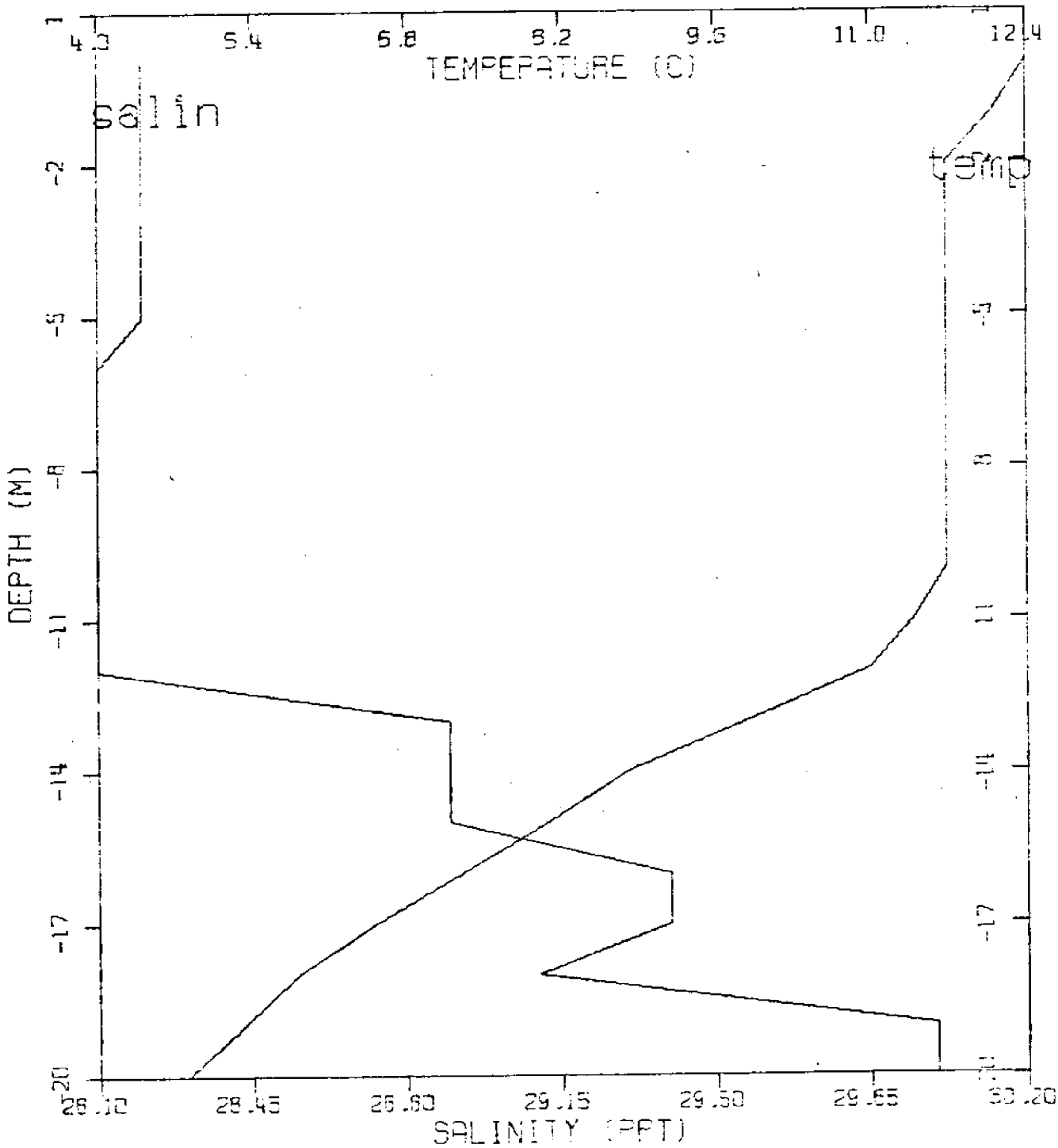
CTD Station 12 Position 42-22-12N 70-49-00W

Date 06 02 73 Time 1300 GMT



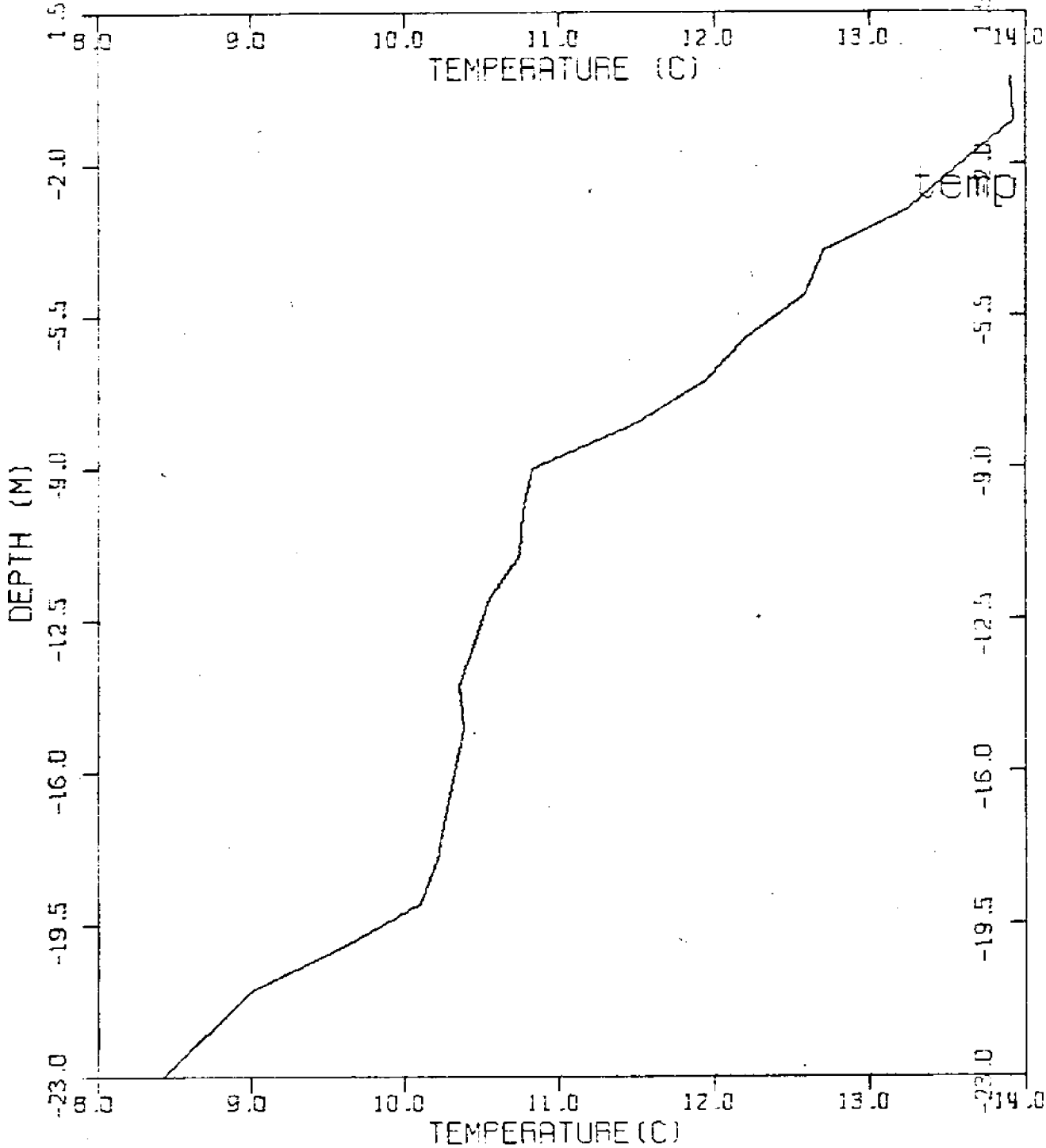
CTD Station 84 Position 42-19-12N
70-43-13W

Date 06 02 78 Time 1900 GMT



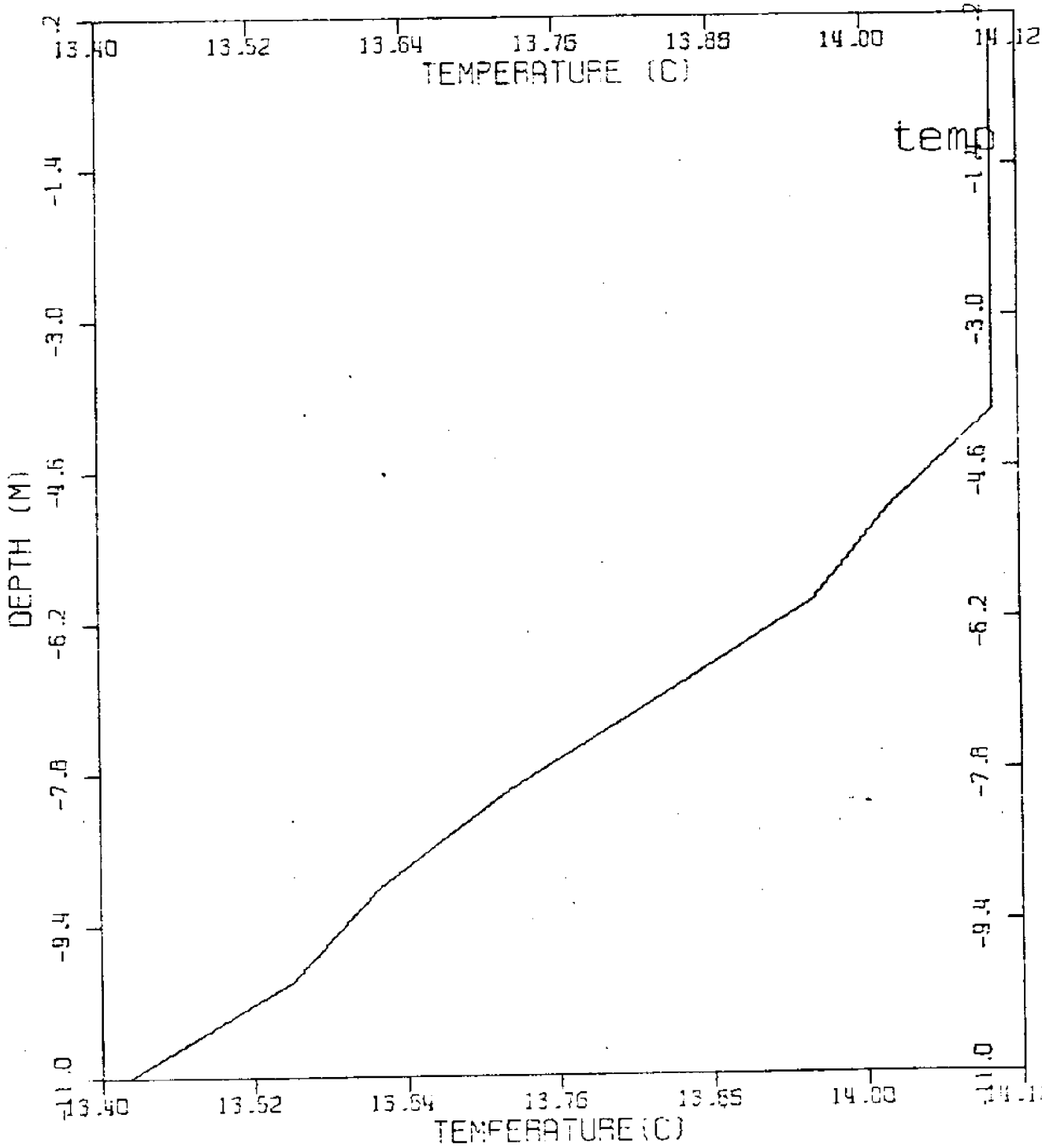
CTD Station 61 Position 42 28 20N 70 45 40W

Date 06 19 78 Time 1900 GMT



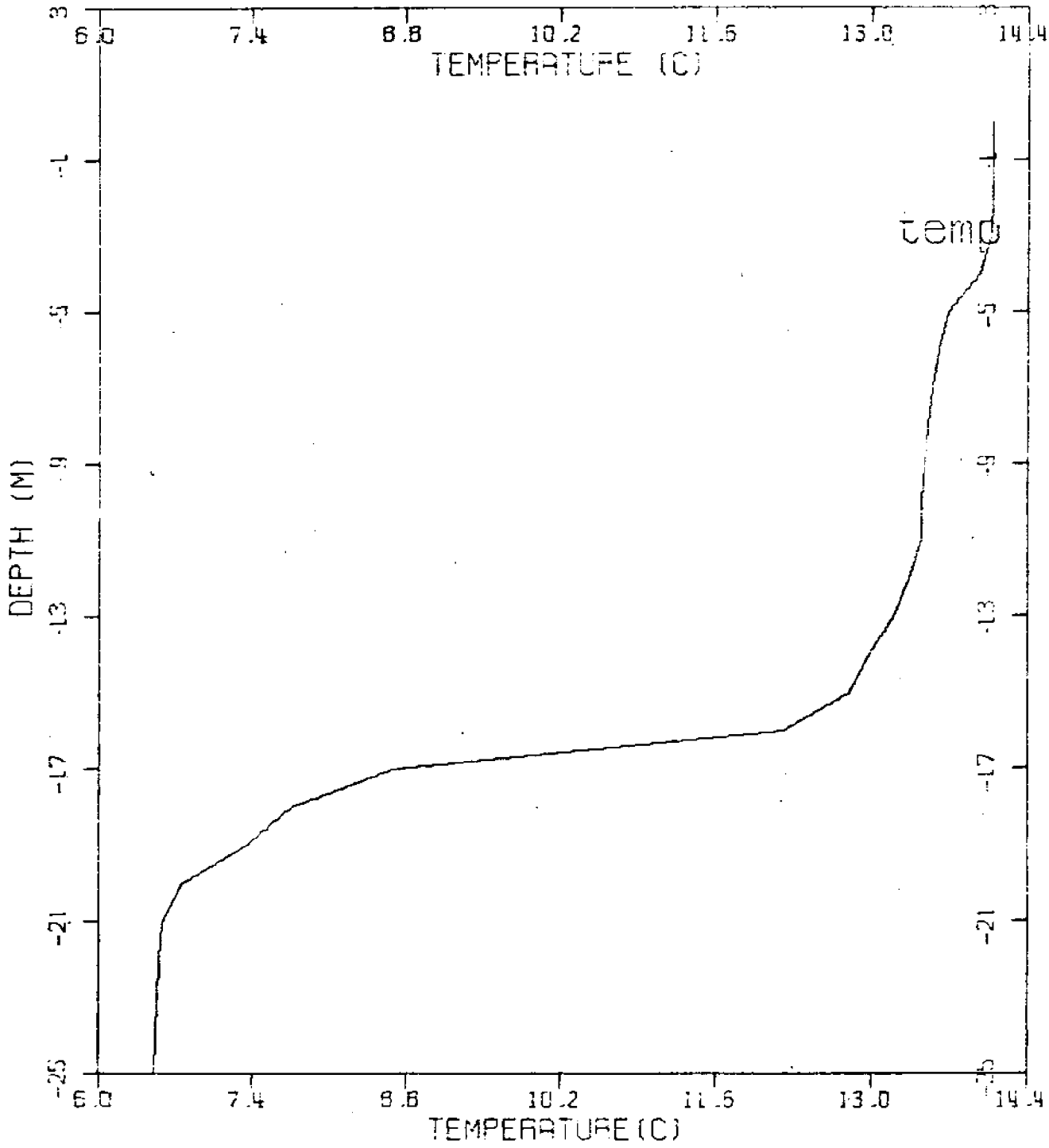
CTD Station t1 Position 42-19-30W 70-50-00N

Date 06 19 73 Time 2000 GMT



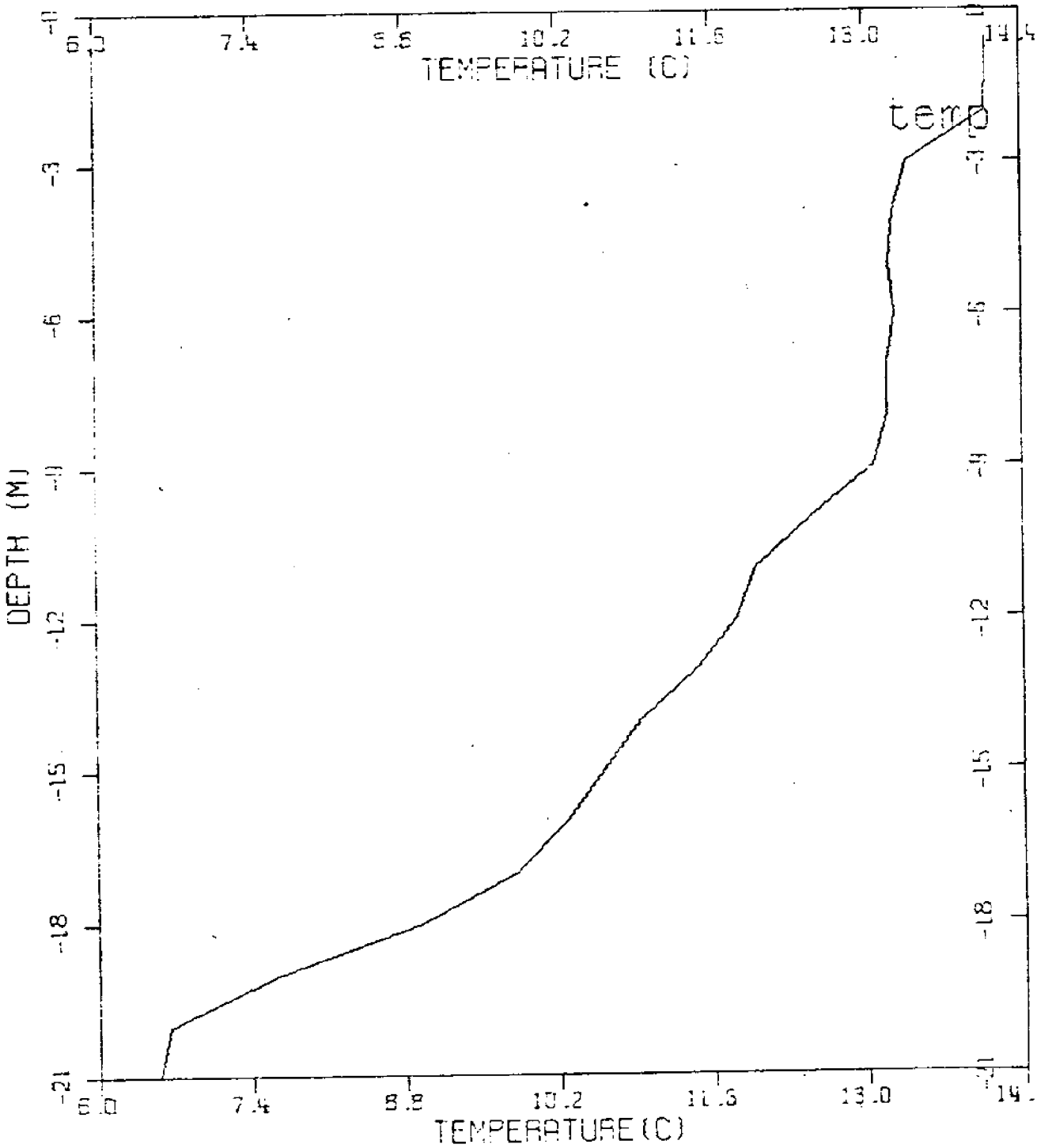
CTD Station #5 Position 42-22-54N
70-51-42W

Date 05 19 73 Time 1700 GMT



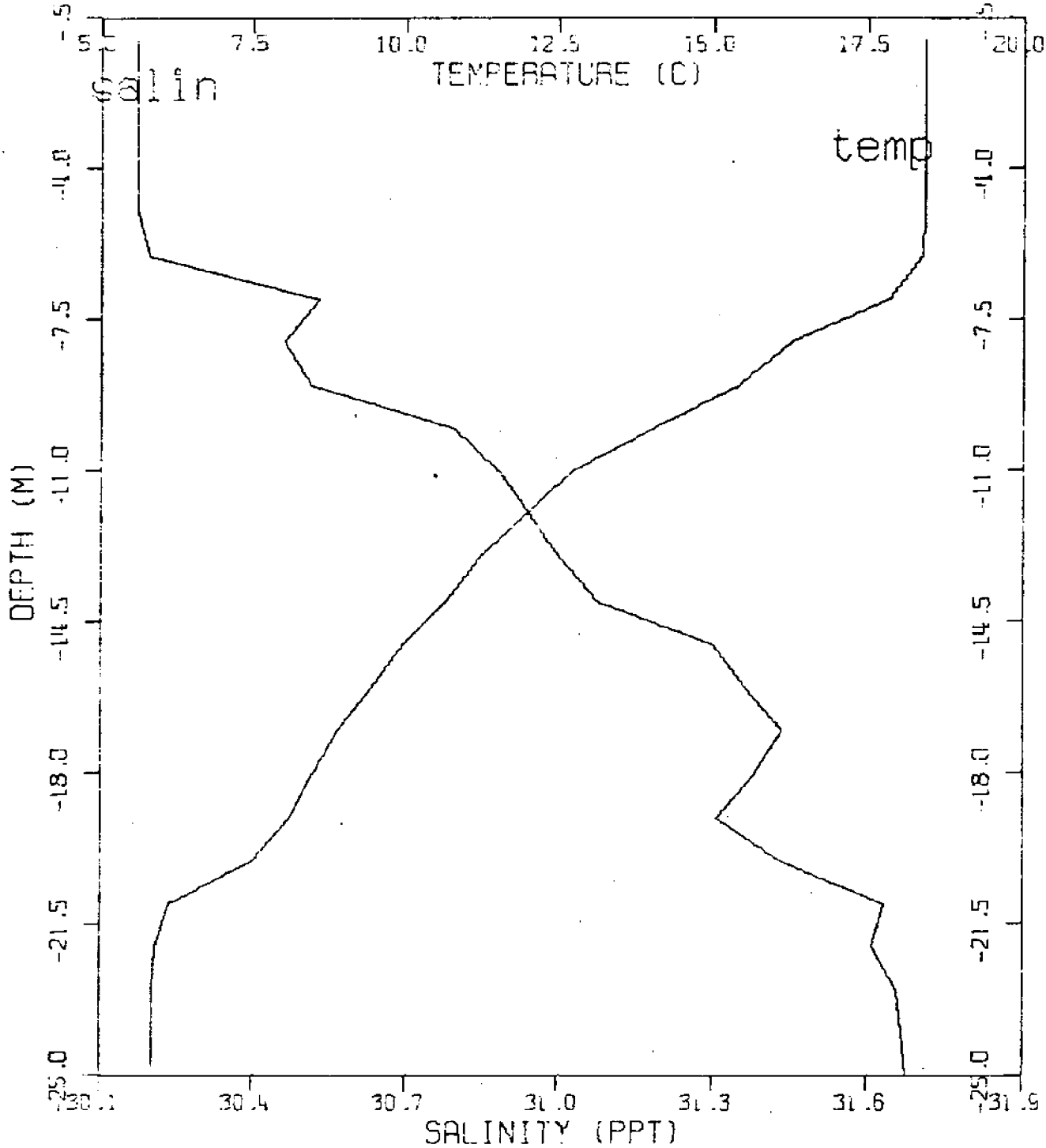
CTD Station 61 Position 42 21 20N
70 49 00W

Date 06 19 78 Time 1900 GMT



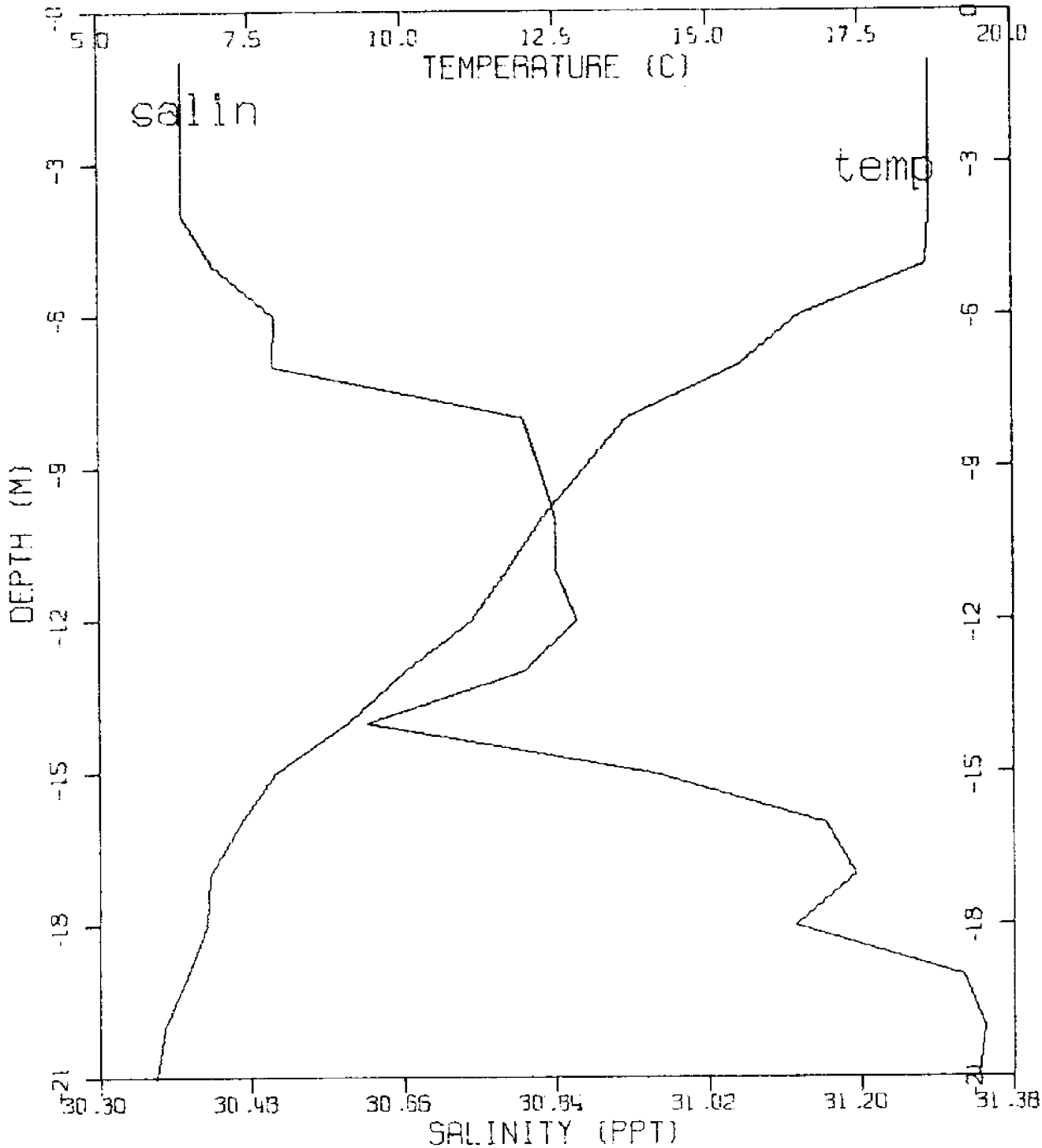
CTD Station eh Position 41 33 48W
70 14 42N

Date 07 26 73 Time 1300 GMT



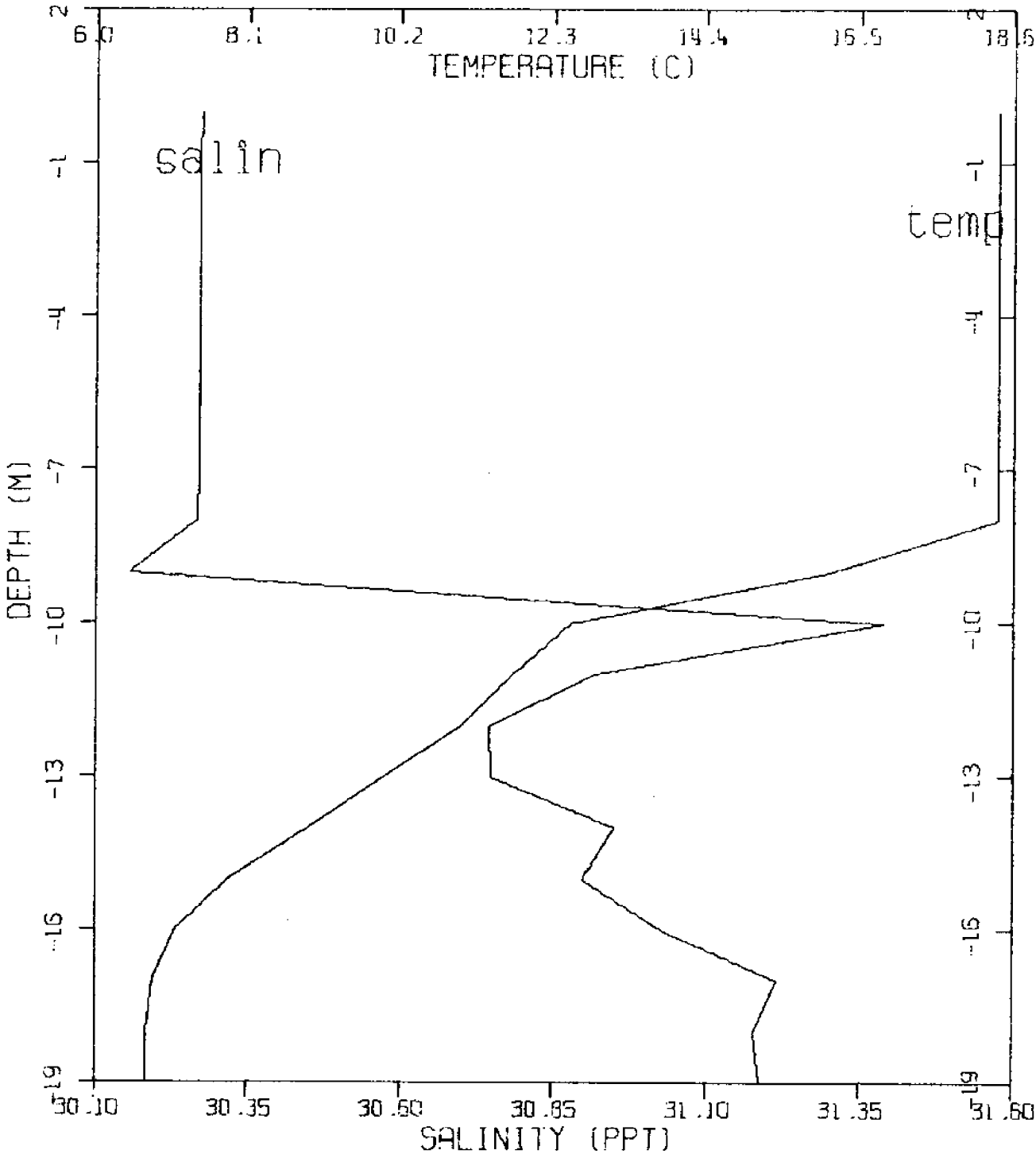
CTD Station a1 Position 41 52 24W
70 21 00N

Date 07 26 73 Time 1400 GMT



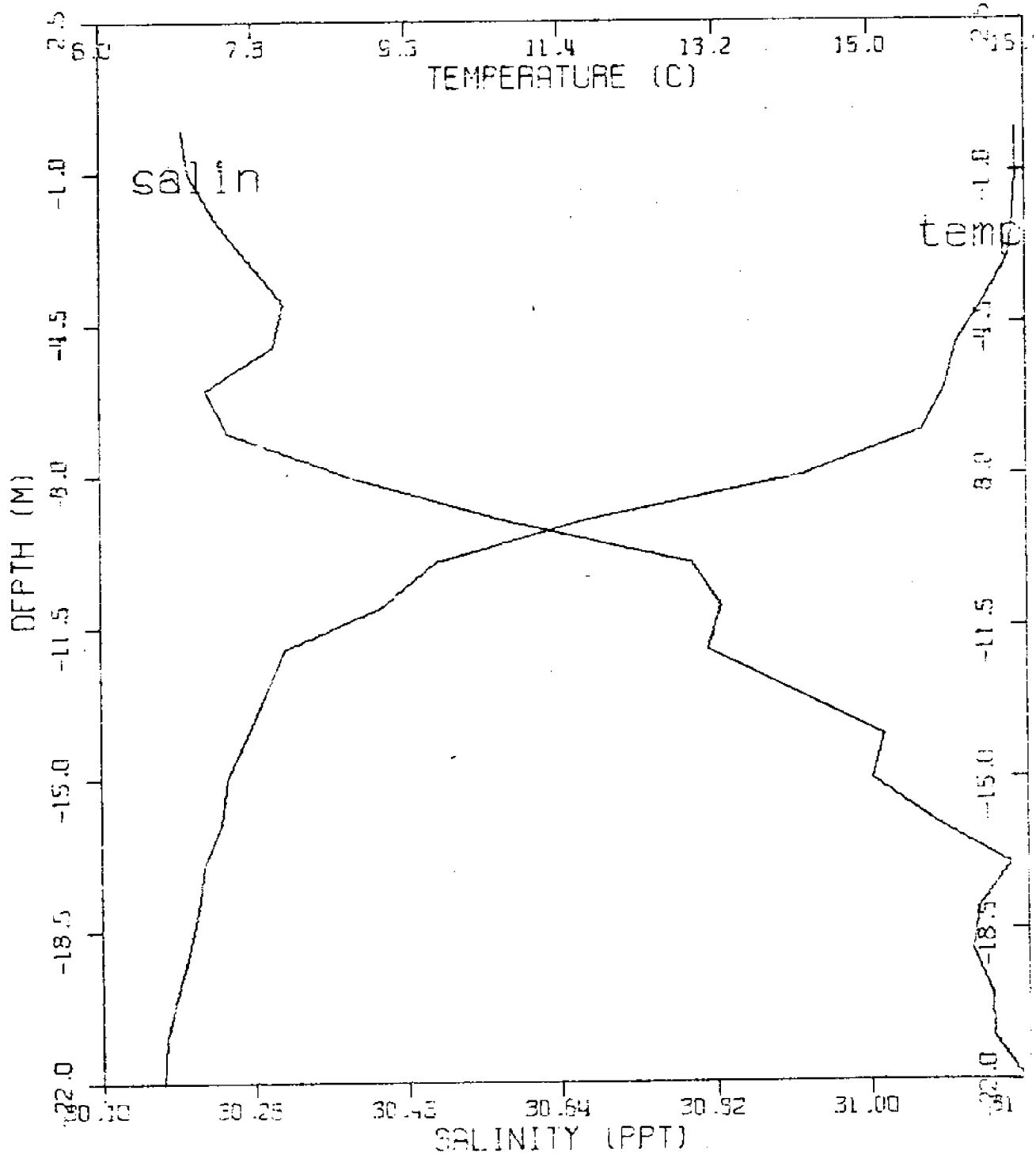
CTD Station aj Position 41 48 54W
70 27 36N

Date 07 26 73 Time 1500 GMT



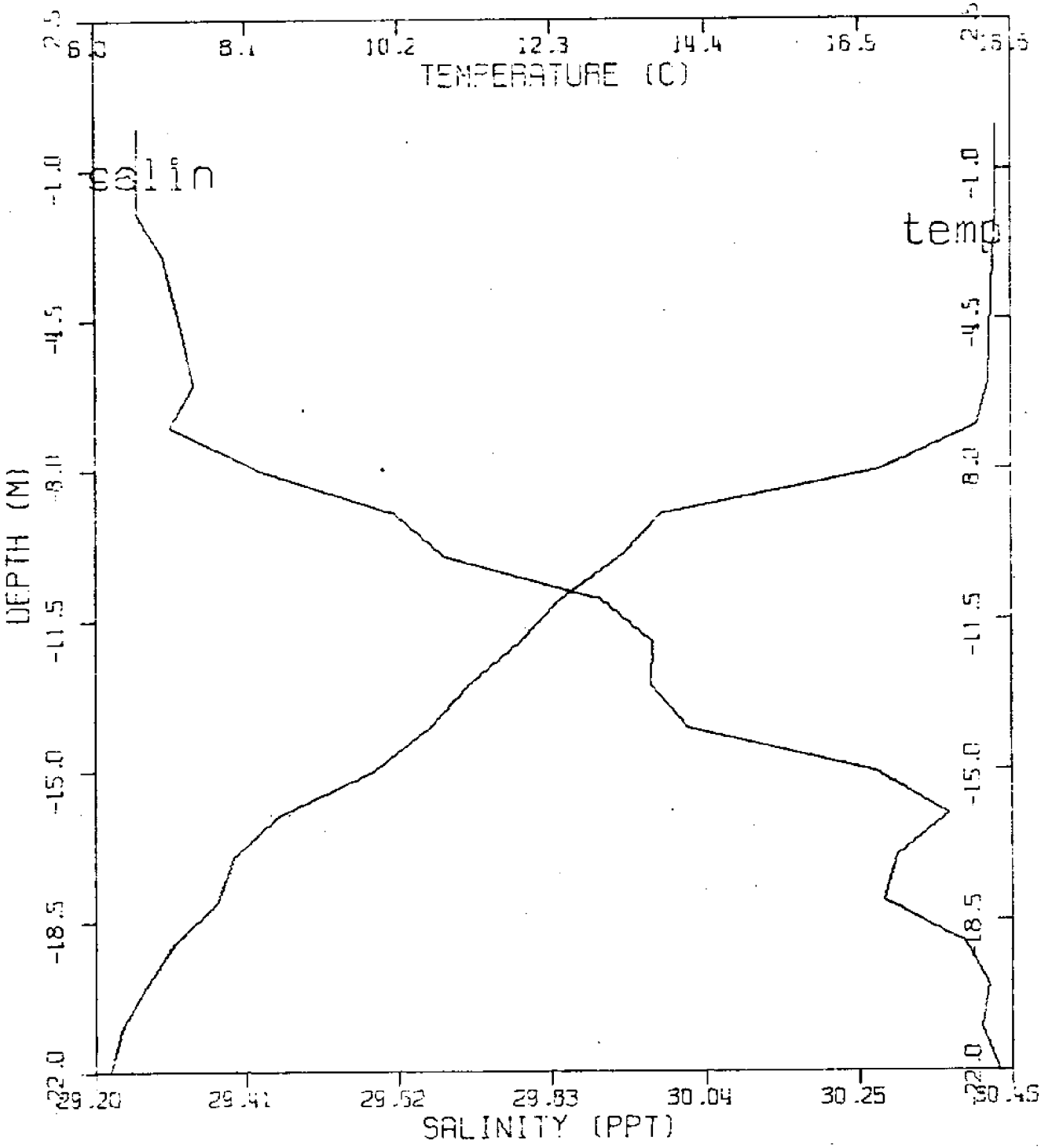
CTD Station #1 Position 41 55 13W
70 29 36N

Date 07 26 73 Time 1630 GMT



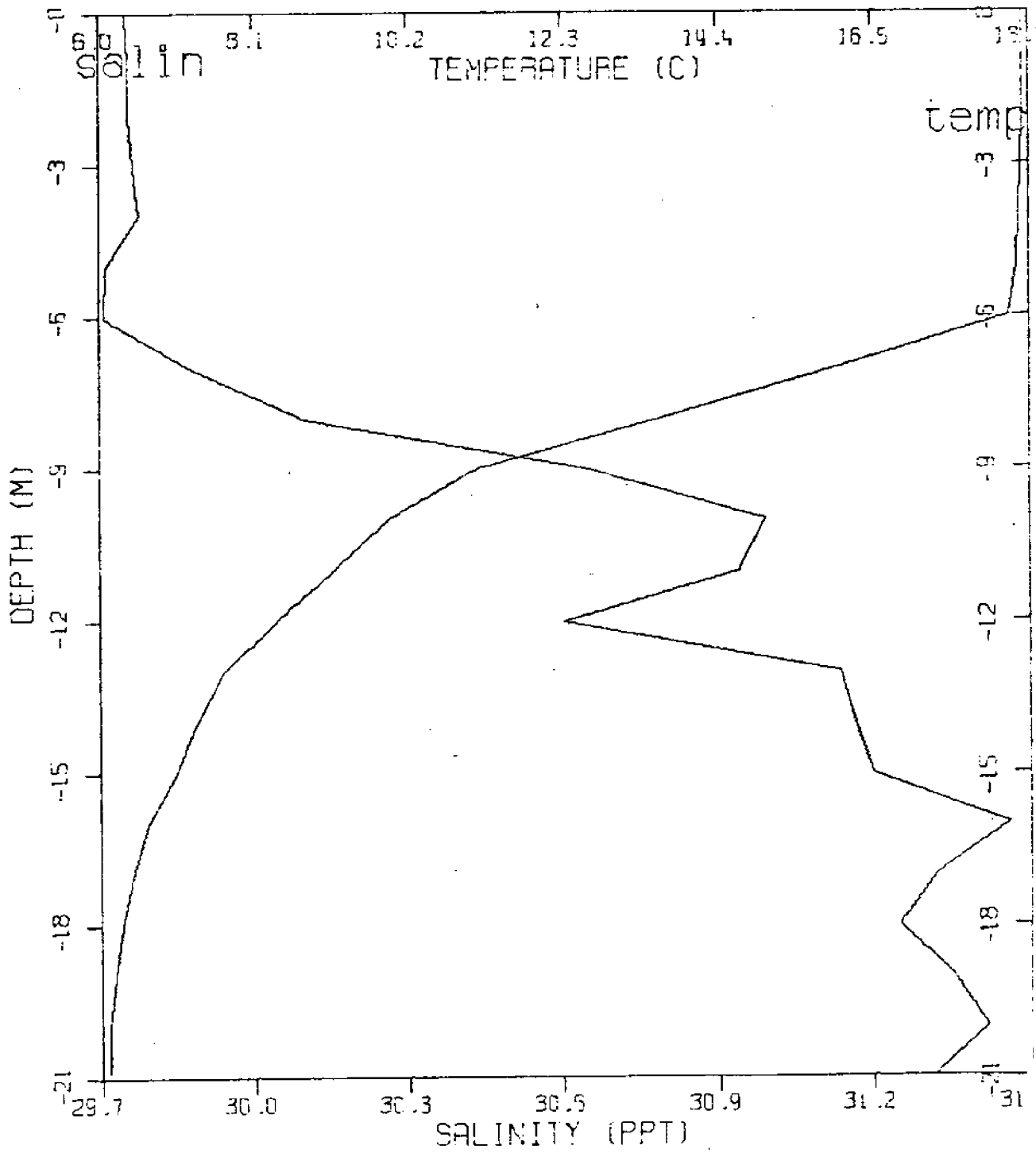
CTD Station 61 Position 42-00-12W
70-29-18N

Date 07/26/73 Time 1700 GMT



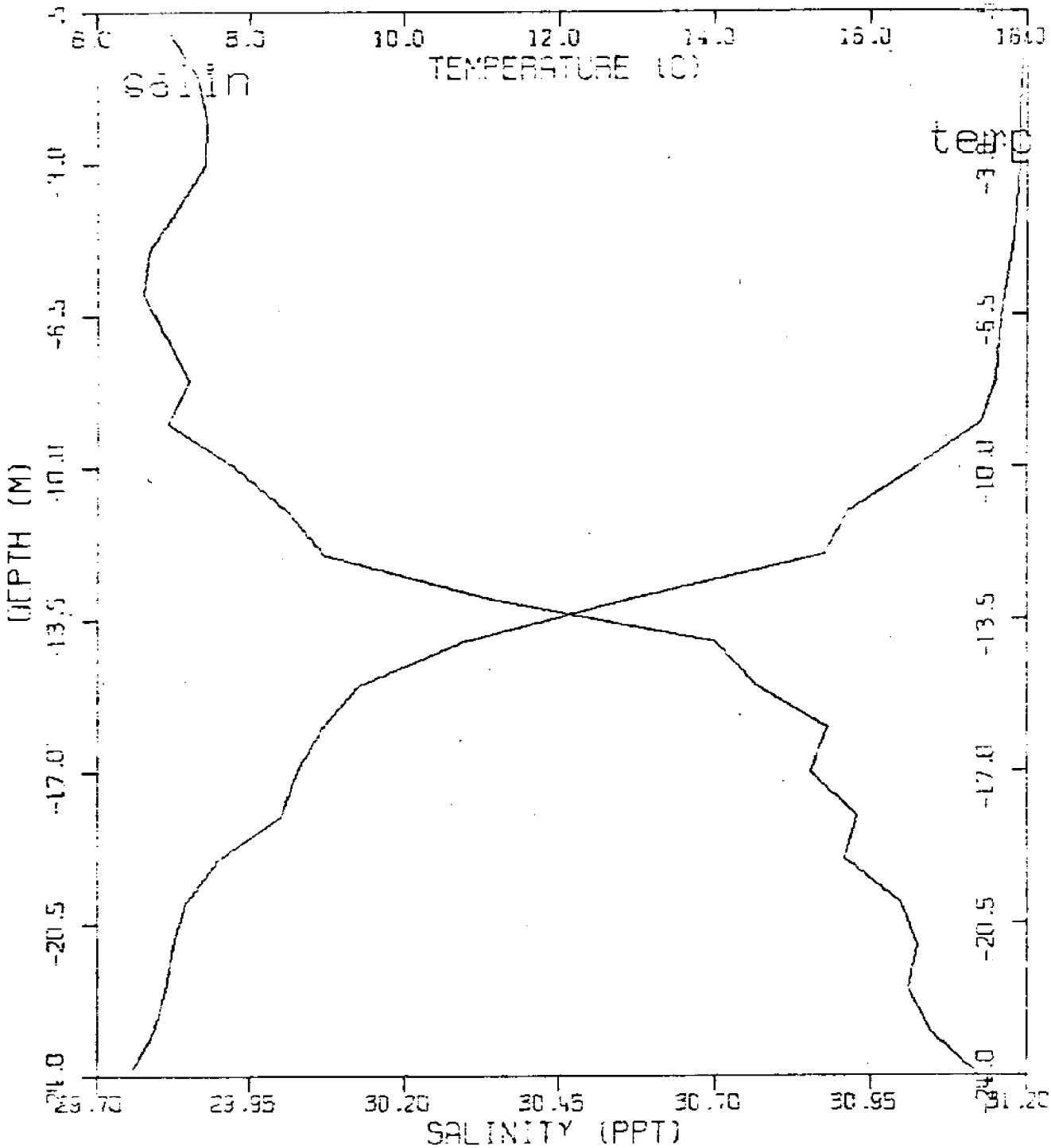
CTD Station am Position 42 05 45W
70 31 15N

Date 07 26 73 Time 1800 GMT



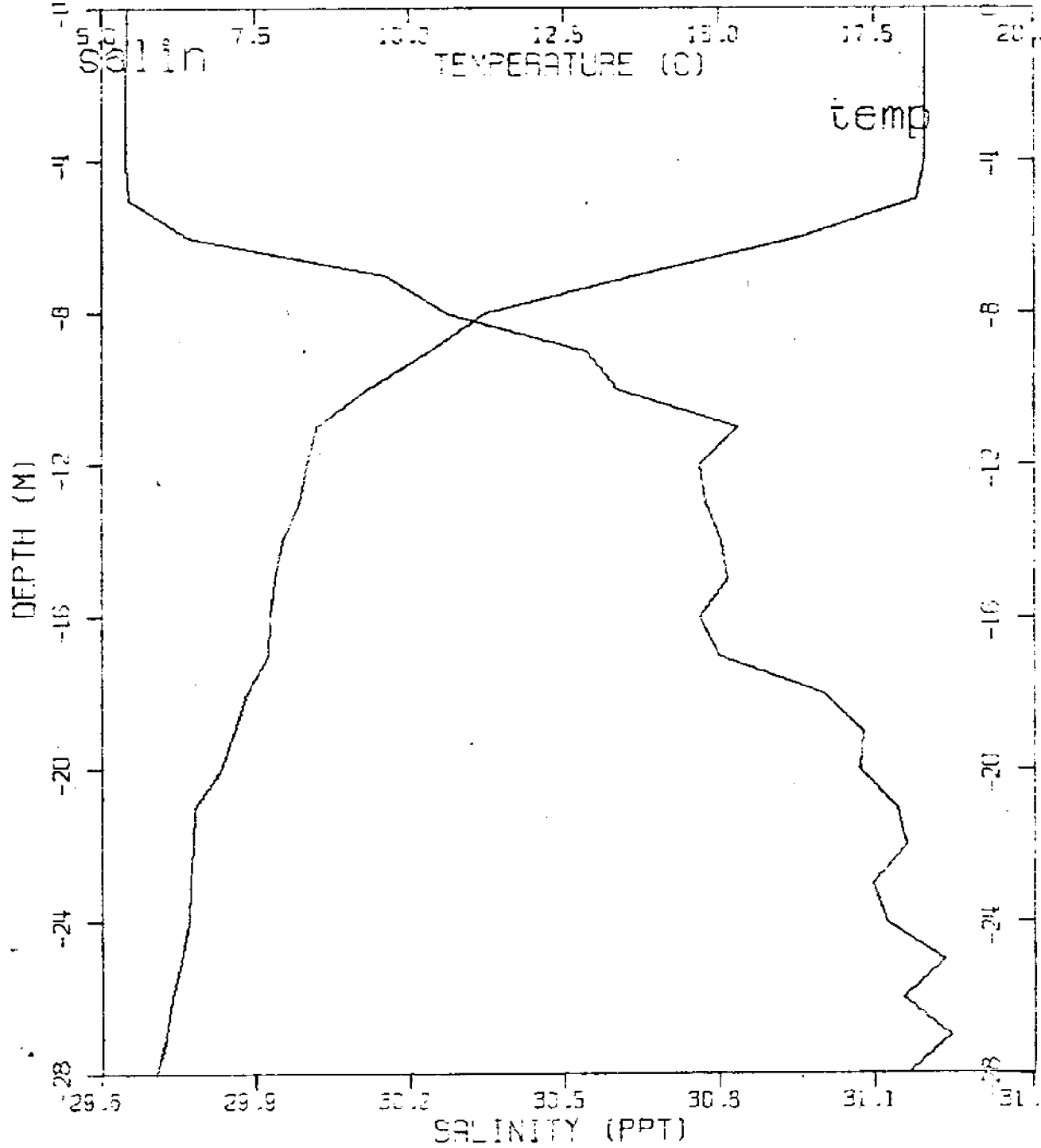
CTD Station an Position 42 [illegible] 70 31 12N

Date 07 25 73 Time 1900 GMT



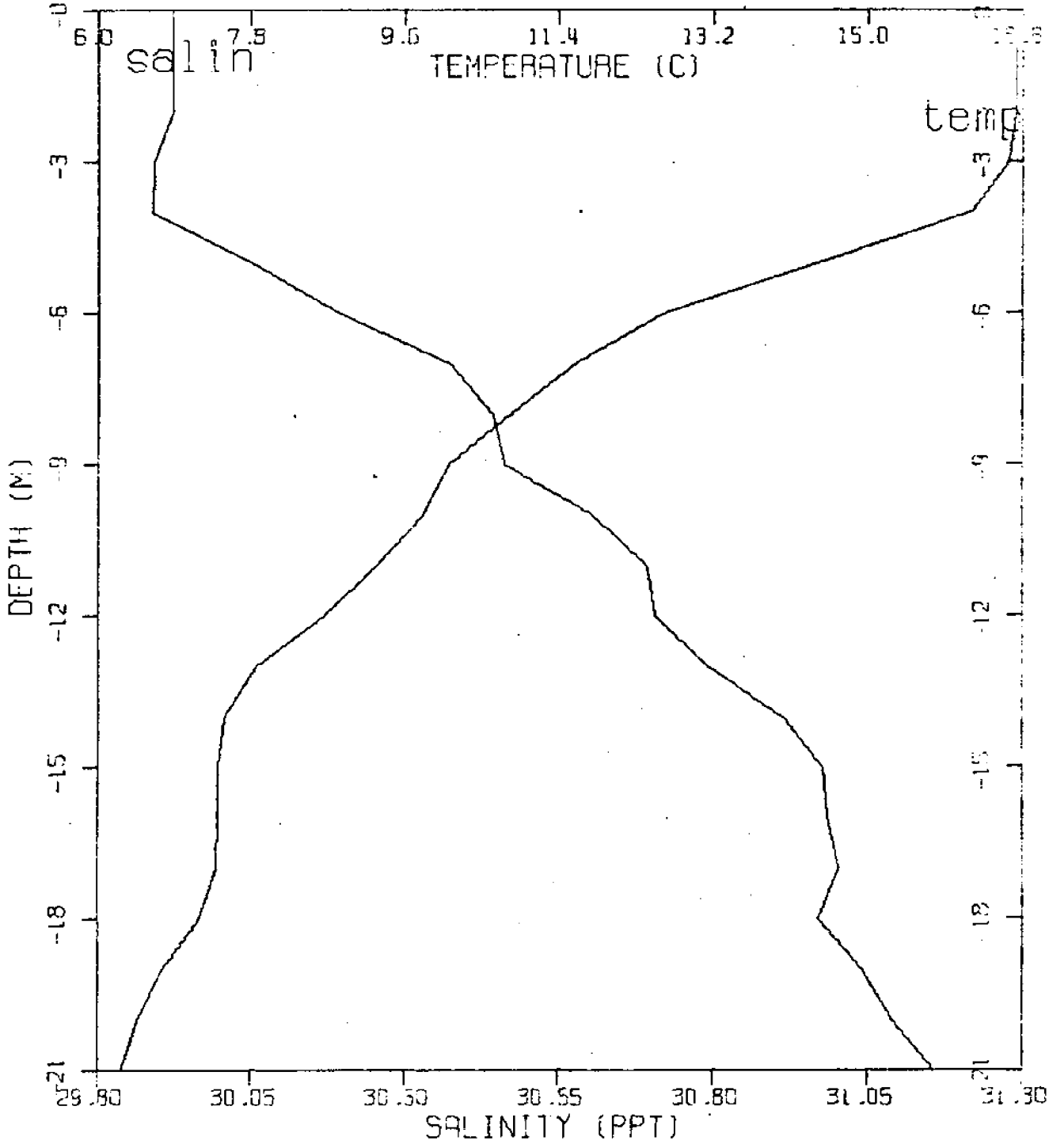
CTD Station 88 Position 42 14 00N
70 37 00W

Date 07 25 78 Time 1900 GMT



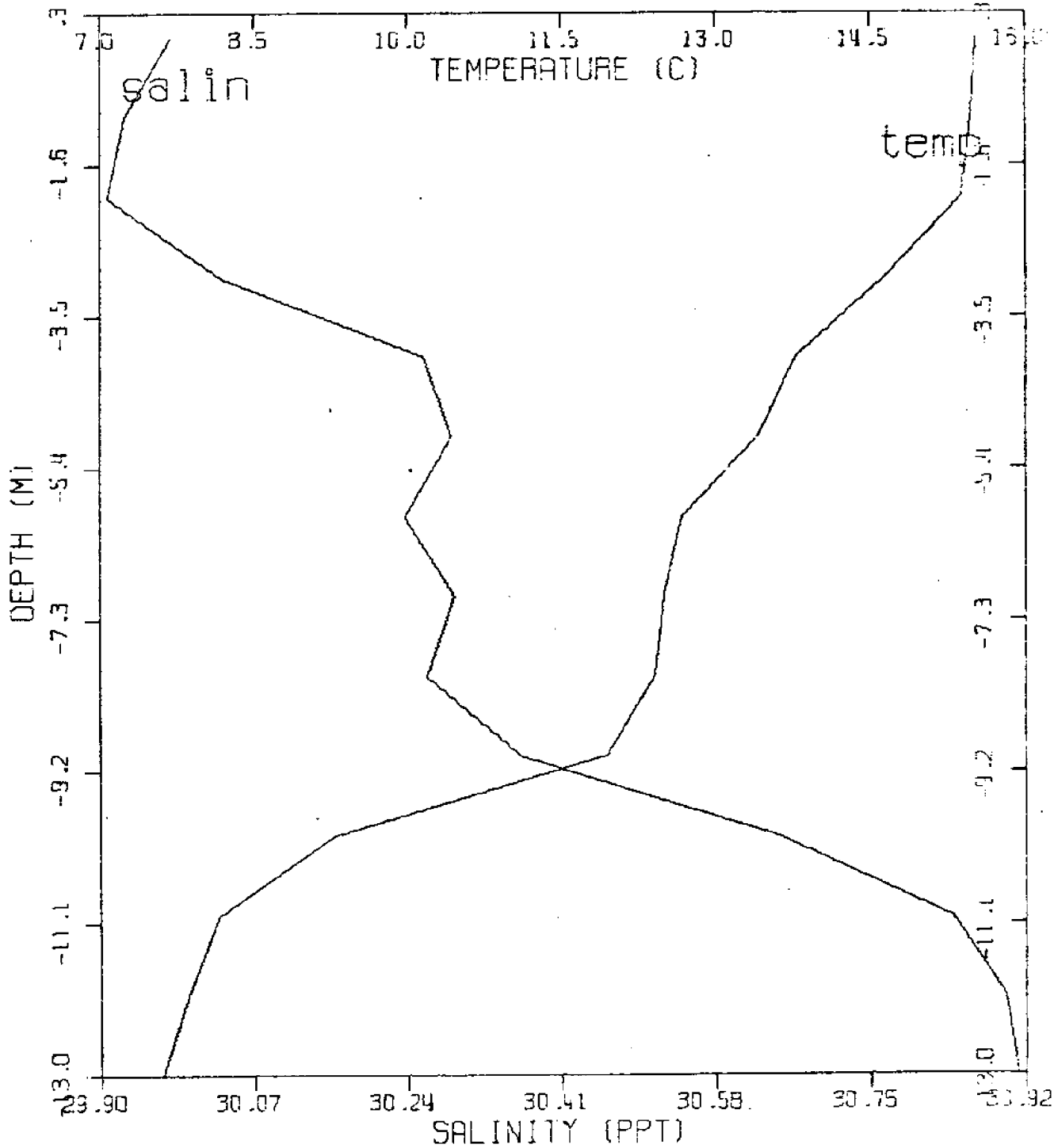
CTD Station ap Position 42 16 30N 70 42 24W

Date 07 28 73 Time 2000 GMT



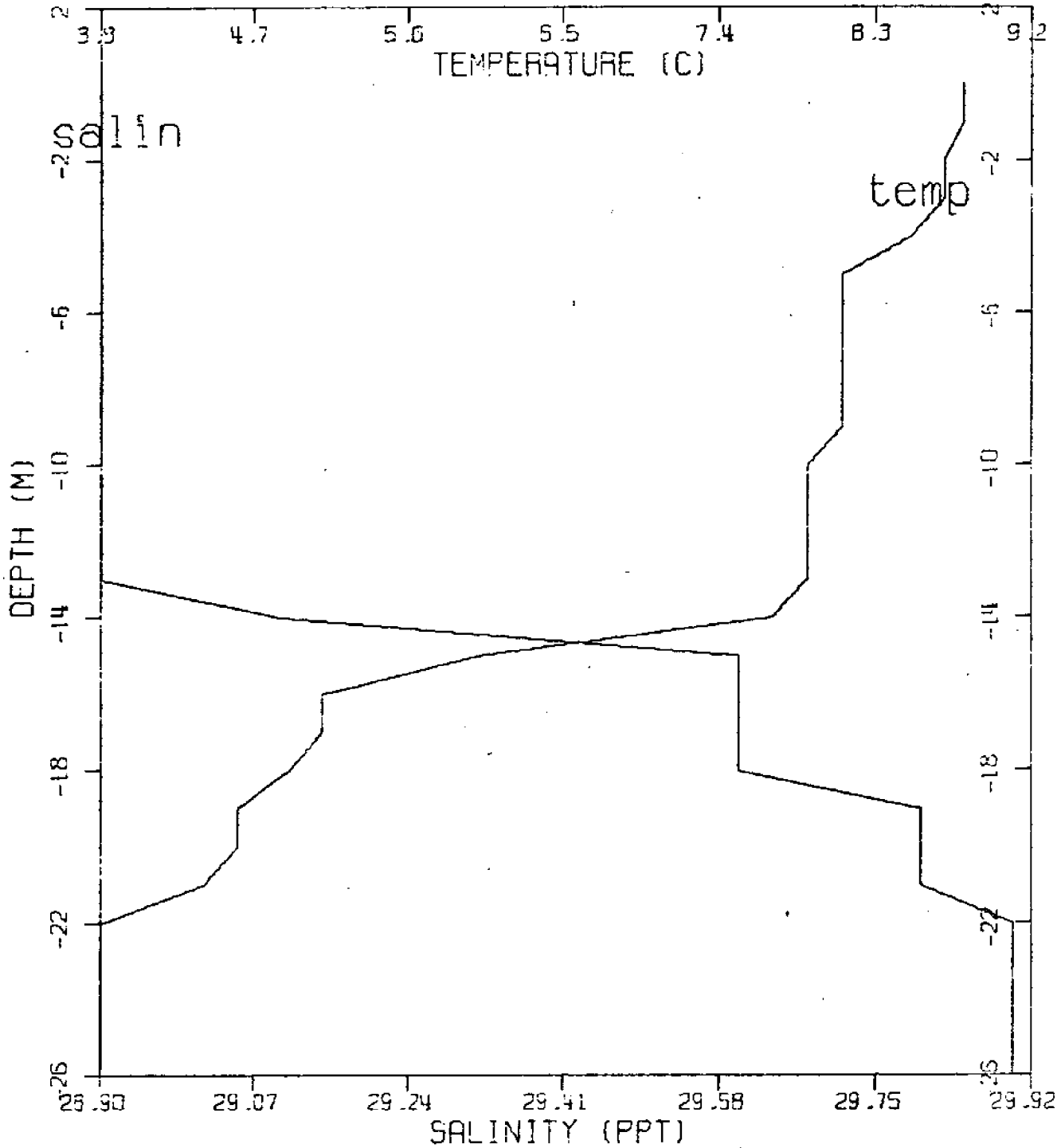
CTD Station aq Position 42 19 30W
70 49 54N

Date 07 26 73 Time 2100 GMT



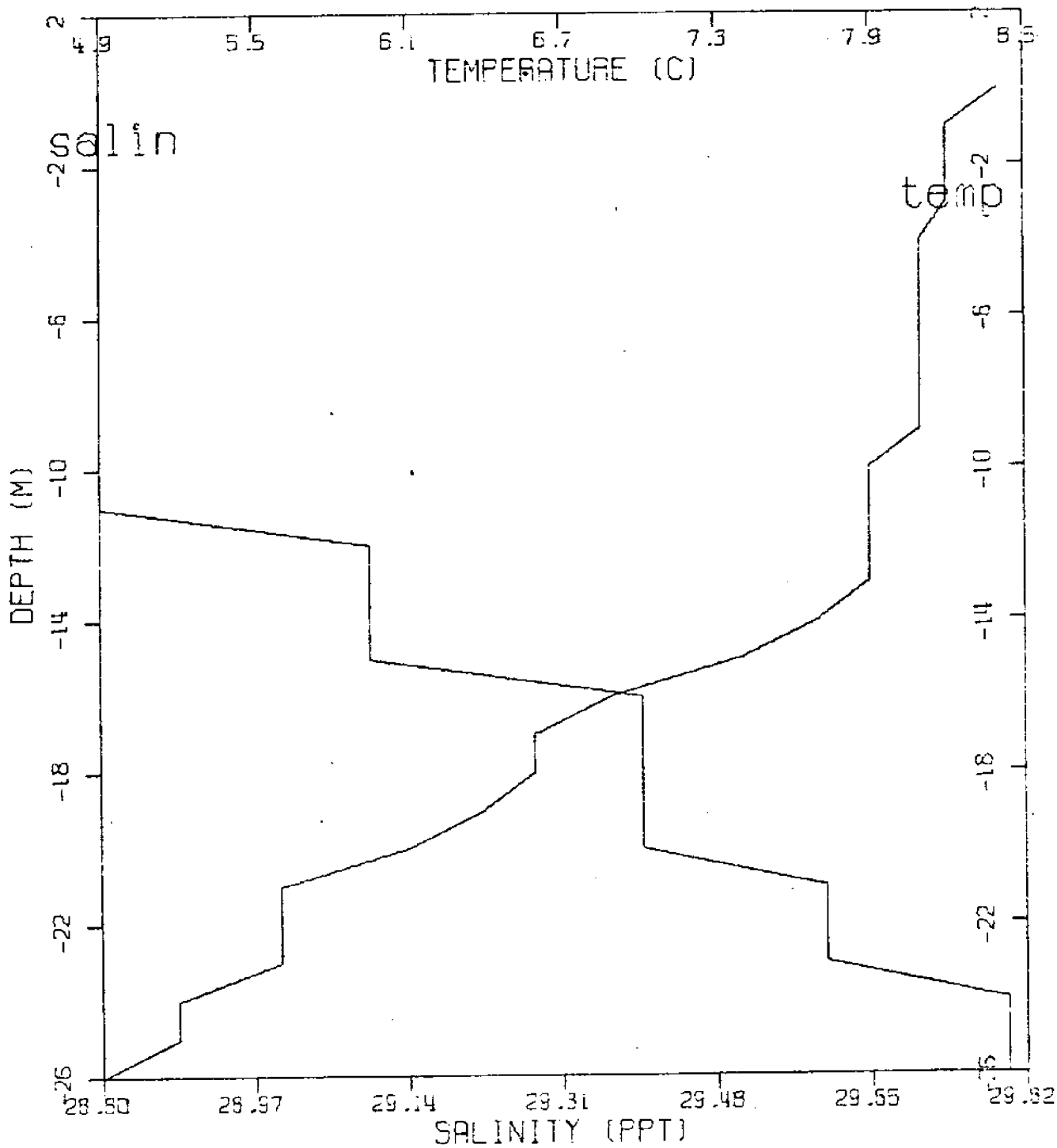
CTD Station 22 Position 42-20-42N 70-49-00N

Date 05 19 73 Time 2000 GMT



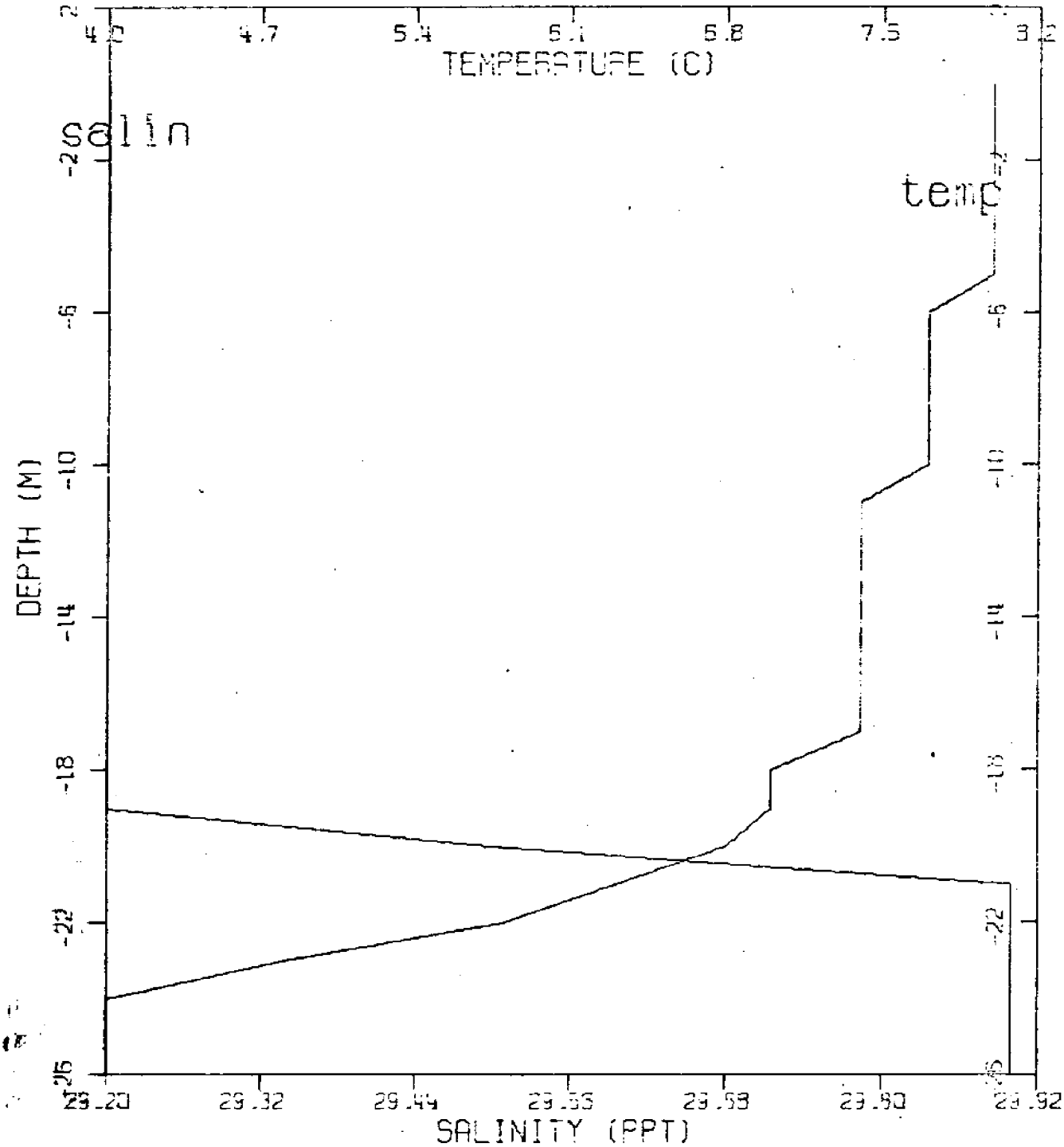
CTD Station 32 Position 42-19-12W 70-49-50N

Date 05 19 73 Time 1800 GMT



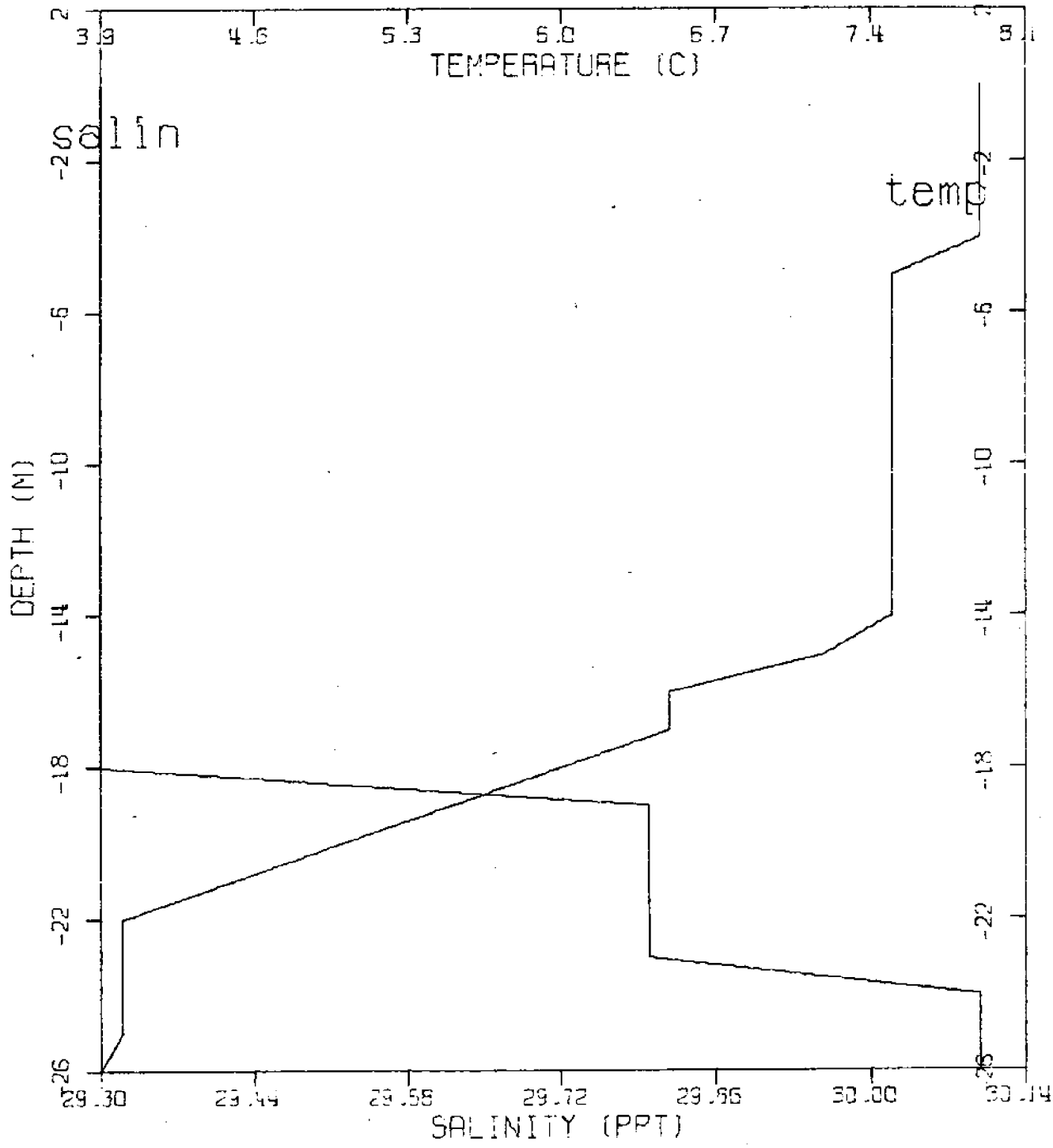
CTD Station 34 Position 42-19-12N
70-43-15W

Date 08 19 73 Time 1700 GMT



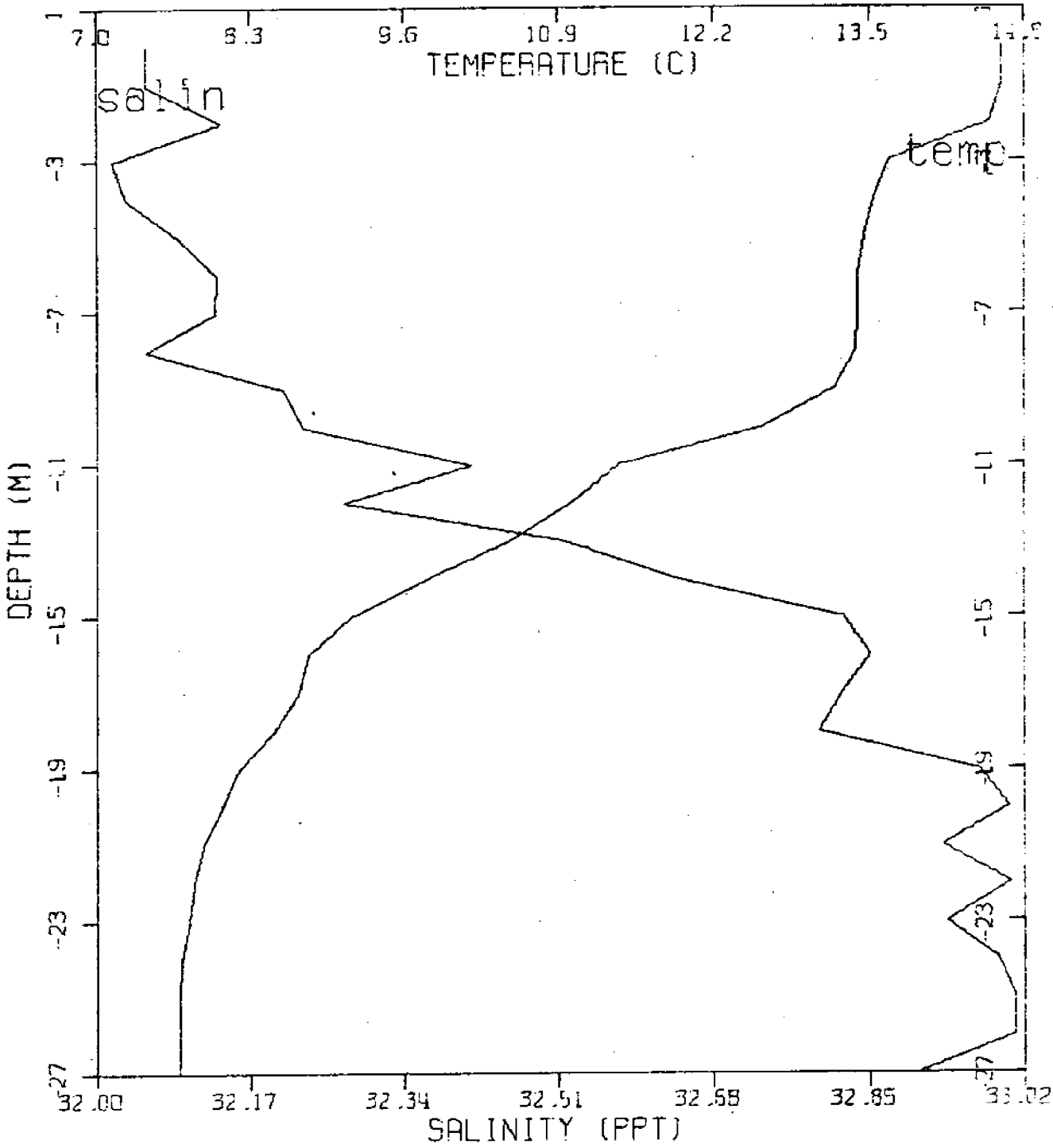
CTD Station 24 Position 42-20-42W 70-53-15N

Date 05 19 73 Time 1700 GMT



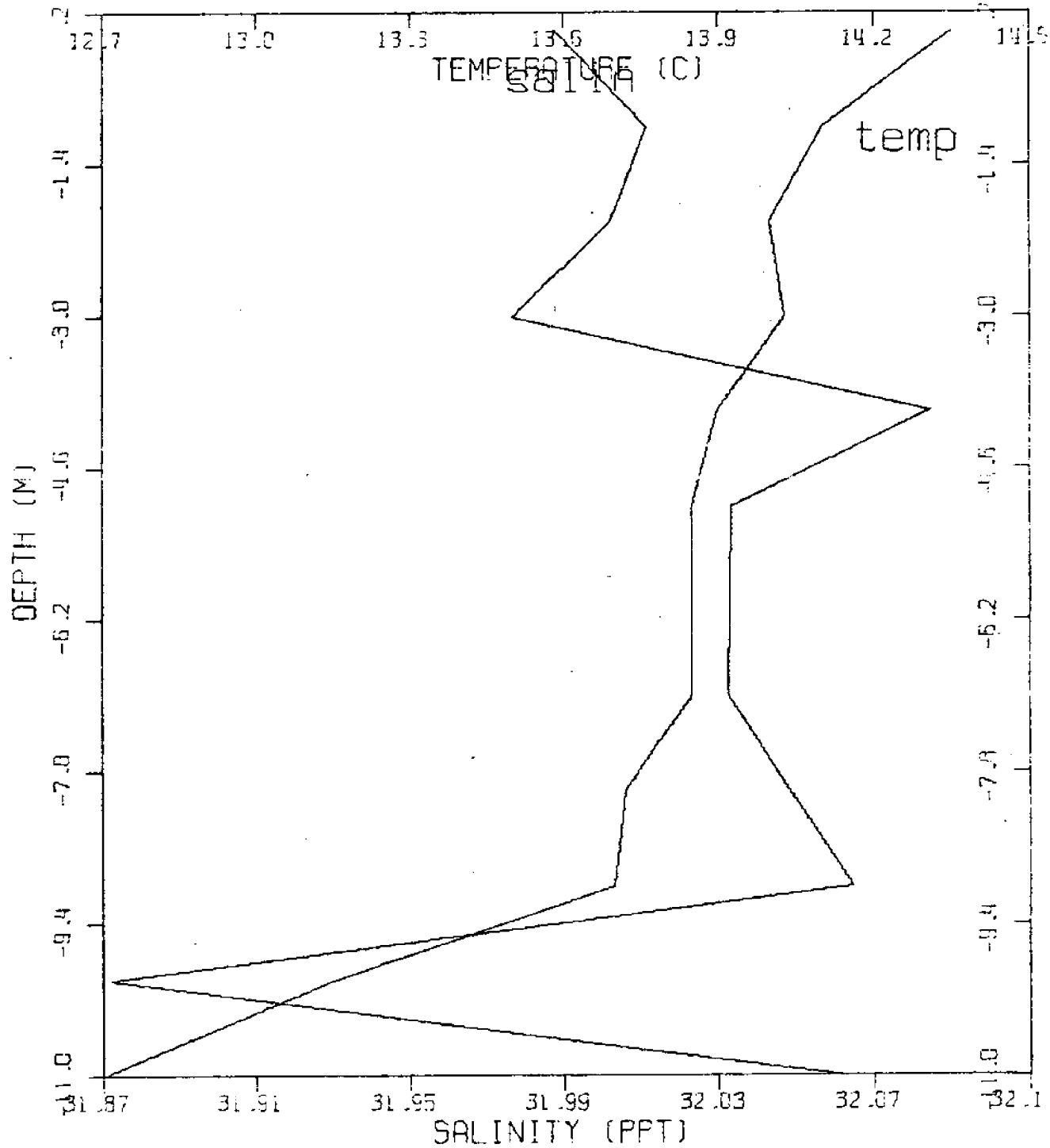
CTD Station b1 Position 42-22-40N
70-47-30N

Date 09 19 73 Time 1800 GMT



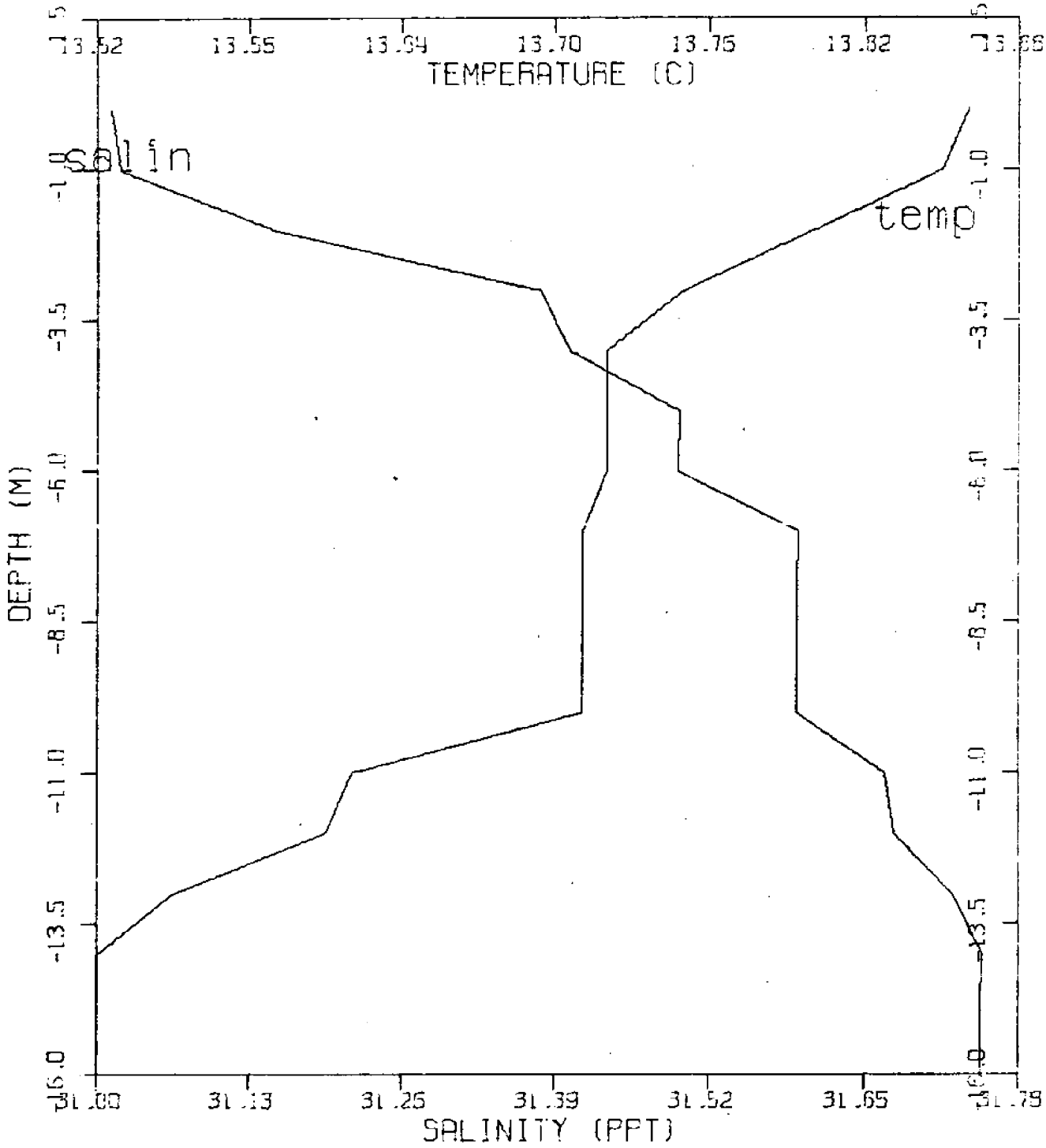
CTD Station 1b Position 42-19-38N 70-49-54W

Date 09 19 73 Time 1500 GMT



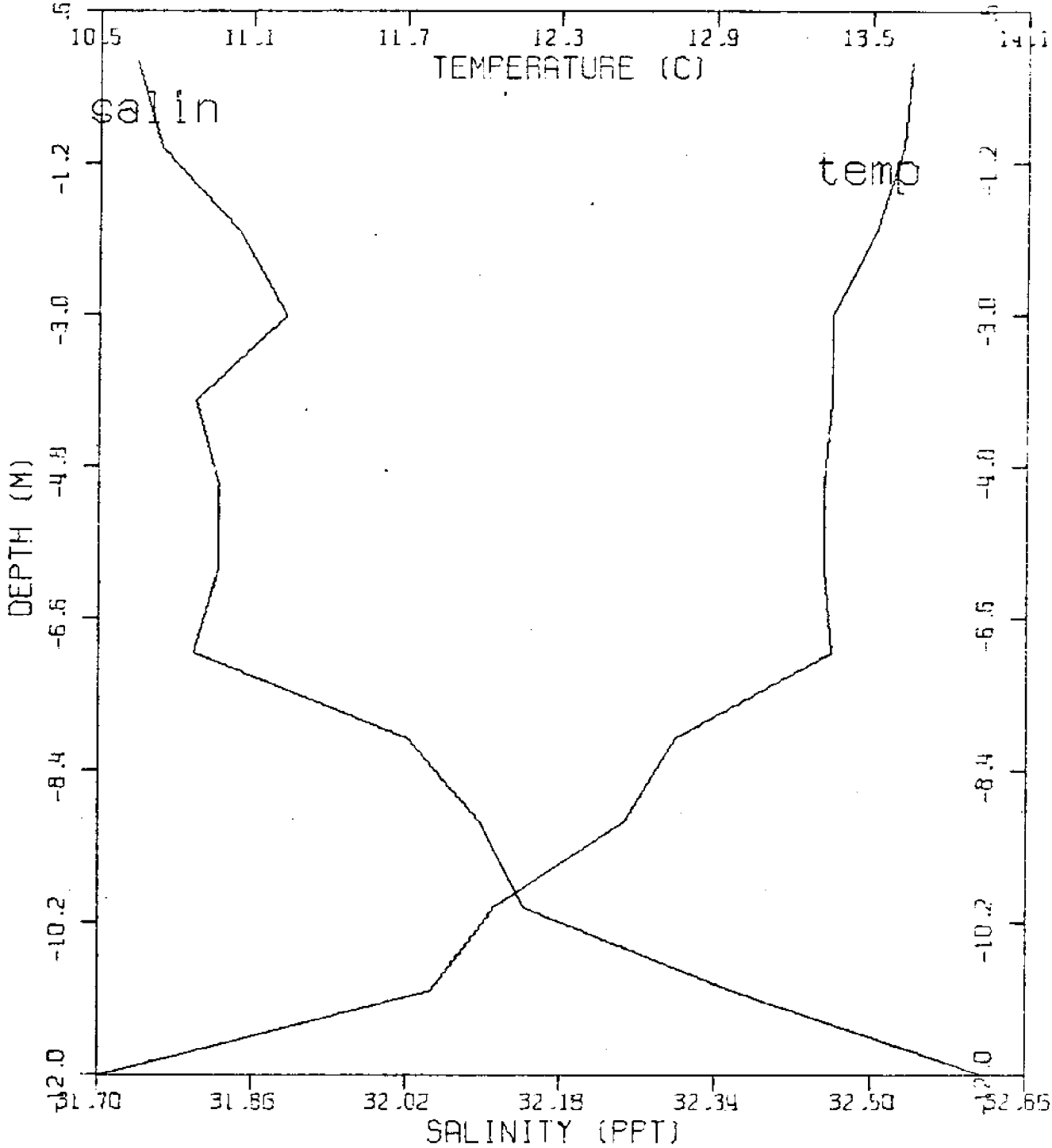
CTD Station d1 Position 42-20-24N 70-57-12N

Date 09 19 73 Time 1600 GMT



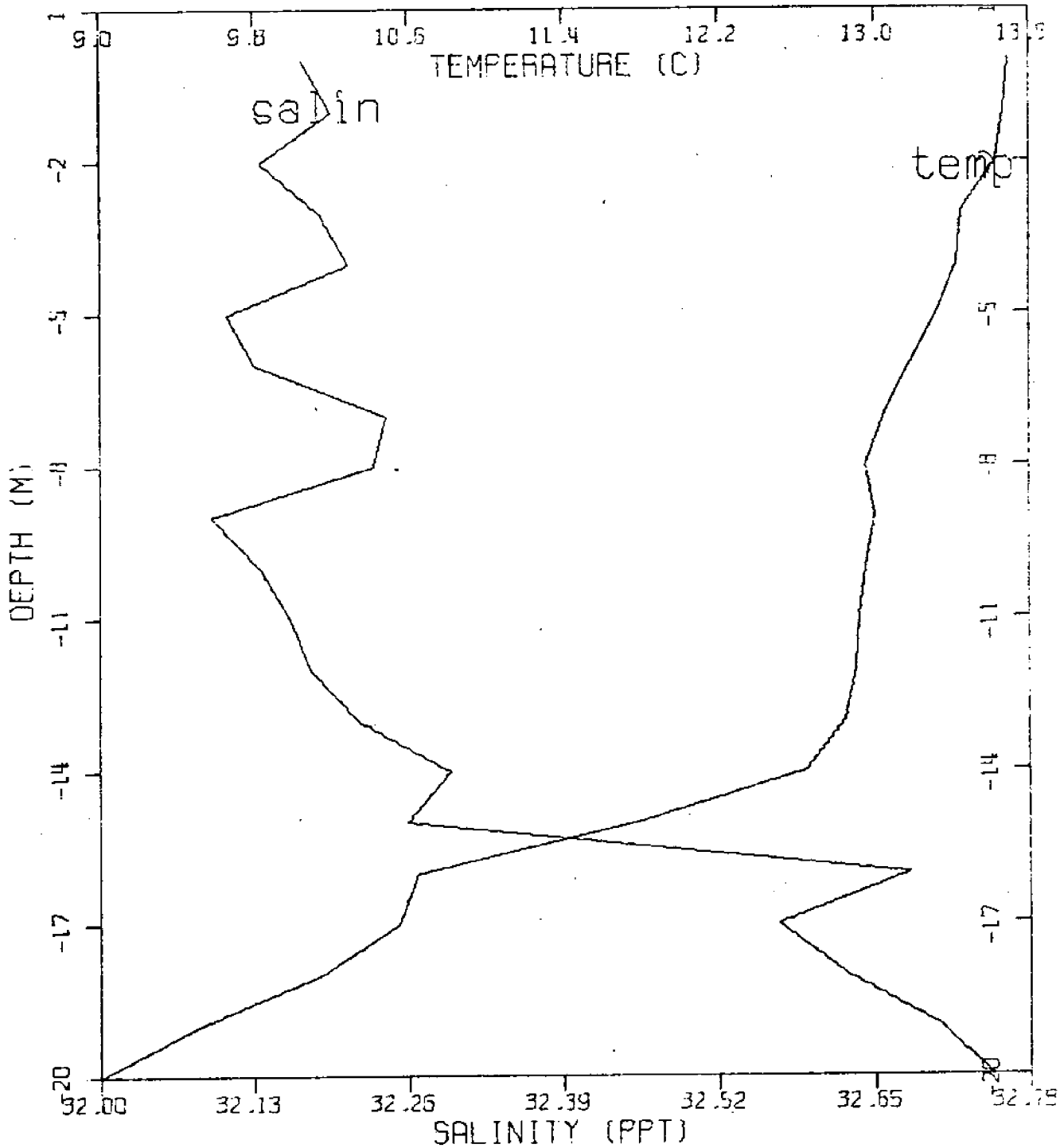
CTD Station f1 Position 42-22-36W
70-55-18N

Date 09 19 73 Time 1700 GMT



CTD Station w5 Position 42-22-54N 70-51-42W

Date 09 19 73 Time 1700 GMT



SECTION C.3

COMPUTER PROGRAM USED TO ANALYSE THE CTD DATA

```
C     FIRST DATA CARD MUST READ ONE OF THE FOLLOWING: '1',IF ONLY A
C     CALCOMP GRAPH IS DESIRED; '2' IF ONLY A PRINTED TABULAR OUTPUT IS
C     DESIRED; '3',IF ONLY PRINTED CARDS ARE DESIRED; '4',IF ALL
C     FORMS OF OUTPUT ARE DESIRED. A 99 MUST BE THE LAST STATION NO.
C     2ND DATA CARD MUST READ: '1',IF COND DATA IS TO BE READ IN;
C     '2', IF NO COND OR SALIN IS AVAIL; '3', IF SALIN DATA IS TO BE
C     READ IN.
      DIMENSION U(50),V(50),W(50)
      DOUBLE PRECISION SC,E1,TO,SO,RT
      REAL*8 TEXT(5),RURD(5),KDATE,IDATE,KLAT,KLON,LAT,LON
      DATA TEXT/'¬C¬T¬D ¬','STATION ','        ','¬POSITIO','N       '/,
     - RURD/'¬CATE  ','        ','    ¬TI','ME   00 ','¬G¬M¬T  '/
     - ,KONST/'99  '/
      READ (5,1) INSTR
      READ(5,1) INSTRI
1     FORMAT (I1)
      IF((INSTR.EQ.4).OR.(INSTR.EQ.1)) CALL NEWPLT('M10017','11782')
      IF((INSTR.EQ.4).OR.(INSTR.EQ.1))CALL PLOT1(0.,1.,-3)
      READ(5,2)IST,KDATE,KTIME,KLAT,KLON,IDEPTH,TEMP,COND
2     FORMAT(A2,1X,A8,1X,A2,1X,A8,1X,A8,1X,I2,1X,F5.2,1X,F5.2)
9     IM=0
      IF ((INSTR.EQ.2).OR.(INSTR.EQ.4)) GO TO 16
      GO TO 8
16    CONTINUE
C     THIS PORTION OF PROG. WRITES THE TITTLE FOR TABULAR OUTPUT
      WRITE(6,3) IST
3     FORMAT('1',////,20X,'CTD STATION ',A2)
      WRITE(6,20)
20    FORMAT(/,20X,'GEOGRAPHIC POSITION')
      WRITE(6,21)KLAT
21    FORMAT (22X,A8,1X,'NORTH')
      WRITE(6,17) KLON
17    FORMAT(22X,A8,1X,'WEST')
      WRITE(6,14) KDATE,KTIME
14    FORMAT(/,20X,'DATE-TIME',4X,A8,4X,A2,'00',1X,'GMT')
      IF (INSTRI.EQ.1) WRITE(6,7)
7     FORMAT(///  ,12X,'DEPTH(M)',2X,'TEMP(C)',2X,'SALINITY(PPT)',2X,
     - 'SIGMA T',4X,'COND(UM/CM)')
      IF (INSTRI.EQ.3) WRITE(6,24)
24    FORMAT(///  ,16X,'DEPTH(M)',2X,'TEMP(C)',2X,'SALINITY(PPT)',2X,
     - 'SIGMA T')
      IF(INSTRI.EQ.2) WRITE(6,25)
25    FORMAT(///,21X,'DEPTH (M)',8X,'TEMP (C)')
C     THIS PORTION OF THE PROGRAM CALCULATES SALINITY.
8     IM=IM+1
      S=35.00
      IF(INSTRI.EQ.3) GO TO 220
      IF(INSTRI.EQ.2) GO TO 18
      T=TEMP
      T1=T
      T2=T1*T1
      T3=T2*T1
      T4=T3*T1
```

```
      TD=T1-15.0
      P1=FLOAT(IDEPTH)
      P2=P1*P1
      P3=P2*P1
      G=1.5192-4.5302E-2 * T1 + 8.3089E-4 * T2 - 7.9E-6 * T3
      F=1.042E-3 * P1 - 3.3913E-8 * P2 + 3.3E-13 * P3
      H=4.0E-4 + 2.577E-5 * P1 - 2.492E-9 * P2
      AJ=1.0 - 1.535E-1 * T1 + 8.276E-3 * T2 - 1.657E-4 * T3
      AL=6.95E-3 - 7.6E-5 * T1
      SP=G * F + H * AJ
      RC=COND/42.909
      RT=0.0676524530D1 + 0.20131661D-1 * T1 + 0.99886585D-4 * T2
     -   - 0.19426015D-6 * T3 - 0.67249145D-8 * T4
  210 SO=S
      AM=35.0-S
      RP=1.0+(1.0+AL*AM)*SP*1.0E-2
      RS=RC/(RT*RP)
      RS2=RS*RS
      R15=RS + 1.0E-5 * RS * (RS - 1.0) * TD * (96.7 - 72.0 *RS
     -    + 37.3 * RS2-(0.63 + 0.21 * RS2) * TD)
       R152=R15*R15
       R153=R152*R15
      R154=R153*R15
      R155=R154*R15
      S    =-0.08996 + 28.2972 * R15 + 12.80832 * R152 - 10.67869 * R153
     -    +5.98624 * R154 - 1.32311 * R155
      S1=SO
      IF (ABS(S-S1)-0.001) 220,210,210
220   CONTINUE
C     THIS PORTION OF THE PROGRAM CALCULATES SIGMA T (SGM)
      TD=TEMP
      SALIN=S
      IF(INSTRI.EQ.3) SALIN=COND
      SD=SALIN
      SO=((6.76786136D-6*SD-4.82496140D-4)*SD+0.814876577D0)*SD
     -   -0.0934458632D0
      E1=(((-1.43803061D-7*TD-1.98248399D-3)*TD-0.545939111D0)*TD
     -   +4.53168426)*TD
      B1=((-1.0843E-6*T+9.8185E-5)*T-4.7867E-3)*T+1.0
      B2=((1.667E-8*T-8.164E-7)*T+1.803E-5)*T
      E2=(B2*SO+B1)*SD
      ST=E1/(T+67.26)+E2
      SGM=ST
C     THE REST OF THE PROGRAM DEALS WITH I-O
18    U(IM)=SALIN
      ITEMP=IST
      V(IM)=FLOAT(-IDEPTH)
      W(IM)=TEMP
      IDATE=KDATE
      ITIME=KTIME
      LAT=KLAT
      LON=KLON
C     THIS PROTION OF THE PROGRAM MAKES AN ENTRY INTO THE TABLE
```

```
      IF ((INSTR.EQ.2).OR.(INSTR.EQ.4)) GO TO 19
      GO TO 12
19    CONTINUE
      IF(INSTRI.EQ.1)WRITE(6,4) IDEPTH,TEMP,SALIN,SGM,COND
4     FORMAT (14X,I2,4(7X,F5.2))
      IF(INSTRI.EQ.3)WRITE(6,26)IDEPTH,TEMP,SALIN,SGM
26     FORMAT(20X,I2,3(7X,F5.2))
       IF(INSTRI.EQ.2)WRITE(6,27)IDEPTH,TEMP
27    FORMAT(24X,I2,14X,F5.2)
12    IF ((INSTR.EQ.3).OR.(INSTR.EQ.4)) GO TO 22
      GO TO 13
22    CONTINUE
C     THIS PORTION MAKES AN OUTPUT DATA CARD SUITABLE FOR THE NATIONAL
C     OCEANIGRAPHIC DATA CENTER
      IF((INSTRI.EQ.1).OR.(INSTRI.EQ.3))WRITE(7,5)IST,KDATE,KTIME,IDEPTH,
     -,TEMP,SALIN
5     FORMAT(A2,1X,A8,1X,A2,1X,I2,47X,F5.2,1X,F5.2)
      IF(INSTRI.EQ.2)WRITE(7,28)IST,KDATE,KTIME,IDEPTH,TEMP
28    FORMAT(A2,1X,A8,1X,A2,1X,I2,47X,F5.2)
13    READ(5,2)IST,KDATE,KTIME,KLAT,KLON,IDEPTH,TEMP,COND
      IF (IST.EQ.ITEMP) GO TO 8
C     THIS PORTION OF THE PROGRAM MAKES PLOT OF SALINITY,TEMP VS. DEPTH
C     FOR EACH STATION
      IF ((INSTR.EQ.2).OR.(INSTR.EQ.3)) GO TO 11
      IF (INSTRI.EQ.2) GO TO 30
23    CALL DXDY1(U,IM,6.,FIRSTU,DELTAU,NBRU,KU)
      CALL DXDY1(V,IM,7.,FIRSTV,DELTAV,NBRV,KV)
      CALL SCLGPH(U,V,IM,0.,IV,FIRSTU,DELTAU,FIRSTV,DELTAV)
      CALL WHERE(XPAGE,YPAGE,FACT)
      YPAGE=YPAGE-0.4
      XPAGE=XPAGE-0.3
      CALL LRCASE(XPAGE,YPAGE,0.2,'SALIN',5)
      CALL AXIS1(0.,0.,'SALINITY (PPT)',14,6.,0.,FIRSTU,DELTAU,NBRU,KU,
     -1.)
30    CALL DXDY1(W,IM,6.,FIRSTW,DELTAW,NBRW,KW)
      CALL DXDY1(V,IM,7.,FIRSTV,DELTAV,NBRV,KV)
      CALL SCLGPH(W,V,IM,0.,IV,FIRSTW,DELTAW,FIRSTV,DELTAV)
      CALL WHERE(XPAGE,YPAGE,FACT)
      XPAGE=XPAGE-0.6
      YPAGE=YPAGE-0.8
      CALL LRCASE(XPAGE,YPAGE ,0.2,'TEMP',4)
      CALL AXIS1(0.,7.,'TEMPERATURE (C)',15,6.,0.,FIRSTW,DELTAW,NBRW,KW,
     -1.)
      IF(INSTRI.EQ.2) CALL AXIS1(0.,0.,'TEMPERATURE(C)',14,6.,0.,FIRSTW,
     -   DELTAW,NBRW,KW,1.)
15    CALL AXIS1(6.,0.,'          ',9,7.,90.,FIRSTV,DELTAV,NBRV,KV,1.)
      CALL AXIS1(0.,0.,'DEPTH (M)',9,7.,90.,FIRSTV,DELTAV,NBRV,KV,1.)
      CALL LRCASE(.5,8.5,.15,TEXT,40)
      CALL LRCASE(2.0,8.5,.15,ITEMP,2)
      CALL LRCASE(4.2,8.6,.1,LAT,8)
      CALL LRCASE(4.2,8.4,.1,LON,8)
      CALL LRCASE(.5,8.0,.15,RUNO,40)
      CALL LRCASE(1.1,8.0,.15,IDATE,8)
```

```
      CALL LRCASE(3.7,8.C,.15,ITIME,2)
      CALL LRCASE(4.9,8.4,.1,'¬N',2)
      CALL LRCASE(4.9,8.6,.1,'¬W',2)
      CALL PLOTI(1C.,0.,-3)
C     STOPS PROGRAM IF STATION NO.=THE PREARRANGED DUMMY VARIABLE 99
11    IF(IST.EQ.KONST) GC TC 6
      GO TO 9
6     WRITE(6,10)
1C    FORMAT('1')
      IF((INSTR.EQ.4).OR.(INSTR.EQ.1)) CALL ENDPLT
      END
```

APPENDIX D

TECHNICON METHODOLOGY USED

AMMONIA IN SEA WATER

(Range: 0-10 µgat N/l)

GENERAL DESCRIPTION

The automated procedure for the determination of ammonia in sea water utilizes the Berthelot Reaction, in which the formation of a blue colored compound believed to be closely related to indophenol occurs when the colution of an ammonium salt is added to sodium phenoxide, followed by the addition of sodium hypochlorite. A solution of potassium sodium tartrate and sodium citrate is added to the sample stream to eliminate the precipitation of the hydroxides of calcium and magnesium.

REAGENTS

Complexing Reagent

Potassium sodium tartrate ($KNaC_4H_4O_6 \cdot 2H_2O$)	33 g
Sodium citrate ($HOC(COONa)(CH_2COONa)_2 \cdot 2H_2O$)	24 g
Distilled water, q.s.	1000 ml

Preparation

Dissolve 33 g of potassium sodium tartrate and 24 g of sodium citrate in 950 ml of distilled water. Adjust the pH of this solution to 5.0 with concentrated sulfuric acid. Dilute to one liter with distilled water. Add 0.5 ml of Brij-35 (Technicon No. T21-0110).

Alkaline Phenol

Phenol (C_6H_5OH)	83 g
Sodium hydroxide, 20% w/v (NaOH)	180 ml
Distilled water, q.s.	1000 ml

Preparation

Using a one liter Erlenmeyer flask, dissolve 83 g of phenol in 50 ml of distilled water. Cautiously add, while cooling under tap water, in small increments with agitation, 180 ml of 20% NaOH. Dilute to one liter with distilled water.

Sodium Hypochlorite (Stock)
(Technicon No. T01-0114)

Any good commercially available household bleach having 5.25% available chlorine may be used.

Sodium Hypochlorite (Working)

Dilute 200 ml of stock sodium hypochlorite to one liter with water.

Sodium Nitroprusside

Sodium nitroprusside $(Na_2Fe(CN)_5NO \cdot 2H_2O)$	0.5 g
Distilled water, q.s.	1000 ml

Preparation

Dissolve 0.5 g sodium nitroprusside in 900 ml of distilled water and dilute to one liter.

STANDARDS

Stock Standard A, 5000 µgat N/l

Ammonium sulfate, $[(NH_4)_2SO_4]$	0.3310 g
Distilled water, q.s.	1000 ml

Preparation

In a one liter volumetric flask, dissolve 0.3310 g of ammonium sulfate in 900 ml of distilled water. Dilute to volume with distilled water. Add 1 ml of chloroform as a preservative.

Stock Standard B, 100 µgat N/1

Stock Standard A	2 ml
Distilled water, q.s.	100 ml

Preparation

Dilute 2 ml of stock standard A in a volumetric flask to 100 ml with distilled water. Prepare fresh daily.

Working Standards

ml Stock B	µgat N/1
0.2	0.2
2.0	2.0
4.0	4.0
6.0	6.0
8.0	8.0
10.0	10.0

Preparation

Pipette stock B into a 100 ml volumetric flask. Dilute to 100 ml with distilled water. Prepare fresh daily.

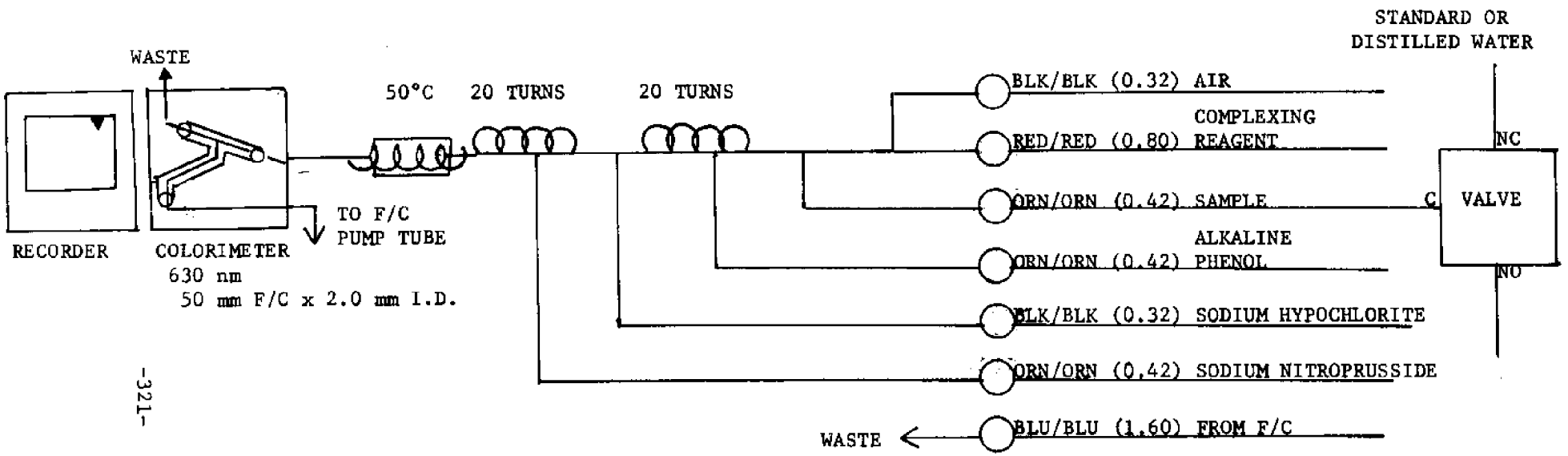
OPERATING NOTES

1. All water used in the preparation of reagents should be deionized acid distilled or distilled water which has been passed through a hydrogen form resin.
2. The alkaline phenol reagent should be filtered through a glass filter prior to use.
3. The sample stream must be clarified before being introduced into the system.
4. If the system is being run in an ammonia contaminated environment, the air for segmenting the stream should be scrubbed through acid prior to its introduction into the system.

5. Alternate ranges may be obtained by utilization of the standard calibration dial on the Colorimeter.
6. The Colorimeter should be operated in the Damp 1 mode.
7. The reagent baseline absorbance with reference to water should be approximately 0.180 absorbance units.
8. Glassware for the preparation of reagents and standards should be washed with one normal hydrochloric acid and rinsed thoroughly with distilled water in order to remove any traces of ammonia.
9. A blank reading for the particular sea water of interest should be determined by sampling the sea water while running distilled water only through the system. The blank reading obtained should then be subtracted from the readings of the unknowns.
10. In line reagent filters (Technicon Part #170-0144-01) should be used in all reagent containers.

AMMONIA IN SEAWATER

(RANGE: 0-10 µgat N/1)



NOTE: FIGURES IN PARENTHESIS SIGNIFY
FLOWRATE IN ML/MIN

Figure D1 Ammonia Flow Chart

NITRITE IN WATER AND SEAWATER

Range: 0-2 µgat N/l
0-28 µg N/l (ppb)

GENERAL DESCRIPTION

This automated procedure for the determination of nitrite is an adaptation of the diazotization method of "Standard Method". Under acidic conditions nitrite ion reacts with sulfanilamide to yield a diazo compound which couples with N-1-naphthylethylenediamine dihydrochloride to form a soluble dye which is measured colorimetrically.

There are very few known interferences at concentrations less than 1000 times that of the nitrite; however, recent addition of strong oxidants or reductants to the samples will readily affect the nitrite concentrations. High alkalinity (600 mg/l) will give low results due to a shifting pH of the color reactions.

REAGENTS

Color Reagent
(Technicon Nos. T11-5065, and T01-5017

Sulfanilamide ($C_6H_8N_2O_2S$)	20	g
Concentrated Phosphoric Acid (H_3PO_4)	200	ml
N-1-Naphthylethylenediamine Dihydrochloride ($C_{12}H_{14}N_2 \cdot 2HCl$)	1.0	g
Distilled Water, q.s.	2000	ml
Brij-35 (Technicon No. T21-0110)	1.0	ml

Preparation

To approximately 1500 ml of distilled water, add 200 ml of concentrated phosphoric acid and 20 g of sulfanilamide. Dissolve completely. (Heat if necessary.) Add 1 g of N-1-naphthylethylenediamine dihydrochloride and dissolve. Dilute to two liters. Add 1.0 ml of Brij-35. Filter through a medium sintered glass filter under vacuum. Store in a cold, dark place. STABILITY: one month.

STANDARDS

Stock Standard A, 5000 µgat N/1 (70,000 µg N/1)

Sodium Nitrite ($NaNO_2$) (Technicon No. T11-0169)	0.345	g
Deionized, Distilled Water, q.s.	1000	ml
Chloroform	1	ml

Preparation

Dissolve 0.345 g of sodium nitrite in deionized, distilled water and dilute to one liter. Store in a dark bottle. Add 1 ml of chloroform as a preservative.

Stock Standard B, 20 µgat N/1 (280 µg N/1)

Stock Standard A	1	ml
Deionized, Distilled Water, q.s.	250	ml

Preparation

Dilute 1 ml of stock standard A in a volumetric flask to 250 ml with deionized, distilled water. Store in a dark bottle. Prepare fresh daily.

Working Standards

ml Stock B	µgat N/l	µg N/l
0.20	0.04	0.56
2.0	0.40	5.6
4.0	0.80	11.2
6.0	1.20	16.8
8.0	1.60	22.4
10.0	2.00	28.0

Preparation

Pipette stock B into a 100 ml volumetric flask. Dilute to 100 ml with deionized, distilled water. Store in a dark bottle. Prepare fresh daily.

OPERATING NOTES

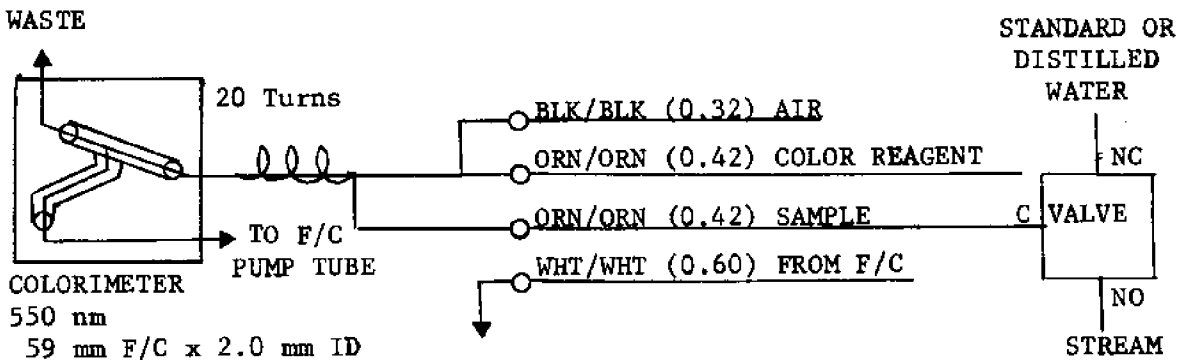
1. Distilled water used for reagent and standard preparation must contain no nitrite.
2. Alternate ranges may be obtained by utilization of the Std Cal control on the Colorimeter.
3. The sample stream must be clarified before being introduced to the system.
4. When analyzing seawater, a blank reading for the particular seawater of interest should be determined by sampling the seawater while running distilled water only through the reagent lines. The blank reading obtained should then be subtracted from the readings of the unknowns.
5. The reagent baseline absorbance with reference to water should be approximately 0.050 absorbance units.
6. The Colorimeter should be operated in the Damp 1 mode.

7. In-line reagent filters (Part No. 170-0144-01) should be used in all reagent containers.

8. The color reagent and air segmentation line should be scrubbed with a charcoal cartridge (Technicon No. T11-5060).

9. The use of multiple working standards is only to establish linearity. For day-to-day operation, the 1.2 µg N/l standard is recommended for instrument calibration.

NITRITE IN WATER AND SEAWATER
RANGE: 0-2 µgat N/l
0-28 µg N/l (ppb)



NOTE: FIGURES IN PARENTHESIS SIGNIFY FLOW RATES IN ML/MIN

Figure D2 Nitrite Flow Chart

SILICATES IN WATER AND SEAWATER

Range: 0-50 µgat Si/l
0-1.4 mg Si/l (ppm)

GENERAL DESCRIPTION

This automated procedure for the determination of soluble silicates is based on the reduction of a silicomolybdate in acidic solution to "molybdenum blue" by ascorbic acid. Oxalic acid is introduced to the sample stream before the addition of ascorbic acid to eliminate interference from phosphates.

Tannin, large amounts of iron, color, turbidity and sulfide interfere.

REAGENTS

Ammonium Molybdate Reagent
(Technicon No. T01-5050)

Ammonium Molybdate

$(NH_4)_6Mo_7O_{24}\cdot 4H_2O$	10	g
Sulfuric Acid, 0.1N	1000	ml

Preparation

Dissolve 10 g of ammonium molybdate in one liter of 0.1 N sulfuric acid (2.8 ml concentrated sulfuric acid, sp.gr. - 1.84/liter). Filter and store in an amber plastic container.

Oxalic Acid

Oxalic Acid ($H_2C_2O_4$)

Technicon No. T11-5051	50	g
Distilled Water, q.s.	1000	ml

Preparation

Dissolve 50 g of oxalic acid in 900 ml of distilled water and dilute to one liter.

Ascorbic Acid Reagent

Ascorbic Acid, U.S.P. ($C_6H_8O_6$)		
Technicon No. T11-5070	17.6	g
Acetone (CH_3COCH_3)	50	ml
Technicon No. T21-5071		
Distilled Water, q.s.	1000	ml
Levor IV		
Technicon No. T21-0332	0.5	ml

Preparation

Dissolve 17.6 g of U.S.P. quality ascorbic acid in 500 ml of distilled water containing 50 ml of acetone. Mix and dilute to one liter with distilled water. Add 0.5 ml of Levor IV per liter of reagent.

STANDARDS

Stock Standard A, 10,000 µgat Si/l(280 mg Si/l)

Sodium Fluosilicate (Na_2SiF_6)	1.88	g
Distilled Water, q.s.	1000	ml

Preparation

Dissolve 1.88 g of sodium fluoscilicate in one liter of recently boiled and cooled distilled water. Store this stock solution in a tightly stoppered plastic bottle.

Stock Standard B, 1000 µgat Si/l (28 mg Si/l)

Stock Standard A	10	ml
Synthetic Seawater, q.s. or Deionized, Distilled Water, q.s.	100	ml

Preparation

Dilute 10 ml of stock standard A in a volumetric flask to 100 ml with synthetic seawater or deionized, distilled water. Store in a dark bottle. Prepare fresh daily.

Working Standards

ml Stock	µgat Si/l	mg Si/l
0.10	1.0	0.028
1.0	10	0.28
2.0	20	0.56
3.0	30	0.84
4.0	40	1.12
5.0	50	1.4

Preparation

Pipette stock into a 100 ml volumetric flask. Dilute to 100 ml with synthetic seawater or deionized, distilled water. Store in tightly stoppered plastic bottles.

OPERATING NOTES

1. The use of glassware should be avoided as much as possible since it may contribute silica .
2. The chemicals used for reagents and distilled water should be low in silica.
3. Alternate ranges may be obtained by utilization of the Std Cal control on the Colorimeter.
4. The sample stream must be clarified before being introduced to the system.
5. When analyzing seawater, a blank reading for the particular seawater of interest should be determined by sampling the seawater while running distilled water only through the reagent lines. The

blank reading obtained should be subtracted from the sample recording.

6. In-line reagent filters (Part No. 170-0144-01) should be used in all reagent containers.

7. When analyzing seawater, standardization should be carried out with synthetic seawater standards. The wash solution should be synthetic seawater. The reagent baseline is adjacent to zero.

   When running actual seawater samples, the wash solution should be deionized, distilled water. The reagent baseline must be re-adjusted to zero.

Synthetic Seawater

Sodium Chloride (NaCl)	31	g
Magnesium Sulfate Heptahydrate ($MgSO_4 \cdot 7H_2O$)	10	g
Sodium Bicarbonate ($NaHCO_3$)	0.041	g
Deionized, Distilled Water, q.s.	1000	ml

Preparation

Dissolve 31 g of sodium chloride, 10 g of magnesium sulfate heptahydrate and 0.041 g of anhydrous sodium bicarbonate in deionized, distilled water and dilute to one liter.

8. The reagent baseline absorbance with reference to water should be approximately 0.016 absorbance units.

9. When analyzing fresh water, use distilled water standards.

10. The use of multiple working standards is only to establish linearity. For day-to-day operation, the 30 µgat Si/l standard is recommended for instrument calibration.

SILICATES IN WATER AND SEAWATER

RANGE: 0-50 µgat Si/1
0-1.4 µg Si/1 ppm

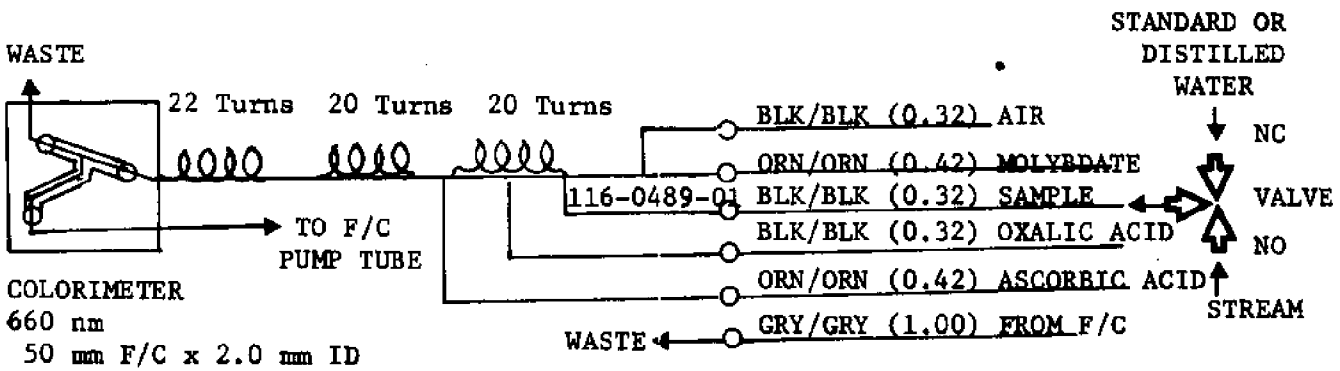


Figure D3 Silicate Flow Chart

NITRATE + NITRITE IN WATER AND SEAWATER

Range: 0-50 µgat N/l
0-700 µg N/l (ppb)

GENERAL DESCRIPTION

This automated procedure for the determination of nitrate and nitrite utilizes the procedure whereby nitrate is reduced to nitrite by a copper-cadmium reductor column. The nitrite ion then reacts with sulfanilamide under acidic conditions to form a diazo compound. This compound then couples with N-1-naphthylethylenediamine dihydrochloride to form a reddish-purple azo dye.

In surface waters normally encountered in surveillance studies, the concentration of oxidizing or reducing agents and potentially interfering metal ions are well below the limits causing interferences. When present in sufficient concentration, metal ions may produce a positive error, i.e., divalent mercury and divalent copper may form colored complex ions having absorption bands in the region of color measurements.

REAGENTS

Ammonium Chloride Reagent
(Technicon No. T01-5064)

Ammonium Chloride Reagent

(NH_4Cl)	10	g
Alkaline Water, q.s.	1000	ml
Brij-35 (Technicon No. T21-0110)	0.5	ml

Preparation

Dissolve 10 g of ammonium chloride in alkaline water and dilute to one liter. Add 0.5 ml of Brij-35 per liter.

NOTE: Alkaline water is prepared by adding just enough ammonium hydroxide to deionized, distilled water to attain a pH of 8.5.

Color Reagent
(Technicon No. T11-5065)

Sulfanilamide		
$(C_6H_8N_2O_2S)$	20	g
Concentrated Phosphoric Acid		
(H_3PO_4)	200	ml
N-1-Napthylethylenediamine Dihydrochloride		
$(C_{12}H_{14}N_2 \cdot 2HCl)$	1	g
Deionized, Distilled Water, q.s.	2000	ml
Brij-35	1.0	ml

Preparation

To approximately 1500 ml of distilled water, add 200 ml of concentrated phosphoric acid and 20 g of sulfanilamide. Dissolve completely. (Heat if necessary). Add 1 g of N-1-naphthylethylenediamine dihydrochloride and dissolve. Dilute to two liters. Add 1.0 ml of Brij-35. Store in a cold dark place. STABILITY: one month.

Cadmium Powder
(Technicon No. T11-5063)

Use coarse cadmium powder (99% pure). Rinse the powder once or twice with a small amount of clean diethyl ether or 1 N HCl to remove grease and dirt. Follow with a distilled water rinse. Allow the metal to air-dry and store in a well-stoppered bottle.

Preparation of Reductor Column

The reductor column tube is a fourteen inch length of 0.081 inch ID standard tubing. Before filling the column, prepare the cadmium in the following manner:

Wash 10 g of previously cleaned cadmium with 50 ml of 2% w/v copper sulfate ($CuSO_4 \cdot 5H_2O$)(Technicon No. T01-5068) until no blue color remains in solution and semi-colloidal copper particles begin to enter

the supernatent liquid. Wash thoroughly with distilled water to remove all of the colloidal copper which is present. A minimum of ten washings is usually required.

Fill the reductor column tube with water to prevent the entrapment of air bubbles during the filling operation. Transfer the prepared cadmium granules to the column using a Pasteur pipette. When the entire column is filled with granules, insert glass wool in both ends of the tube. Insert an N5 nipple on one side of the tube.

Start pumping reagents. When the pump tubes are filled with reagents and all air is removed from transmission lines, attach the distal end of the tube to the 0.034 polyethylene resample line and connect the other end of the tube directly to the A2 debubbler.

To reactivate cadmium which has lost its reducing power, wash the cadmium with 1N hydrochloric acid and rinse thoroughly with deionized, distilled water. Re-treat the metal with copper sulface.

STANDARDS

Stock Standard A, 500 µgat N/l (70,000 µg N/l)

Potassium Nitrate (KNO_3)	0.505	g
Deionized, Distilled Water, q.s.	1000	ml
Chloroform ($CHCl_3$)	1	ml

Preparation

Dissolve 0.505 g of potassium nitrate in deionized distilled water and dilute to one liter. Store in a dark bottle. Add 1 ml of chloroform as a preservative.

Stock Standard B, 500 µgat N/l (7,000 µg N/l)

Stock Standard A	10 ml
Synthetic Seawater, q.s. or Deionized, Distilled Water, q.s.	100 ml

Preparation

Dilute 10 ml of stock standard A in a volumetric flask to 100 ml with synthetic seawater or deionized distilled water. Store in a dark bottle, Prepare fresh daily.

Working Standards

ml Stock B	µgat N/l	µg N/l
0.20	1.0	14
2.0	10	140
4.0	20	280
6.0	30	420
8.0	40	560
10.0	50	700

Preparation

Pipette stock B into a 100 ml volumetric flask. Dilute to 100 ml with synthetic sea water or deionized, distilled water. Store in a dark bottle. Prepare fresh daily.

OPERATING NOTES

1. The sample stream must be clarified before being introduced to the system.
2. It is of the utmost importance that the water used in preparing reagents and standards be completely free of contamination.
3. In order to determine nitrate levels, the nitrite alone must be subtracted from the total (nitrate and nitrite). The nitrite value can be determined by eliminating the reductor column from the

manifold, or by using the Technicon Method for Nitrite, Method No. 178-72WM.

4. The reductor column must be clean and have good flow characteristics for the system to operate satisfactorily. Colloidal copper is the primary contaminant.
5. For initial activation of the reductor, a midscale standard should be pumped through the system for about one hour.
6. The efficiency of the reductor column has been found to be 99%.
7. Alternate ranges may be obtained by utilization of the Std Cal control on the Colorimeter.
8. When analyzing seawater, a blank reading for the particular seawater of interest should be determined by sampling the seawater while running distilled water only through the reagent lines. The blank reading obtained should be subtracted from the sample recording.
9. The reagent baseline absorbance with reference to water should be approximately 0.06 absorbance units.
10. The Colorimeter should be operated in the Damp 1 Mode.
11. When analyzing seawater, standardization should be carried out with synthetic seawater standards. The wash solution should also be synthetic seawater. The reagent baseline is adjusted to zero. When running actual seawater samples, the wash solution should be deionized, distilled water. The reagent baseline must be readjusted to zero.

Synthetic Seawater

Sodium Chloride (NaCl)	31	g
Magnesium Sulfate Heptahydrate ($MgSO_4 \cdot 7H_2O$)	10	g
Sodium Bicarbonate ($NaHCO_3$)	0.041	g
Deionized, Distilled Water, q.s.	1000	ml

Preparation

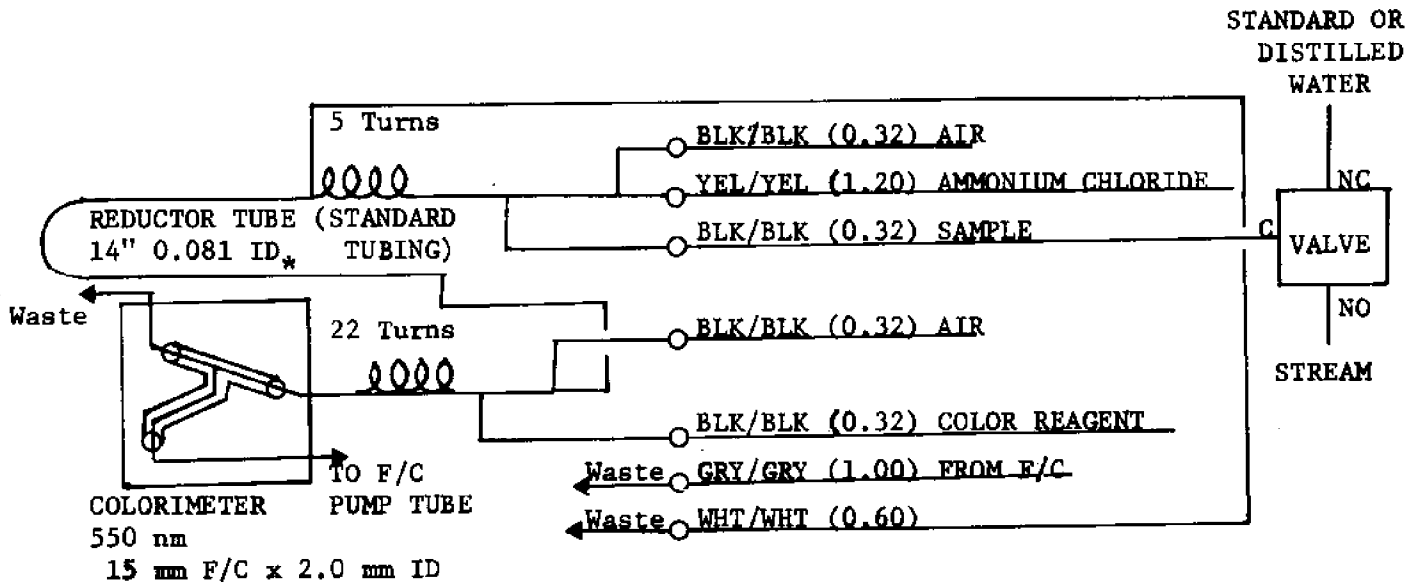
Dissolve 31 g of sodium chloride, 10 g of magnesium sulfate heptahydrate and 0.041 g of anhydrous sodium bicarbonate in deionized, distilled water and dilute to one liter.

12. When analyzing fresh water, use distilled water standards.
13. In-line reagent filters (Part No. 170-0144-01) should be used in all reagent containers.
14. The efficiency of the reductor column should be determined daily by comparing a nitrate standard to an equivalent nitrite standard. At least 95% efficiency should be obtained. If the efficiency is found to decrease below this level, a new column should be prepared.

    It has been determined, empirically, that a reductor column can last for at least one week of continuous operation.
15. When the column is not in use, it should be clamped off and left filled with ammonium chloride reagent.

NITRATE + NITRITE IN WATER AND SEAWATER

RANGE: 0-50 µgat N/l
0-700 µg N/l (ppb)



NOTE: FIGURES IN PARENTHESES SIGNIFY FLOW RATES IN ML/MIN.

* 0.034 POLYETHYLENE

Figure D4 Nitrate - Nitrite Flow Chart

ORTHO PHOSPHATE IN SEA WATER

(Range: 5 µgat P/l)

GENERAL DESCRIPTION

The automated procedure for the determination of ortho phosphate in sea water depends on the formation of a phosphomolybdenum blue complex which is read colorimetrically at 660 nm.

A single reagent solution is used consisting of an acidified solution of ammonium molybdate containing ascorbic acid and a small amount of antimony.

Interference from copper and iron is insignificant. Silicon at a level of 100 µgat Si/l causes an interference equivalent to approximately 0.04 µgat P/l.

Although arsenate produces a similar color to phosphate, sea water rarely contains arsenate in concentrations high enough to interfere. The sale error has been found to be less than 1%.

REAGENTS

Sulfuric Acid, 4.9N

Sulfuric acid, concentrated (sp. gr. 1.84)		
(H_2SO_4)	136	ml
Deionized, distilled water, q.s.	1000	ml

Preparation

Add 136 ml of concentrated sulfuric acid to 800 ml of deionized, distilled water while cooling. After this solution has been cooled, dilute to one liter with deionized, distilled water.

Ammonium Molybdate

Ammonium molbydate ($(NH_4)_6Mo_7O_{24}\cdot 4H_2O$)	40	g
Deionized, distilled water, q.s.	1000	ml

Preparation

Dissolve 40 g of ammonium molybdate in 800 ml of deionized, distilled water. Dilute to one liter with deionized, distilled water.

Ascorbic Acid

Ascorbic Acid, U.S.P. (Technicon No. T11-5070)

$(C_6H_8O_6)$	18 g
Deionized, distilled water, q.s.	1000 ml

Preparation

Dissolve 18 g of U.S.P. quality ascorbic acid in 800 ml of deionized, distilled water. Dilute to one liter with deionized, distilled water.

Antimony Potassium Tartrate

Antimony potassium tartrate

$[K(SbO)C_4H_4O_6 \cdot 1/2H_2O]$	3.0 g
Deionized, distilled water, q.s.	1000 ml

Preparation

Dissolve 3.0 g of atimony potassium tartrate in 800 ml of deionized, distilled water. Dilute to one liter with deionized, distilled water.

Combined Working Reagent

Sulfuric acid, 4.9N	50 ml
Ammonium molbydate	15 ml
Ascorbic Acid	30 ml
Antimony potassium tartrate	5 ml

Preparation

Combine reagents together in the order listed above; 50 ml of sulfuric acid, 15 ml of ammonium molybdate, 30 ml of ascorbic acid, and 5 ml of antimony potassium tartrate. This reagent is stable for about eight hours.

Water Diluent

To deionized, distilled water, add 0.5 cc Levor IV per liter.

STANDARDS

Stock Standard A, 1000 µgat P/l

Anhydrous potassium dihydrogen phosphate (Technicon No. T13-5069) (KH_2PO_4)	0.136	g
Deionized, distilled water, q.s.	1000	ml

Preparation

Dissolve the potassium phosphate in 500 ml of deionized, distilled water in a volumetric flask. Dilute to one liter with deionized, distilled water. Add 1 ml of chloroform as a preservative.

Stock Standard B, 50 µgat P/l

Stock standard A	5	ml
Deionized, distilled water, q.s.	100	ml

Preparation

Dilute 5 ml of stock standard A in a volumetric flask to 100 ml with deionized, distilled water. Prepare fresh daily.

Working Standards

ml Stock B	µgat P/l
0.20	0.10
2.0	1.0
4.0	2.0
6.0	3.0
8.0	4.0
10.0	5.0

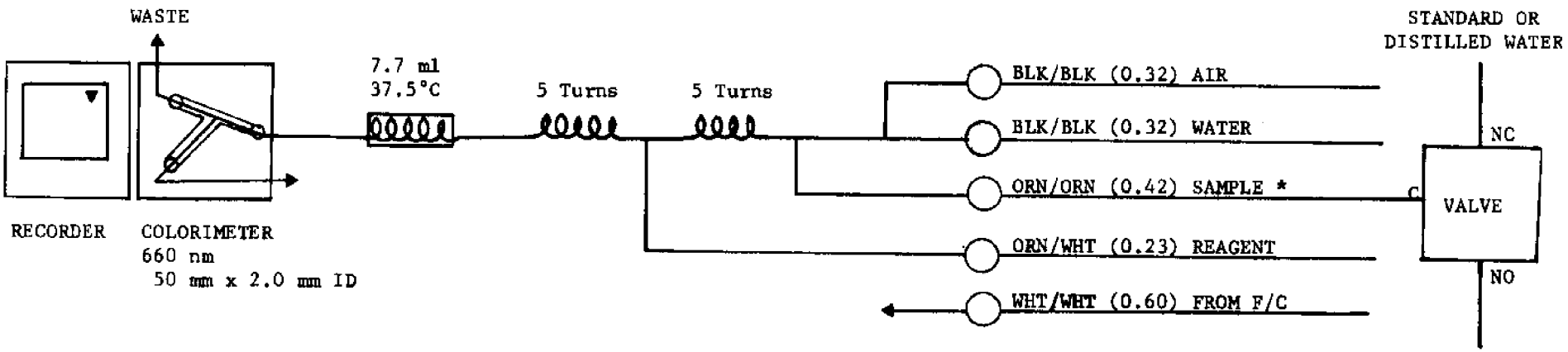
Preparation

Pipette stock B into a 100 ml volumetric flask. Dilute to 100 ml with deionized, distilled water. Prepare fresh daily.

OPERATING NOTES

1. A blank reading for the particular sea water of interest should be determined by sampling the sea water while running distilled water only through the reagent lines. The blank reading obtained should then be subtracted from the sample reading.
2. Glassware for the preparation of reagents and standards should be washed with one normal hydrochloric acid and rinsed thoroughly with deionized, distilled water in order to remove any traces of phosphate.
3. The ascorbic acid solution is stable for about two months if kept in a freezer or refrigerator. It is stable for about two weeks if not refrigerated. However, the container must be kept well stoppered.
4. Samples which are not run immediately should be preserved with 1 ml/l of chloroform.
5. Alternate ranges may be obtained by utilization of the standard calibration dial on the Colorimeter.
6. The Colorimeter should be operated in the Damp 1 mode.
7. The sample stream must be clarified before being introduced to the system.
8. In line reagent filters (Technicon Part #170-0144-01) should be used in all reagent containers.

ORTHO PHOSPHATE IN SEAWATER
RANGE: 5 µgat P/l



NOTE: FIGURES IN PARENTHESIS SIGNIFY FLOWRATE IN ML/MIN

* .034 POLYETHYLENE

Figure D5 Phosphate Flow Chart