Monitoring Cruise at the
New London Disposal Site
July 1987

Disposal Area Monitoring System DAMOS

Contribution 66
March 1990

US Army Corps of Engineers
New England Division

MONITORING CRUISE AT THE NEW LONDON DISPOSAL SITE JULY 1987

CONTRIBUTION #66

March 1990

Report No.
SAIC-88/7511&C66

Submitted to:

Regulatory Branch
New England Division
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149

Submitted by:

Science Applications International Corporation
Admiral's Gate
221 Third Street
Newport, RI 02840
(401) 847-4210

US Army Corps
of Engineers
New England Division

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1.0 INTRODUCTION

The New London Disposal Site covers a one square nautical mile area located approximately two nautical miles south of the mouth of the Thames River, CT. This site, centered at latitude 41°16.1'N and longitude 72°04.6'W, has been monitored since 1977. It has received an average of approximately 150,000 m^3 (200,000 yds^3) of dredged material annually.

During the period 24 July to 1 August 1987, field operations were conducted at the New London Disposal Site to provide information related to the environmental effects of dredged material disposal. The field operations included precision bathymetric and sediment-profile photographic (REMOTS) surveys, sediment sampling for chemical and physical analysis, collection of a dominant suspension-feeding organism for bioaccumulation analysis of selected contaminants, and measurement of temperature, salinity, and dissolved oxygen in the water column at the disposal and reference sites. The primary objectives of this study were to:

- Delineate the extent and topography of the dredged material deposited at the site;
- Obtain sediment and tissue samples of a dominant suspension-feeding organism along the axis of predominant water movement to provide an initial assessment of the relationship between sediment contamination and biological uptake; and
- Characterize the depth gradient in dissolved oxygen and assess near-bottom dissolved oxygen concentrations relative to REMOTS benthic analyses at the disposal and reference sites.

2.0 METHODS

2.1 Bathymetry and Navigation

The precise navigation required for all field operations was provided by the SAIC Integrated Navigation and Data Acquisition System (INDAS). This system uses a Hewlett-Packard 9920 series computer to collect position, depth, and time data for subsequent analysis, as well as providing real-time navigation. Positions were determined to an accuracy of ±3 meters from ranges provided by a Del Norte Trisponder System interfaced to the INDAS. For the present survey, shore stations were established at known benchmarks at Millstone Point and New London Light, CT.

The bathymetric survey was conducted at the New London Disposal Site on 28 July 1987. Individual depth measurements were determined to a resolution of 3.0 cm (0.1 feet) using a Raytheon DE-719 Precision Survey Fathometer with a 208 kHz transducer. A Raytheon SSD-100 Digitizer was used to transmit the depth values to the SAIC computer system. A more detailed description of these systems is provided in DAMOS Contribution #48 (SAIC, 1985). For subsequent analysis procedures, the actual speed of sound in water was determined from temperature and salinity data obtained using an Applied Microsystems STD probe. Bathymetric survey lanes were run east and west at a 25 meter lane spacing over a 1600 x 1600 meter area. The survey area encompassed the five disposal mounds and included an area within the disposal site 530 m northwest of the buoy, where 40% of the past year's dredged material presumably was deposited due to miscommunication about the disposal point (Figure 2-1). This lane spacing provided adequate resolution for subsequent data analysis and the production of detailed depth contour charts. During data analysis, raw bathymetric data was corrected to Mean Low Water by adjusting for both ship draft and changes in tidal height during the survey. A detailed discussion of the bathymetric analysis technique is given in DAMOS Contribution #60 (SAIC, 1989).

2.2 REMOTS Sediment Profile Photography

REMOTS sediment-profile photographic surveys of the New London Disposal Site have been carried out since June 1984. REMOTS photography is used to detect and map the distribution of thin (1-20cm) dredged material layers. This capability compliments the precision bathymetric data which can resolve bottom elevation changes greater than 15 cm. In addition, REMOTS is used to map benthic disturbance gradients and to monitor the process of infaunal recolonization on and adjacent to disposal mounds. A detailed description of REMOTS image acquisition, analysis, and interpretative rationale is given in DAMOS Contribution #60 (SAIC, 1989).

Forty-one REMOTS stations were occupied on 27 and 29 July 1987 in and around the New London Disposal Site (Figure 2-2). Three replicate images were obtained at each station located in a 6 x 5 grid with 200 m spacing centered at the disposal buoy. Additional stations were located at 800S (i.e., 800 meters south of station CTR), 1000S, 600E, 1000E, 1500NW, 400NW, 400SE, and 800SE. In order to compare ambient and on-site conditions, six replicate images were also obtained and analyzed at each of three outlying reference stations (W-Ref, NE-Ref and NLON-Ref).

The location of the disposal buoy at the New London Disposal Site has not changed since the July 1986 REMOTS survey. That survey focused primarily on the NL-85 mound formed at the buoy. In order to delineate the extent of the dredged material deposited during the past year's disposal activities and to document any changes in bottom conditions, the results of the present survey have been compared with the results of the July 1986 survey.

2.3 Dissolved Oxygen

The depth gradient in dissolved oxygen was characterized at REMOTS stations using a Rexnord Instruments Model 66 dissolved oxygen probe interfaced to an STD probe (Applied Microsystems, Ltd. Model STD-12). The STD-12, used to measure salinity, temperature, and pressure (depth), was mounted vertically on the REMOTS camera frame such that its sensors were located approximately 42 cm from the camera base. The attached Rexnord probe was mounted horizontally on the camera base frame such that its membrane was located between 6 to 9 cm above the sediment surface during deployment, depending on how deep the camera frame settled into the bottom. In this configuration, vertical hydrographic profiles were obtained during REMOTS image acquisition.

The STD-12 is capable of sampling up to 8 scans per second and can store up to 7648 scans in 56k of internal RAM. Commands are sent to and data read from the instrument with a Compaq Portable II microcomputer via an RS-232 interface. Prior to commencing the REMOTS survey, the STD-12 was set to internally log data at 1 second intervals. The data were downloaded to the microcomputer during REMOTS film changes and stored on floppy disks for later analysis.

The Rexnord Model 66 probe is a polarographic oxygen electrode (platinum-lead galvanic couple with a potassium-iodide electrolyte). The probe was covered with a 1 mm thick diffusion membrane. Calibration of the Rexnord Model 66 was performed at the SAIC Oceanographic Service Center by the standard method of comparison with Winkler titration (Strickland and Parsons, 1972). Calibration must be done whenever the membrane and electrolyte are changed. The calibration of the conductivity, temperature, and pressure sensors on the STD-12 was performed by the manufacturer. Salinity was calculated from conductivity data based on procedures described by Perkin and Lewis (1980).

2.4 Sediment Sampling and Analysis

Triplicate sediment samples were collected with a 0.1 m^2 Smith-McIntyre grab sampler at six stations located across the disposal site northwest to southeast (the direction of the dominant current regime) (Figure 2-3). Six polycarbonate plastic core liners (6.5 cm ID) were pushed into the sediment grab sample and extracted; the top 2 cm of sediment from five of these cores were combined and placed into bags for subsequent chemical analysis by the NED laboratory. The top 2 cm of the remaining core from each of the triplicate grab samples were combined and placed into a bag for subsequent physical analysis by the NED laboratory. The samples were kept on ice until delivered to the NED laboratory where they were stored at 4C until analyzed. The parameters measured include grain size, trace metals (Fe, As, Cd, Hg, Pb, and Cu), total PHC's and PCB's, and % total organic carbon. Analytical methods are those of the U.S. Environmental Protection Agency (Plumb, 1981).

2.5 Body Burden Analysis

The test organisms (tubicolous amphipods) for body burden analysis were collected using the Smith-McIntyre grab at each of the six stations where sediment samples were taken (Figure 2-3). As the sediment was discharged and rinsed from the grab into a collection tub, the amphipods vacated their tubes and accumulated at the surface of the water and could be scooped out with a plastic dip net. Adding more water to the sediment and breaking down any sediment clumps released additional amphipods. Initial examination of amphipods collected in this manner revealed that approximately 95% (wet weight) of the individuals were of the genus Leptocheirus. Therefore, Leptocheirus was chosen as the target organism for all New London body burden stations. The animals were allowed to depurate for 24 hours in aerated seawater before being frozen for transport to the laboratory. Amphipod tissue was analyzed for five metals (Fe, Cd, Hg, Pb, and Cu) following methods in US EPA (1983) and total PCBs (as Aroclor 1254) following methods in US EPA (1977). These analyses were conducted by Environmental Monitoring Laboratory, Inc. (Wallingford, CT).

3.0 RESULTS

3.1 Bathymetry

The contour plot resulting from the analysis of the July 1987 bathymetric survey at New London (Figure 3-1) depicts the five disposal points: "NL-RELIC", "NL-I", "NL-II", "NL-III" and "NL-85". Comparison of this plot with the July 1986 plot (Figure 3-2) reveals a marked depth change at "NL-85". At this mound, depth decreased from 17.5 meters in 1986 to 15.5 meters in 1987, a maximum reduction of 2.2 meters. The peak of this mound was found to be approximately 60 meters south-southeast of the disposal buoy.

Contours representing the "NL-RELIC", "NL-I", "NL-II" and "NL-III" disposal points were identical to those determined in 1986. Minimum depths remain the same at 13.0, 15.5, 15.5 and 14.5 meters, respectively, indicating no loss or addition of material at these mounds.

According to the year's scow logs, of a total of 67,500 m^3 (88,240 yd^3) of dredged material was deposited at the New London disposal site, an estimated 12,400 m^3 (16,225 yds^3) of material was deposited approximately 530 m northwest of the disposal buoy on the extreme southern flank of the NL-RELIC mound. No depth change, however, was apparent for this area in the contour chart. The remaining 55,100 m^3 (72,000 yds^3) of sediment, representing 82% of the year's disposed sediment as estimated from the scow logs, were added to the NL-85 disposal mound. The logs verify that almost all of this disposal occurred in the immediate vicinity of the buoy.

Volume calculations based on a comparison of the depth data from the 1986 and 1987 surveys indicate a total of 43,000 m^3 (12,400 m^3) of material was added during the past year's disposal activities. Because the majority of disposal operations took place at NL-85, a volume was also calculated for the five survey lanes passing directly over this mound. This volume, 33,951 m^3 (4615 m^3), represents 79% of the total volume of material disposed within the survey area. The remaining 21% apparently consisted of relatively thin layers located farther out on the flanks of the NL-85 mound and/or in the area of inadvertent disposal 530 m northwest of the buoy.

3.2 REMOTS Sediment-Profile Photography

Distinct dredged material layers with a thickness exceeding the penetration of the REMOTS prism (> 16 cm) were evident in the REMOTS images from stations in the immediate vicinity of the disposal buoy (Figure 3-3). These stations were CTR, 200E, 200W, 2-200SW, 200S, 2-200SE and 400SE. In general, the dredged material was characterized by a distinct boundary (i.e., RPD depth) between oxygenated sediment at the surface and sediment with extremely low reflectance below (suggesting apparent high sediment oxygen demand, Figure 3-4). Similar low-reflectance dredged material exceeding the prism penetration depth was mapped in this same area in the July 1986 REMOTS survey. This made it difficult to distinguish between material deposited in the past year versus that from previous years. Less sharply contrasting layers of apparent dredged material were evident at stations 200N, 2-200NE, 2-400NE, 4-200NE and 4-400NE (Figure 3-5). The deposits at these stations, which occur in the vicinity of the NL-III and NL-II mounds, were more readily distinguished as "relict" material disposed in previous years (i.e., prior to the 1986-87 disposal season).

There was no evidence of low-reflectance dredged material layers in the northwest corner of the survey grid, where it has been presumed that roughly 20% of the 1986-87 material was disposed. Some clayey and sandy deposits observed in this region may represent disposed material. However, given the wide range of sediment types characteristic of the New London Disposal Site, it is impossible to unequivocally classify these heterogeneous sediments as dredged material. It should be noted that no apparent dredged material was observed at the three reference stations.

The dredged material deposit extending south, east and west 200 to 400 m from the disposal point (Figure 3-3) was markedly smaller in areal extent than that observed at this location in July 1986. The discernible extent of the 1986 mound can be expected to shrink over time as a result of bioturbational mixing on the flanks of the deposit. Such mixing can erase evidence of thin layers of deposited material by homogenizing near-surface strata. This phenomenon was documented on the flanks of the Field Verification Program (FVP) mound during the first year of monitoring (SAIC, 1982). In addition, significantly less material was disposed at the NL-85 buoy in the past year relative to prior years. It was therefore likely that the dredged material deposit by REMOTS (Figure 3-3) largely consisted of material deposited prior to the July 1986 survey, with a minor addition of material deposited in the past year.

As determined from REMOTS images, surface sediments at most stations consisted of mixtures of silt-clay and very fine sand (>4-3 phi) (Figure 3-6). Slightly coarser-grained sediment, consisting of very fine and fine sands (4-3 and 3-2 phi), occurred in the southwest and in the northwest corner of the sampling grid. At several stations (2-200SW, 200W, 400W, and 4-200NE), layers of fine sand overlaid silt-clay (Figure 3-7). This possibly reflects inputs of coarse-grained dredged material. Sediments at the three reference stations consisted of silt-clay to very fine sands (>4-3 phi).

The frequency distributions of boundary roughness values for the disposal area and reference stations (Figure 3-8) indicate that no significant difference exists between these stations (Mann Whitney U-test; $p = 0.4603$). Also, there has been no change in small-scale bottom roughness in the vicinity of the NL-85 mound since the July 1986 survey (Mann-Whitney U-test; $p = 0.2929$).

The mapped distribution of apparent RPD depths at the disposal site (Figure 3-9) reveals that most stations exhibited an RPD depth greater than 3.0 cm. Five stations from the disposal point south (CTR, 200S, 400S, 400SE, and 1000S) show values 3.0 cm. All three reference stations exhibited average RPD depths 3.9 cm. Overall, RPD values were significantly shallower at the disposal area than at the reference sites (Mann-Whitney U-test; $p = 0.0299$) (Figure 3-10). The RPD values in the disposal site have significantly deepened since the July 1986 REMOTS survey (Mann-Whitney U-test; $p < 0.001$). This suggests enhanced biogenic sediment reworking by the infaunal benthos.

The mapped distribution of infaunal successional seres at the disposal site (Figure 3-11) shows that only one station, 4-200SE, lacks evidence of Stage III infauna. This contrasts with the pattern observed in July 1986 when many stations lacked evidence of deep-dwelling, deposit-feeding taxa. The widespread appearance of Stage III taxa at the disposal site indicates that successful infaunal recolonization of the region is occurring. The disposal activity of the past year does not appear to have markedly affected the rate of this recolonization. In addition, tube-dwelling amphipods were evident at many of the stations in the disposal area (Figure 3-12). These Stage II seres have been observed in all previous New London REMOTS surveys. Stage III taxa were present at all three reference stations, while Stage II taxa were observed only at NLON-Ref.

The distribution of Organism-Sediment Indices (OSI) at the disposal site (Figure 3-13) indicates that most stations exhibited relatively high OSI values; this reflects the high-order successional status and relatively deep RPD values present across the site. It is noteworthy that the lowest OSI value occurs well south of the disposal area (station 1000S). This relatively deep area may be subject to periodic hypoxic conditions which were not occurring at the site. OSI values within the disposal site do not differ significantly from the values at the reference stations (Mann-Whitney U-test; $p = 0.0715$) (Figure 3-14). OSI values were significantly greater than those observed in July 1986 (Mann-Whitney U-test; $p < 0.001$). This increase in OSI values reflects the successful infaunal recolonization which has occurred at the site in the past year.

3.3 Dissolved Oxygen

Near-bottom dissolved oxygen (DO) concentrations were analyzed at approximately 50% of the REMOTS stations occupied at New London on 27 and 29 July (Figure 3-15). The sampling on 27 July occurred solely at stations in and immediately adjacent to the disposal site; the DO values on this day ranged between 6.57 mg/l to 7.35 mg/l. On 29 July, the reference stations and stations to the extreme south and north of the site were found to have near bottom DO concentrations ranging from 3.58 mg/l to 7.02 mg/l. It is noteworthy that the three reference stations (W-Ref, NE-Ref and NLON-Ref) and 1500NW had the lowest near-bottom DO values (3.58, 4.00, 4.37, 3.61, respectively).

Plots of the depth gradients in dissolved oxygen, temperature, salinity, and density (as sigma-t) at the selected REMOTS stations indicated in Figure 3-15 are given in Appendix I. A representative CTD/DO plot obtained on 27 July at station 2-400SE (Figure 3-16) indicates that the water column was stratified, with evidence of a thermocline and halocline (and resultant pycnocline) at a depth of 12 to 15 m. Above and below this steep density gradient, the water column appears to have been well-mixed, as indicated by the vertical structure of the temperature, salinity, and DO data. In contrast, the 27 July CTD/DO plot from station 400W (Figure 3-17) does not show strong gradients in any of the measured parameters. The gradual decrease in temperature and increase in salinity and density with depth indicates an unstratified water column.

On 29 July, there were wider variations in the vertical distributions of temperature, salinity, and density. For example, the steady decrease in temperature and gradual increase in salinity and density at station 4-400NE (Figure 3-18) indicate a lack of strong vertical gradients in these parameters. Conversely, a complicated and stratified water column structure was observed at station W-Ref (Figure 3-19), where there was a near-surface (i.e., less than 5 meters deep) thermocline, halocline, and pycnocline as well as sharp gradients in temperature, salinity, and density at a depth of 18-20 meters. Concurrently, station NE-Ref exhibited remarkable uniformity in temperature, salinity, and density throughout the water column (Figure 3-20).

There was no notable depth gradient in dissolved oxygen concentrations at any of the stations sampled on 27 July. All of the plots from this day show only a slight, steady decrease in DO concentrations with depth. With the exception of stations 800S and 1000S, near-bottom DO concentrations measured on 29 July were generally lower than those measured on the 27th. However, as on 27 July, DO concentrations did not exhibit marked gradients with depth.

3.4 Sediment Characteristics

Sediments at all six stations appeared olive gray with variable amounts of fine sand and silt/clay as the dominant grain-size fractions (Table 3-1). Stations CTR and 400SE contained relatively higher percentages of silt and clay (69% fines), while fine-grained sand occurred in higher proportions than silt at stations NLON-Ref, 800SE, 400NW and 1500NW.

The mean concentrations of Hg, Pb, As, Cd, and Cu in surface sediments at the six stations sampled (Table 3-2) were all at Low levels, according to the New England River Basins Commission's (NERBC) interim criteria (NERBC, 1980). While such criteria do not exist for Fe and percent total organic carbon (Table 3-2), the results of statistical testing show that at all stations, except 400NW and 400SE, metal concentrations and percent total carbon were below detection limits or were not significantly different from those at the reference station (Table 3-3). Concentrations of Pb, As, Fe, Cu, and percent total organic carbon at station 400SE were all significantly elevated relative to NLON-Ref levels, whereas concentrations of As and Cu at 400NW were depressed (Table 3-3). Concentrations of metals and percent carbon were elevated above reference levels at station 400SE within a factor of one or two (Figure 3-21).

Concentrations of organochlorine pesticides and PCB's in sediments at New London were generally below the analytical detection limits at all stations (Table 3-4). Exceptions to this were heptachlor at station 400NW, which was just above the detection limit, and PCB's as Aroclor 1232 at stations CTR and 1500NW and PCB's as Aroclor 1242 at stations 800SE and 400NW. Concentrations of PCB's at these stations were well below the 1.0 ppm level considered to be confirmation of high contamination according to the NERBC interim criteria (NERBC, 1980).

3.5 Body Burden Analysis

The results of the triplicate analyses for five trace metals (Cd, Pb, Cu, Fe, and Hg) in body tissues of the suspension-feeding amphipod Leptocheirus are reported on a dry weight basis (Table 3-5). In the case of station center (CTR), the laboratory was sent two jars of organisms (collected on two different sampling days) which were to be combined and treated as a single sample. Inadvertently, the two jars were treated as separate samples and the results were reported accordingly (i.e., CTR#1 and CTR#2).

Concentrations of both cadmium and mercury in Leptocheirus were below analytical detection limits at all stations. Pb, Fe, and Cu were elevated at station 400SE and Cu was elevated at station CTR#2 (Figure 3-22), although in all cases the magnitude of these elevations above the reference were less than a factor of three. Statistical tests confirm that Pb and Cu at CTR#2 and 400SE, Fe at 400SE, and Cu and Fe at 1500NW were all significantly higher than the reference concentrations (Table 3-6). Elsewhere, Leptocheirus body burden levels were either significantly less than or did not differ significantly from the reference animals.

The results of the triplicate analyses for PCBs (as Aroclor 1254) in body tissues of Leptocheirus (Table 3-7) indicated that concentrations were below the detection limit in two of the replicates at station 1500NW and one replicate at station 400NW. Although the highest PCB body burdens occurred at the reference station (Figure 3-22), the difference between the

PCB concentrations in the reference animals and those from the on-site stations was not statistically significant, except at station 1500NW where PCB body burdens were significantly lower than the reference (Table 3-6).

4.0 DISCUSSION

4.1 Bathymetry

The results of the bathymetric survey at the New London Disposal Site revealed a significant addition of dredged material at the "NL-85" mound, centered approximately 60 meters south-southeast of the disposal buoy. Scow logs verified that approximately 82% of the material was disposed at this location in the past year. No depth change was observed 530 m northwest of the buoy on the southern flanks of the NL-RELIC mound, where an estimated 12,400 cubic meters of material was disposed due to miscommunications about the disposal location.

The lack of an observable depth change at the northwest location suggests that the material deposited there occurred in layers less than 15 cm thick, which could not be detected reliably by acoustic measurement. In addition, although some potentially allochthonous sediment was observed in the REMOTS images from this area, it is impossible to unequivocally classify this sediment as dredged material due to the heterogeneity of the sediments historically disposed within the New London site. Any disposed material which might be present probably occurs in discontinuous, thin coarse-grained layers, making it difficult to detect by either bathymetry or REMOTS.

A comparison of the dredged material volume estimated from scow logs (67,500 m^3) with the volume calculated from depth data (43,000 m^3) indicates a decrease in volume of 36%. If only the area in the vicinity of the NL-85 mound is considered, a scow estimate of 55,100 m^3 compares with a volume estimate of 33,951 m^3, representing a 38% decrease in volume. These decreases in estimated volume compare well with the results of a study by the New York District COE (Tavolaro, 1984), where it was determined that the volume of material detected on the bottom by acoustic techniques was approximately 40.7% less than the scow volume estimates. Of this 40.7% volume decrease, 15.4% is attributed to the loss of interstitial water during disposal and compaction of the material after impacting the bottom. The remaining 25.3% presumably occurs as thin layers of dredged material not detected by the survey fathometer.

4.2 REMOTS Sediment Profile Photography

The present REMOTS survey indicates that the areal extent of dredged material was well within the disposal site boundaries and, in large part, the material occurred within 400 meters of the disposal buoy. In many of the REMOTS images, it was difficult to determine precisely how much of this dredged material was deposited during the past year versus previous years. Comparing the bathymetric contours from 1986 and 1987 (Figures 3-1 and 3-2) shows the disposal mound formed in the past year was approximately 300 m in diameter and centered southeast of the disposal buoy. The REMOTS data (Figure 3-3) indicates that dredged material layers in excess of the prism penetration (i.e., greater than about 15 cm in thickness) extended approximately 200 m farther west, south, and southeast than indicated by the bathymetric data. If these layers had actually been deposited since the 1986 survey, then they should have been detected acoustically. The fact that no changes in bathymetry correspond with these dredged material layers suggests that much of this material was probably not deposited in the past year but rather represents material which was seen in these locations (with both REMOTS and bathymetry) at the time of the July 1986 survey.

Some clayey and sandy sediments, probably allocthonous, were present approximately 400 meters northwest of the disposal point. This may represent the dredged material which was mistakenly disposed in this area. However, due to the sediment heterogeneity present at this site, definitive identification of these materials as new dredged material was not possible.

Infaunal recolonization at the site is proceeding well within expected rates based on previous DAMOS surveys; head-down deposit-feeding assemblages (Stage III) were found across the survey area. This indicates that significant infaunal recolonization has occurred since the 1986 survey. Also, tubicolous amphipods (Stage II taxa) continue to be a major faunal component of the region. At the three reference stations located west, northeast, and east of the disposal site, Stage III taxa were also abundant, while Stage II forms were observed only at the eastern reference station (NLON-Ref).

4.3 Dissolved Oxygen Regime

In view of the objectives of the CTD/DO sampling at New London, the results illustrate the difficulties in characterizing oceanographic dissolved oxygen regimes based on instantaneous measurements at this site. A major confounding factor stems from the fact that the New London site is located within an estuary, very close to the opening to the Atlantic Ocean (The Race), where dissolved oxygen concentrations typically vary diurnally, tidally, and seasonally. The results indicate small-scale spatial and temporal variability not only in DO concentrations, but also in the vertical distribution of salinity and temperature. In part, this variability is the result of frequent tide or wind-induced mixing of the water column. In addition, estuarine flow patterns (i.e., the interaction of variable freshwater inputs from the Connecticut and Thames Rivers with changing tidal regimes) move parcels of water having very different temperature, salinity, and DO characteristics through the area at different times.

While some of the CTD/DO plots obtained on 27 and 29 July suggest that the water column was seasonally stratified, others show a vertically mixed pattern at a variety of bottom depths with no apparent correlation between depth or location. Given the above considerations, the observed changes in temperature, salinity, and density at depth more likely reflect the passage of different parcels of water at the time of sampling rather than a stable and persistent density gradient. The absence of near-bottom oxygen depletion, and the uniform vertical distribution of dissolved oxygen observed at nearly every station, further suggest that the water column was well-mixed at the time of the survey. Similar results were found at the Western Long Island Sound (WLIS) Disposal Site and the Central Long Island Sound (CLIS) Disposal Site in 1987. The WLIS survey was performed in November 1987 and a well-mixed water column was seen (due to the cooler water temperatures). At CLIS, which was sampled in late August and early September 1987, results were similar to those found at NLON. An absence of near-bottom oxygen depletion and a uniform vertical distribution of dissolved oxygen concentrations suggested a mixed water column at the time of the CLIS survey.

In the absence of a strong and persistent pycnocline, the development of hypoxia or anoxia in near-bottom waters at New London would not be expected. The data support this conclusion but also indicate a strong daily fluctuation in the DO regime. On 27 July, DO concentrations throughout the water column were well above levels which have been defined as biologically "critical" (Table 4-1). Two days later, most of the DO values at the site could still be considered aerobic but were noticeably lower, while values at three nearby reference stations (W-Ref, 1500NW and NE-Ref) were in the "hypoxic" range (Table 4-1). These results might be attributable to either the in-situ consumption of oxygen or an influx of low DO parcels of water. The sampling used in the present survey did not allow accurate assessments of either the spatial distribution of such water masses or the frequency and duration of their passage.

One of the objectives of the CTD/DO sampling at New London was to assess near-bottom dissolved oxygen concentrations relative to REMOTS benthic analyses at and near the disposal site. While it is difficult to relate the instantaneous DO measurements to potential biological effects, the CTD/DO results generally show that while the potential for transient hypoxic conditions exists, most near-bottom waters at the site were aerobic (> 4 mg/l) and had higher DO concentrations than the reference stations at the time of the survey. It had been hypothesized that stressed benthic habitats at the site in 1986 were directly related to the Sound-wide phenomenon of near-bottom hypoxia. There was no evidence in the REMOTS images from 1987 of widespread hypoxic stress in the benthos at New London. Significantly higher OSI values in 1987 compared to 1986 suggest that successful infaunal recruitment and recolonization has occurred at the site in the past year. Such recruitment success indicates an absence of chronic near-bottom hypoxia in the weeks and months preceding the survey.

4.4 Sediment Characteristics

The results of physical testing of sediments at New London, which show that mixtures of silt-clay and very fine sand predominate at the surface, generally were in good agreement with the results obtained in the REMOTS survey. These results reflect both the natural heterogeneity in sediment types characteristic of the site, as well as the addition of dredged material which consisted primarily of sand and silty-sand with lesser amounts of clay.

One objective of the sediment chemical analyses was to determine the concentrations of sediment-associated contaminants that were deposited at the site and to determine whether the contaminants were subject to further resuspension and transport. As indicated by the REMOTS dredged material mapping (Figure 3-3), station 400SE, the only station with significantly elevated levels of several metals and % total carbon compared to NLON-Ref, is located within the mound formed by recently disposed material. While 400SE is elevated compared to NLON-Ref, the metals (for which NERBC *interim criteria exist)* occur at this and other stations exclusively at Class I levels. This is consistent with their classification in the dredged material prior to disposal. Likewise, significant contamination was not observed in and around the disposal mound in terms of Fe, % total carbon, organochlorine pesticides and PCB's.

The lack of a significant contaminant signature in the disposed material confounds attempts to assess contaminant resuspension and transport. Although the sediment chemistry data (Figure 3-21) indicate that the stations on the mound (CTR and 400SE) were higher in concentrations of trace metals and PCB's, a consistent concentration gradient was not evident. The statistical results (Table 3-3) show that contaminant levels at these outer transect stations were not significantly different from the reference station. If transport was occurring along the transect (the axis of predominant current movement), it is expected that the off-mound transect stations would show higher contaminant levels than the reference station.

As a second approach to addressing the question of contaminant transport, a statistical test (Kruskal-Wallis test) was performed to determine differences in contaminant concentrations among the five transect stations (1500NW, 400NW, CTR, 400SE and 800SE). This test showed that for those contaminants which were detected (As, Cu, Fe, and Pb), there was no significant difference in concentrations among the five stations. As the next step, for each of these metals the replicate values obtained at the five transect stations were pooled and tested against the three replicate reference values (two in the case of Hg). This test (Mann-Whitney U-test) showed that there was no significant difference in the metal concentrations between the reference station and the pooled transect stations. The fact that the transect stations do not differ from each other and collectively do not differ from the reference station strongly suggests that resuspension, transport, and redeposition of the contaminants is not occurring.

4.5 Body Burden Analysis

Reflecting the pattern of sediment contaminant levels, Leptocheirus body burdens at stations in and around the disposal site were generally below detection limits or were significantly less than or not different from those at NLON-Ref. The exceptions to this are various elevations of Pb, Cu, and Fe at stations CTR#2, 400SE and 1500NW (Table 3-6). The variations between CTR#1 and CTR#2 in Pb, Cu, and Fe levels are notable. However, based on the excellent recovery for these elements from spiked laboratory quality assurance procedural blanks (Pb = 88%, Fe = 99%, Cu = 99%), the results reflect station population variability as opposed to analytical inconsistencies.

The objective of the body burden analyses was to assess the relationship between sediment contamination and biological uptake. This relationship was examined for Pb, Cu, and Fe, the only three contaminants displaying both body burdens and sediment concentrations significantly above detection limits. The results of a nonparametric test for association (Spearman's coefficient of rank correlation) show that the mean body burden concentrations of Fe and Cu are not significantly associated with the mean sediment concentrations of these metals (Spearman's rho = 0.66, $P > 0.05$ for both metals). There was some suggestion of a significant association between mean body burdens and sediment concentrations of Pb (Spearman's rho = 0.81, $P = 0.051$), but the small sample size in conjunction with the uncertain exposure history of the test organisms implicit in studies of this nature render any definitive conclusions tenuous.

5.0 CONCLUSIONS

The results of both the bathymetric and REMOTS surveys at New London indicate an accumulation of dredged material well within the disposal site boundaries in the immediate vicinity of the buoy. The bathymetric results show that the mound formed as a result of the past year's disposal activities was approximately 300 m in diameter centered about 60 m southeast of the buoy. The REMOTS images show dredged material layers exceeding the prism penetration depth both on the mound and extending approximately 200 m farther west, south, and southeast than indicated by the bathymetric data. While some of this material was deposited in the past year, it is likely that much of it was the result of disposal prior to the July 1986 REMOTS survey.

There was no depth change observed 530 m northwest of the buoy on the southern flanks of the NL-RELIC mound, where some dredged material was disposed due to miscommunications about the precise disposal point. The apparently allocthonous sediments seen in some REMOTS images from this location can not be identified unequivocally as dredged material due to the heterogeneity in sediments at the site. It is hypothesized that the amount of material indicated in scow logs to have been disposed northwest of the buoy occurred in discontinuous, thin layers which were difficult to detect by either bathymetry or REMOTS.

The widespread occurrence of Stage III taxa at New London indicates that despite on-going disposal activities, significant infaunal recolonization has occurred since the 1986 REMOTS survey. As in 1986, tubicolous amphipods continued to be a major faunal component of the region. The high order successional status and relatively deep RPD values present across the site result in OSI values which were significantly greater than those observed in July 1986.

The relatively high OSI values in 1987 further suggest a lack of stress which might otherwise be attributed to near-bottom hypoxia in this region of the Sound. The absence of hypoxia was confirmed by the results of the CTD/DO sampling, which show that while the potential for transient hypoxic conditions exists, most near-bottom waters at the site were aerobic (i.e., > 4 mg/l DO) and had higher DO concentrations than the reference stations at the time of the survey. It is hypothesized that the observed small-scale spatial and temporal variability in both DO concentrations and the vertical distribution of salinity, temperature, and density was due to the complex interplay of tidal, riverine, and wind-induced water column mixing, which is characteristic of an estuary such as Long Island Sound.

The results of physical testing of sediments at New London were in good agreement with the REMOTS grain-size analyses and reflect both the natural heterogeneity in sediment types characteristic of the site, as well as the addition of dredged material consisting of sand and silty-sand with lesser amounts of clay. Chemical analyses of the sediments indicate the occurrence of several metals (Hg, Pb, As, Cd and Cu) and PCB's at Low concentrations; this is consistent with the classification of these contaminants in the dredged material prior to disposal. There was no significant contamination observed in and around the disposal mound in terms of Fe, % total carbon, and organochlorine pesticides. Based on statistical tests, it does not appear that contaminant resuspension and transport is occurring, although the lack of strong contaminant signature in the recently deposited material makes it difficult to assess such processes unequivocally.

Contaminant levels in tissues of the suspension-feeding amphipod, Leptocheirus, at stations in and around the disposal site were either below detection limits, significantly less than, or not different from levels obtained at the reference station. Statistical tests for association between sediment concentrations and body burdens indicate a lack of strong correlation between the two, but definitive conclusions cannot be made because of the relatively small sample sizes.

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Table 3-1

Results of Physical Testing of Sediment Collected at New London, July 1987

Station	Visual Classification	% Coarse Material	% Medium Sand	% Fine Sand	% Fines
NLON-Ref	olive gray-silty sand	<1	2	59	39
CTR	olive gray-organic sandy silt	<1	7	24	69
800SE	olive gray-silty sand	<1	6	49	45
1500NW	olive gray-silty sand	4	6	44	46
400NW	olive gray-silty sand	2	11	59	28
400SE	olive gray-organic sandy silt	<1	4	27	69

Table 3-2

Trace Metal and Total Organic Carbon Concentrations
in Surface Sediment Collected at New London, July 1987
(Concentrations Based on Dry Weight)

Station/Replicate	Hg ppm	Pb ppm	As ppm	Fe ppm	Cd ppm	Cu ppm	% Total Organic Carbon
NLON-Ref/1	0.07	17	5.6	12,800	Nd	14	0.77
NLON-Ref/2	0.07	19	6.0	14,400	Nd	15	0.87
NLON-Ref/3	Nd	25	6.4	15,300	Nd	13	1.20
Mean	0.07	20	6.0	14,167	-	14	0.95
±Std. Dev.	0	4	0.4	1,266	-	1	0.22
CTR/1	Nd	10	3.9	11,800	Nd	8	1.20
CTR/2	Nd	10	3.3	10,100	Nd	9	1.20
CTR/3	Nd	79	6.9	17,000	Nd	29	3.40
Mean	-	33	4.7	12,967	-	15	1.93
±Std. Dev.	-	40	1.9	3,595	-	12	1.27
800SE/1	0.10	34	7.9	19,400	Nd	21	1.70
800SE/2	0.07	21	6.5	13,200	Nd	12	0.99
800SE/3	0.06	16	5.1	13,300	Nd	13	0.85
Mean	0.08	24	6.5	15,300	-	15	1.18
±Std. Dev.	0.02	9	1.4	3,551	-	5	0.46

Nd = Below minimum detection limit

Table 3-2 (continued)

Station/Replicate	Hg ppm	Pb ppm	As ppm	Fe ppm	Cd ppm	Cu ppm	% Total Organic Carbon
1500NW/1	Nd	20	6.0	10,100	Nd	9	0.40
1500NW/2	0.23	44	10.0	25,300	Nd	37	1.90
1500NW/3	0.06	19	5.3	12,800	Nd	16	1.20
Mean	0.14	28	7.1	16,067	-	21	1.17
±Std. Dev.	0.12	14	2.5	8,109	-	15	0.75
400NW/1	Nd	31	4.4	10,700	Nd	12	1.40
400NW/2	Nd	21	3.2	8,220	Nd	9	0.58
400NW/3	Nd	11	4.4	13,800	Nd	12	0.84
Mean	-	21	4.0	10,907	-	11	0.94
±Std. Dev.	-	10	0.7	2,796	-	2	0.42
400SE/1	0.18	32	9.1	19,300	Nd	22	1.90
400SE/2	0.16	30	7.1	15,800	Nd	23	1.90
400SE/3	0.15	46	8.3	18,400	Nd	31	2.10
Mean	0.16	36	8.2	17,833	-	25	1.97
±Std. Dev.	0.02	9	1.0	1,817	-	5	0.12

Nd = Below minimum detection limits

Table 3-3

Results of Statistical Testing for Significant Differences in Chemical Concentrations in Sediment Collected at New London, July 1987

	Variable						
Station	Hg	Pb	As	Fe	Cd	Cu	% Total Carbon
CTR	na	ns	ns	ns	na	ns	ns
800SE	ns	ns	ns	ns	na	ns	ns
1500NW	ns	ns	ns	ns	na	ns	ns
400NW	na	ns	-	ns	na	-	ns
400SE	ns	+	+	+	na	+	+

+ = concentrations significantly higher than Reference station ($p \leq 0.05$, Mann-Whitney U-test)

- = concentrations significantly less than Reference station ($p \leq 0.05$, Mann-Whitney U-test)

ns = not significantly different from Reference station ($p > 0.05$, Mann-Whitney U-test)

na = statistical test not applicable because chemical concentrations were below detection limits in some or all replicates

Table 3-4

Organochlorine Pesticides and PCB's in Sediment Collected at New London, July 1987. Concentrations are Based on Dry Weight (ppb).

Parameter	Detection Limits (ppb)	REF	CTR	800SE	1500NW	400NW	400SE
Alpha-BHC	8	ND	ND	ND	ND	ND	ND
Beta-BHC	8	ND	ND	ND	ND	ND	ND
Delta-BHC	8	ND	ND	ND	ND	ND	ND
Gamma-BHC (Lindane)	8	ND	ND	ND	ND	ND	ND
Heptachlor	8	ND	ND	ND	ND	8.9	ND
Aldrin	8	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	8	ND	ND	ND	ND	ND	ND
Endosulfan I	8	ND	ND	ND	ND	ND	ND
Dieldrin	16	ND	ND	ND	ND	ND	ND
4,4'-DDE	16	ND	ND	ND	ND	ND	ND
Endrin	16	ND	ND	ND	ND	ND	ND
Endosulfan II	16	ND	ND	ND	ND	ND	ND
4,4'-DDD	16	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	16	ND	ND	ND	ND	ND	ND
4,4'-DDT	16	ND	ND	ND	ND	82	ND
Methoxychlor	80	ND	ND	ND	ND	ND	ND
Endrin Ketone	16	ND	ND	ND	ND	ND	ND
Chlordane	80	ND	ND	ND	ND	ND	ND
Toxaphene	160	ND	ND	ND	ND	ND	ND
Endrin aldehyde	16	ND	ND	ND	ND	ND	ND
Aroclor-1016	80	ND	ND	ND	ND	ND	ND
Aroclor-1221	80	ND	ND	ND	ND	ND	ND
Aroclor-1232	80	ND	220	ND	280	ND	ND
Aroclor-1242	80	ND	ND	160	ND	380	ND
Aroclor-1248	80	ND	ND	ND	ND	ND	ND
Aroclor-1254	160	ND	ND	ND	ND	ND	ND
Aroclor-1260	160	ND	ND	ND	ND	ND	ND
Aroclor-1262	***	ND	ND	ND	ND	ND	ND
Aroclor-1268	***	ND	ND	ND	ND	ND	ND

ND = not detected
***The detection limits for Aroclors 1262 and 1268 are similar to that for Aroclor 1260.

Table 3-5

Trace Metal Concentrations in Body Tissues (Dry Weight) of *Leptocheirus* Collected at New London, July 1987

	Concentrations in ppm				
Station/Replicate	Cd	Pb	Cu	Fe	Hg
NLON-Ref/1	<0.26	3.6	81.9	663	<0.03
NLON-Ref/2	<0.26	4.7	90.2	725	<0.03
NLON-Ref/3	<0.26	3.1	87.6	674	<0.03
Mean	<0.26	3.8	86.6	687	<0.03
±Std. Dev.	-	0.8	4.2	33	-
CTR #1/1	<0.65	3.9	50.7	458	<0.03
CTR #1/2	<0.65	<3	50.7	417	<0.03
CTR #1/3	<0.65	<3	54.6	505	<0.03
Mean	<0.65	3.3	52.0	460	<0.03
±Std. Dev.	-	0.5	2.3	44	-
CTR #2/1	<0.64	5.1	284.1	404	<0.03
CTR #2/2	<0.64	5.1	247.1	377	<0.03
CTR #2/3	<0.64	5.1	207.6	359	<0.03
Mean	<0.64	5.1	246.3	380	<0.03
±Std. Dev.	-	0	38.3	23	-
800SE/1	<0.28	<3	79.7	671	<0.03
800SE/2	<0.28	3.4	84.8	660	<0.03
800SE/3	<0.28	<3	78.5	751	<0.03
Mean	<0.28	3.1	81.0	694	<0.03
±Std. Dev.	-	0.2	3.3	50	-
400NW/1	<0.27	3.2	47.9	872	<0.03
400NW/2	<0.27	<3	69.7	692	<0.03
400NW/3	<0.27	<3	62.8	840	<0.03
Mean	<0.27	3.1	60.1	801	<0.03
±Std. Dev.	-	0.1	11.1	96	-

Table 3-5 (continued)

Station/Replicate	Cd	Pb	Cu	Fe	Hg
	Concentrations in ppm				
400SE/1	<0.51	8.1	130.3	1405	<0.03
400SE/2	<0.51	6.1	141.5	1282	<0.03
400SE/3	<0.51	10.1	126.2	1242	<0.03
Mean	<0.51	8.1	132.7	1310	<0.03
±Std. Dev.	-	2	7.9	85	-
1500NW/1	<0.42	5.1	114.4	898	<0.03
1500NW/2	<0.42	4.2	106.8	898	<0.03
1500NW/3	<0.42	4.2	106.8	881	<0.03
Mean	<0.42	4.5	109.3	892	<0.03
±Std. Dev.	-	0.5	4.4	10	-

Table 3-6

Results of Statistical Testing for Significant Differences in Chemical Concentrations in Body Tissues of *Leptocheirus* Collected at New London, July 1987

	Variable					
Station	Cd	Pb	Cu	Fe	Hg	PCBs (as Aroclor 1254)
CTR #1	na	ns	-	-	ns	ns
CTR #2	na	+	+	-	ns	ns
800SE	na	ns	ns	ns	ns	ns
400NW	na	ns	-	ns	ns	ns
400SE	na	+	+	+	ns	ns
1500NW	na	ns	+	+	ns	-

\+ = concentrations significantly higher than Reference animals ($p \leq 0.05$, Mann-Whitney U-test)

\- = concentrations significantly less than Reference animals ($p \leq 0.05$, Mann-Whitney U-test)

ns = no significant difference between station value and Reference value ($p > 0.05$, Mann-Whitney U-test)

na = not applicable, statistical tests were not performed because of varying analytical detection limits

Table 3-7

PCBs (as Aroclor 1254) in Body Tissues (Dry Weight) of *Leptocheirus* Collected at New London, July 1987

Concentrations in ppm

Station/Replicate	PCBs (as Aroclor 1254)	Mean ± Std. Dev.
NLON-Ref/1	0.372	
NLON-Ref/2	0.105	
NLON-Ref/3	0.180	0.219 ± .138
CTR #1/1	0.248	
CTR #1/2	0.080	
CTR #1/3	0.131	0.153 ± .086
CTR #2/1	0.033	
CTR #2/2	0.178	
CTR #2/3	0.192	0.134 ± .088
800SE/1	0.227	
800SE/2	0.163	
800SE/3	0.150	0.180 ± .041
400NW/1	0.094	
400NW/2	0.057	
400NW/3	<0.005[1]	0.052 ± .045
400SE/1	0.115	
400SE/2	0.101	
400SE/3	0.138	0.118 ± .019
1500NW/1	0.016	
1500NW/2	<0.005[1]	
1500NW/3	<0.005[1]	0.009 ± .006

[1] below detection limit

Table 4-1

Ecologically Important Dissolved Oxygen Ranges as Determined from Permanently Stratified Low-Oxygen Marine Basins (from Rhoads and Morse, 1971)

Dissolved Oxygen Range (mg/l)	Facies
> 4.2	Aerobic
4.2 to 0.41	Hypoxic*
0.4 to 0.14	Dysaerobic
< 0.14	Anaerobic

* The hypoxic facies has been added to the Rhoads and Morse (1971) basin model by Dr. Barbara Welsh, University of Connecticut, to include responses of high metabolic rate demersal or benthic megafauna.

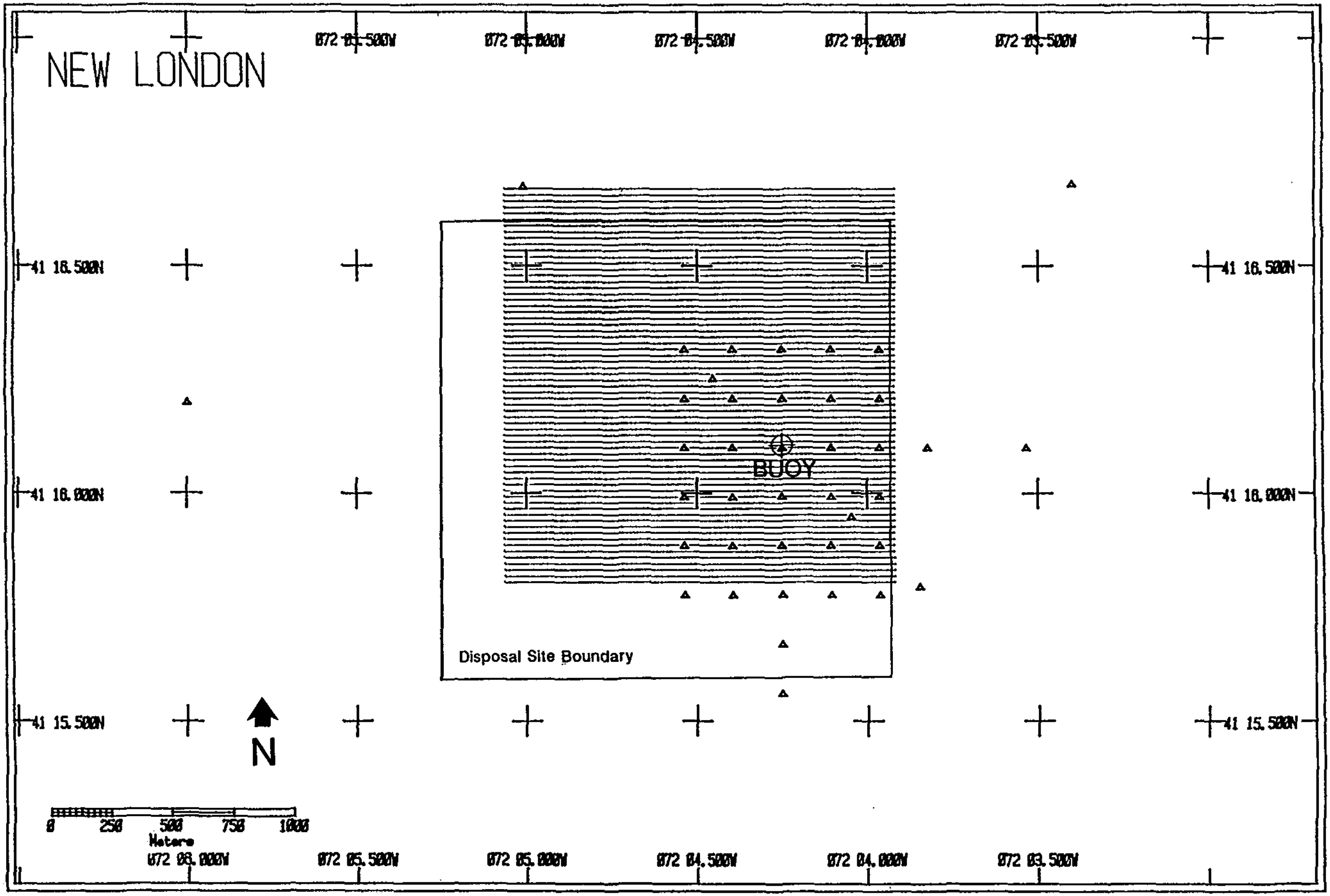


Figure 2-1. Bathymetric survey lanes at the New London Disposal Site. The triangles represent REMOTS® stations.

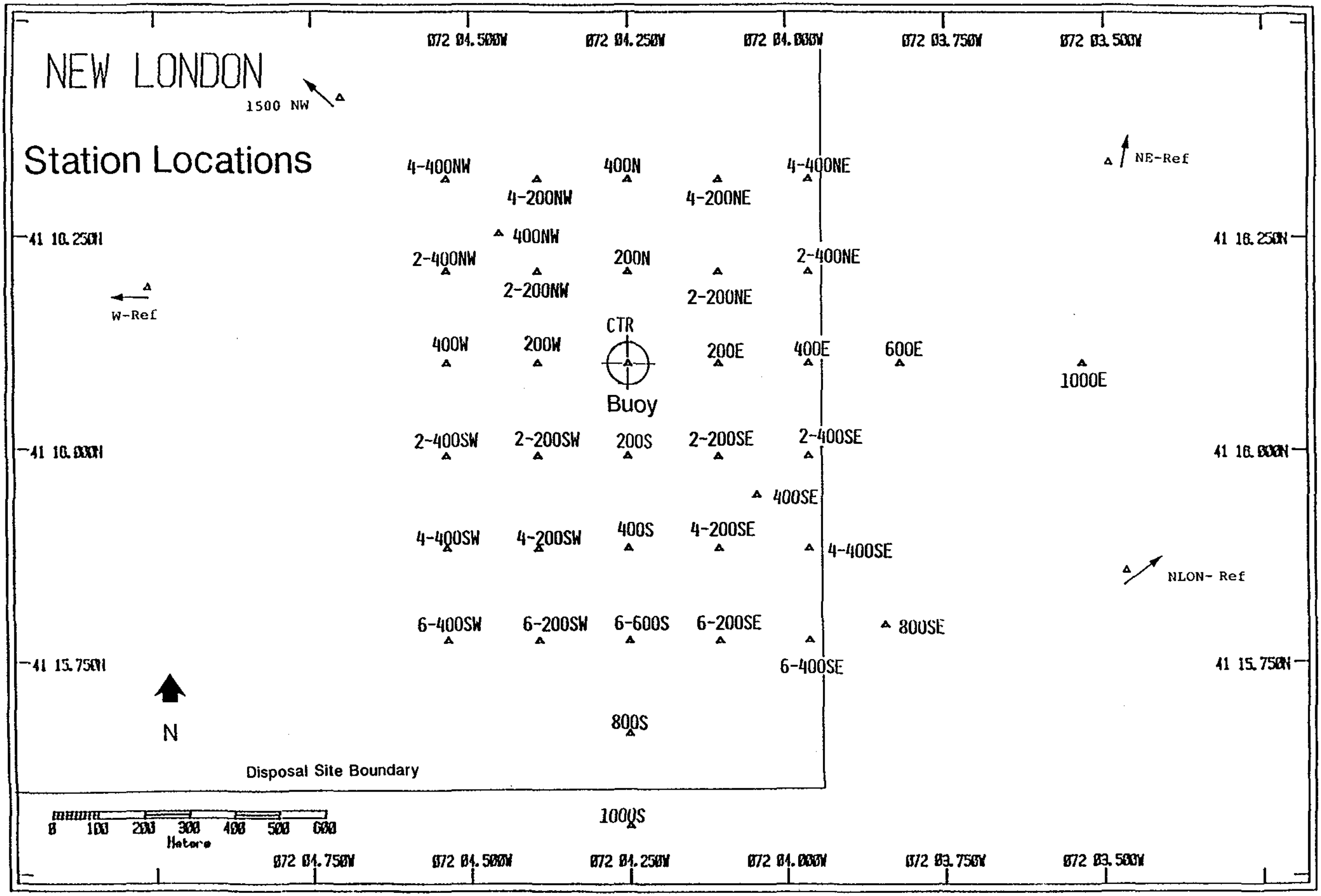


Figure 2-2. Locations and designations of REMOTS stations (triangles) at the New London Disposal Site, July 1987.

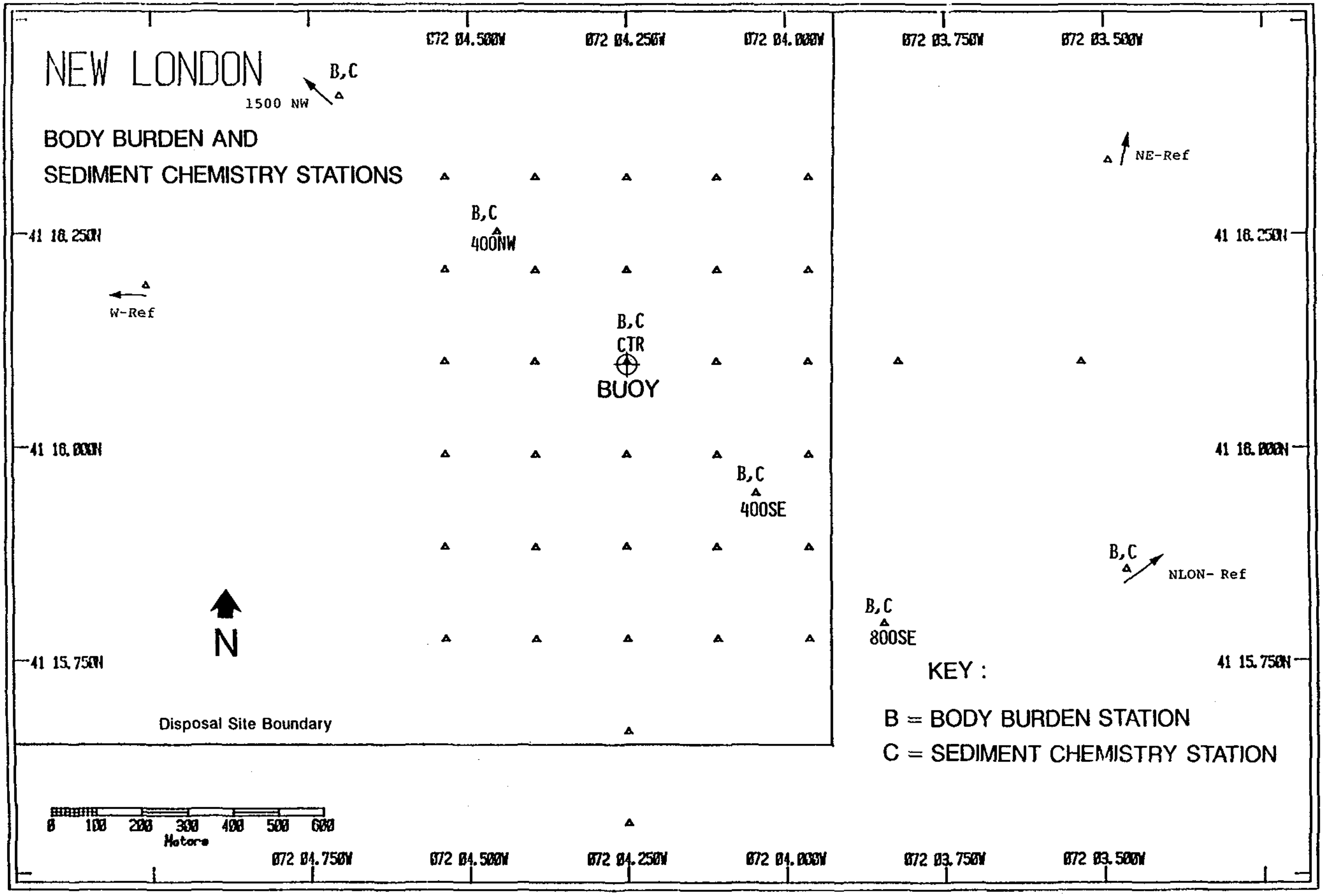


Figure 2-3. The location of sediment chemistry and body burden stations at the New London Disposal Site, July 1987.

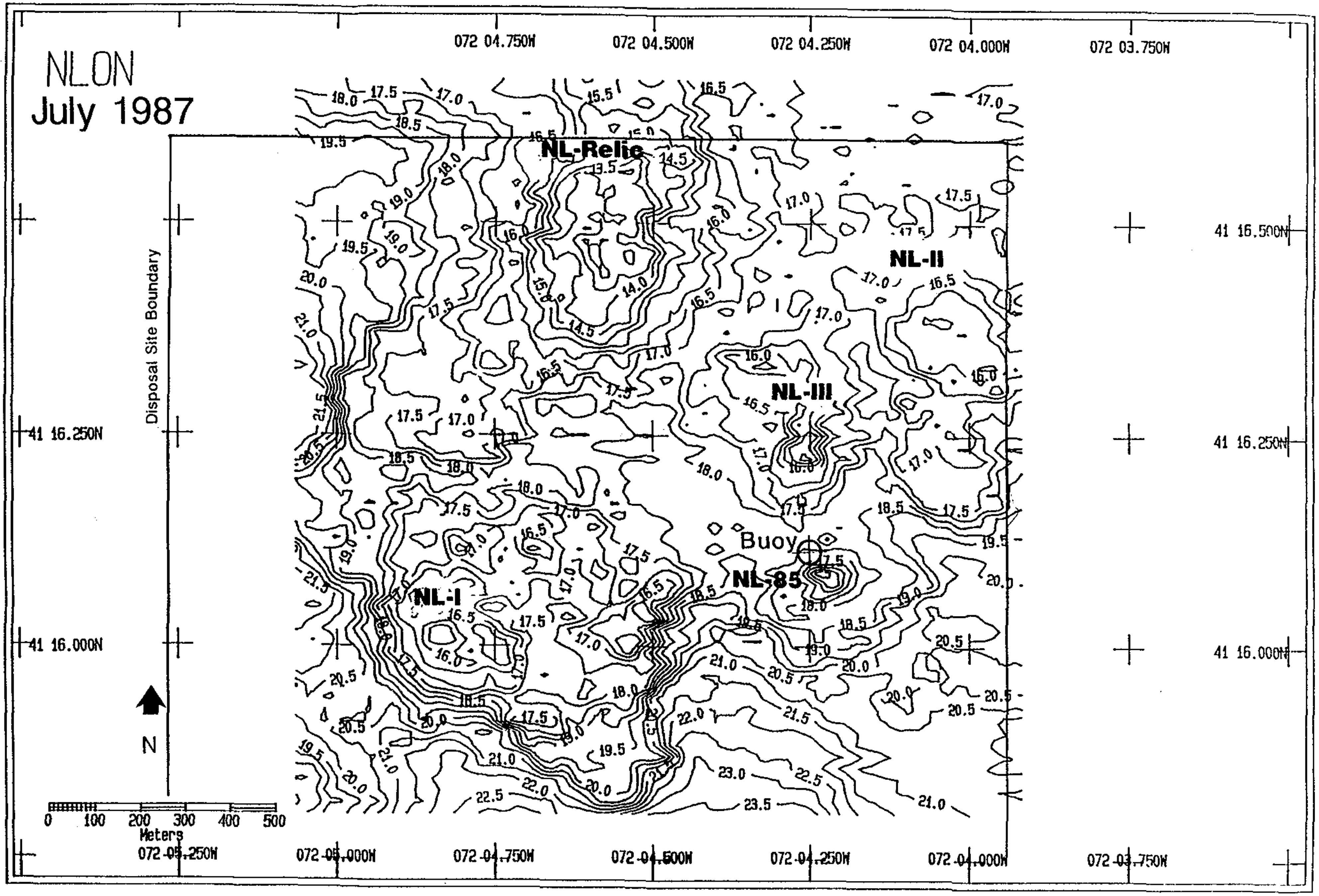


Figure 3-1. Contoured bathymetric chart of the New London Disposal Site in July 1987. Depth in meters.

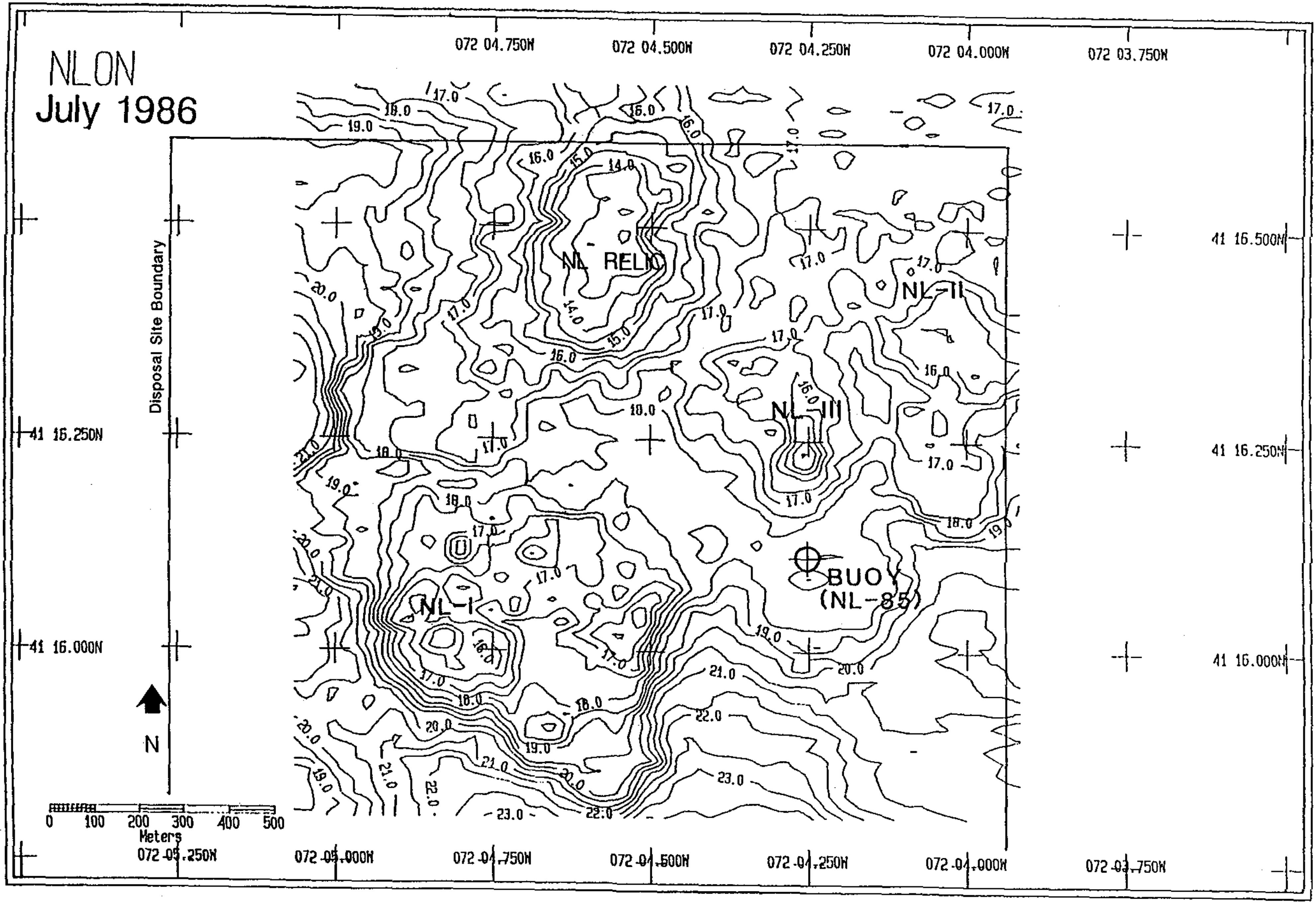


Figure 3-2. **Contoured bathymetric chart of the New London Disposal Site in July 1986. Depth in meters.**

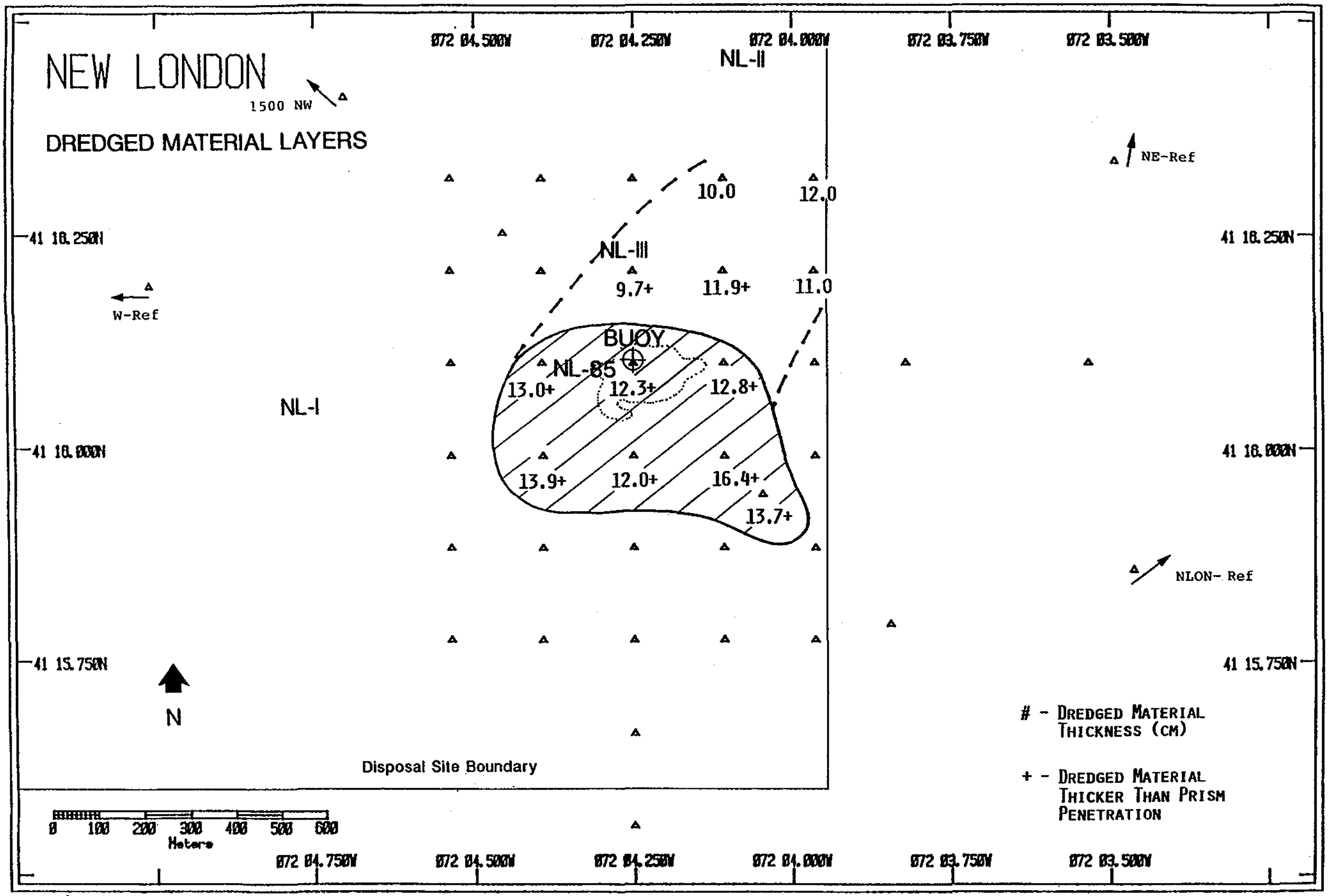


Figure 3-3. Distribution of dredged material at the New London Disposal Site, July 1987. The solid contour delimits the extent of low reflectance dredged material layers which exceed the prism peneteration depth. The dashed line encloses dredged material apparently deposited in past years. The dotted outline shows the accumulation of material since the 1986 survey depicted by bathymetry. Dredged material was not evident at stations where no values are indicated.

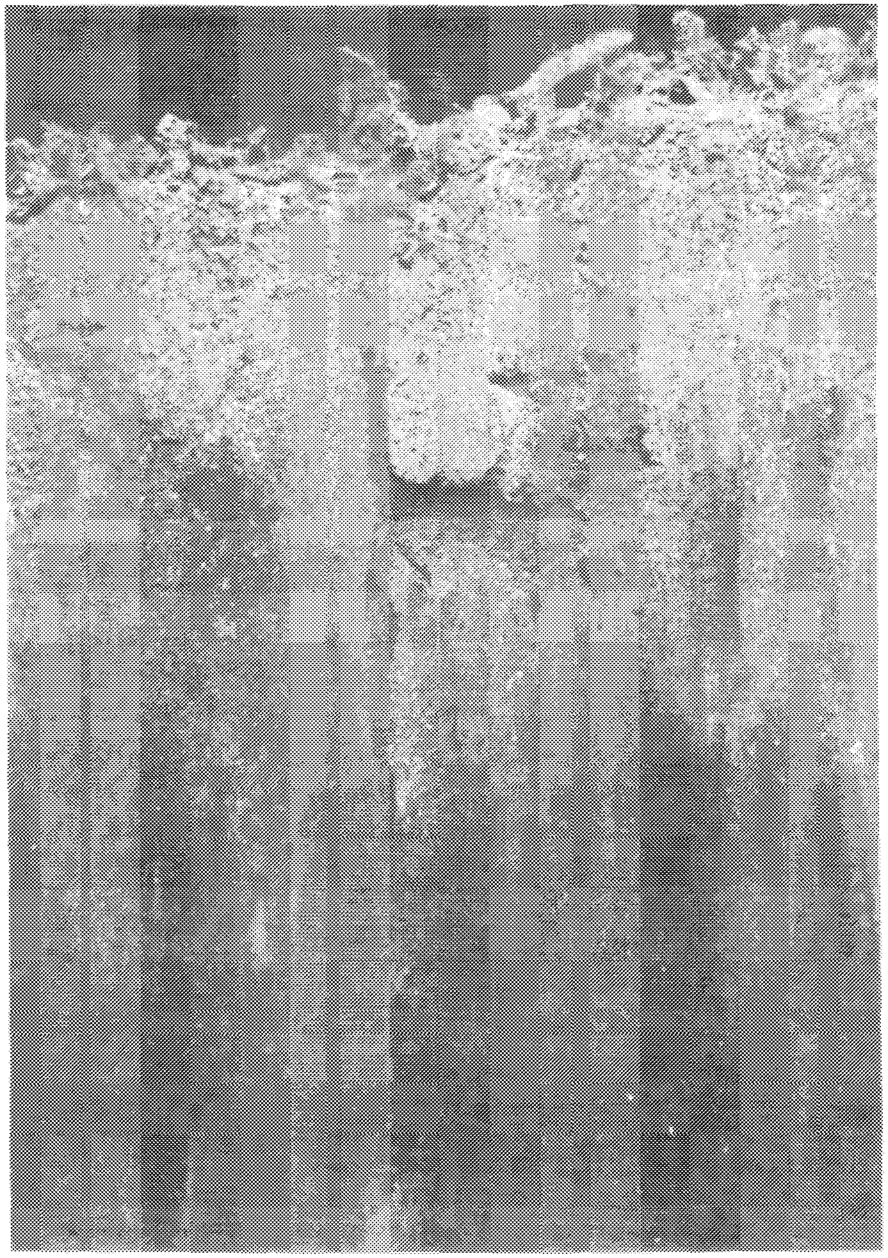


Figure 3-4. REMOTS® image from station 200W showing a typical dredged material layer which exceeds the camera prism penetration depth. This material is characterized by a distinct redox contrast and extreme low reflectance. Also note the amphipod mat at the sediment surface. Scale of image = 1X.

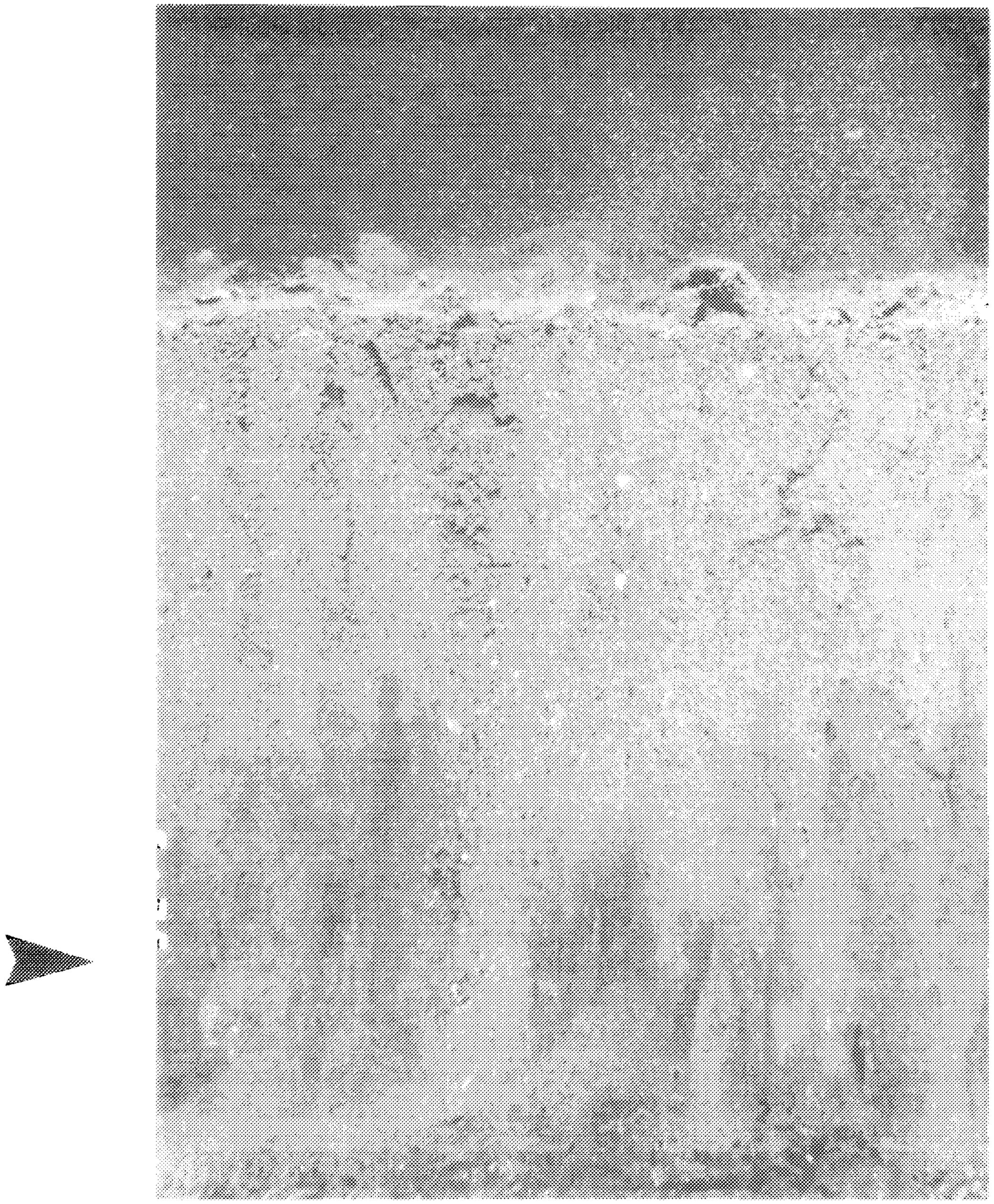


Figure 3-5. REMOTS® image from station 2-400NE illustrating an apparent "relict" dredged material layer. This low contrast layer (arrow) has a maximum depth of approximately 11 cm. Scale = 1X.

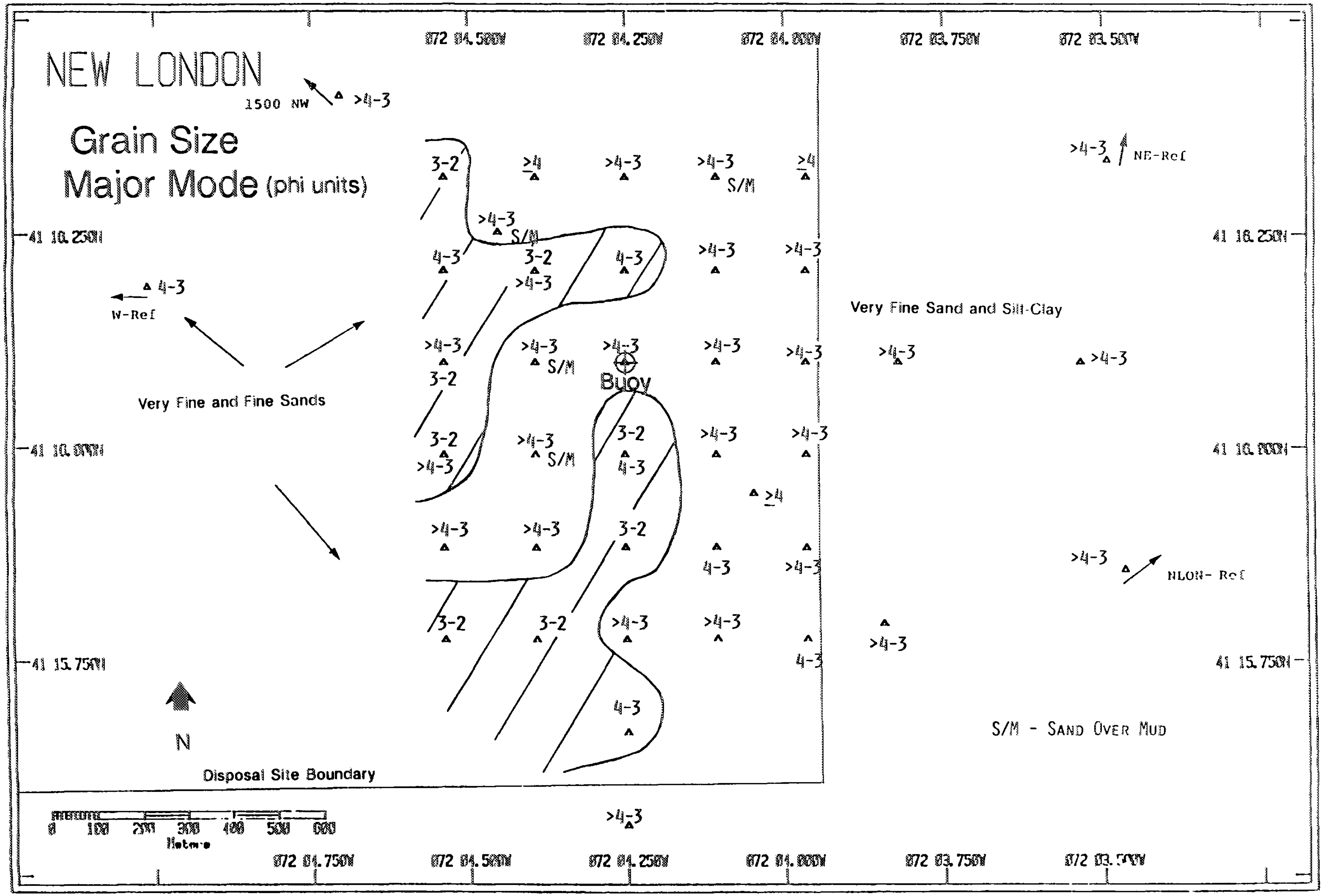
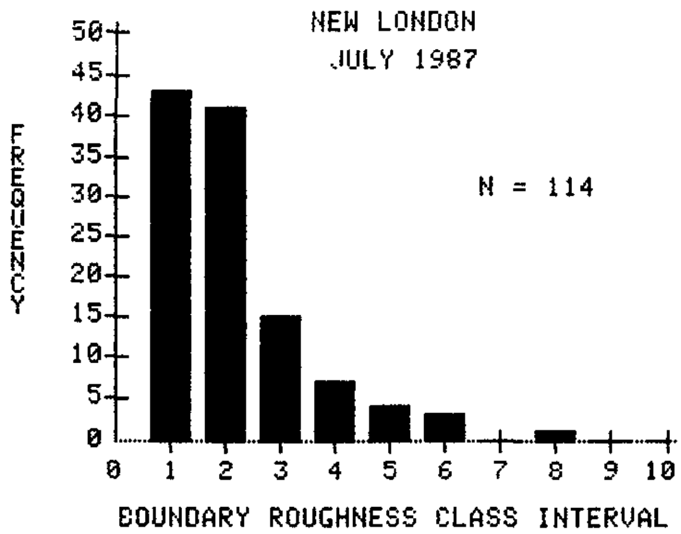
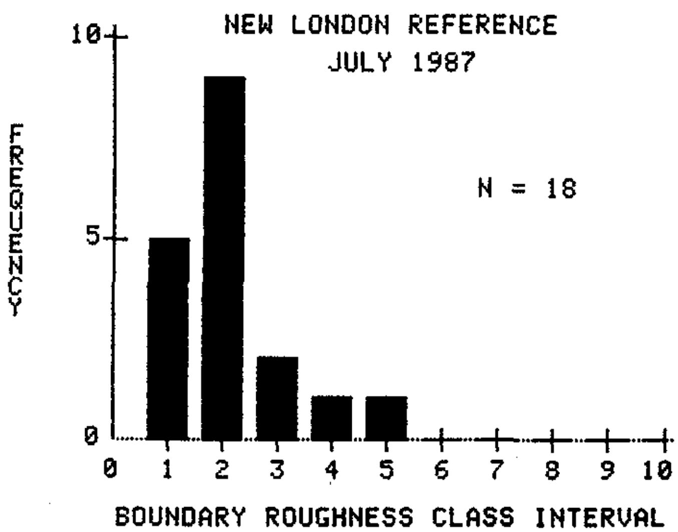


Figure 3-6. Map of sediment grain size major mode (in phi units) at the New London Disposal Site, July 1987.

Figure 3-7. A layer of fine sand overlies silt-clay in this REMOTS® image from station 4-200NE. The sand layer may reflect inputs of coarse-grained dredged material. Scale = 1X.





KEY

Class Interval	Range of Boundary Roughness (cm)
1	0.0 - 0.6
2	0.6 - 1.0
3	1.0 - 1.4
4	1.4 - 1.8
5	1.8 - 2.2
6	2.2 - 2.6
7	2.6 - 3.0
8	3.0 - 3.4
9	3.4 - 3.8
10	3.8 - 4.2
11	4.2 - 4.6
12	4.6 - 5.0

Figure 3-8. Frequency distributions of small-scale surface boundary roughness values for all replicates at the New London Disposal Site and reference stations, July 1987.

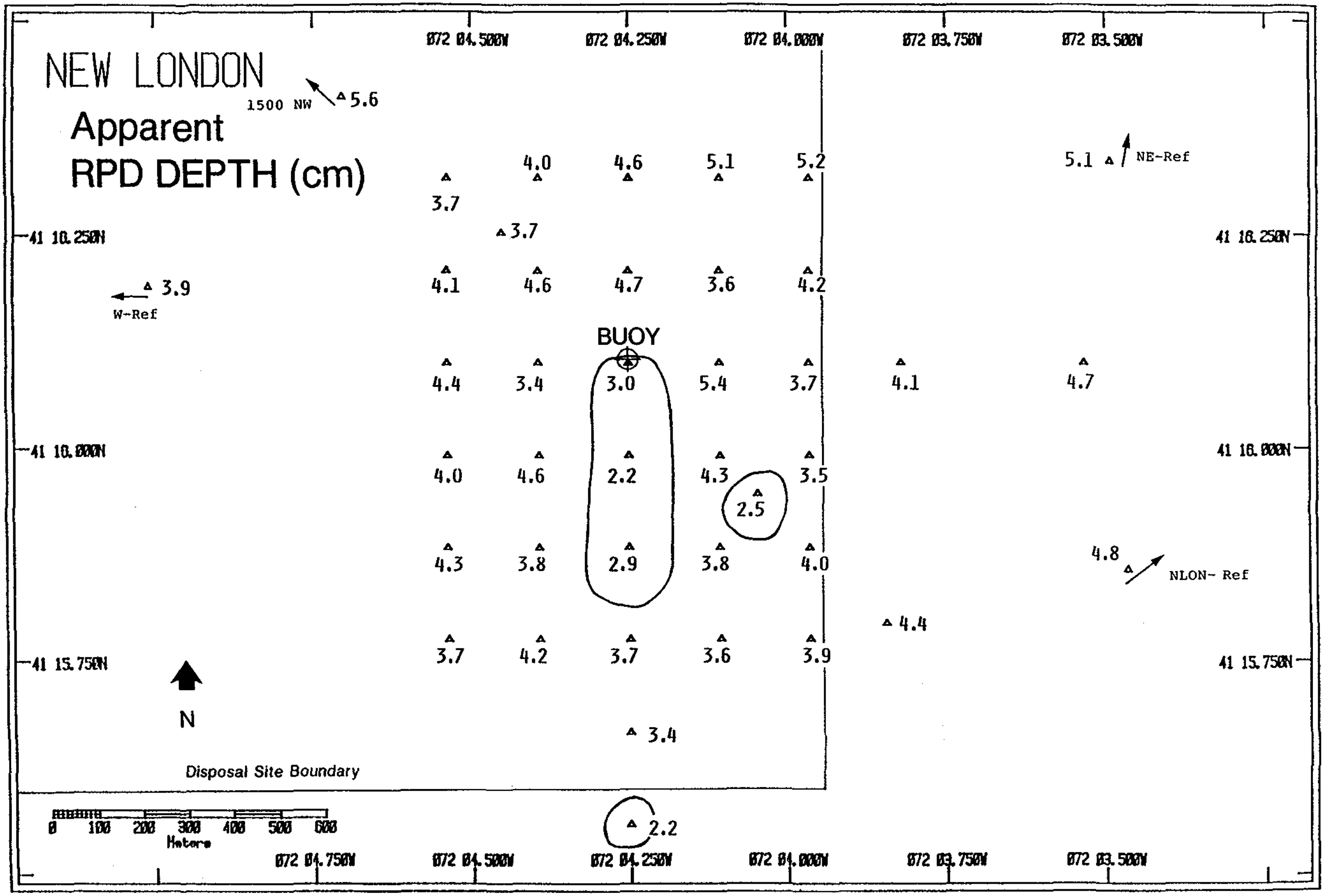


Figure 3-9. The distribution of apparent RPD depths (cm), averaged by station, at the New London Disposal Site, July 1987. The solid lines show the outline of the stations exhibiting average RPD depths ≤ 3.0 cm.

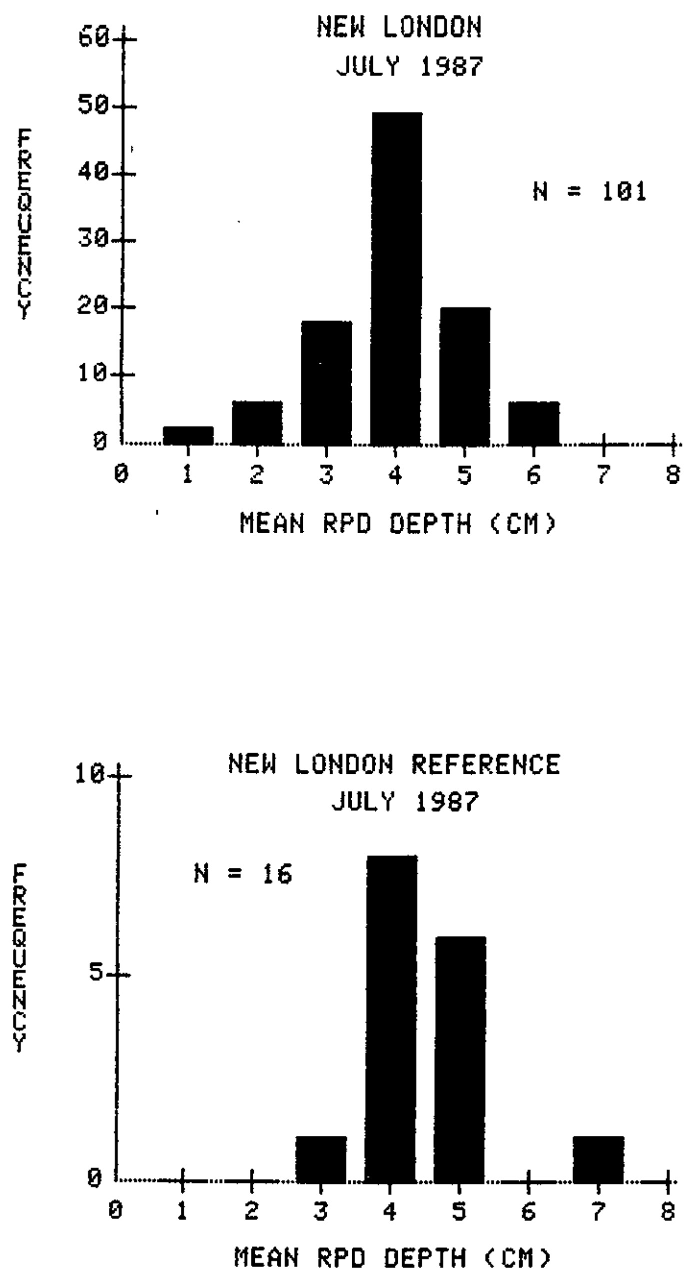


Figure 3-10. Frequency distributions of apparent RPD depths for all replicates at the New London Disposal Site and reference stations, July 1987.

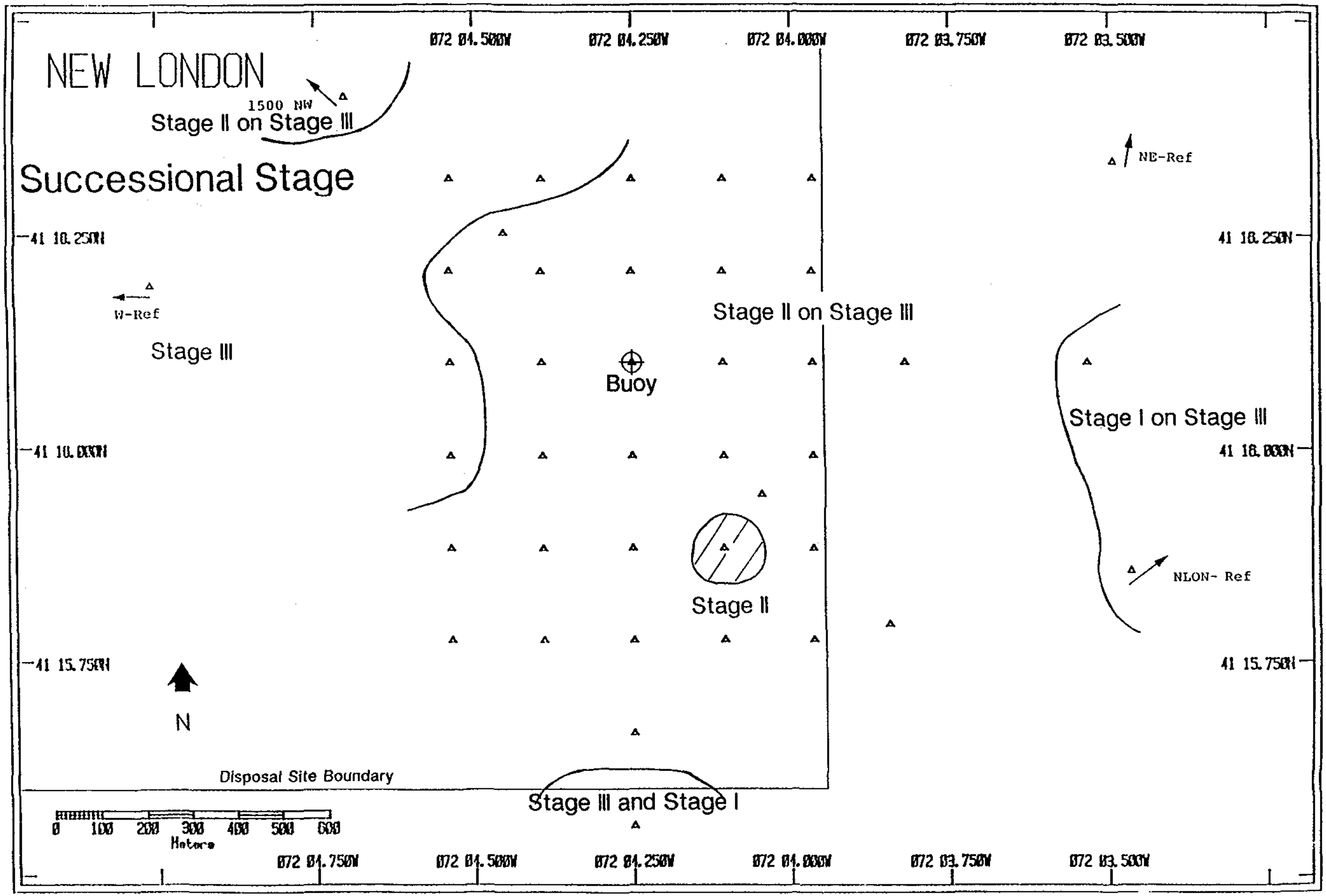


Figure 3-11. The distribution of infaunal successional stages at the New London Disposal Site, July 1987. The hatching indicates the single station where Stage III taxa were not present. The contours delimit areas lacking Stage II taxa (tube dwelling amphipods).

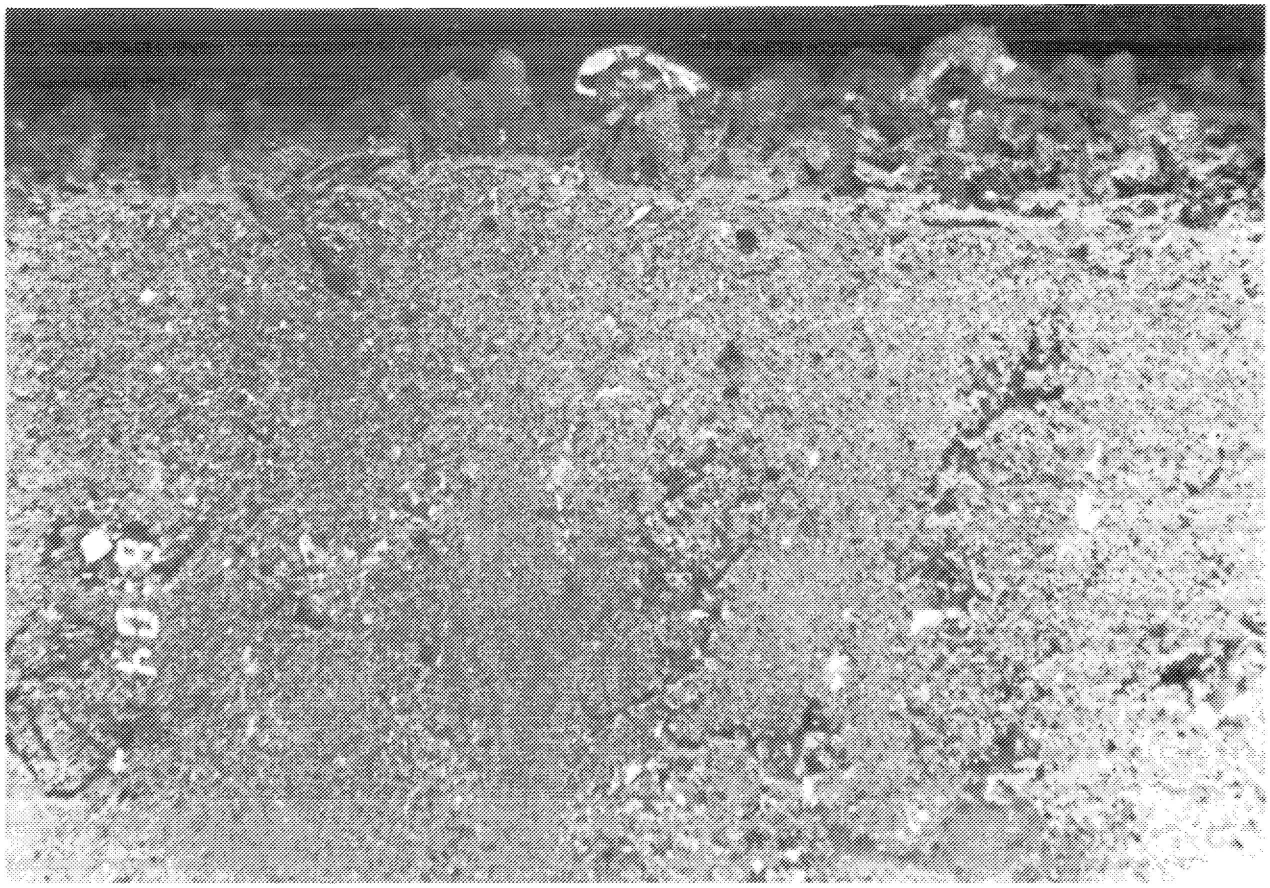


Figure 3-12. A dense assemblage of tube-dwelling amphipods is visible at the sediment surface in this REMOTS® image from station 2-200NW. These amphipods occur throughout the New London site, usually together with Stage III taxa. Also note the hermit crab. Scale = 1X.

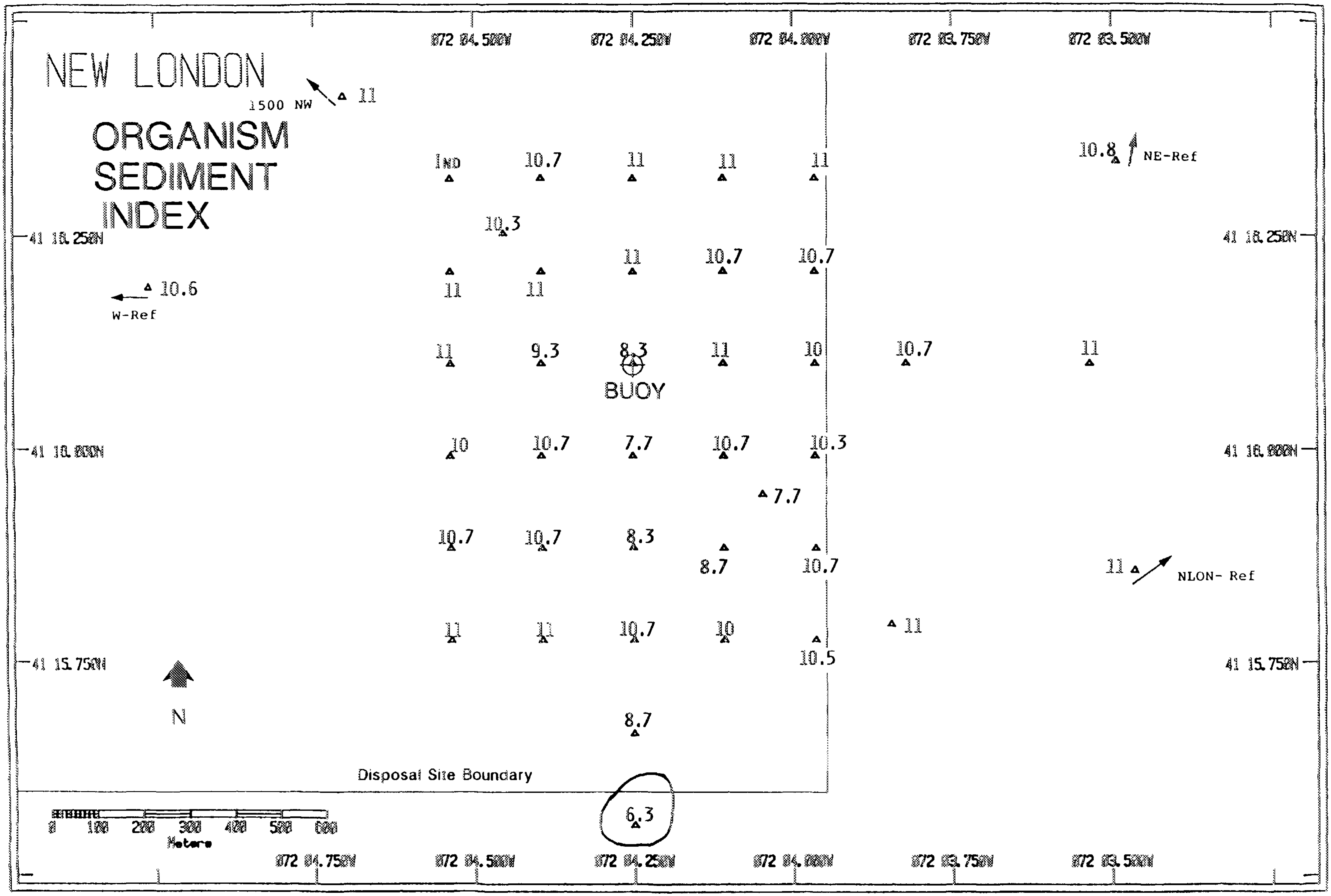
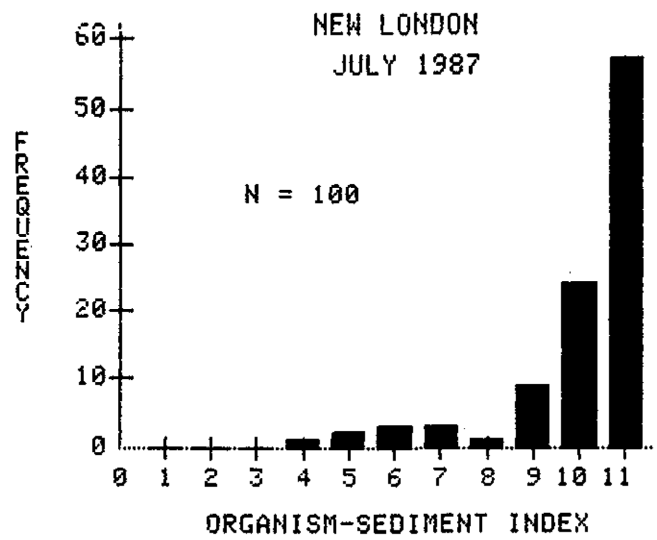


Figure 3-13. The distribution of Organism-Sediment Indices, averaged by station, at the New London Disposal Site, July 1987.



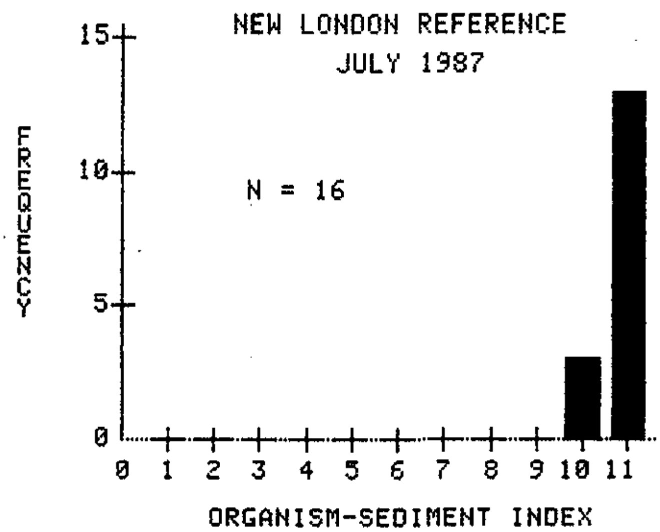


Figure 3-14. Frequency distributions of Organism-Sediment Index values for all replicates at the New London Disposal Site and reference stations, July 1987.

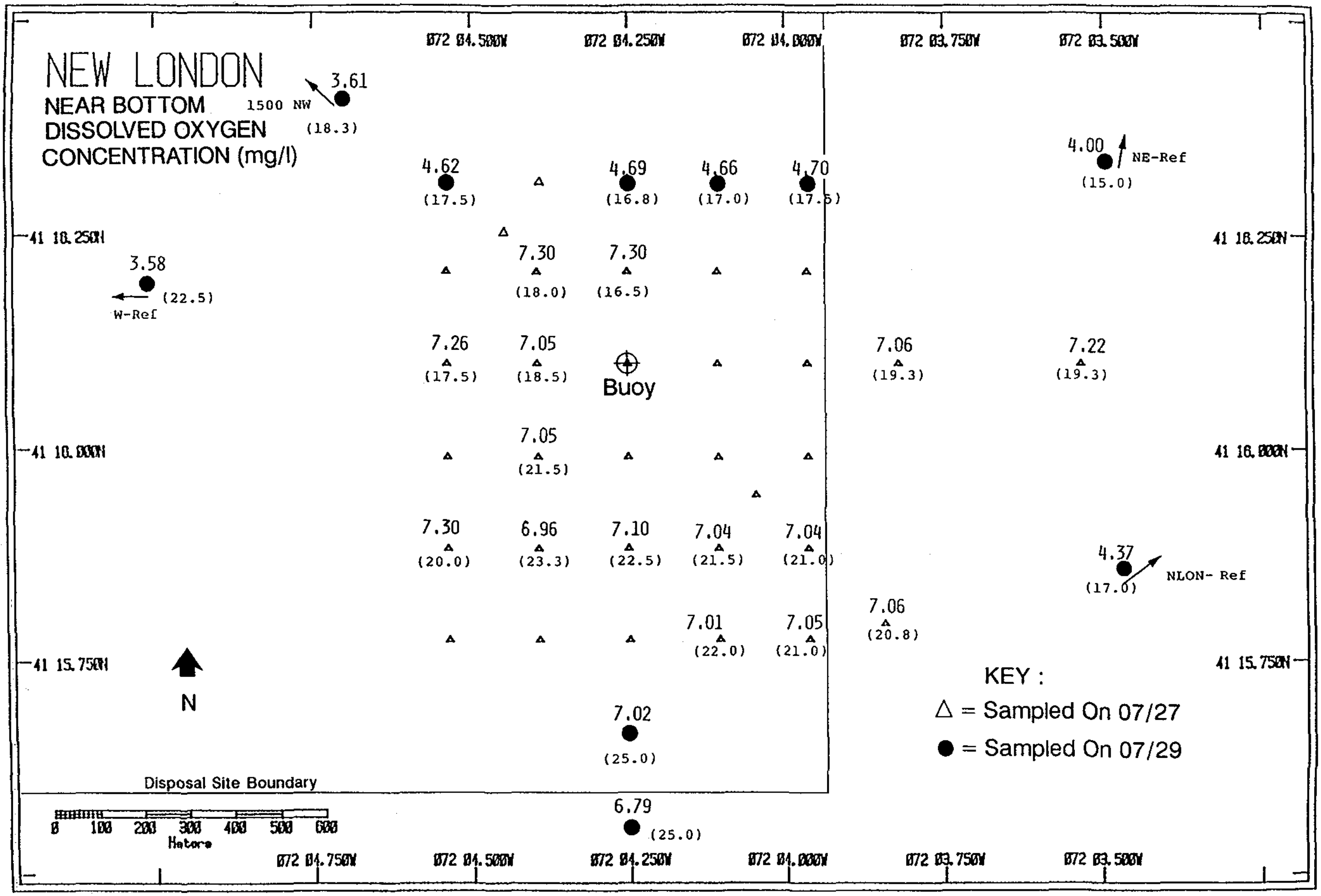


Figure 3-15. Near-bottom dissolved oxygen levels (mg/l) measured at selected stations at the New London Disposal Site in July 1987. Depths (in meters) at which measurements were made are in parentheses. Depths were obtained from the CTD pressure data and are not corrected to MLW.

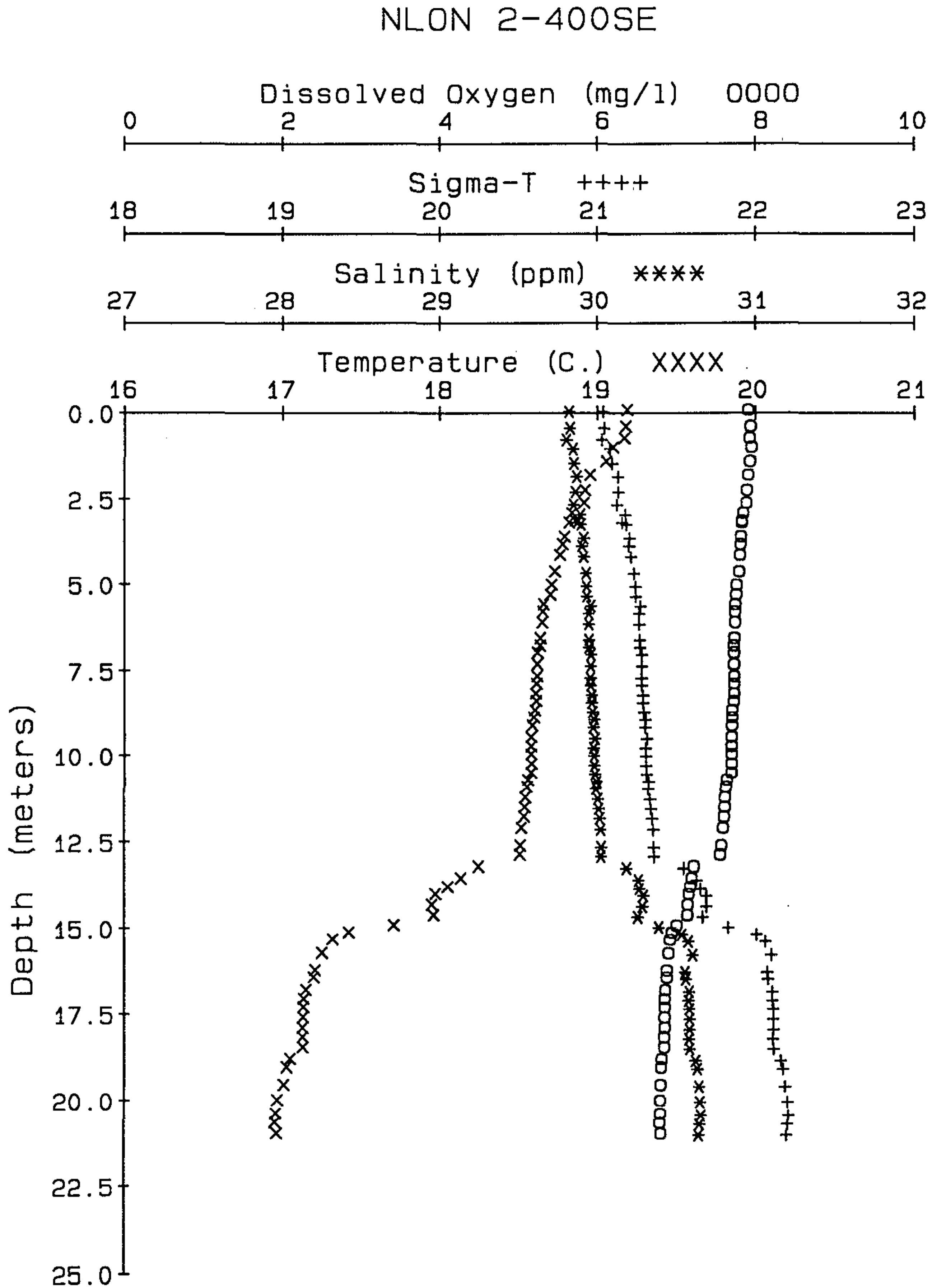


Figure 3-16. **A CTD/DO plot obtained at Station 2-400SE on 27 July 1987.**

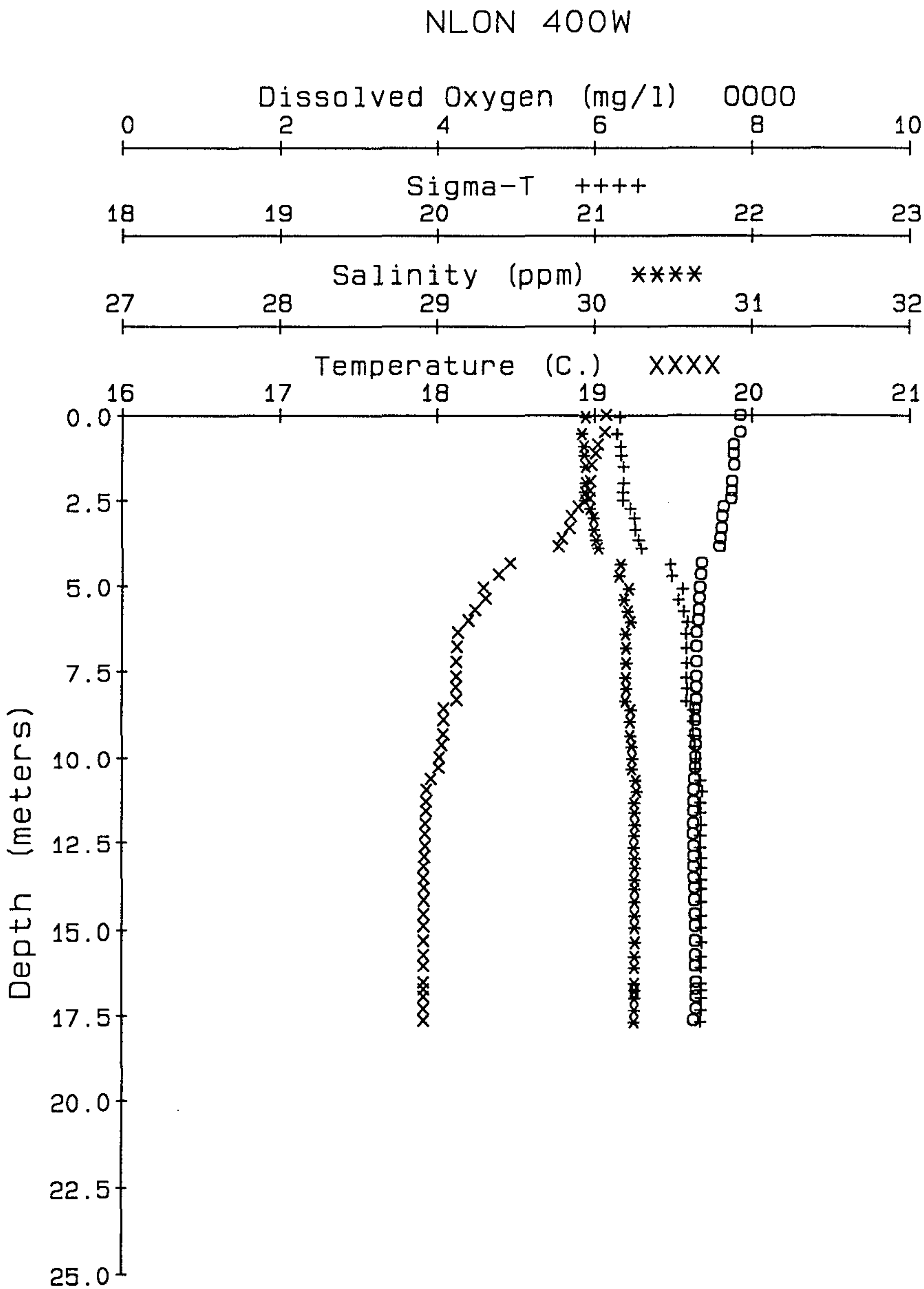


Figure 3-17. A CTD/DO plot obtained at Station 400W on 27 July 1987.

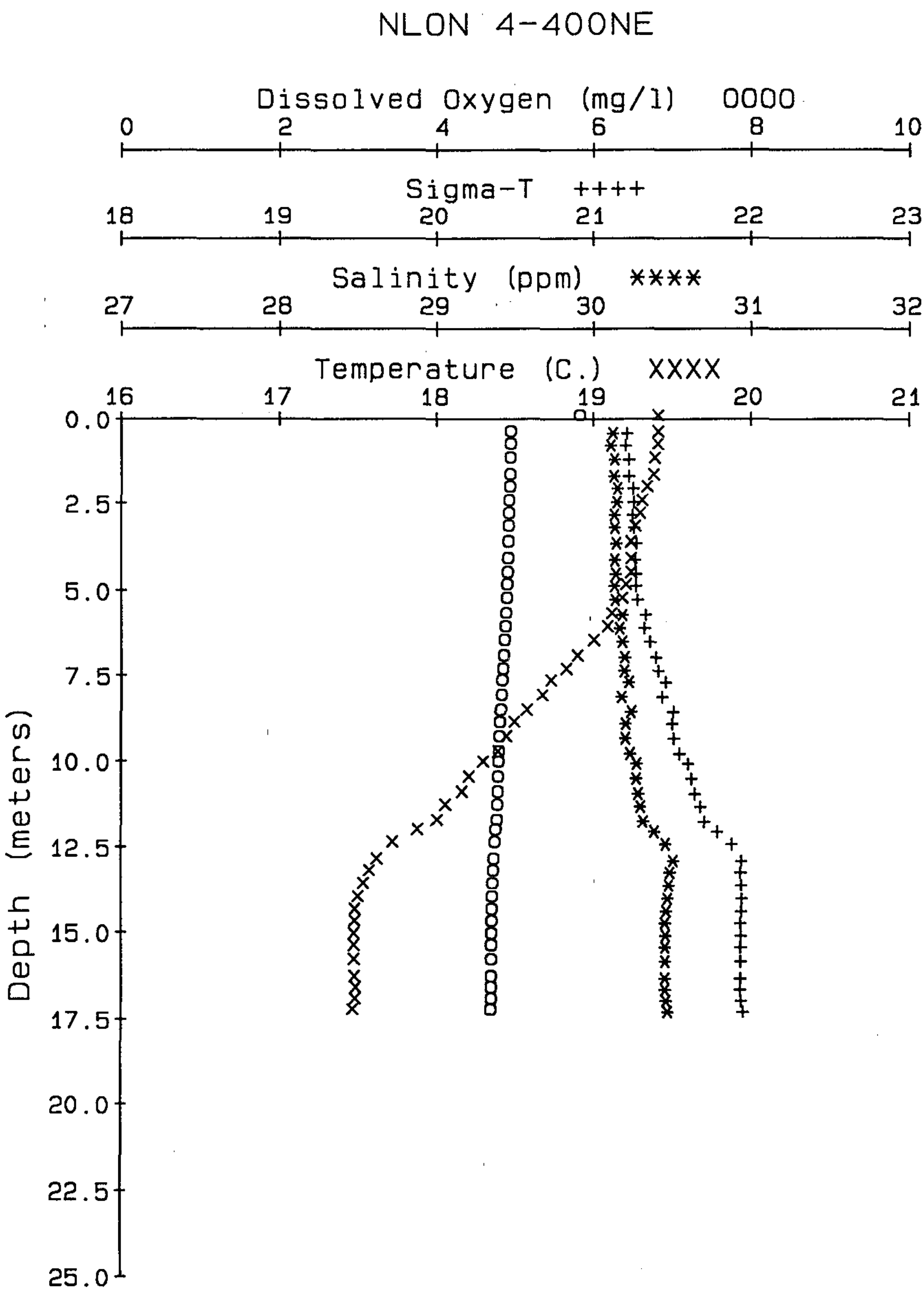


Figure 3-18. **A CTD/DO plot obtained at Station 4-400NE on 29 July 1987.**

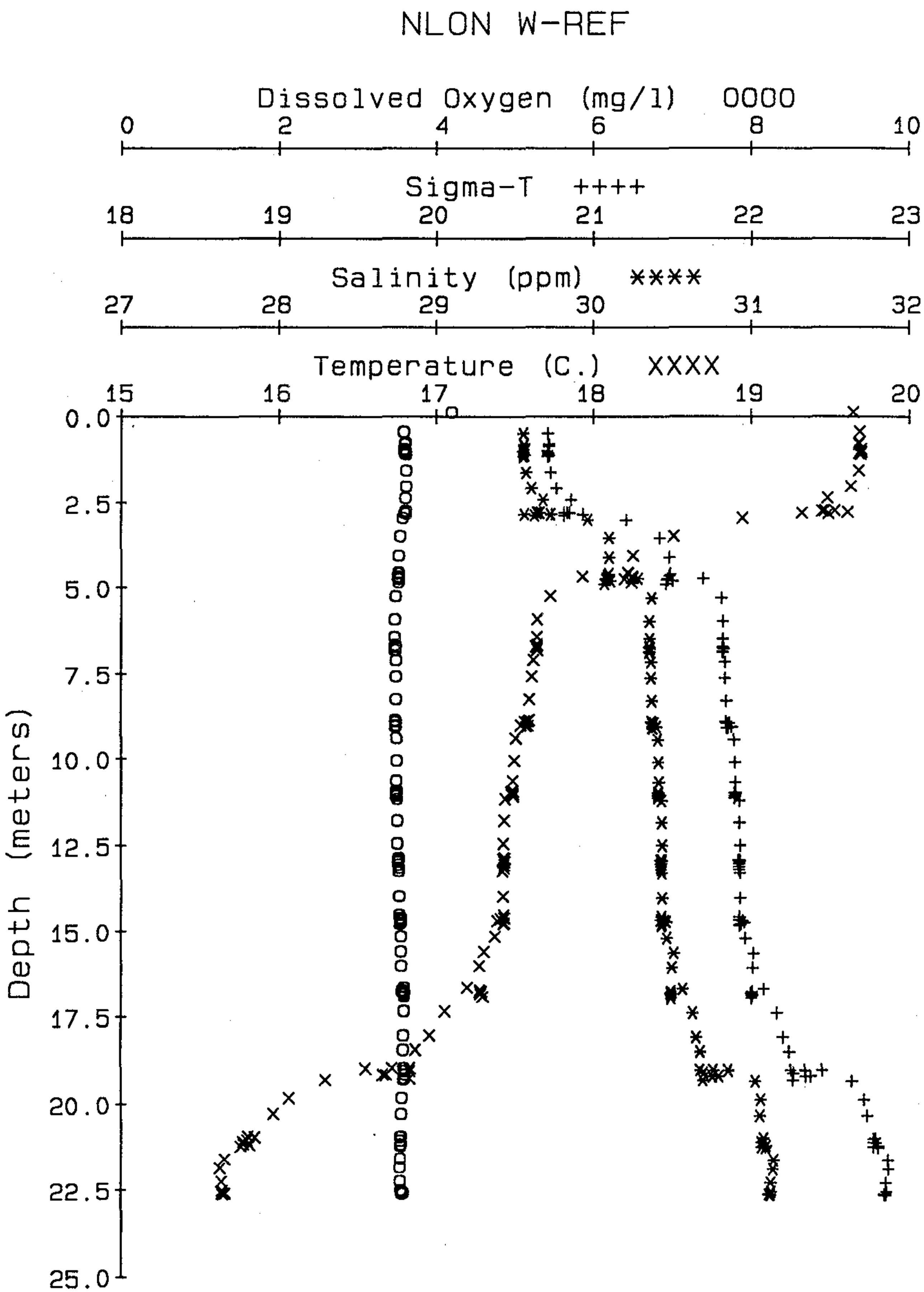


Figure 3-19. **A CTD/DO plot obtained at Station W-Ref on 29 July 1987.**

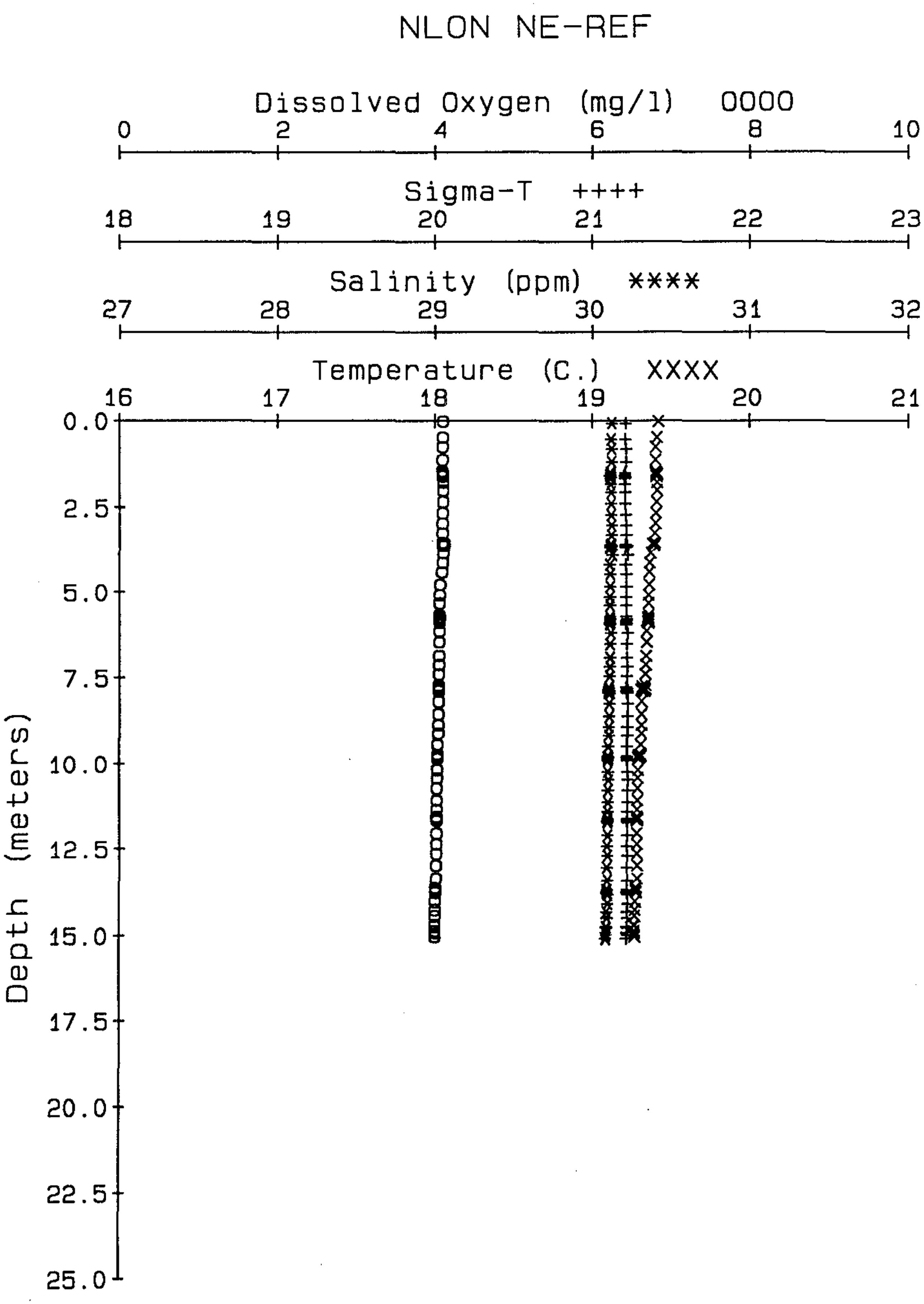


Figure 3-20. A CTD/DO plot obtained at Station NE-Ref on 29 July 1987.

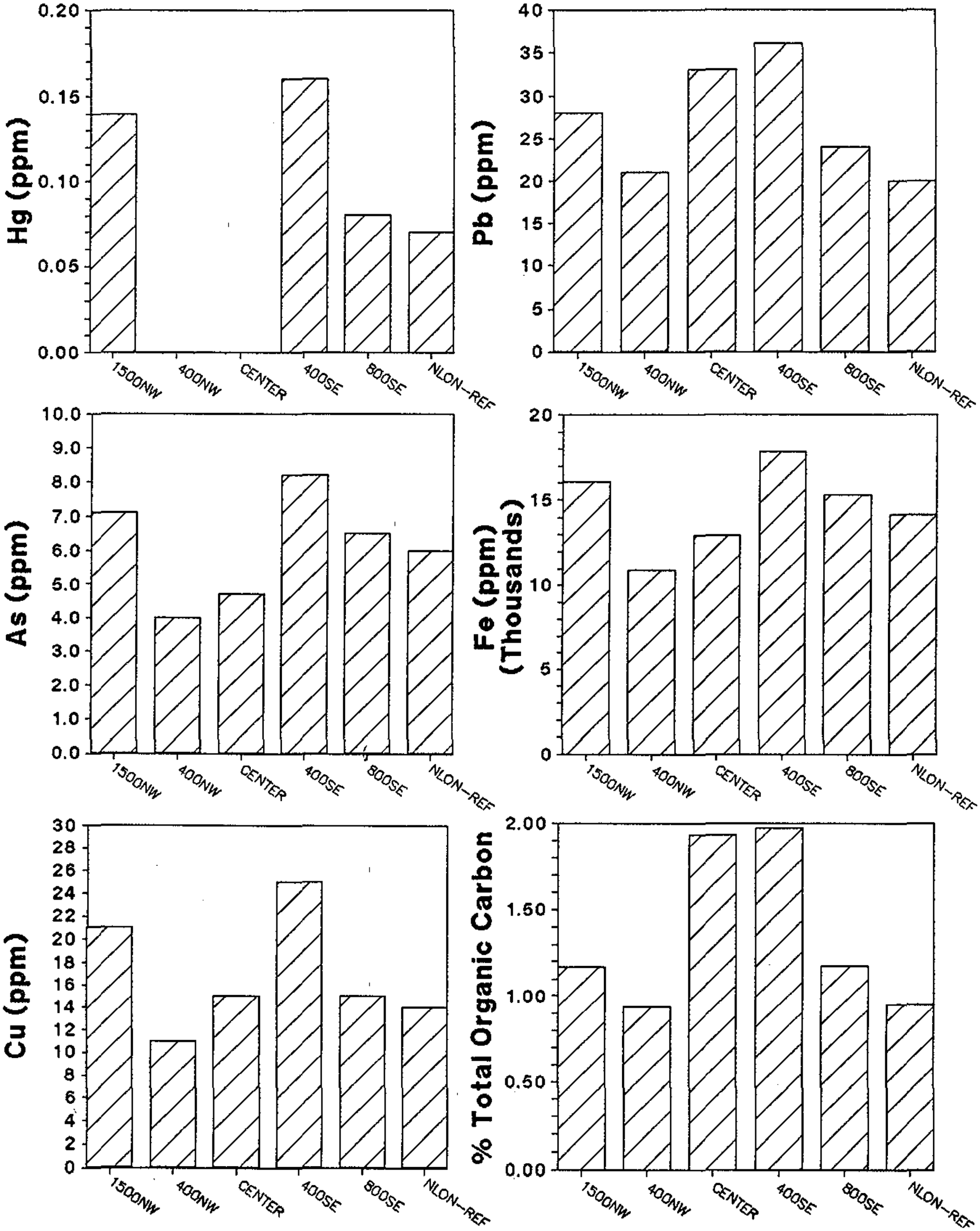


Figure 3-21. Trace metal and total organic carbon concentrations in sediment collected at New London, July 1987. Concentrations are based on dry weight. Hg was not detected at stations 400NW and Center.

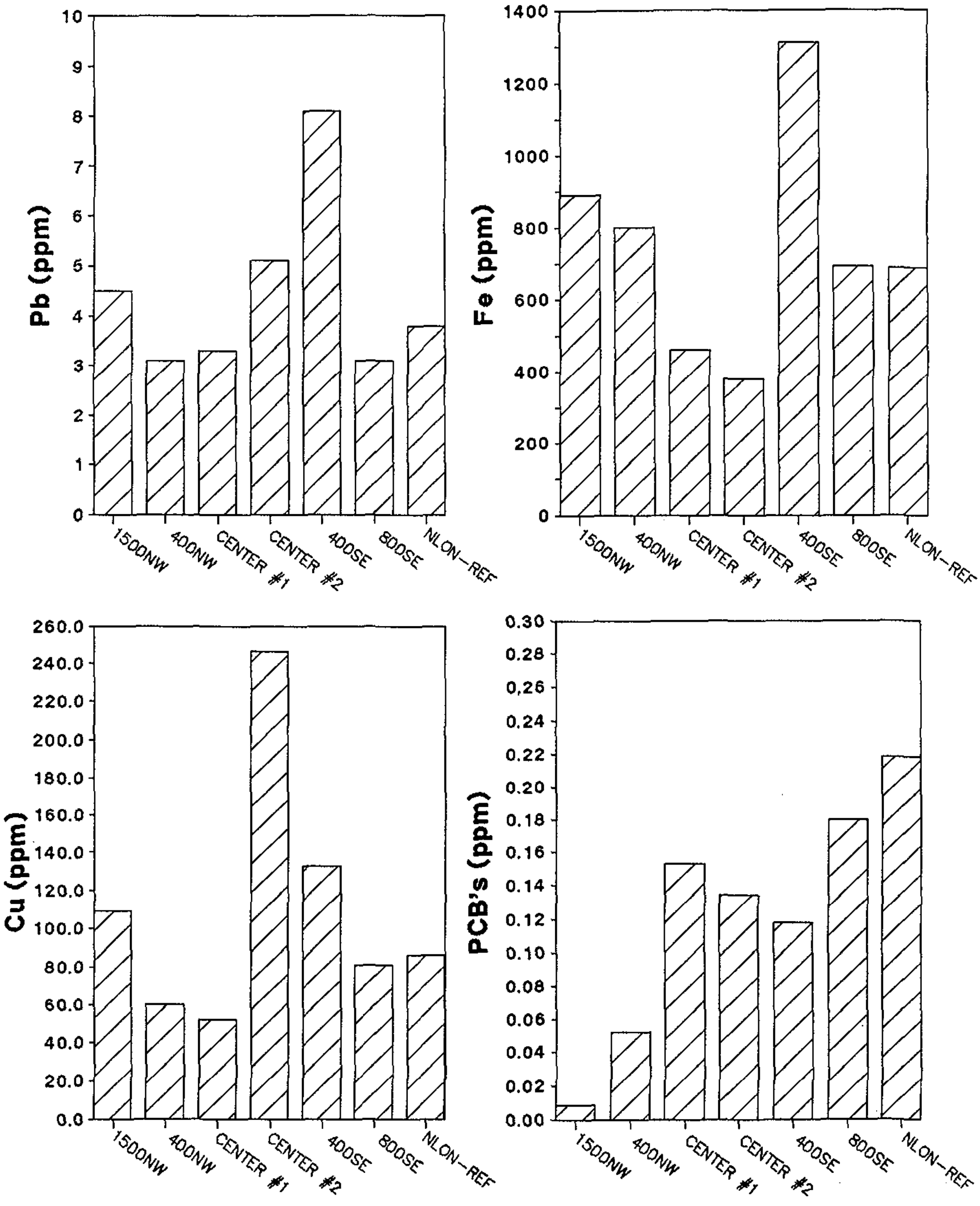
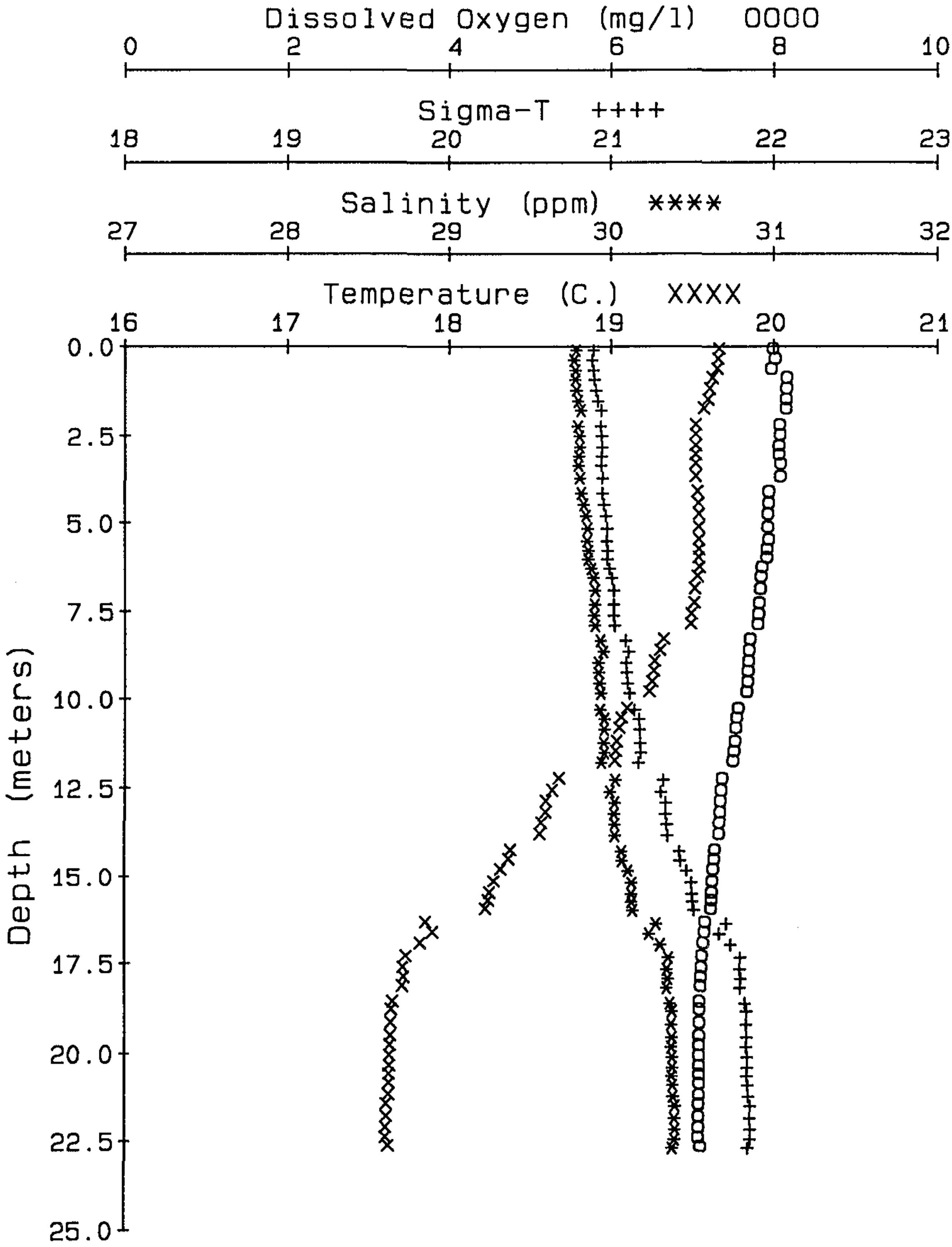


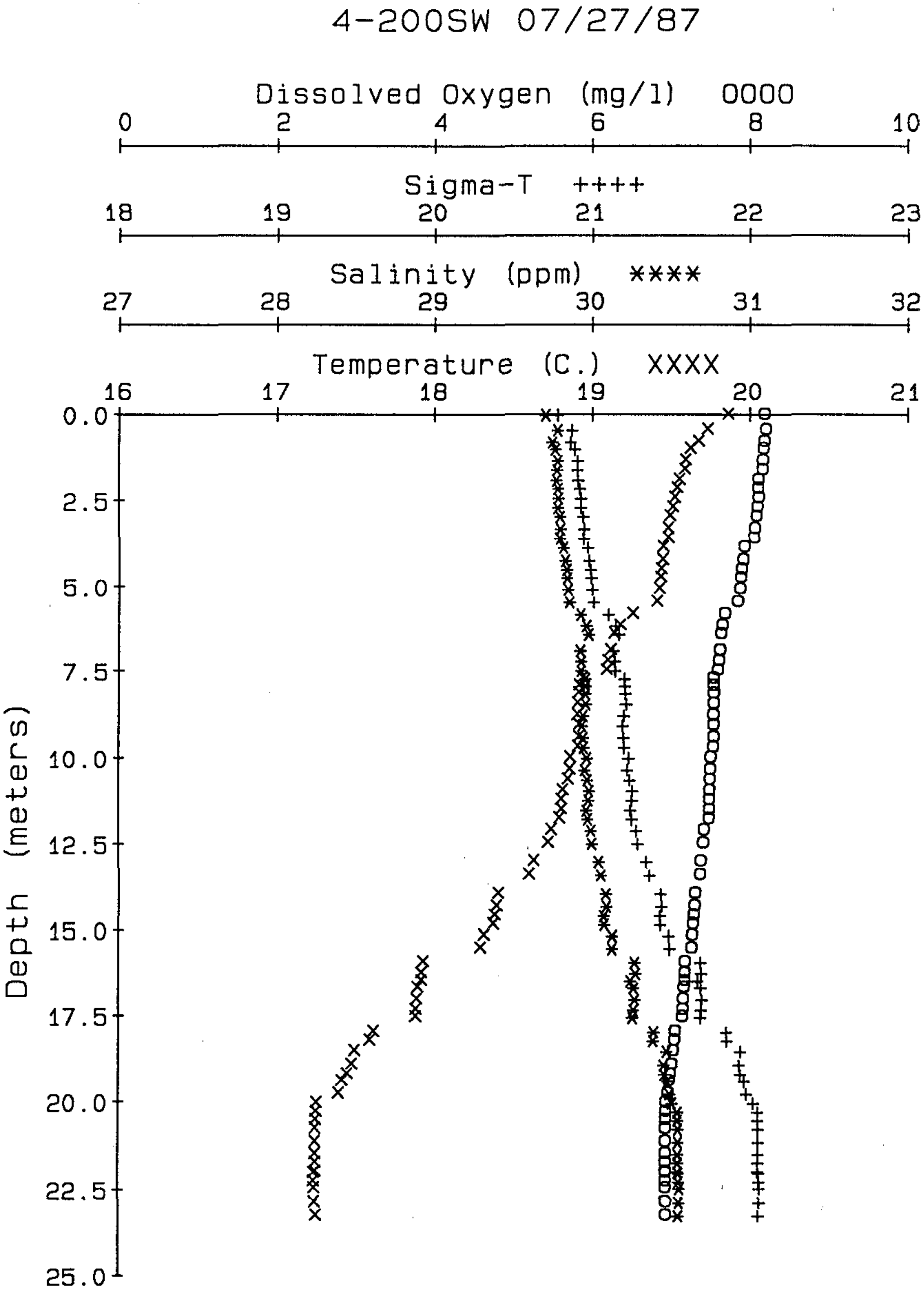
Figure 3-22. Trace metals and PCB's (as Aroclor 1254) in body tissues (dry weight) of Leptocheirus collected at New London, July 1987.

APPENDIX I

400S 07/27/87

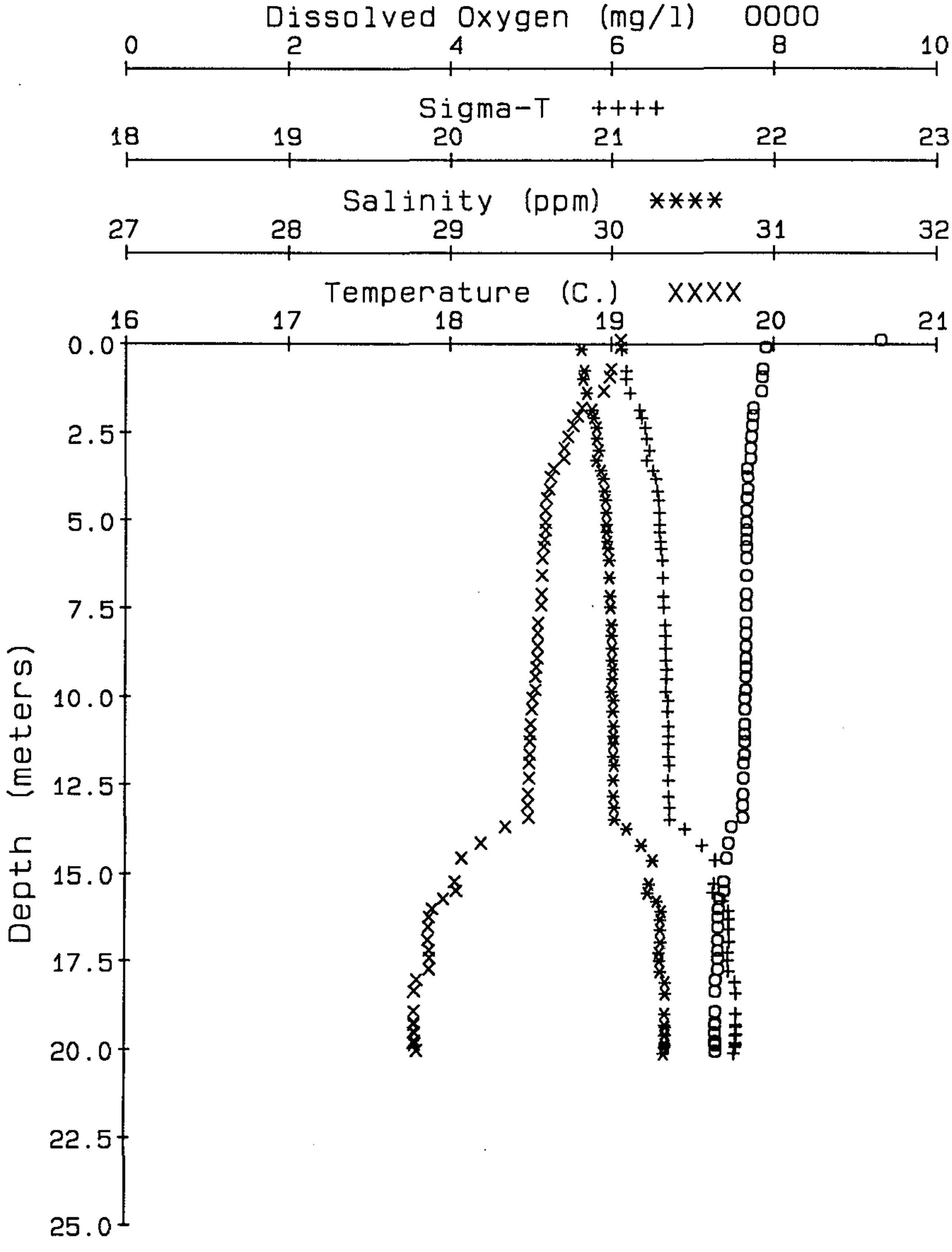


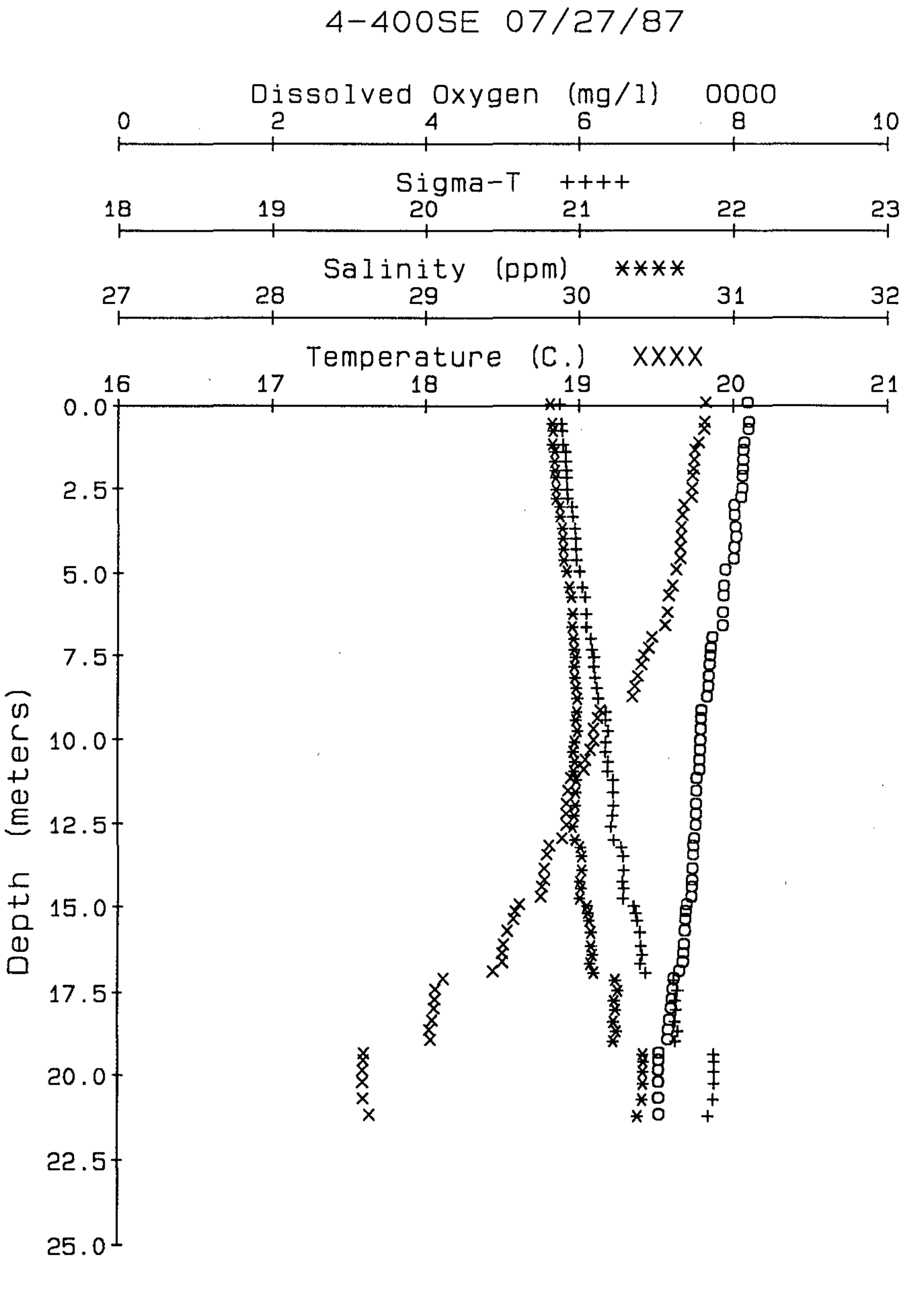
Dissolved Oxygen (mg/l) 0000
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
Depth (meters)
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0



4-200SW 07/27/87
Dissolved Oxygen (mg/l) OOOO
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Depth (meters)

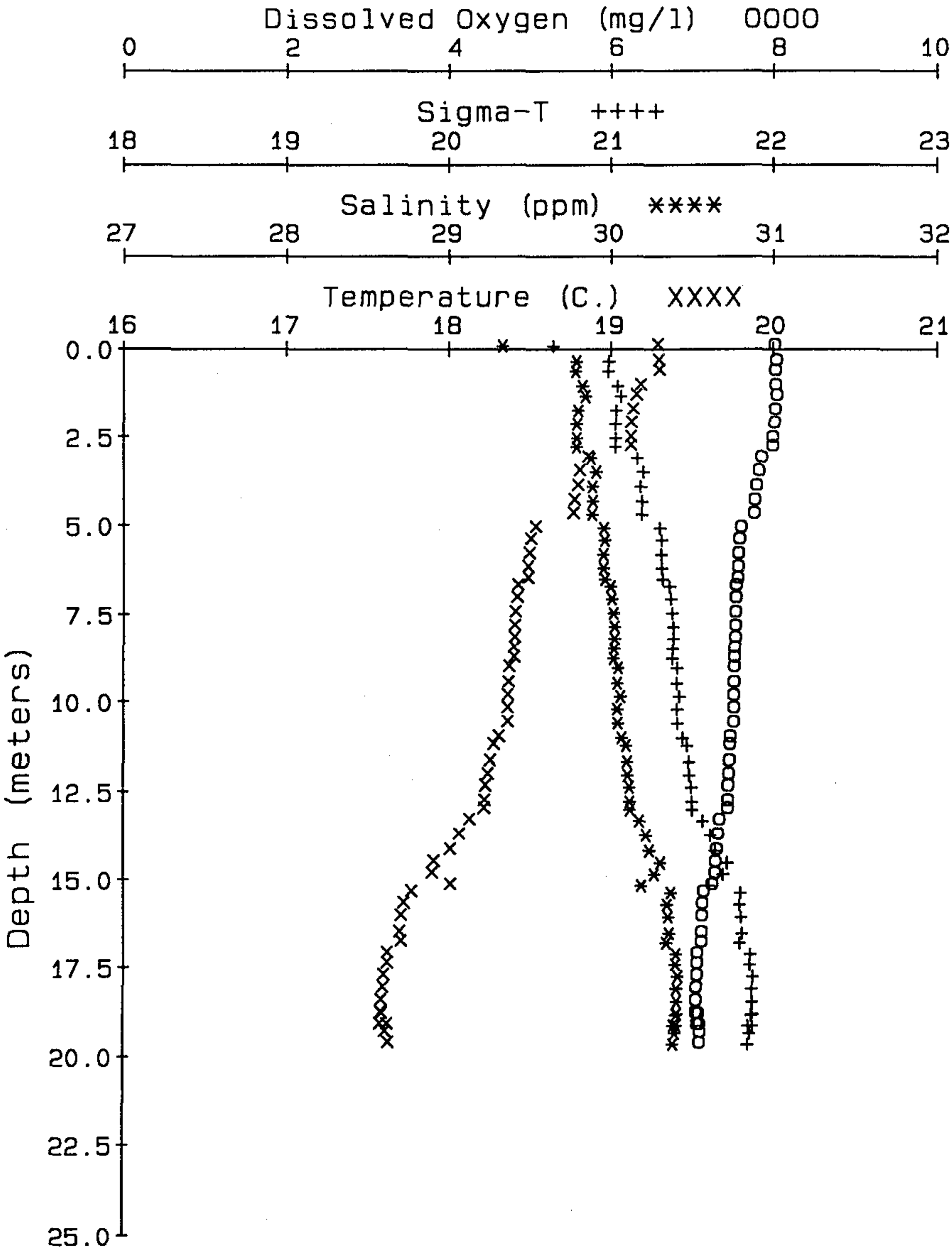
4-400SW 07/27/87





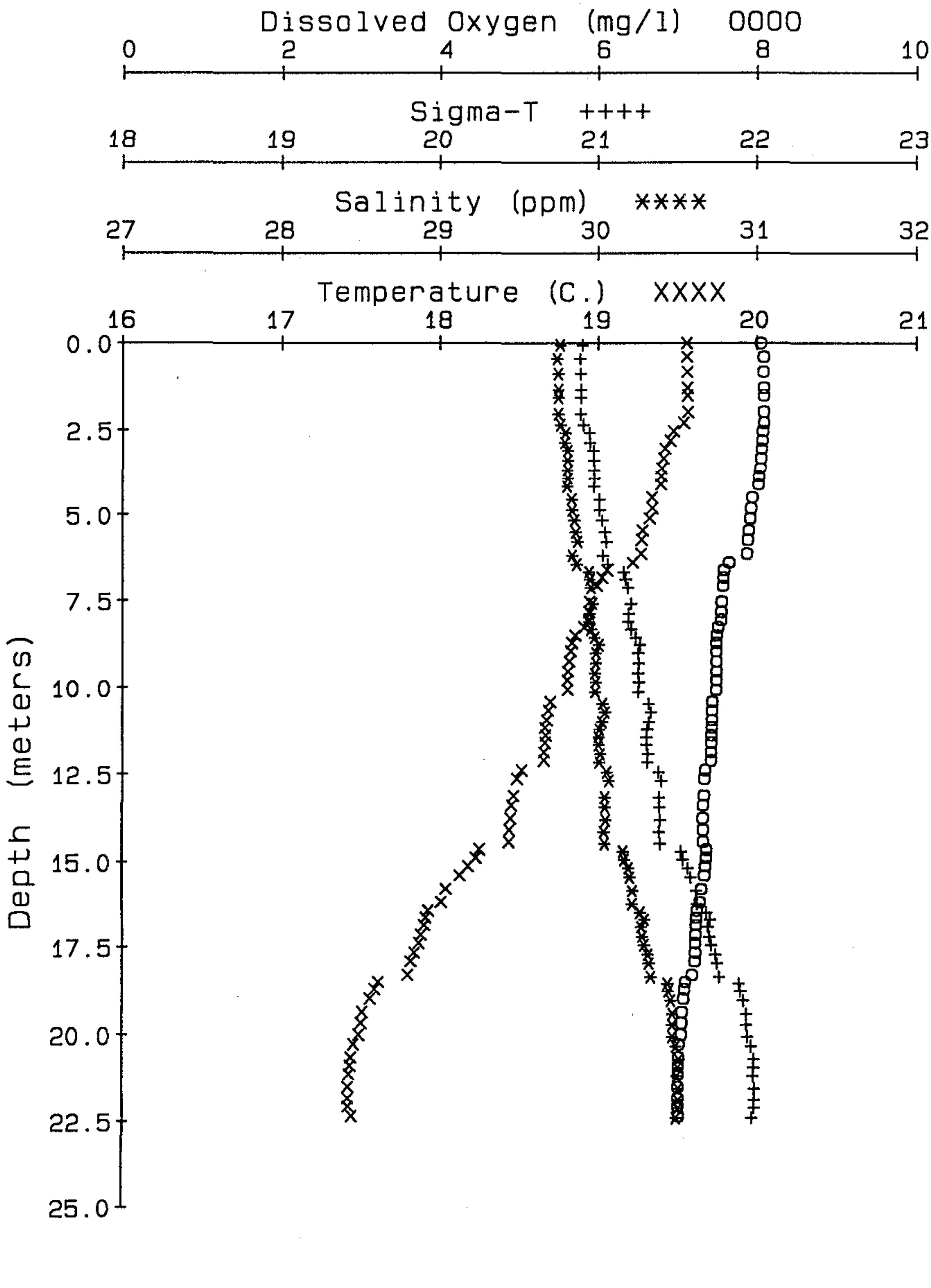
4-400SE 07/27/87
Dissolved Oxygen (mg/l) 0000
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
Depth (meters)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0

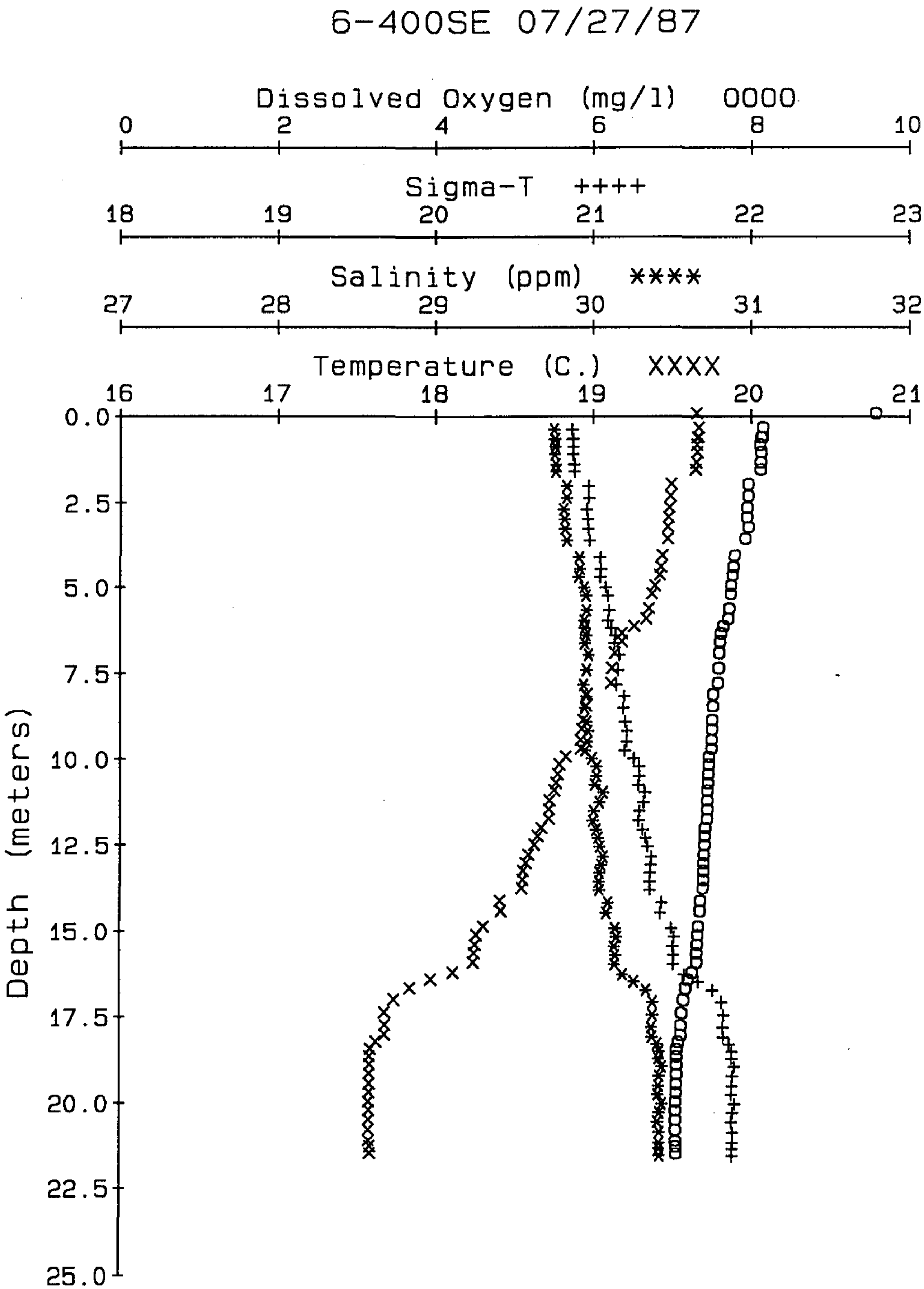
600E 07/27/87



Dissolved Oxygen (mg/l) OOOO
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
Depth (meters)
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0

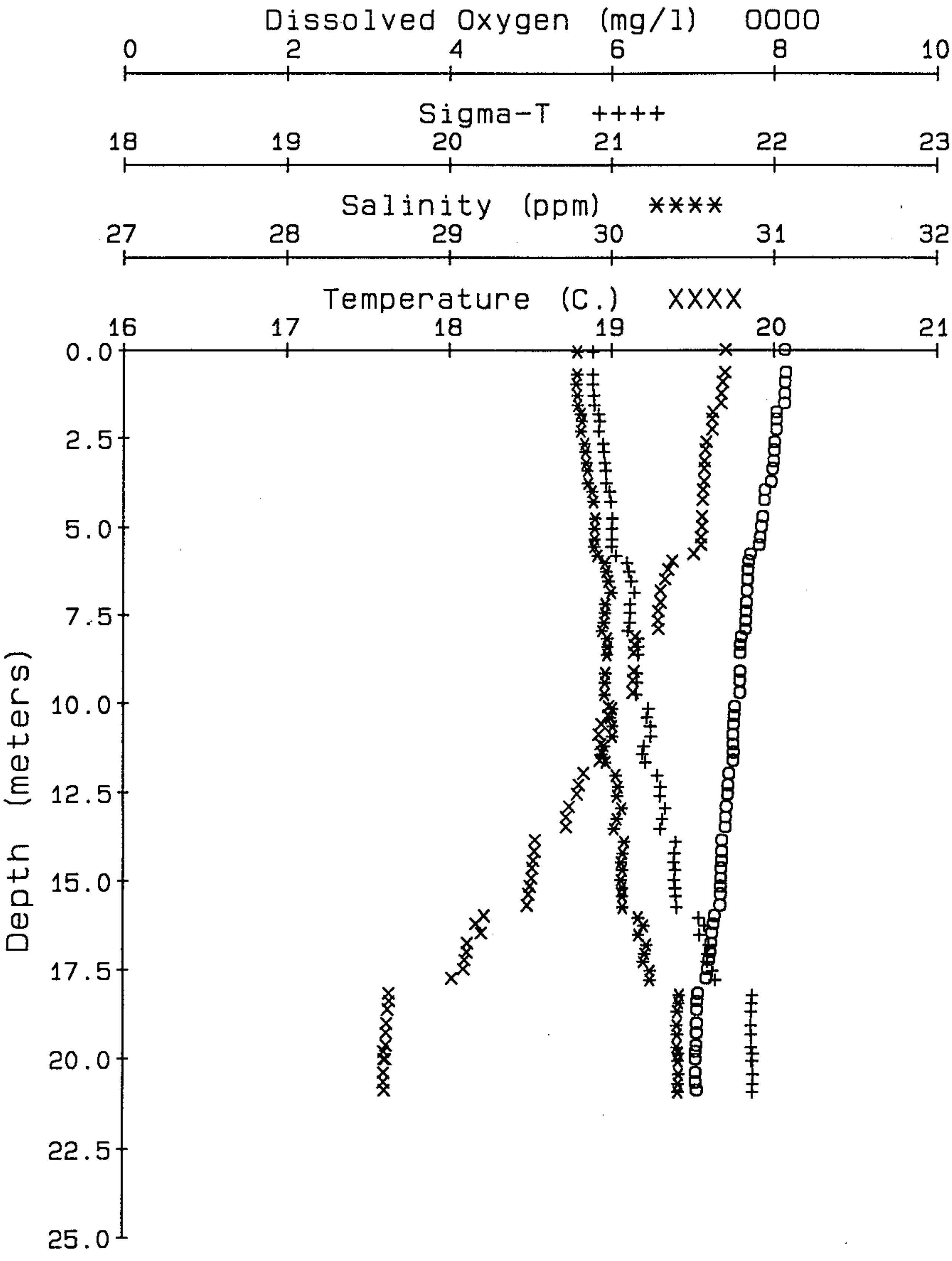
6-200SE 07/27/87



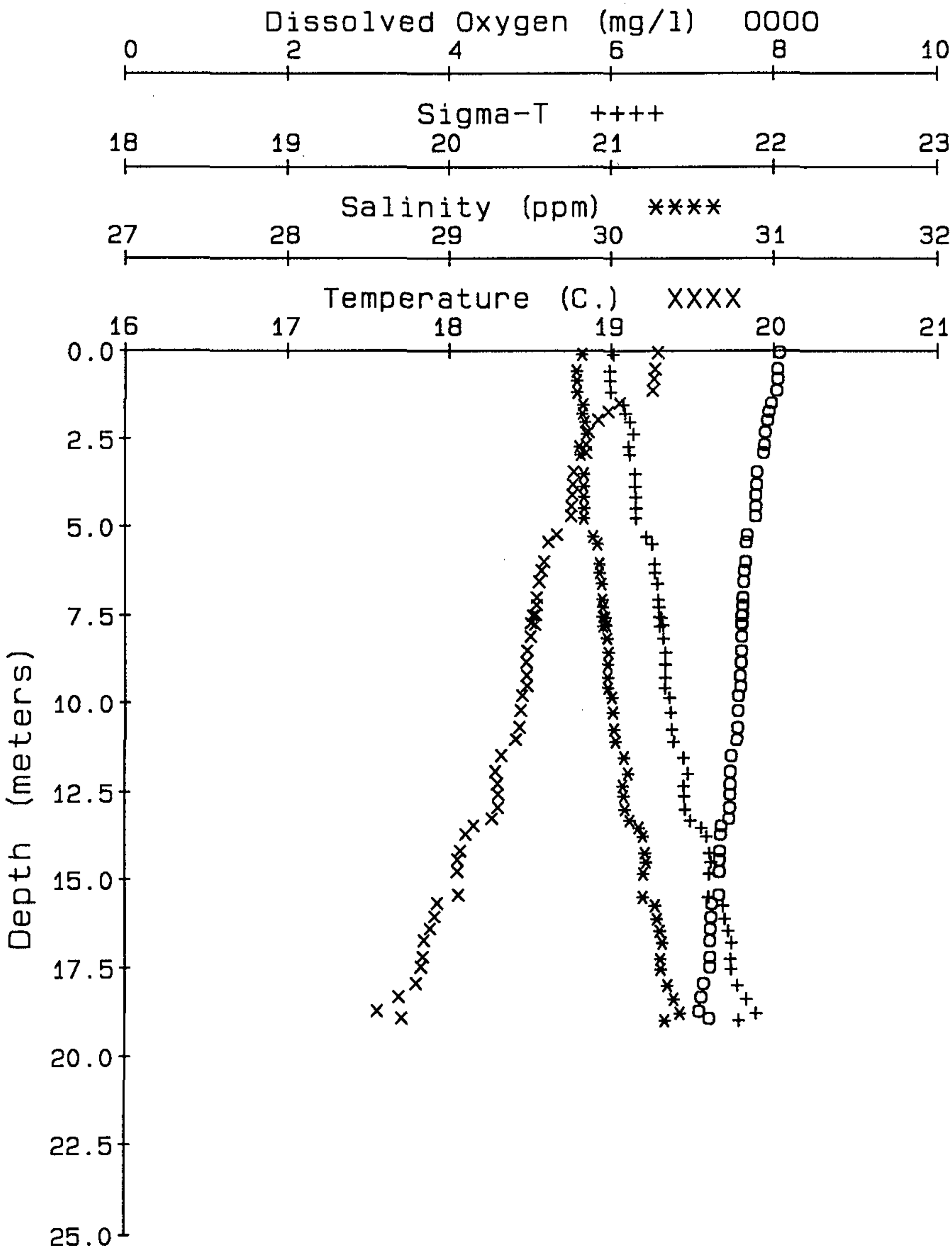


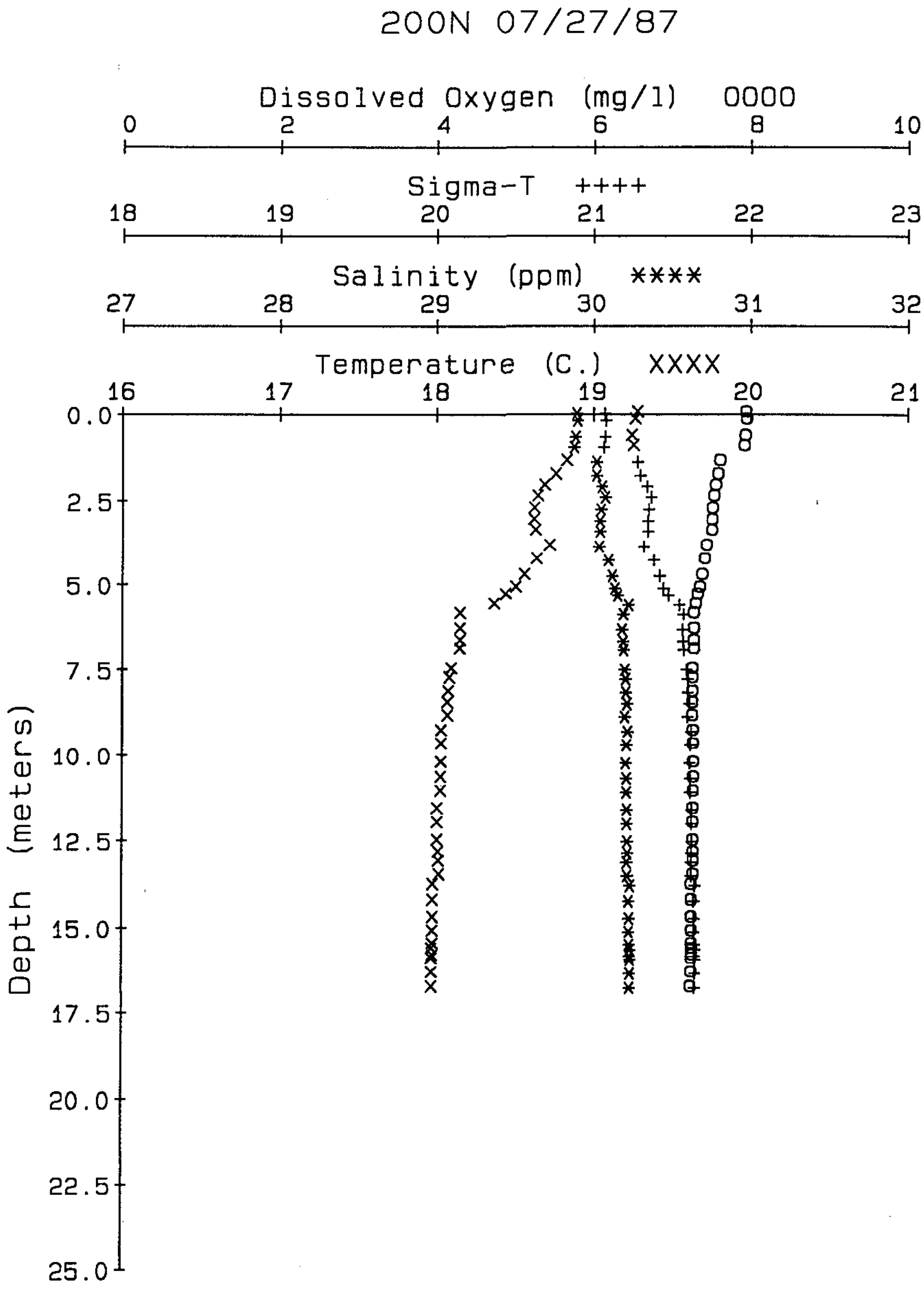
6-400SE 07/27/87
Dissolved Oxygen (mg/l) OOOO
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
Depth (meters)
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0

800SE 07/27/87

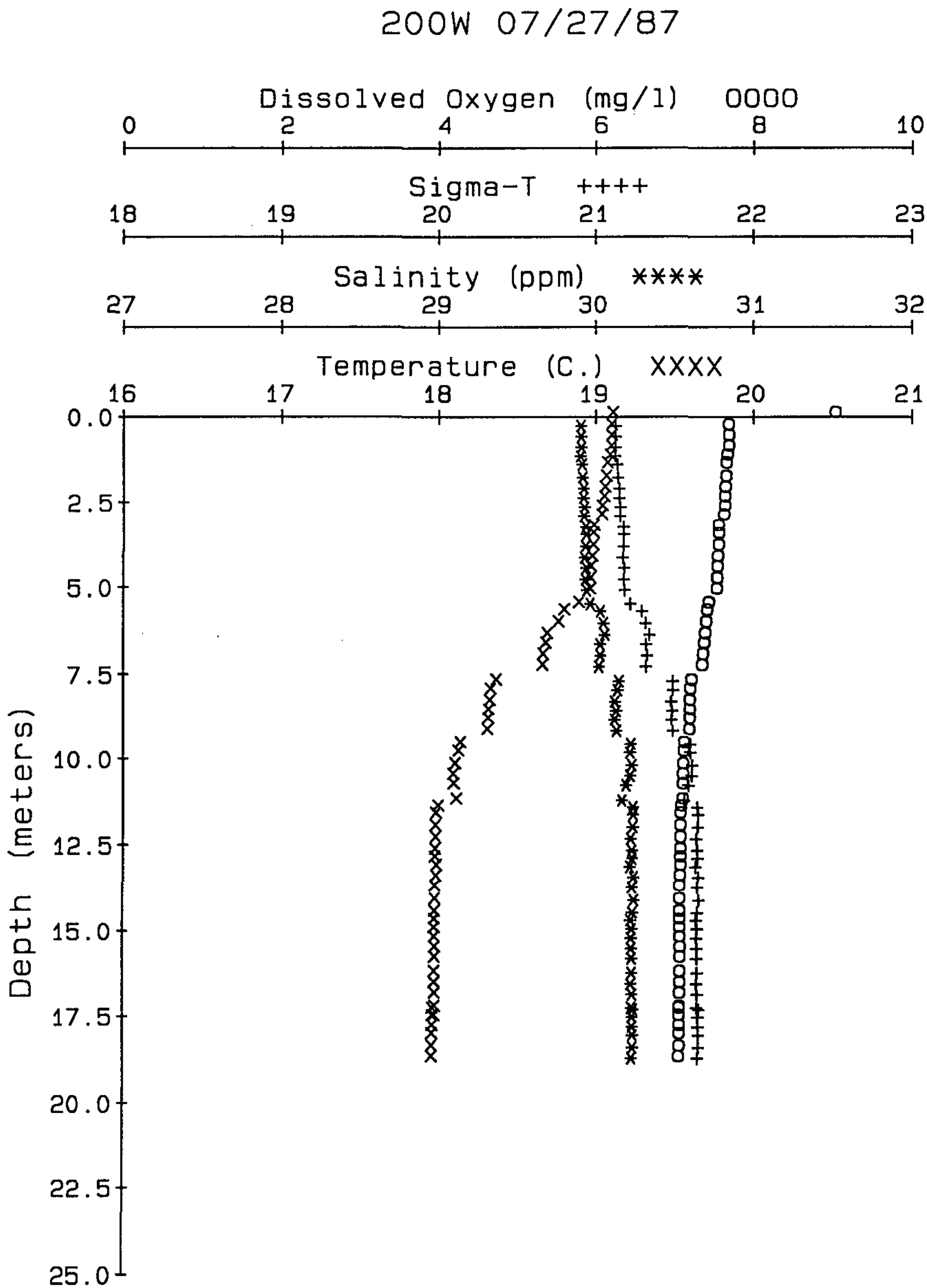


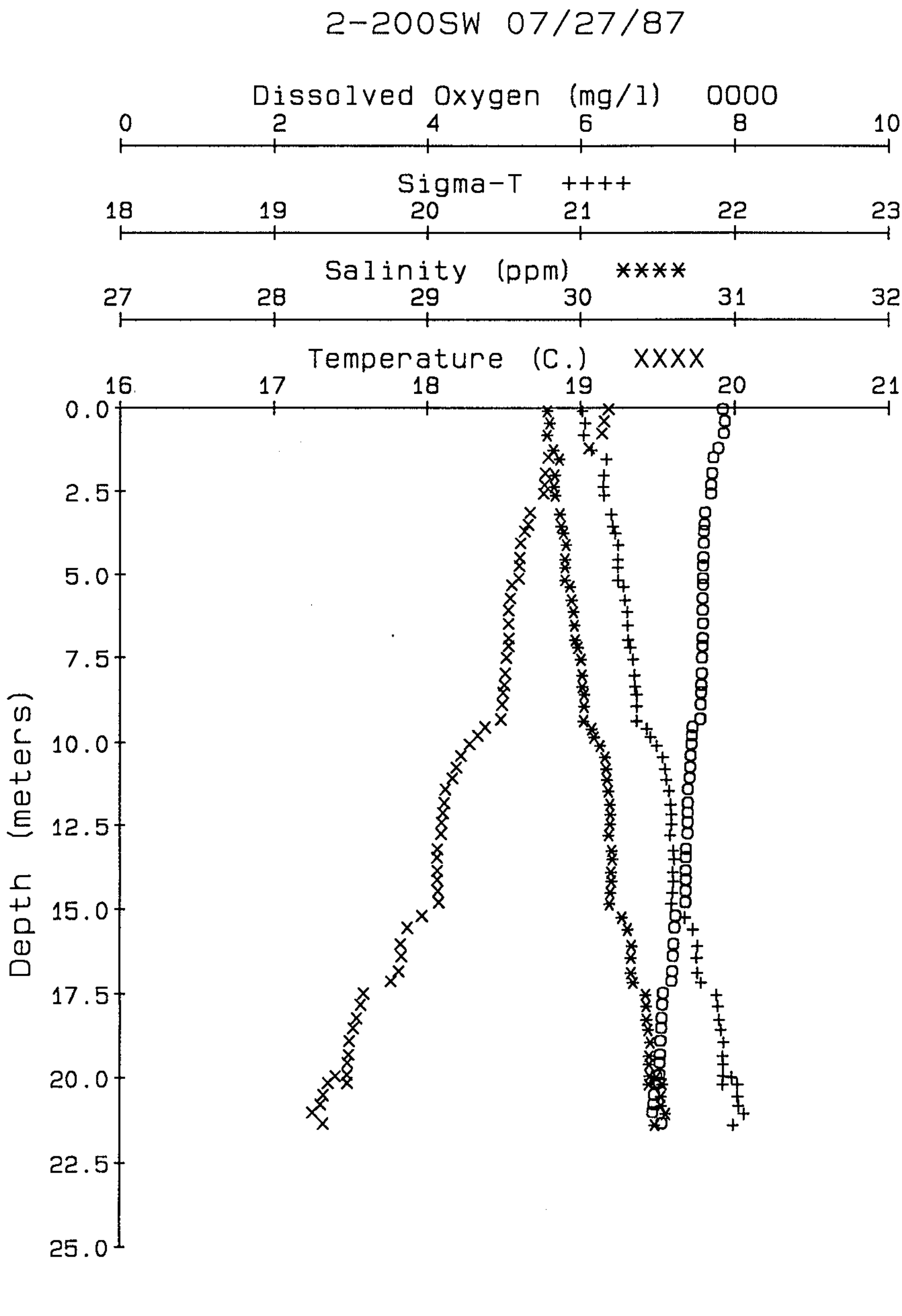
1000E 07/27/87

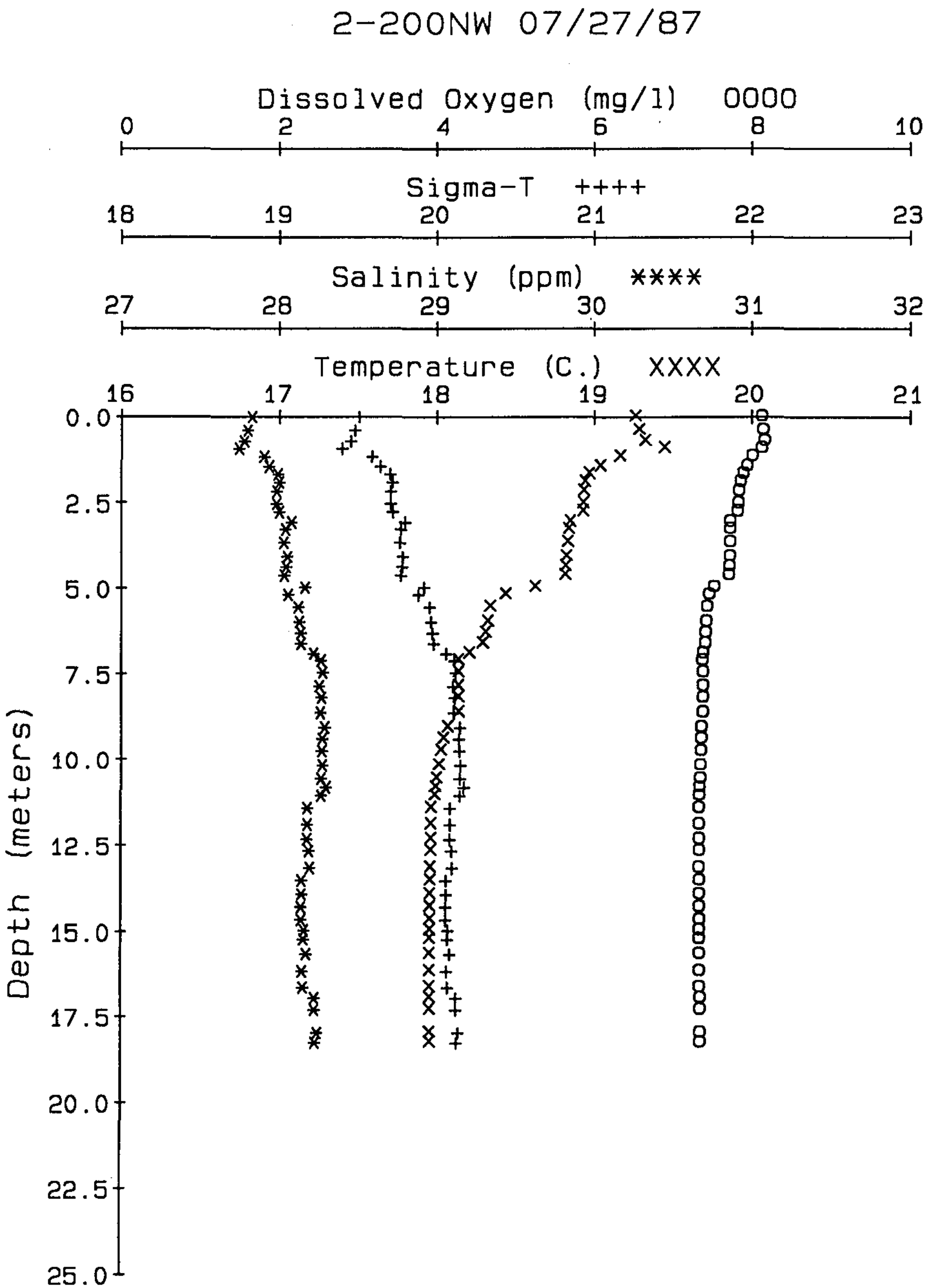


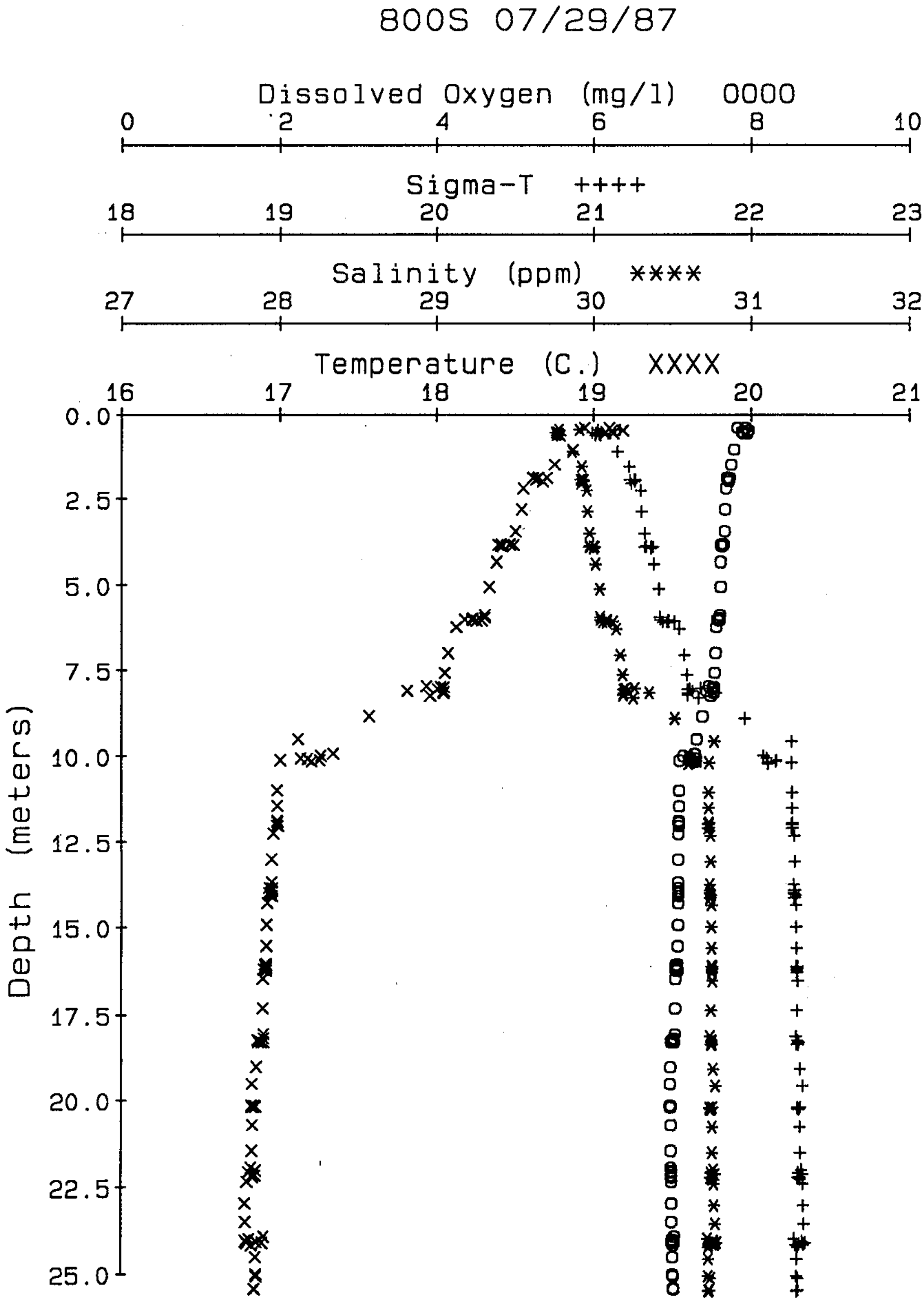


200N 07/27/87
Dissolved Oxygen (mg/l) 0000
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
Depth (meters)

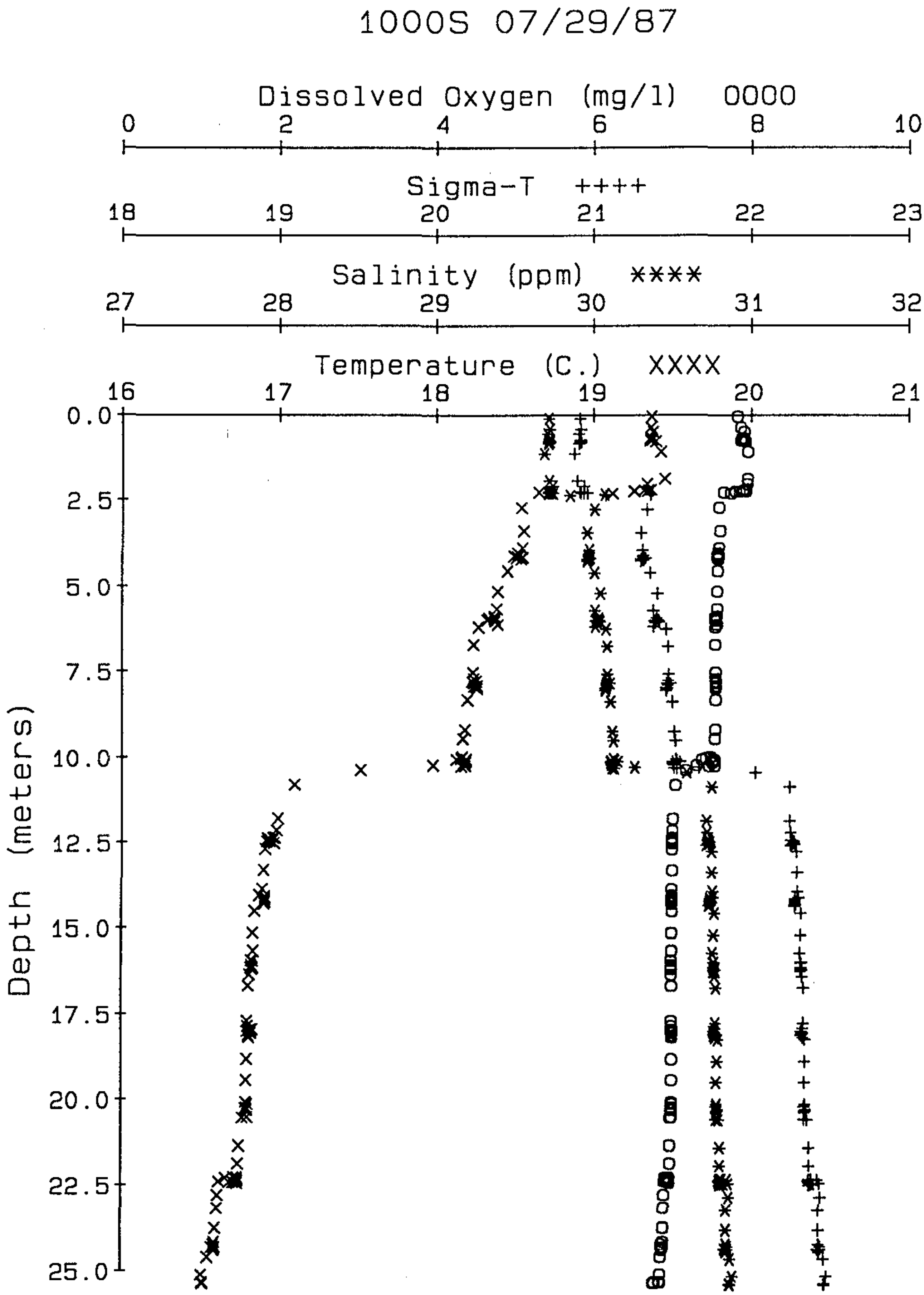

200W 07/27/87
Dissolved Oxygen (mg/l) OOOO
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
Depth (meters)
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0

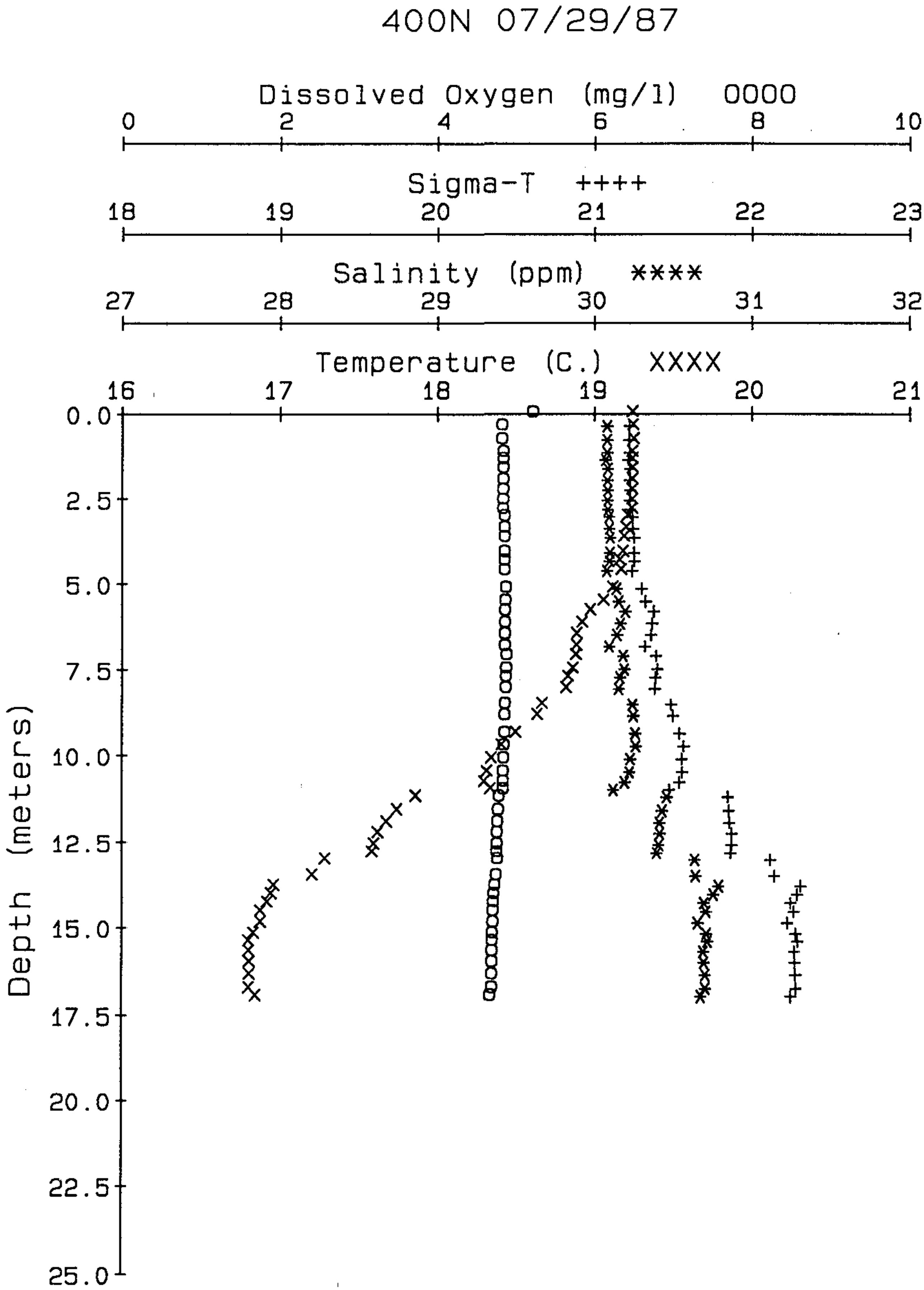

2-200SW 07/27/87
Dissolved Oxygen (mg/l) 0000
0
2
4
6
8
10
Sigma-T ++++
18
19
20
21
22
23
Salinity (ppm) ****
27
28
29
30
31
32
Temperature (C.) XXXX
16
17
18
19
20
21
Depth (meters)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0


2-200NW 07/27/87
Dissolved Oxygen (mg/l) OOOO
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
Depth (meters)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0



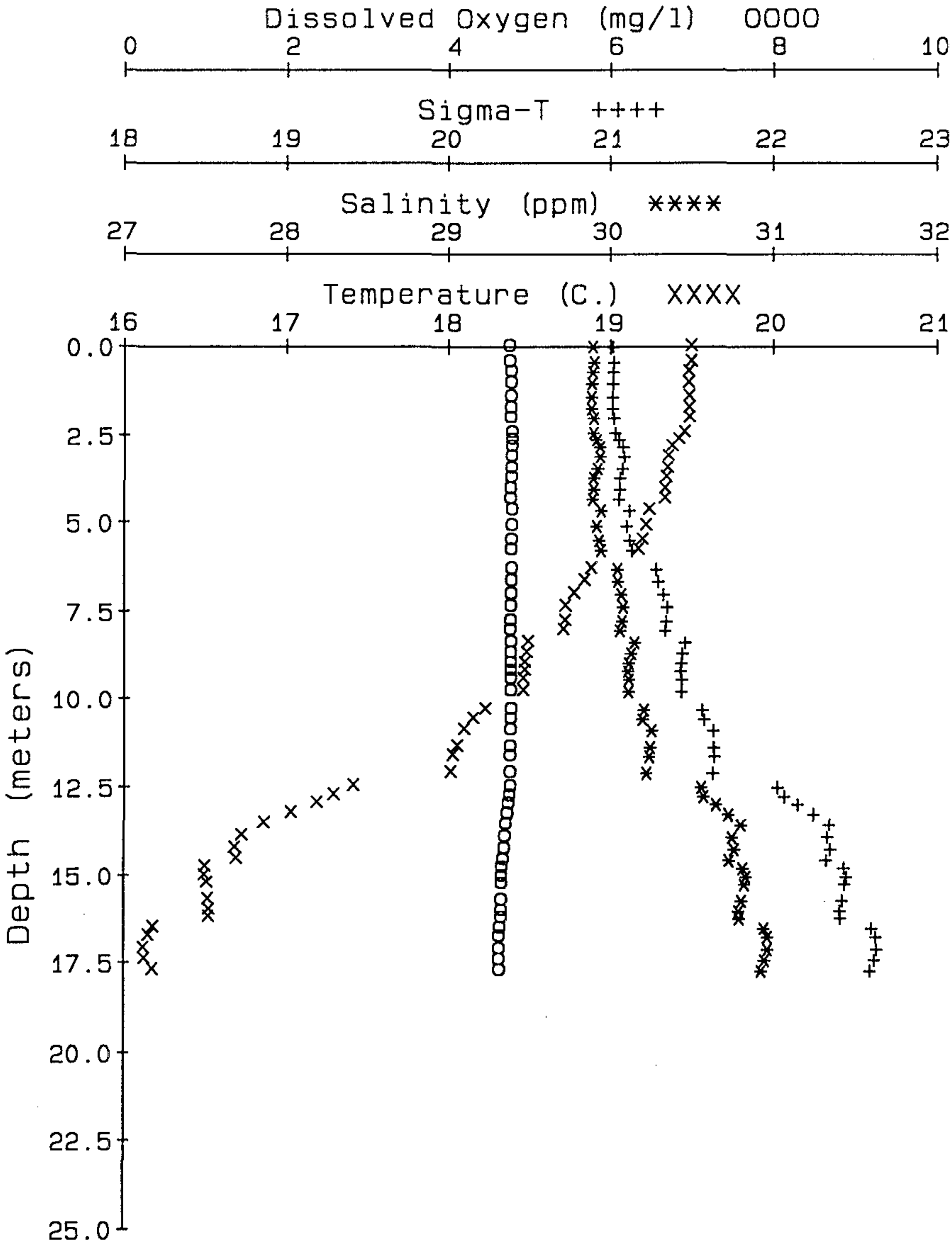
800S 07/29/87
Dissolved Oxygen (mg/l) OOOO
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Depth (meters)

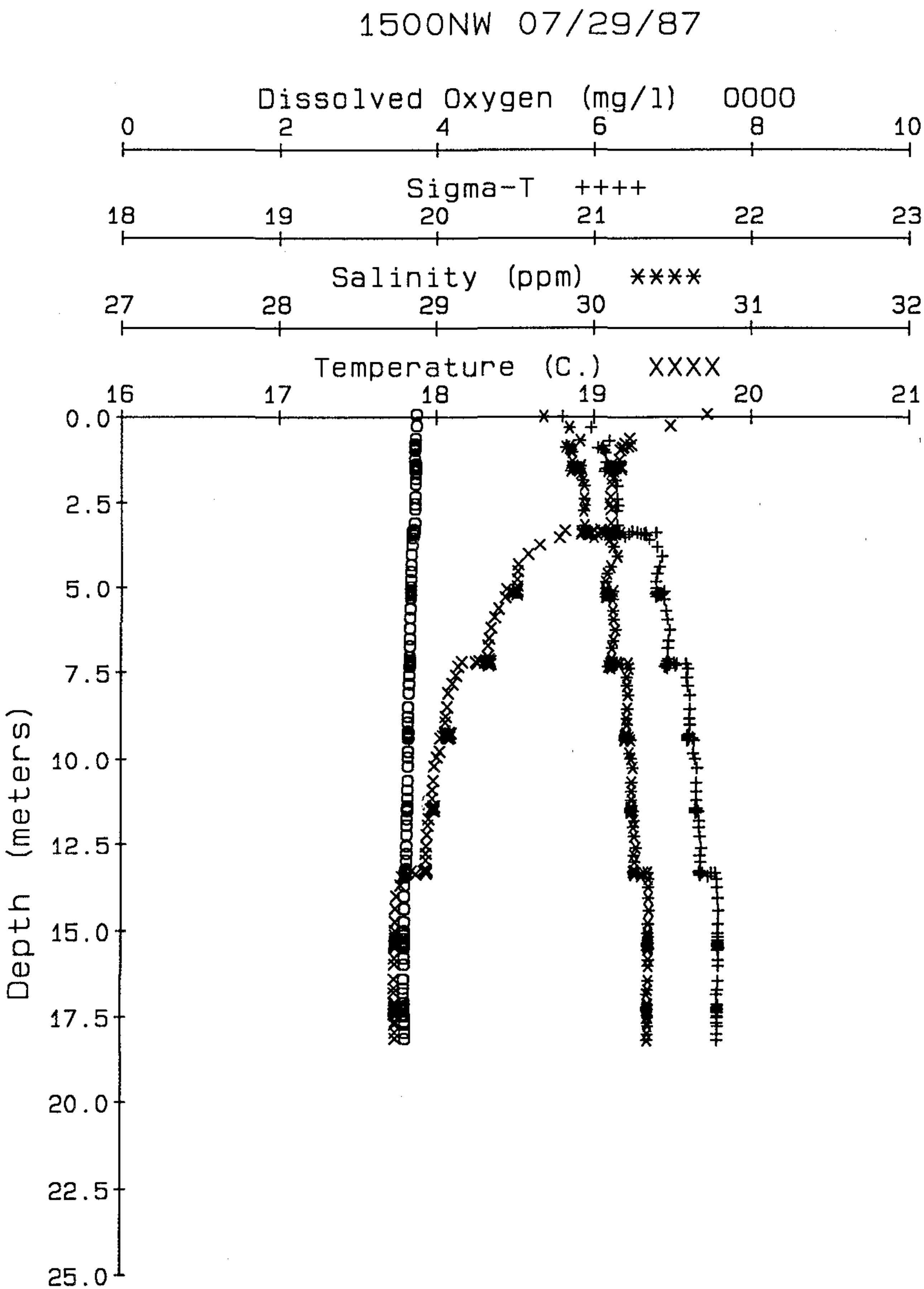

1000S 07/29/87
Dissolved Oxygen (mg/l) OOOO
0 2 4 6 8 10
Sigma-T ++++
18 19 20 21 22 23
Salinity (ppm) ****
27 28 29 30 31 32
Temperature (C.) XXXX
16 17 18 19 20 21
Depth (meters)
0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0



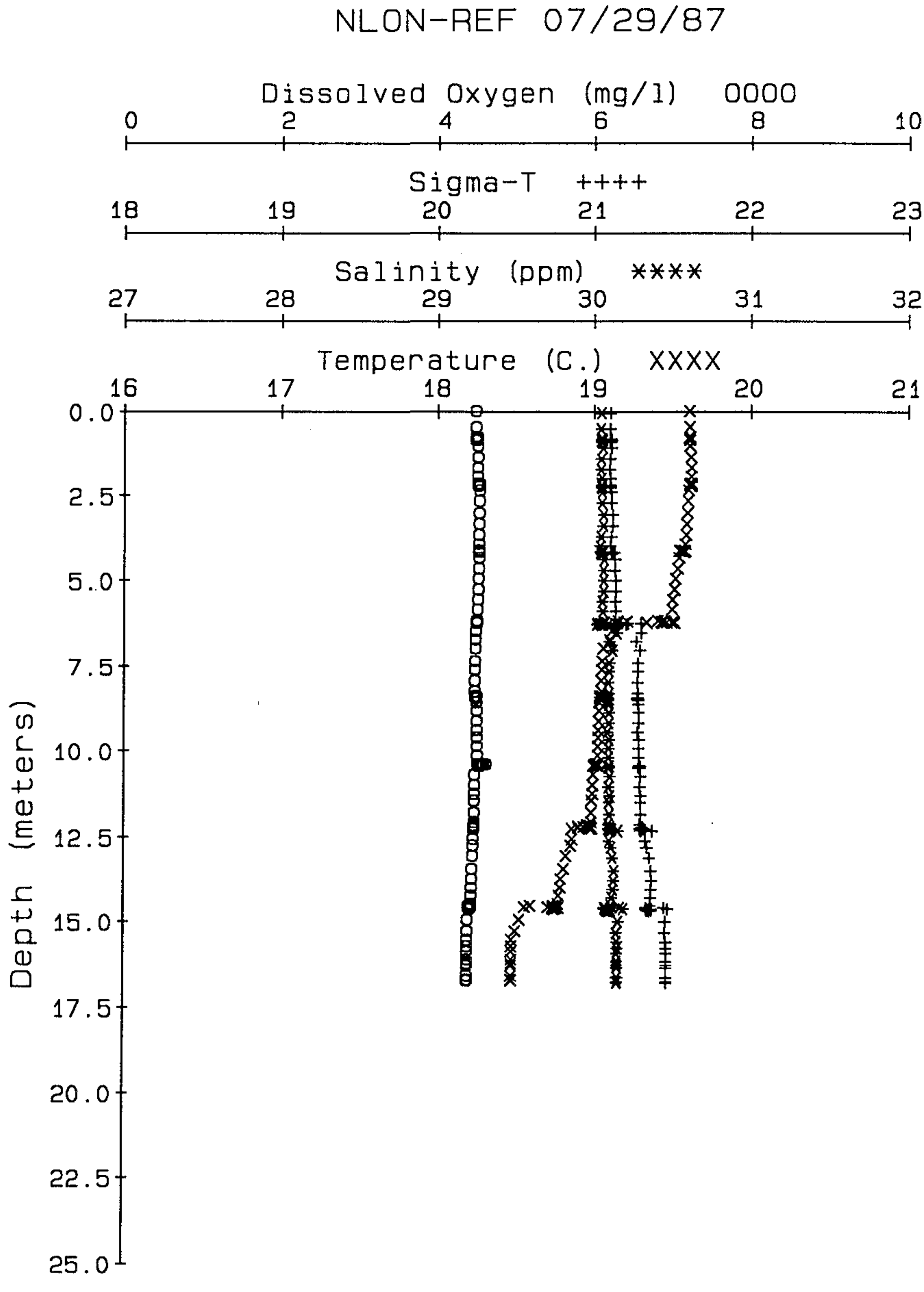
400N 07/29/87
Dissolved Oxygen (mg/l) 0000
0
2
4
6
8
10
Sigma-T ++++
18
19
20
21
22
23
Salinity (ppm) ****
27
28
29
30
31
32
Temperature (C.) XXXX
16
17
18
19
20
21
Depth (meters)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0

4-400NW 07/29/87





1500NW 07/29/87
Dissolved Oxygen (mg/l) OOOO
0
2
4
6
8
10
Sigma-T ++++
18
19
20
21
22
23
Salinity (ppm) ****
27
28
29
30
31
32
Temperature (C.) XXXX
16
17
18
19
20
21
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
Depth (meters)



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