12-1-1974

Hydrography and Hydrodynamics of Virginia Estuaries XIII: A Report of the Prototype Data Collected in the York, Back, Poquoson, Piankatank, Great Wicomico and James Rivers for the Chesapeake Bay Model Study During 1973

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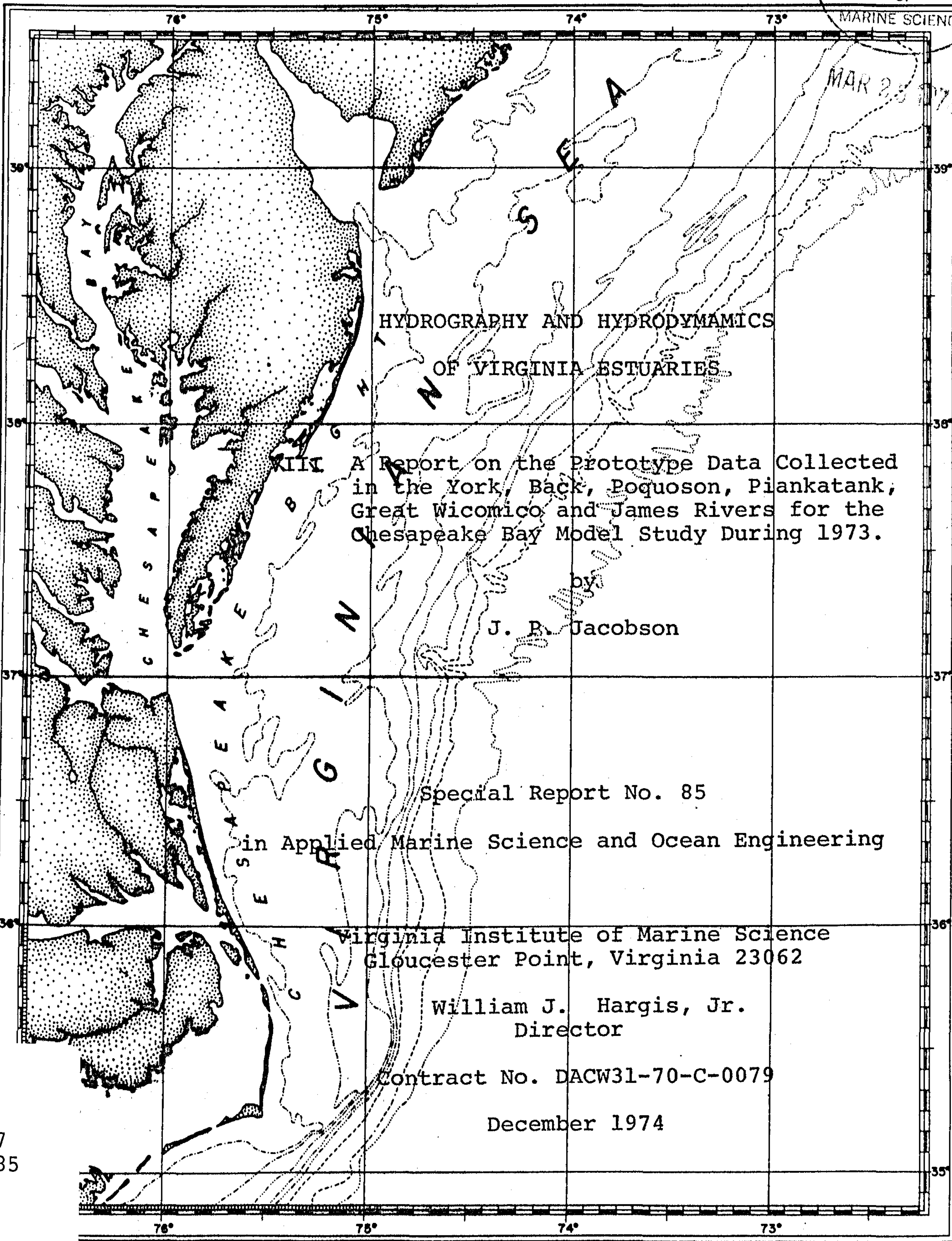

HYDROGRAPHY AND HYDRODYMAMICS OF VIRGINIA ESTUARIES

XIII. A Report on the Prototype Data Collected in the York, Back, Poquoson, Piankatank, Great Wicomico and James Rivers for the Chesapeake Bay Model Study During 1973.

by

J. P. Jacobson

Special Report No. 85

in Applied Marine Science and Ocean Engineering

Virginia Institute of Marine Science
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William J. Hargis, Jr.
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Contract No. DACW31-70-C-0079

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ACKNOWLEDGEMENTS

The author thanks the Corps of Engineers, Baltimore District, for funding this hydrographic survey of the Chesapeake Bay estuarine system.

A large number of individuals were involved in collecting and processing the data described in this report. All deserve credit for many hours of hard work under conditions which were frequently less than desirable. Dr. W. J. Hargis, Jr. was responsible for obtaining this contract. Dr. C. S. Fang deserves particular credit for his overall management of the project. Mr. John Ruzecki was in charge of a portion of the field work. Particular thanks are due to Ms. Marilyn Cavell for her work on the figures and to Ms. Shirley Crossley for typing the report. Ms. Susan Sturm deserves particular thanks for the many long tedious hours spent reading current meter film and for her able assistance in processing the data.

ABSTRACT

This report describes methods used to collect and process current and salinity data for the York, Back, Poquoson, Piankatank, Great Wicomico and James Rivers, Virginia. Data was collected during 1973 as part of a study which investigates water utilization and control in the Chesapeake Bay Basin. Field procedures, equipment and data processing techniques are discussed in full.

I. INTRODUCTION

The 89th Congress of the United States directed the Secretary of the Army to conduct an investigation of water utilization and control in the Chesapeake Bay Basin. This investigation was to include, but not be limited to, the collection of field data which would determine fluctuations in water levels (tides), currents, and quantities of ocean derived salt within Chesapeake Bay and its tributaries. The task of supervising the investigation was assigned to the Corps of Engineers with specific supervisional duties further assigned to the Chief Engineer, Baltimore District.

Specific locations for collection of hydrographic data were established by the Corps and, on 23 June 1970, Contract Number DACW31-70-C-0079 was awarded to the Virginia Institute of Marine Science to perform hydrographic studies of the lower Chesapeake Bay System. This report concerns data collected during 1973 on the York, James, Back, Poquoson, Piankatank and Great Wicomico Rivers. All efforts were made to conform with the general guidelines established by the Baltimore District. Transfer, to the Corps, of processed field data described herein was accomplished during 1974.

II. DESCRIPTION OF FIELD PROGRAM

A. General Program

The field program involved two distinct projects: same slack salinity runs and time series measurements of currents and salinity at fixed stations. Specific locations of current-salinity stations and slack water stations may be obtained by consulting figures 1 through 7 and tables 1, 2 and 3.

Same slack salinity runs on the York River were made on a monthly basis for a one year period starting in December 1972. Channel stations were occupied on each range from the river mouth to a location where ocean-derived salts dropped below one part per thousand. Same slack stations are shown as squares in figure 2.

Currents and salinities were measured in two deployments on the York River between 10 April and 20 April 1973, one deployment on the Back and Poquoson Rivers from 30 April to 4 May 1973, on the Piankatank and Great Wicomico Rivers from 4 May to 11 May 1973, and on the James River from 10 September to 14 September 1973. Current-salinity stations are shown as circles in figures 1 through 7.

B. Station Designation for Current-Salinity Deployments and Slack Water Runs.

Whenever possible, station designations outlined in the contract were followed for identifying current-salinity data.

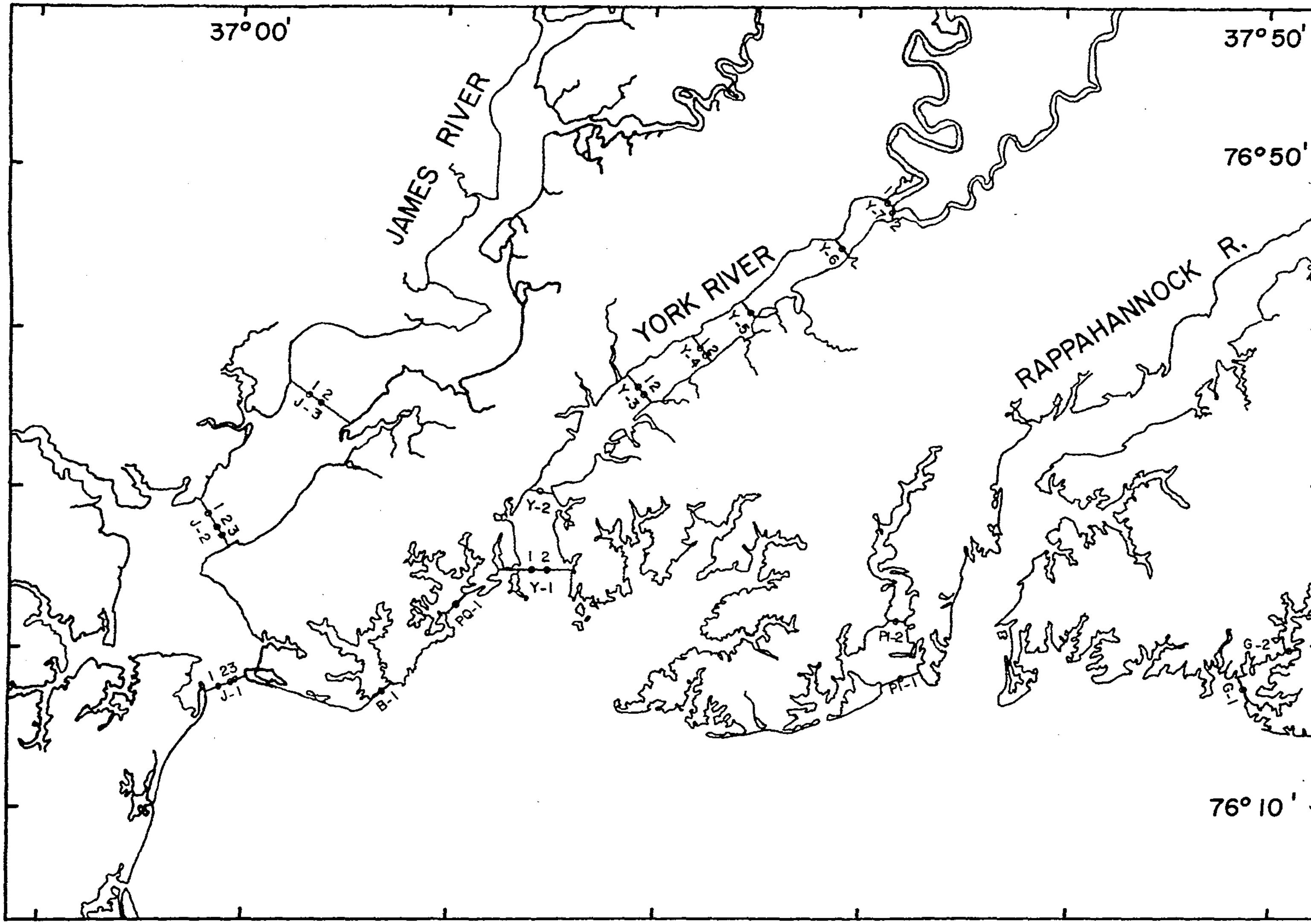

Figure 1. Location map showing current-salinity stations sampled during 1973.

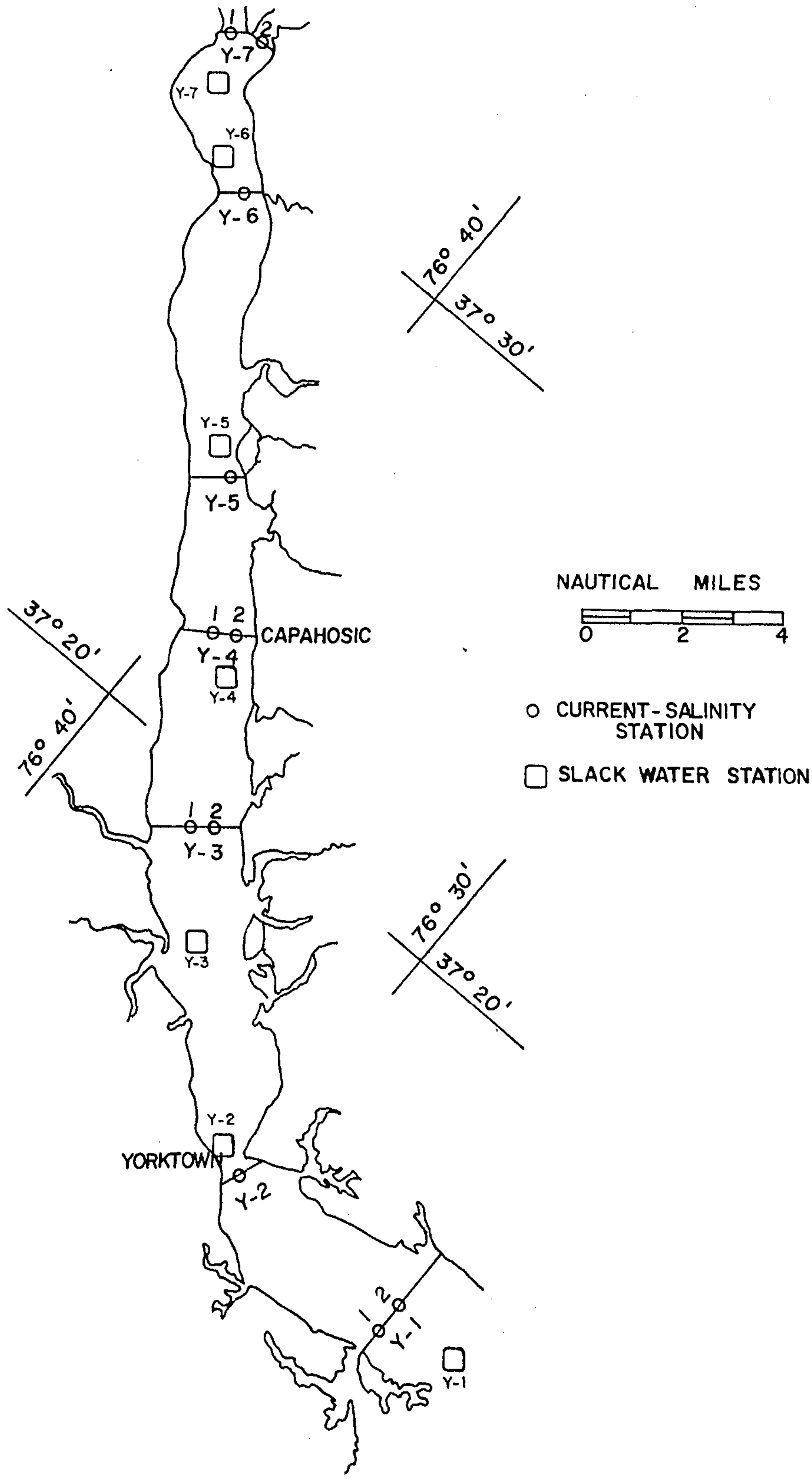

Figure 2. Chart showing positions of the current-salinity and slack water stations in the York River

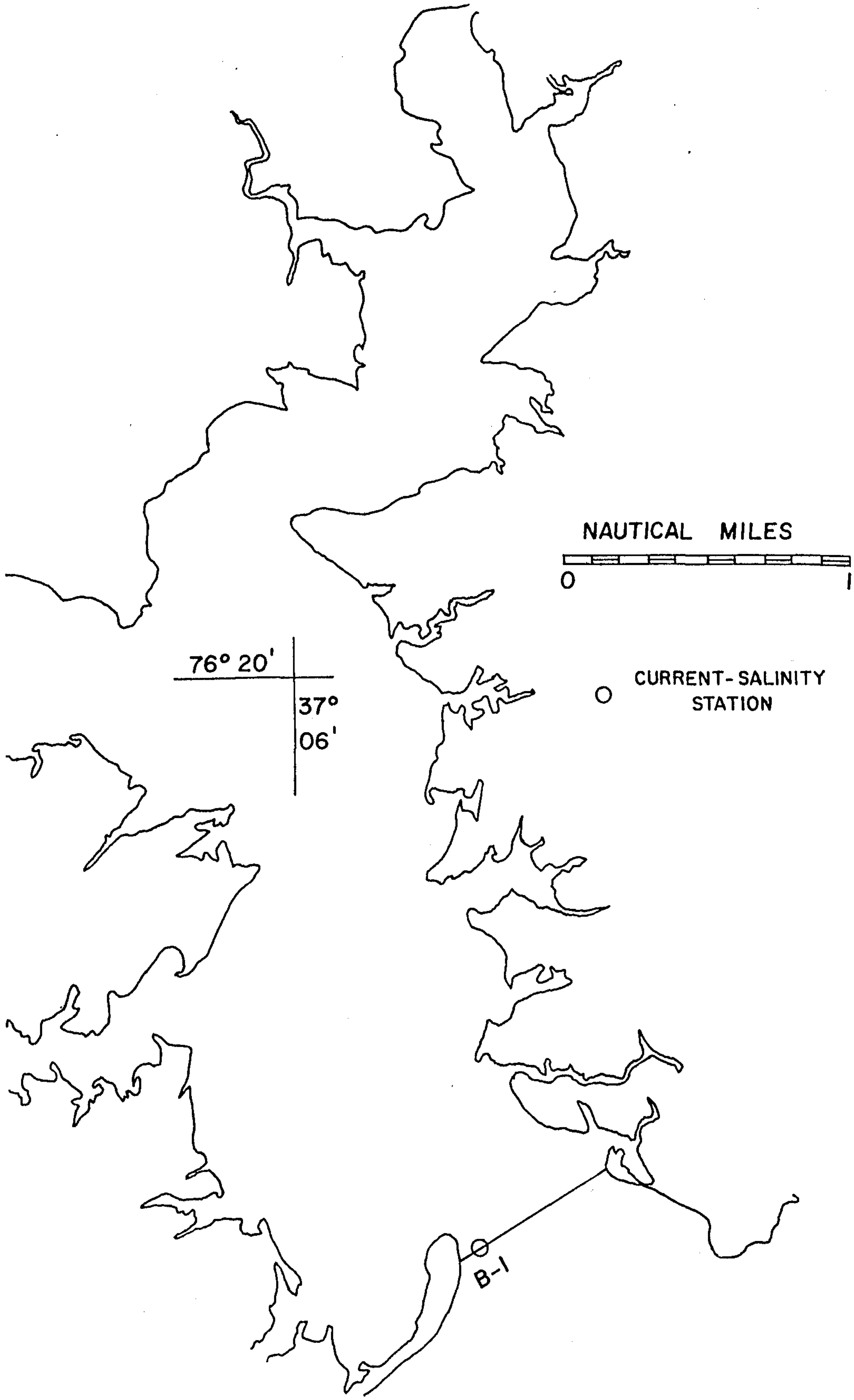

Figure 3. Chart showing position of the current-salinity station in the Back River.

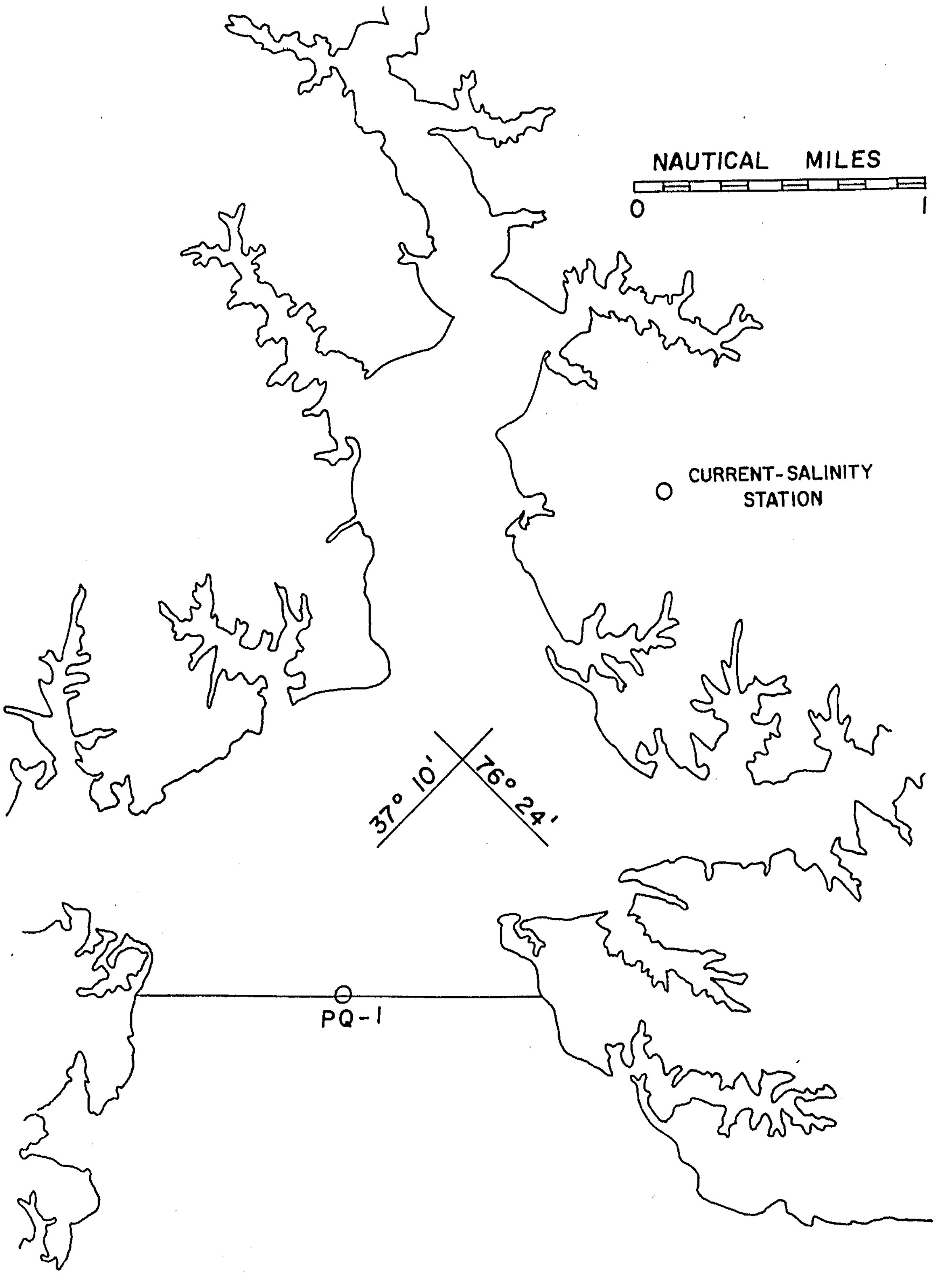

Figure 4. Chart showing position of the current-salinity station in the Poquoson River.

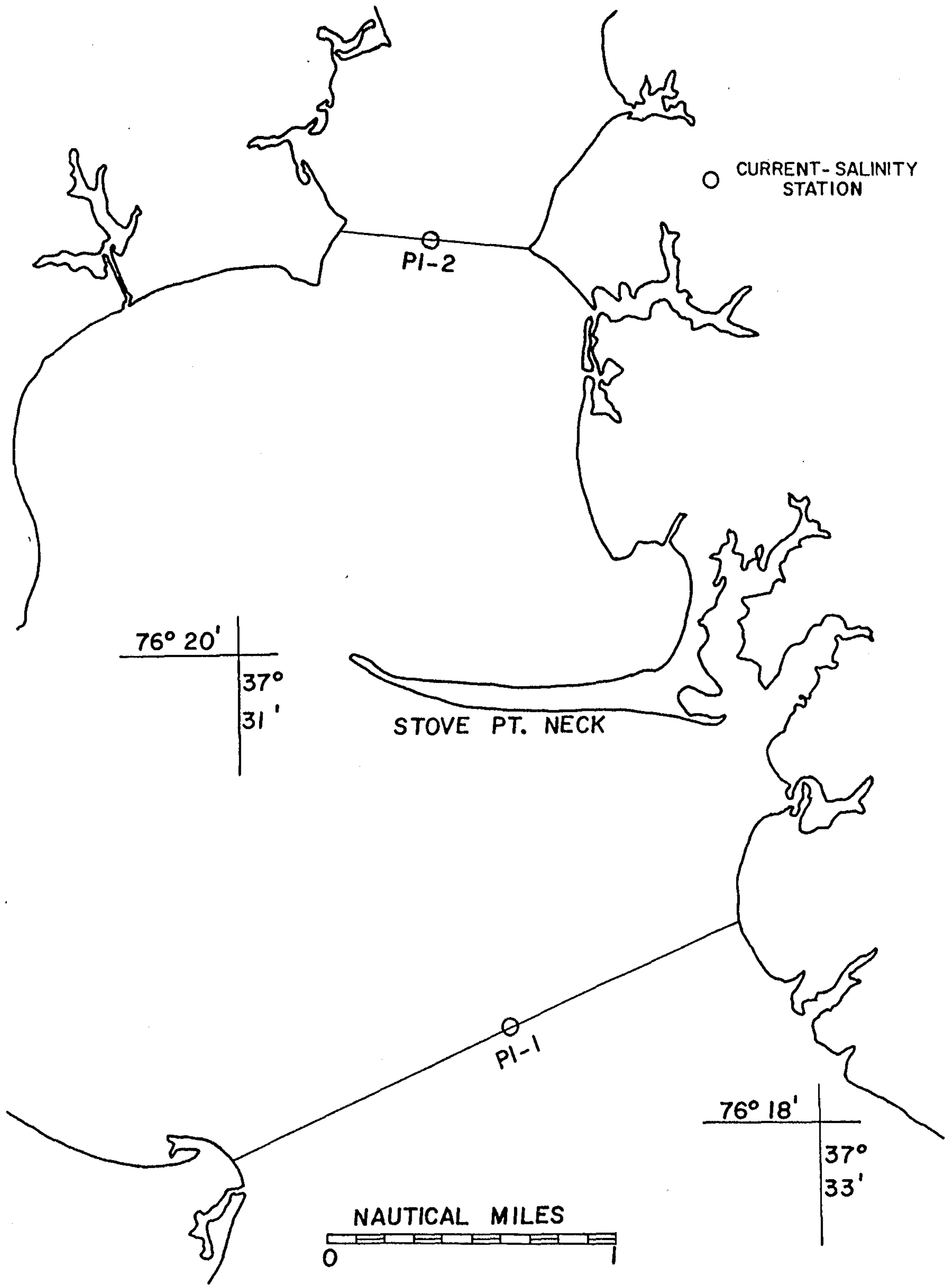

Figure 5. Chart showing positions of the current-salinity stations in the Piankatank River.

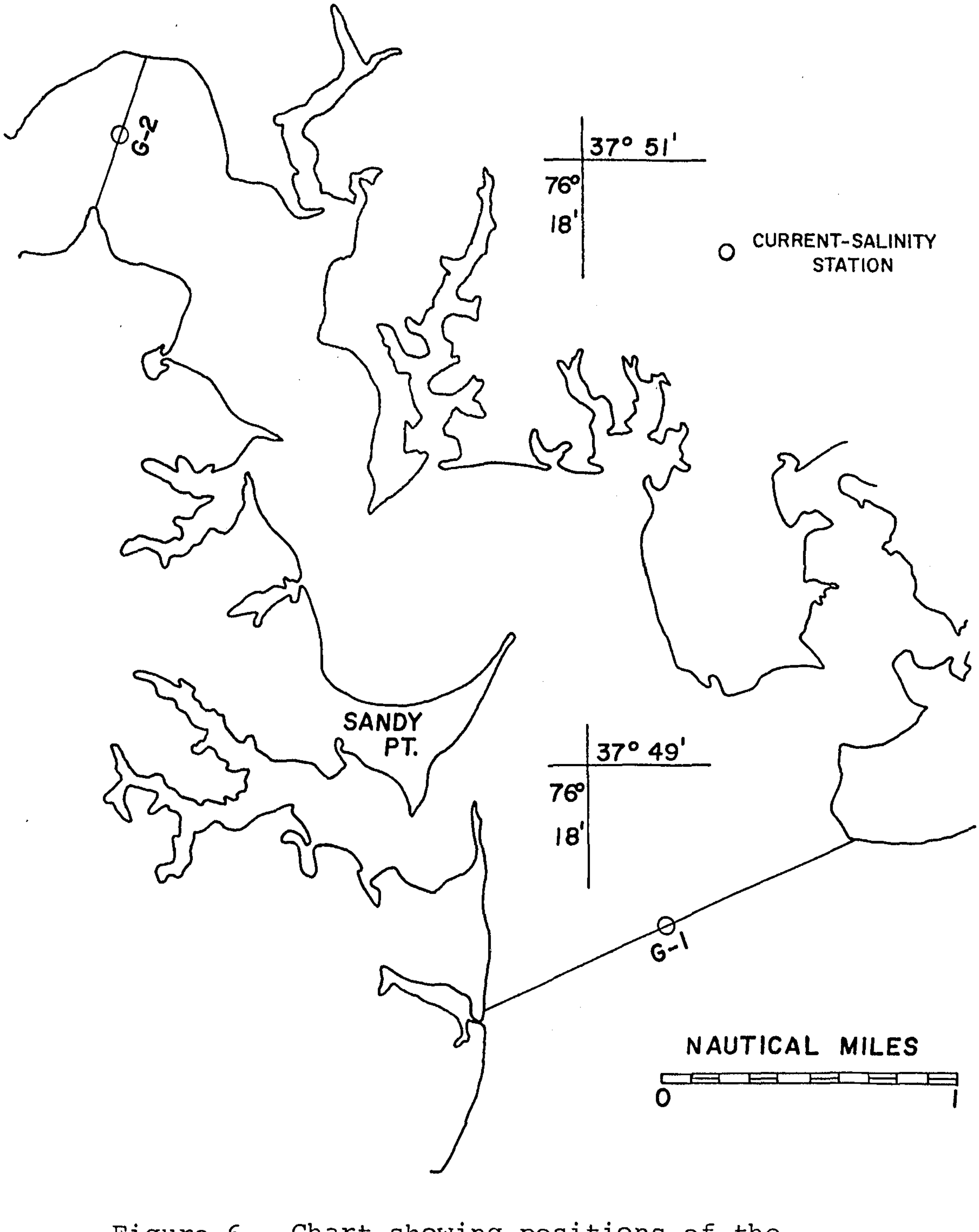

Figure 6. Chart showing positions of the current-salinity stations in the Great Wicomico River.

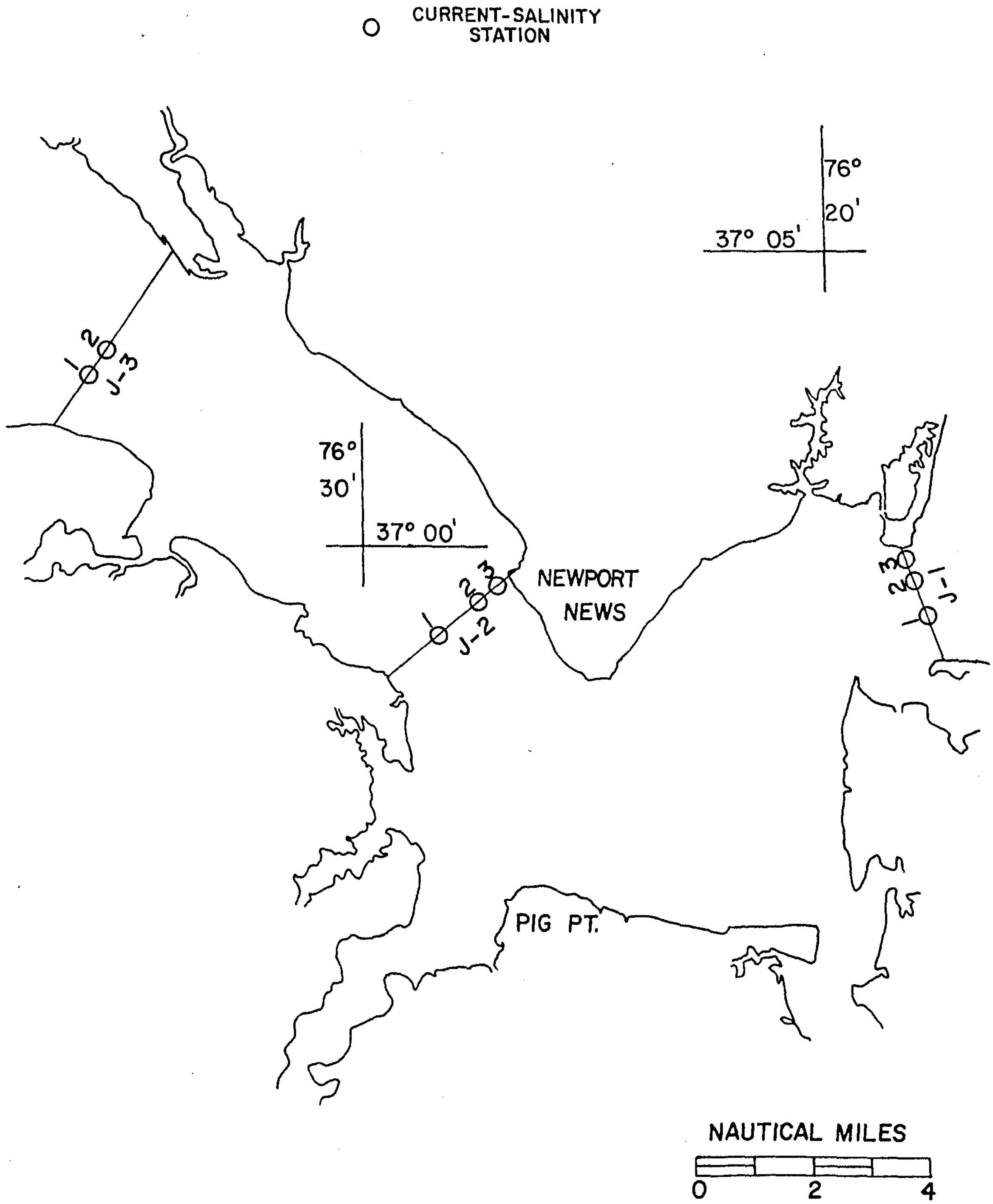

Figure 7. Chart showing positions of the current-salinity stations in the James River.

Table 1

Current Meter Stations

York River 1973

Station	Latitude (N)	Longitude (W)	Water Depth (ft)	Depths Sampled (feet)	Time In	Time Out
Y-1-1	37°14'12"	76°25'01"	35	3,13,23,33	1140,4/10	0920,4/16
Y-1-2	37°14'32"	76°25'02"	55	5,15,25,35,45,54	1100,4/10	0940,4/16
Y-2-1	37°14'20"	76°30'13"	72	4,14,24,34,44,54, 64,70	1340,4/10	1420,4/20
Y-3-1	37°18'58"	76°36'21"	17	2, 9,13	1540,4/10	1120,4/16
Y-3-2	37°19'18"	76°35'51"	35	3,13,23,33	1520,4/10	1200,4/16
Y-4-1	37°22'09"	76°39'00"	15	2,12	1640,4/10	1300,4/20
Y-4-2	37°22'22"	76°38'33"	32	3,13,23,33	1720,4/10	1240,4/20
Y-5-1	37°24'49"	76°41'07"	28	4,14,23,26	1640,4/16	1140,4/20
Y-6-1	37°29'15"	76°45'25"	27	4,14,24	1800,4/16	1000,4/20
Y-7-1	37°31'18"	76°47'52"	20	4,12.5,17.5	1940,4/16	0840,4/20
Y-7-2	37°31'29"	76°47'21"	16	4,14	1840,4/16	0800,4/20

Table 2

Current Meter Stations

Back, Poquoson, Piankatank, Great Wicomico and James Rivers 1973

Station	Latitude (N)	Longitude (W)	Water Depth (ft)	Depths Sampled (feet)	Time In	Time Out
B-1-1	37°06'38"	76°17'32"	15	2,12	1200,4/30	0520,5/4
PQ-1-1	37°10'14"	76°23'00"	15	4,12	1440,4/30	0740,5/4
PI-1-1	37°31'56"	76°18'24"	25	4,12,20	1220,5/4	1100,5/11
PI-2-1	37°31'45"	76°21'44"	33	4,14,24	1320,5/4	1200,5/11
G-1-1	37°48'30"	76°17'38"	20	4,14,17	1720,5/7	0820,5/11
G-2-1	37°51'05"	76°20'00"	20	4,14,17	1320,5/7	0740,5/11
J-1-1	36°58'51"	76°17'37"	19	4,14	1420,9/10	0500,9/14
J-1-2	36°59'33"	76°17'54"	51	5,15,25,35,45	1600,9/10	0900,9/18
J-1-3	37°00'01"	76°18'09"	79	4,14,24,34,44, 54,64,74	1540,9/10	1240,9/12
J-2-1	36°58'38"	76°27'51"	14	4,12	1400,9/10	1220,9/14
J-2-2	36°58'53"	76°27'15"	27	5,15,25	1320,9/10	1200,9/14
J-2-3	36°59'15"	76°26'51"	51	5,15,25,35,45	1340,9/10	1140,9/14
J-3-1	37°02'56"	76°35'52"	25	3,13,19	1100,9/10	0940,9/14
J-3-2	37°03'28"	76°35'36"	21	3,12,18	1140,9/10	0940,9/14

Table 3

Slack Water Stations

York River

1972-1973

Station	Lat. (N)	Long. (W)	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Y-1	37°14'30"	76°23'12"	X	X	X	X	X	X		X	X	X	X	X
Y-2	37°14'45"	76°30'45"	X	X	X	X	X	X	X	X	X	X	X	X
Y-3	37°17'24"	76°34'24"	X	X	X	X	X	X	X	X	X	X	X	X
Y-4	37°21'45"	76°38'00"	X	X	X	X	X	X	X	X	X	X	X	X
Y-5	37°25'06"	76°41'36"	X	X	X	X	X	X	X	X	X	X	X	X
Y-6	37°29'24"	76°46'12"	X	X	X	X	X	X	X	X	X	X	X	X
Y-7	37°30'30"	76°47'24"	X	X	X	X	X	X	X	X	X	X	X	X

1. Same Slack Runs

Slack water stations were designated as stations located at mid-navigation channel on each designated range in the York River.

2. Current-Salinity Deployments

Stations for current-salinity deployments were designated by a three increment code. The first increment consists of one or two letters designating the body of water sampled (Y for York, J for James, B for Back, PQ for Poquoson, PI for Piankatank and G for Great Wicomico). The second increment is a one or two digit number indicating the range sampled on a particular body of water. Range numbers are in increasing sequence moving upstream on the rivers. The third increment of the code indicates the number of a particular station on a given range. It is a number (1 through 3) with sequencing from left to right looking upstream.

C. Sampling Depths

Designated sampling depths were at ten (10) foot increments starting two (2) feet below local mean low water.

1. Current Meter Depths

Current meters were integral segments of taut wire moorings. A typical current meter station is illustrated in figure 8 and shows the anchor, (a railroad wheel), the surface meter mounted in a plank-on-edge buoy, and placement of additional current meters in the line. Generally the surface plank-on-edge buoy was set so that at MLW the top of the buoy was just under the water. This was done to reduce buoy motion. A swivel was placed between the bottom-most current meter and the anchor to allow free rotation of the buoy which served as a direction sensing vane for the upper-most current meter. Actual depths of all current meters below mean low water are given in tables 1 and 2.

2. Salinity and Slack Water Sampling Depths

During current-salinity deployments and slack water runs, salinity samples were obtained at all stations at current meter depths. Sample depths were measured from the water surface at the time of sampling. Depths were recorded in meters and converted to the nearest integer foot during data processing.

Salinity was measured by obtaining a water sample at the desired depth, placing the sample

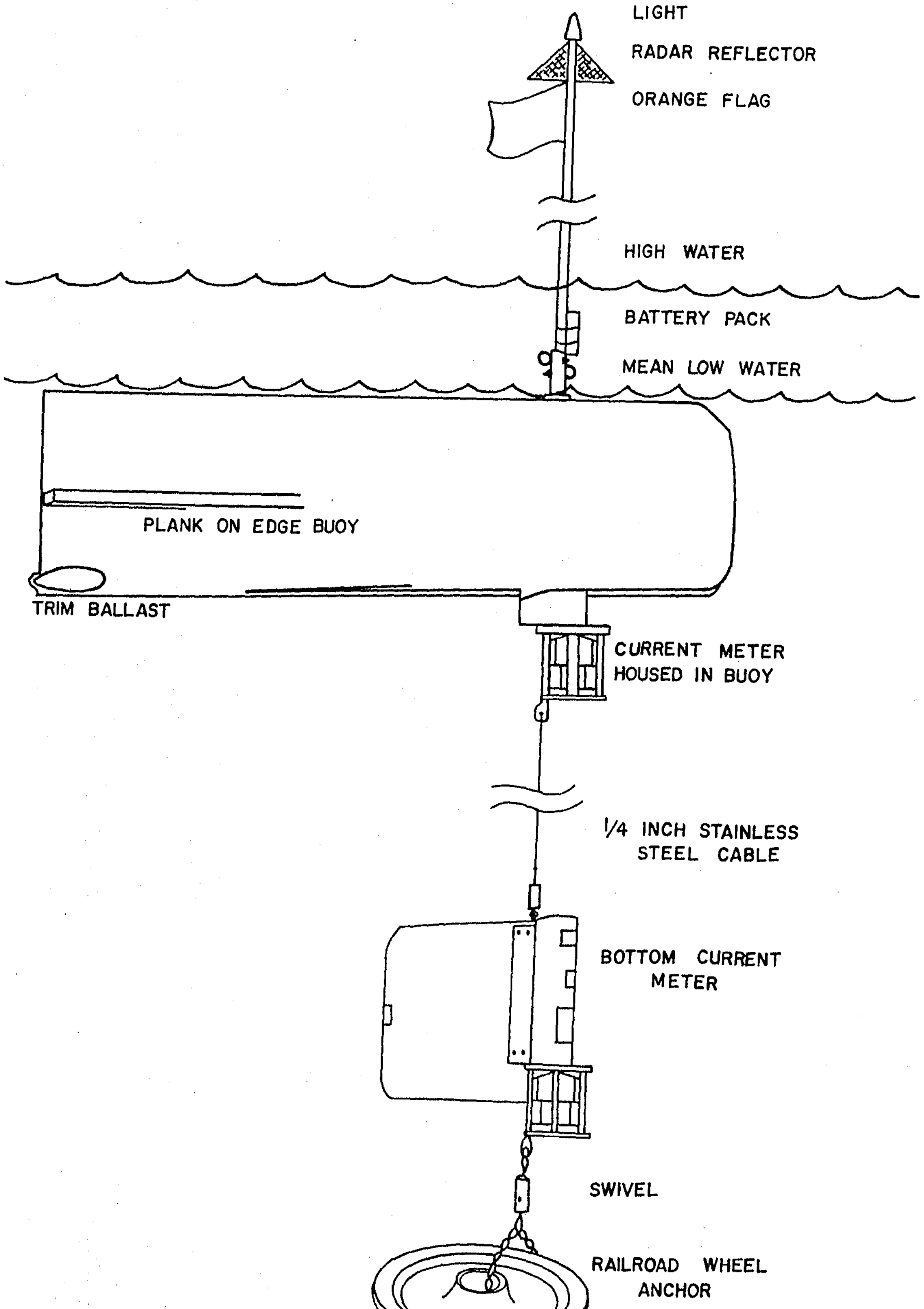

Figure 8. Schematic Diagram of a typical current meter station.

in a bottle which had been thoroughly rinsed with sample water, and conducting a laboratory analysis of the water sample with an inductance salinometer. Water samples were obtained with weighted Frautschy bottles attached to metered lines. Sampling bottles were sufficiently weighted to preclude angles greater than 10° between metered lines and the vertical.

III. INSTRUMENT DESCRIPTION AND DATA QUALITY

A. Current Velocity Measurements

All current velocities were measured with Braincon Type 1381 Histogram current meters. Water speed is sensed by a Savonious rotor while direction is sensed by a four (4) square foot vane (2 ft. x 2 ft.) rigidly attached to the current meter case. Rotor movement is transferred to the inside of the current meter case by a magnetic coupling which drives a 7200:1 gear train. The gear train, in turn, rotates the case of a viscous damped magnetic compass to which has been attached a radioactive source. Attached to the compass assembly are three additional radioactive sources located as follows:

1) at the top center of the glass compass dome,
2) on the north seeking portion of the compass card, and
3) at the end of a gimballed rod attached to the compass card.

A fifth radioactive source is attached to the inside of current meter case in the vicinity of the exterior vane. This fifth source has a current meter identification number impressed over the radioactive material.

Recording is accomplished with a 16 mm time exposure movie camera mounted on the inside top of the current meter case. Time exposure for each frame is 19.5 minutes. Film is advanced for 30 seconds between each frame by a battery operated DC motor which is activated by an "Accutron" (TM) timing device.

Figure 9 shows the position of the various elements of the recording system described above. Figure 10 is a typical data frame showing the resulting histograms used to determine average current speed and average current direction during the recording period. The instrument will operate unattended for approximately 45 days at three data frames per hour. Loading and unloading film magazines results in fogging of the film exposed at these times hence camera loading and unloading times cannot be used as references.

Current meter reference times used during this study were the times that an obstruction was removed from, or placed on the current meter savonious rotor. The obstruction normally used was a segment of foam rubber placed between the bottom of the rotor and the top of the bottom plate of the current meter. Both release and stoppage times of the rotor were recorded. As an added check, times at which current meters went into the water and came out of the water were also recorded.

Prior to deployment, each current meter timing device was adjusted to start the film advance mechanism

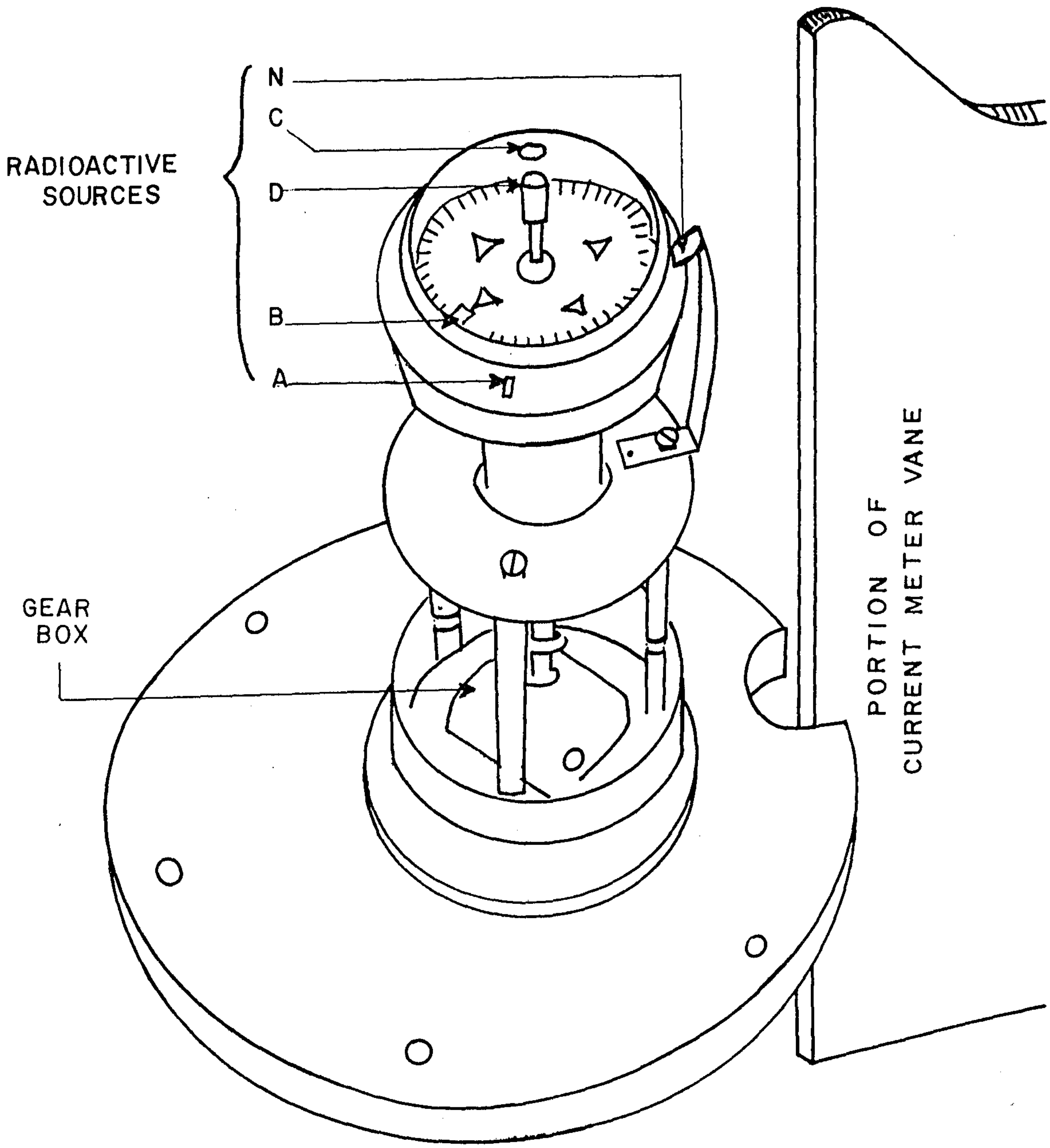

Figure 9. Internal portion of a Braincon 1381 Histogram current meter showing relative positions of radioactive sources (mounted on, in or near the compass) which produce a film record of average speed, direction and instrument tilt as shown in figure 10.

at 00, 20 and 40 minutes after the hour. Data records show current measurements at 00, 20 and 40 minutes after the hour which represent the start of each data frame. Because each data frame represents a form of average speed and direction for a twenty minute period, the average should be treated as centering around 10, 30 and 50 minutes after the hour. Stated starting times for each data frame are accurate to within ± 1 minute.

Once corrections for individual current meter errors and effects of tilt are applied, current speeds, as recorded, are accurate to better than ± 0.1 foot per second. The viscous damped compass yields directions which, referenced to magnetic north, are accurate to within ± 5°.

B. Salinity Measurements

As previously indicated, water salinity was determined by analysis of water samples obtained at specified times and positions in three dimensional space. During each current-salinity deployment, water samples were taken at two meter intervals from surface to bottom once every hour at each sampling station. Samples were obtained from a small boat near each current meter station. Surface samples were taken by submerging a rinsed sample bottle in surface waters. Samples below the surface were obtained with weighted sampling bottles lowered, on a metered line, to the desired depth. The sampling bottle was then closed by a messenger and pulled to the surface. Water from the sampling bottle was used to rinse and then fill a 4 oz. sample bottle. Water thus obtained was returned to the laboratory and analyzed for salt content with a Beckman RS7-A laboratory salinometer. This instrument has a rated accuracy of $\pm$ 0.01 ppt or better, however, salinities were recorded to the nearest 0.1 ppt.

Sampling bottles were fabricated from two foot lengths of 2 inch (I.D.) polyvinylchloride pipe. Sample depths were reckoned from the center of the sampling bottle hence recorded salinities should be treated as being integrated over a two foot vertical distance centered on the recorded depth.

Salinity measurements for slack water runs were obtained through procedures identical to those used during current-salinity deployments except that the sampling boat was not anchored. All times are actual times of salinity sampling and are expressed in military time referring to Eastern Standard Time.

IV. DATA REDUCTION AND PROCESSING PROCEDURES

A. General

The large volume of data generated during this project required various reduction techniques and rapid processing using digital computers. Each type of data, salinity and current, required its own specific type of reduction procedure to change the record from field sheets or exposed film to a digitized information amenable to computer processing.

B. Current Data

Field data on currents, generated by Braincon type 1381 Histogram current meters, consist of exposed 16mm film.

1. Data Frame. Once developed, a frame of current data is similar to figure 10 and contains the following information:
   a. Current meter identification, given by the current meter number, radioactive spot N.
   b. Current speed, determined by the total number of revolutions of the Savonious rotor during the 19.5 minute recording period. The length of arc B is a measure of this quantity and therefore, represents an integrated measure of current speed.
   c. Current direction, is measured as the angle (counter clockwise) between the

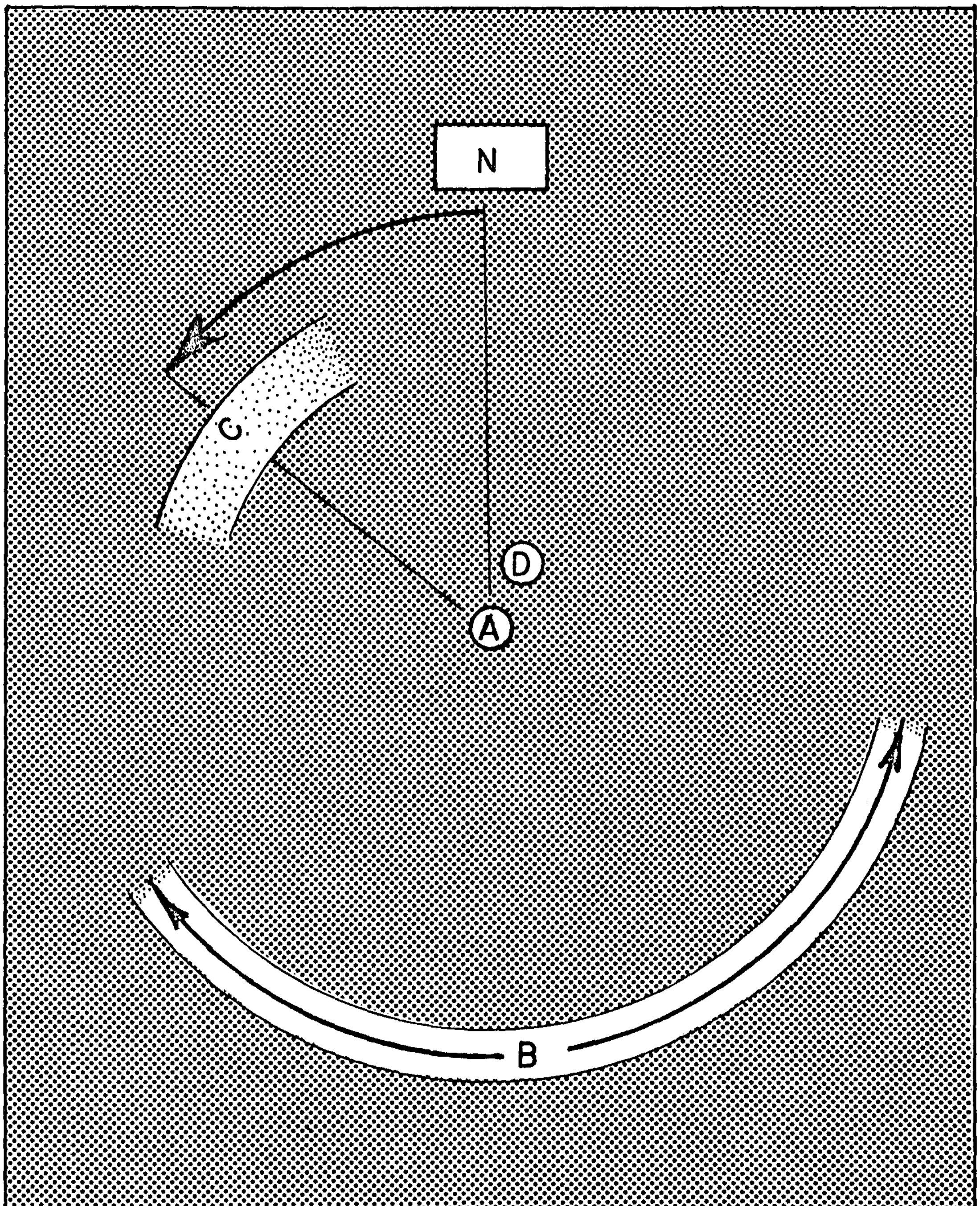

Figure 10. Typical data frame from a Braincon 1381 Histogram current meter showing center of field (A), speed arc (B), direction smear (C), tilt indication (D), and identification-orientation number (N).

center of the current meter number (N) and the "midpoint" of "smear" C which results from the radioactive source on the north seeking portion of the compass card.

d. Direction and magnitude of current meter tilt (from the vertical) during exposure time, is determined by the position of the exposed spot D, caused by the radioactive source at the end of a gimballed rod, relative to the exposed spot, A, caused by the radioactive source at the center of the compass dome. Tilt direction is given as the angle NAD while tilt magnitude is a function of the distance AD.

2. Film Reading

Current meter film is read using a modified 310A Recordak Film Reader interfaced with a Scientific Accessories Corp. Graf/Pen digital coordinate locator and DigiData Corp. digital tape recorder. The Recordak Film Reader serves as a film transport and projection mechanism, while the working face of the Graf/Pen serves as the projection screen. The projected image has a radius of approximately 5 inches and the cartesian coordinates of the following locations were automatically recorded on 9 track magnetic tape for each frame:

a. Center of the data frame (A of figure 10);

b. Beginning of speed arc;

c. End of speed arc;

d. Center of direction smear;

e. Center of tilt indication or, if tilt was indicated, center of data frame.

Four digits were assigned to each coordinate value. The Graf/Pen resolves distances to 7×10^{-3} inch and an unskilled operator can locate a point to within $\pm$ .035 inch. (Thus an unskilled operator can locate desired points on the projected image to within $\pm$ 0.7% of the image radius). Coordinate values for each current meter file were preceded on tape by the following "header" information: project name, river, range, station, depth, current meter number, date and time.

3. Data Processing

Once current meter data has been recorded as x,y coordinates on the magnetic tape, the following procedure is followed:

a. Program DATACHKA run

1) checks mainly for machine errors;

2) generates edited raw tape;

3) generates listing of data with error messages.

b. Listing from DATACHKA visually inspected for errors. If uncorrectable errors found, film reread.

c. Program CRNTCOMP run

1) calculates current speed and direction from edited raw tape.

2) time sequences frames

3) flags various errors such as

A. skipped frames

B. duplicate frames

C. misreading

D. excessive speed

4) writes time, current speed and direction on disk.

5) writes hard copy of time, current speed direction and error flags.

6) generates line plot of current speed and direction.

d. Listing of calculated speeds and direction and line plot checked for time sequencing, error messages and reasonableness of speed and direction values. If uncorrectable errors found, the film was reread.

e. Procedures "a" through "d" repeated until all current meter film from current meter string on disk.

f. Program CBMWRITE run

1. writes output tape of individual current meter files in Corps of Engineers format.

2. writes hard copy of current meter string in Corps of Engineers format.

g. Hard copy check for errors and time sequencing.

C. Salinity Data

Samples of water were gathered at hourly intervals at designated field stations and analyzed in the laboratory as previously described. Results of salinometer determinations were recorded with a precision of .1 ppt, on a general data handling log (VIMS Form 1). These data were then reduced as follows:

1. Forms were manually edited.
   a. Omissions and incomplete data were checked.
   b. Inspection was made of data in general.
2. Data were keypunched from corrected Form 1.
3. Punched cards were verified using a verifier.
4. Machine Process #1
   a. Read data in from cards.
   b. Check for the following types of errors:
      1) Incorrect dates and times.
      2) Sample depths exceed specified range.
      3) Salinity values exceed specified range.

5. If errors are detected in step 4, repunch cards needed to correct errors and repeat from step 4.
6. Machine Process #2
   a. Read in corrected cards.
   b. Print data out in standard VIMS format.
7. Proofread listing from step 6.
8. If errors are detected, correct cards and reprocess only page in question from step 6.
9. Machine Process #3
   a. Read in corrected cards.
   b. Convert time from hours and tenths (HH.H) to military time (HHMM).
   c. Place data on a disk file.
10. Print data in Corps of Engineers format.
    a. Read data from disk.
    b. Group data by depths to nearest foot.
    c. Assign classes of data by depth to a single (most frequently occurring) nominal depth.
    d. Print data in Corps of Engineers format.
       1) Individual missing data values are blank.
       2) An entire missing depth sequence is omitted.

e. Read data from disk and write tape in Corps of Engineers format. NOTE: On the tape, the actual depth with precision .001 ft. (resolution .1 meter) is used and the data are sorted by range, station, depth and time in that order. The resolution should be interpreted keeping the 2 ft. sample bottle size in mind. Incomplete records at end of file are filled with times of 0.0 and salinities of 0.0.

e. Read data from disk and write tape in Corps of Engineers format. NOTE: On the tape, the actual depth with precision .001 ft. (resolution .1 meter) is used and the data are sorted by range, station, depth and time in that order. The resolution should be interpreted keeping the 2 ft. sample bottle size in mind. Incomplete records at end of file are filled with times of 0.0 and salinities of 0.0.

V. FIELD LOG BOOK ABSTRACTS

A. General

This section describes methods used in establishing current meter stations and indicates difficulties encountered in maintaining a large number of oceanographic instruments in the field.

Sampling in the York River was accomplished during two deployments in the spring of 1973: 10 to 16 April for the lower York and 16 April to 20 April for the upper York. Sampling in the Back and Poquoson Rivers was during one deployment from 30 April to 4 May. Sampling in the Piankatank River took place from 4 May to 11 May and in the Great Wicomico River from 7 May to 11 May. The James River was sampled from 10 Sept. to 14 Sept.

The planned procedure during each deployment was first to set the current meter stations using either the R. V. Langley or the R. V. Retriever. Hourly salinity samples were taken the following three days at the established current meter stations fourteen times each day, usually 0600 to 1900. Various types of vessels were used as station boats, some of which were: 26 foot inboard and a 42 foot inboard boat. The sampling crew usually consisted of two people per boat.

B. Current Meter Stations

Current meters were set from two different vessels, the R. V. Langley and the R. V. Retriever. Current meters were set from the stern of the Langley while the vessel was anchored fore and aft. When setting current meters from the Retriever, the vessel was anchored from the bow facing into the current. Meters were then set over the side using the boom. The station depth was determined using a lead weighted sounding line and was adjusted to mean low water using the predicted tides for the location. Once the depth was determined the current meter string was assembled and lowered hand over hand style using a winch and standing line. After the station was set an anchor buoy (styrofoam sphere float with 150 lb. of steel ballast for an anchor) for the sampling boats was placed approximately 50 yards upstream from the current meter station.

C. Log Book Abstracts

9	April	0930	Attempt to set station Y-1-2. Had to abort due to frozen winch clutch on Langley. Returned to VIMS.
10	April	1020	Set station Y-1-2. Meters at 5, 15, 25, 35, 45, 54 feet.
		1120	Set station Y-1-1. Meters at 3, 13, 23, 33 feet.
		1320	Set station Y-2-1 downstream from Coleman Bridge due to weather. Meters at 4, 14, 24, 34, 44, 54, 59 feet.

10	April	1420	Set station Y-3-2. After set Langley swung over buoy and bent the mast. Meters at 3, 13, 23, 33 feet.
		1540	Set station Y-3-1. Meters at 2, 9, 13 feet.
		1700	Set station Y-4-2. Meters at 3, 13, 23, 33 feet.
		1740	Set station Y-4-1. Meters at 2, 12 feet.
11	April		No sampling due to bad weather. All stations visited and masts reported missing at stations Y-3-1 and Y-4-1.
12	April	0600-1900	Sampling at stations Y-1, Y-2, Y-3.
13	April	0700-0900	Sampling stopped at 0900 due to 30 knot wind blowing down river. Station Y-4-1 and Y-4-2 buoys listing in water.
14	April	0700-2000	Sampling at stations Y-1, Y-2, Y-3.
15	April	0600-1900	Sampling at stations Y-1, Y-2, Y-3.
16	April	0940	Pull station Y-1-2.
		1000	Pull station Y-1-1.
		1200	Pull station Y-3-1. Broken rotor on middle meter.
		1300	Pull station Y-3-2.
		1400	Pull station Y-4-1. Bottom meter vane missing and rotor broken.
		1420	Reset station Y-4-1.
		1500	Pull and reset station Y-4-2 since surface buoy too high in water.

16	April	1620	Set station Y-5-1. Meters at 4, 14, 23, 26 feet.
		1740	Set station Y-6-1. Meters at 4, 14, 24 feet.
		1840	Set station Y-7-2. Meters at 4, 14 feet.
		1920	Set station Y-7-1. Meters at 4, 13, 17 feet.
		2000	Dock at Chesapeake Corporation at West Point.
17	April	0600-1900	Sampling at stations Y-2, Y-4, Y-5, Y-6, Y-7.
18	April	0600-1900	Sampling at stations Y-2, Y-4, Y-5, Y-6, Y-7.
19	April	0600-1900	Sampling at stations Y-2, Y-4, Y-5, Y-6, Y-7.
20	April	0900	Pull station Y-7-1.
		0940	Pull station Y-7-2.
		1020	Pull station Y-6-1.
		1140	Pull station Y-5-1. Bottom meter had mud in rotor.
		1240	Pull station Y-4-2.
		1300	Pull station Y-4-1.
		1440	Pull station Y-2-1. Top meter had broken bearing.
		1500	Dock at VIMS pier.
30	April	1300	Set station B-1-1. Had trouble anchoring because of sandy bottom. Repositioned three times. Meters at 2, 12 feet.
		1600	Set station PQ-1-1. Meters at 4, 12 feet.

1	May	0530-1830	Sampling at stations B-1-1 and PQ-1-1.
2	May	0530-1830	Sampling at stations B-1-1 and PQ-1-1.
3	May	0530-1830	Sampling at stations B-1-1 and PQ-1-1. Boat problems at Back River station. Missed 4 hours data.
4	May	0720	Cut station B-1-1 loose using scuba diver from Capt. John Smith.
		0920	Cut station PQ-1-1 loose using scuba diver from Capt. John Smith.
		1320	Set station PI-1-1 using Langley. Meters at 4, 12, 20 feet.
		1400	Set station PI-2-1. Meters at 4, 14, 24 feet.
		1430	Dock Langley at Fishing Bay on Piankatank River.
7	May	0940	Reset station PI-1-1 since riding too high in water.
		1300	Set station G-1-1. Meters at 4, 14, 17 feet.
		1400	Set station G-2-1. Meters at 4, 14, 17 feet.
		1430	Dock Langley at Reedville on Great Wicomico River.
8	May	0500-1830	Sampling at stations PI-1-1, PI-2-1, G-1-1, G-2-1.
9	May	0500-1830	Sampling at stations PI-1-1, PI-2-1, G-1-1, G-2-1.
10	May	0500-1830	Sampling at stations PI-1-1, PI-2-1, G-1-1. G-2-1.
11	May	0920	Pull station G-2-1.
		0940	Pull station G-1-1.

11	May	1240	Pull station PI-1-1.
		1340	Pull station PI-2-1.
		1400	Dock Langley at Fishing Bay on Piankatank River.
10	Sept.	1140	Set station J-3-1 using R. V. Retreiver. Meters at 3, 13, 19 feet.
		1200	Set station J-3-2. Meters at 3, 12, 18 feet.
		1400	Set station J-2-3. Meters at 5, 15, 25, 35, 45 feet.
		1420	Set station J-2-2. Meters at 5, 15, 25 feet.
		1440	Set station J-2-1. Meters at 4, 12 feet.
		1500	Set station J-1-1. Meters at 4, 14 feet.
		1620	Set station J-1-3. Meters at 4, 14, 24, 34, 44, 54, 64, 74 feet.
		1640	Set station J-1-2. Meters at 5, 15, 25, 35, 45 feet.
		1720	Dock Retreiver at Fort Monroe on James River.
11	Sept.	0500-1800	Sampling at stations J-1, J-2, J-3.
		1800	Station J-2-1 reported missing. Mast had fallen off. Marked using styrofoam floats.
12	Sept.	0500-1800	Sampling at stations J-1, J-2, J-3.
		1400	Pull station Y-1-3 because Coast Guard changed channel markings due to construction on Hampton Roads tunnel. Station was in middle of new channel.

13	Sept.	0500-1800	Sampling at stations J-1, J-2.
		0500-1600	Sampling at station J-3 terminated early due to rough water.
14	Sept.	0820	Pull station J-1-1.
		0840	While attempting to pull station J-1-2 in rough weather the eye-bolt and mast broke. The buoy was totally submerged and were unable to locate in the rough water.
		1120	Pull station J-3-2. Bearing broken on middle current meter.
		1140	Pull station J-3-1.
		1320	Pull station J-2-3.
		1330	Pull station J-2-2.
		1340	Pull station J-2-1.
15	Sept.		Dragged and used pinger receiver to try and locate station J-1-2. No luck.
17	Sept.		Again tried to locate J-1-2 using pinger receiver. Could hear the pinger but could not home in on it.
18	Sept.	1100	Located buoy for J-1-2 about 3 feet under the water using pinger receiver. The buoy had been cut in two by a ship prop. A scuba diver was deployed and cut the string loose at the bottom. The current meter in the buoy had a broken bearing.

APPENDIX A

Research Vessels

1. The Research Vessels Langley and Retreiver were used to set and retrieve current meter stations. The R. V. Langley is a double ended ferry boat modified for trawling. She is 83 feet long with a 32 foot beam and a navigational draft of 5.5 feet. The Langley has one diesel engine rated at 550 HP and cruises at approximately 7 knots. A double drum trawl winch is located amid ship with cables leading to the center of an H frame mounted on the stern. The R. V. Retreiver is a converted landing craft. It is 115 feet long with a 34 foot beam and a maximum draft of 5 feet. The Retreiver has 3 General Motors 671 diesels for propulsion and has a cruising speed of 6 knots. The Retreiver has a 7.5 ton boom that was used to set the current meters.

2. Various boats were used as platforms for obtaining salinity samples. Fiberglass runabouts ranging in size from 17 to 22 feet were used. These boats had cruising speeds in excess of 20 knots. A 30 foot long, 9 foot wide Deltaville deadrise, Investigator, with a draft of 3 feet was sometimes used for sampling.

Investigator was propelled by a Chrysler marine engine at a cruising speed of 10 knots. A 26 foot long, 9 foot wide Penn Yan, Reynolds, with a 1.5 foot draft was also used as a sampling boat. The Reynolds had a cruising speed of 20 knots and was propelled by a Merc Cruiser engine. The Captain John Smith, a Bruno and Stillman boat, was used occasionally as a sampling boat. The Capt. John Smith is 42 feet long, 14 feet wide and draws 4 feet of water. It cruises at 14 knots and has a 125 HP Caterpillar diesel for propulsion.