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***Environmental impact assessment:  
sea-outfall for the Larnaca sewerage system***

***UNEP Regional Seas Reports and Studies No. 131***

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## PREFACE AND ACKNOWLEDGEMENTS

Environmental impact assessments (EIA) have been extensively prepared and used over the last 15 years. Their wide application clearly indicates a need to ensure that environmental considerations are included in the decision-making process. However, particularly in developing countries, the procedures established for EIA in developed countries have met much criticism.

Realizing the shortcomings of these procedures and responding to frequent requests for a simple and practical, but still adequate approach to EIA, the Oceans and Coastal Areas Programme Activity Centre (OCA/PAC) of UNEP has attempted to formulate procedures, supplemented with guidelines, which could be used in preparing EIAs for typical development projects in the context of legal agreements supporting the UNEP Regional Seas Programme.

The procedures and guidelines advocated by UNEP<sup>1/</sup> were tested through a series of concrete case studies. One of the first case studies and the way it was prepared is described in this document.

The analysis of the case study and the description of the procedures used in the environmental impact assessment (Part I and II of the document) were prepared by the Priority Actions Programme Regional Activity Centre of the Mediterranean Action Plan, with assistance of consultants (Messrs. A. Baric and A. Jernelov). The guidelines for the preparation of the EIA document for the sea-outfall for the Larnaca sewerage system (Part III of this document) were originally prepared by Messrs. A. Jernelov and U. Marinov, and modified for the specific situation in Larnaca by Mr. A. Baric. The environmental impact assessment document (Part IV of the document) was prepared by Mr. L. Loizides and Ms. L. Athanassiadou, Fisheries Officers of the Fisheries Department, Ministry of Agriculture and Natural Resources of Cyprus, with Ms. M. Hadjichristophorou, Fisheries Officer of the same Department, contributing on biological conditions. They provided all the information in tables, graphs etc., for which sources are not given. In the preparation of the document they were assisted and guided by Messrs. A. Baric and A. Jernelov, consultants of the Priority Actions Programme Regional Activity Centre of the Mediterranean Action Plan.

## **PART I: ANALYSIS OF THE CASE STUDY**

In evaluating the process of preparation of EIAs in Cyprus, the general background has to be kept in mind. No EIA procedure had previously been practiced in Cyprus. Evolving environmental groups were suspicious of the Government's attitude to environmental questions. Governmental bodies had no experience in collaboration on multidisciplinary environmental questions.

The first positive effect of the procedure of EIA preparation was that interagency governmental collaboration was established and functioned well.

Secondly, public participation was for the first time formally introduced in Cyprus in connection with the presentation and evaluation of the EIA documents. NGOs and concerned individuals participated in the meeting and were in agreement with the decisions reached.

Thirdly, a decision was reached to prolong the outfall to 2.8 km and locate it below the thermocline to achieve a better protection of beaches. The fact that the EIA procedure led to a modification of the project, even at a higher cost, contributed to the positive attitude among NGOs and the public.

Naturally, some problems arose as existing information was not always in the format foreseen in the guidelines and as collected data were tailored for other needs than those of an EIA. However, these problems were considered to be of minor importance and not affecting the quality of the assessment as such but only the elegance of the presentation.

## **PART II: PROCEDURES USED IN THE ENVIRONMENTAL IMPACT ASSESSMENT**

### **Background**

The fourth ordinary meeting of the Contracting Parties to the Barcelona Convention (Genoa, September 1985), when considering the workplan of the Priority Actions Programme Regional Activity Centre (PAP/RAC) of the Mediterranean Action Plan, "stressed the interest to develop suitable methodologies for environmental impact assessment, with a view to their introduction in coastal zone development planning"<sup>2/</sup>. The same meeting adopted ten targets to be achieved as a matter of priority during the second decade (1986-1995) of the Mediterranean Action Plan (MAP). Among these targets were<sup>3/</sup>:

- establishment, as a matter of priority, of sewage treatment plants in all cities around the Mediterranean with more than 100,000 inhabitants and appropriate outfalls and/or appropriate treatment plants for all towns with more than 10,000 inhabitants; and
- applying environmental impact assessment as an important tool to ensure proper development activities.

In response to similar requests from other meetings convened in the framework of the UNEP Regional Seas Programme, UNEP has developed a simple and practical approach to the environmental impact assessment (EIA)<sup>1/</sup> which might be applicable in the context of the legal agreements supporting that Programme.

In consultation between PAP/RAC and the National Focal Point of Egypt for the Mediterranean Action Plan, the preparation of an EIA for the sewage treatment for the city of Port Said was among the first case studies selected to test the new approach to EIAs.

This chapter of the present document describes, step-by-step the application of the general approach advocated for the EIA procedure<sup>1/</sup>.

## **Request for building a sea-outfall for the Larnaca sewerage system**

The Municipality of Larnaca originally planned to use treated waste-water for irrigation. However, the feasibility study demonstrated that the high salinity of the water, due to intrusion of sea-water into the sewage system, would render it unsuitable. Hence the Municipality looked at the option of a sea-outfall and requested a permit to build one.

## **Decision on the need for an EIA**

According to a newly adopted governmental policy an EIA is a requirement for any such development project.

## **Guidelines for the preparation of an EIA document**

Building on the goals and principles of EIAs, adopted by the Governing Council of UNEP and endorsed by the United Nations General Assembly<sup>4/</sup> and on the procedures developed for a practical approach to EIAs<sup>1/</sup> the guidelines for the preparation of the EIA document for a sewage treatment plant were prepared by PAP/RAC with assistance of consultants (Part III of this document). The guidelines list the issues which were expected to be addressed in the preparation of the EIA document for the Larnaca sewerage system.

## **The environmental impact assessment document**

The preparation of the EIA document was entrusted to the Fisheries Department of the Ministry of Agriculture and Natural Resources of the Republic of Cyprus.

Several consultations were held between the staff of the organization and of PAP/RAC's consultants during the preparation of the EIA.

The information used for the preparation of the EIA consisted of:

- meteorological data available from the nearby airport;
- hydrographic, microbiological and sea-current data obtained through earlier measurements, as well as measurements during the preparation of the EIA, at the site of the proposed outfall and in its vicinity;
- hydrographic data available from the Limassol area (situation analogous to Larnaca bay); and
- biological data on benthos and detailed bathymetric measurements collected specifically for the EIA.

The EIA document was prepared in a period of 5 months, (from May to September 1988) and it involved an estimated time of 1 w/m (working/month) of a scientist and of 0.5 w/m of a technical staff.

The EIA document, as submitted for evaluation, is reproduced as Part IV of this document.

## **Evaluation of the EIA document**

The draft of the EIA document was presented, together with a draft of an EIA for a marina in Paphos<sup>5/</sup>, to the Review Meeting on Environmental Impact Assessment Procedure, jointly organized in Nicosia, Cyprus, 24-27 October 1988, by PAP/RAC, OCA/PAC and the Co-ordinating Unit for MAP, in co-operation with the Environmental Conservation Service and the Fisheries Department of the Ministry of Agriculture and Natural Resources of Cyprus.

The meeting was hosted by the Agricultural Research Institute in Nicosia and was attended by 26 participants from seven Ministries and Departments of the Cyprus Government, one participant of a non-governmental environmental organization from Cyprus, four participants from the government departments of four countries other than Cyprus, two UNEP staff members and two consultants to UNEP (for a full list see Appendix of this document).

The meeting started by the participants' visit to the planned location of the outfall in order to familiarize them with the physical setting and the technical details of the planned project.

The visit to the site was followed by the presentation of the approach used in the preparation of the EIA and by the detailed presentation and discussion of the EIA.

The main comments and suggestions offered at the meeting may be summarized as follows:

- (a) the general approach proposed by UNEP for the preparation of EIAs was considered as suitable in principle, although some amendments were introduced into the proposed procedures<sup>\*</sup>;
- (b) the guidelines used for the preparation of the EIA were considered, with some amendments<sup>\*</sup>, as sufficient general guidelines for the preparation of EIAs related to sewerage sea-outfalls but they should have been supplemented with more specific guidelines tailored to the concrete case of the outfall for Larnaca.
- (c) the presented draft EIA document was considered, after some amendments, as adequate for the decision-making process; the suggested amendments included the following:
  - information on the method for corrosion control was missing from the submission of the consultants who proposed the design of the outfall;
  - although a bathymetric map covering a distance of 2 km was prepared as part of the draft EIA (tentatively the length of the outfall was estimated as 1.5 km), the result of the study indicates that a longer outfall may be needed in order to take full advantage of the thermocline and therefore the bathymetric map should be extended to cover 2.5 km;
  - no information was provided on the possible effects of turbulence and waves;
  - data on the present nutrient levels and colour are lacking; and
  - there is no information on plankton.

The EIA document was also considered by the governmental technical committee which was established to advise the Municipality of Larnaca on the project.

#### **Decision of the Authorizing Authority**

The conclusion of the EIA study was accepted. The provision for a prolonged outfall was included in a new feasibility study and was part of the terms of reference for the tenders. The project proceeded as modified.

The EIA study of the Larnaca sewage outfall has also been a model for a corresponding study of a sewerage system in Limasol due for completion in 1995.

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\* The amendments suggested at the meeting are incorporated in the document listed under Reference<sup>1/</sup>.

## **Monitoring of the impact of the sea-outfall**

As the execution of the project has not yet started the monitoring programme is not in force.

### **References**

- 1/ UNEP: An approach to environmental impact assessment for projects affecting the coastal and marine environment. UNEP Regional Seas Reports and Studies No. 122, UNEP, 1990.
- 2/ Report of the fourth ordinary meeting of the Contracting Parties to the Convention for the Protection of the Mediterranean Sea Against Pollution and its related Protocols. UNEP/IG.56/5, Part I, para. 89. UNEP, 1985.
- 3/ Ibid. Part II, para. 17 (b) and (c).
- 4/ Decision 14/25 of UNEP Governing Council; 17 June 1987. UNEP/GC/14/26, Annex I.
- 5/ UNEP: Environmental impact assessment: The Marina in Paphos. UNEP Regional Seas Reports and Studies No. , UNEP, 1990.

### **PART III: GUIDELINES FOR THE PREPARATION OF THE ENVIRONMENTAL IMPACT ASSESSMENT DOCUMENT FOR THE LARNACA SUBMARINE SEWERAGE OUTFALL**

#### **Introduction**

The main purpose of a sea outfall is to enable effluents to be discharged at a point well away from the coast. The discharge point should be selected with respect to the flushing characteristics of the proposed area to ensure dilution and dispersal of the effluent.

Until fairly recently, the sea was taken for granted as a convenient natural body of water to discharge sewage, disregarding the fact how much polluted effluent it is able to accept. Growing interest in environmental problems brought forth the awareness that the sea capacity is, in fact, limited. In addition, present policy concerning the reuse of water should be taken into consideration.

However, a sea outfall is sometimes the only feasible solution. In such cases, the importance of minimizing pollution impacts is generally recognized and, accordingly, official regulations were issued on the subject and optimized outfall design methods developed.

Once a decision on sea outfall project implementation has been taken, it is up to the project authority's technical staff to site the outfall so as to ensure the water in respective areas to be protected from contamination and meet the required quality criteria. The effects of sea outfall effluent should be determined keeping in mind the most critical pollution conditions for the areas which need to be protected.

The location of the discharge point will be considered acceptable, if the pollution inputs are consistent with the anticipated use of the waters in question (beaches, shellfish breeding areas) and the quality of seawater required.

#### **A. Description of the proposed project**

The proposed outfall should be described, including the following:

##### **(a) The outfall**

- Length of the outfall pipeline, diameter, depth, pipe materials;
- Pipeline laying method: anchoring on seabed, buried below the sea bed;
- Diffuser length, orifices, configuration and diameter;
- Discharge rate; and
- Initial dilution, final dilution.

##### **(b) The effluents**

- Effluent characteristics: quantity, degree of treatment, physical, chemical and bacteriological composition, seasonal variations; and
- T90 measurements.

#### **B. Description of the environment**

A description of the environment of the site of the proposed discharge point should include the following:

##### **(a) Physical site characteristics**

- An onshore topographic and offshore bathymetric map of the site and its surroundings at a scale of 1:5000 covering at least 2 kilometres of the coast, appropriate distance from the waterline offshore and 200 meters from the waterline inland; and
- Geological and geophysical conditions at outfall site, including rock outcrops on and offshore, sedimentary properties and cliff stability.



(b) Hydrographic and meteorological information

- Surface and subsurface currents under various tides, densities and weather conditions;
- Currents at depth of effluent disposal;
- Existence and characteristics of thermocline;
- Seawater temperature and salinity and their variation with depth;
- Wind velocities and intensities; and
- Oxygen and nutrient concentration, turbidity and colour;

(c) Biological conditions

- Status of benthic communities on different substrates;
- Microbial pollution - pathogens survival.

(d) Present and intended uses of the seawater and beaches

- Tourism, recreation, fishing, aquaculture; and
- Shellfish breeding.

(e) Ambient quality criteria

**C. Identification of Possible Impacts**

An assessment of anticipated or forecasted impacts, using accepted standards whenever possible, should include the following:

(a) Impacts of construction from

- Earthworks;
- Road access; and
- Noise of equipment.

(b) Impacts of operation on

- Flora and fauna;
- Seawater temperature;
- Bacterial concentration;
- Oxygen and nutrient concentrations; and
- Water turbidity and colour;

(c) Impacts on other present and intended land uses on and offshore

- Recreational activities, including bathing waters and sand beaches; and
- Fishing grounds, particularly with respect to shellfish.

(d) Expected impacts on the reduction of enteric diseases

**D. Proposed Measures to Prevent, Reduce or Mitigate the Adverse Effects of the Proposed Submarine Sewage Outfall**

This section should describe all the measures, either technical, legal, social, economic or other, to prevent, reduce or mitigate the adverse effects of the proposed submarine sewage discharge. In addition, it should propose the elements for monitoring the effects on a long-term basis, including the collection and analysis of data, as well as the available enforcement procedures to ensure the implementation of the measures.

**PART IV: ENVIRONMENTAL IMPACT ASSESSMENT DOCUMENT FOR A SEA-OUTFALL OF THE LARNACA SEWERAGE SYSTEM**

**INTRODUCTION**

Larnaca is a tourist resort with a resident population of 52,000 which depends on tourism for a significant proportion of its prosperity. Currently there is no main sewerage system in the town, almost all of which is served by ground disposal systems: septic tanks, absorption pits and simple holding tanks.

Presently, occasional discharges and temporary but repeated leakage of sewage water result in excess bacterial concentration in bathing waters. A sewerage system with treatment plant and outfall will improve the present situation.

However, there is some public concern that sewage disposal may harm or interfere with recreational pursuits. Therefore the EIA study of the sea outfall is of particular importance, taking into consideration the decision to discharge treated effluents into the sea.

**Description of the Proposed Project**

(a) The outfall

The proposed outfall would be located adjacent to Dates Point, approximately 5 km south of the town centre. The outfall will be 600 mm in diameter and tentatively about 1.25 km to 1.5 km long, reaching a depth of 15 m. The pipeline, of steel or HDPE, will be buried below the seabed with one metre cover and should follow the line of the prominent trough running east of Dates Point.

A layout plan and a longitudinal section of the outfall as provided by the designers are given in the enclosed ANNEX I.

Tables 1 and 2 given in ANNEX I present the results of calculations of the initial dilution for different outfall lengths and for different diffuser systems. Considered flows for the outfall design were as follows:

- 123 l/s - Commissioning peak flow in 1988 based on 3.1 x average flow plus infiltration.
- 382 l/s - Year 2000 peak flow of 33000 m<sup>3</sup>/day.

(b) The effluents

(i) Daily flow of sewage to treatment plant (in m<sup>3</sup>/d)

	<u>Phase I (to 1992)</u>	<u>Phase II (to 2000)</u>
Winter	5,400	8,060
Summer	13,200	19,760

(ii) Predicted composition of raw sewage to treatment plant

	<u>Phase I (to 1992)</u>	<u>Phase II (to 2000)</u>
BOD5	156 mg/l	194 mg/l
TDS (SO <sub>4</sub> , Cl)	1000 mg/l	700 mg/l

(iii) Degree of treatment.

- The treatment plant will be operated to attain the following standards in the discharged effluent:
  - BOD5: 20 mg/l
  - Suspended Solids: 30 mg/l
  - pH: in the range 6-9

- Disinfection

The effluent quality range is expected after full treatment and chlorination to be:

Total coliforms 10-10<sup>3</sup>/100 ml (Typically 100/100 ml)  
Faecal coliforms 0-10<sup>3</sup>/100 ml (Typically 100/100 ml)  
Faecal streptococci 0-10/100 ml (Typically 10/100 ml)  
Salmonellae 0-10/100 ml (Typically 0/100 ml)  
Enteroviruses 5-20/10 litres

It was assumed that T-90, time within which 90 % die, will be 4h for bacteria and 18h for enteroviruses. However, doubts about the efficiency of chlorination in the presence of ammonia and the likelihood of generating trihalomethane compounds by reaction with remaining organics will necessitate reconsideration of disinfection by chlorination.

Legislation concerning discharges into the marine environment

Regulations issued on 22 July 1971 in pursuance of the Fisheries Law CAP. 135 prohibit (in section 8B) the contamination of maritime waters by substances that may have an adverse effect, whether directly or indirectly, upon the development or survival of marine life. Free translation of regulation 8B as amended by Law No.322/81 with the introduction of a set of standards appears here below:

4. The basic regulations are modified by the insertion immediately after regulation 8 the following regulations:
  - 8A "No person shall kill, pursue, catch or possess or endeavour to kill, pursue, catch, possess or sell sea turtles or turtle eggs, or seals, or dolphins of any species without the written permission of the Fisheries Officer."
  - 8B "No person shall pollute sea areas or waters in dams, river waters, lake waters or any other natural or artificial reservoirs, where fish are found by any substance which might have direct or indirect harmful effects on the growth or survival of the following fish stocks:
    - (a) Freshwater fish
    - (b) Fish of the coastal sea areas within a radius of 6 miles from the coast."

Note: Regulation 8B was made under section 6 of the Fisheries Law Cap.135.

7. Section 8A of the Basic Regulations is amended and the word "sea" is deleted and substituted by the word "aquatic".
8. Section 8B of the Basic Regulations is amended by the insertion at the end of the following:

For the purpose of the present Regulation the phrase "direct or indirect harmful effect on the growth or survival of the said fish stocks" includes the act of introduction of sewage waters into the sea water for which:

  - (a) The temperature exceeds by 10 degrees (10°C) the temperature of the aquatic environment which is accepting such water.
  - (b) The concentration of organic substances is such that the consumption of oxygen for their oxidation estimated as the consumption of oxygen for biological oxidation (20° C) within five days (Biochemical Oxygen Demand BOD5) shall not exceed 30 mg per litre of water.
  - (c) The concentration of any substance is such that the consumption of oxygen for their oxidation (Chemical Oxygen Demand COD) shall not exceed 80 mg per litre of water.
  - (d) Its pH range is not outside the range of pH6 - pH9.

- (e) The total content of solid substances shall not exceed 80 parts per million (80 ppm).
- (f) The concentration of zinc (Zn) shall not exceed 0.1 parts per million (0.1 ppm).
- (g) The concentration of copper (Cu) shall not exceed 0.1 parts per million (0.1 ppm).

## **Description of the Environment**

### **(a) Physical site characteristics**

The proposed site for the outfall location is given in ANNEX II.

A seabed survey showed that the seabed is fine silt overlaid by up to 0.5 m sand. There are several prominent rock pinnacles offshore and calcareous rock outcrops closer to the shore and alongshore. A prominent ridge runs perpendicular to the shore with a trough on its northern flank. This trough offers the possibility of attaining deeper water at the same distance from the coast.

### **(b) Hydrographic and meteorological information**

Extensive hydrographic studies carried out at Limassol show a general picture with the following main features.

From May through October, the seawater is thermally stratified with maximum 27°C temperature. The thermocline (the sharp gradient between warm surface and cold bottom water) generally occurs at 25-40 m depth. A thermocline does not occur from November to April. Throughout the water column temperature ranges from 16°-17°C. The Larnaca area has been much less studied. The results of measurements outside the fishing port are consistent with the data for Limassol (Figures 5, 7, 8 and 13; Tables 2 and 3 of ANNEX III).

Surface currents are mainly wind-generated and change direction during the day following the wind pattern. Bottom currents are generally weak (<0.1 m/s) and periodically absent. Currents flow to the south in summer and the north in winter.

A single surface drift was performed in the proposed sewage discharge area, on November 11, 1985. Four drifters were released at a depth of 1 m at hourly intervals. Position readings and wind speed and direction measurements were performed at half-hour intervals over approximately 11 hours. All the drifters followed the changes of wind direction. The flow patterns are presented in Figures 1-4 of ANNEX III. When superimposed, they showed northern drift. Currents were measured by current metre at a depth of 18 fathoms (33 metres) and 29 metres above the seabed, for about two months (March 29 to June 7, 1985). Results show most current speeds to be mostly lower than 0.10 m/s and to the south.

Another current metre used at the proposed effluent disposal site again at a depth of 18 fathoms but 4 metres above the seabed during the same period, gave the same results.

### **Wind velocities and intensities**

In winter the winds at night blow from the northwest with a characteristic speed of 7 knots. In the late morning the direction changes to south with a speed of 10-12 knots. In the afternoon the wind will start to blow towards west at a somewhat reduced speed and at nightfall turns northwest again, completing the daily cycle.

The daily cycle is the same in summer, with winds from northwest at night. Wind speed is typically 4 knots. The shift via east to the south occurs earlier in the morning and the summer southerly winds are generally stronger than the winter ones (16 knots). In the evening the winds again turn to northwest completing the cycle.

Mean hourly wind speed and direction at 10 metres height at Larnaca Airport (1981-85) are given in the table 1 of ANNEX III.

## Oxygen and nutrient concentration, turbidity and colour

In summer, oxygen concentrations range from about 5.0 ml/l at the surface, to a maximum of approximately 6.0 ml/l at a depth of 50 meters (Figures 7, 11 and 13; Tables 2 and 3).

Oxygen saturation exceeds 100% at all the depths for this period.

Data on nutrients are not available, but based on our experience, waters around Cyprus are very poor in nutrients. Water is blue and highly transparent, with light penetrating to about 40 metres (Secchi disc).

### (c) Biological conditions

#### State of benthic communities on different bottoms

Benthic fauna and flora from the proposed site of the sewage outfall were sampled at four stations, using a dredge sampler (orange peel) (Figure 1 of ANNEX IV).

The station (A) is at 5 fm depth and 1 km offshore, the station (B) at 10 fm and 1.5 km offshore, station (C) at 20 fm and 2 km and station (D) at 30 fm and 2.5 km offshore at the point at which discharge is to take place.

The data obtained from a total of 80 samples (at each station 20 grab samples of 5 litres were collected) are tabulated in Table 1 of ANNEX IV.

The bottom is mainly covered by sand and mud. The hydrometer analysis and wet sieve analysis (according to B.S 1377 of 1975) show that sediment cover becomes more fine-grained from shallower to deeper stations.

The samples show the presence of green algae, with Caulerpa prolifera dominant at three stations (A, B and C). At station D the seagrass Halophila stipulacea is dominant.

Marine phanerogams Zostera marina and Posidonia oceanica were recorded only at station A (5 fm).

The bottom fauna study also show a diverse fauna of Crustacea, Mollusca, Echinodermata and Polychaeta dominated by molluscs Loripinus lacteus and Nucula nucleus at 10 fm depth and Pseudentalis rubescens at 20 fm depth. Echinodermata with Amphiura chiajei are dominant at 30 fm depth. A higher number of species and individuals was expected at station B (10 fm) (ANNEX IV). The bottom at this station is sandy-muddy, while it is predominantly sandy at station A (5 fm) and mostly muddy at all deeper stations. The number of individual organisms was mostly small and the total biomass low. The species diversity is high with as many as 45 animal species present in the samples, even though in small numbers. Therefore, the total biomass was low (see Figure 2 of ANNEX IV).

Thus, it may be stated that the flora and fauna are typical of an area poor in nutrients and largely unaffected by pollution.

#### Microbial pollution - pathogen survival

Assessment of microbial pollution in Larnaca Bay is based on the data provided by the Medical Services of the Ministry of Health. Sampling and analysis for faecal coliforms are carried out at a series of 29 fixed stations, covering the entire coastal area of Larnaca Bay, on a monthly basis.

The results of the bacterial monitoring for the years 1985, 1986, and 1987 are shown in Tables 1, 2 and 3 of Annex V. As seen from the tables, there is no station with results exceeding the proposed criteria set by UNEP/WMO for bathing waters.

In other studies, occasional excess faecal coliform numbers were recorded but at a small number of stations.

Although no data for bacteria inactivation in Cyprus waters are available, it is well known that the rate of bacterial disappearance in the Mediterranean Sea is greater than in other seas (Paoletti et al., 1978).

Experiments carried out by C.E.R.B.O.M. in Nice and in Israel in the waters off Nice and Tel-Aviv show T-90 to range from less than an hour to a little less than two hours. (Aubert and Desirotte, 1968).

(d) Present and intended uses of the seawater and beaches

Larnaca beach is extensively used for local and tourist recreational activities especially during May-October. The activities include swimming, wind surfing, small boat sailing and angling.

Larnaca Bay has an overall beach area of 287,500 sq. metres and a total length of 13,650 metres from north of Larnaca town up to the Kiti observatory. The beach is mostly sandy and has a capacity for approximately 34,000 persons. In this area, there are hotel apartments and villas which could accommodate a total population of 7,751 in 1986, which is expected to expand to 8,350 for 1988 and up to 8,900 for 1990.

**Fishing Industry**

There is a fishing shelter in Larnaca Bay which accommodates 171 coastal fishing boats. Three trawlers are stationed in the port of Larnaca. The total catch and earnings for the years 1982-1986 are given below:

Year	CATCH		EARNINGS		TOTAL	
	Trawling in m.t.	Coastal in m.t.	Trawling CYP	Coastal CYP	Catch in m.t.	Earnings CYP
1982	130	627	142,055	1,301,084	757	1,443,139
1983	219	963	230,782	1,890,671	1,182	2,121,453
1984	215	1,097	227,463	2,525,000	1,312	2,752,463
1985	264	1,171	290,638	2,634,000	1,435	2,924,638
1986	275	1,169	300,000	3,330,000	1,444	3,630,000

Red mullet (M. barbatus), picarel (M. smaris), bogue (B. boops), and pandora (P. erytrinus) dominate in the catches. Shellfish culture has not been developed in the area as yet and is not anticipated in the near future.

**Meneou Hatchery**

A hatchery for marine species is being established at Meneou, an area adjacent to the proposed site of sewage discharge.

Water for the hatchery will be taken from a distance of 250 metres from the shore. The pumping rate of the sea water will be 250 m<sup>3</sup> per day all year round. Half of this water quantity must be crystal clear, i.e. will be passed through a gravel filter and a bench-type plastic filter. The rest will be used directly from the sea and is required to have the quality of natural sea water, i.e. pH 8.2, S 39.8 0/00.

(e) Ambient quality criteria

Although there is an obvious concern to protect the beaches in the Larnaca area from sewage pollution, no specific requirements have been set with regard to the minimum levels of water pollution acceptable in the bathing areas.

The Government of Cyprus has adopted the WHO/UNEP interim environmental quality criteria for coastal recreational waters, shellfish and shellfish-growing areas and has applied them, to the extent possible, through appropriate legal and/or administrative measures.

## Identification of Possible Impacts

### (a) Impacts of construction

A 3 km long access road is to be constructed at the site of the outfall, starting from the main Larnaca - Meneou road. Alternatively the existing earth road can be widened and reinforced. Earthworks will be carried out for the construction or reinforcement of these roads and for burying the outfall.

However, given the location, the type of ground and the short duration of the work, the impact on landscape, flora and fauna is considered negligible.

Machines used for the earthworks will be noisy. Since the site is well apart, the degree of disturbance will be very low.

### (b) Impacts of operation

Earlier experience from other places show that the effects of the initial discharge of treated municipal sewage can be expected in three main forms:

- bacterial concentration in bathing water and on the shore;
- oxygen depletion in the bottom layer adjacent to the point of sewage discharge; and
- concentration of nutrients in the area in question.

#### (i) Flora and Fauna

As to the bottom fauna, polychaetes are expected to increase in abundance at the expense of crustaceans and molluscs.

Attached green algae in the phototrophic zone are expected to increase in surface coverage.

Algal communities may be degraded as a result of turbidity and sedimentation.

#### (ii) Sea Water Temperature

No significant change is expected as a consequence of sewage discharge.

#### (iii) Bacterial concentration

According to the engineers, the sewage outfall is designed to meet the EEC criteria for the quality of bathing waters and shellfish-growing areas.

Since the discharge point is above the thermocline, and thus in the surface water, and since daytime winds and surface currents are onshore, excess bacterial levels may be expected to occur in bathing waters, especially during periods of malfunctioning of the sewage treatment works.

A computer simulation model by M. Bonazountas of the Technical University of Athens indicates that the WHO/UNEP water quality criteria can be met with the present design, provided that the sewage undergoes secondary treatment and chlorination, but not otherwise.

#### (iv) Oxygen and nutrient concentrations

As the sewage treatment plant will substantially reduce the BOD of the sewage, resulting in a BOD<sub>5</sub> of 20 mg/l, and the discharge point following the present design of the outfall is above the thermocline, no oxygen deficiency is expected.

In case a discharge point below the thermocline is chosen, oxygen deficiency and anaerobic conditions in the bottom water close to the point of discharge are to be expected during periods when there are no currents in the bottom layer.

Nutrient concentrations are going to increase substantially consequent to the sewage discharge in surface waters.

In addition, production of phytoplankton and attached green algae will increase, possibly suppressing other forms of underwater vegetation such as Posidonia sp.

(v) **Water turbidity and colour**

During normal operation of the sewage treatment works, no direct effects on turbidity and colour are expected.

As a secondary effect of the nutrient enrichment and increased production of phytoplankton, transparency is going to decrease and a greenish water colour is expected.

In case of disturbances in the sewage treatment plant, direct effects on turbidity and colour could occur. If the sewage is discharged below the thermocline, these effects are likely to be negligible at least during the summer water stratification.

(c) **Impacts on other present and potential uses on and offshore**

**Recreational activities, including bathing waters and sand**

The Larnaca Bay is intensively used for bathing. Presently occasional discharges and leakage of sewage water temporarily but repeatedly result in excess bacterial levels in bathing waters.

Generally, the sewerage system with treatment plant and outfall will result in an improvement of the present situation. However, the position of the sewage discharge point in the surface water above the thermocline combined with the daytime wind and surface currents towards the shore will result in decreased transparency, some colouration of the water, and possibly excessive bacterial levels in bathing waters and on beaches especially in periods of malfunctioning of the sewage treatment works. These may be factors of importance.

The location of the sewage discharge point below the thermocline would eliminate these risks.

**Fishing grounds**

No interference with the present small scale seine-net fishing is expected. Trawling in the area is carried out at the depth of 54 m or more which is outside the area of primary consideration. There is no shellfish culture or catch in the area.

(d) **Expected impacts on the reduction of enteric diseases**

No statistics are available on present or past extent and frequency of enteric diseases. Therefore, there is no basis from which to forecast the expected reduction.

**Proposed Measures to Prevent, Reduce or Mitigate the Adverse Effects of the Proposed Submarine Sewage Outfall**

(a) **Technical measures**

From the previous analyses it seems that the proposed length of the submarine sewage outfall discharging above the thermocline would cause adverse effects, especially when the sewage treatment works malfunction.

Therefore, it is proposed to lengthen the outfall to reach the depth below the thermocline.

The impact of sewage on the marine environment will depend on the proper function of the sewage treatment plant. The proposed type of sewage treatment plant (activated sludge) is very sensitive to changes in the sewage load. Since this treatment system will serve tourist complexes too, during the tourist season,



the treatment plant could be less effective during that period. To avoid this, the following technical options are suggested:

- construction of a buffer pond to accept the temporarily increased load;
- speeding up the sedimentation process by adding appropriate chemicals; and
- oxidation of organic matter in sewerage system by adding chemical oxidants.

Each of the above-mentioned options should be carefully examined before a final decision is taken.

Another very important prerequisite for the proper functioning of the sewage treatment plant is the constant supply of electric power. A power shortage for a few hours could make the activated sludge process anaerobic. To return the process back to full operation will take about a week.

Chlorination is frequently used to kill bacteria and other organisms in waste waters and to achieve a partial oxidation of organic matter. However, chlorination will also lead to the formation of various organo-chlorine compounds, which may be of environmental concern. Thus, it is desirable to design the sewage outfall so as to enable water quality criteria for micro-organisms to be met without chlorination.

#### (b) Monitoring

A continuous monitoring system must be set up which can be undertaken jointly by the relevant authorities, i.e. Medical Services, Fisheries Department, Health Engineers of the Department of Town and Planning. Monitoring should include the following:

##### (i) Sampling

Sampling of treated effluents before entering the outfall.  
Sampling at the site of effluent discharge and at a number of stations covering the whole coastline of Larnaca Bay.

##### (ii) Analysis of the samples

Samples will be analysed for the following parameters:

1. Bacterial concentration (faecal coliforms and from time to time viruses)
2. Nitrites, nitrates, ammonia, phosphates, BOD5.

At the same time permanent stations will be positioned by the Fisheries Department to observe any changes of the physico-chemical characteristics of the seawater, i.e. salinity, dissolved oxygen, density and turbidity at different depths (profiles). Studies of the effects on the bottom fauna and flora will also be carried out by the Fisheries Department.

##### (iii) Frequency

Sampling for microbiological analyses on the beach will be carried out on a weekly basis at least during the tourist season. Sampling should preferably be carried out late in the afternoon.

Other microbiological analyses (out of season on the beach and at other stations) will be carried out on a monthly basis.

Samplings for physico-chemical parameters will be carried out on a monthly basis all year round.

Studies of the effects on the bottom fauna and flora will be performed on a yearly basis.

## **References**

- 1/ Lamaca Stormwater Drainage and Sanitary System. Final design incorporating the preliminary engineering report. Book 2 of 2. REID CROWTHER INTERNATIONAL LTD in association with SOLON HADJIMINAS AND ASSOCIATES.**
- 2/ Waste discharge into the Marine Environment. Published by WHO/UNEP-Pergamon Press, 1982.**
- 3/ Comprehensive National Tourism Development Plan for Cyprus. Published by CYPRUS TOURISM ORGANIZATION, 1987.**
- 4/ A study of the surface winds in Cyprus. Meteorological Service, Ministry of Agriculture and Natural Resources.**

**ANNEX I**

**LAYOUT PLAN AND ESTIMATED DILUTIONS  
FOR THE OUTFALL**

**Contents: Figure 1  
Tables 1 and 2**

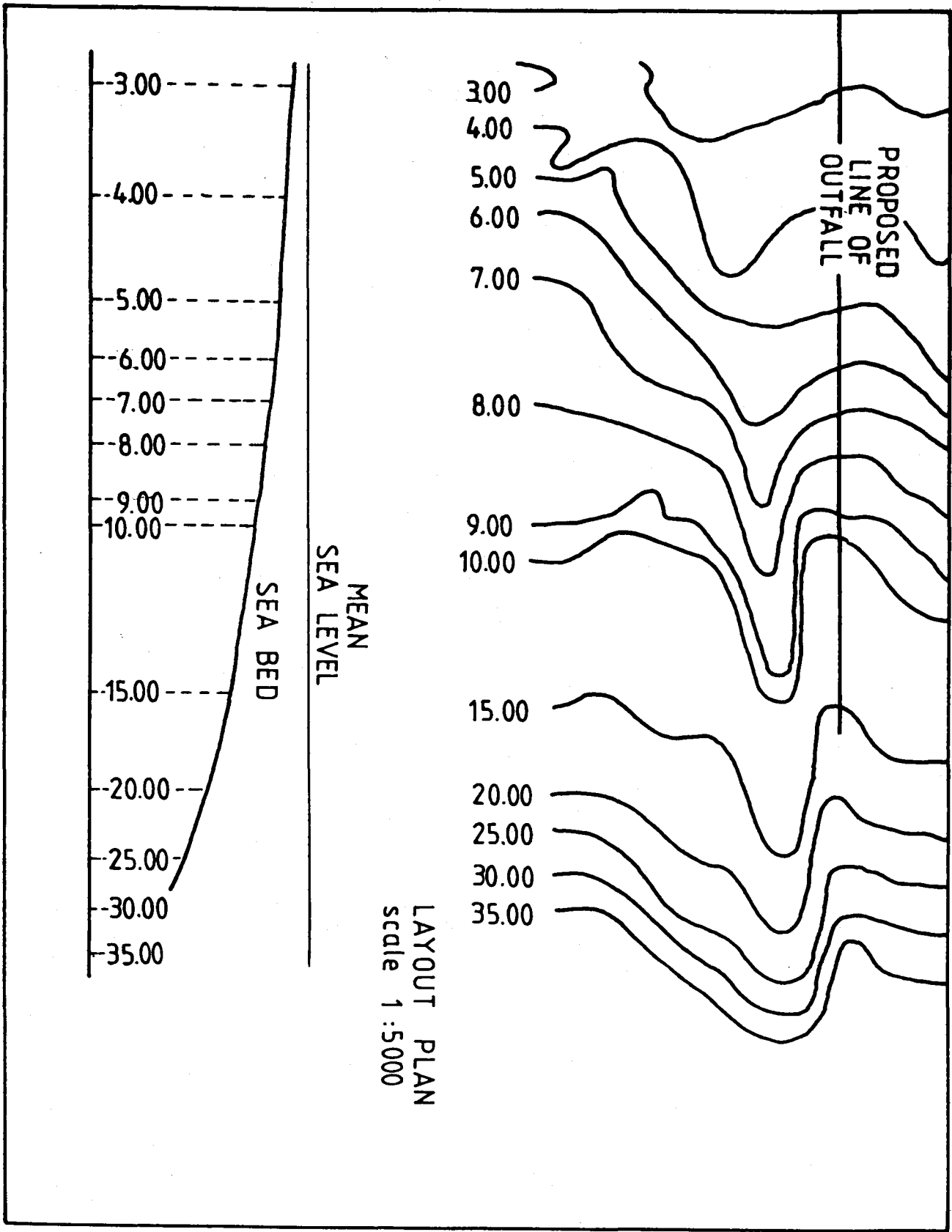


Figure 1. Layout plan and longitudinal section of the outfall

**TABLE 1**

Dilution achieved by 600 mm diameter outfall with different diffuser systems for current speeds of 0.2 and 0.5 m/s

Port Arrangement		Current Speed m/s					
		0.2			0.5		
No.	Dia (mm)	1988	2000	Stage 3	1988	2000	Stage 3
<b>1 km Outfall</b>							
25	100	353	72	60	834	171	139
11	150	208	45	37	492	106	87
6	200	139	31	26	328	74	61
<b>1.25 km Outfall</b>							
25	100	525	102	82	1241	242	194
11	150	308	62	51	727	148	120
6	200	204	43	35	482	102	83
<b>1.5 km Outfall</b>							
25	100	1055	193	153	2492	456	361
11	150	614	115	92	1450	273	218
6	200	404	78	63	954	184	148

**TABLE 2**

Dilution achieved by 700 mm diameter outfall with different diffuser systems for current speeds of 0.2 and 0.5 m/s

Port Arrangement		Current Speed m/s					
		0.2			0.5		
No.	Dia (mm)	1988	2000	Stage 3	1988	2000	Stage 3
<b>1.5 km Outfall</b>							
34	100	1695	298	235	3979	705	554
15	150	980	177	140	2316	419	331
8	200	621	115	91	1467	272	216
<b>1.75 km Outfall</b>							
34	100	387	581	453	8000	1372	1069
15	150	1963	342	267	4638	807	631
8	200	1239	219	172	2926	517	406

**ANNEX II**

**SITE OF THE OUTFALL**

**Contents: Figure 1**

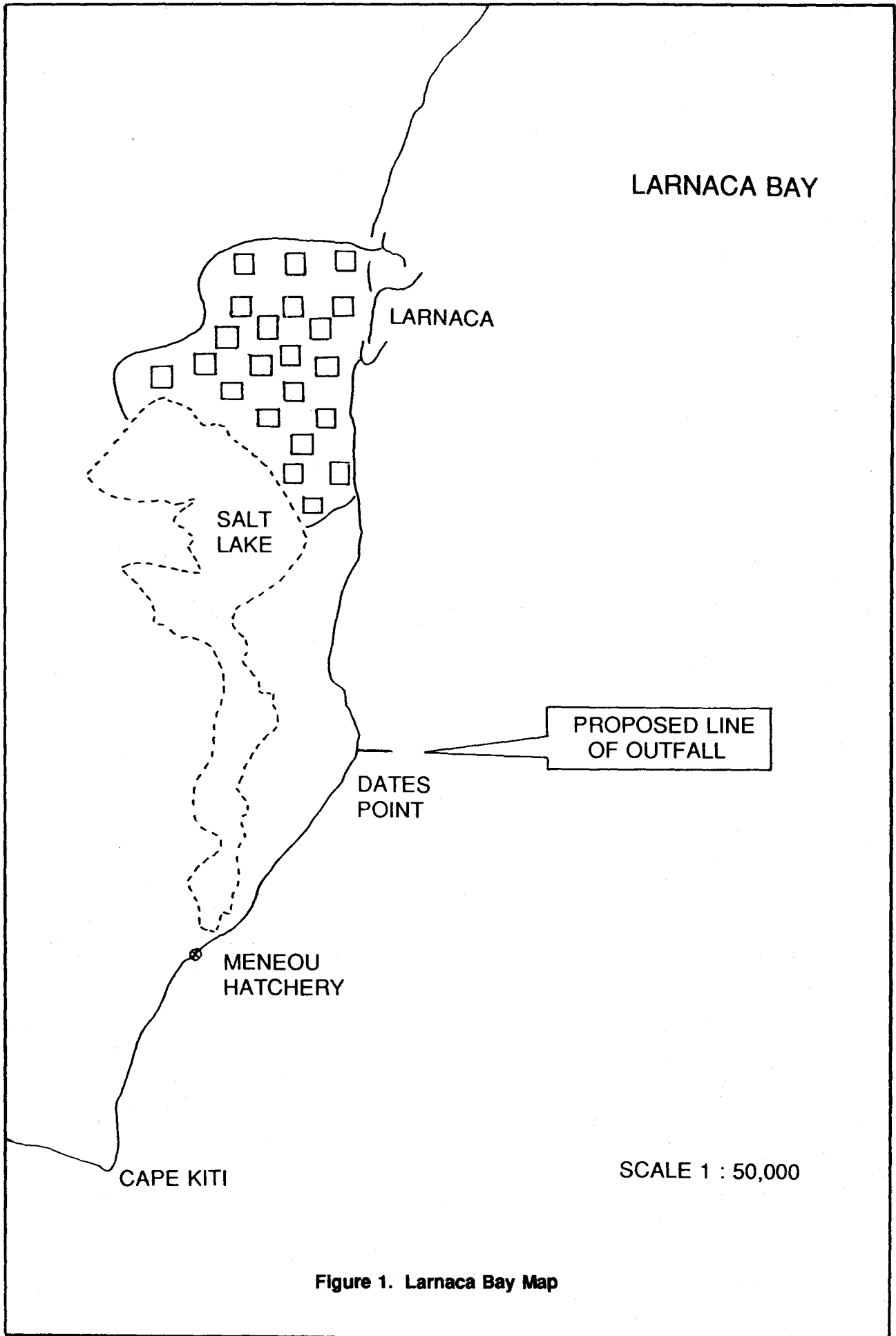


Figure 1. Larnaca Bay Map

**ANNEX III**

**METEOROLOGICAL AND HYDROGRAPHIC INFORMATION**

**Contents: Figures 1 - 13**  
**Tables 1 - 3**



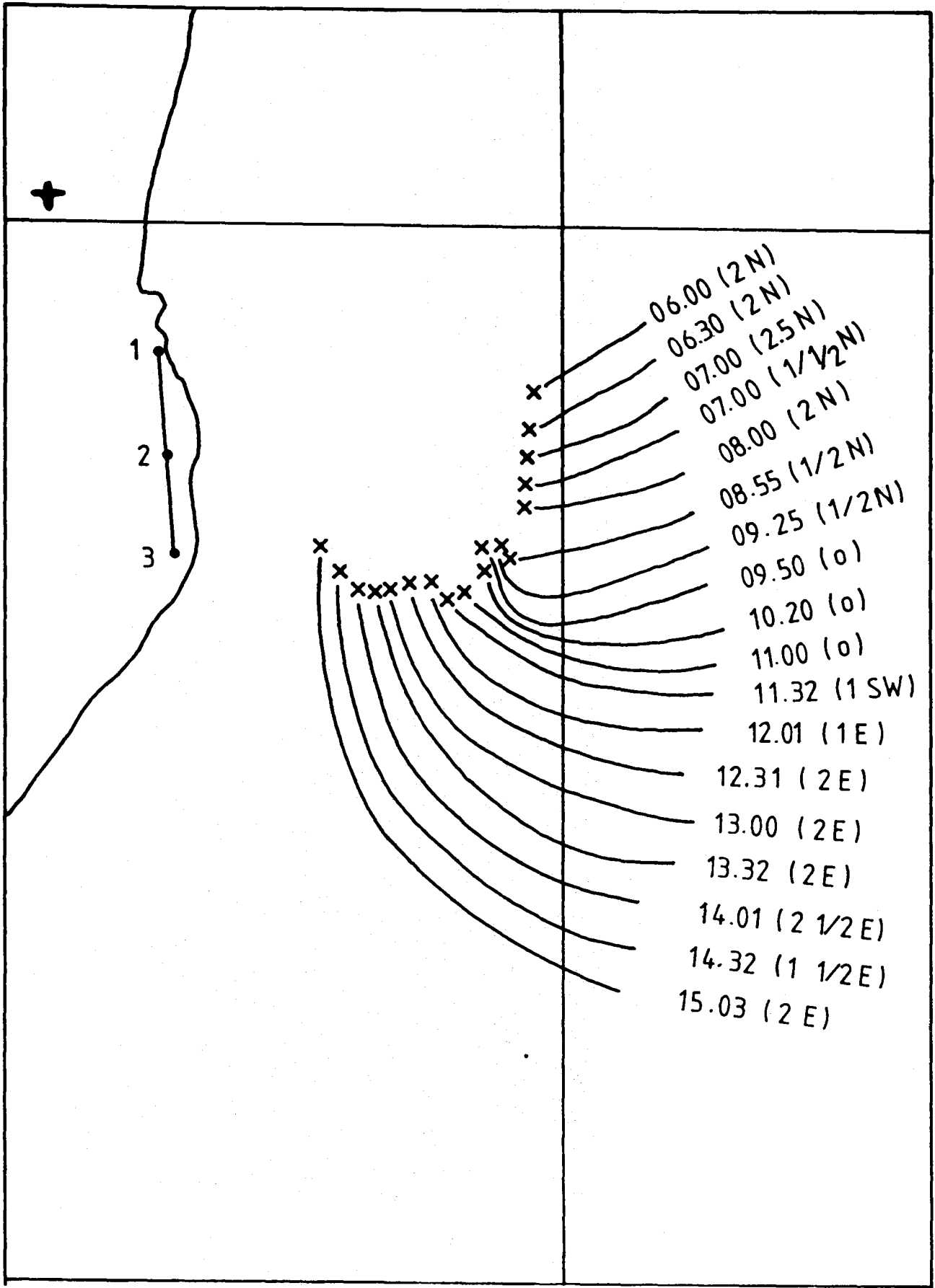


Figure 1. Surface current information

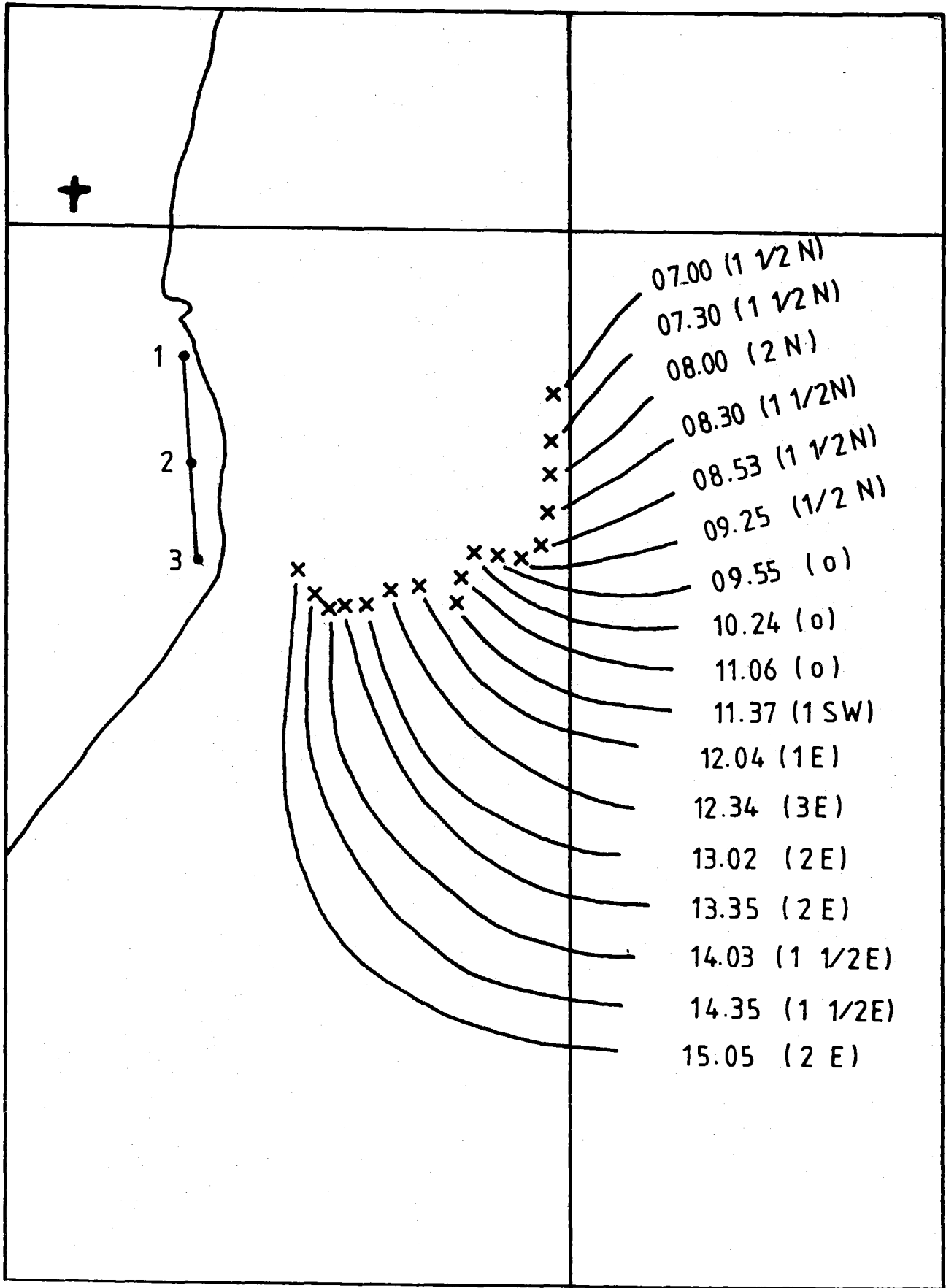


Figure 2. Surface current information

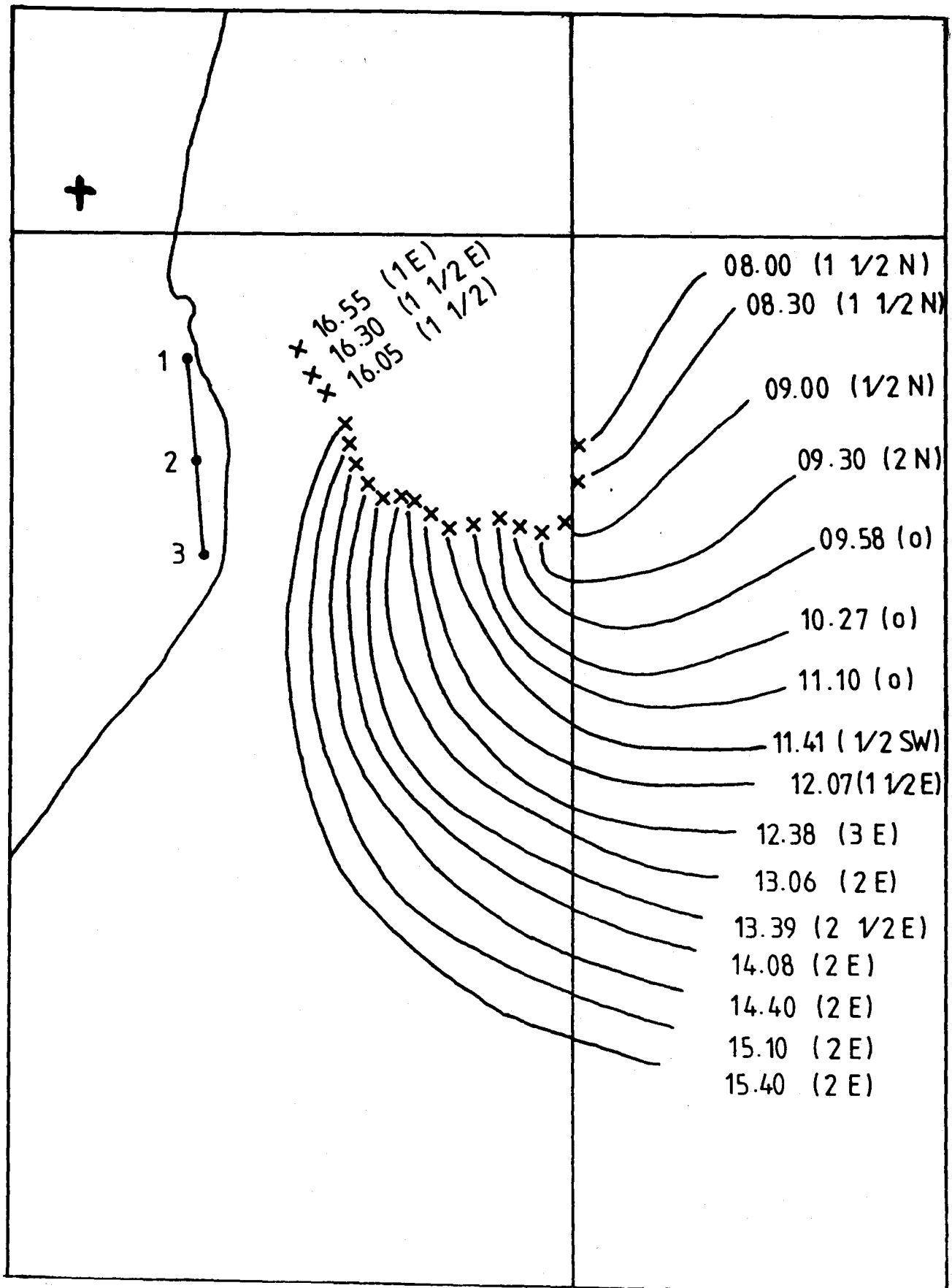


Figure 3. Surface current information

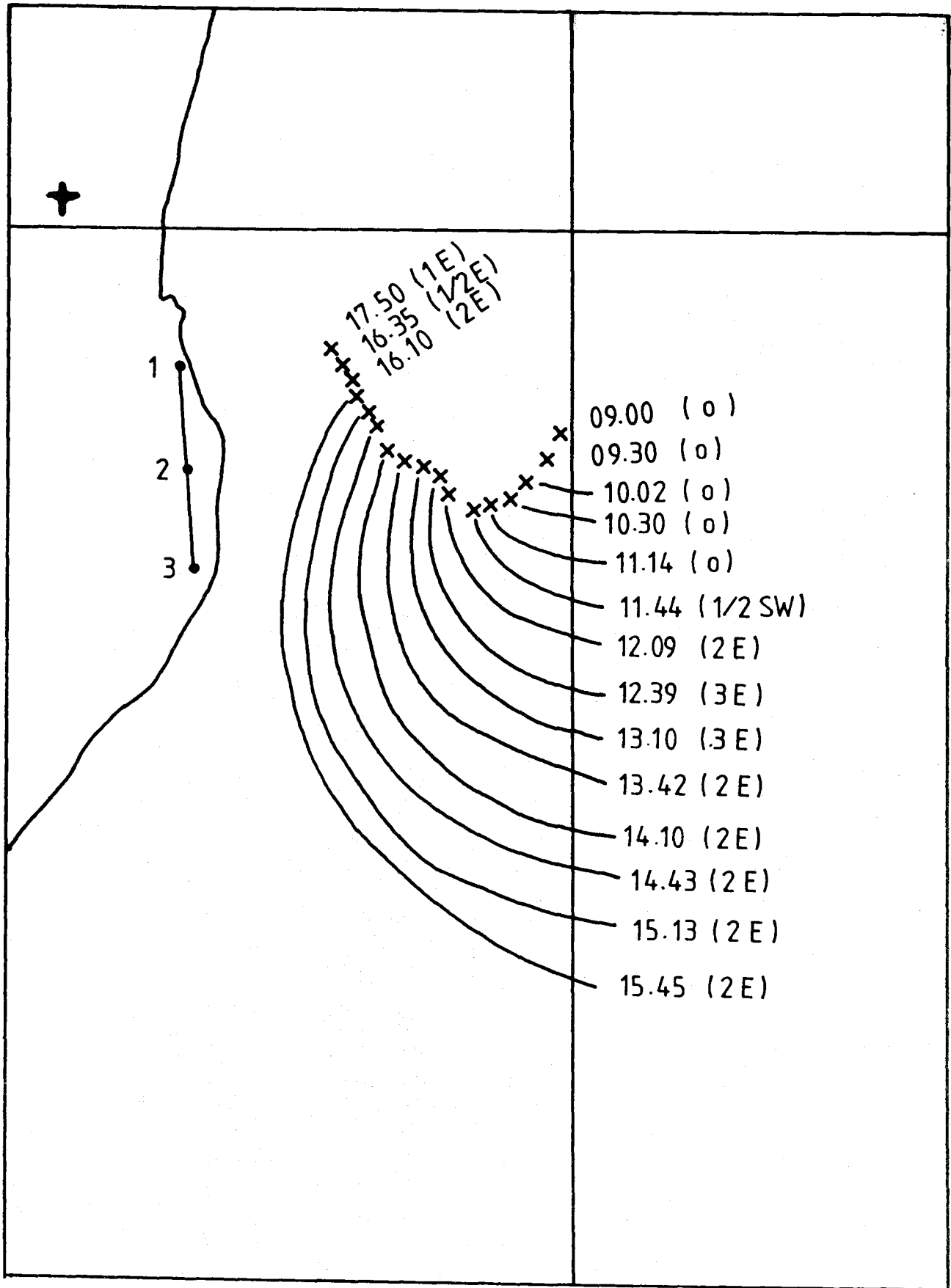


Figure 4. Surface current information

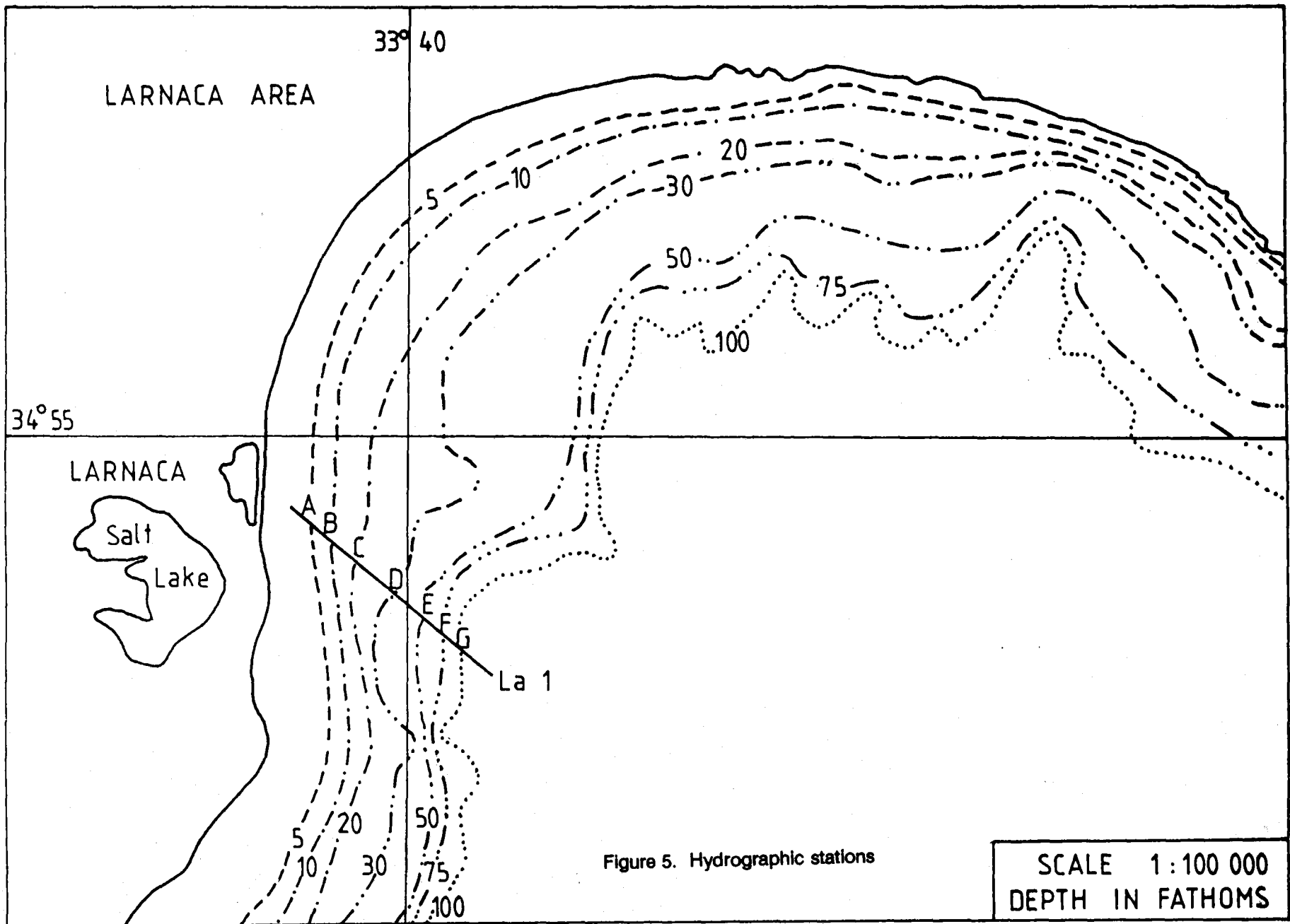
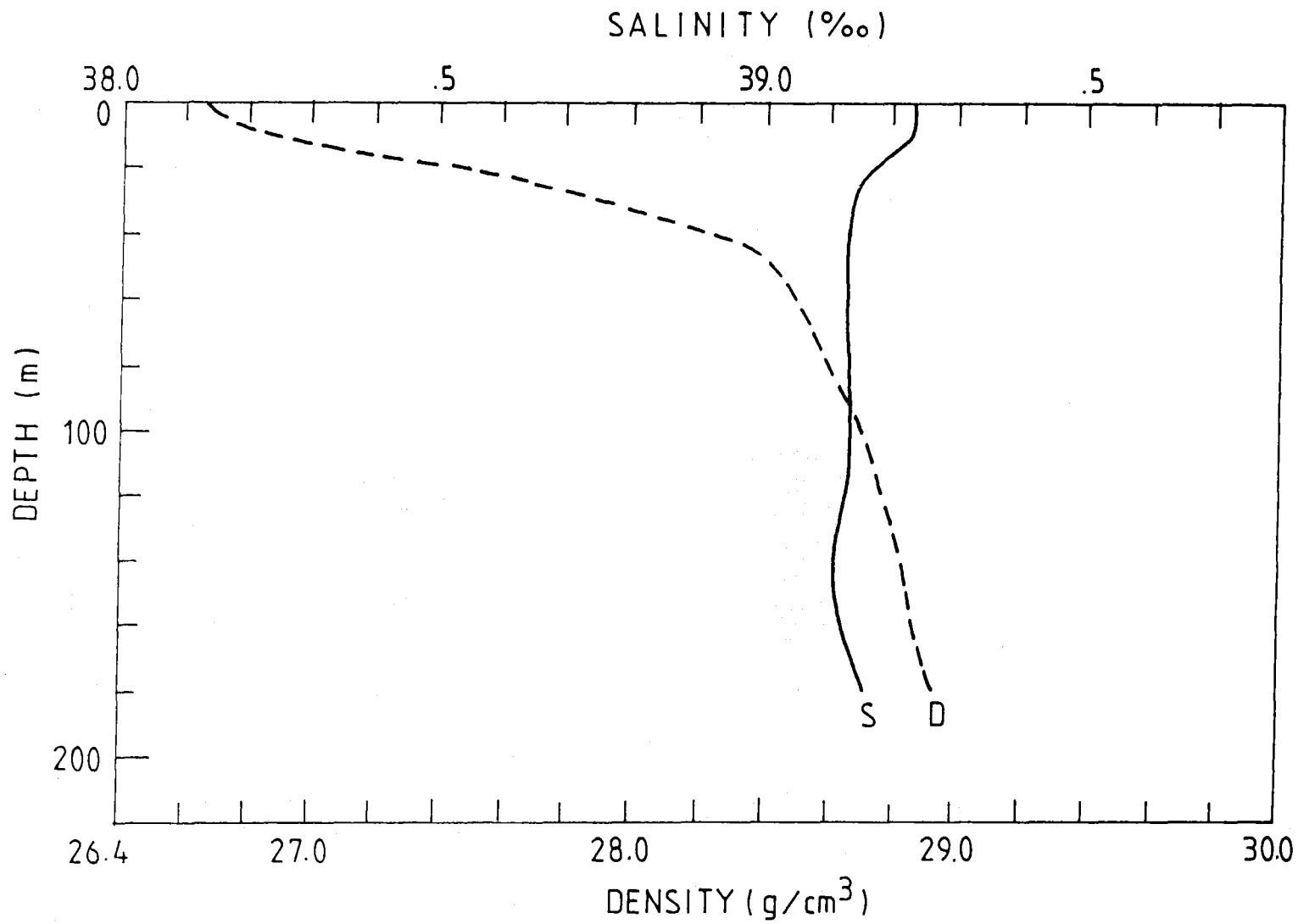


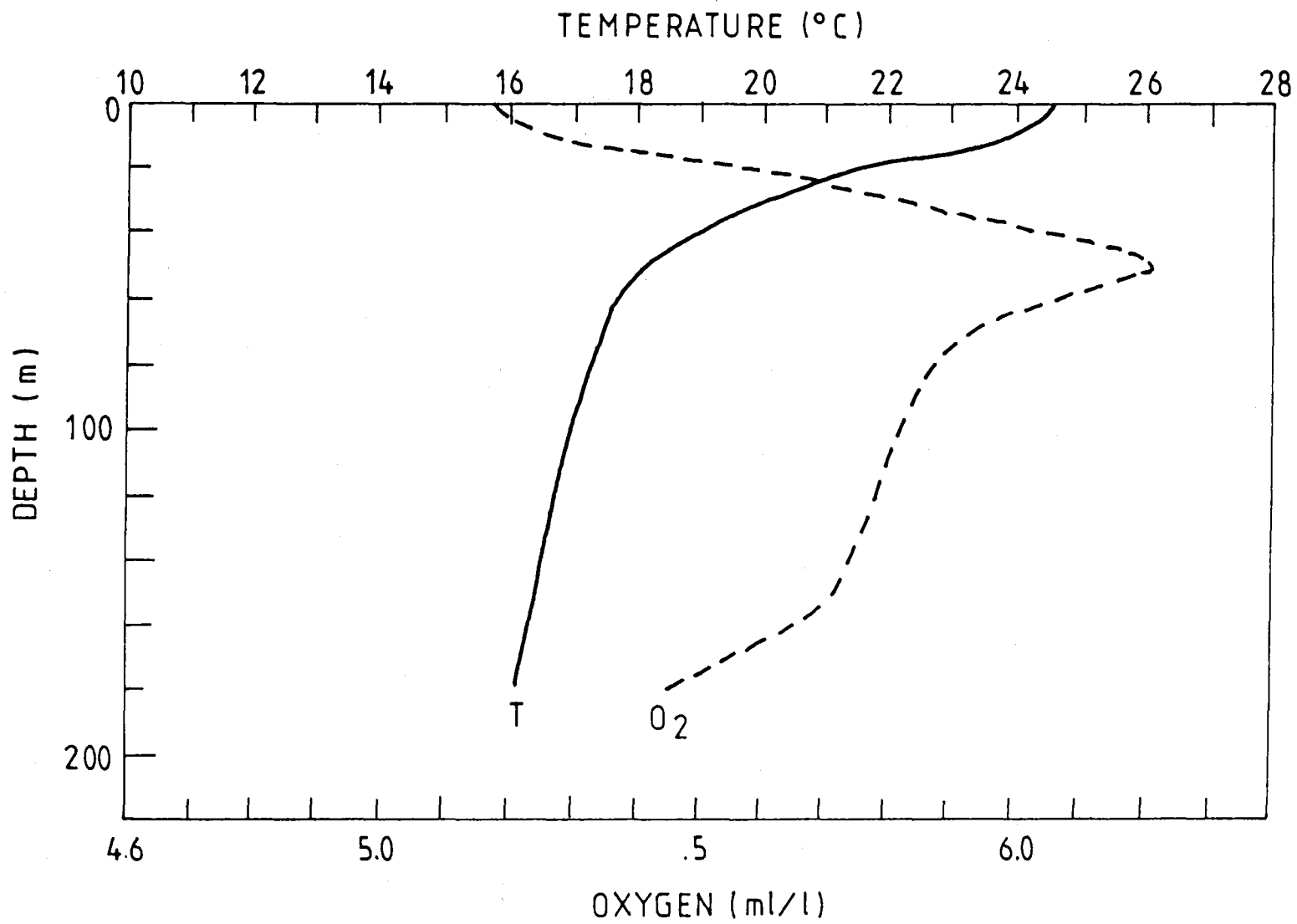
Figure 5. Hydrographic stations

SCALE 1:100 000  
DEPTH IN FATHOMS



La 1 STATION G 25/6/1986

Figure 6. Vertical distribution of salinity and density



La 1 STATION G 25/6/1986

Figure 7. Vertical distribution of temperature and oxygen

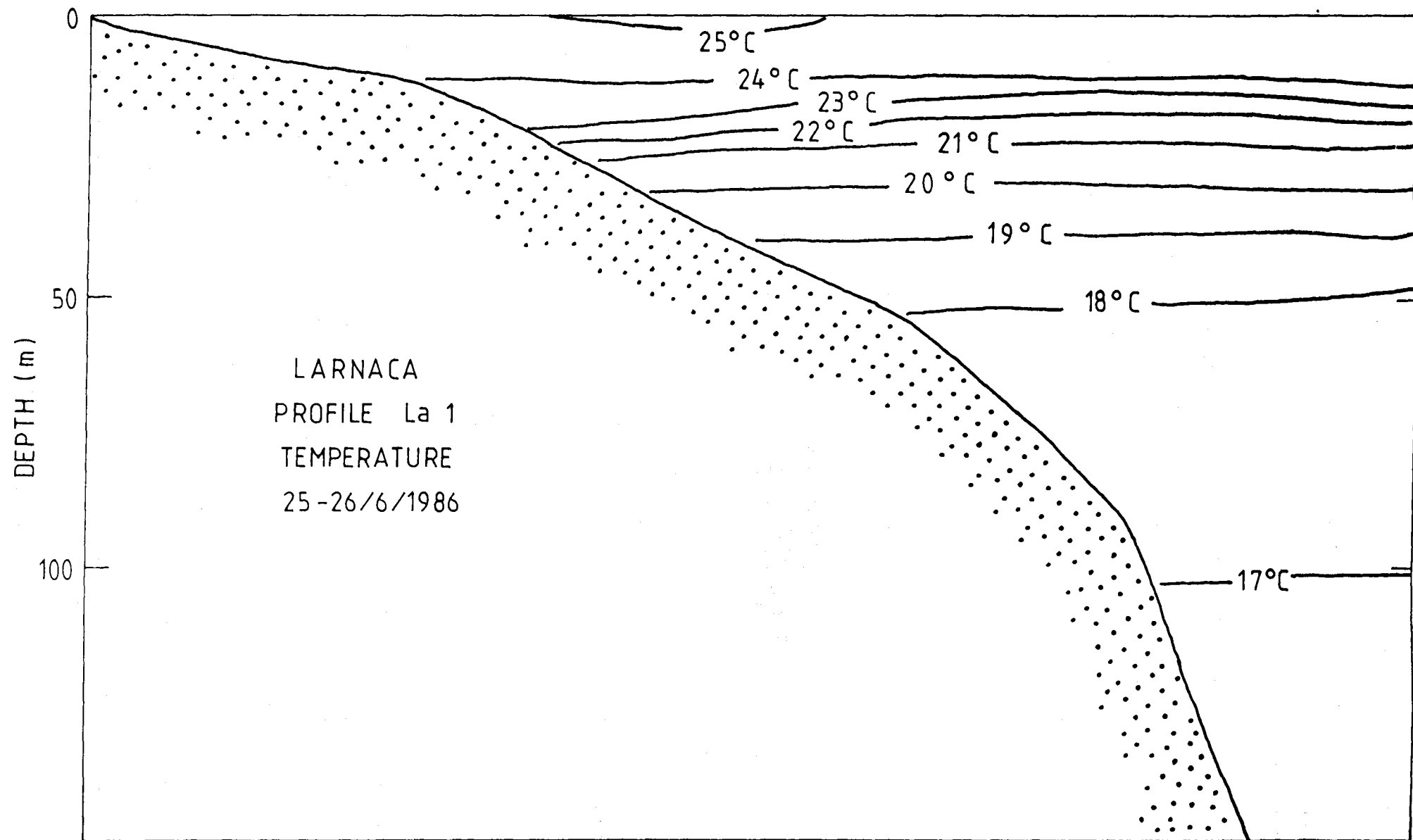


Figure 8. Temperature profile



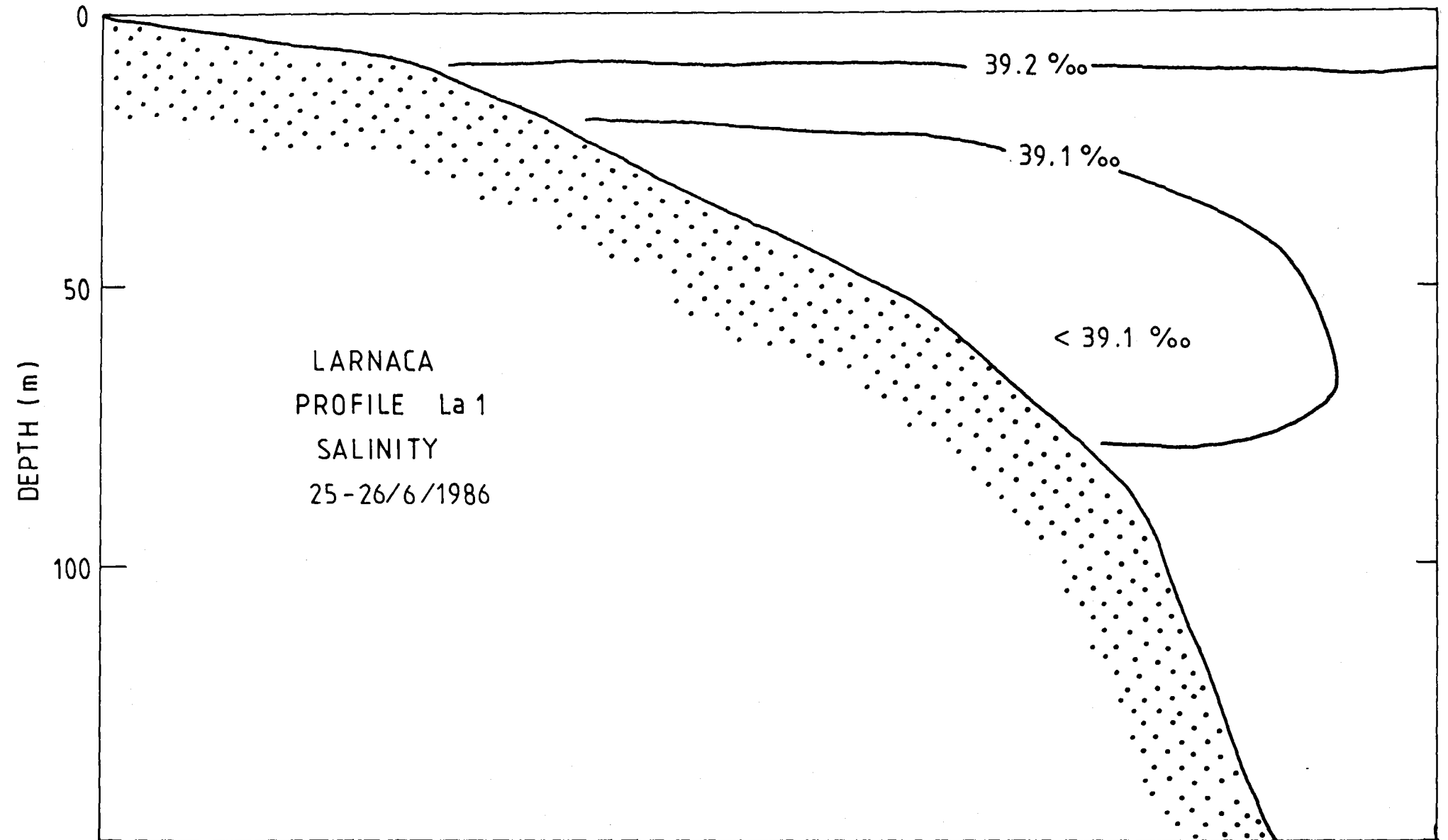


Figure 9. Salinity profile

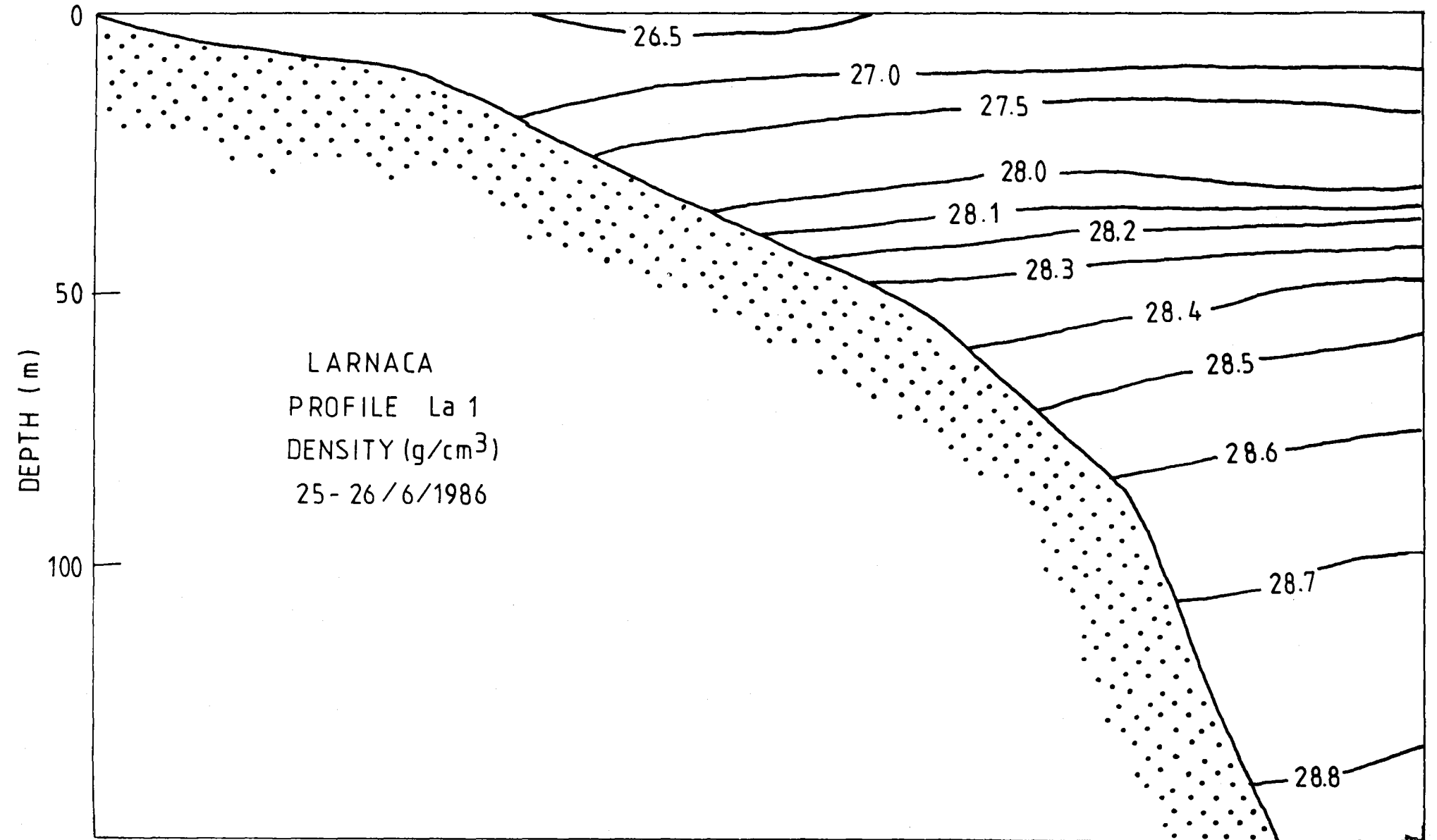


Figure 10. Density profile

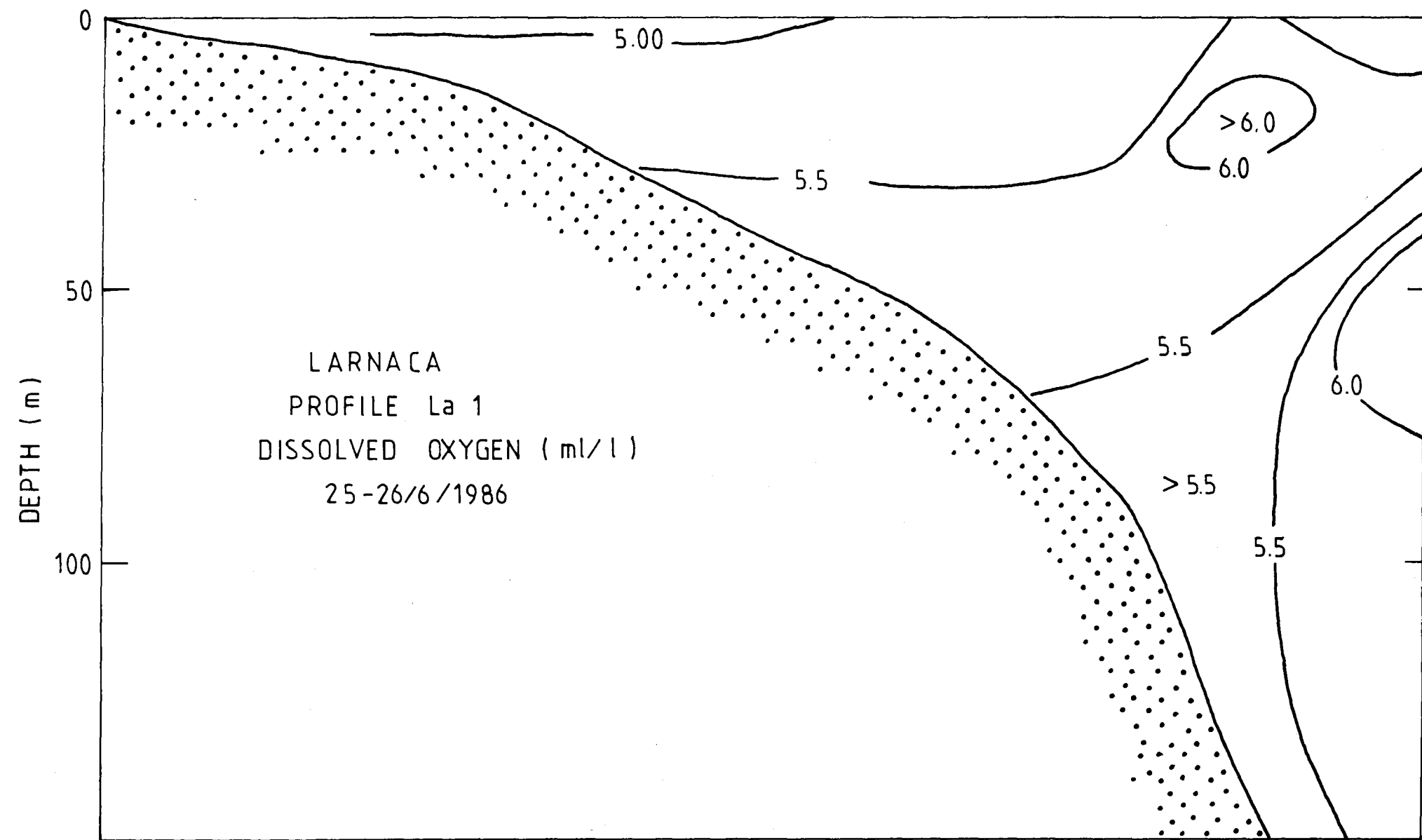
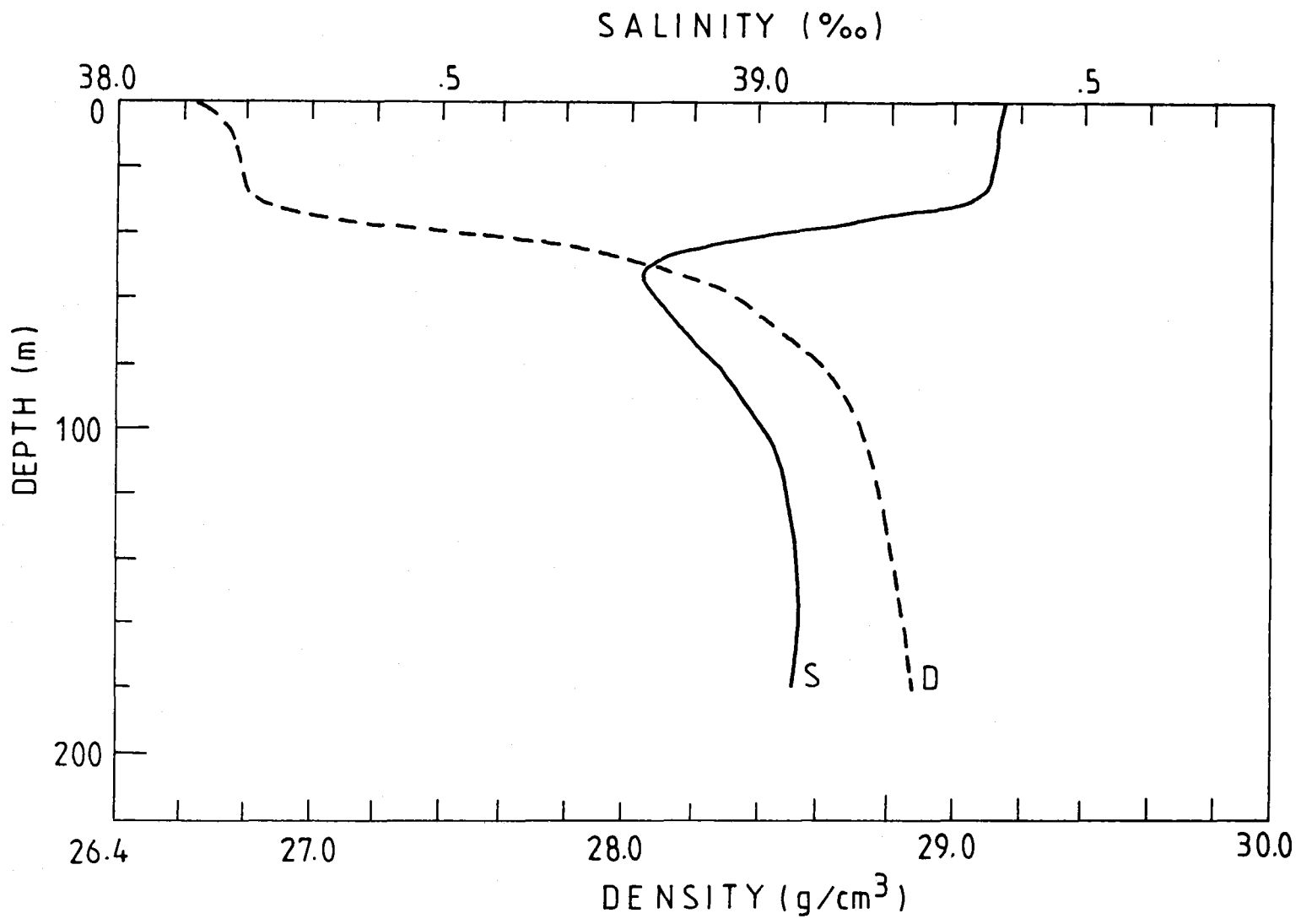
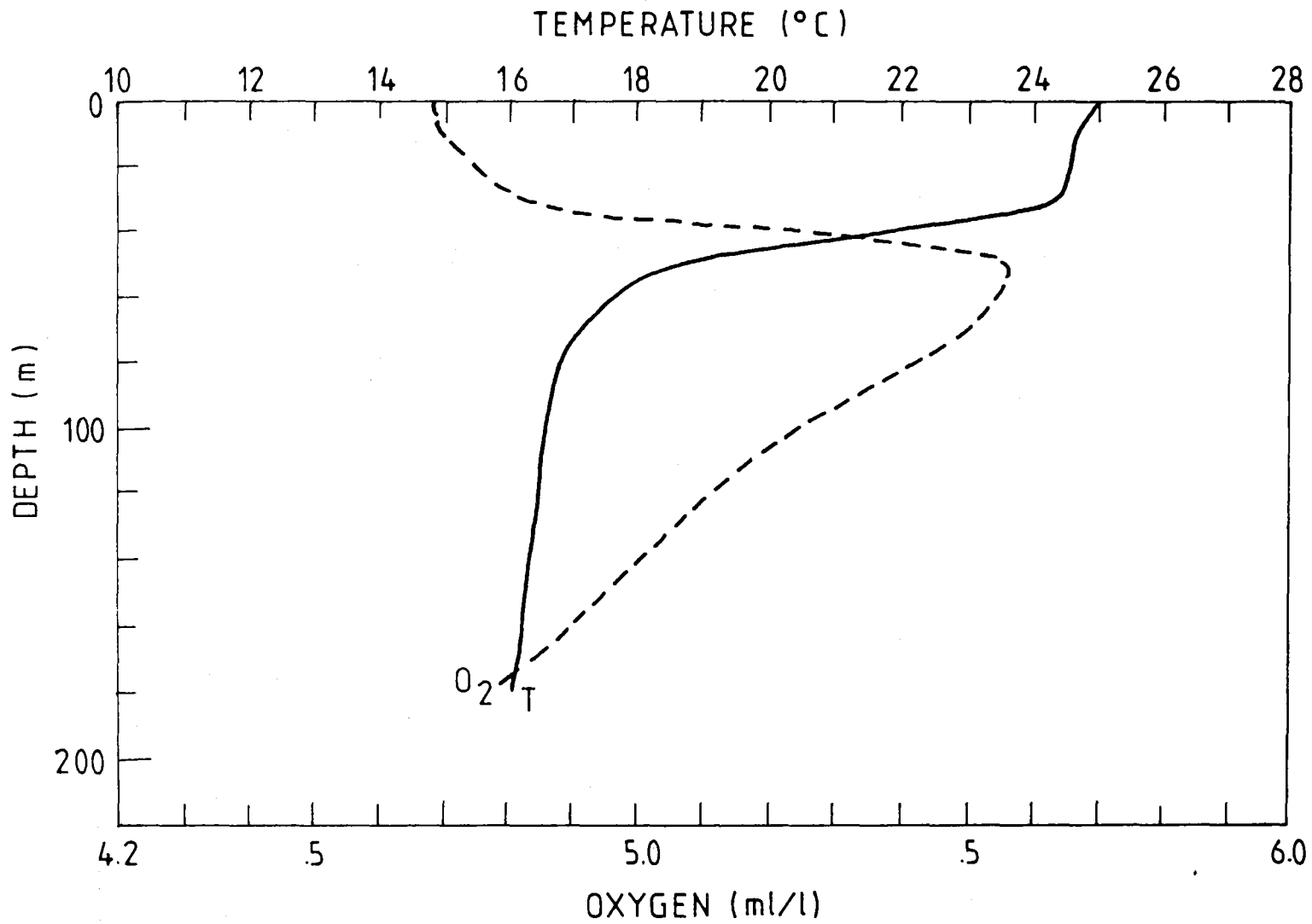


Figure 11. Dissolved oxygen profile



LARNACA La1 STATION G 14/10/1987

Figure 12. Vertical distribution of salinity and density



LARNACA La 1 STATION G 14 / 10 / 1987

Figure 13. Vertical distribution of oxygen and temperature (October 1987)

TABLE 1

Mean Hourly Wind at 10 Metres Larnaca Airport (1981-1985)

Hour	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
00	320/ 7.7	320/ 7.6	320/ 6.7	320/ 6.0	320/ 5.0	270/ 4.7	270/ 5.3	320/ 4.9	320/ 4.5	320/ 5.8	320/ 6.5	320/ 6.7
01	320/ 7.5	320/ 7.5	320/ 6.9	320/ 6.1	320/ 5.2	320/ 4.8	320/ 5.2	320/ 4.8	320/ 4.6	320/ 5.8	320/ 6.4	320/ 6.9
02	320/ 7.7	320/ 8.1	320/ 6.7	320/ 5.9	320/ 5.4	320/ 4.8	320/ 5.0	320/ 4.6	320/ 4.7	320/ 5.8	320/ 6.7	320/ 7.1
03	320/ 7.8	320/ 7.9	320/ 6.5	320/ 5.8	320/ 5.1	320/ 4.5	320/ 5.0	320/ 4.6	320/ 4.5	320/ 6.0	320/ 6.9	320/ 7.2
04	320/ 7.9	320/ 7.8	320/ 6.4	320/ 5.7	320/ 5.2	320/ 4.5	320/ 4.6	320/ 4.4	320/ 4.5	320/ 5.9	320/ 6.8	320/ 6.9
05	320/ 7.5	320/ 7.7	320/ 6.7	320/ 5.9	320/ 5.3	320/ 4.3	320/ 4.4	320/ 4.2	320/ 4.4	320/ 6.0	320/ 6.7	320/ 6.7
06	320/ 7.5	320/ 7.7	320/ 6.8	320/ 6.1	320/ 5.7	320/ 4.9	320/ 4.8	320/ 4.3	320/ 4.4	320/ 5.7	320/ 6.7	320/ 6.9
07	320/ 7.5	320/ 7.8	320/ 7.0	320/ 7.2	180/ 7.3	050/ 6.5	180/ 6.9	180/ 5.8	320/ 4.9	320/ 5.8	320/ 6.6	320/ 6.7
08	320/ 7.5	320/ 8.0	360/ 7.9	050/ 8.8	090/ 8.6	090/ 8.0	180/ 8.6	090/ 7.1	050/ 6.3	320/ 7.2	320/ 7.4	320/ 6.8
09	320/ 8.5	320/10.2	050/ 9.6	180/10.4	180/10.2	140/ 9.9	180/10.2	140/ 8.6	090/ 7.8	050/ 8.7	360/ 8.6	320/ 7.6
10	320/ 9.8	050/11.7	180/10.7	180/12.0	180/12.2	180/11.7	180/12.5	180/10.7	140/ 9.6	050/ 9.4	360/ 9.4	050/ 9.1
11	180/10.9	050/12.5	180/11.9	180/13.4	180/13.9	180/13.1	180/14.3	180/13.0	180/11.2	180/10.3	050/10.0	050/ 9.6
12	180/11.8	180/12.7	180/12.4	180/14.6	180/14.9	180/14.4	180/15.8	180/14.5	180/12.4	180/11.4	180/10.6	050/10.7
13	180/12.1	180/13.4	180/13.0	180/15.2	180/15.3	180/16.2	180/17.2	180/16.1	180/13.5	180/12.4	050/11.1	180/10.7
14	180/12.2	180/13.9	180/12.9	180/15.1	180/15.8	180/16.5	180/18.3	180/17.3	180/14.5	180/12.6	090/11.2	090/10.9
15	180/11.8	180/13.2	230/12.2	180/14.8	180/15.4	180/16.7	180/18.3	180/17.3	180/14.6	180/12.1	050/10.6	230/10.2
16	230/10.5	230/11.9	230/11.4	230/13.5	230/14.8	180/15.9	180/18.0	180/16.9	180/13.8	180/10.4	320/ 9.1	230/ 9.0
17	230/ 9.3	230/10.2	230/ 9.6	230/11.5	230/13.3	230/14.6	180/16.5	180/15.4	180/11.5	230/ 8.2	360/ 8.0	230/ 8.1
18	320/ 8.1	230/ 8.4	230/ 7.8	230/ 9.2	230/10.2	230/12.0	230/14.0	180/12.1	230/ 8.4	230/ 6.1	320/ 7.4	320/ 7.4
19	320/ 8.3	320/ 7.9	320/ 6.6	320/ 7.6	230/ 8.0	230/ 8.8	230/10.6	230/8.9	230/ 6.3	320/ 5.8	320/ 6.8	320/ 6.9
20	320/ 7.8	320/ 7.5	320/ 6.8	230/ 9.2	230/ 6.7	230/ 6.8	230/ 7.8	230/6.6	320/ 5.3	320/ 5.7	320/ 6.8	320/ 6.8
21	320/ 7.6	320/ 7.2	320/ 6.7	320/ 6.6	320/ 5.9	230/ 5.5	230/ 6.1	230/5.5	320/ 4.9	320/ 5.7	320/ 6.8	320/ 6.7
22	320/ 7.7	320/ 7.6	320/ 6.9	320/ 6.2	320/ 5.4	270/ 5.0	230/ 5.4	270/5.1	320/ 4.8	320/ 5.8	320/ 6.5	320/ 6.8
23	320/ 7.7	320/ 7.9	320/ 6.7	320/ 6.1	320/ 5.5	270/ 4.9	320/ 5.1	270/4.8	320/ 4.6	320/ 5.7	320/ 6.5	320/ 6.8

TABLE 2

Oceanographic data  
(Stations A-E refer to June 26 and F-G to June 25, 1986)

STATION	DEPTH m	TEMPER °C	SALINITY ‰	DENSITY g/cm <sup>3</sup>	OXYGEN ml/l	SECCHI- DISK m
A	0	24.74	39.211	26.626	4.96	
	5	24.41	39.206	26.724	5.03	-
	10	24.04	39.214	26.842	5.03	
B	0	24.90	39.218	26.583	4.76	
	10	23.99	39.200	26.846	5.03	-
	15	23.55	39.177	26.960	4.96	
	18	23.21	39.163	27.050	5.24	
C	0	25.38	39.223	26.437	4.90	
	10	24.26	39.200	26.764	5.03	
	20	22.03	39.120	27.359	5.38	31
	30	20.26	39.069	27.814	5.52	
	35	19.66	39.054	27.963	5.52	
D	0	24.52	39.195	26.689	5.07	
	10	24.24	39.202	26.772	5.14	
	20	21.20	39.105	27.582	5.31	32
	30	19.98	39.093	27.907	5.58	
	50	18.23	39.043	28.328	5.55	
E	0	24.15	39.234	26.823	5.10	
	10	23.73	39.245	26.957	5.03	
	20	21.13	39.140	27.629	5.31	
	30	19.65	39.142	28.034	5.52	32
	50	18.21	39.120	28.392	5.62	
	75	17.41	39.087	28.568	5.49	
	85	17.29	39.102	28.609	5.31	
F	0	24.66	39.249	26.679	5.59	
	10	24.14	39.236	26.827	5.93	
	20	21.60	39.166	27.516	6.00	
	30	20.31	39.109	27.830	5.93	
	50	18.23	39.058	28.340	5.52	32
	75	17.44	39.084	28.558	5.38	
	100	17.09	39.127	28.678	5.17	
135	16.60	39.086	28.765	5.35		
G	0	24.63	39.243	26.685	5.17	
	10	24.16	39.235	26.821	5.27	
	20	21.48	39.164	27.549	5.59	
	30	20.27	39.143	27.867	5.83	
	50	17.95	39.129	28.465	6.21	35
	75	17.44	39.129	28.592	5.90	
	100	17.04	39.141	28.701	5.83	
	150	16.37	39.118	28.845	5.72	
180	16.15	39.163	28.932	5.45		

TABLE 3

Oceanographic data  
(Stations A-E refer to Oct. 15, 1987 and F-G to Oct. 14, 1989)

STATION	DEPTH m	TEMPER °C	SALINITY ‰	DENSITY g/cm <sup>3</sup>	OXYGEN ml/l	SECCHI- DISK m
A	0	24.50	38.387	26.832	4.98	
	5	24.41	39.496	26.871	4.84	-
	10	24.38	39.336	26.875	4.82	
B	0	24.51	39.411	26.847	4.87	
	10	24.42	39.398	26.863	4.84	-
	15	24.38	39.374	26.860	4.92	
	18	24.37	39.388	26.871	4.82	
C	0	24.65	39.491	26.865	4.90	
	10	24.49	39.396	26.843	4.87	
	20	24.47	39.389	26.843	4.84	30
	30	24.19	39.354	26.902	4.95	
	35	23.98	39.331	26.949	4.95	
D	0	24.79	39.404	26.757	4.76	
	10	24.60	39.432	26.836	4.79	
	20	24.50	39.430	26.865	4.87	36
	30	24.19	39.492	27.007	4.82	
	50	18.62	39.170	28.326	5.72	
E	0	24.72	39.423	26.792	4.73	
	10	24.61	39.363	26.781	3.82	
	20	24.48	39.391	26.842	3.83	
	30	24.44	39.411	26.870	3.91	38
	50	18.93	38.830	27.985	4.63	
	75	17.05	38.921	28.523	4.36	
	85	16.71	38.924	28.613	4.23	
F	0	24.98	39.249	26.708	4.63	
	10	24.68	39.236	26.769	4.69	
	20	24.67	39.166	26.773	4.72	
	30	24.65	39.109	26.765	4.63	
	50	19.06	38.875	27.984	5.60	36
	75	17.20	38.838	28.382	5.64	
	100	16.62	38.923	28.637	5.18	
	135	16.33	38.993	28.759	4.92	
G	0	25.07	39.378	26.650	4.69	
	10	24.65	39.371	26.774	4.69	
	20	24.58	39.363	26.790	4.75	
	30	24.47	39.345	26.810	4.79	
	50	18.66	38.822	28.049	5.57	40
	75	17.13	38.881	28.478	5.51	
	100	16.55	39.012	28.720	5.25	
	150	16.33	39.059	28.809	4.95	
	180	16.60	39.045	28.877	4.79	



**ANNEX IV**

**INFORMATION ON BENTHOS**

Contents: Figures 1 - 2  
Table 1

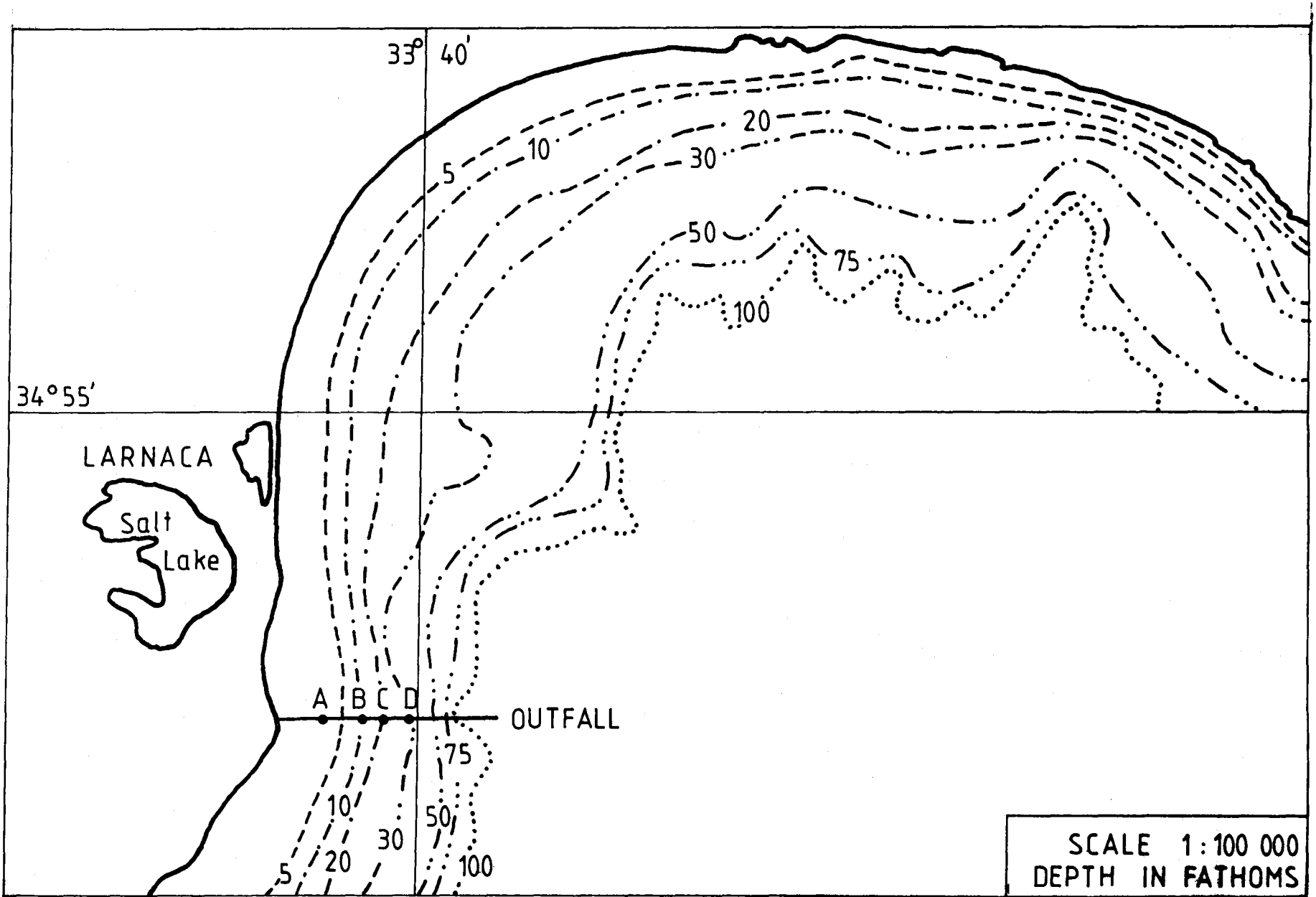


Figure 1. Location of sampling stations

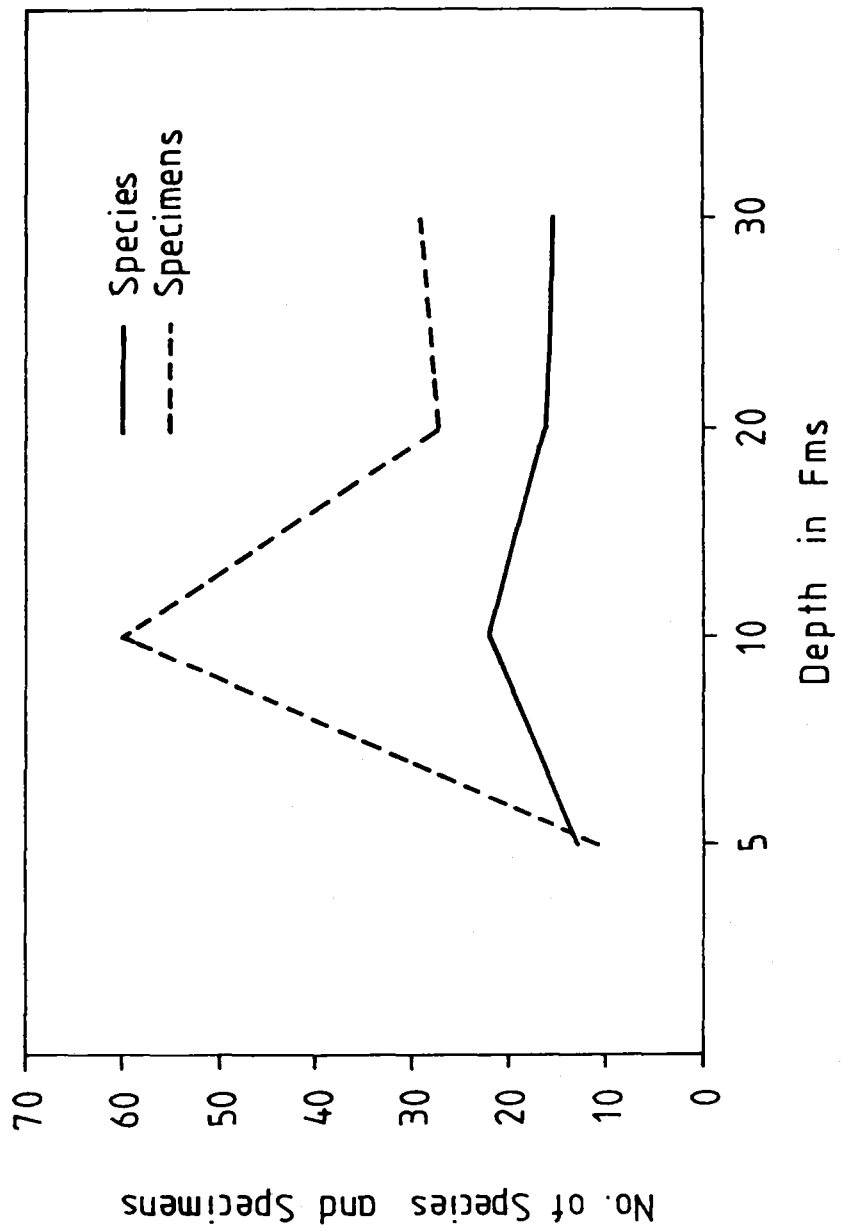


Figure 2

Figure 2. Number of species and specimens at sampling stations

TABLE 1

## Benthos

Stations	A	B	C	D
Depth in fathoms	5	10	20	30
Number of dredgings	20	20	20	20
<i>Callianassa tyrrhena</i>		1	1	
<i>Processa cariculata</i>		2		
<b><u>MOLLUSCA</u></b>				
<b><u>Gastropoda</u></b>				
<i>Pseudodentalis dentalis</i>	1			
<i>Smaragdia viridis</i>	1	2		
<i>Natica hebraea</i>		2		
<b><u>Scaphopoda</u></b>				
<i>Dentalium dentalis</i>				2
<i>Pseudodentalis rubescens</i>			5	
<b><u>Lamellibranchiata</u></b>				
<i>Solemya togata</i>	1			
<i>Parvicardium exiguum</i>		1		
<i>Parvicardium papillosum</i>	1	1	1	
<i>Arca barbata</i>	1			
<i>Gafrarium minimum</i>	1	3		
<i>Venerubis pullastra</i>		1	1	
<i>Glycimeris pilosus</i>			1	
<i>Loripinus fragilis</i>		23	2	
<i>Myrtea spinifera</i>			1	
<i>Phaxas pellucidus</i> (Pennant)			2	
<i>Aloidis giba</i>				6
<i>Nucula nucleus</i>		8		
<i>Cerastoderma eduli</i>		1		1
<b>Series A</b>				
	A	B	C	D
Depth in fathoms	5	10	20	30
Number of dredgings	20	20	20	20
<b><u>ECHINODERMATA</u></b>				
<i>Astropecten platyacanthus</i>			1	
<i>Astropecten spinulosus</i>		1		
<i>Holothuria tubulosa</i>		2		
<i>Amphiura chiajei</i>			3	11
<i>Centrostephanus longispinus</i>				1
<i>Schizaster canaliferus</i>		1		2
<b><u>VARIOUS</u></b>				
Ascidia ( <i>Ascidia</i> sp.)				1
Isopoda ( <i>Cymodocea truncata</i> )		2		
Fishes ( <i>Gobius</i> sp.)				1
TOTAL SPECIES	13	22	16	15
TOTAL SPECIMENS	11	60	27	29

**ANNEX V**

**MICROBIAL POLLUTION**

**Contents: Tables 1 - 3**

TABLE 1

Results on microbial pollution monitoring for the year 1985

STATION	GREATER THAN 10		SMALLER THAN 10		NIL	
	No.	%	No.	%	No.	%
28	3	33.33	1	11.11	5	55.56
29	2	25.00	1	12.50	5	62.50
30	1	7.69	10	76.92	2	15.38
31	1	8.33	7	58.33	4	33.33
32	3	23.08	6	46.15	4	30.77
33	3	23.08	5	38.46	5	38.46
34	2	15.38	6	46.15	5	38.46
35	6	50.00	2	16.67	4	33.33
36	3	23.08	7	53.85	3	23.08
37	3	23.08	6	46.15	4	30.77
38	3	23.08	6	46.15	4	30.77
39	2	16.67	6	50.00	4	33.33
40	6	46.15	7	53.85	0	0.00
41	9	64.29	5	35.71	0	0.00
42	9	69.23	4	30.77	0	0.00
43	9	69.23	4	30.77	0	0.00
44	6	46.15	6	46.15	1	7.69
45	5	38.46	6	46.15	2	15.38
46	3	23.08	6	46.15	4	30.77
47	4	30.77	6	46.15	3	23.08
48	5	38.46	4	30.77	4	30.77
49	5	41.67	4	33.33	3	25.00
50	1	7.69	8	61.54	4	30.77
51	2	15.38	6	46.15	5	38.46
52	1	7.69	8	61.54	4	30.77
53	2	15.38	8	61.54	3	23.08
54	1	7.69	8	61.54	4	30.77
55	2	15.38	2	15.38	9	69.23
56	1	9.09	2	18.18	8	72.73
57	1	9.09	3	27.27	7	63.64

**TABLE 2**

Results on microbial pollution monitoring for the year 1986

STATION	GREATER THAN 10		SMALLER THAN 10		NIL	
	No.	%	No.	%	No.	%
28	1	5.56	9	50.00	6	33.33
29	2	10.53	10	52.63	6	31.58
30	1	5.56	7	38.89	5	27.78
31	2	10.53	8	42.11	6	31.58
32	1	5.56	10	55.56	6	33.33
33	2	10.53	9	47.37	7	36.84
34	2	11.11	5	27.78	8	44.44
35	3	15.79	9	47.37	3	15.79
36	2	11.11	4	22.22	6	33.33
37	2	10.53	9	47.37	6	31.58
38	2	11.11	7	38.89	8	44.44
39	2	10.00	12	60.00	4	20.00
40	3	16.67	7	38.89	6	33.33
41	2	10.53	9	47.37	6	31.58
42	1	5.56	7	38.89	8	44.44
43	2	10.53	10	52.63	5	26.32
44	2	11.11	7	38.89	7	38.89
45	5	26.32	10	52.63	3	15.79
46	1	5.56	7	38.89	8	44.44
47	0	0.00	0	0.00	2	100.00
48	4	20.00	10	50.00	6	30.00
49	2	10.00	11	55.00	7	35.00
50	2	10.00	4	20.00	14	70.00
51	0	0.00	5	25.00	15	75.00
52	1	5.00	3	15.00	16	80.00
53	0	0.00	4	20.00	16	80.00
54	0	0.00	4	20.00	16	80.00
55	4	20.00	3	15.00	13	80.00

**TABLE 3**

Results on microbial pollution monitoring for the year 1987

STATION	GREATER THAN 10		SMALLER THAN 10		NIL	
	No.	%	No.	%	No.	%
28	1	7.69	8	61.54	4	30.77
29	6	46.15	4	30.77	3	23.08
30	2	14.29	5	35.71	7	50.00
31	2	14.29	5	35.71	7	50.00
32	5	35.71	6	42.86	3	21.43
33	2	14.29	7	50.00	5	35.71
34	2	14.29	7	50.00	5	35.71
35	2	14.29	6	42.86	6	42.86
36	3	21.43	6	42.86	5	35.71
37	3	21.43	7	50.00	4	28.57
38	2	14.29	5	35.71	7	50.00
39	2	14.29	8	57.14	4	28.57
40	10	71.43	4	28.57	0	0.00
41	9	64.29	5	35.71	0	0.00
42	13	92.86	1	7.14	0	0.00
43	11	68.75	4	25.00	1	6.25
44	7	43.75	6	37.50	3	18.75
45	3	18.75	10	62.50	3	18.75
46	7	43.75	4	25.00	5	31.25
47	5	25.00	6	30.00	9	45.00
48	2	12.50	10	62.50	4	25.00
49	3	18.75	8	50.00	5	31.25
50	2	12.50	5	31.25	9	56.25
51	0	0.00	5	31.25	11	68.75
52	3	20.00	5	33.33	7	46.67
53	1	6.25	6	37.50	9	56.25
54	2	12.50	7	43.75	7	43.75
55	1	7.14	7	50.00	6	42.86
56	0	0.00	3	42.86	4	57.14



## APPENDIX

### ORGANIZATIONS AND INSTITUTIONS WHICH WERE REPRESENTED IN THE REVIEW MEETING ON EIA PROCEDURES

Nicosia, Cyprus, 24-27 October 1988

- Six departments of the Ministry of Agriculture and Natural Resources (Cyprus): 14 participants
- Department of Town Planning and Housing of the Ministry of the Interior (Cyprus): 5 participants
- Department of Public Works of the Ministry of Communications and Works (Cyprus): 2 participants
- Ministry of Commerce and Industry (Cyprus): 1 participant
- Ministry of Health (Cyprus): 1 participant
- Ministry of Justice (Cyprus): 1 participant
- Planning Bureau (Cyprus): 2 participants
- Cyprus Ornithological Society: 1 participant
- Ministry of Urban Development and Ecology (Mexico): 1 participant
- Organization for Physical Planning and Environmental Protection (Greece): 1 participant
- Ministry of the Interior (Morocco): 1 participant
- Department of Natural Sciences, Faculty of Arts, University of Split (Yugoslavia): 1 participant
- PAP/RAC: 1 staff member and 1 consultant
- UNEP (Co-ordinating Unit for MAP): 1 staff member
- UNEP (OCA/PAC): 1 consultant