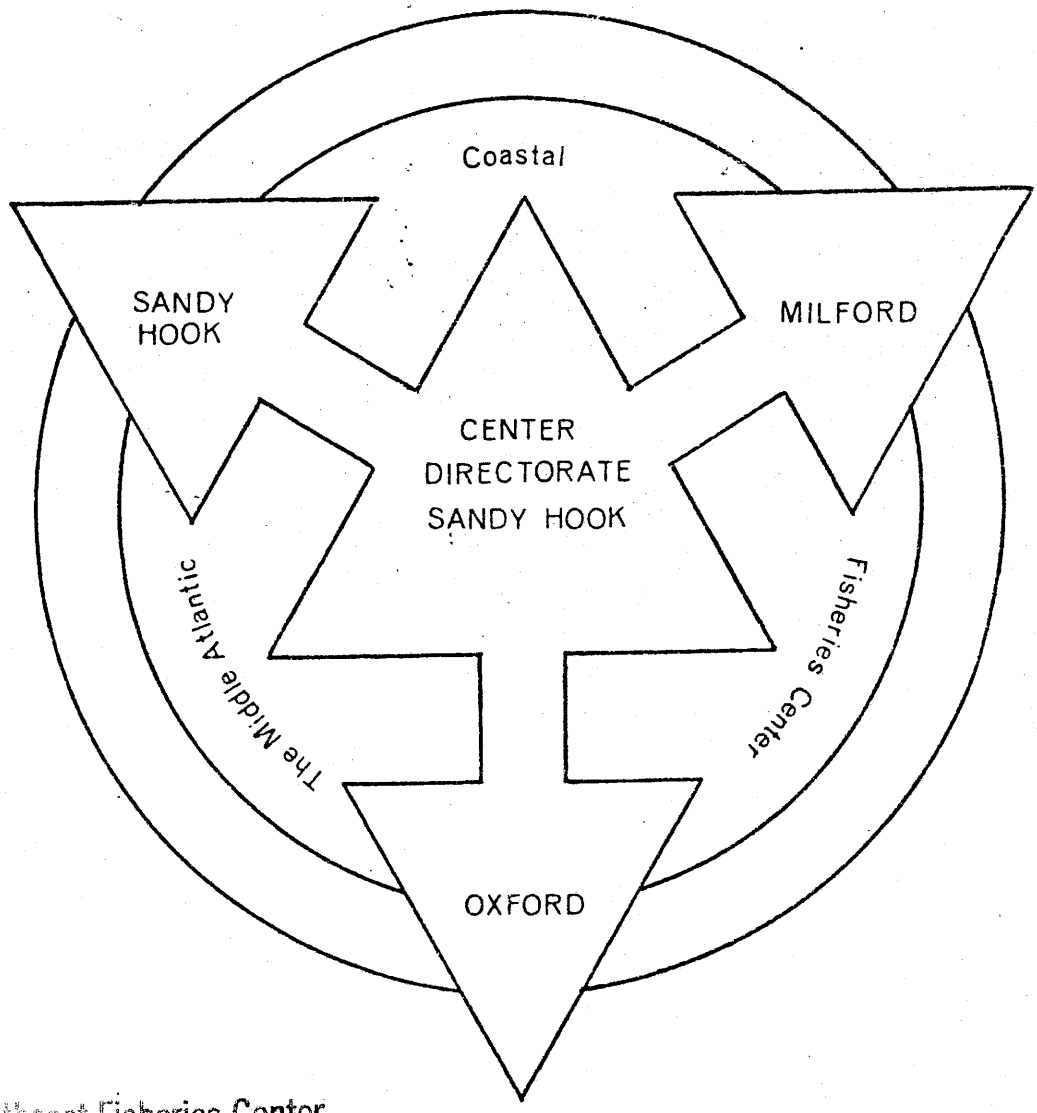
AN ENVIRONMENTAL SURVEY OF EFFECTS OF DREDGING AND SPOIL DISPOSAL, NEW LONDON, CONNECTICUT: 5TH QUARTERLY REPORT

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



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Informal Report No. 84

November 1975

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U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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SANDY HOOK LABORATORY
Informal Report No. 84
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ABSTRACT

Surveys conducted by the University of Connecticut in the Thames River continue to indicate that short-term dredging impacts have been spatially and temporally limited. Assessment of long-term effects is still underway. This study includes testing of a numerical streamflow model which will aid in determining whether dredging has modified the river's hydraulic regime. Data in hand show that suspended loads in the Thames are more a function of intrusions of Fishers Island Sound water than of river flow levels. Mercury in river waters increased 4-5 fold between spring and summer 1975. This was attributed to natural seasonality rather than to dredging, since summer 1975 values were still well below the maximum predisposal (July 1974) levels measured. Analysis of other heavy metals in the water column has been slowed by equipment malfunctions, but the predisposal data now available show Thames River water to have had concentrations of zinc, copper, nickel and cadmium which were respectively 11, 2, 7 and 35 times as high as had been reported for the adjacent Sound. Cadmium increased and mercury decreased in *Crassostrea virginica*, *Pitar morrhuana* and *Mercenaria mercenaria* between July 1974 and July 1975. *P. morrhuana* also experienced an increase in Zn, while Cu in *C. Virginica* and Ni in *M. mercenaria* and *P. morrhuana* appeared to undergo seasonal fluctuations. No gross pathological conditions were detected in the shellfish.

The New York Ocean Science Laboratory continued its investigations of currents and water movements in the disposal area, and of the effects of dumping on water and sediment characteristics there. In one experiment conducted on an ebbing tide, surface and bottom drogues were tracked from the disposal buoy through the Race and well into Block Island Sound. On another ebb tide the drogues moved east toward Fishers Island Sound, and then turned north and west as the tide began to flood. Turbidity changes measured along the paths of these drogues were minimal. Transmissometer readings taken after a barge release on 9 July again showed only transient increases in turbidity, with beam transmittance returning to ambient by 30 minutes after the dump. On July 17 transmissometer readings taken upstream and downstream of the spoil pile indicated that bottom waters gained approximately one mg/l of suspended materials in passing over the spoil pile on a maximum ebb tide. Transmissivity

measurements were also taken on two other dates: once in conjunction with plankton tows on N-S and E-W transects from the dump buoy, and once to examine horizontal and vertical turbidity changes at NYOSL's standard sampling points throughout the study area. In no case could a clear relation be seen between turbidity and proximity to the spoil pile. Current meter records again indicated that greatest velocities and durations at the disposal buoy were in a generally easterly direction.

Surveys of disposal area water quality were made on 26 August and 17 September 1975. Values for dissolved oxygen, pH, Eh, suspended and volatile solids were fairly uniform and unremarkable throughout the study area. Chemical oxygen demand and heavy metals of sediment generally had higher values near the center of the disposal area, but overall variations were thought to be random. No increases were seen when compared to January 1975 concentrations. It was concluded that no major changes attributable to dumping had yet been detected in sediments or water column.

Middle Atlantic Coastal Fisheries Center's grab sampling showed that as of October 1975, spoils extended somewhat further than ½ mile to the east and south of the disposal buoy, and between ¼ and ½ mile in other directions. Calcium carbonate and organic contents of disposal area sediments fluctuated widely with space and time; based on these constituents alone, the spoils could not be distinguished from natural sediments at several stations. Macrofauna populations of June-July 1974 (predisposal) samples from ten stations were compared with the fauna of June-July 1975 collections. Changes significant at the 95% confidence level were found at only two stations. Station C3, a mile WNW of the disposal buoy, had a large increase in faunal density; this was due largely to increased numbers of the amphipod, Ampelisca vadorum. Station C6, at the disposal buoy, had significant decreases in density, number of species and Shannon-Weaver species diversity. Changes at other stations showed no definite gradients of impacts relative to distance from the spoil pile. Control stations at two-mile radii from the disposal buoy had fluctuations as large as several stations in much closer proximity to the spoils. This evidence continues to support the earlier statement that major effects of spoiling to date have been limited to areas where fauna are actually buried by the spoils.

Recolonization at C6 was traced through October 1975 collections. By that time, faunal density, species richness and diversity had increased significantly over October 1974, January and April 1975 values, though values of these parameters were still well below predisposal levels. Data from grab samples and dive surveys agreed that the tube-dwelling amphipods (chiefly Ampelisca vadorum and Leptocheirus pinguis) which had characterized the predisposal fauna at C6, were beginning to reestablish themselves. The diving observations revealed that much of the spoil pile supported moderate densities of these amphipods and other tube-dwelling forms. A number of macroinvertebrates, finfish, burrows and tracks were also seen on the spoils. It was tentatively concluded that spoil materials were not inhospitable to biological activity, and that complete recolonization could eventually be expected. Sediment trap experiments showed no relation between distance from the spoils and amount of sedimenting material. Suspended sediment levels in the disposal buoy may be influenced more by river inputs than by resuspension of spoils.

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Submitted by

Ecosystems Investigations
Middle Atlantic Coastal Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U. S. Department of Commerce
Highlands, New Jersey 07732

to

U. S. Navy, Northern Division, Naval Facilities Engineering Command

U. S. Army Corps of Engineers

Interagency Scientific Advisory Subcommittee on
Ocean Dredging and Spoiling

November 1975

FOREWORD

This report deals with the fifth three-month period of studies monitoring effects of dredging in the Thames River and spoil disposal at the New London Dumping Ground. Activities and findings of the principal contractor, the Middle Atlantic Coastal Fisheries Center (MACFC), National Marine Fisheries Service, are discussed in detail. All subcontractors' quarterly reports were received by MACFC by November 1975. These documents are summarized in the body of the report, and included as appendices thereto.

Overall goals, schedules and methodologies for the monitoring survey are contained in MACFC Informal Report No. 25-A, "A Proposal for an Environmental Survey of Dredging and Spoil Disposal in the Thames River and New London Dumping Ground" (21 May 1974), and will not be repeated in the quarterly reports. Changes or additions will be described in the pertinent quarterly report, but not in subsequent reports. All parties to the operations are again reminded that the stipulation to immediately report any observed violations of the dumping criteria or other impacts judged significant is in effect and an extremely important component of the monitoring and research program.

Reproduction or use of data from these reports must first be approved through MACFC (and through subcontractors if applicable).

Errata from the 4th quarterly report:

Page 11 of the body of the report and Page 11 of the Appendix C should be exchanged.

Dr. Hollman of the New York Ocean Science Laboratory points out that transmissometer readings reported earlier may have been erroneously high;

this condition has since been corrected. Dr. Hollman cautions against making firm conclusions on the area's turbidity, currents, etc., based on the partial data sets and incomplete analyses available to date.

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A. Suspended Material Transport in the Thames River

B. Effects of Dredging in the Thames River on Shellfish Resources and Phytoplankton

C. Physical Oceanography of Dump Site Area

D. Chemical Oceanography of Dump Site Area

I. UNIVERSITY OF CONNECTICUT SUBTASKS

A. Suspended Material Transport in the Thames River (Appendix A).

A review of all data collected during the first year's study supports the conclusion of several prior reports that short-term dredging impacts have been transient and limited to the proximity of active dredging. Long-term impacts cannot yet be assessed; these will be examined more intensively during the second year. Levels of suspended materials have shown a variability which appears weakly correlated to time of year. Particulate and dissolved organic carbon values have shown little seasonal variability. Ratios of organic carbon to total suspended load have in general been reduced in the dredging plume. The Thames has been found to differ from many estuaries in that river flow levels are not a primary determinant of suspended loads. Suspended material levels are influenced more by intrusions of Fishers Island Sound waters. The numerical model now in use suggests that during average streamflow conditions there is a net inflow in the lower estuary. The model will next be used to examine effects of high streamflow and probable modifications due to dredging. The investigation of storm effects on suspended loads will also be continued; to date, no significant effects have been seen.

The geofungi investigation continues to report greater fungal densities in surface than in bottom waters. In core samples, fungi are more abundant near the surface than 20 mm or more into the sediments. Numbers of fungal colonies are again found to be inversely related to salinity - this is probably a reflection of the terrestrial - riverine origin of these organisms. There is still no apparent relation between

numbers of fungal colonies and suspended load.

B. Effects of Dredging in the Thames River on Shellfish Resources and Phytoplankton (Appendix B).

Monitoring of heavy metals and chlorophyll a in river waters continued, as did examination of heavy metals and gross pathology in shellfish. Cadmium in *Crassostrea virginica*, *Pitar morrhuana* and *Mercenaria mercenaria*, and zinc in *M. mercenaria*, increased between July 1974 (predisposal) and July 1975 samples. Mercury concentrations decreased in all three species over the same period. Copper in *C. virginica* and nickel in *M. mercenaria* and *P. morrhuana* have shown seasonal fluctuations. No gross pathological conditions have yet been detected in these shellfish. Mercury in river water increased four to fivefold between spring and summer of 1975, again indicating a seasonality with higher concentrations in warmer months. Values did not approach the July 1974 maxima, however. Analysis of other metal concentrations, which has been slowed due to equipment malfunctions, has now been completed for the July 1974 samples. Zinc, copper, nickel and cadmium were found to be respectively 11, 2, 7 and 35 times as concentrated in Thames River water as has been reported for the adjacent Sound. It is noted that zinc levels in the Thames are comparable to those found in the Housatonic River, while copper concentrations in the Housatonic are 10 times higher. These levels are related to those found in oysters of the two rivers, since zinc concentrations in the oysters are comparable, while copper is three times as concentrated in Housatonic oysters as in those from the Thames.

II. NEW YORK OCEAN SCIENCE LABORATORY SUBTASKS

A. Physical Oceanography of Dump Site Area (Appendix C).

Six cruises were completed between July and September 1975. Surface and bottom drogues were tracked on two dates to continue the study of currents and water movements in the disposal area. On an ebbing tide on 22 July, both surface and bottom drogues travelled from the disposal buoy through the Race and well into Block Island Sound. Both drogues were roughly 15 km ESE of the release point when retrieved after 7-8 hours. Figure 5 of Appendix C reveals the disparity between the path of the bottom drogue and that extrapolated from a bottom current meter positioned at the disposal buoy during the same period. On 16 September, surface and bottom drogues released at the buoy on a maximum ebb tide were carried almost due east, with the bottom drifter running aground near the SW tip of Fishers Island. As the tide changed, both drogues began to move to the north and west.

Effects of a barge release on bottom turbidity were measured with a transmissometer positioned 80 m downstream of the release on 9 July. Beam transmittance dropped to nearly 0 within 12 minutes of release, but returned to approximately ambient values within 30 minutes of release; maximum bottom currents measured during this period were 45 cm/sec.

On 17 July, transmissometer readings were taken upstream and 230 m downstream of a spoil mound. This experiment was conducted on a maximum tide, with bottom currents averaging 36 cm/sec. Results indicate that approximately 1 mg/l of suspended material was added to bottom waters in passing over

the spoil pile on this maximum current.

On 25 August, readings were taken from a transmissometer towed at 7-10 m depths in conjunction with plankton tows made on the N-S and E-W transects. The transmissivity values (Figure 6, Appendix C) illustrate the spatial variability of water column turbidity, and show no clear relation between light transmittance and position relative to the disposal buoy. Transmittance studies were also conducted on the 22 July and 16 September cruises, and on 26 August. The 22 July data showed an increase in transmittance from 71% to 86%, attributed to mixing with other water masses and settling out of particles, as the bottom drogue was followed from the dump site into Block Island Sound. The drogues tracked on 16 September remained in Long Island - Fishers Island Sounds, where all transmittance readings were between 79 and 86%. The 26 August survey examined vertical turbidity changes at the standard sampling stations. Transmittance decreased with depth at all stations, but the reduction was only on the order of 5% between surface and bottom waters.

Current meters were also deployed on 25-26 August 1975, and indicated maximum surface velocities of 47.5 cm/sec during this period, with bottom velocities approximately 50% of the surface values. As a rule, current measurements made during this quarter reinforced earlier evidence that currents at all depths at the disposal buoy have greatest durations and velocities in a NE to E direction. Temperature, salinity and water quality measurements were made on 26 August, and temperatures, salinities and densities are reported for the paths of the surface and bottom drogues

followed on 16 September.

Fifty-six percent of bottom drifters and 19% of surface drifters released at the disposal buoy have been returned to date. Sixty percent of bottom drifters returned (19 drifters) have been recovered along the Connecticut coast, and 40% (13) along Long Island's north shore. Ninety-two percent (11) of surface drifter returns have been from east of New London, and 8% (1) from the west, but the number of returns is not yet sufficient to draw conclusions about surface current patterns.

B. Chemical Oceanography of Dump Site Area (Appendix D).

Water quality of the dump site was monitored during cruises conducted on 26 August and 17 September 1975. The former survey included the sampling of 14 standard stations throughout the disposal area; the latter used surface and bottom drogues in an attempt to examine changes in a discrete water mass as it passed over the spoil pile. Dissolved oxygen concentrations showed little variation (ranging from 68-86% of saturation) and no spatial patterns on either cruise, with the exception of a very low concentration (23% saturation) in bottom waters at station N3, two nautical miles north of the disposal buoy, on 26 August. This station is close to the mouth of the Thames River; the dissolved oxygen depression may reflect an input of river water which, as discussed in Section III below, is often deficient in oxygen relative to open Sound waters. Measurements of pH and Eh also revealed no noteworthy trends on 26 August, except for depressed pH in a mid-depth sample taken at the disposal buoy. This may have been an effect of a dump (not necessarily related to the Navy's dredging project) which occurred just prior to sampling. Values of suspended and volatile solids sampled on 26 August and 17 September were similar to those recorded in predisposal surveys, and gave

no evidence of significant resuspension of spoil material. On 30 July, plankton tows were made over the dumping grounds to determine amounts and composition of seston. Analysis of these samples is still in progress.

Sediment samples were collected during a June-July 1975 MACFC cruise. Chemical oxygen demand of sediments was high at several stations near the disposal point, though variations in the data were thought to be random. Heavy metals were also sometimes found in higher concentrations near the spoil pile, but spatial patterns were quite irregular. Metals values for July were slightly higher than those measured in May 1975, but were similar to January 1975 concentrations. July levels were comparable to those measured at the proposed alternate disposal site, the "East Hole" in Block Island Sound. The overall conclusion of the chemical oceanography section was that no major changes attributable to dumping had yet been detected in the water column or sediments.

III. MIDDLE ATLANTIC COASTAL FISHERIES CENTER SUBTASKS

A. Benthic Macrofauna Studies

1. Field Activities: The sixth quarterly cruise to collect Smith-McIntyre grab samples of sediments and benthic macrofauna was conducted between 23 September and 1 October 1975. Methods and objectives continue to follow those outlined in our first quarterly report (Middle Atlantic Coastal Fisheries Center, 1974). Inspection of grab samples taken on this cruise, in combination with diving observations (Section D below), yields the following picture of extent of the spoil pile: spoils were again evident at stations A5, A7, C5, C6, and E7 (see Figure 1 for station locations), as was the case in July. We had earlier reported the questionable presence of spoils at C8, F4, F5 and F7; on the present cruise no spoils were detected at the F stations, but spoils were seen at C8. We observed spoils at A8 and E8 for the first time. Thus we tentatively conclude that spread of the spoils has been greater to the south and east of the original dump point than in other directions. It is not known how much of this "spread" is actually due to the moving of the disposal point some 600 feet SE of the dumping buoy in December 1974.

Dissolved oxygen values in bottom waters of the disposal area invariably ranged between 7.0 and 8.0 mg/l, and showed no relation to distance from the disposal point. Bottom dissolved oxygen in the Thames River showed a general decrease in an upriver direction, with a range from 7.6 mg/l at the river's mouth to 5.5 mg/l just above the submarine base. The dissolved oxygen patterns

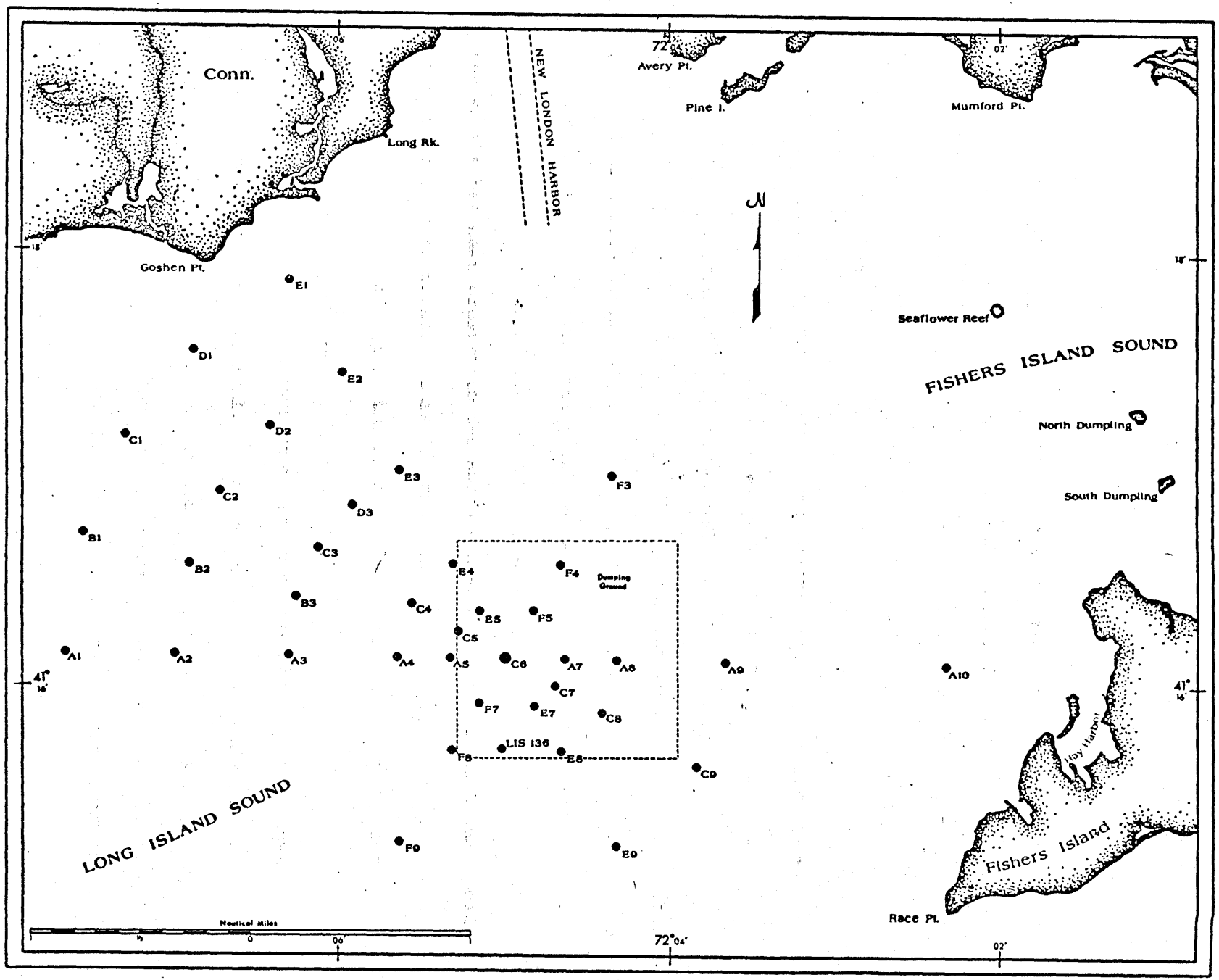

Figure 1. Sampling pattern for sediments and benthic macrofauna.

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in conjunction with heavy metals and microbiological data presented in this and prior reports, indicate the Thames to have generally poorer water quality than is found in the disposal area.

2. Laboratory Activities: Considerable data on benthic macrofauna found in June-July 1975 grab samples are now available for comparison with the summer 1974 predisposal data. These comparisons enable a more direct assessment of spoiling impacts than was possible in earlier reports, since the seasonal aspect of observed changes is eliminated. Table 1 compares means and 95% confidence limits (CLs) of numbers of individuals (N) and species (S), Shannon-Weaver species diversity (H'), and equitability (J') for those stations from which grabs have been analyzed for the succeeding summers. Note that the 95% CLs are in general quite wide; a dramatic change in the fauna must take place before the confidence intervals between summers for a given station and parameter become nonoverlapping. Such changes were found at only two of the 10 stations listed in Table 1. At C3, one n. mi. WNW of the disposal buoy (Figure 1) numbers of individuals increased significantly between June 1974 and June 1975. The amphipod, *Ampelisca vadorum*, made the largest contribution to this increase, but there were gains in populations of a number of other species, including the anemone, *Metridium senile*, polychaetes, *Scalibregma inflatum*, *Polycirrus eximius*, *Lumbrineris tenuis*, *Prionospio steenstrupi*, and *Tharyx annulosus*, and a bivalve, *Nucula proxima*. We see no obvious explanation for the increase in faunal density at C3. The predisposal values we recorded at C3 may have been atypically low for that area; we found a large increase in density at C3 between July 1974 and January 1975, while other stations typically had decreasing densities during this period, probably attributable to seasonal change. Conversely, preliminary analysis of

Table 1. Mean values for number of individuals (N), number of species (S), species diversity (H') and equitability (J'), from 0.1 m^2/Smith-McIntyre bottom grab samples. Upper value at each station represents June-July 1974 samples. Second value is June-July 1975, and lower figure is percentage change between the means of the two years. 95% confidence limits given in parentheses where calculated. Bracketed values denote areas in which 95% confidence limits for succeeding years do not overlap. n = number of replicate samples used in calculations.

STATION	N	S	H'	J'	n
A1 1974	116.8 (46.9-186.7)	23.4 (13.8-33.0)	2.23 (1.34-3.11)	.708 (.451- .966)	5
1975	38.2 (4.8- 71.6)	16.8 (6.2-27.4)	2.42 (1.85-2.99)	.901 (.843- .959	5
% change	-67.3	-28.2	+8.5	+27.3	
A3 1974	614.0 (232.4-995.7)	50.5 (35.1-65.9)	2.74 (1.90-3.58)	.697 (.528- .866)	4
1975	121.3 (0 -367.7)	37.7 (0 -81.4)	3.16 (1.93-4.40)	.893 (.794- .992)	3
% change	-80.2	-25.3	+15.3	+28.1	
A9 1974	458.3 (178.5-738.0)	39.5 (31.2-47.8)	2.02 (1.37-2.66)	.529 (.408- .650)	4
1975	344.4 (155.9-533.0)	34.6 (20.1-49.1)	2.18 (1.81-2.55)	.621 (.566- .677)	5
% change	-24.9	-12.4	+7.9	+17.4	
C1 1974	1471.4 (294.8-2648.0)	40.0 (33.9-46.2)	0.94 (0.42-1.47)	.259 (.104- .415)	5
1975	382.3 (0 - 929.5)	30.7 (26.9-34.5)	1.82 (0 -3.67)	.533 (0 -1.0)	3
% change	-74.0	-23.3	+93.6	+105.8	
C3 1974	[169.4 (73.8-265.0)]	38.0 (23.3-52.7)	3.00 (2.34-3.65)	.831 (.697- .965)	5
1975	[481.0 (328.9-633.1)]	54.5 (41.7-67.3)	2.79 (2.31-3.28)	.699 (.613- .785)	4
% change	+183.9	+43.4	-7.0	-15.9	
C4 1974	414.2 (220.5-607.9)	44.8 (37.5-52.1)	2.41 (2.07-2.74)	.637 (.529- .744)	5
1975	333.4 (149.1-517.8)	37.8 (21.8-53.8)	2.06 (1.62-2.50)	.574 (.496- .652)	5
% change	-19.5	-15.6	-14.5	-9.9	
C5 1974	98	31	3.02	.878	1
1975	90.0 (19.4-160.6)	23.8 (13.1-34.4)	2.50 (1.81-3.19)	.796 (.608- .984)	4
% change	-8.2	-23.2	-17.2	-9.3	
C6 1974	[424.3 (320.6-528.0)]	[52.0 (41.2-62.8)]	[2.79 (2.03-3.55)]	.706 (.530- .882)	3
1975	[15.3 (0 - 55.8)]	[5.7 (0 -15.1)]	[1.27 (0.63-1.90)]	.838 (.360-1.0)	3
% change	-96.4	-89.0	-54.5	+18.7	

Table 1. (continued)

STATION	N	S	H'	J'	n
R4 1974	57	6	1.33	.743	1
1975	58.2 (10.3-106.1)	9.2 (5.5-12.9)	1.41 (1.11-1.70)	.650 (.570- .731)	5
% change	+2.1	+53.3	+6.0	-12.5	
R5 1974	254	21	1.35	.444	1
1975	125.8 (35.9-215.7)	12.0 (7.6-16.4)	1.51 (0.88-2.13)	.610 (.380- .840)	5
% change	-50.5	-42.9	+11.9	+37.4	

October 1975 samples from C3 shows a large (though within 95% CLs) decrease in N when compared to October 1974 data. This illustrates the variability present in our samples. As discussed in the prior report, this variability is greater for N than for S or H'. Values for N will ultimately be log transformed for final data analysis - this may "smooth" the observed fluctuations and aid in interpretation of density patterns.

The only other station for which the 95% confidence intervals between summers did not overlap was C6, the original disposal point and the only station we've analyzed from which grab samples have been completely spoil material. At C6, values of N, S and H' for July 1975 all showed significant decreases from predisposal levels. This is clearly a direct effect of burial by spoils. Predisposal samples from C6 consisted of sandy silt sediments containing a fauna typical of much of the offshore New London area. Species richness was high (with a mean of 52 species per $0.1m^2$) and diversity moderately so ($\bar{x}$ = 2.79). Tube-dwelling amphipods (Ampelisca, Leptocheirus) numerically dominated an assemblage which included several species from each major taxon. Among other important constituents were the polychaetes, Scalibregma inflatum, Clymenella spp., Lumbrineris tenuis, Harmothoe extenuata, Potamilla reniformis, and Tharyx annulosus; the gastropod, Mitrella lunata; bivalves, Musculus corrugatus and Nucula proxima; pycnogonid, Nymphon grossipes; and amphipods, Unciola irrorata, Maera danae and Aeginina longicornis.

July 1975 sediments were the grey clayey silts characteristic of the spoils removed from the Thames during the first dredging increment. N, S ($\bar{x}$ = 5.7) and H' ($\bar{x}$ = 1.27) were all sharply reduced from predisposal levels. This sparse fauna was dominated by Nucula proxima. It cannot be determined whether the specimens of this small bivalve were introduced with the spoils

(it is also common in the river), or migrated from the underlying or adjacent natural sediments.

No other stations showed changes which were meaningful at the 95% confidence level. Stations at 1-mile radii from the disposal buoy (the monitoring criteria established by the Interagency Scientific Advisory Subcommittee on Ocean Dredging and Spoiling consider this distance the outer limit for acceptable impacts) displayed no consistent trends indicative of spoiling impacts. For example, station A3, 1 mile W of the disposal buoy, (Figure 1) had decreases in N and S which were fairly large, but comparable to the decreases at control stations A1 and C1 at 2 mile radii. As noted above, C3 had increases in these parameters of the same magnitude as the decreases at A3. A9, a mile E of the dump site, showed little change between summers. Station C4, ½ mile WNW of the NL buoy, had experienced a significant decrease in N between June and October 1974 (see 2nd Quarterly Report). By June 1975, however, density at C4 again approached the predisposal value. It is thus likely that the earlier decline was more a seasonal than a spoil-related effect. Even station C5, which has apparently been near the WNW margin of the spoil pile (spoils were seen in grabs taken in April and June 1975, but were questionably present in January 1975 and were not noted in September 1975) has not been obviously impacted. The limited data (Table 1) indicate values for the faunal parameters were only slightly lower in 1975 than in 1974 (Table 1). Species composition at C5 showed little change, with moderate domination by Ampelisca vadorum in both years.

As in the 4th Quarterly Report, we have again used percent changes in means of N, S and H' to visually present spatial patterns of faunal change.

These percent changes between summers are listed in Table 1. Figures 2-4 present the spatial distribution of several degrees or levels of change, with ranges for these levels of change again chosen by analysis of the variability in predisposal values. Thus in Figure 2, a change of 33.5% in N between summers is equivalent to a predisposal variability of less than one standard deviation from the mean. The 1975 value would therefore be well within the expected variability of the population, based on predisposal samples. From 33.5-66.8% change between years corresponds to 1-2 standard deviations from the predisposal mean. A change of 66.8% exceeds two standard deviations from the predisposal mean, and so is not likely attributable to that population's natural variability.

Figure 2 illustrates the moderate decline in N at several stations, including the 2-mile controls A1 and C1. It is debatable whether a gradient of spoil effects can be seen moving out from C6 to C3 on the WNW transect. Such a gradient could also be present in Figure 3, which shows changes in numbers of species between summers, and in Figure 4, presenting species diversity changes. Figures 2 and 3 appear to justify our considering C1 to be a control, free from effects of spoils; if any gradient of impacts <u>is</u> present, effects have disappeared by station C3; and none of our information on currents, bottom topography, etc., suggests that C3 would be spared if spoil materials were being transported to C1. A similar inference can be made for station A1, since A1 shows changes of the same magnitude as C1, and also no smaller than those at A3, which is a mile closer to the spoil pile. A1 therefore also appears to be a suitable control location.

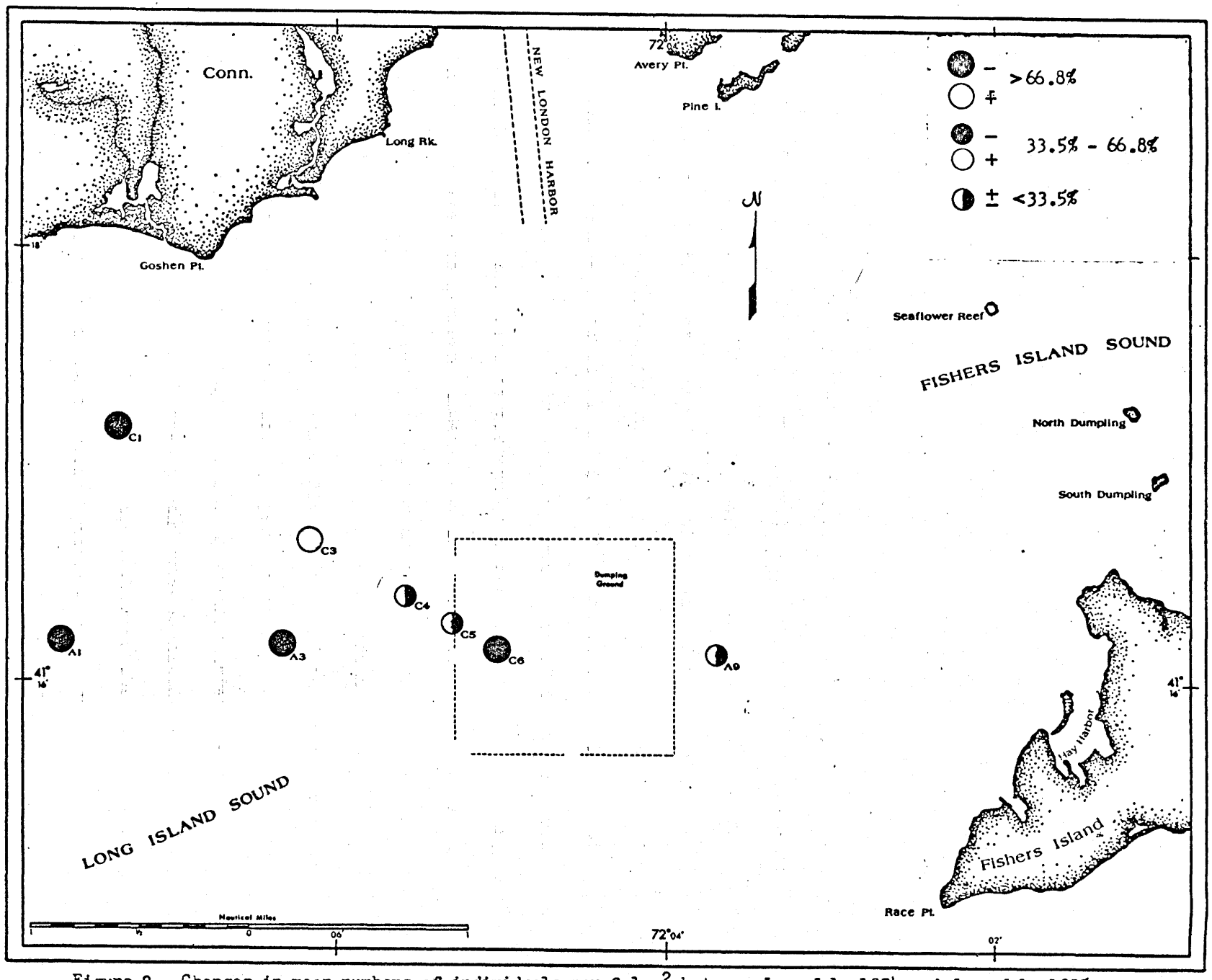

Figure 2. Changes in mean numbers of individuals per 0.1 m^2 between June-July 1974 and June-July 1975. Actual values are given in Table 1.

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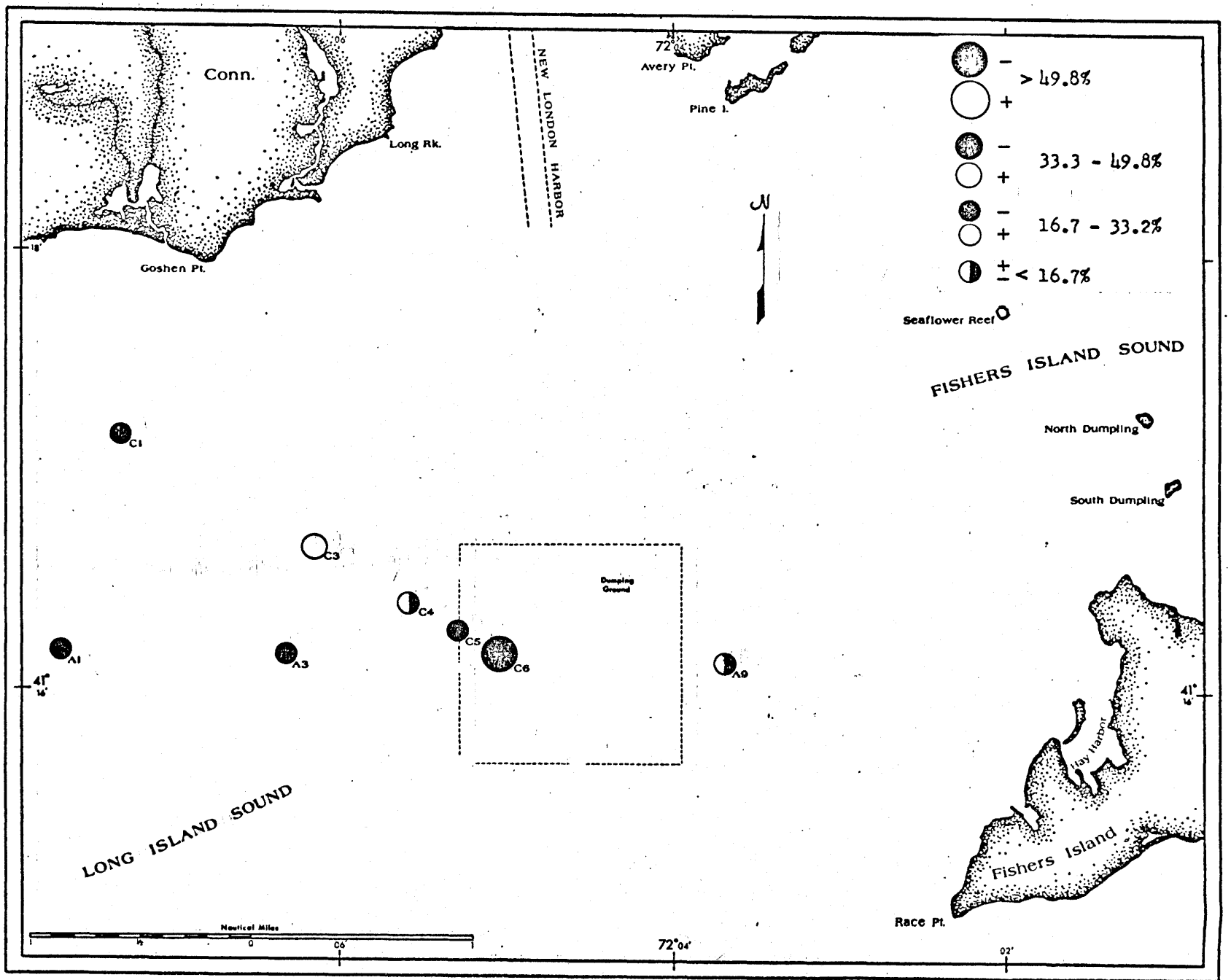

Figure 3. Changes in mean numbers of species per 0.1 m^2 between June-July 1974 and June-July 1975. Actual values are given in Table 1.

GPO 954-805

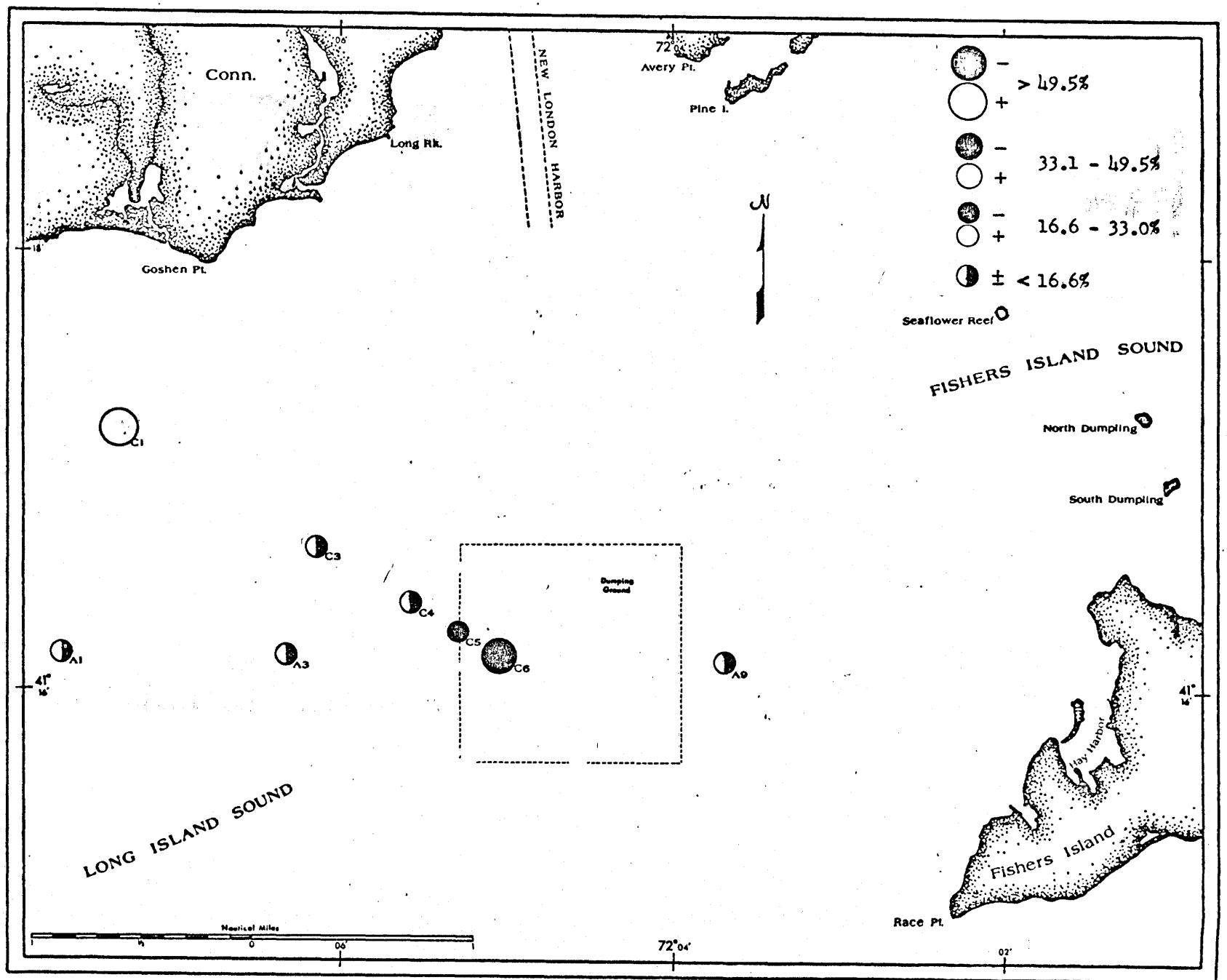

Figure 4. Changes in Shannon-Weaver species diversity (H') mean values between June-July 1974 and June-July 1975. Actual values are given in Table 1.

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In the 4th Quarterly Report, comparisons of N and S (similar to Figures 2 and 3 above) had shown large decreases at most stations from summer 1974 to April 1975. The present between-summer comparisons reveal considerably smaller changes. This implies that the earlier decreases are probably a seasonal phenomenon, and that recruitment returns the populations to peak values in the summer months.

A somewhat distinct study involves the recolonization of the spoil pile. Figure 5 depicts the changes in N ($\log_{10}$ scale), S and H' which have been found in samples taken quarterly from the disposal buoy (C6) between July 1974 and September 1975. Spoil disposal began on 19 August 1974, was relocated 600 feet SE of C6 on 20 December 1974, and ceased in early July 1975. Thus the July 1974 values in Figure 5 characterize the predisposal population at C6; September 1974 levels demonstrate the impacts of one month of spoiling; January, April and perhaps July 1975 indicate the reaction of the fauna to a reduction in perturbation after the disposal point was shifted; and September 1975 values show the effects of at least two months of relative quiescence of the spoil pile during a period of active recruitment.

The predisposal fauna at C6 exhibited moderate density, and S and H' values were near the highest we have recorded in the New London region. Species composition is discussed above; tube-dwelling amphipods characteristic of silty sand sediments throughout the area dominated. By October, values for all faunal parameters had dropped precipitously. None of the five 0.1 m^2 samples, which were completely spoil material, contained more than two macrofaunal species or two individuals. Of a total of seven organisms found, four were *Nucula proxima* or *Pitar morrhuana*, both of which could have been introduced with the river sediments. In January collections, there was only a slight

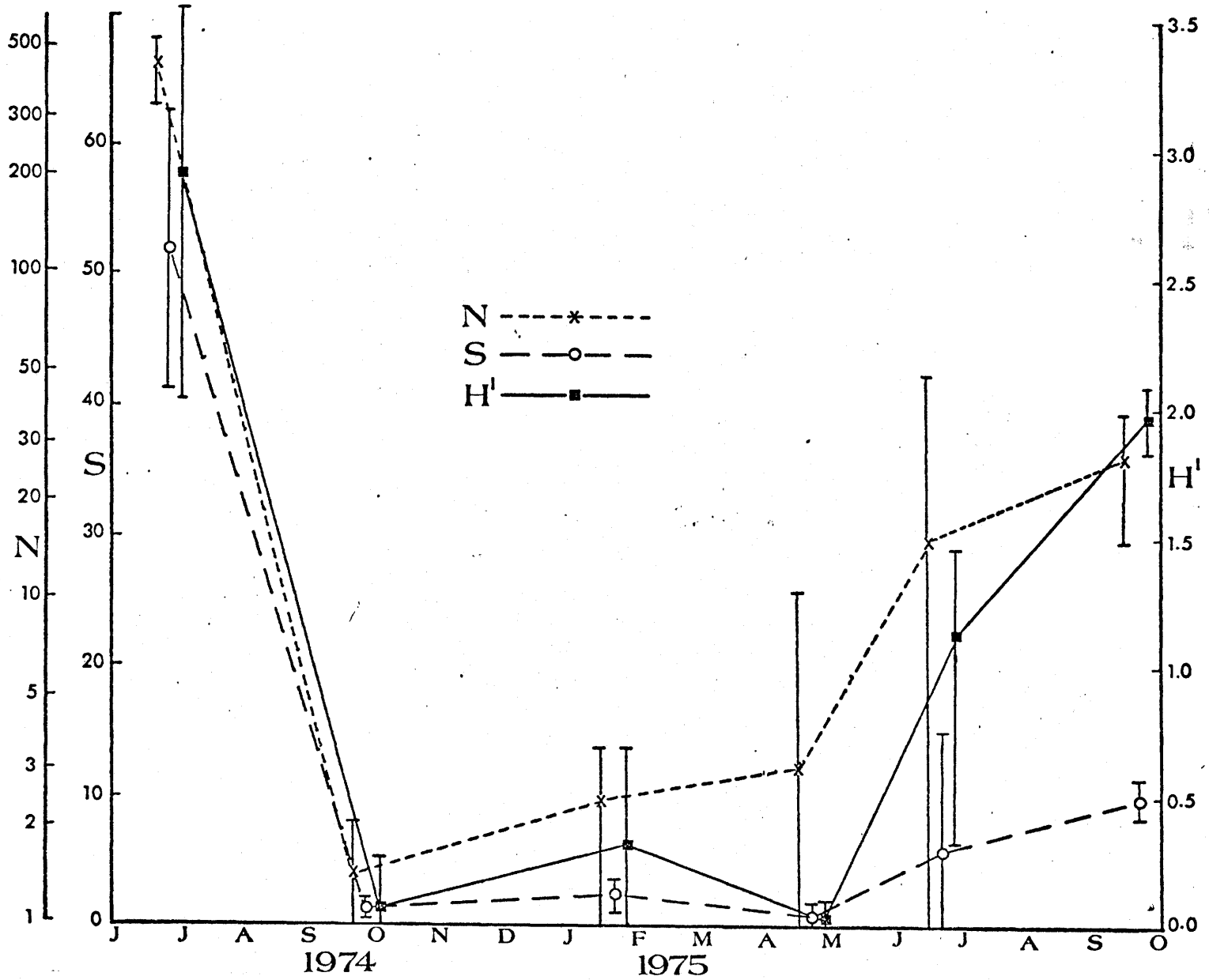

Figure 5. Means and 95% confidence limits for numbers of individuals (N), numbers of species (S) and species diversity (H') at the original disposal point, July 1974 to October 1975; spoiling began in August 1974.

increase in N (to 2.4 individuals/0.1 m^2) and S (to 2.2 species). At this time the small bivalve Gemma gemma was present in three of five grabs. April 1975 samples from C6 showed little change from the prior October and January. Mean N increased slightly, due only to the presence of 13 Nucula proxima in one grab sample; three samples contained no living macrofauna.

By July 1975 an upward trend in all faunal parameters was evident. Mean values were: N = 15.3; S = 5.7; H' = 1.27. In addition to N. proxima, the large burrowing polychaete, Nephtys incisa, and hermit crab, Pagurus longicarpus, were present; these are relatively mobile species which most likely migrated in from surrounding undisturbed areas. Finally, our September 1975 samples showed recolonization to be well underway. The 95% CLs for N, S and H' no longer overlapped those for the October 1974, January or April 1975 samples. September 1975 limits still were not within the range of predisposal levels, however. Although species diversity had returned to 2/3 of its July 1974 value, the N and S data indicated that the spoil pile assemblage was far from regaining predisposal characteristics.

The amphipods, Ampelisca vadorum and Leptocheirus pinguis, were again prominent in the collections, as they had been in the predisposal samples. Their appearance at this time was presumably due to larval recruitment. Tubes of these amphipods have been demonstrated to stabilize sediments (Mills, 1967). They may thus inhibit erosion of the spoil pile while modifying the benthic environment to promote further recolonization.

Ampeliscid amphipods have been shown by Fisher (1973) to appear early in the sequence of species colonizing sediments which have experimentally been made azooic. However, in many parts of the New London area, ampeliscids are dominant members of what must be considered a "climax" assemblage. In this

sense, the disposal site bears a marked similarity to the designated dumping area of Rhode Island Sound. That area had contained ampeliscid-dominated fauna (Saila, Pratt and Polgar, 1972) before the disposal there of 8.2 million cubic yards of spoils apparently similar in nature to those dredged from the Thames. While spoiling was still ongoing in another part of the Rhode Island Sound disposal area, ampeliscids were found to be colonizing an edge of the spoils which may have been relatively free from active spoiling for as much as three years. This indicated that "the spoil is an acceptable substrate for juvenile amphipods, but that it might take several years to establish a dense colony" (Saila, Pratt and Polgar, 1972). A year later, on the amphipod dominated fringe of the spoils, "many spoil samples contained 30-40 species and are not separable from natural bottoms on the basis of species numbers alone" (Pratt, Saila and Sissenwine, 1973).

Ampeliscid amphipods are also considered to be relatively sensitive to environmental contamination (See Sanders, Grassle and Hampson (1972) for a discussion of the effects of the West Falmouth, Mass., oil spill on this group).

The presence of these amphipods over much of the spoil pile at New London indicates that these spoils may also be expected to eventually show complete faunal recovery. It should also be noted that both Ampelisca and Leptocheirus are important in the diets of several of the area's more valuable finfish species (prior Quarterly Reports and Middle Atlantic Coastal Fisheries Center, unpublished). Recolonization of the spoils is discussed further in Section D (below) concerning diving observations.

To summarize the macrofaunal information: Our data show appreciable change between 1974 and 1975 at most stations; because of within-station sample variability, these changes nevertheless have not been found to be statistically significant. We feel the variability is real and a reflection of small-scale natural changes, both spatial and temporal, in the fauna throughout the New London area. That the original disposal site shows significant decreases in N, S and H' while no stations not dominated by spoils show significant change (with the exception of increased N at a single station), is evidence that we can distinguish between natural changes and spoiling impacts, at least on a gross scale.

The question of whether more grabs should be processed, to tighten our confidence limits and perhaps improve chances of detecting spoil-induced change, was raised at a workshop of the Interagency Scientific Advisory Subcommittee on Ocean Dredging and Spoiling (ISASODS) held at Avery Point, Connecticut, 21-22 July 1975. The number of replicates required to detect a specified amount of change is given by: $n \geq 2\left(\frac{\sigma}{\delta}\right)^2\left\{t_{\alpha}[v] + t_{2(1-P)}[v]\right\}^2$ where: n = number of replicate grabs required; σ = true standard deviation; δ = the smallest true difference it is desired to detect; $[v]$ = degrees of freedom; α = significance level; P = desired probability that a difference as small as δ will be found to be significant; $t_{\alpha}[v]$ and $t_{2(1-P)}[v]$ = values from a two-tailed t table with v degrees of freedom, and corresponding to probabilities of α and 2(1-P), respectively (Sokal and Rohlf, 1969, p. 247). The choice of amount of change we wish to detect as significant and spoil-related is critical to analysis. The rationale for our choice is based on the observed variability at A1 and C1. We maintain (see above) that these stations are controls, their variability due to natural causes. C1 had a decrease in N of 74.0% between summers, while S at A1 was lower by 28.2% in 1975 (Table 1). We wish to detect only changes somewhat larger than these "natural" fluctuations. We arbitrarily chose a change of 1.1 times times as great as the fluctuations at control stations as being probably spoil-related, rather than natural, change. Thus we wish to detect a change in N of $\geq$81.4% and for S, $\geq$31.0%. Use of these figures appears reasonalbe - between-year decreases were far larger than these values in the spoil pile center (C6), but no other stations had reductions as large as 81.4% for N or 31.0% for S (note that a decrease of only 1.35x that which naturally occurred in N at C1 would reduce faunal density there to zero.
This is further evidence that the raw N is not as conservative a

parameter as is S, and should not be given as much weight in analysis of change).

Solving the above equation, with a significance level (α) of 0.05, a desired detectable difference for N of $\geq$ 81.4%, a P = 90% certainty of detecting this difference if it occurs, and assuming that the observed standard deviation for predisposal N at C1 approaches that population's true standard deviation, n is found to = 15 replicate grabs needed. Similarly, to detect a difference in S at A1 of 31.0%, with α and P again 0.05 and 90% respectively, n = 25 replicates required. If we desire a certainty P of 95% that occurrence of a change in S $\geq$ 31.0% will be detected, 31 grabs must be processed. If only interested in detecting a change in S of 50% or more with 90% certainty, nine replicates must be processed.

However, increasing the number of replicates would not necessarily make our data more meaningful. We calculated the effects on the 95% CLs of increasing the number of replicates at C1 from five to 10 for summer 1974, and from three replicates to nine for 1975. We did this by tallying each observed N twice or three times, respectively (this treatment assumes that between-sample variability would not change as the number of replicates increased). The confidence limits between 1974 and 1975 then became nonoverlapping by a large margin. This would indicate a significant change

in N at C1. We do not in fact wish to detect this change, since this station is considered a control. The C1 area contains extensive mussel beds, which in summer 1974 supported a dense set of juvenile mussels. By summer 1975 there were smaller numbers of larger mussels - this must be assumed to be a natural progression. SCUBA observations here have revealed a small-scale patchiness in the mussel beds - thus the variability in the macrofauna data is real rather than a sampling artifact. We conclude from the above that it is undesirable to increase the sensitivity of our macrofaunal data through increased replication (although increasing sensitivity by improving navigation is desirable, and is being acted upon). We will continue to use five replicate grabs per station to detect gross changes in the fauna.

During the next quarter, we will concentrate on making available comparative data on additional stations for summer 1974 vs summer 1975 to further investigate the spatial pattern of spoiling impacts. This information will be combined with analysis of species compositions, SCUBA observations, recolonization studies (both remote and by divers) and reported findings on effects of spoil disposal elsewhere, to arrive at an overall assessment of spoiling impacts in the New London area. Based on these considerations, our evaluation to date is that the spoils have not had a detrimental effect on macrofauna except in those areas where large quantities of spoil materials are present. Here impacts appear restricted to actual burial by spoils. The spoil materials are apparently not inimical to the area's macrofauna since recolonization by some of the area's more important and sensitive species is well underway.

B. Sediment Analysis

Duplicate cores taken at 20 selected stations on the fifth and sixth quarterly cruises are presently being analyzed by Dr. James Parks, Lehigh University, for sediment size parameters, calcium carbonate and organic contents. No new analyses of size parameters have been returned since those discussed in the prior report. Data on amounts of $CaCO_3$ and organic materials in sediments have been received for samples taken in July and October 1974 and January 1975 (Table 2). Calcium carbonate values were extremely variable both over the study area (with a range from 1.2 - 32.1% by weight of sediments sampled in October 1974) and at a given station (for instance, station F8 had an increase from 7.3 to 31.2% between July 1974 and January 1975). Organic carbon values ranges from 0.07 - 8.91% by weight of sediments.

Table 2. Calcium carbonate and organic contents of disposal area sediments. NL 1: June - July 1974; NL 2: September - October 1974; NL 3: January 1975.

Station	Wgt % $CaCO_3$	Wgt % Org	Station	Wgt % $CaCO_3$	Wgt % Org
NL1-A1-G5	20.51	0.18	NL2-C7-G3	3.06	0.33
NL1-A3-G1	18.30	1.46	NL2-C8-G2	11.84	0.14
NL1-A5-G2	8.60	0.70	NL2-C8-G3	8.93	0.52
NL1-A8-G4	3.28	0.54	NL2-C9-G5	3.70	0.36
NL1-A9-G5	2.85	0.14	NL2-E3-G2	1.15	1.37
NL1-B3-G1	14.44	0.66	NL2-E9-G5	2.36	0.19
NL1-B3-G3	4.91	0.70	NL2-F3-G4	1.94	0.33
NL1-C1-G5	1.95	0.07	NL2-F4-G4	2.23	3.09
NL1-C3-G4	25.60	4.49	NL2-F8-G2	20.55	1.32
NL1-C4-G3	4.05	8.90	NL3-A1-G2	9.91	0.17
NL1-C5-G3	16.76	1.00	NL3-A3-G4	4.25	0.00
NL1-C6-G2	3.19	1.11	NL3-A4-G4	3.20	0.38
NL1-C7-G1	1.33	0.68	NL3-A5-G4	5.23	1.13
NL1-C9-G4	27.86	1.53	NL3-A8-G4	10.38	0.50
NL1-F3-G5	4.38	0.31	NL3-A9-G5	1.99	0.37
NL1-F4-G1	5.36	0.38	NL3-C1-G1	1.50	0.25
NL1-F8-G5	7.34	3.64	NL3-C3-G3	1.17	0.67
NL2-A1-G5	32.09	0.31	NL3-C4-G2	3.07	0.56
NL2-A3-G3	10.73	0.25	NL3-C5-G3	6.60	0.32
NL2-A4-G3	8.91	1.80	NL3-C6-G2	2.75	(insuff.sample)
NL2-A4-G4	11.45	8.91	NL3-C7-G4	4.21	0.19
NL2-A5-G1	22.86	0.69	NL3-C9-G1	2.99	0.19
NL2-A8-G5	7.96	0.25	NL3-E3-G3	3.48	0.18
NL2-A9-G2	1.78	0.73	NL3-E8-G3	8.06	0.81
NL2-B3-G1	4.90	0.34	NL3-E9-G3	1.47	0.25
NL2-B3-G5	12.64	0.32	NL3-F3-G2	1.52	0.31
NL2-C1-G4	7.05	0.40	NL3-F4-G3	3.98	0.14
NL2-C3-G4	2.91	0.26	NL3-F8-G4	31.20	0.25
NL2-C4-G1	8.94	0.73			
NL2-C5-G2	5.87	0.56			
NL2-C6-G1	2.57	3.17			

As a rule, concentrations of organics decreased in the sequence July > October > January. Calcium carbonate and organic contents of the dumped spoils (as seen in values for the disposal point, station C6, in October and January) differ little from those of the natural sediments at many stations. This, plus the observed variability of $CaCO_3$ and organics with time, make it unlikely that these characteristics alone can be used to trace presence or spread of spoils. We will continue to monitor these constituents, however, as a possible aid in understanding observed distributions of macrofauna.

C. Sedimentation Rate Studies

Sediment traps were set at stations A2, A3, A4, A5 and E3 on 22-23 October, and retrieved on 24 October. Analyses of prior collections are now complete through the May 1975 samples, and partial data are available for July 1975 experiments. Table 3 presents information on total materials collected in the traps between July 1974 and July 1975. Table 4 lists total and organic carbon contents of the collected materials.

Several inferences can be drawn from these data. As expected, total suspended materials were greatest during the March 1975 sampling (Table 3) - this period typically has higher wind and wave energies than do our other sampling dates. On the A transect, there is no apparent relation between distance from the spoil pile and amount of suspended material collected. Suspended sediment levels are consistently greatest at the station closest to the river mouth, E3. This suggests that suspended sediment levels in the disposal area are influenced more by inputs from the Thames than from

TABLE 3. AMOUNTS OF MATERIALS COLLECTED IN SEDIMENTATION TRAPS

July & October 1974, March, May and July (one station) 1975

STATION	DISTANCE FROM DISPOSAL BUOY n. mi.	HEIGHT ABOVE SEDIMENT (cm)	TOTAL MATERIAL COLLECTED (gm/cm^2 of trap/da)				
			July	October	March	May	July
A2	1.5	55					
		15	0.12*	0.033			
A3	1.0	55			0.182	0.028	
		15	0.133	0.051	0.225		
A4	0.5	55			0.125		0.022
		15		0.023	0.214	0.033	0.052
E3	1.0	55			0.130	0.076	
		15		0.012*	0.271	0.194	

* Estimate based on weight recovered and volume observed in trap prior to spillage during sampler recovery.

TABLE 4. CARBON CONTENT OF MATERIALS COLLECTED IN SEDIMENTATION TRAPS

July & October 1974, March, May and July (one station) 1975

STATION	HEIGHT ABOVE SEDIMENT (cm)	DEPTH IN SAMPLE	TOTAL CARBON, %					ORGANIC CARBON, %			
			July	Oct.	Mar.	May	July	Oct.	Mar.	May	July
A2	55	TOP									
		BOTTOM									
	15	TOP	1.62	3.64				1.58			
		BOTTOM	0.79	3.78				3.47			
A3	55	TOP			1.59	2.25			1.54	1.97	
		BOTTOM			1.93	2.84			1.86	2.22	
	15	TOP	2.43	3.57	2.47	2.24		3.21	2.29	1.54	
		BOTTOM	0.36	3.13	2.41	2.74		2.42	2.01	2.58	
A4	55	TOP			1.54		1.89		1.48		1.30
		BOTTOM			3.05		1.82		2.05		1.68
	15	TOP		3.55	2.53	2.04	2.49	2.61	2.26	1.80	2.37
		BOTTOM		3.40	2.93	2.63	2.15	3.33	2.59	2.16	1.93
E3	55	TOP			1.58	0.96			1.09	0.49	
		BOTTOM			3.76	2.57			3.93	1.99	
	15	TOP		2.49	2.90	0.88		2.19	2.52	0.23	
		BOTTOM		2.96	2.92	2.59		1.16	2.46	2.30	

resuspension of spoil materials. The traps held 15 cm above the sediment continue to collect roughly twice as much material as those positioned 55 cm above the sediment. Again, this near-bottom gradient in suspended materials should be considered when using transmissometers or water bottles to obtain data on bottom waters.

An examination of values for total and organic carbon contents of suspended sediments (Table 4) reinforces the concept that station E3 has a hydrological regime different from that of the A transect. Seasonal trends in carbon contents are similar at A2, A3 and A4, with maximal values in October, while the maxima at E3 occur in March. The October maxima at the A stations could reflect the fact that spoiling had just begun, with the surficial spoils being dumped at the time presumably higher in carbon content than the river sediments in deeper strata which were dredged later in the project. Additional samples must be analyzed to determine whether the high carbon levels were indeed related to onset of spoiling, or whether seasonal or other factors are more important.

D. Biological Dive Studies

These were conducted on 22-23 October 1975. Only two stations could be intensively sampled for comparison with similar surveys made in October 1974. Station A3 showed little change between the two surveys, and still contained a rather sparse visible macrofauna consisting mostly of a sponge (*Haliclona loosanoffi*), hermit crab, *Pagurus longicarpus*, blood star, *Henricia* sp., seastar, *Asterias forbesi*, and anemone, *Metridium senile*. Station C3 was dominated in both surveys by *M. senile* and a snail, *Anachis translirata*, but counts made of single $0.25m^2$ quadrats indicated an approximately 10-fold reduction in density of these species between 1974 and 1975.

We continued the effort, begun in the prior survey, to run SCUBA transects from the center toward perimeters of the spoil pile while unspooling a line marked at 50-foot intervals. Objectives were to determine both extent of the spoils and characteristics of sediments and fauna along the transects. On a flooding tide on 23 October, we swam with the current in a WSW direction from the NL buoy for 750 feet without detecting any obvious changes in nature of the spoils. Depths increased gradually from 66 feet at the disposal buoy to 78 feet at the end of the transect. The surface of the spoil pile was for the most part a uniformly smooth soft grey silt-clay. Lag deposits, consisting mostly of broken shell material, were in evidence. Clumps of cohesive silts or clays, two to four feet high, were occasionally seen. These clumps appeared to have been burrowed into, although no lobsters or Cancer crabs were seen in the burrows. Macrofauna observed near the disposal buoy consisted of occasional hermit crabs and sparsely distributed tubes of polychaetes and ampeliscid amphipods. Density of amphipod tubes increased moving along the transect; tubes were abundant (they appeared to exceed the mean of 15.5 amphipods per $0.1m^2$ found in grab samples from the disposal buoy) by 400 feet WSW of the buoy, and remained abundant to the end of the transect at 750 feet. In this region the sand shrimp, Crangon septemspinosus, was also common. Several specimens of windowpane flounder, Scophthalmus aquosus, and seastars were seen. Small tubes, burrows and tracks across the bottom indicated that the spoils were supporting considerable biological activity.

A second transect was run on the succeeding ebb tide. We began at a point just south of station A8 (See Figure 1) and swam with the current

nearly due east (100° mag.) for 930 feet without detecting any natural sediments or any change in the nature of the surface spoils. Thus the spoil pile extended to a distance of greater than 0.68 mi (0.59 n. mi.) to the east of the disposal buoy. Depths along the transect were consistently between 68 and 70 feet. As in the above observations, the spoils were mostly level soft grey materials, with occasional large cohesive clumps, for the entire length of the transect. Some lag deposit was again present. Amphipod tubes were denser than on the WNW transect described above - the tubes covered approximately 25% of the bottom at the beginning of this transect, and became somewhat more abundant toward the east. Single specimens of fluke, Paralichthys dentatus, little skate, Raja erinacea, windowpane and seastar were sighted. It should be noted that on these transects the divers often create turbidity clouds which limit visibility - it is thus probable that finfish and macroinvertebrates were more common than reported.

The overall conclusion drawn from these SCUBA transects agrees with the information discussed in the section on grab samples, i.e. that the spoil materials are not inhospitable to benthic macrofauna, at least in the short term, and that colonization by some of the dominant species of nearby assemblages is well underway. These surveys were conducted three days after a fairly intense northeasterly storm of three days' duration. No disruption of the spoil pile or its fauna by this storm was apparent. Dives conducted ¼-1½ n. mi. from the disposal buoy the day after the storm subsided did not encounter abnormal turbidity.

A cooperative experiment with the New York Ocean Science Laboratory (NYOSL) was undertaken on 23 October. Middle Atlantic Coastal Fisheries Center divers used Niskin samplers to collect water samples both at the bottom and next to a NYOSL transmissometer measuring scouring just above the bottom over the spoil pile. The samples will be analyzed by NYOSL to determine the relationship between these transmissometer readings and suspended sediment concentrations.

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V. ACKNOWLEDGMENTS

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UCONN - Dr. W. F. Bohlen (Suspended Material Transport, Thames River); Dr. S. Y. Feng (Dredging Effects on Shellfish Resources and Phytoplankton, Thames River); Mr. J. Cook (Geofungi).

NYOSL - Mr. H. DuBois (Chemical Oceanography of Dump Site); Dr. R. Valenti (Fish Distribution and Abundance); Dr. R. Hollman (Physical Oceanography of Dump Site).

MACFC - Mr. A. Draxler (Sediment Trap Experiments); Dr. J. Graikoski (Microbiology); Mr. R. McGrath (Benthic Macrofauna); Mr. R. Reid (SCUBA Surveys, Cage Experiments, Contract Representative).

APPENDIX A

TO: Dr. Robert Reid, Monitoring Project Leader

FROM: Dr. W. Frank Bohlen, Principal Investigator

SUBJECT: The Investigation of Suspended Material Transport in the Thames Estuary: Progress Report for the quarter ending September 30, 1975.

During the past quarter a detailed review of all data obtained since the initiation of this project in August 1974 has been completed. Portions of this review were presented at the Workshop held at Avery Point on July 21-22, 1975. These data have been used to analyze the initial impacts of dredging on the suspended material field and to determine the necessity for modification of the second years sampling program. As indicated at the Workshop, the acute impact of dredging appears to be an essentially near field phenomenon confined to the immediate area of the operating dredge and barge. Long term impact remains to be determined. This subject represents a primary objective of the studies to be conducted during the second year of the project. This work will be closely coordinated with the studies conducted by Dr. Feng.

The data review does not indicate a need for substantive modification in the proposed sampling routine. Emphasis will remain on the composition and concentration of suspended materials with particular effort directed to the determination of the factors governing the variability of the suspended material field. The completion of the dredging in July 1975 now permits examination of these factors under conditions typically prevailing in the

estuary. Monthly surveys will be continued in order to detail seasonal variability. The first year's data displays an irregular seasonal variability (Fig. 1-6). Simple correlations with stream flow, characteristic of most estuaries, are not observed. These data suggest that material supplies within the lower estuary and the variability of the concentration field are dominated by intrusions of Fishers Island Sound water. River borne materials represent a second order input. The accuracy of this hypothesis will be investigated using the field data in combination with a numerical hydraulic model.

During the past month the model developed by Festa and Hansen has been applied to the Thames River estuary. To date only average streamflow conditions have been examined. Calculations of the average mass flux over the vertical indicate a net inflow within the lower estuary supporting the above assumption. During the next quarter this model will be applied in the examination of high streamflow conditions and the analysis of probable hydraulic modifications induced by dredging. The accuracy of the salinity predictions will be checked by supplementary field surveys.

Despite several attempts during the first year of this investigation an inadequate data set exists for the determination of storm effects on the suspended material field. Sampling conducted after two wind stress events has revealed essentially no significant modification in concentration levels. Additional sampling is required, however, in order to determine whether the limited response was due to insufficient storm duration or area sheltering.

During the past quarter the analyses of organic carbon content (both particulate and dissolved) have been completed on all samples obtained during the first year. Analysis of selected station data indicates relatively little seasonal variability (Fig. 3-6). The influence of the dredging project on these concentrations awaits completion of an adequate number of post-dredging surveys. At present, impacts must be defined as near field and limited to observed variations in the relative percentage of particulate organic carbon versus total suspended load. Previous reports have displayed these variations within the plume of suspended material produced by the operating dredge and barge.

Coulter Counter analyses of the grain size distribution within the suspended load have displayed limited seasonal variability. Sample-to-sample variations dominate and effectively mask any long term trends. An investigation of sampling adequacy will be completed during the second year of this project.

TABLE 1

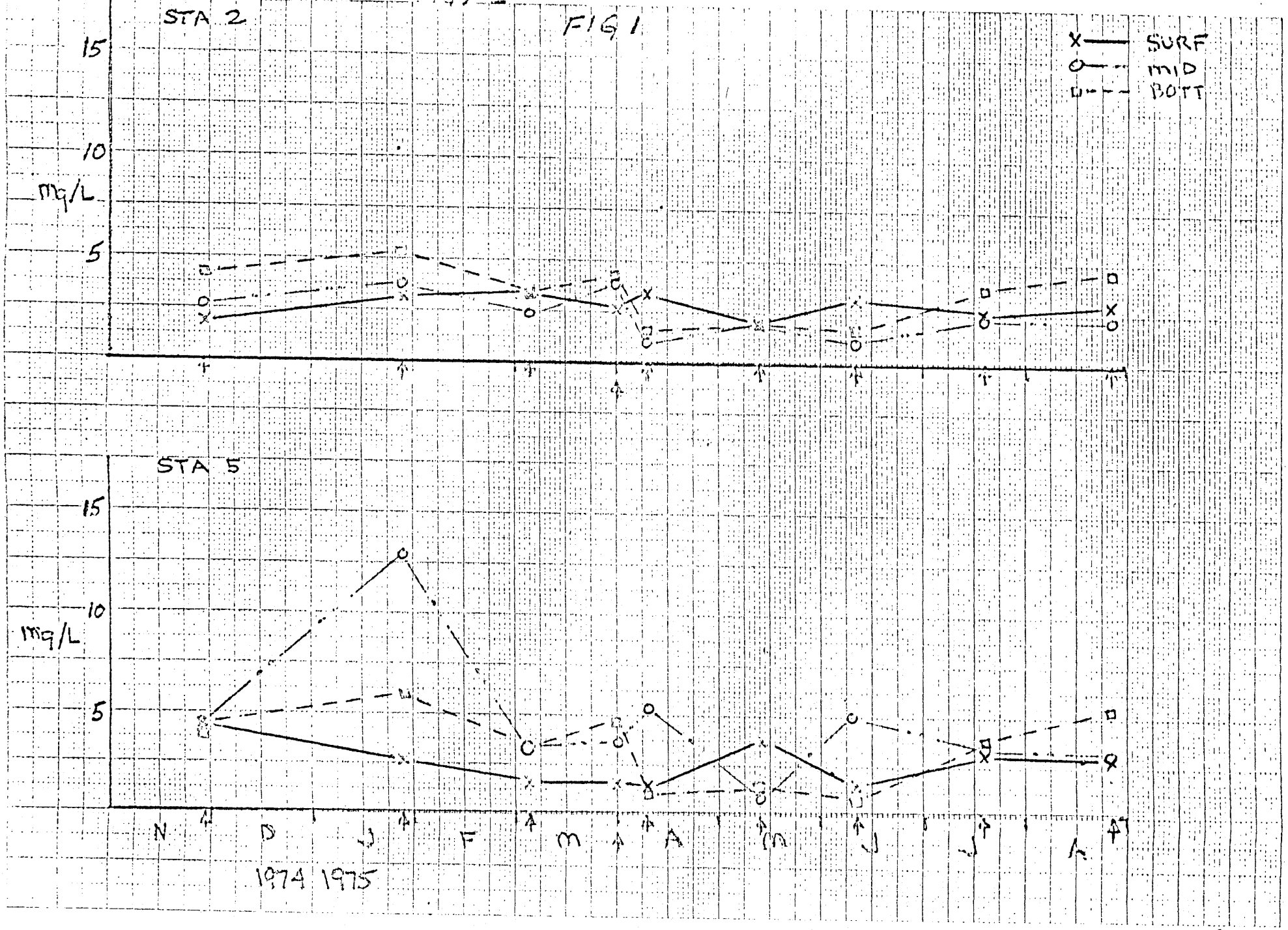
SURVEY SUMMARY

June 30, 1975 - September 30, 1975

DATE	NO. OF STATIONS	PARAMETERS SAMPLED
July 18, 1975	12	Monthly survey, temperature, salinity suspended solids, dissolved and particulate organic carbon, orthophosphate
August 25, 1975	12	Monthly survey, same parameters as above
September 29, 1975	12	Monthly survey, same parameters as above

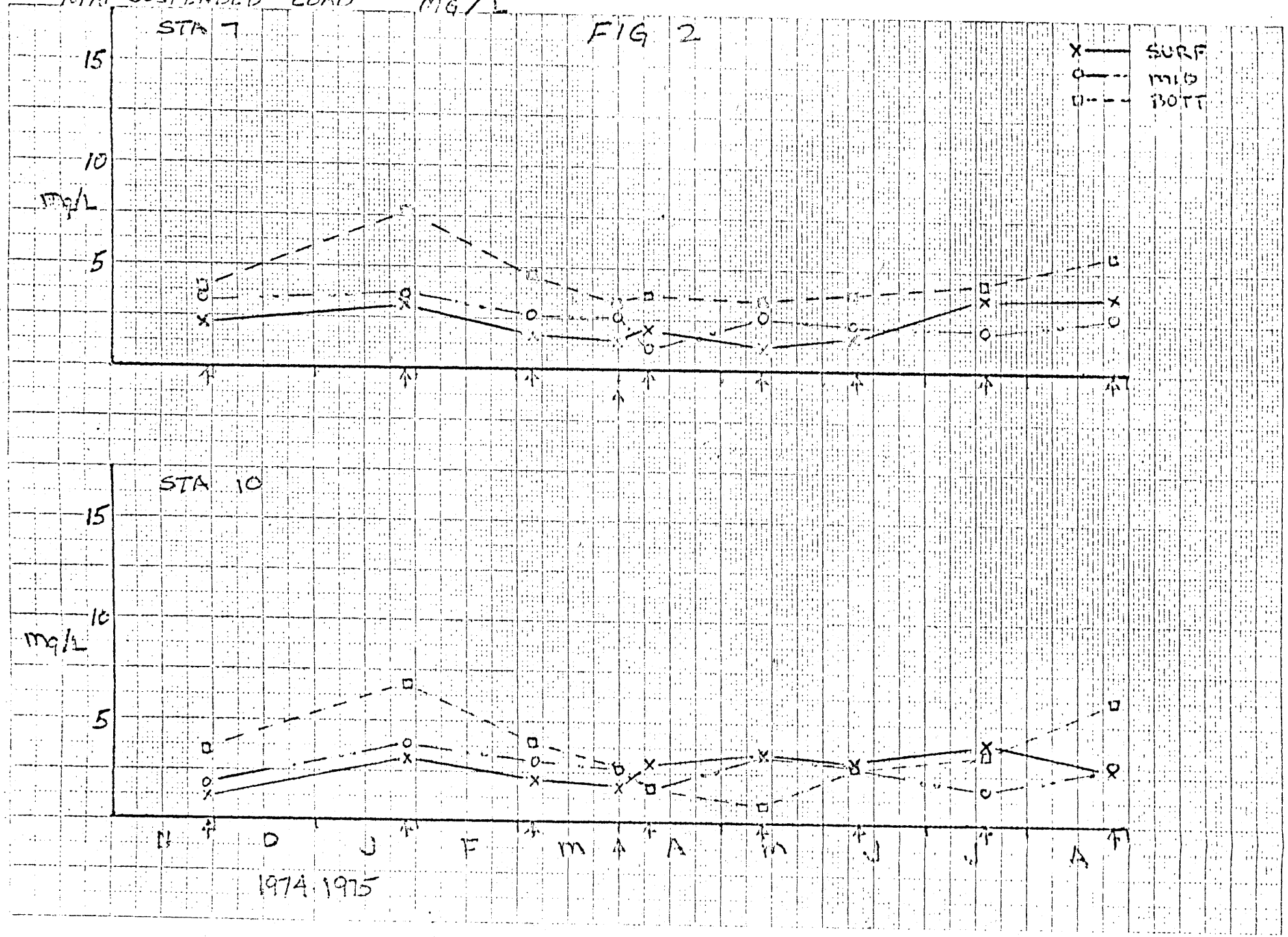
TOTAL SUSPENDED LOAD mg/L

FIG 1



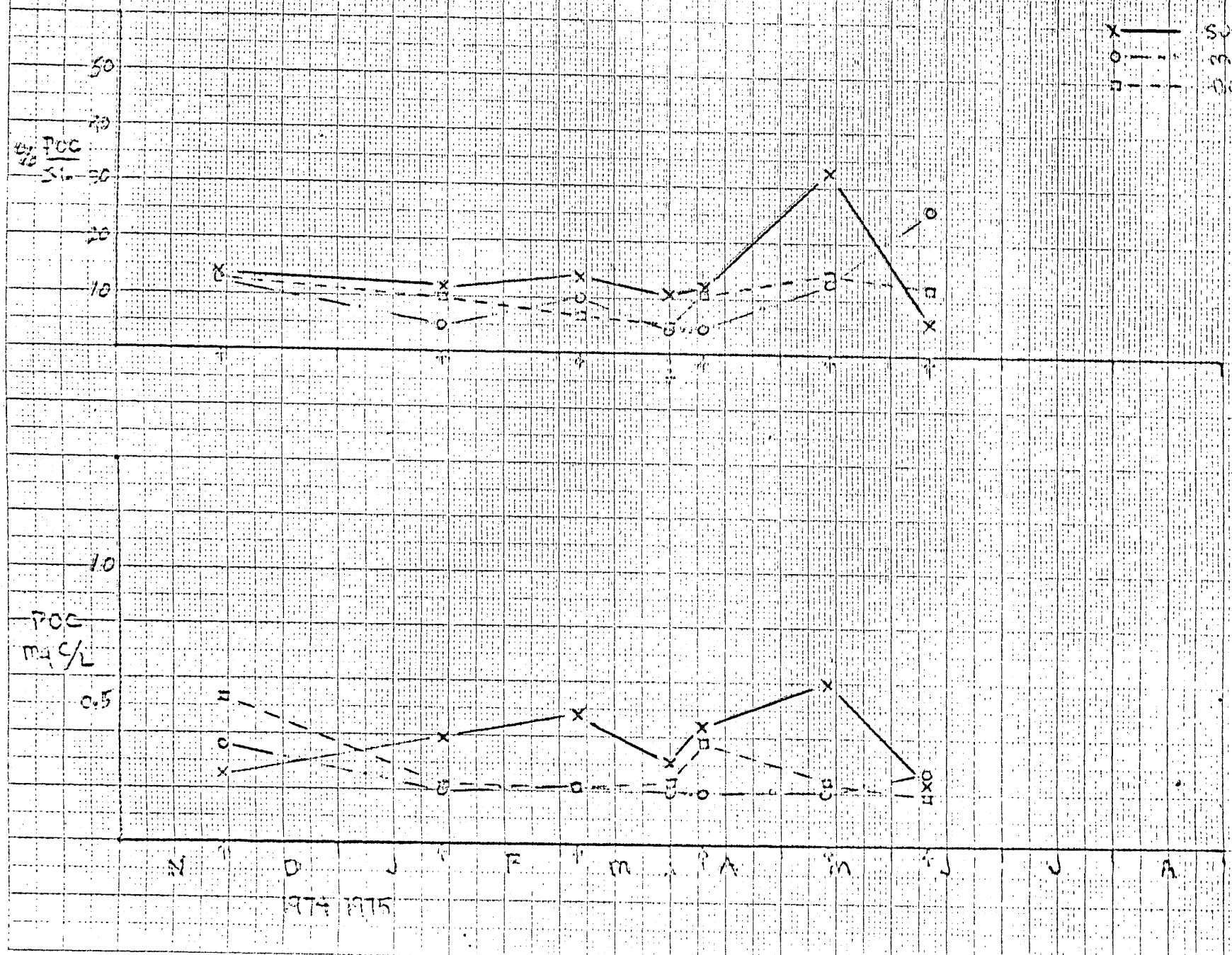
TOTAL SUSPENDED LOAD MG/L

FIG 2



STA 2

FIG 3


SURF
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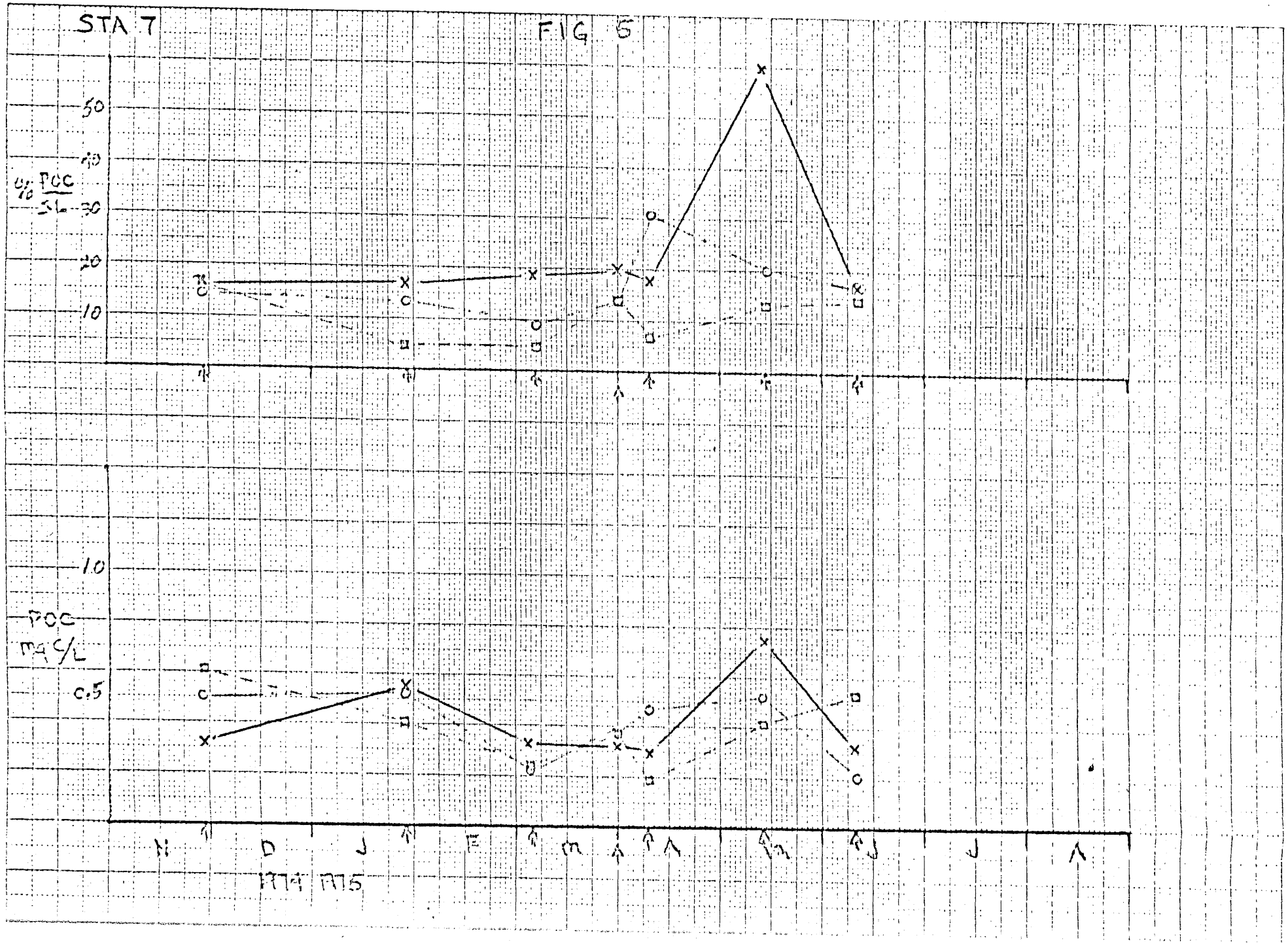
STA 7
FIG 5
% POC
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POC
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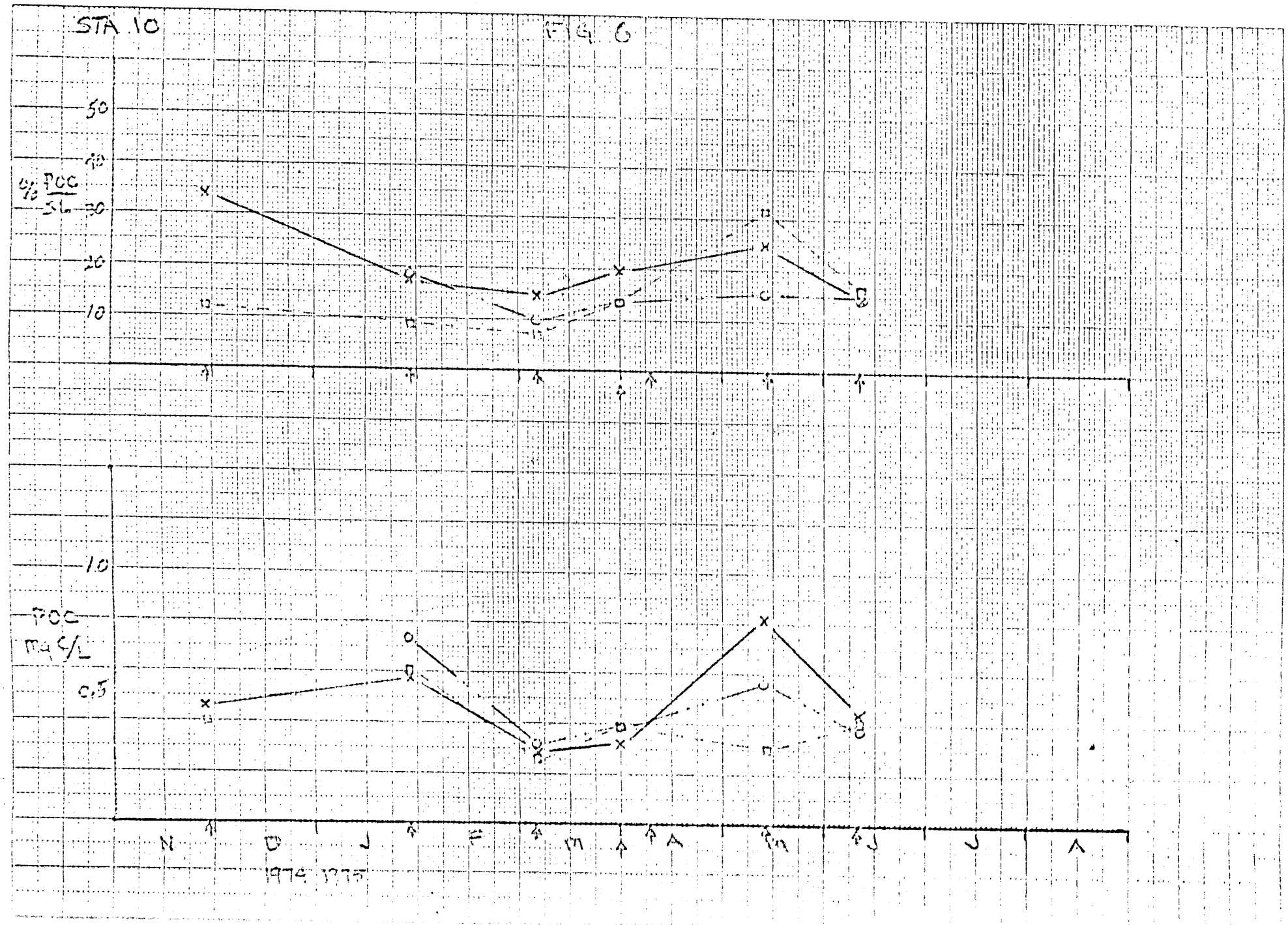

QUARTERLY REPORT: July - September 1975

CONTRACT NO. 03-5-043-302

SUBMITTED TO: Sandy Hook Laboratory, Middle Atlantic Coastal Fisheries Center
National Marine Fisheries Service
NOAA/U.S. Department of Commerce

TITLE: Geofungi Associated with Suspended Sediments in the Main Channel of the Thames River Estuary.

BY: John C. Cooke, Ph.D., Biology

I. Sampling: Two cruises were made during this quarter: July 18 and August 25. Information available from these cruises is presented in TABLE I. Core samples were collected at stations A, B and D on the July cruise and from the Dump Site and 1/4 mile North of the Dump Site on the August cruise. The methods for sampling and processing the samples are given in the Second Quarterly Report.

II. Results: Table I lists the amount of suspended sediments, salinity and the total number of fungal colonies present for samples collected June 5, June 11, July 18 and August 25. The total number of fungal colonies for samples collected on August 25 is being determined.

As reported previously, the number of fungi from surface water samples is significantly greater than from bottom water samples at any station. The higher count in fungal colonies in the bottom water sample at Station B on June 5 was due to intake of bottom mud during the sampling.

The majority of fungal colonies observed from the core samples were obtained on agar plates made from material taken at the surface of the cores. Relatively few fungi or bacteria grew on plates made from material taken at about 20mm below the surface. This is consistent with observations made from previous cores.

The data included in this report supports the apparent relationship between salinity and number of fungi. This relates to the mixing of river

water and sound water as reported in the last report. No relationship between fungal colonies and amount of suspended sediments has been found.

III. Future Work: Study of sample plates from August are now being completed. Two water sample collections from the river and adjacent sound will be made during the next quarter.

TABLE I

Amount of suspended sediment, salinity and number of fungi from each station indicated.

	mg/l SEDIMENT		SALINITY (S ‰)		TOTAL # OF COLONIES/SAMPLE		
DATE	Surface	Bottom	Surface	Bottom	Surface	Bottom	Core
STATION A: BUOY #2 - New London Harbor							
6-5-75	0.96	2.63	28.10	30.40	6/6 plates	3/6 plates	---
6-11-75	3.20	---	30.40	---	5/6 plates	---	68/20 plates
7-18-75	2.49	---	29.39	---	10/6 plates	---	43/20 plates
8-25-75	3.03	4.57	30.40	30.40	To be examined		
STATION B: BUOY #6 - New London Harbor							
6-5-75	1.89	468.94 (coll. on bottom)	27.64	29.48	14/6 plates	15/6 plates	---
6-11-75	1.59	---	21.66	---	20/6 plates	---	68/20 plates
7-18-75	4.43	---	18.59	---	13/6 plates	---	34/20 plates
8-25-75	2.98	5.36	29.48	29.48	To be examined		
STATION C: Below dredge in channel - New London Harbor							
6-5-75	1.59	1.25	27.64	29.94	13/6 plates	3/6 plates	---
STATION D: Thames River Buoy #2 (North of Gold Star Memorial Bridge)							
6-5-75	7.35	7.56	16.60	29.48	31/6 plates	6/6 plates	---
6-11-75	3.01	---	18.44	---	31/6 plates	---	93/20 plates
7-18-75	7.04	---	12.55	---	16/6 plates	---	35/20 plates
8-25-75	2.76	6.19	26.72	29.48	To be examined		
STATION E: Vixen Ledge (Red Buoy Marker)							
6-5-75	1.16	---	29.94	---	2/6 plates	---	
7-18-75	3.39	---	30.25	---	6/6 plates		
8-25-75	1.37	---	30.40	---	To be examined		
STATION F: Mumford Cove (West of Channel Marker #5)							
6-5-75	1.48	---	29.48	---	3/6 plates		
7-18-75	2.94	---	28.96	---	8/6 plates		
8-25-75	0.82	---	30.40	---	To be examined		

TABLE I - continued

DATE:	mg/l SEDIMENT Surface	mg/l SEDIMENT Bottom	SALINITY (S‰) Surface	SALINITY (S‰) Bottom	TOTAL # OF COLONIES/SAMPLE Surface	TOTAL # OF COLONIES/SAMPLE Bottom	TOTAL # OF COLONIES/SAMPLE Core
STATION DUMP SITE: (Vicinity of marker buoy)							
6-5-75	0.63	18.96	29.48	30.81	1/6 plates	0/6 plates	---
8-25-75	0.77	1.69	30.40	30.40	To be examined		
STATION INTREPID ROCK (East of Buoy Marker)							
6-5-75	1.68	---	29.94	---	5/6 plates		
7-18-75	3.49	---	29.39	---	2/6 plates		

APPENDIX B

QUARTERLY REPORT

AN INVESTIGATION ON THE EFFECTS OF DREDGING IN THE THAMES RIVER ON SHELLFISH RESOURCES AND PHYTOPLANKTON

(Contract No. 03-5-043-301)

July 1 to September 30, 1975

Submitted to

Sandy Hook Laboratory, Middle Atlantic Coastal Fisheries Center
National Marine Fisheries Service
N. O. A. A.
U. S. Department of Commerce

by

S. Y. Feng
Marine Research Laboratory
University of Connecticut
Noank, Connecticut, 06340

September 30, 1975

Introduction

Monitoring of the level of zinc, copper, cadmium, nickle and mercury in shellfish and in sea water samples has been continued during this quarter. Fifteen samples of Mercenaria mercenaria (113 clams), 10 samples of Pitar morrhuana (148 individuals) and 4 samples of Crassostrea virginica (32 oysters) were collected from Thames River on July 26-28, 1975. Twenty four sea water samples for zinc, copper, cadmium and nickle determinations and 64 samples for chlorophyll analyses were obtained from the six transects in the River on July 24, 1975. A duplicate set of 24 sea water samples was also collected for mercury determinations.

Methods

The procedures for gross examination of pathological conditions and determination of heavy metals in shellfish samples as well as analysis of chlorophyll a, b and c were detailed in the original proposal. Mercury in water samples were determined by the method of Fitzgerald et al. (1974).

Zinc, copper, cadmium and nickle in water samples were determined by a modified APDC-MIBK extraction method of Brewer et al. (1969). The procedure is outlined briefly as follows: Adjust the pH of 400 ml of Millipore filtered seawater (0.45μm) with 2% APDC solution. The filter used in the filtration was soaked in 1% APDC solution overnight to eliminate the metal contaminates in the filter. The water sample was divided equally into four 250-ml teflon separatory funnels previously acid cleaned and rinsed with a 2% APDC solution. Add to each funnel 2.5 ml of 2% APDC and 0, 1, 2 and 3 ml of the mixed working standard solution. Shake the funnels to mix the reagent. Transfer 7 ml of MIBK to each funnel and shake vigorously for 5 minutes. Let the funnels to stand for 30 minutes to allow the separation of phases. Drain off the lower aqueous phase and save the solution. About 5.5 ml of MIBK are recovered and drained into a test tube. Repeat the same procedure with the once extracted aqueous solutions. The organic layer (MIBK) is again recovered.

The nickle and lead contents of the first and second extraction are determined by the use of a graphite flameless atomizer and copper, zinc and cadmium by the standard flame atomic absorption spectrophotometry.

The linear regression equations for the absorbance values vs. the unspiked and spiked samples of the first and second extraction are obtained by the least square method. The concentration of the metal in the sample can then be determined by solving the two simultaneous equations.

Results and Discussion

A. Gross Pathological Examination of Shellfish

Examinations of the inner and outer aspects of gills and palps, as well as the pericardial cavity revealed no discernible abnormalities.

B. Heavy Metal Concentrations in *Mercenaria mercenaira*, *Pitar morrhuana* and *Crassostrea virginica*.

The metal content in the three species of shellfish is summarized in Table I. The results should be considered with Table I-V of the last quarterly report.

Zinc concentrations in *M. mercenaria* show a significant increase as contrasted with that of the July 1974 sample. In *P. morrhuana* and *C. virginica*, however, the concentration of zinc remains fairly constant.

The average concentrations of copper in *M. mercenaria* and *P. morrhuana* appear to vary within narrow limits throughout the year. A seasonal fluctuation which peaks in July is clearly discernible in *C. virginica*.

On the average the concentrations of cadmium in *M. mercenaria*, *P. morrhuana* and *C. virginica* have increased 1.8, 1.4 and 1.3 times respectively in one year. It is also noted that most of the increases have occurred in May and July 1975 samples.

Nickle concentrations in *M. mercenaria* and *P. morrhuana* vary between 7-8 ppm most of the time except during March it was significantly lower (ca. 5ppm).

TABLE 1. The concentration of zinc, copper, cadmium, nickle and mercury in shellfish from the Thames River, July 26-28, 1975. The results are expressed as ppm.

Station	Zn	Cu	Cd	Ni	Hg
			Mercenaria mercenaria		
B	138	16.0	1.89	10.88	.129
C	202	20.0	2.00	8.16	.164
D	366	19.4	2.16	7.86	.174
E	209	21.9	1.95	6.96	.209
F	595	26.2	2.22	6.94	.231
G	320	28.2	1.79	6.34	.327
H	236	30.4	1.90	6.05	.245
Avg.	295	23.1	1.99	7.60	.211
			Pita morrhuana		
A	204	16.6	3.95	6.95	.160
B	371	16.0	4.00	7.85	.149
C	340	13.0	4.88	6.61	.151
D	443	14.0	3.52	6.95	.172
E	424	20.4	4.22	7.56	.178
Avg.	356	16.0	4.11	7.18	.162
			Crassostrea virginica		
O-II	18,300	748	7.69	4.23	.217
O-III	23,000	1255	8.34	7.87	.292
O-VI	13,500	950	6.17	7.86	.276
O-VII	20,600	1139	10.28	4.83	.353
Avg.	18,800	1023	8.12	6.19	.284

In C. virginica on the other hand the range of variations encountered in the past year was from 5.18 to 6.19 ppm.

The mercury level has reduced 40% in M. mercenaria and 30% in P. morrhuana and C. virginica from the original concentrations of July 1974 samples.

C. Mercury Concentrations in Thames River Water Samples

The distribution of mercury in the surface and bottom water during flood and ebb for July 24, 1975 is shown in Table II. The data show a 4- to 5- fold increase in the mercury concentration since February and April, 1975. The results, viewed with the previously reported data (see Table VI in the last quarterly report) suggest the probable existence of seasonality of mercury in the Thames River, which exhibits the lowest concentration of mercury in the colder months, February and April 1975.

D. The Concentration of Nickle, Lead, Zinc, Cadmium and Copper in Thames River Water Samples, July 2, 1974.

To date we have only completed the analysis of 12 samples which were collected on July 2, 1974. The results are shown in Table III. Analyses of the remaining water samples for the five heavy metals are in progress. Since the extraction procedure is tedious and time consuming, we can only process four samples per week.

Although it is too early to comment on the significance of the data relative to the dredging operation, the results appear to be in good agreement with those obtained by Fitzgerald et al. (1974) from the adjacent waters in Long Island Sound. His figures are generally lower than ours, but this is to be expected for the River is considered more polluted than the Sound.

Fitzgerald et al. (1974) have shown that the water samples from Housatonic River contain 40 and 44 μg/l of copper and zinc respectively. In the Thames River water, the concentration of zinc (33 μg/l) is in the same order of magnitude as

TABLE II. Mercury concentrations in Thames River water (expressed in ng/L or parts per trillion), July 24, 1975

Transect	Hg(ng/L)	Transect	Hg(ng/L)
I-LW-S	42	IV-LW-S	12
-B	12	-B	69
HW-S	29	HW-S	34
-B	42	-B	14
II-LW-S	16	V-LW-S	11
-B	25	-B	16
HW-S	15	HW-S	10
-B	26	-B	17
III-LW-S	8	VI-LW-S	30
-B	8	-B	46
HW-S	14	HW-S	18
-B	18	-B	37

Average 24 ng/L

TABLE III. The concentration of nickle, lead, zinc, cadmium, mercury and copper in the Thames River water samples, July 2, 1974. All concentrations are expressed in ppb, except mercury which is in ppt.

Transect	Ni	Pb	Zn	Cd	Cu	Hg
I-NW-S	7	2	53	<0.05	3	12
-B	1	1	37	0.11	2	12
II-HW-S	2	2	25	0.05	2	12
-B	2	1	30	<0.05	2	15
III-HW-S	8	2	26	1.21	1	10
-B	33	5	32	0.30	7	30
IV-HW-S	1	1	30	3.35	4	14
-B	56	2	15	0.77	7	15
V-HW-S	8	1	18	0.94	3	6
-B	5	2	27	<0.05	6	16
VI-HW-S	2	4	53	1.50	3	28
-B	19	5	51	<0.05	3	10
Average	12	2	33	0.70	4	15

that of the Housatonic River water, which is nevertheless 11 times more concentrated than that of the Sound water (3μg/l). The concentration of copper in Thames River (4 μg/l) is twice as concentrated as the Sound water, but it is only 1/10 of the concentration found in the Housatonic River water. While there is little difference in the concentration of zinc in the oysters obtained from the two river systems, the copper content in the Housatonic River oysters is about 3 times higher than that of the Thames River oysters (Feng and Ruddy, 1975; Quarterly reports of the present study). In this instance, the concentrations of zinc and copper in oysters seem to reflect closely the characteristic geochemical composition of the overlaying water mass of the two rivers.

The data also indicate that the concentrations of nickle (12 μg/l) and cadmium (0.7 μg/l) in Thames River water are 7 and 3.5 times higher than that of the Sound water respectively.

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APPENDIX C

QUARTERLY REPORT

Physical Oceanography of the New
London Dump Site Area
July through September, 1975

Submitted to

Sandy Hook Laboratory, Middle Atlantic Coastal
Fisheries Center, National Marine Fisheries Service
NOAA/U.S. Dept. Commerce
under Contract No. 03-5-043-305

by

Rudolph Hollman, Ph.D.
New York Ocean Science Laboratory
Montauk, New York

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A. Cruise Descriptions

1. 9 July 1975:

An experiment to determine if there was any significant scouring in the proximity of the spoil mound was planned for this date. However, as the program was being set up, a barge release was made and the experiment was changed to monitor the spoil plume downstream of the release point. The sampling frequency was 1 minute starting 10 minutes after the release. A current meter was installed on the bottom.

2. 17 July 1975:

The experiment to monitor possible scouring effects during the period of maximum tidal flow was accomplished. Transmissometer measurements were made from a fixed point 1 meter off the bottom downstream from the spoil mound over a period of 90 minutes. In addition, vertical transmissometer profiles were obtained at the anchor station and upstream. A current meter was installed at the bottom throughout the experiment.

3. 22 July 1975:

An experiment to study the Lagrangian motion of the waters relative to the Center Buoy was carried out. Surface and bottom drogues were launched at slack water at the Center Buoy and tracked through the following ebb tidal cycle. Positions of each drogue were fixed every 1/2 hour and vertical transmissometer profiles were obtained every hour along the track of the bottom drogue. A three (3) current meter subsurface array was installed at the Center Buoy.

4. 25 August 1975:

Concurrent plankton and transmissometer tows were made along the East/West transect and the North/ South transect. Sampling frequency for the transmissometer was 2 minutes at a towing depth of between 9 and 10.5 meters. A three (3) current sub-surface array was installed at the Center Buoy.

5. 26 August 1975:

Water quality measurements were obtained at all stations; one vessel was anchored at the Center Buoy. Vertical transmissometer measurements were also made. The station sampling (Figure 1) routine was as follows:

Flood:	C, W3, W2, W1
Slack:	C, N3, N2, N1, S1
Ebb:	C, E3, E2, E1

6. 17 September 1975:

Another Lagrangian flow experiment was performed. A surface and bottom drogue were launched and tracked during the period of maximum ebb flow. Position fixes were obtained every half hour and water quality parameters sampled in the water column every hour at both drogues. A three (3) current meter sub-surface array was installed at the Center Buoy.

B. Discussion and Comments

An experiment to determine the extent of possible scouring of the disposed dredge material near the Center Buoy was planned for the 9th of July during the period of maximum tidal flow. As the instrumentation was being set up, however, an unexpected barge loaded with dredge material came into the area; the experiment was therefore reorganized to try to monitor the effects of the dump approximately 80 meters downstream of the point of release. Monitoring was started 10 minutes after release and the normalized transmissometer results, t, are plotted in Figure 2 as a function of time. The maximum speed of the current during this period of time was 45 cm/sec; the vector components of the current are shown in Figure 3 for 9 July. As can be seen in Figure 2, it took approximately 12 minutes for the cloud of material to pass the monitoring point.

The scouring experiment was performed on the 17th of July. A spoil mound was identified by bottom soundings and the vessel then anchored approximately 230 meters downstream; the transmissometer was lowered to 1 meter of the bottom and readings obtained every 2 minutes. Results are tabulated in Table 1. A vertical transmissometer profile was made upstream of the spoil mound at the end of the series of measurements. Using this profile as background and a linear relationship between transmission and suspended particles, a "scouring" of approximately 1 mg/ℓ obtains. That is to say, that during the period of maximum tidal flow, the increase in

suspended load as the water passes the spoil mound, a distance of about 300 m, is approximately 1 milligram per liter of water. The average speed of the flow during the measuring period was 36 cm/sec (0-7 knots). The vector components of the flow during this experiment are plotted as a function of time in Figure 3 for 17 July.

Results of drogue tracking on 22 July are shown in Figure 4 for the surface drogue, and in Figure 5 for the bottom drogue. The dashed line in these figures represents the progressive vectors based on concurrent current meter observations. The difference between where the bottom current meter indicates a volume of water would go and where the drogue actually went is quite dramatic. Even the distance between end points in the surface flow is significant, thereby indicating again the problem inherent in relying solely upon Eulerian measurements in predicting water movement away from the point of measurement.

Beam transmittance measurements along the track of the bottom drogue are tabulated in Table 2. The increase in transmittance from 71% at 19m at the Dump Side to 86% in The Race and Block Island Sound can be attributed to mixing with other water masses and settling out. Results from current meter measurements for 22 July are tabulated in Tables 5 and 6. Maximum surface velocity was 76.5 cm/sec (1.5 knots), and 48.9 cm/sec (1.0 knot) near the bottom (see Table 6.).

Towed transmissometer measurements were made concomitantly with plankton

tows along the North-South and East-West transects on 25 August. Beam transmittance in percent are plotted as a function of distance for both transects in Figure 6. A 1 meter path length had to be used in order to tow the transmissometer which accounts for the low transmissivity readings. The depth of the tow on the East-West transect varied between 9 and 10 meters, and between 7 and 10 meters on the North-South transect. The figure points out very clearly the spatial variability or "patchiness" of the beam transmittance and therefore suspended materials.

Temperatures on 26 August from the 11 stations shown in Figure 1 are tabulated in Table 3a, b, and c, as a function of depth. Accompanying transmissometer measurements are tabulated in Table 4a, b, and c. Vertical temperature gradients are in the order of 1°C; vertical variations in transmissivity are at most about 5%.

Results from current meter observations for the 25th and 26th of August are tabulated in Tables 5 through 9. In Tables 5 and 6, the months of the year are listed in Roman Numerals so that VII would be July and VIII August. The maximum velocity encountered during the 2 day period was 47.5 cm/sec (1.5 knots) at the surface on the 25th of August. Bottom speeds are nearly 50% of the surface values. In general, the results of these observations are in agreement with past or background results. That is to say, there does not appear to be anything out of the ordinary in these latest results.

The movement of the surface and bottom drogues launched at the time of

maximum ebb current on September 16th, are illustrated in Figures 7 and 8. The bottom drogue had gone around just off Fishers Island and was relaunched further offshore. Apparently the bottom waters had reversed in the meantime, for the drogue proceeded to run toward the Northwest (Figure 8). The size of the drogues is 6 feet by 3 feet showing a face with a total area of 18 ft^2. Current meter measurements were not completely reduced at the time of writing but will be included in later reports.

Accompanying temperature, salinity, and beam transmittance measurements for the 16th of September are tabulated in Tables 10 to 12 respectively. Note that the vertical temperature gradient is now only about 1/2°C as compared to 1°C in August. The transmissivity values remain high since the drogue remained more or less near the dump site area.

Vector components of the flow for the periods: 22 July, 25 and 26 August, and 11 September are shown in Figures 9 through 11. In general, these results are in agreement with past experience. Analysis is continuing on these data, particularly the ebb flow conditions.

The current meter results for the alternate dump site ("The East Hole") in Block Island Sound during the period of 29 July through 31 July, are shown in Figure 12. These data are addended to this report because the figure was not ready for the interim report submitted in September.

Of the bottom drifters released to date, 60% (19) have been found along

Connecticut shores and 40% (13) along the north shore of Long Island. The average velocity calculated from these drifter returns is 1.5 cm/sec, in agreement with previous results. In total, 56% of the bottom drifters have been returned as compared to only 19% of the surface drifters. For the surface drifters, 92% (11) have been found to the east of New London and 8% (1) to the west. No significance is drawn from these results considering the small number of surface drifter returns.

C. Definitions:

u: east/west velocity component in cm/sec

v: north/south velocity component in cm/sec

R: speed of the current in cm/sec,

$R = [u^2 + v^2]^{1/2}$

θ: direction of the current relative to geographic north,

$\theta = \arctan v/u$

D(R): virtual distance in kilometers of a half-tidal cycle,

$$D(R) = \int_{1/2 \text{ tidal cycle}} R(t)\, dt$$

t: duration of half-tidal cycle in hours

Beam Attenuation Coefficient (β): sum of the absorption coefficient and total scattering coefficient and calculated from

$$\beta = (^{-1}/L) \ln (T/100)$$

where T is the beam transmittance in percent and L is the path length in centimeters.

"Transmission": the degree of daylight penetration in the water (transmission of downwelling irradiance over the visible spectrum) and calculated from:

$$\% \text{ Transmission} = [I(z)/I(z=0)] \times 100\%$$

Table 1 : Beam transmittance (T) and attenuation coefficient (β) as a function of time, 1 meter off the bottom, approximately 230 meters downstream from a dredge spoil mound, 17 July 1975.

Time	T(%)	$\beta(m^{-1})$	Time	T(%)	$\beta(m^{-1})$
0839	79	2.36	0923	80	2.23
0841	78	2.48	0925	81	2.11
0843	77	2.61	0927	82	1.98
0845	79	2.36	0929	81	2.11
0847	78	2.48	0931	81	2.11
0849	79	2.36	0933	81	2.11
0851	79	2.36	0935	81	2.11
0853	80	2.23	0937	81	2.11
0855	80	2.23	0939	81	2.11
0857	80	2.23	0941	81	2.11
0859	80	2.23	0943	81	2.11
0901	80	2.23	0945	80	2.23
0903	80	2.23	0947	80	2.23
0905	80	2.23	0949	81	2.11
0907	80	2.23	0951	80	2.23
0909	80	2.23	0953	80	2.23
0911	79	2.36	0955	81	2.11
0913	81	2.11	0957	80	2.23
0915	81	2.11	0959	80	2.23
0917	81	2.11	1001	80	2.23
0919	81	2.11	1003	80	2.23
0921	81	2.11			

Table 2 : Beam transmittance (T) and attenuation coefficient (β) as a function of depth while following bottom drogue on 22 July 1975.

Distance	0 km		0.6 km			0.8 km			1.9 km		
Time	0906 hours		1005 hours			1107 hours			1215 hours		
Depth(m)	T(%)	β(1/m)	Depth	T(%)	β(1/m)	Depth	T(%)	β(1/m)	Depth	T(%)	β(1/m)
1	84	1.74	1	85	1.63	1	86	1.51	1	91	0.94
5	81	2.11	5	83	1.86	5	81	2.11	5	85	1.63
10	79	2.36	10	80	2.23	10	81	2.11	10	86	1.51
15	77	2.61	15	78	2.48	15	82	1.98	15	86	1.51
19	71	3.42	20	77	2.61	20	83	1.86	20	87	1.39
-	-	-	-	-	-	23	82	1.98	24	84	1.74

Distance	5.5 km		9.8 km			12.8 km			15.3 km		
Time	1335 hours		1435 hours			1535 hours			1635 hours		
Depth(m)	T(%)	β(1/m)	Depth	T(%)	β(1/m)	Depth	T(%)	β(1/m)	Depth	T(%)	β(1/m)
1	84	1.74	1	84	1.74	1	91	0.94	1	-	-
5	82	1.98	5	81	2.11	5	83	1.86	5	90	1.05
10	84	1.74	10	84	1.74	10	83	1.86	10	90	1.05
15	84	1.74	15	84	1.74	15	84	1.74	15	86	1.51
20	85	1.63	20	85	1.63	20	85	1.63	20	86	1.51
25	85	1.63	25	85	1.63	25	87	1.39	25	88	1.28
30	87	1.39	30	86	1.51	27	87	1.39	30	89	1.17
35	88	1.28	34	86	1.51	-	-	-	35	89	1.17
37	88	1.28	-	-	-	-	-	-	-	-	-

Table 3 : Observed values of temperature on 26 August, 1975

a) During period of flood current

Station	C	W3	W2	W1
Time	1148	1045	1150	1200
Depth (m)	T(°C)	T(°C)	T(°C)	T(°C)
0	19.7	19.3	19.8	19.9
5	19.5	19.0	19.2	19.3
10	19.4	18.8	19.0	19.0
15	19.3	18.6	19.0	18.9
20	-	18.5	18.9	18.8
25	-	18.2	-	-

b) During period of slack water

Station	C	N3	N2	N1	S1
Time	1355	1330	1350	1415	1445
Depth(m)	T(°C)	T(°C)	T(°C)	T(°C)	T(°C)
0	19.5	19.2	19.6	19.6	19.7
5	18.9	19.1	19.3	19.1	18.9
10	18.7	18.9	19.0	19.1	18.7
15	18.5	-	-	18.9	18.4
20	-	-	-	-	18.0

c) During period of ebb current

Station	C	E3	E2	E1
Time	1555	1530	1555	1615
Depth(m)	T(°C)	T(°C)	T(°C)	T(°C)
0	19.3	19.6	19.6	19.6
5	19.1	19.4	19.4	18.9
10	18.8	19.3	19.2	18.7
15	18.4	-	19.2	18.5
20	-	-	-	18.3

Table 4 : Beam transmittance (T) and attenuation coefficient (β) as a function of depth on 26 August 1975.

a) During period of flood current

Station	W3		W2		W1	
Time	1100		1200		1230	
Depth(m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(1/m)
1	92	0.83	85	1.63	91	0.94
5	92	0.83	86	1.51	88	1.28
10	90	1.05	84	1.74	86	1.51
15	90	1.05	83	1.86	83	1.86
20	90	1.05	81	2.11	82	1.98
25	89	1.17	-	-	-	-
30	89	1.17	-	-	-	-
35	88	1.28	-	-	-	-

b) During period of slack water

Station	N3		N2		N1		S1	
Time	1340		1402		1425		1500	
Depth(m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(1/m)
1	83	1.86	92	0.83	-	-	-	-
5	80	2.23	87	1.39	92	0.83	90	1.05
10	78	2.48	85	1.63	88	1.28	89	1.17
15	-	-	83	1.86	86	1.51	88	1.28
20	-	-	-	-	-	-	86	1.51

c) During period of ebb current

Station	E3		E2		E1	
Time	1542		1605		1626	
Depth(m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(1/m)
1	89	1.17	-	-	91	0.94
5	86	1.51	88	1.28	89	1.17
10	83	1.86	85	1.63	88	1.28
15	-	-	83	1.86	88	1.28

Table 5 : The resultant current velocities at Center Buoy Stations

			Flood							Ebb					
	Date	Cycle	(5) Z	(1) U	(1) V	(1) R	(2) θ	(3) D(R)	(4) t	(1) U	(1) V	(1) R	(2) θ	(3) D(R)	(4) t
Surface	22 VII 75	1*	3	-	-	-	-	-	-	33.8	-14.9	37.0	114	11.6	7.
	25 VIII 75	1	3	-19.1	10.1	21.6	298	3.1	3.8	33.8	-7.1	34.5	102	12.2	8.
	26 VIII 75	2	3	-13.0	11.6	17.4	312	1.8	2.8	33.1	-6.9	33.8	102	11.8	8.
Mid-depth	22 VII 75	1	9	-	-	-	-	-	-	32.9	-2.5	33.0	94	10.8	8.
	25 VIII 75	1	9	-21.0	17.4	27.3	310	3.8	3.7	37.2	-7.3	37.9	101	11.7	7.
	26 VIII 75	2	9	-16.6	17.9	24.4	317	3.6	4.0	34.7	-7.0	35.4	101	11.2	8.
Bottom	22 VII 75	1	17	-	-	-	-	-	-	24.6	6.0	25.3	76	8.6	8.
	25 VIII 75	1	17	-19.9	2.4	20.1	277	3.5	4.7	26.3	-0.1	26.3	90	7.1	7.
	26 VIII 75	2	17	-20.9	5.7	21.7	285	4.0	5.0	25.4	1.8	25.5	86	6.9	7.
On top spoil mound	9 VII 75	1*		-	-	-	-	-	-	34.3	-6.1	34.8	100	3.9	3
	17 VII 75	1*		-	-	-	-	-	-	35.6	-5.6	36.0	99	3.0	2

*Incomplete cycle
1 - cm/sec
2 - circular degrees relative to geographic north
3 - kilometers
4 - hours
5 - meters

Table 6 : The maximum observed speeds over 15 minute averages.

		Flood		Ebb	
		R(cm/sec)	θ(°T)	R(cm/sec)	θ(°T)
22 VII 75	Surface			76.5	99
	Mid-depth			66.5	86
	Bottom			48.9	90
25VIII 75	Surface	37.1	290	77.5	72
	Mid-depth	44.3	304	71.9	99
	Bottom	33.1	272	44.0	99
26VIII 75	Surface	25.0	300	70.7	99
	Mid-depth	40.2	303	66.7	118
	Bottom	38.0	266	41.9	102

Table 7 : Average velocities for flood and ebb tidal cycles calculated from the half-tidal cycle data, 25, 26 August, 1975

	Flood		Ebb	
Depth	R(cm/sec)	θ(°T)	R(cm/sec)	θ(°T)
Surface	19.4	304	34.2	102
Mid-depth	25.8	313	36.7	101
Bottom	20.8	281	25.9	88

Table 8 : Average effective distances and duration calculated from the half-tidal cycle data, 25, 26 August, 1975

	Flood		Ebb	
Depth	$\overline{D}$(km)	$\overline{t}$(Hrs)	$\overline{D}$(km)	$\overline{t}$(hrs)
Surface	2.4	3.3	12.0	8.8
Mid-depth	3.7	3.8	11.4	8.0
Bottom	3.8	4.8	7.0	7.2

Table 9 : The net tidal cycle flow for each depth from the average velocities, 25, 26 August, 1975

Depth	R(cm/sec)	θ(°T)
Surface	17.8	78
Mid-depth	20.1	59
Bottom	7.3	48

Table 10 : Observed values of temperature, salinity, and resultant σ_t as a function of depth while following the surface drogue, 16 September 1975

	1120 hours			1220 hours				1325 hours				1430 hours			
(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t
0	18.1	30.64	21.94	0	18.0	30.72	22.03	0	18.2	30.62	21.90	0	18.3	30.62	21.88
5	17.8	30.83	22.16	5	18.0	30.79	22.08	5	18.1	30.70	21.99	5	18.1	30.65	21.95
10	17.6	31.02	22.35	10	17.9	30.85	22.15	10	17.8	30.77	22.11	10	18.0	30.69	22.00
14	17.4	31.16	22.50	14	17.6	30.91	22.26	11	17.7	30.79	22.15	11	17.9	30.69	22.03

	1525 hours			1625 hours			
(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t
0	18.3	30.62	21.88	0	18.3	30.60	21.86
5	18.1	30.67	21.96	5	18.0	30.69	22.00
10	18.0	30.72	22.03	10	17.8	30.79	22.13
13	17.9	30.75	22.07	11	17.7	30.81	22.17

(1) Depth - meters
(2) Temperature - °C
(3) σ_t - gm/cm^3

Table 11 : Observed values of temperature, salinity, and resultant σ_t as a function of depth while following the bottom drogue, 16 September 1975.

	1120 hours			1215 hours				1315 hours				1415 hours			
(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t
0	18.0	30.64	21.96	0	18.2	30.61	21.89	0	18.1	30.62	21.92	0	18.2	30.66	21.93
5	17.8	30.88	22.19	5	17.9	30.82	22.13	5	17.9	30.73	22.06	5	18.1	30.72	22.00
10	17.5	31.11	22.44	10	17.5	31.04	22.39	10	17.8	30.84	22.16	10	17.9	30.79	22.10
14	17.3	31.30	22.63	14	17.4	31.21	22.54	14	17.7	30.92	22.25	14	17.7	30.84	22.19

	1515 hours			1615 hours				1705 hours			
(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t	(1) Z	(2) T	S°/oo	(3) σ_t
0	18.1	30.67	21.96	0	18.2	30.53	21.83	0	18.2	30.56	21.86
5	17.9	30.72	22.05	5	18.1	30.63	21.93	5	18.0	30.64	21.96
10	17.8	30.77	22.11	10	17.9	30.72	22.05	10	17.9	30.71	22.04
12	17.7	30.79	22.15	14	17.8	30.80	22.13	14	17.8	30.77	22.11

(1) Depth - meters
(2) Temperature - °C
(3) σ_t - gm/cm^3

Table 12 : Beam transmittance (T) and attenuation coefficient (β) as a function of depth while following bottom drogue on 16 September 1975.

Distance	0 km		1.8 km		2.8 km		3.3 km		3.4 km		2.6 km		1.6 km	
Time	1120 hours		1215 hours		1315 hours		1415 hours		1515 hours		1615 hours		1705 hou	
Depth (m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(1/m)	T(%)	β(
1	86	1.51	84	1.74	84	1.74	82	1.98	82	1.98	82	1.98	81	2
5	84	1.74	83	1.86	84	1.74	80	2.23	82	1.98	82	1.98	80	2
10	84	1.74	82	1.98	83	1.86	81	2.11	82	1.98	83	1.86	81	2
14	84	1.74	84	1.74	84	1.74	80	2.23	-	-	83	1.86	83	1
15	82	1.98	84	1.74	84	1.74	79	2.36	-	-	-	-	82	1

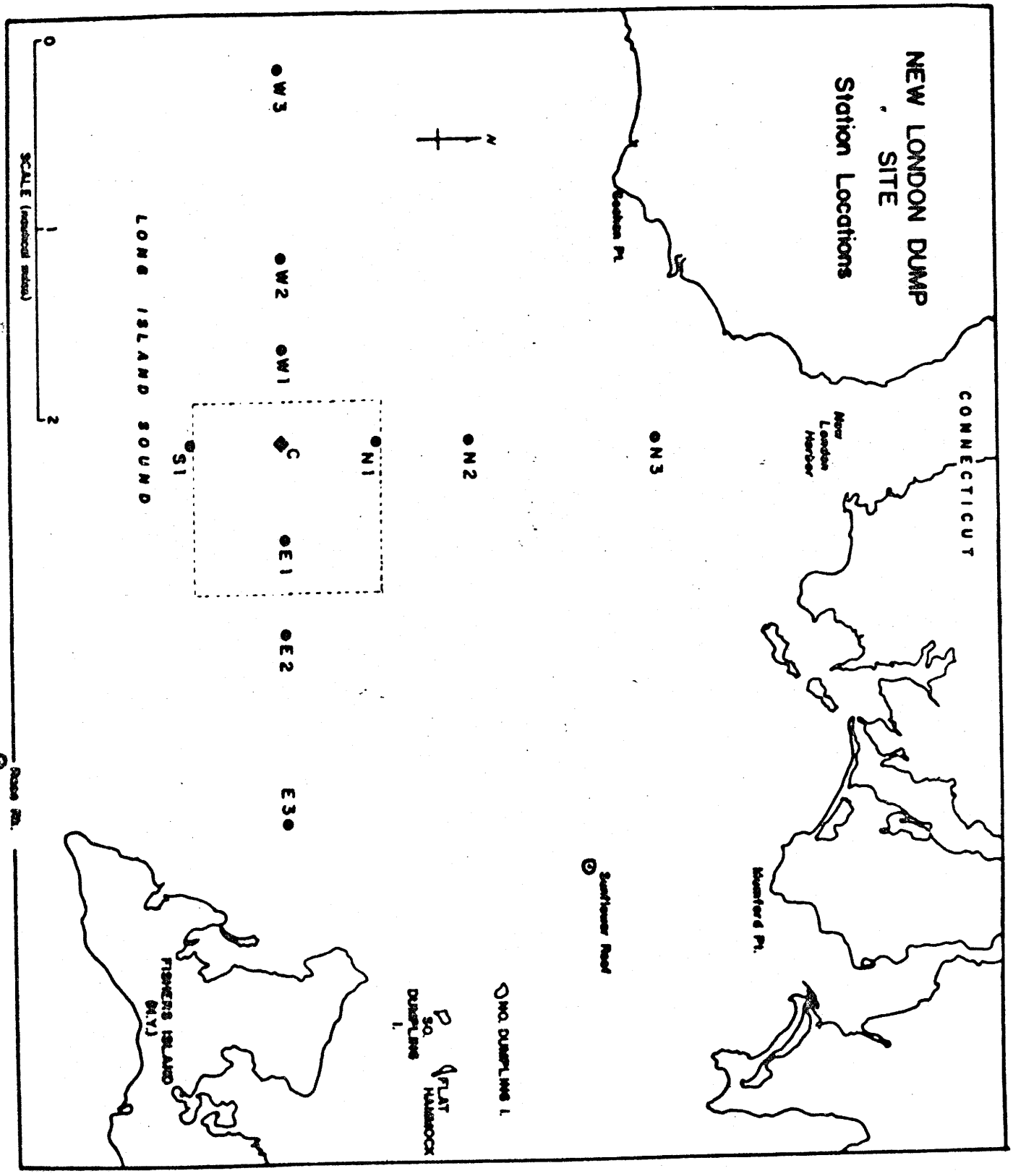


Figure 1. Map of Dump Site (dotted square) and Station Locations

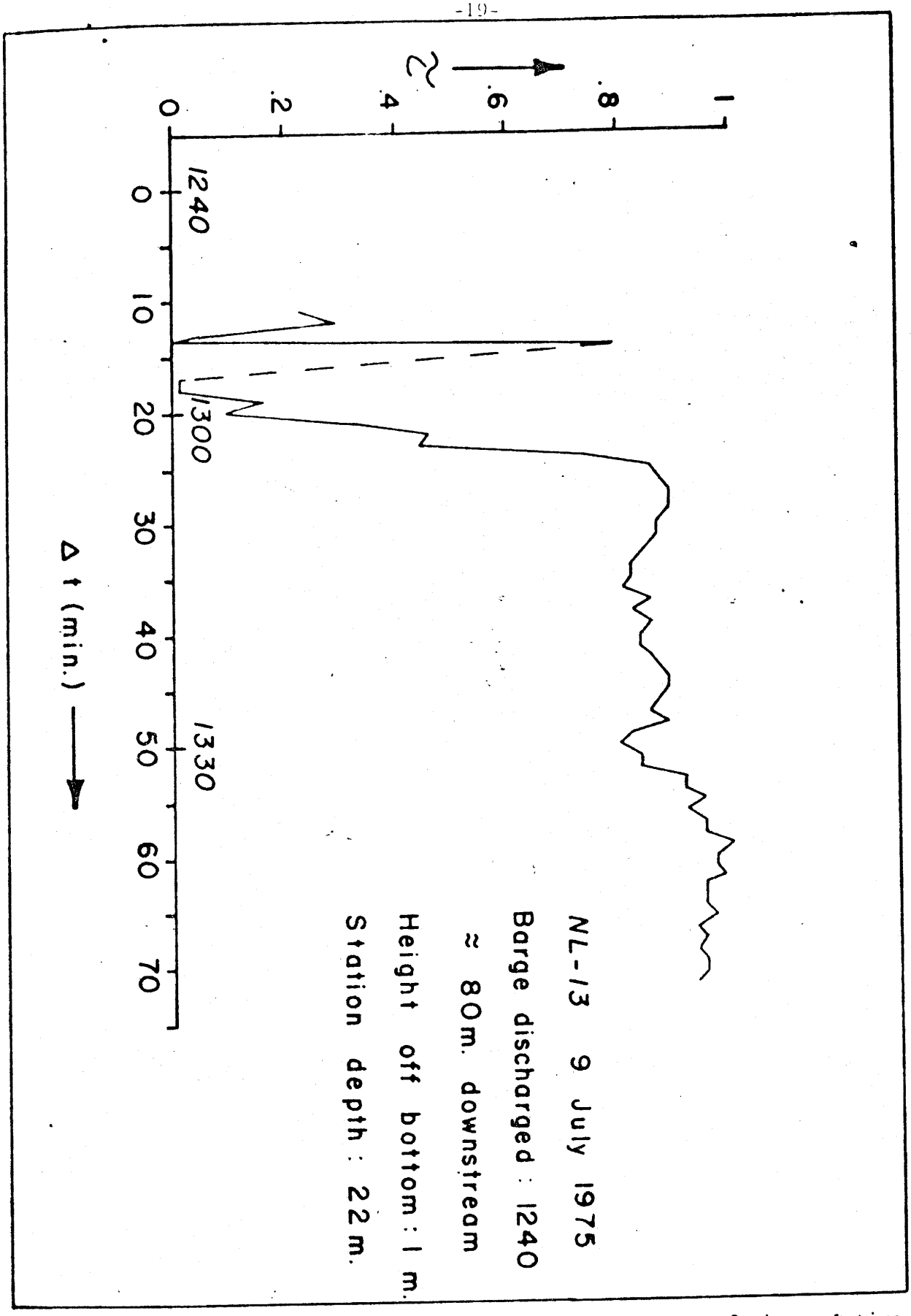


Figure 2: Normalized transmissometer results as a function of time relative to a barge discharge approximately 80 meters upstream on 9 July 1975.

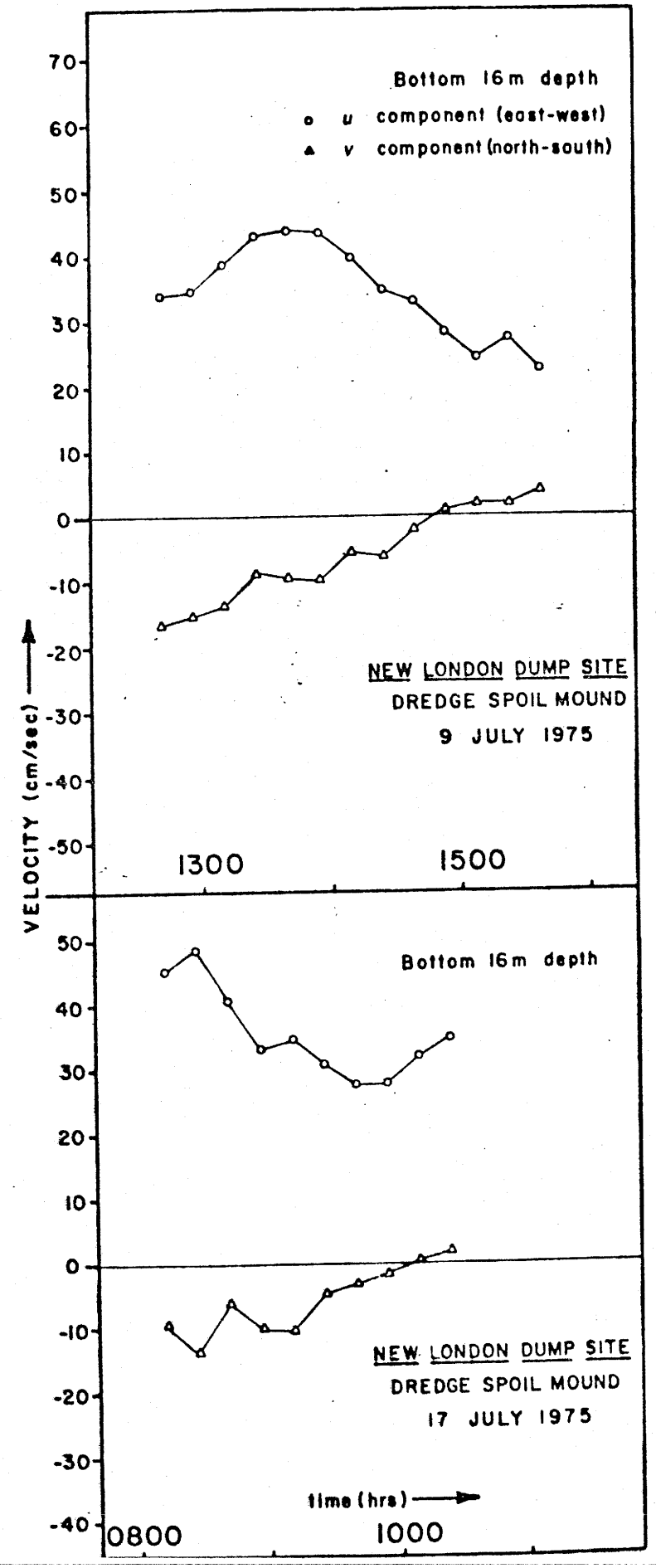


Figure 3 : Vector components of the bottom flow on top of the dredge spoil mound on 9 July 1975, upper figure, and 17 July 1975, lower figure.

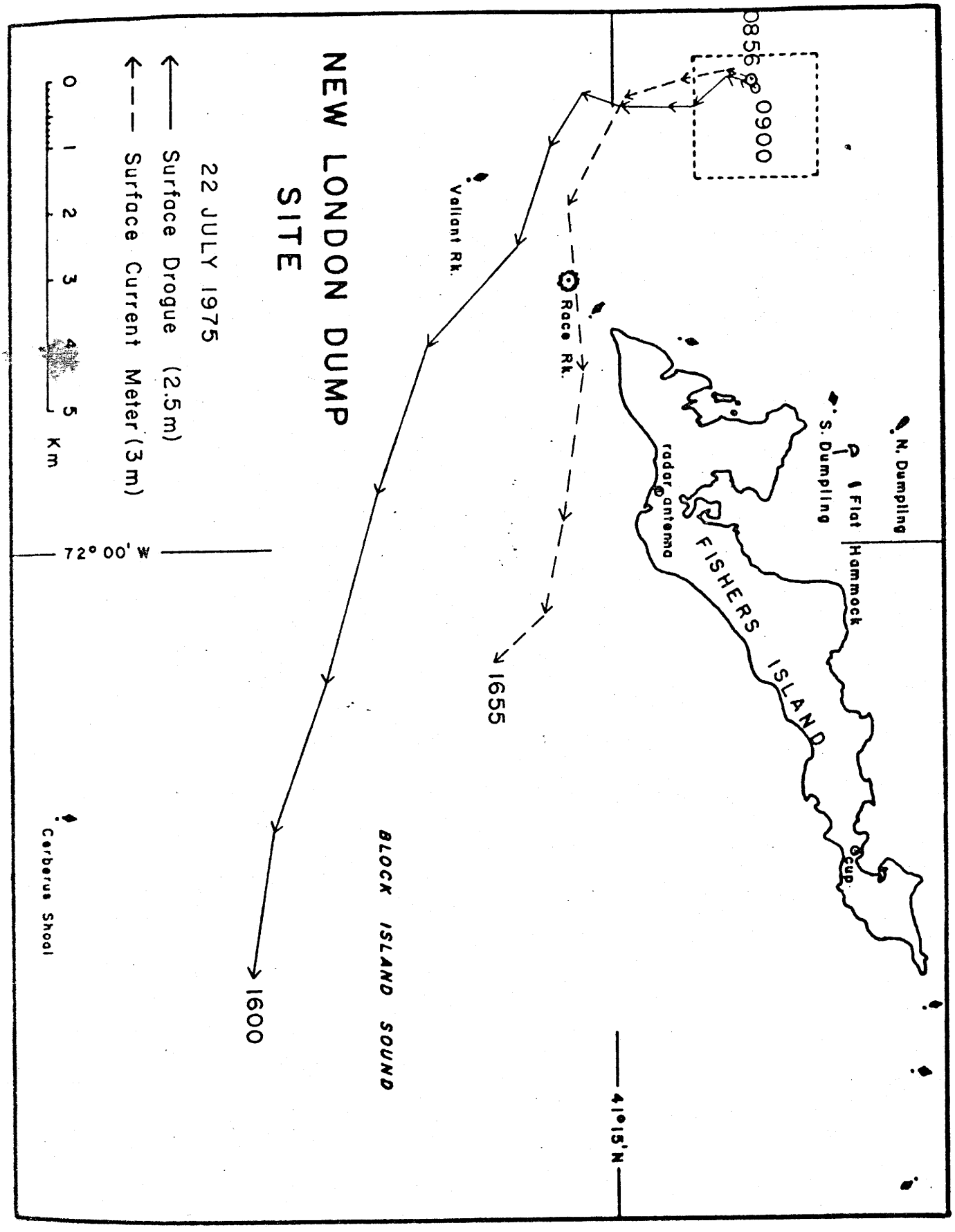


Figure 4: Displacement diagram for the surface drogue and corresponding progressive vector current meter observations, 22 July 1975

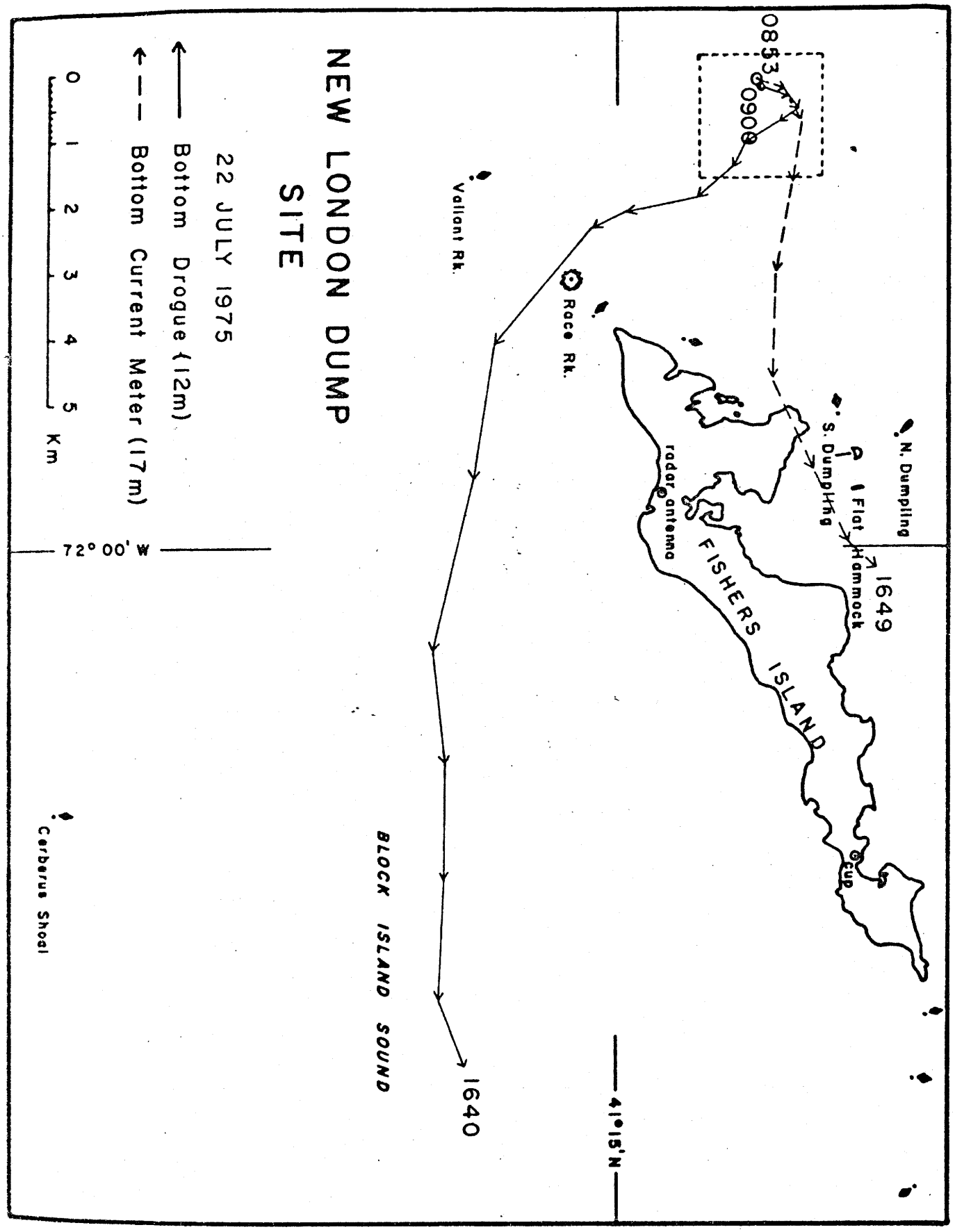
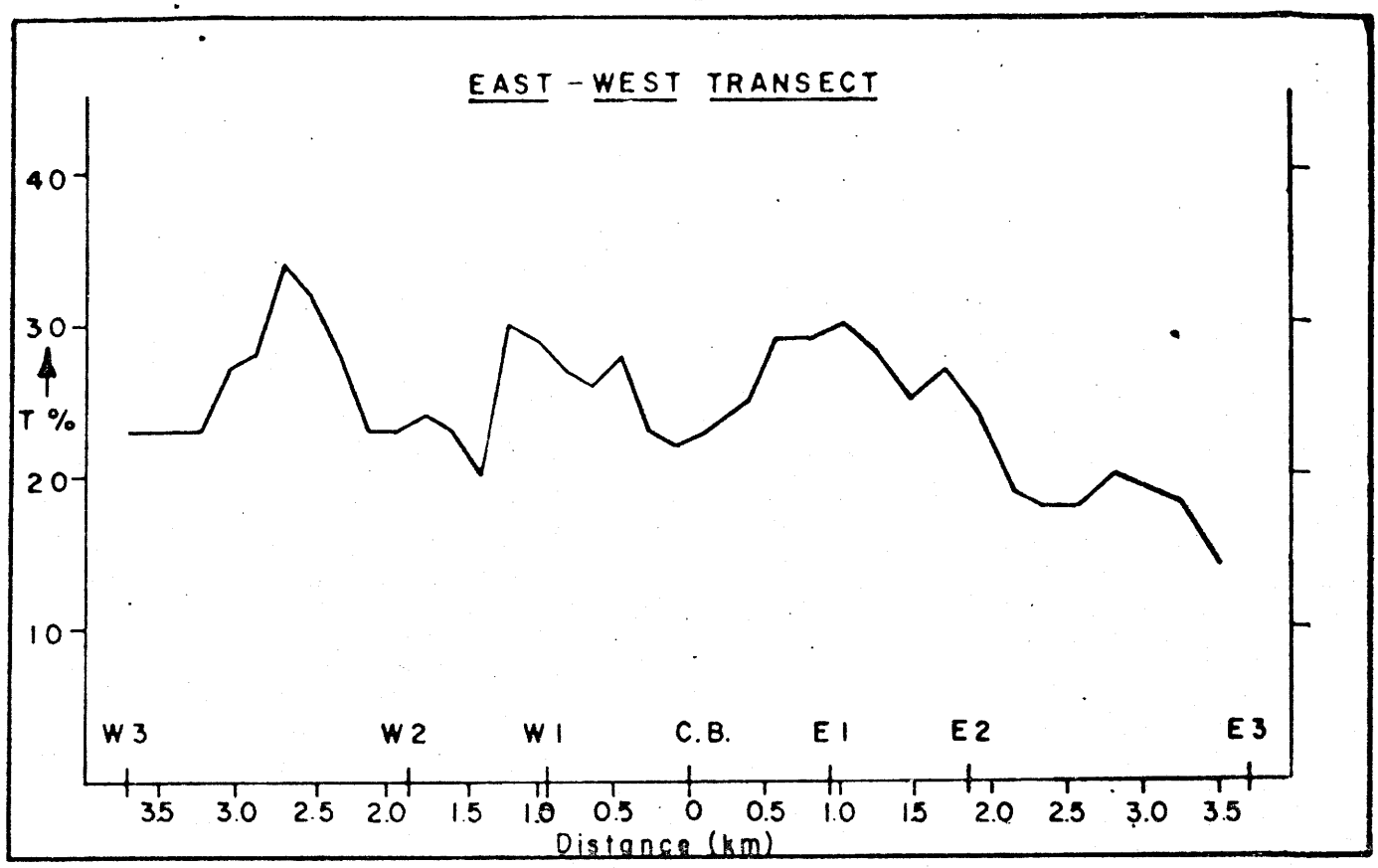


Figure 5: Displacement diagram for the bottom drogue (12m depth) and corresponding progressive vector diagram based on current meter observations



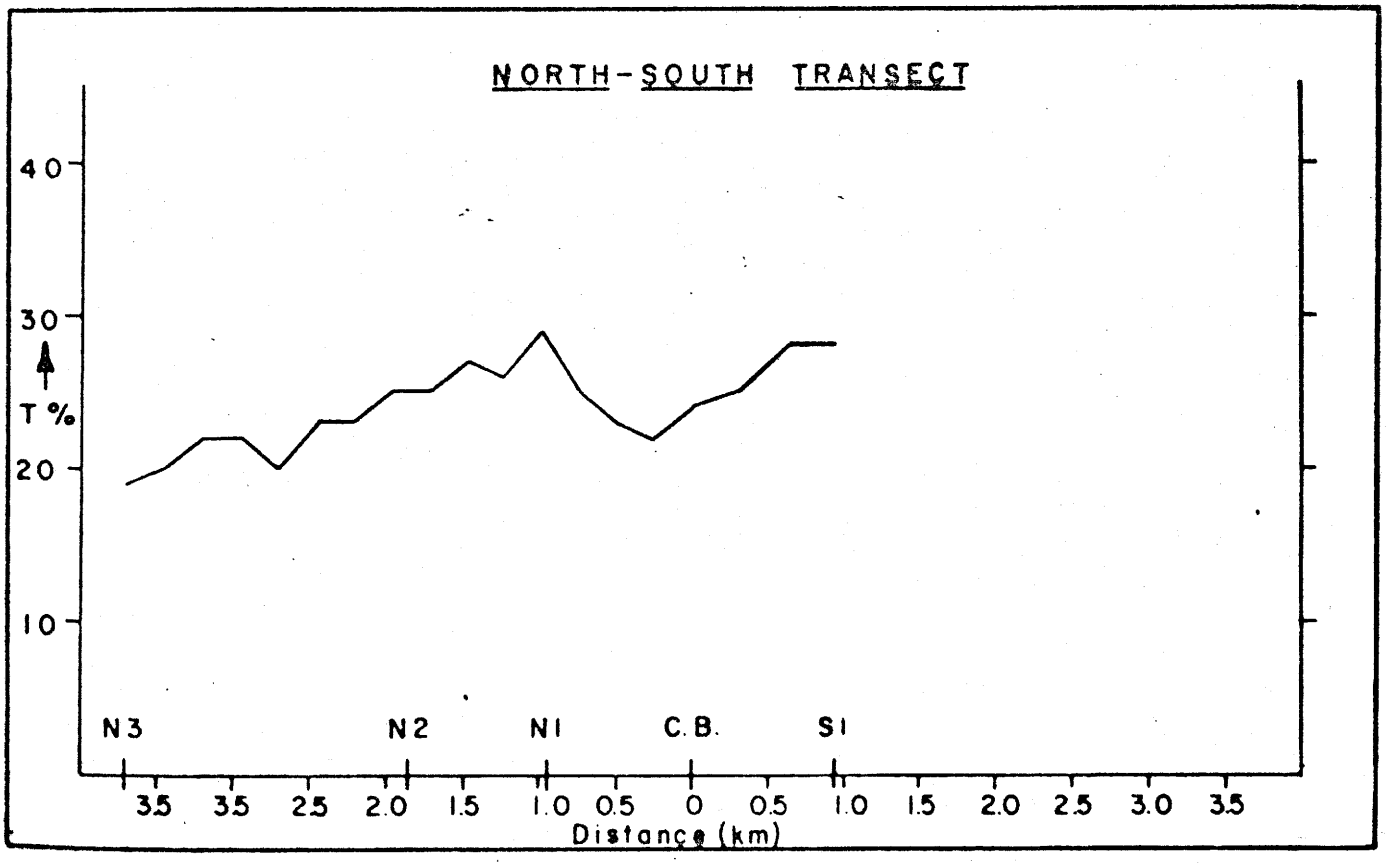


Figure 6: Lateral transmissometer profiles using a 1 meter light path towed at a depth between 9 and 10 meters on the East-West transect between Stations W3 and E3 and towed at a depth between 6.5 to 10 meters on the North-South transect between Stations N3 and S1, on 25 August 1975.

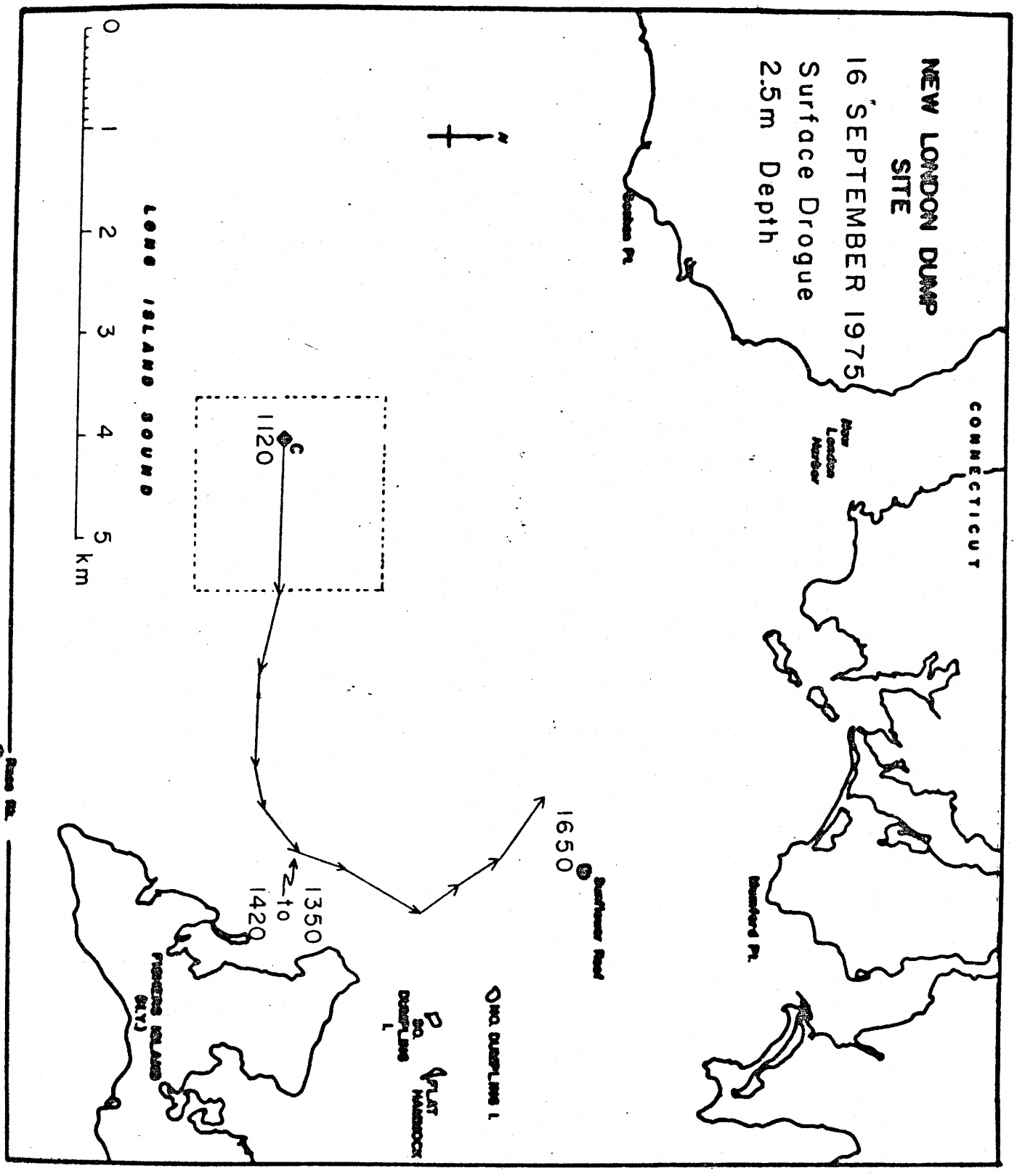


Figure 7: Displacement diagram for the surface drogue launched at maximum ebb on 16 September 1975.

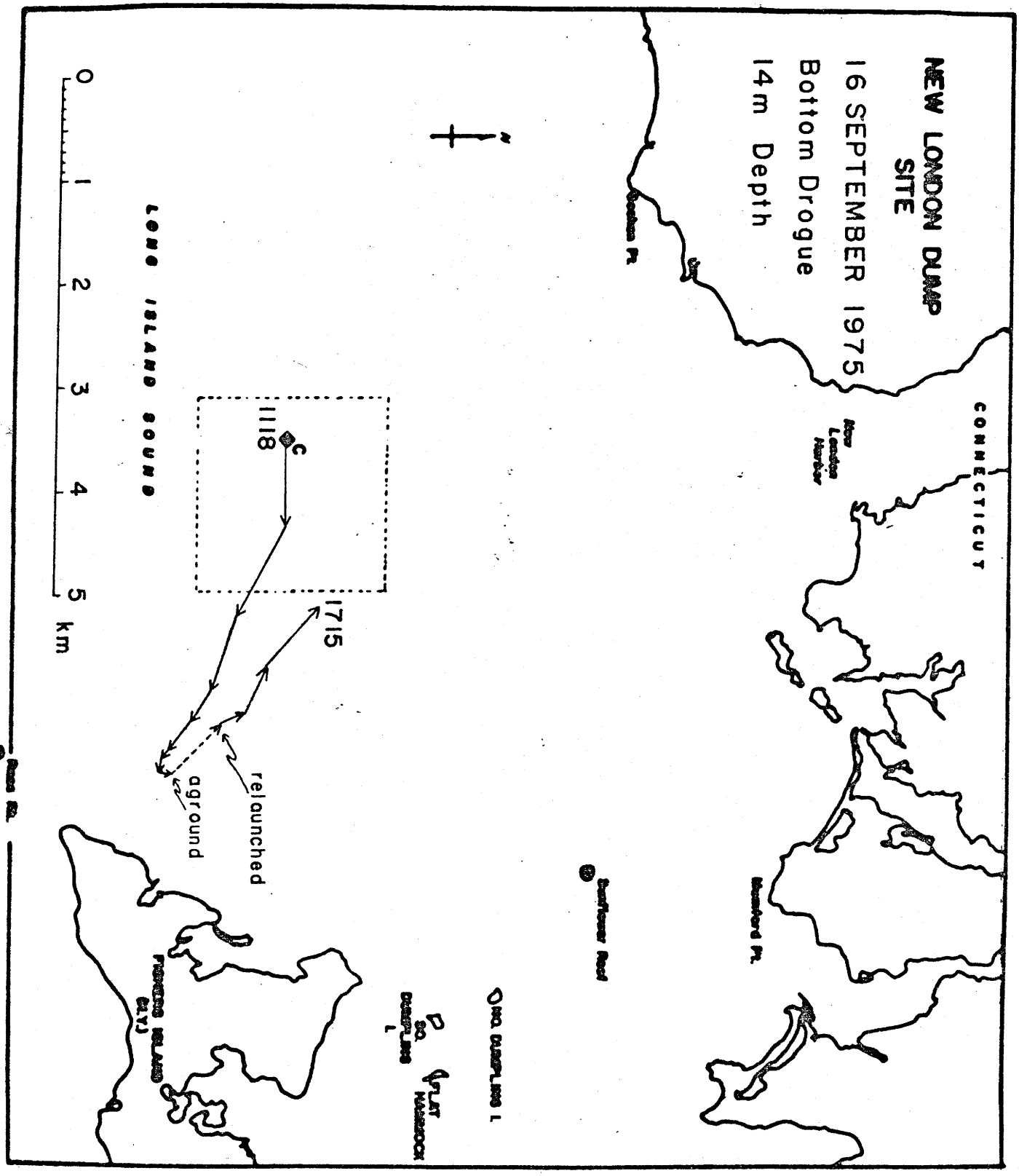


Figure 8: Displacement diagram for the bottom drogue (14m depth) launched at maximum ebb on 16 September 1975.

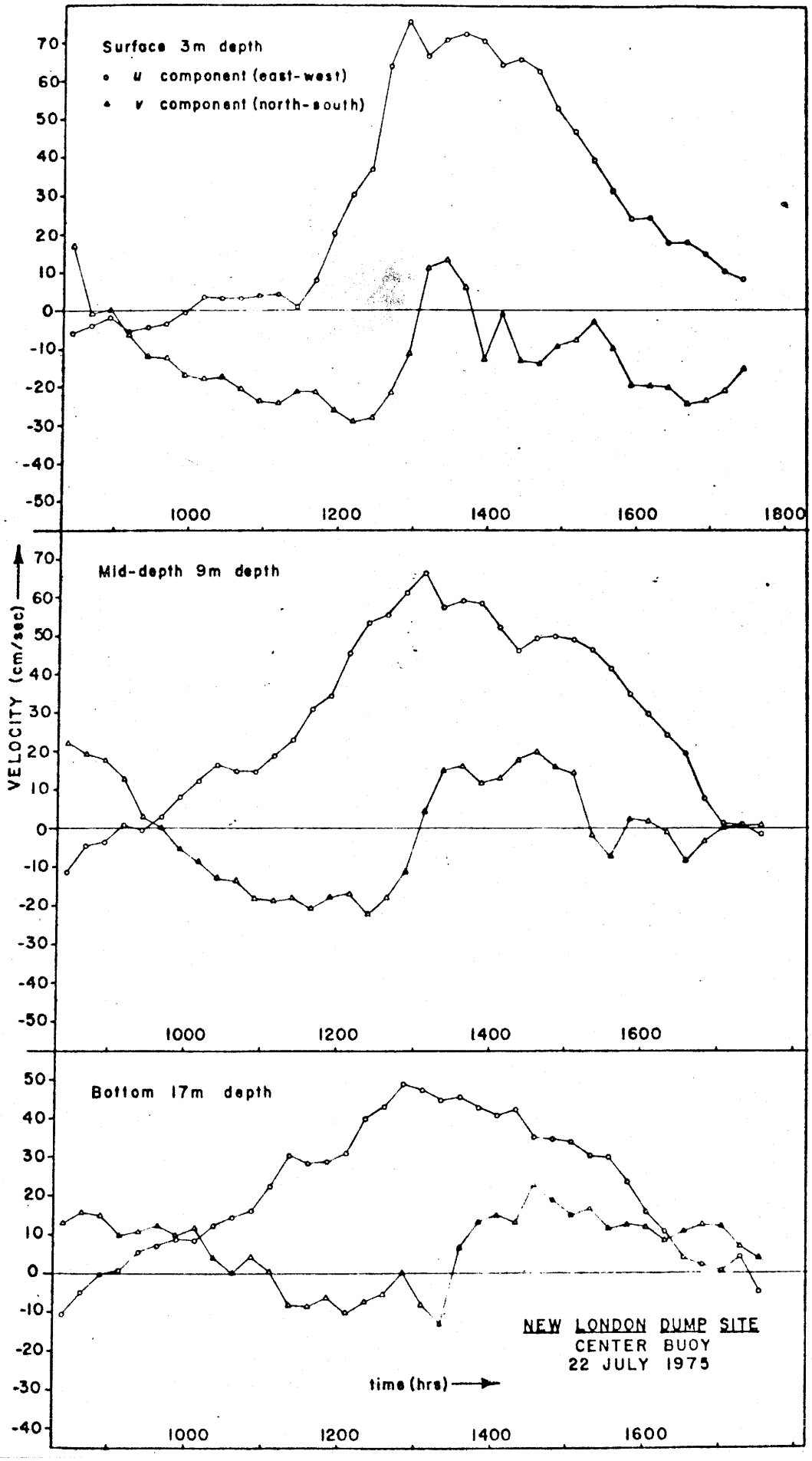


Figure 9: Current meter results for 22 July 1975

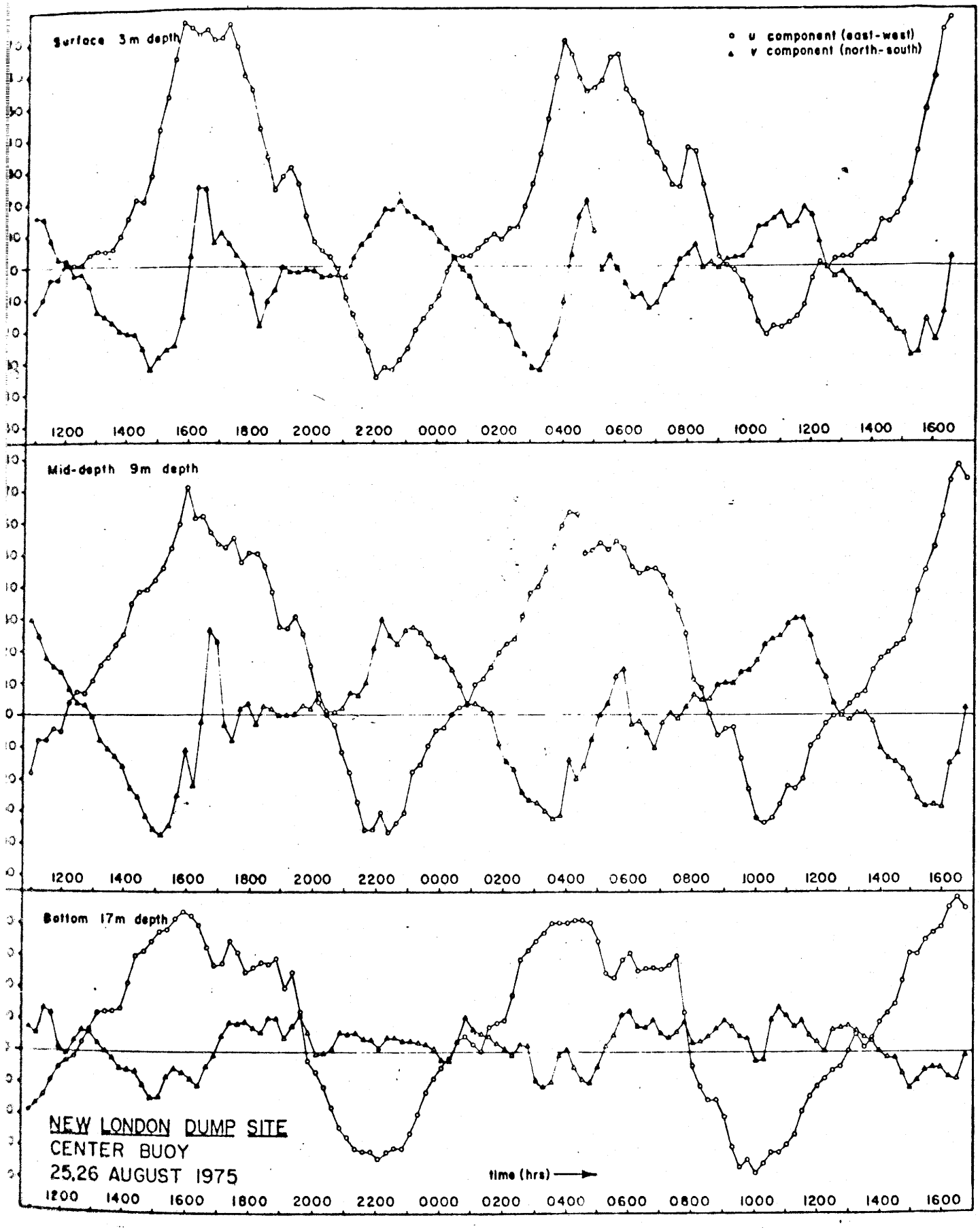


Figure [illegible] Current meter results from 25 and 26 August 1975

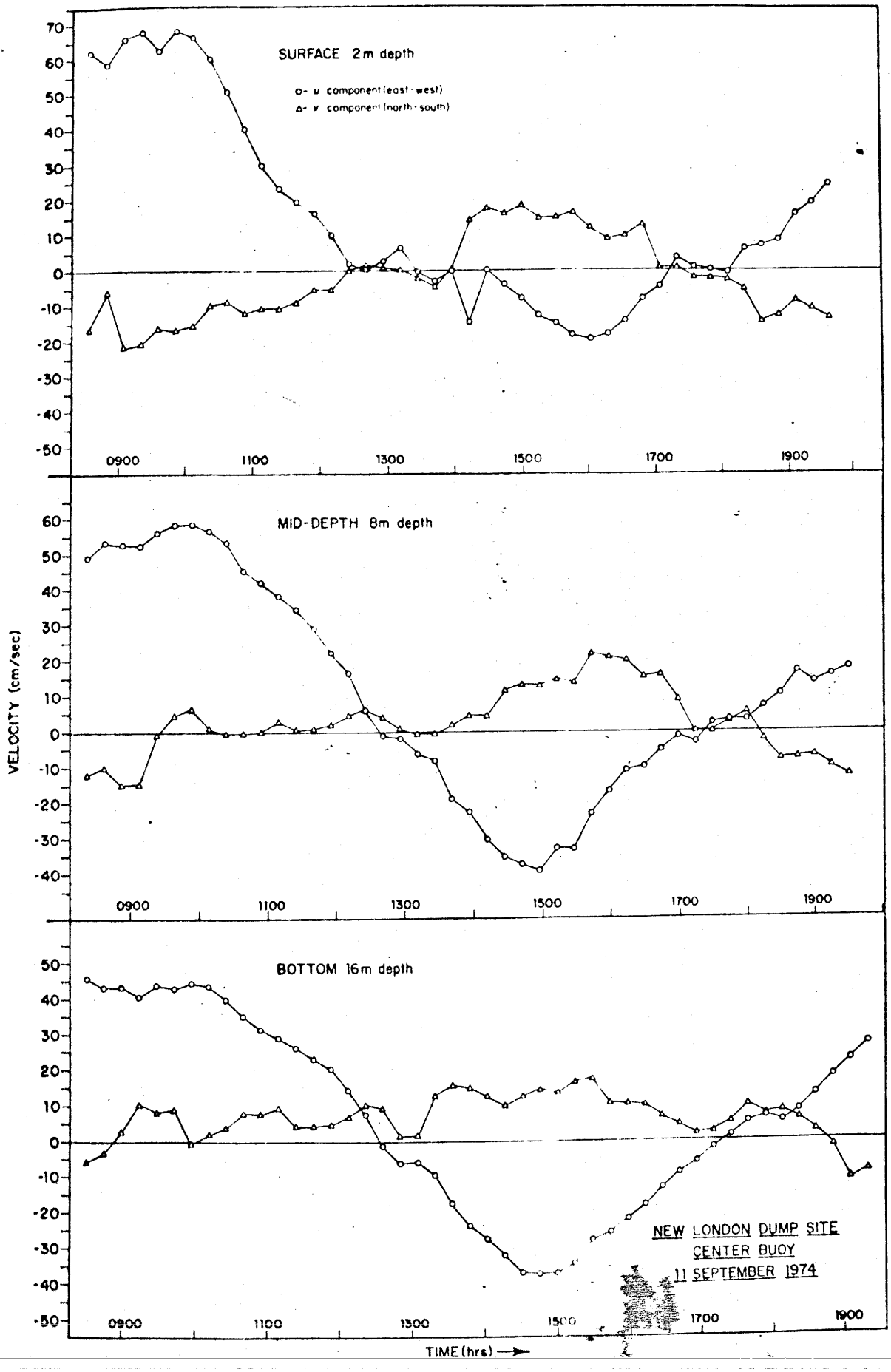


Figure 11: Current meter results for 11 September 1975.

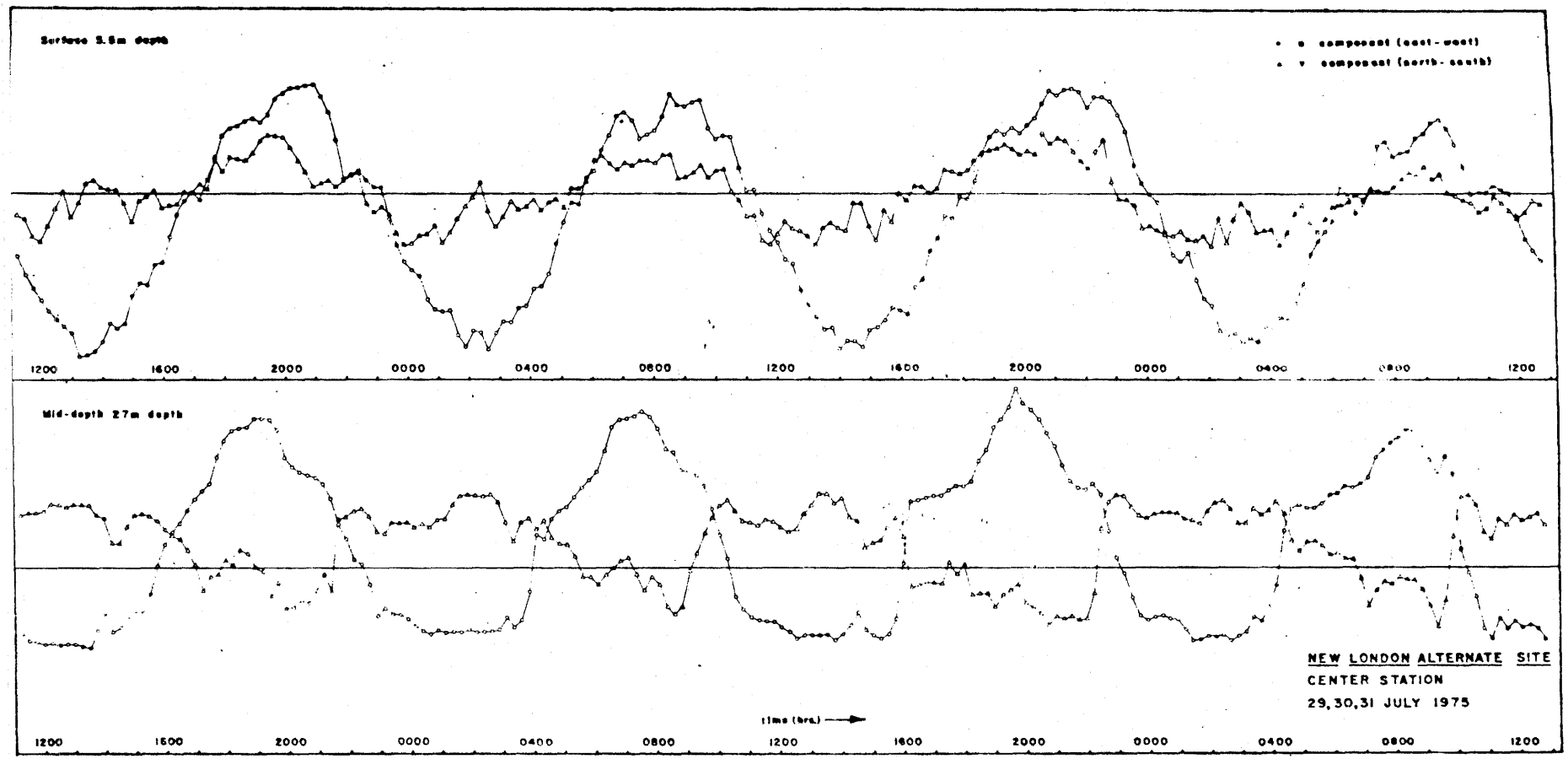


Figure 12: Current meter results for the Alternate Dump Site ("East Hole") in Block Island Sound during 29, 30, 31 July 1975.

APPENDIX D

QUARTERLY REPORT

Chemical Oceanography

of the

New London Dumpsite Area

July through September, 1975

Submitted to

Sandy Hook Laboratory

Middle Atlantic Coastal Fisheries Center

National Marine Fisheries Service

NOAA/U.S. Dept. of Commerce

Contract No. 03-5-043-303

by

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INTRODUCTION

Previous reports have presented the rationale behind these studies. We present in this report the result of the quarterly areal study of the New London Dump and a study of the Alternate Dump Site for the dumping of dredged material.

During this quarter, three cruises were undertaken. On 26 August a tidal cycle cruise was made to determine if dumped material is being resuspended into the water column. On 17 September a cruise was made in which water movement was studied by drogue experiments. This experiment was designed to determine if there was any significant increase in the quantity of suspended material as a given water mass passed over the dump area.

Also presented in this report are results of the heavy metal analysis of the sediments collected at the dumpsite in July, 1975. In July, 1975 the dumping of dredged spoils from the Thames River was halted, but other permits are still in existence for the dump site. On 30 July, 1975, a dump was made while sampling was being conducted. The nature of the dumped material is unknown.

METHODS

Detailed descriptions of field and laboratory procedures employed for the collection, on board processing and subsequent laboratory analysis, are contained in our October through December 1974 Quarterly Report.

All sampling efforts required for our tidal studies were completed in

this quarter. However, seston analysis is not yet available.

Station locations for the water column are shown in Fig. 1. The drogue studies are shown in Figs. 2 and 3. Sediment locations are shown in Fig. 15.

During the last three quarters sufficient data have been collected to allow us to estimate 95% confidence intervals for the various water column parameters. These are presented in Table 1.

Table 1: 95% Confidence Interval - Water Column Parameters

Parameter	O_2	pH	Eh	Susp. Solids	Volatiles
95% Confidence Interval	±1%	±0.024	±10 MV	±0.7 mg/ℓ	±5%

RESULTS

A. Water

The results of the areal survey conducted 26 August 1975 and the drogue study conducted on 17 September, 1975, are given in Figures 4 through 14.

Dissolved oxygen (reported in percent saturation) is fairly uniform, ranging from 68-86% on the areal survey (Fig. 4) and 67-81% on the drogue study (Figs. 5 and 6). The only exception was the N3 stations on the areal survey when the bottom sample was 23% saturation.

pH - The pH ranged from 7.30 to 8.16 on 26 August 1975 (Fig. 7) except for the mid-depth sample at the Center Buoy which was 6.87. This low reading may be due to the dump as sampling commenced shortly after it.

Eh - The Eh (Fig. 8) appears to be fairly uniform on all transects excluding the East. This may be due to the effect of the tidal cycle, however, not enough information is presently available to verify this.

Suspended Solids - The concentrations for suspended solids (Fig. 9) for the areal survey average 2.25 and on the drogue studies (Figs. 10 and 11) 1.76. Both studies show the values to be similar to those of July through September, 1974. There is no evidence in this quarter's study of significant resuspension.

Volatile Solids (percent of total solids) - For the areal survey (Fig. 12) the average was 18%, the drogue studies (Fig. 13 and 14) averaged a little higher, 26%. Both studies values are similar to those values reported before the release of dredged material. Again, there is no evidence of any significant resuspension of suspended material.

B. Sediments

Chemical Oxygen Demand - Table 2 lists the COD of the composited sediments of July, 1975. Variations occur in a random manner with the higher values generally occurring toward the center of the dump area.

Metals - Table 2 lists the acid soluble metals present in the sediments

of July, 1975. The values of July, 1975 were similar to those values of the sediments collected in January, 1975, and slightly higher than those of May, 1975.

Although variations occur, higher concentrations are seen as the Center Buoy is approached. The variations occur in a random manner, however.

In conclusion, very little variation in data is apparent, using the available data, between the July 1974 data and this quarter's data. We cannot find any major change in the water column or sediments that can be attributed to the dumping in this area.

Alternate Site

INTRODUCTION

On 30 July, 1975, a cruise was made to the Alternate Dump Site for dredged materials. All water parameters were monitored. As this was our only cruise to this site, we will report this as a baseline study.

METHODS

The methods used here are the same as those previously cited in our October through December, 1974 Quarterly Report of the New London Dump Site area.

Station locations are shown in Fig. 16.

RESULTS

Water

The results of the Alternate site survey are given in Table 3.

Dissolved Oxygen - Throughout this area, no significant differences between the stations were found. The concentrations ranged between 75 and 94% of saturation.

pH - The pH of the area waters ranged between 7.91 and 8.40, with the surface waters being slightly more alkaline. The pH showed very little station variation.

Eh - During this sampling period no significant differences were found between stations, with the Eh ranging between 178 and 237.

Suspended Solids - The distribution of suspended solids in this area ranges between 0.8 and 8.1. The CB1-D station reading of 8.9 was the highest reading and 3.2 above the next highest reading. This difference is probably due to contamination of the sample as the bottom Niskin bottles hit at this station. The relative variation between stations was minimal and the average suspension was 2.1

Volatile Solids - The overall average concentration of volatile material for this site was 27 percent of the total amount of suspended material present. The variation between stations again was minimal, the concentration of material ranging between 10 and 61 percent.

Table 2. Acid soluble metals and chemical oxygen demand
New London Dump sediments, June - July, 1975

	Cd	Cu	Fe	Hg	Ni	Pb	Zn	C.O.D.
	(←			(mg/kg)			→)	(mg O/kg)
Min. Detect.	2	2	3	.02	9	20	2	-
95% Confidence Interval	±1.4	±6.3	±1.6x10^3	±.09	±2.7	±10	±13.4	540
A1	↑	5	9.8	.05	<9	<20	52	2300
A2	↑	9	8.5	.05	<9	<20	50	15600
A3	<2	28	13.3	<.02	13	29	76	37700
A4	↑	15	8.8	.03	<9	<20	[illegible]	28300
A5	↓	21	14.9	<.02	18	<20	60	38800
A7	7	56	18.5	<.02	19	16	123	[illegible]
A8	↑	40	9.2	.04	[illegible]	<20	60	[illegible]
A9	<2	12	8.0	.03	<9	<20	44	16800
A10	↓	6	5.9	.03	↓	<20	32	9600
B1	↑	15	10.0	.07	↑	↑	51	13100
B2	<2	11	7.7	.05	<9	<20	46	11700
B3	↓	14	8.2	.05	↓	↓	50	16400
C1	↑	12	6.7	<.02	↑	↑	36	19700
C2	<2	7	5.6	-	<9	↑	22	4300
C3	↓	10	13.1	.05	↓	↑	50	11000
C4	11	21	8.5	.04	10	<20	51	21600
C5	<2	19	10.0	<.02	10	↑	54	24000
C6	2	14	17.3	<.02	<9	↑	50	41700
C7	<2	21	15.4	<.02	<9	↓	63	40000
D1	↑	17	10.4	.04	10	↑	141	27000
D2	<2	8	5.6	.09	<9	<20	31	11000
D3	↓	11	18.4	.09	<9	↓	65	12300
E2	↑	3	3.2	.02	↑	<20	17	4400
E3	↑	16	8.7	.04	↑	<20	63	18300
E4	<2	15	10.0	<.02	↑	<20	56	24400
E5	↑	16	8.8	.06	<9	36	54	20200
E7	↑	14	11.5	.08	↑	29	58	40500
E8	↓	20	7.9	<.02	↓	<20	84	24700

Table 2 (cont.)

	Cd	Cu	Fe	Hg	Ni	Pb	Zn	C.O.D.
	(←	----------	----------	(mg/kg)	----------	----------	----------	→) (mg O/kg)
F3	↑	20	9.3	-	<9	<20	71	17500
F4	<2	14	14.2	<.02	<9	39	69	37600
F5		41	13.5	<.02	12	27	95	45900
F7	↓	20	14.7	<.02	<9	<20	57	35900
ANL1	↑	8	10.7	.03	↑	↑	35	14800
ANL2		10	17.5	.09			50	22600
ANL3	<2	11	13.9	.14	<9	<20	33	12000
ANL4		10	11.4	<.02			46	20000
ANL5		10	11.0	.03			46	21100
ANL6	↓	12	21.0	.02	↓	↓	40	14200

Table 3
New London Dump Study
alternate dump site water quality data

Station	Time (EDT)	Depth z (m)	% O_2 Saturation %	pH	Eh (mv)	Suspended Solids (mg/ℓ)	Volatile Solids (% Total)
CB-1A	0940	0	88	8.09	190	1.2	36
B		13	77	8.04	234	1.6	29
C		33	74	8.00	235	2.0	21
D		53	73	7.96	178	8.1	12
CB2-A	1130	0	90	8.13	228	1.3	47
B		16	82	8.06	229	1.3	29
C		32	75	8.00	228	2.0	15
D		48	74	7.96	229	3.0	14
CB-3A	1320	0	94	8.26	227	1.0	43
B		16	79	8.14	226	1.5	20
C		32	75	8.07	227	2.8	10
D		48	75	8.14	226	3.9	14
N-1A	0955	0	87	8.06	225	1.1	36
B		10	86	8.11	219	0.9	35
C		20	78	8.06	223	1.8	25
D		30	74	8.03	217	3.8	12
N-2A	1145	0	88	8.11	225	0.9	39
B		10	87	8.14	224	0.8	35
C		20	77	8.12	225	1.2	36
D		30	75	8.09	224	2.8	17
N-3A	1335	0	93	8.28	223	1.2	50
B		10	81	8.17	206	1.3	33
C		20	75	8.14	210	1.8	25
D		30	75	8.10	214	3.5	10

Table 3 (cont.)

Station	Time (EDT)	Depth z (m)	% O_2 Saturation %	pH	Eh (mv)	Suspended Solids (mg/ℓ)	Volatile Solids (% Total)
S-1A	1040	0	93	8.09	224	1.1	45
B		15	83	8.00	235	1.3	28
C		30	75	7.91	233	2.2	12
D		45	75	7.95	229	3.1	14
S-2A	1225	0	93	8.20	224	0.9	52
B		15	83	8.13	226	1.4	31
C		30	79	8.08	226	1.8	15
D		45	78	8.10	228	4.9	14
S-3A	1412	0	89	8.36	221	0.8	61
B		15	79	8.25	211	1.4	34
C		30	78	8.26	210	2.2	21
D		45	76	8.23	213	3.4	15
W-1A	1203	0	94	8.18	232	0.9	54
B		15	83	8.08	228	1.4	30
C		30	77	8.06	228	1.8	18
D		45	76	8.00	228	3.5	11
W-2A	1355	0	94	8.40	228	1.1	53
B		16	78	8.28	225	1.4	29
C		32	75	8.22	223	1.7	19
D		48	75	8.21	223	4.9	15
E-1A	1015	0	88	8.17	237	1.3	43
B		11	83	8.11	232	1.2	23
C		29	75	7.99	228	1.9	14
D		47	74	7.93	226	4.6	13

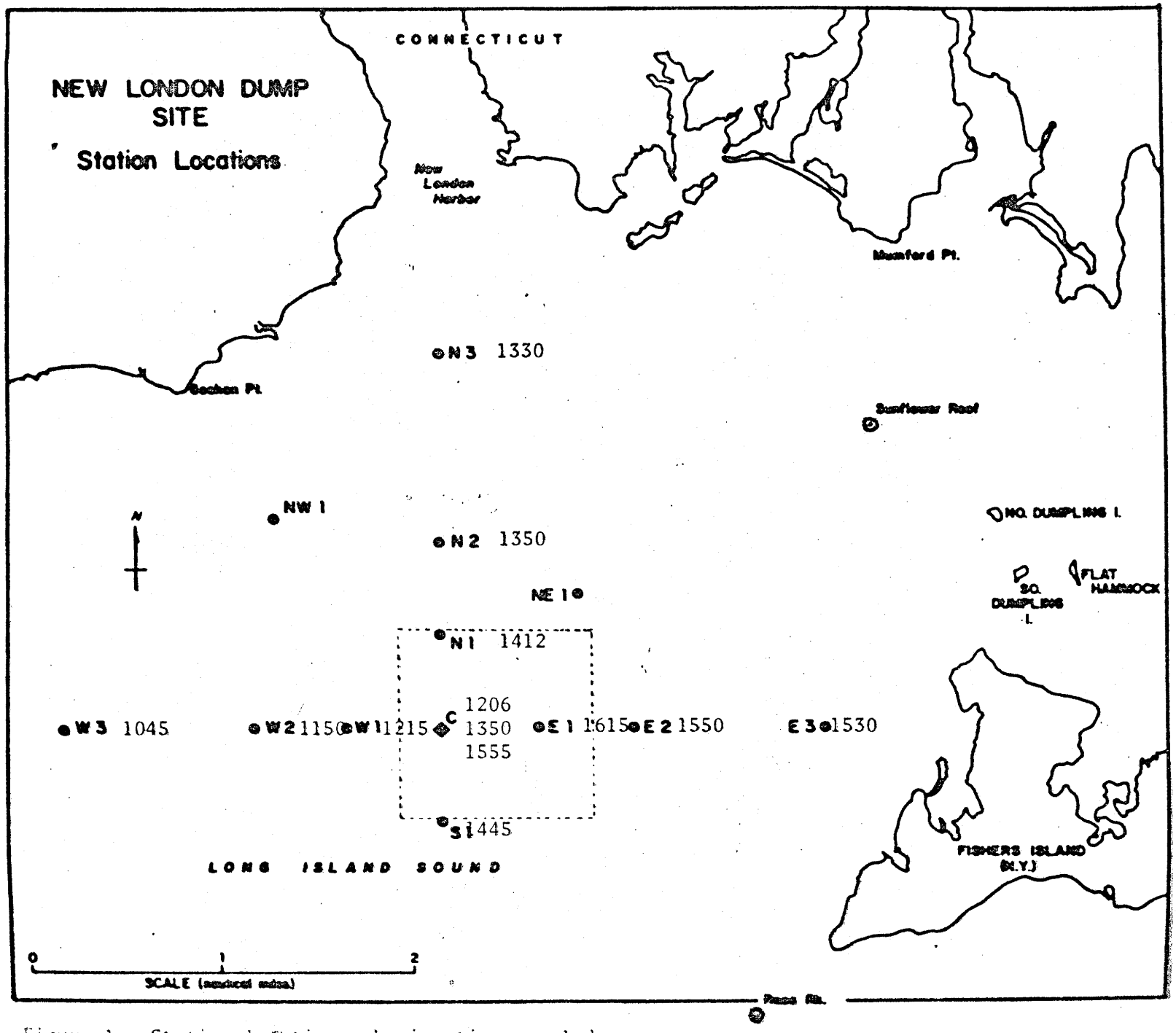


Figure 1: Station locations showing time sampled.

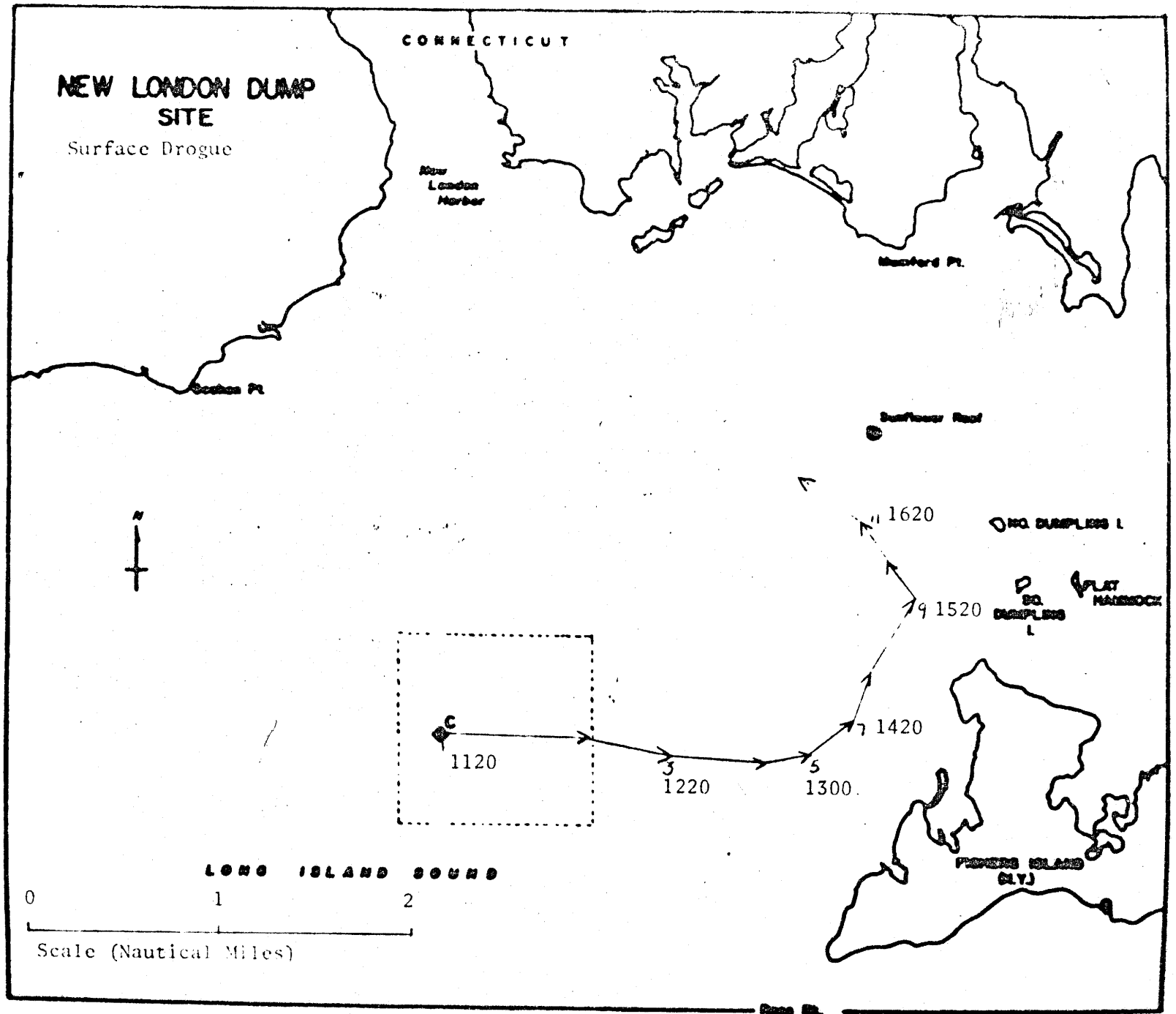


Figure 2. Surface drogue station locations showing time sampled

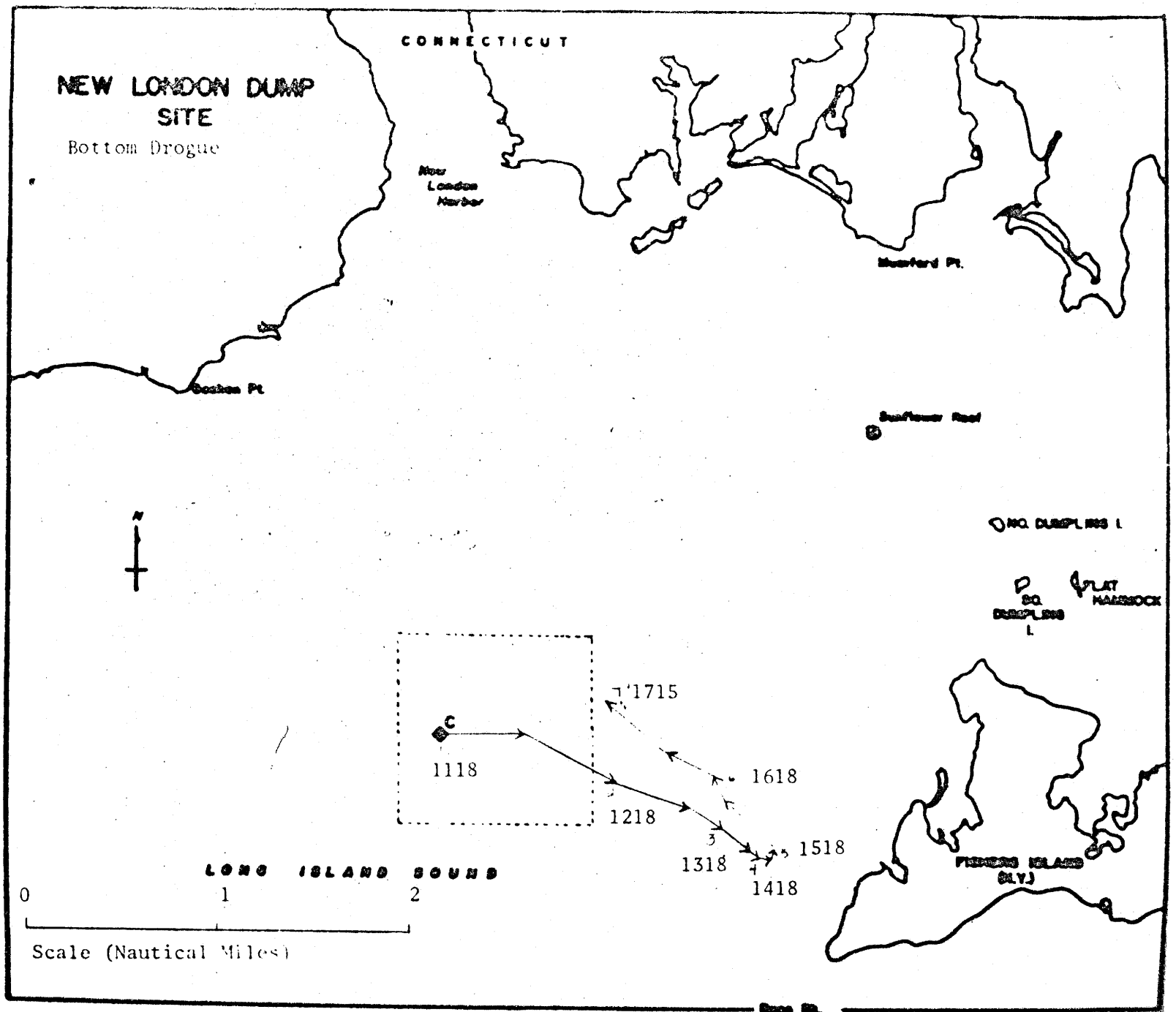


Figure 3: Bottom drogue station locations showing time samples.

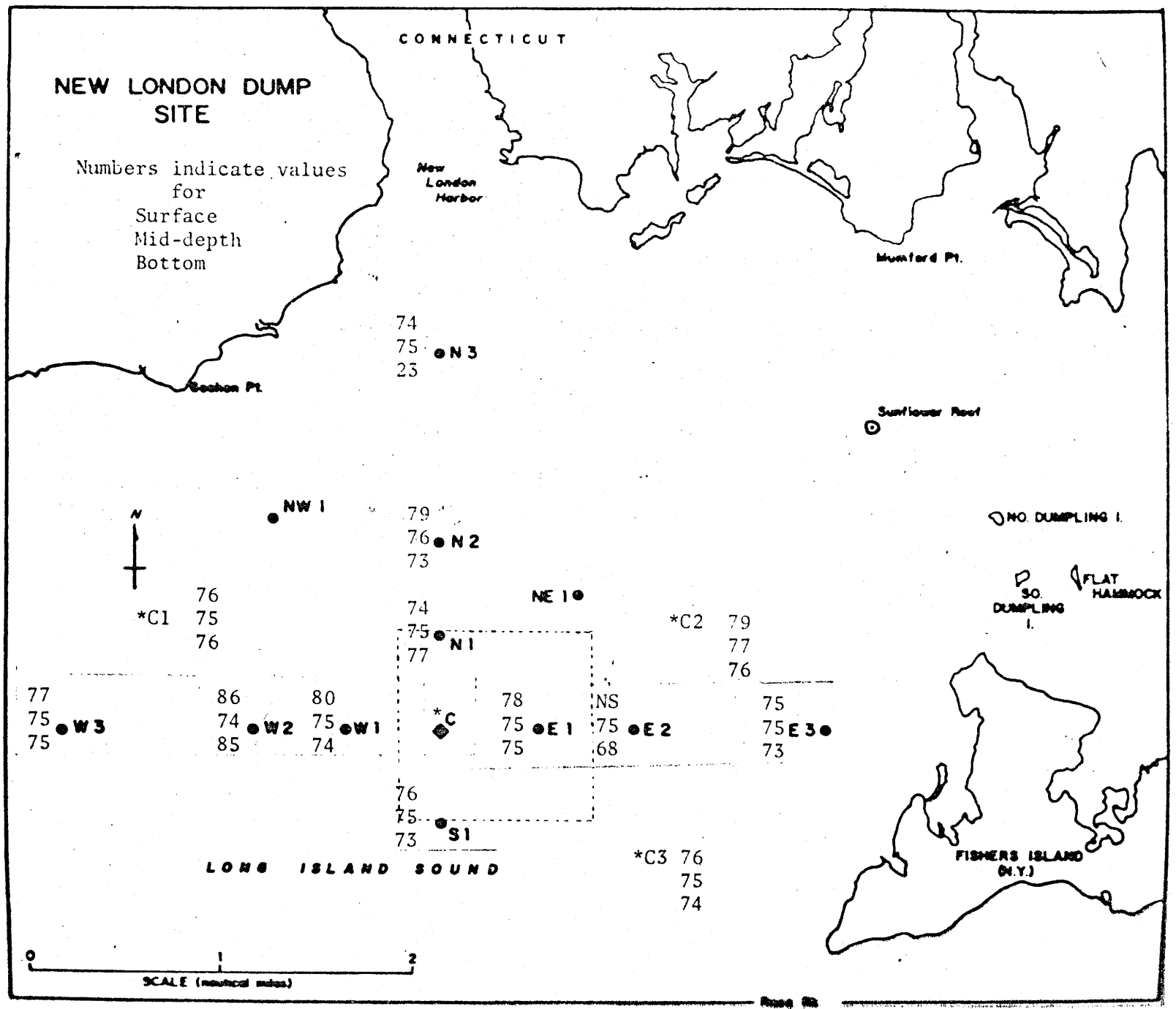


Figure 4. The distribution of dissolved oxygen (percent saturation), 26 August, 1974. *C1, C2 and C3 were sampled concurrently with the W, N-S, and E transects respectively.

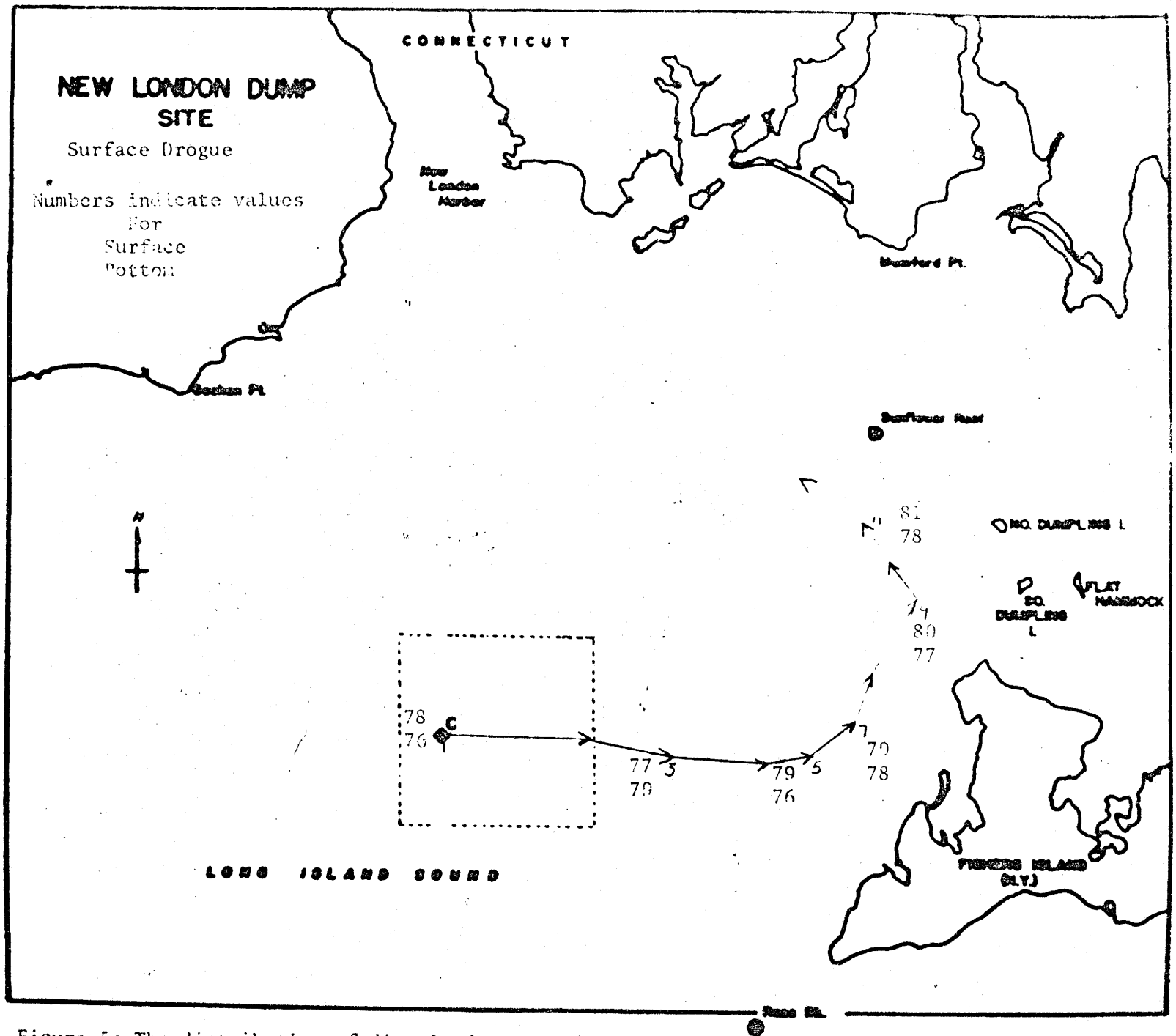


Figure 5: The distribution of dissolved oxygen (percent saturation), 17 September, 1975.

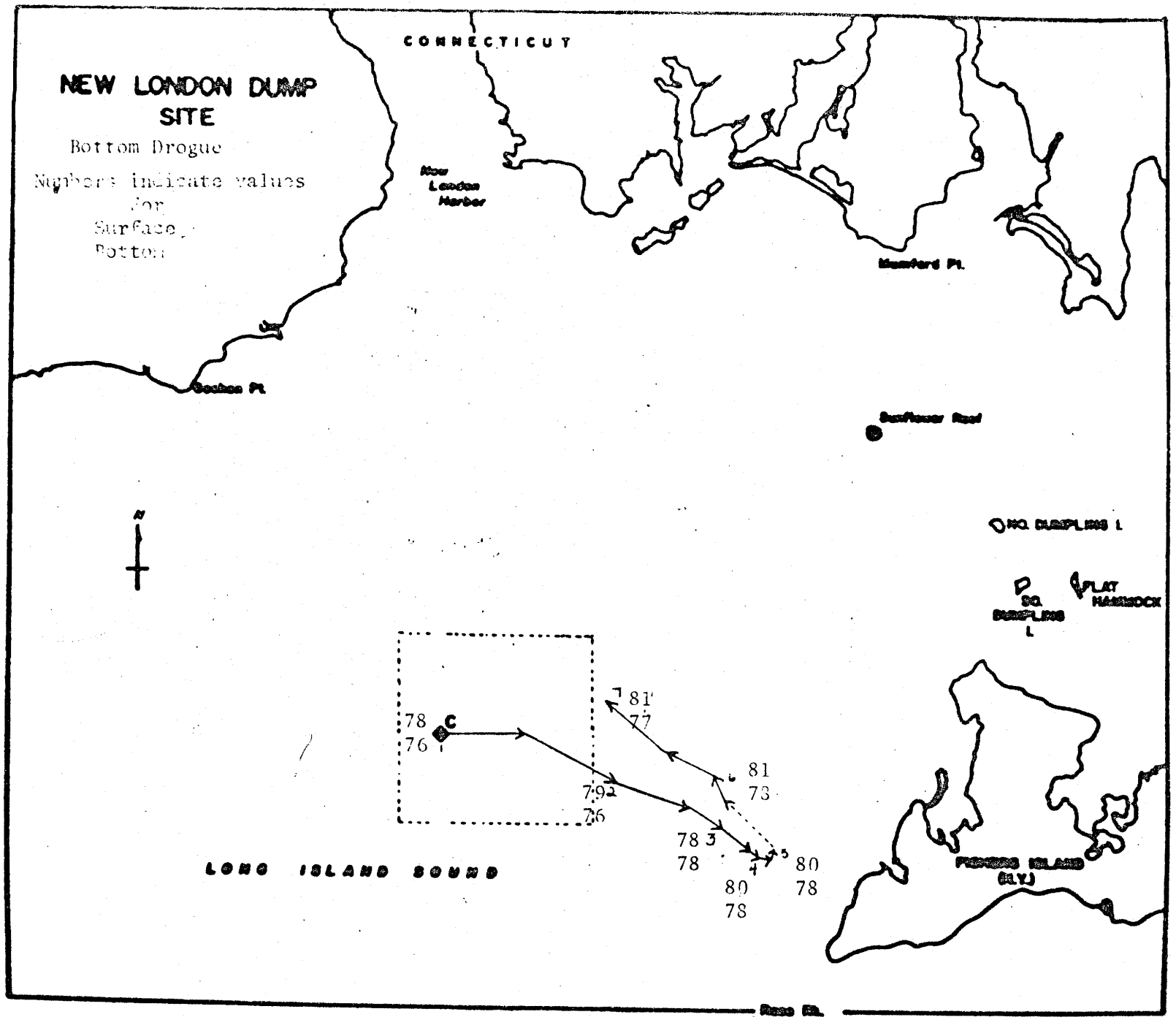


Figure 6: The distribution of dissolved oxygen (percent saturation), 17 September, 1975.

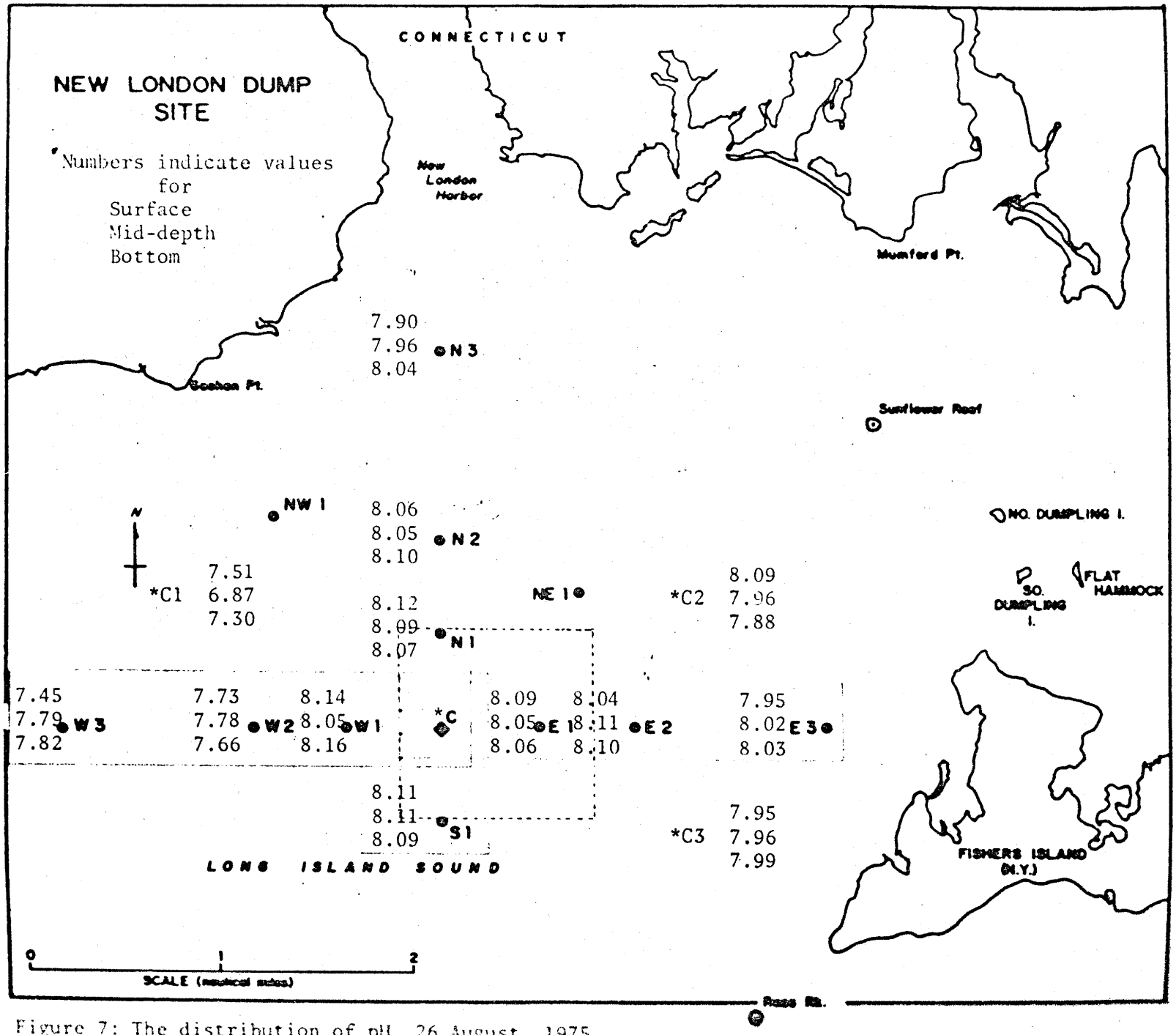


Figure 7: The distribution of pH, 26 August, 1975
*C1, C2 and C3 were sampled concurrently with the W, N-S and E transects respectively

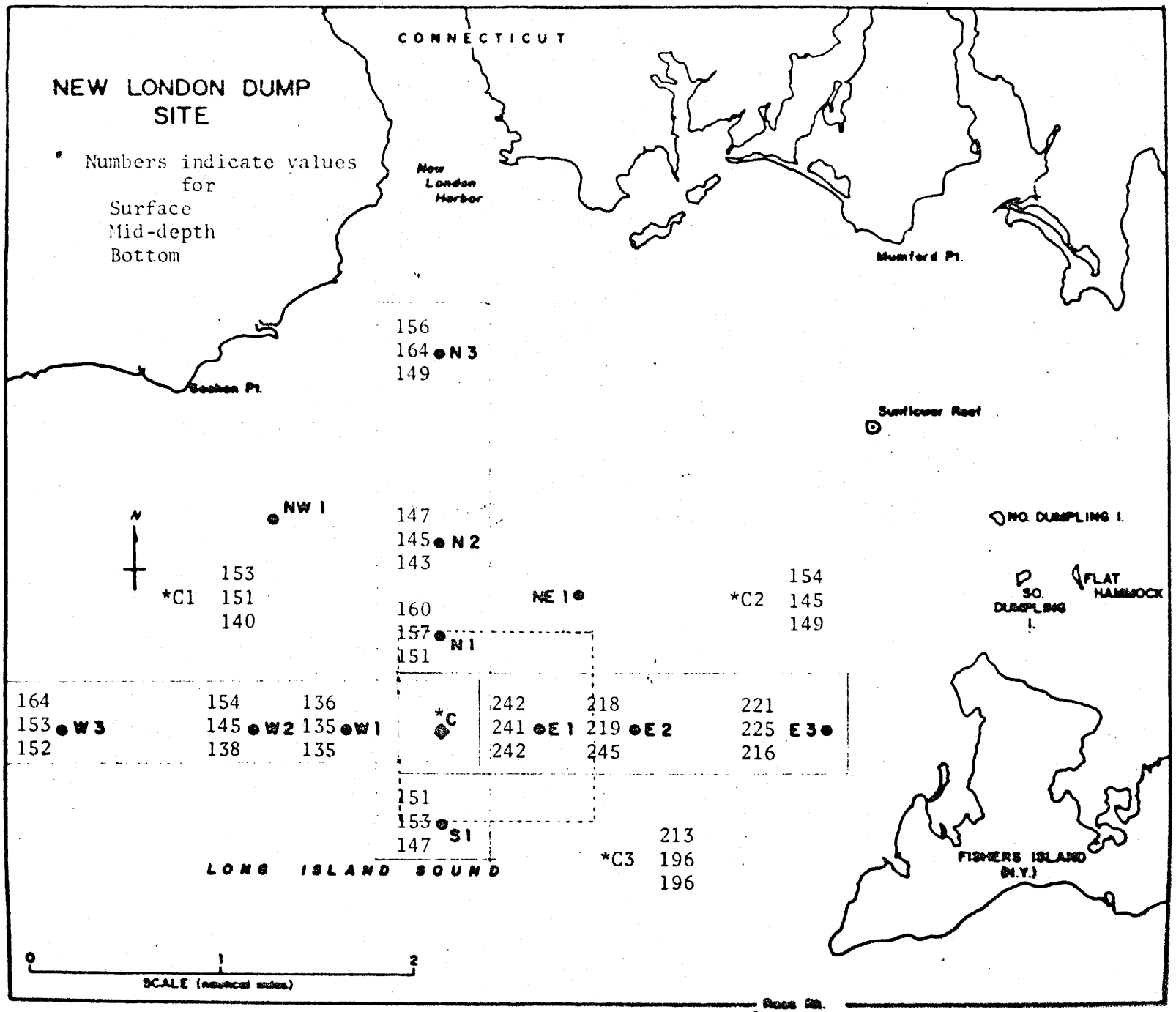


Figure 8: The distribution of Eh (mv), 26 August 1975.
*C1, C2, and C3 were sampled concurrently with the W, N-S and E transects respectively.

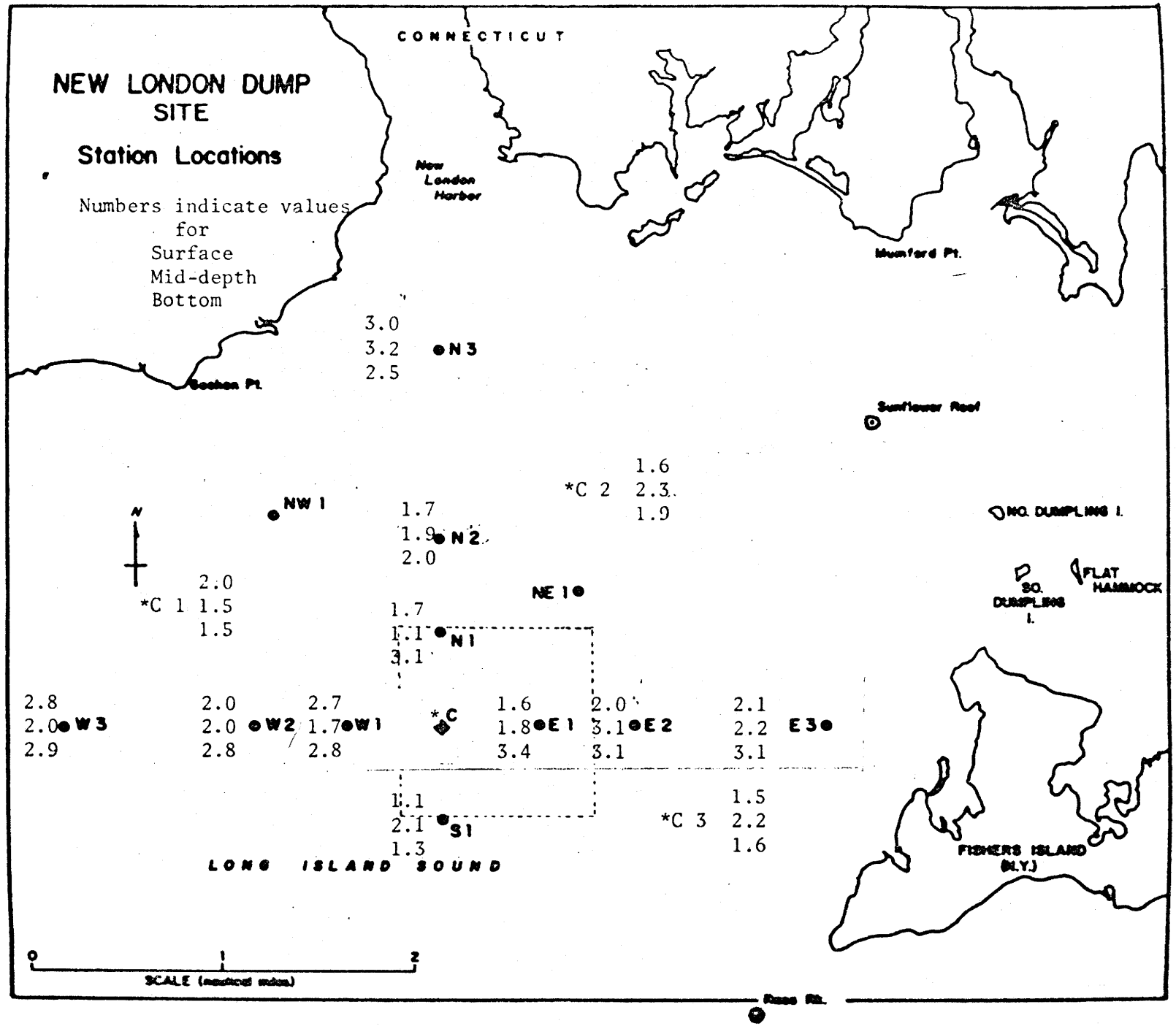


Figure 9 : The distribution of suspended solids (mg/ℓ), 26 August 1975. *C1, C2, and C3 were sampled concurrently with the W, N-S, and E transects respectively.

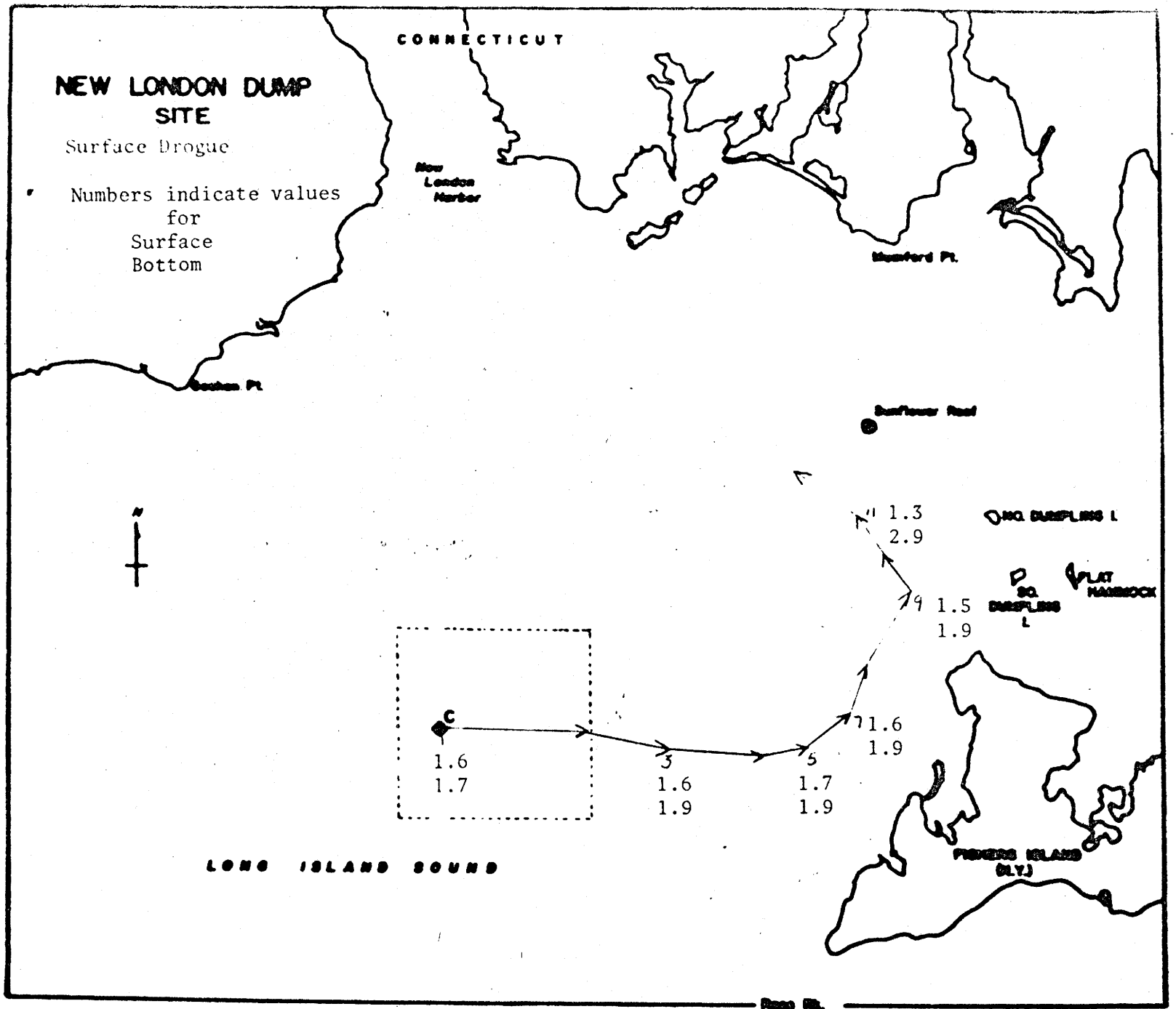


Figure 10 : The distribution of suspended solids (mg/ℓ), 17 September 1975

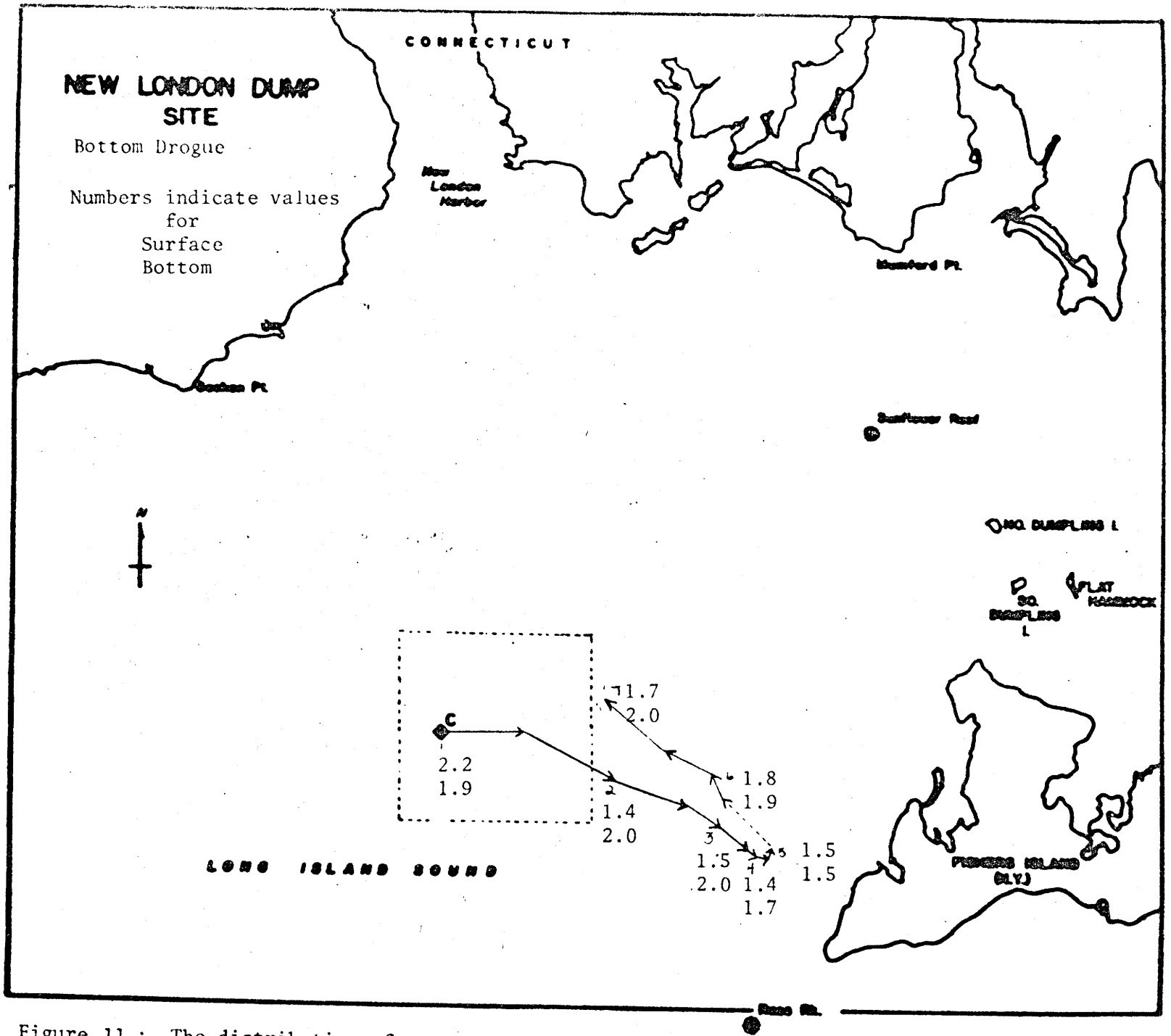


Figure 11 : The distribution of suspended solids (mg/ℓ), 17 September 1975

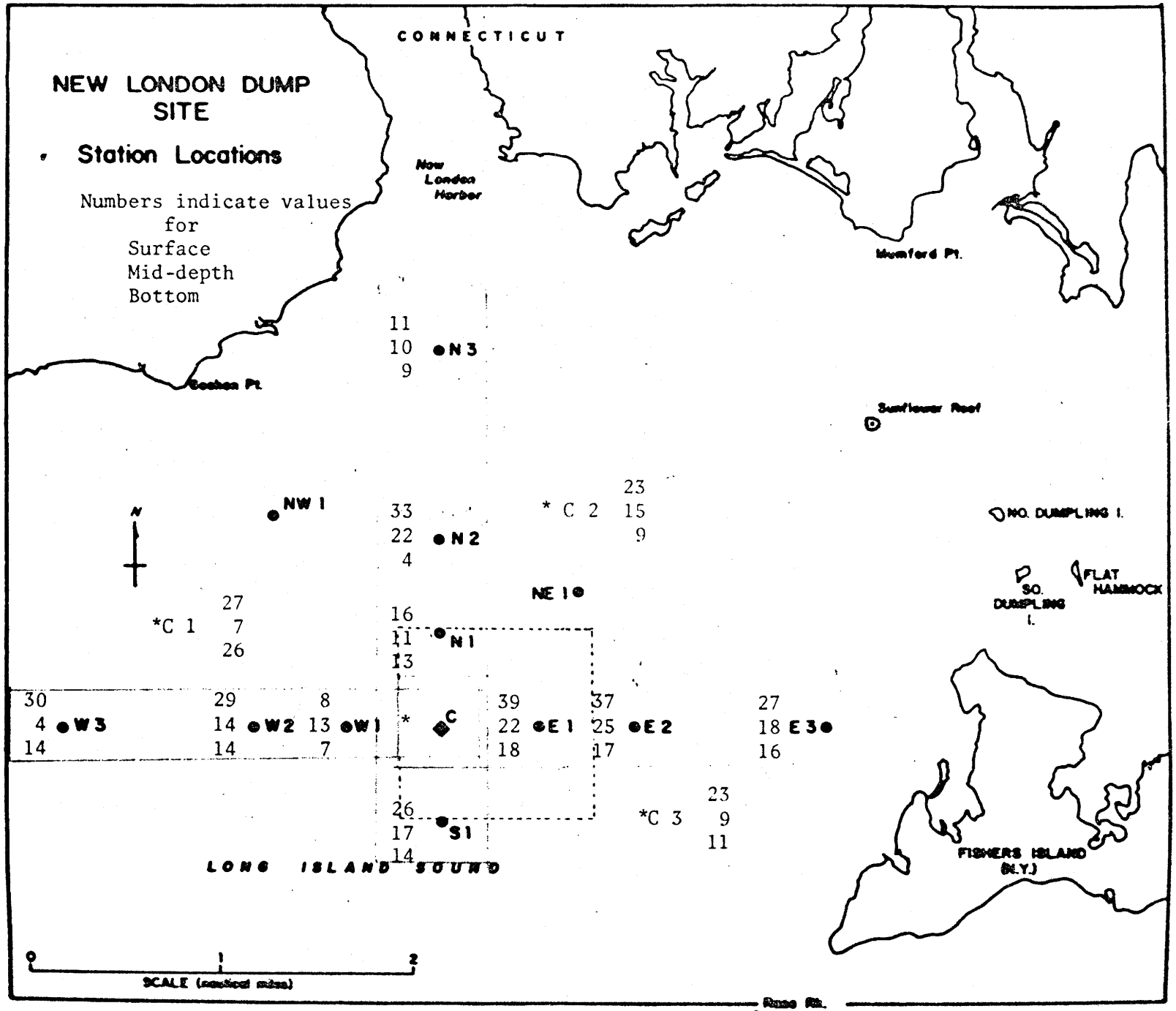


Figure 12: The distribution of volatile solids (percent of total solids), 26 August 1975. *C1, C2 and C3 were sampled concurrently with the W, N-S, and E transects respectively.

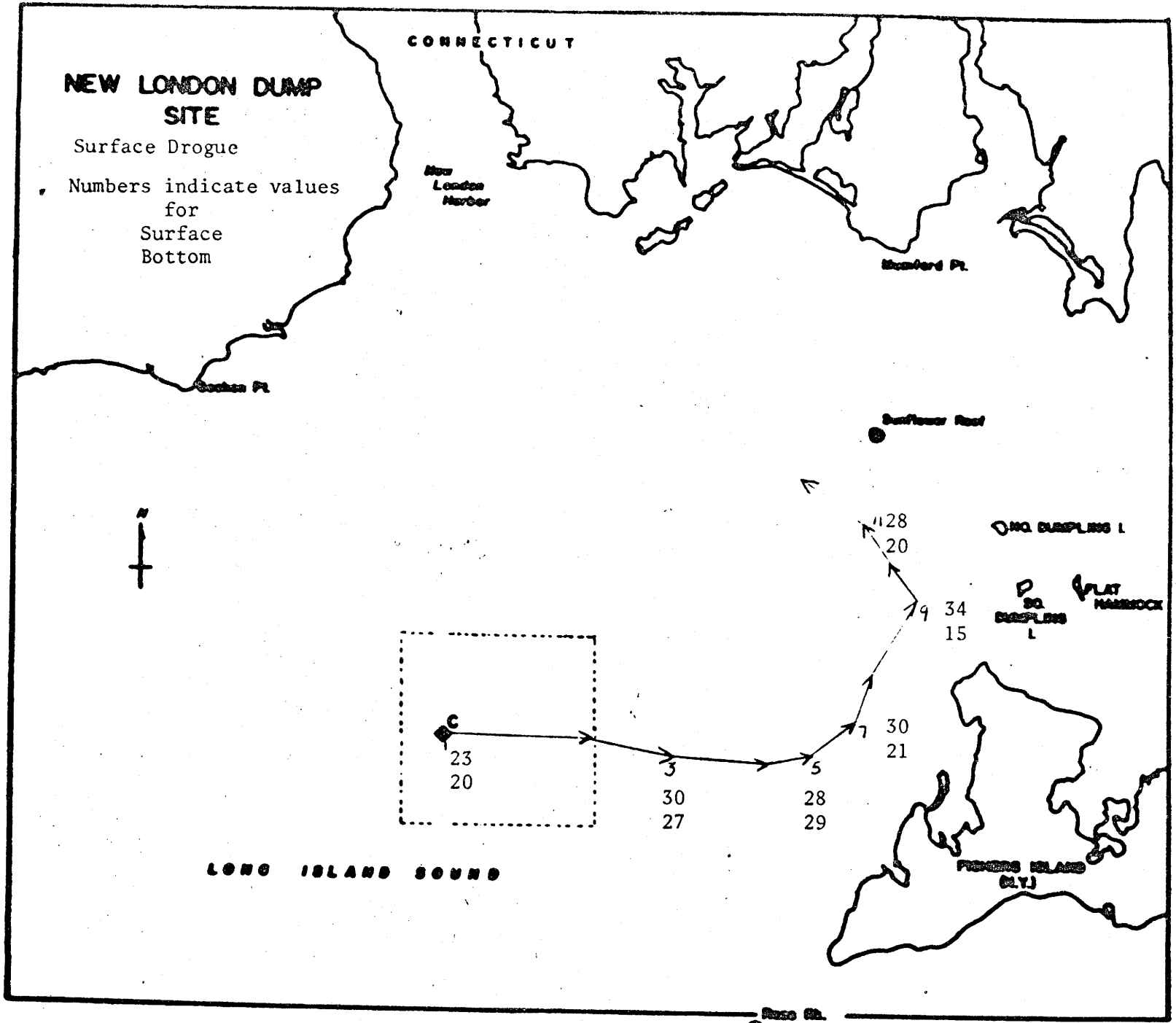


Figure 13 : The distribution of volatile solids (percent of total solids), 17 September 1975

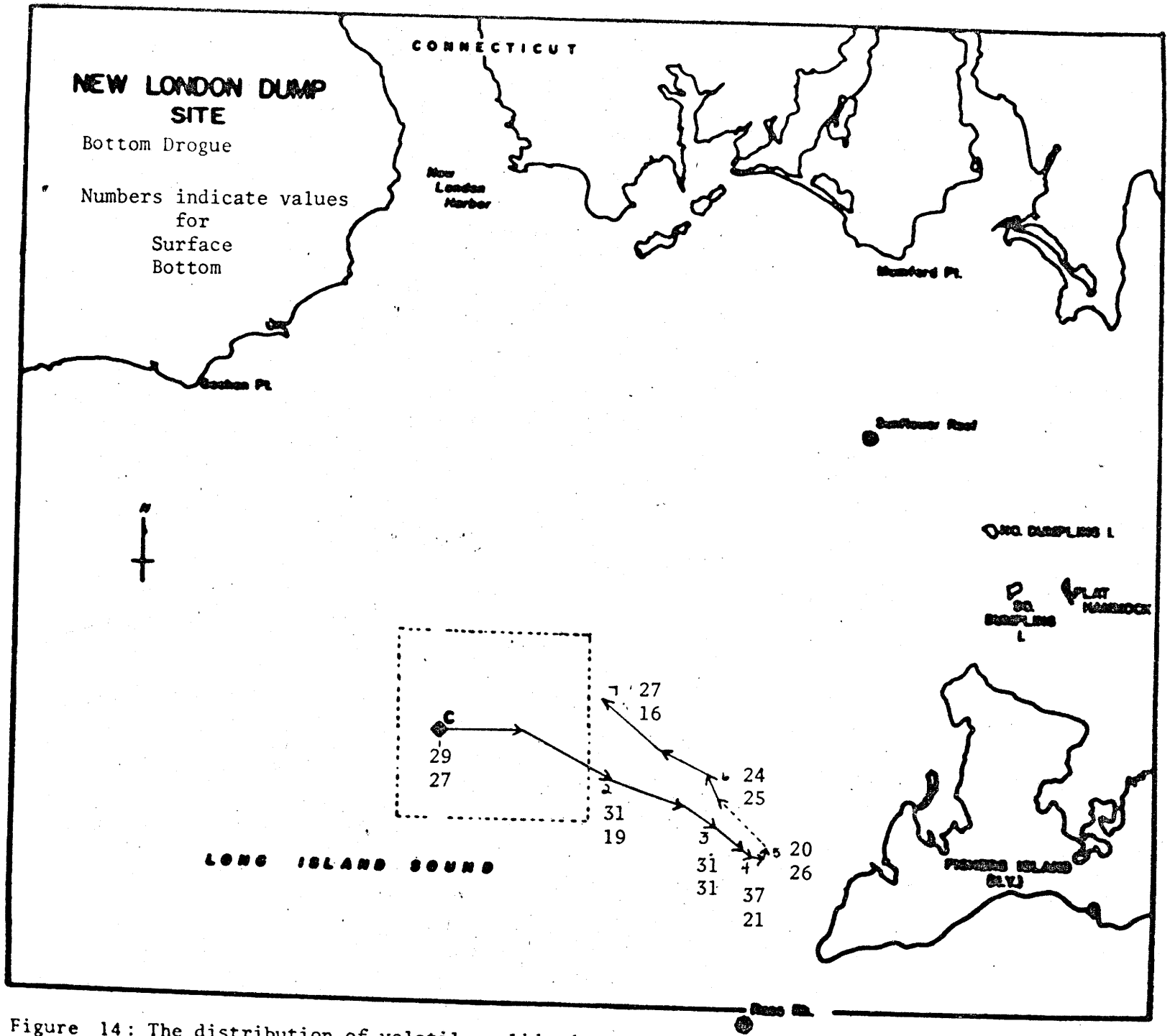


Figure 14: The distribution of volatile solids (percent of total solids) 17 September 1975

NEW YORK OCEAN SCIENCE LABORATORY

CRUISE REPORT
NEW LONDON DUMP SITE

NL-16

1 August 1975
SR74-48

I. OBJECTIVE

To monitor current velocities and directions at three depths and to continue zooplankton sampling and water sampling associated with water quality studies of the New London Dump Site Study at the alternate site.

II. ACTUAL SCHEDULE

29 July 1975	0900	Departed NYOSL.
Tuesday	1030	Arrived Alternate Dump Site.
	1100	Deployed current meter array.
	1130	Commenced plankton tows.
		R/V Louise departed Dump Site.
	1300	R/V Louise arrived NYOSL.
	1515	R/V Swordfish departed Alternate Dump Site.
	1700	R/V Swordfish arrived NYOSL.
30 July 1975	0740	R/V Swordfish departed NYOSL.
Wednesday	0900	Arrived Alternate Dump Site and commenced water quality sampling.
	1412	Terminated sampling and departed dump site.
	1600	Arrived NYOSL.
31 July 1975		
Thursday	1130	R/V Louise departed NYOSL.
	1315	Arrived Alternate Dump Site.
		Retrieved current meter array.
	1400	Departed Alternate Dump Site.
	1600	Arrived NYOSL.

III. VESSELS INVOLVED

29 July 1975	R/V Swordfish, R/V Louise
30 July 1975	R/V Swordfish
31 July 1975	R/V Louise

IV. OPERATIONS

29 July 1975 - R/V Louise deployed a 3 current meter array at the alternate dump site after being placed on station with the radar of the R/V Swordfish. R/V Swordfish continued with plankton tows in the area of the alternate dump site. Calm winds, 2 - 4 ft. swell, 7 - 10 miles visibility, clear skies.

30 July 1975 - R/V Swordfish sampled the center station and 4 other stations located 1/2 mile north, south, east and west of the center station. All stations were sampled at four depths for chemical analysis and at 5 meter intervals for transmittance. A/C generator aboard R/V Swordfish was inoperative and samples were filtered using shore power upon arrival at NYOSL.

Sampling Routine:	Current	Stations
	Ebb	C_1, N_1, E_1, S_1
	Slack	C_2, N_2, W_1, S_2
	Flood	C_3, N_3, W_2, S_3

Calm winds, 1 - 3 ft swell, 7 miles visibility, clear skies.

31 July 1975 - R/V Louise retrieved current meter array. Clear Skies, haze, 2 miles visibility, calm seas, winds W @ 0 - 5 mph.

V. STATION POSITIONS

C - 71° 51.0'W; 41° 14'N
N - 1/2 mile due North of C
S - " " " South " "
E - " " " East " "
W - " " " West " "

VI. PERSONNEL

29 July 1975

H. DeCastro	Captain - R/V Swordfish
D. Uttley	Captain - R/V Louise
S. Gill	Chief Scientist
T. Condit	Marine Technician
T. Chico	" "
J. Flynn	" "
T. Gaines	" "

VI. PERSONNEL (Cont'd)

30 July 1975

H. DeCastro	Captain - R/V Swordfish
T. Chiuchiolo	Chief Scientist
H. Dubois	Marine Technician
T. Gaines	" "
S. Gill	" "
T. Condit	" "

31 July 1975

D. Uttley	Captian, R/V Louise
T. Condit	Chief Scientist
S. Gill	Marine Technician
T. Chico	" "

NEW YORK OCEAN SCIENCE LABORATORY
Cruise Report NL-17
Project SR74-48
25, 26 August 1975

I. OBJECTIVE

To continue sampling program associated with the New London Dump Site Study.

II. ACTUAL SCHEDULE

25 August 1975
(Monday)

0905 - *R/V Swordfish* departed NYOSL
1035 - Arrived New London Dump Site
1050 - Implant current meter array near center buoy
1120 - Commenced plankton and transmissometer tows on west-east transect
1314 - Commenced tows on north-south transect
1400 - Departed New London Dump Site
1535 - Arrived NYOSL

26 August 1975
(Tuesday)

0810 - *R/V Swordfish* and Whaler 19' departed NYOSL
1010 - Arrived New London Dump Site
1045 - Commenced sampling west stations
1330 - Commenced sampling north-south stations
1530 - Commenced sampling east stations
1650 - Retrieved current meter array
1700 - Departed New London Dump Site
1850 - Arrived NYOSL

III. VESSELS USED

25 August 1975 - *R/V Swordfish*
26 August 1975 - *R/V Swordfish* and Whaler 19'

IV. OPERATIONS

25 August 1975 - A three depth current meter array was implanted 75 yards south of the center buoy. Concurrent plankton (at two depths) and transmissometer (at mid-depth) tows were made on the west to east and north to south transects.

Visibility was 4 miles in haze. Winds SE at 5 mph.

Cruise Report NL-17 (cont.)

IV. OPERATIONS (cont.)

26 August 1975 - Dump Site stations were sampled on a tidal basis. Each station was sampled using a three depth Niskin bottle cast for chemical and coulter counter analysis, a bathythermograph cast, and a transmissometer profile. *R/V Swordfish* was tied to the center buoy with the Whaler, 19' sampling the transect stations:

Flood: C2, W3, W2, W1
Slack: C2, N3, N2, N1, S1
Ebb: C3, E3, E2, E1

The current meter array was retrieved before departing the dump site.

Visibility varied from 100 yards to over 10 miles throughout the day with winds SE at 5-10 mph.

A dredge barge *Canarsie* made a dump at near 1200 hours just south of the center buoy. The barge was not out of New London Harbor.

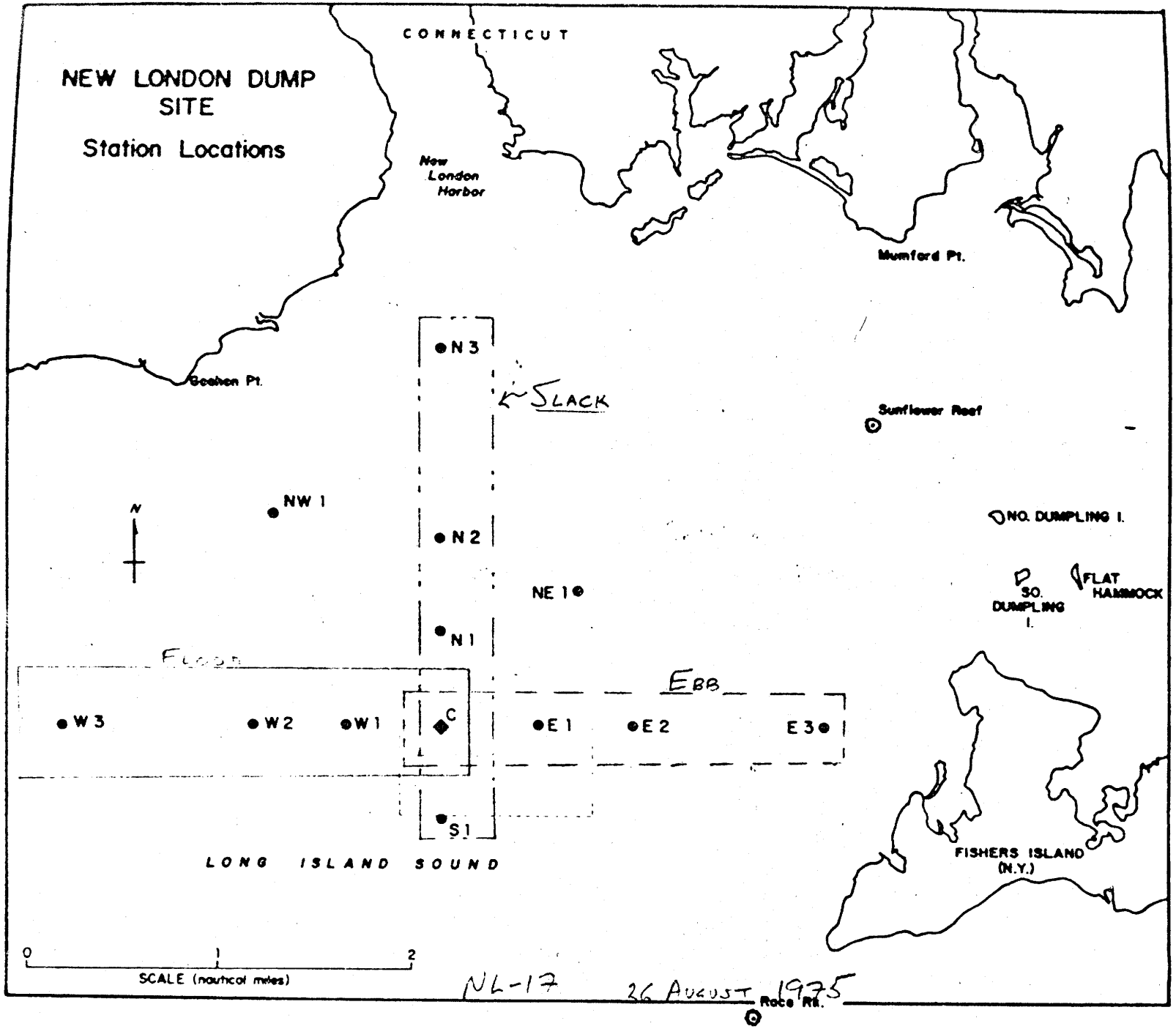
V. PERSONNEL

25 August 1975

H. DeCastro	Captain, *R/V Swordfish*
S. Gill	Research Assistant - Chief Scientist
T. Chiuchiolo	Marine Technician
J. Flynn	" "
T. Condit	" "
T. Chico	" "

26 August 1975

T. Condit	Captin, *R/V Swordfish*
T. Chiuchiolo	Marine Technician - Chief Scientist
H. Dubois	" "
J. Flynn	" "
T. Gaines	" "
S. Gill	Research Assistant
T. Condit	Marine Technician
T. Chico	" "
P. Humphreys	Technical Aide


NEW LONDON DUMP SITE
Station Locations
CONNECTICUT
New London Harbor
Mumford Pt.
Beehen Pt.
Sunflower Reef
NO. DUMPLING I.
SO. DUMPLING I.
FLAT HAMMOCK
FISHERS ISLAND (N.Y.)
Race Rk.
N
N3
N2
N1
NW 1
NE 1
W3
W2
W1
C
E1
E2
E3
S1
SLACK
FLOOD
EBB
LONG ISLAND SOUND
0
1
2
SCALE (nautical miles)
NL-17
26 AUGUST 1975

NEW YORK OCEAN SCIENCE LABORATORY
Cruise Report NL-18
New London Dump Site
17 September 1975
Project SR74-48

I. OBJECTIVE

To continue drogue tracking and water quality studies concurrent with current meter measurements at the New London Dump Site.

II. ACTUAL SCHEDULE

16 September 1975
(Tuesday)

0810 - *R/V Swordfish* and Whaler 19' departed NYOSL
1020 - Arrived New London Dump Site
1040 - Implanted current meter array at Center Buoy
1120 - Commenced tracking drogues and water sampling routine
1715 - Terminated tracking and sampling
1735 - Retrieved current meter array
2000 - Arrived Fort Pond Bay, Montauk

III. VESSELS

R/V Swordfish
Whaler 19'

IV. OPERATIONS

Surface (3m) and bottom (14m) drogues were tracked for 6 hours after launching them at the Center Buoy near time of maximum ebb current. Bearings were recorded every 1/2 hour, and the water columns were sampled at the surface and at 14m every hour for chemical analysis. In addition, a transmissometer profile was taken every hour while following the bottom drogue.

A 3-depth current meter array was monitoring water currents at the Center station over the duration of the sampling program.

Winds were SE @ 5-10 mph with seas less than 1 foot throughout the day. Cloud cover - 9/10 with visibility greater than 10 miles.

V. PERSONNEL

H. DeCastro	Captain, *R/V Swordfish*
S. Gill	Chief Scientist
T. Condit	Marine Technician
T. Chico	" "