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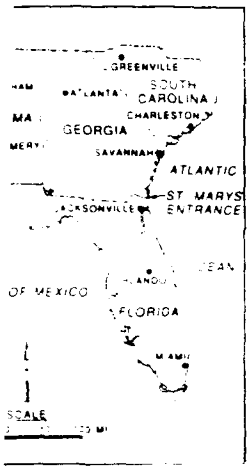

HYDRAULICS
LABORATORY

TECHNICAL REPORT HL-91-4

CUMBERLAND SOUND MONITORING

Report 2
1989 DATA COLLECTION REPORT

by

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US ARMY ENGINEER WATERWAYS EXPERIMENT STATION

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Water levels, conductivity, temperature, and salinities were measured in the Cumberland Sound study area during January 1989 through December 1989. The data were collected as part of a long-term study to assess, through comparisons to earlier data collection programs, if changes to the estuarine processes of the study area have occurred. This report describes the equipment and procedures used in the data collection effort and presents tables and plots of representative data.

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PREFACE

The work described in this report was performed by the Hydraulics Laboratory (HL) of the US Army Engineer Waterways Experiment Station (WES) during January 1989 through December 1989 as a part of the overall Cumberland Sound Monitoring Program conducted for the Department of the Navy under the coordination of US Army Engineer Division, South Atlantic (SAD).

This study was conducted under the direction of Messrs. Frank A. Herrmann, Jr., Chief, HL; Richard A. Sager, Assistant Chief, HL; William H. McAnally, Jr., Chief, Estuaries Division (ED), HL; and George M. Fisackerly, Chief, Estuarine Processes Branch (EPB), ED; and Ms. Joan Pope, Chief, Coastal Structures and Evaluation Branch, Coastal Engineering Research Center, WES. Technical direction and guidance during the study were provided by Messrs. Albert G. Green, Jr., National Park Service (NPS); Thomas J. Peeling, Naval Facilities Engineering Command (NAVFACENGCOM); John Headland, NAVFACENGCOM; Darryl Molzan, NAVFACENGCOM; the late William Odum, University of Virginia, Charlotte, VA; and Robert G. Dean, University of Florida, Gainesville, FL, as members of the Kings Bay Coastal and Estuarine Monitoring Program Technical Review Committee. This report was prepared by Messrs. Fisackerly, Timothy L. Fagerburg, and Joseph W. Parman and Mrs. Clara J. Coleman, all of EPB. The HL portion of the project study was managed by Mr. Fisackerly. The field Data collection program was designed by Messrs. Fisackerly, A. M. Teeter, EPB, H. A. Benson, EPB, and M. A. Granat, Estuarine Processes Branch, ED, and executed under the direction of Messrs. Fisackerly, Fagerburg, and Benson. Other EPB personnel participating in the data collection effort were Messrs. S. E. Varnell, B. G. Moore, J. M. Savage, T. C. Pratt, and L. G. Caviness.

Commander and Director of WES during the preparation of this report was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic metres
cubic yards	0.7645549	cubic metres
Fahrenheit degrees	5/9*	Celsius degrees or kelvins
feet	0.3048	metres
inches	2.54	centimetres
miles (US nautical)	1.852	kilometres
miles (US statute)	1.609344	kilometres
square feet	0.09290304	square metres
square miles	2.589998	square kilometres

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

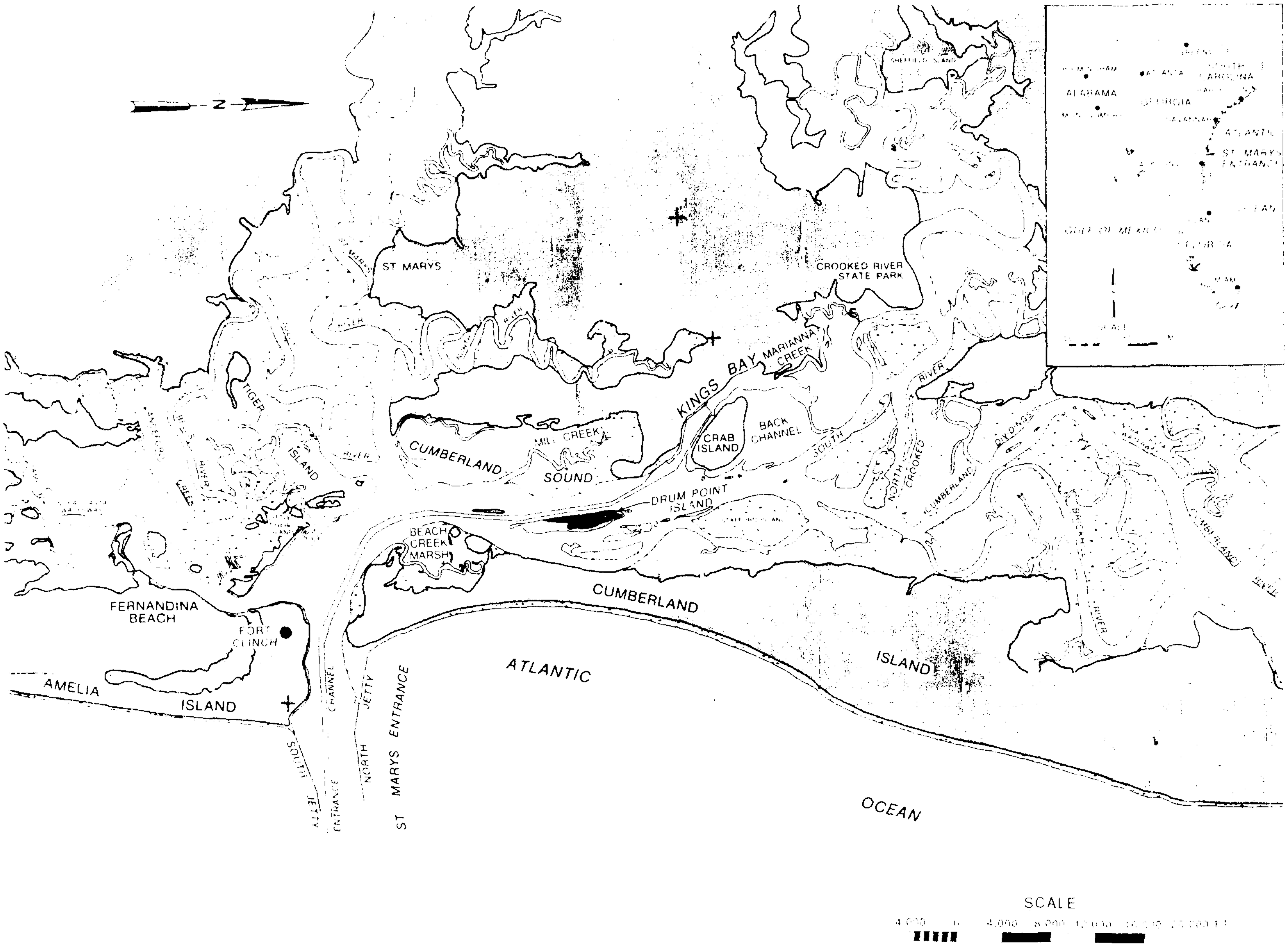

Figure 1. Cumberland Sound and Kings Bay vicinity map

CUMBERLAND SOUND MONITORING

1989 DATA COLLECTION REPORT

PART 1: INTRODUCTION

Background

1. The original Kings Bay facility, located adjacent to Cumberland Sound in southeast Georgia, was designed and developed as an emergency Army Munitions Operation Transportation facility in the late 1950's. Initial channel depths were authorized at 32 ft* mean low water.** The facility was never placed into operational use and was in a standby mobilization status with channel depths of about 32 ft. Figure 1 shows the general Cumberland Sound and Kings Bay area.

2. In July 1978, ownership of the Kings Bay facility was transferred to the Department of the Navy for use as a Naval submarine base for Poseidon class submarines. Between July 1978 and July 1979, approximately 8.6 million cubic yards of material were removed for Poseidon facility expansion. Major channel realignment, widening, and deepening were performed. The lower entrance channels were authorized at depths of 38 to 40 ft and width of 400 ft. The remaining interior approach channels were authorized at a depth of 34 ft and a width of 300 ft. Kings Bay was authorized at a depth of 37 ft. The total length of the interior Poseidon channel, from the throat of St. Marys entrance adjacent to Fort Clinch to the end of the main docking facility, was about 7 nautical miles (n.m.). The channel width widened from about 650 ft at the Kings Bay entrance to about 1,200 ft at the downstream end of the main docking facility.

3. The most recent changes to the channel, to accommodate the Trident submarines, were completed in October 1988 and included widening the approach channel to 500 ft and deepening it to 46 ft; deepening the ocean entrance to 49 ft; deepening Kings Bay to 48 ft; some additional widening within Kings Bay

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* A table of factors for converting non-SI units of measurement to SI (metric) units is found on page 3.

** All depths and elevations (el) described in this report refer to local mean low water (mlw), which is 2.75 ft below National Geodetic Vertical Datum (NGVD).

and at some of the lower channel bends; relocating the Poseidon tender from perpendicular to the channel to parallel to the channel above the floating dry dock; extending Kings Bay another nautical mile to the northwest to include a small boat facility, a Trident dry dock, and an upper turning basin; and building a magnetic silencing facility adjacent to the submarine channel across from Drum Point Island.

4. The State of Florida raised concerns about the potential for adverse impacts to coastal processes on Amelia Island to the south. In addition, the Department of Interior (DOI) raised concerns about potential impacts to the Cumberland Island National Seashore to the north of St. Mary's inlet. These concerns included both the ocean coast of Cumberland Island and the interior Cumberland Sound Estuary. Partly as a result of these concerns, a 5-year study (1988-1992) was established to assess the effects of the Trident project on the estuarine and coastal processes in the area of Cumberland and Amelia Islands and Cumberland Sound. The US Army Engineer Waterways Experiment Station (WES) Hydraulics Laboratory is responsible for the program's estuarine studies. These studies include some numerical and physical model testing, and long- and short-term field data collection to assess the potential effects on the hydrodynamics of the system, such as tidal effects, changes in salinity, and sedimentation. The Coastal Engineering Research Center (CERC), WES, is responsible for the coastal portions of the programs and provides the central point of contact for the entire Kings Bay monitoring effort of WES. The US Army Engineer Division, South Atlantic, serves as the lead agency for coordination between the US Army Corps of Engineers and the Navy. In addition to WES, other agencies involved in the overall monitoring program are the US Navy, US Army Engineer South Atlantic Division, DOI, NPS, and the US Army Engineer Districts of Savannah and Jacksonville.

Purpose

5. The purpose of the overall Cumberland Sound monitoring program is to provide long-term monitoring of tides, conductivity, and temperature measurements at six stations throughout the system over the 5-year project duration. The purpose of this report is to present representative samples of the long-term data that were collected during the second year of the project.

Scope

6. This is report 2 of a series, and presents representative results of the field data collection program in the Cumberland Sound system during 1989 calendar year January through December. Measurements consisted of the following:

a. Water level elevations at six stations.

b. Salinity measurements at each station.

c. Conductivity measurements at each station.

d. Temperature measurements at each station.

e. Composite water samples at each station.

7. This report describes the field investigation methods used to collect the data, shows representative results of the data reduction efforts, and describes the availability of the data for further use.

PART II: THE CUMBERLAND SOUND SYSTEM

8. The Naval Submarine Base, Kings Bay, is located in southeast Georgia, about 9.6 n.m. north of the St. Marys Inlet entrance jetties at the Atlantic Ocean. The base is within the Cumberland Sound estuarine system, which includes extensive salt marshes and sand flats (shaded areas on Figure 1) typical of the sea island system of southeast Georgia. The mean tidal range at the ocean entrance between Amelia Island, in the state of Florida, and Cumberland Island, in the state of Georgia, is 5.8 ft. Maximum spring tidal ranges can exceed 8.0 ft in the interior portions of the estuary.

9. The primary source of fresh water for the Cumberland Sound estuarine system is the St. Marys River. The river originates in the Okefenokee Swamp, approximately 120 n.m. upstream from Cumberland Sound, and enters the sound about 5.5 n.m. south of the Kings Bay entrance. The St. Marys drainage basin includes about 1,478 square miles of swampland and coastal plain. The long-term average freshwater discharge at the mouth of the river is about 1,500 cfs. Freshwater discharges as high as 18,000 cfs have been recorded. Suspended sediment loads within the St. Marys River are generally low.

10. The Crooked River, located approximately 2 n.m. north of Kings Bay, is the second largest contributor of fresh water to the Cumberland Sound system. This river is much smaller than the St. Marys and consists of a drainage basin of about 90 square miles with an average freshwater discharge of about 100 cfs. The total fresh water entering Cumberland Sound from the remaining drainage basins is estimated to be less than the Crooked River flow.

11. The relatively low average total freshwater discharge into Cumberland Sound and the relatively high tidal range and associated strong current velocities generally maintain the sound as a well-mixed estuarine system. Salinity within the sound and Kings Bay is generally vertically and laterally homogeneous. Longitudinally, salinity within the sound is only slightly reduced from the ocean entrance conditions. Salinity in Kings Bay typically varies from about 26 to 32 ppt during the year.

PART III: EQUIPMENT DESCRIPTION, PROCEDURES, AND CONDITIONS

Equipment

12. Water level elevations and temperature, conductivity, and salinity measurements were recorded using Environmental Devices Corporation (ENDECO) model 1152 SSM (solid state measurement) water level recorders similar to that shown in Figure 2. Water samples for suspended sediment concentrations were obtained using American Sigma Streamline Model 720 automatic water samplers similar to that shown in Figure 3.

Water Level Elevations

13. The ENDECO model 1152 SSM recorders contain a strain gage type pressure transducer located in a subsurface case which is used to record the absolute pressure of the column of water above the case. The pressure transducer is vented to the atmosphere by a small tube in the signal cable to compensate for any changes in atmospheric pressure. The pressure is measured for 49 seconds of each minute of the recording interval with a frequency of 5-55 KHz to filter out surface waves, therefore eliminating the need for a stilling well. The accuracy is ±0.1 percent of full scale. The sampling time interval can be set from 1 minute to 1 hour on the 1152SSM. A 10-min sampling interval was chosen for this study.

Temperature, Conductivity, and Salinity Measurements

14. Temperature is measured by means of a thermistor built into the water level recorder. The thermistor has a range of -5° C to +45° C, with an accuracy of ±0.2 percent of full scale. Conductivity is measured by means of an inductively coupled probe. The probe has a range of 0-80 mmho/cm with an accuracy of ±0.55 mmho/cm. Salinity values are then computed from the output of the conductivity and temperature measurements and displayed in units of parts per thousand (ppt).

15. The sampling time interval for these parameters is set the same (10 min) as for the water level measurements; they cannot be set independently. The data from each recorder are stored on a removable EPROM solid

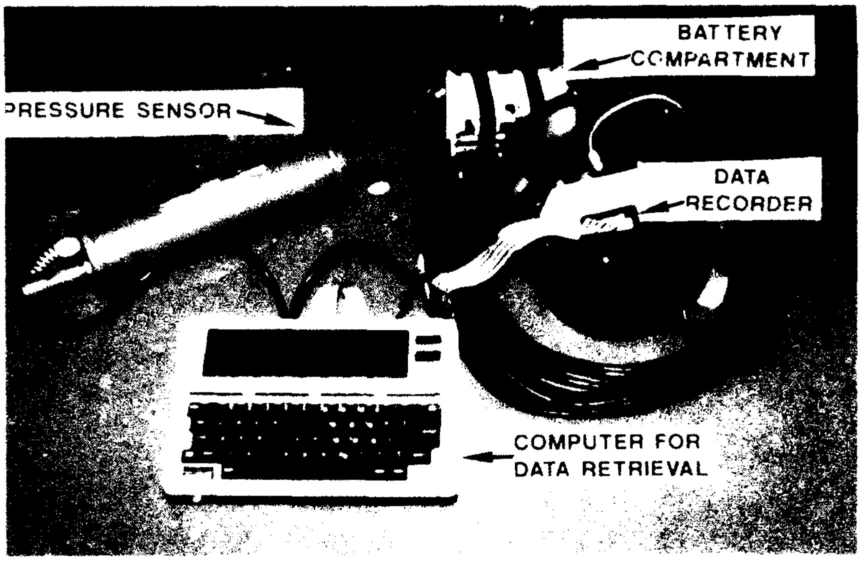

Figure 2. Water level recorder

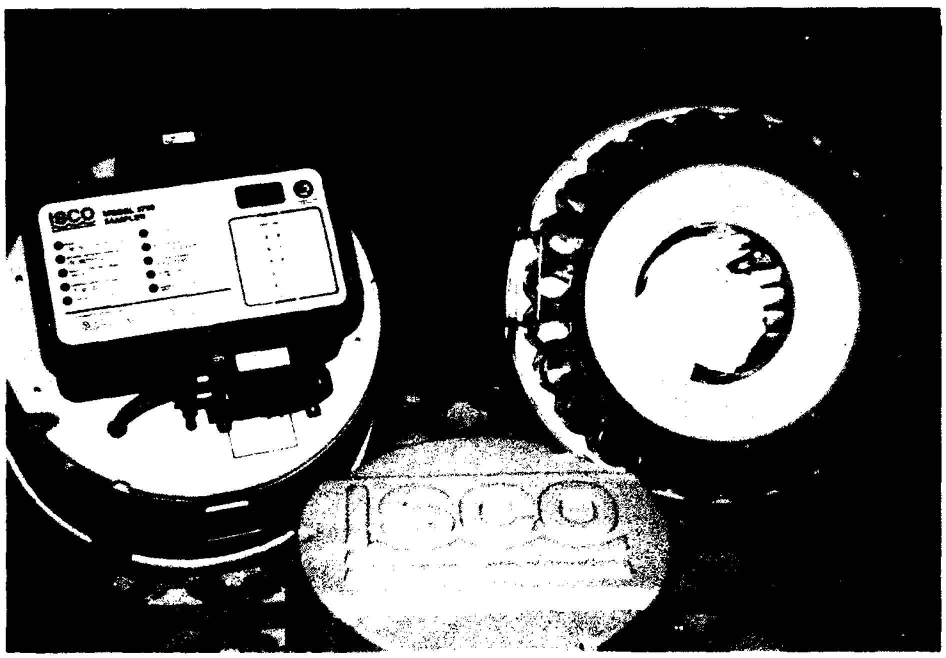

Figure 3. Automatic water sampler

state memory cartridge located in a waterproof surface unit which also contains the DC power supply.

Automatic Water Samplers

16. Composite water samples (multiple samples per sample bottle) were obtained at each water level recorder location using American Sigma Streamline water samplers model 702, as shown in Figure 3. A typical field installation of these water samplers is shown in Figure 4. The samplers operate from a

Figure 4. Field installation of water sampler

12-v d-c battery. Samples are collected in 1-liter plastic bottles inside the sampler housing. The samplers are fully programmable for obtaining any volume of sample desired up to the maximum size of the bottle, for obtaining composite samples, and for setting times to begin the sampling routine. Upon completion of the sampling program, the bottles are removed and replaced with empty ones to begin the new sampling period.

17. Six samplers, one at each water level recorder location, were installed in July 1989. The intake lines to the samplers were set to obtain samples at approximately the middepth of each location. The samplers were

programmed to collect four samples per bottle with the time interval between samples set for 373 minutes.

Measurement Locations

18. A total of six water level recorders and water samplers were deployed throughout the Cumberland Sound system as shown in Figure 5. It should be noted here that the water level recorder location TLR-1 no longer exists due to the loss of the mounting structure. The new location TLR-7 was established as a replacement for TLR-1. The locations were chosen for the availability of a mounting structure and relative distances from jetties at the St. Marys entrance. The locations adequately covered the total study area to provide information on differences in time of peak tides and range of tides.

Field Service Procedures

19. Periodic equipment service trips (usually monthly) were made by WES personnel. Servicing included first making a visual inspection of the equipment. The sample bottles from each sampler were removed and replaced with empty ones. The intake lines were inspected and cleaned of any aquatic growth or obstruction. The batteries were replaced and the samplers were reprogrammed to begin the new sampling period. A portable computer was connected to the 1152SSM water level recorder to obtain a current display of the data that the sensor is obtaining. These data were compared to in-field checks of salinity and water level. In-field checks of salinity were made using a portable Aanderaa salinity meter, shown in Figure 6. A water sample was also collected at the same depth of the sensor and returned to the laboratory along with the other water samples for analysis of salinity and sediment concentrations. The approximate water depth over the sensor was also recorded by measuring the distance from the water surface to a known reference point on the sensor support bracket. The data recording cartridge was then removed and replaced with a new cartridge. New batteries were installed and the desiccant, used to displace moisture in the surface housing, was replaced. The subsurface sensor was brought to the surface, inspected and any barnacles or other aquatic growth removed. After cleaning the sensor, it was returned to

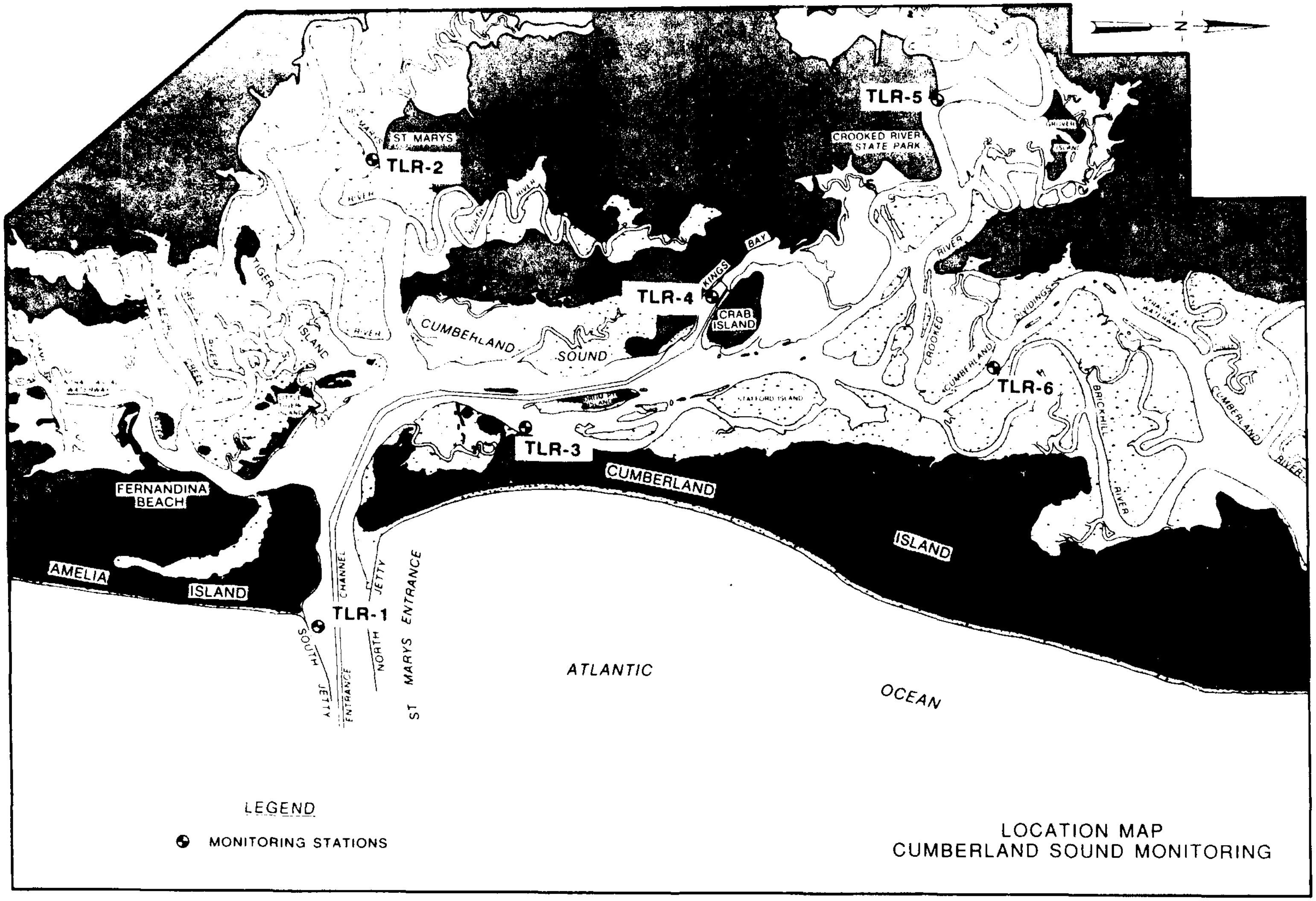

Figure 5. Location of Cumberland Sound monitoring stations

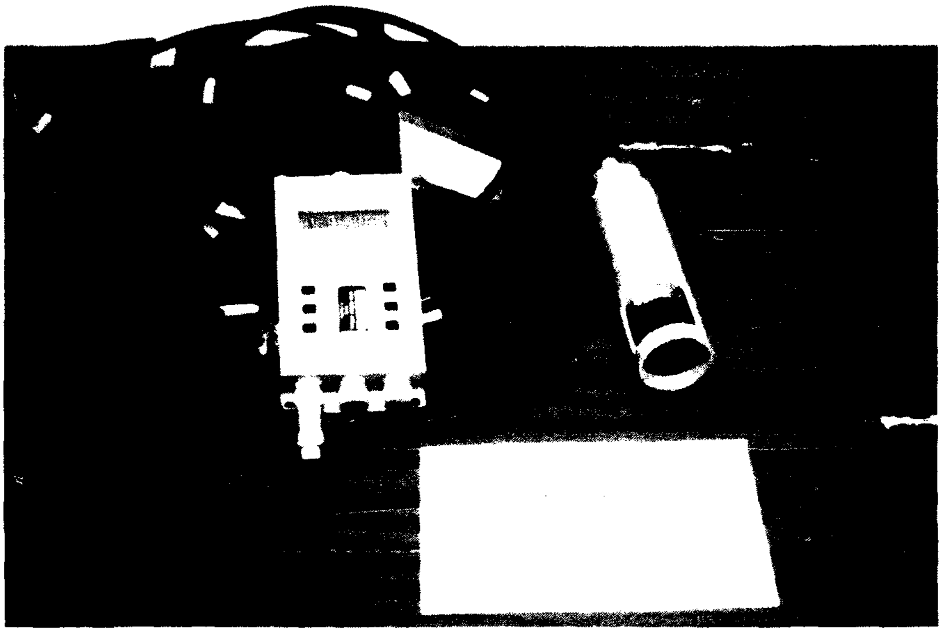

Figure 6. Portable salinity meter

its original position and the computer connected to the 1152SSM. The instruments' readings were then compared to a new set of in-field measurements. This procedure was performed on all the recording units to verify their proper operation.

Conditions

20. The Cumberland Sound/Kings Bay area has an annual mean temperature of 70 degrees F with extremes ranging from the teens to 100 degrees F. The yearly average rainfall is 50-55 inches. A wide variety of hydrodynamic and weather conditions were sampled during the period of data collection. Most of these conditions could be documented from the data (water level changes, salinity, etc.). Freshwater inflows from the St. Marys river are given by stages recorded from a USGS gaging station located near Gross, FL. These data, gage height and discharges for the water year January - September 1989, are presented in Tables 1 and 2. The total discharge for water year 1989 was 703,726 cfs, which was lower than that observed for water year 1988—1,144,310 cfs.

Laboratory Analysis of Water Samples

21. The samples collected by the water samplers were analyzed in the laboratory at the US Army Engineer Waterways Experiment Station. Total suspended materials were determined by filtration of the samples. Nuclepore polycarbonate filters with 0.4 micron pore size were used in this procedure. The samples were desiccated and preweighed, and a vacuum system was used to draw the sample through the filter. The filters and holders were washed with distilled water, dried at 105 deg C for 1 hr and reweighed. The total suspended materials were calculated based on the weight and volume of the filtered sample.

22. The laboratory analyses of the salinities for the water samples were performed using an AGE Instruments Incorporated Model 2100 MINISAL salinometer. This microprocessor controlled instrument calculates and displays salinity with corrections for temperature, cell constant, and salinity of standard sea water. Standard sea water is used as the standard during all analyses. The accuracy of the measurements is ±0.003 ppt on samples ranging from 2 to 42 ppt. The samples were analyzed and recorded to the nearest 0.01 ppt.

PART IV: THE DATA

23. The data described herein are available in both tabular and graphical format. Due to the enormous amounts of data only representative samples are presented in this report. For more detailed information, the tabulated computer printouts and plots are available upon request. Written requests for the data can be made to the following address.

> USACE Waterways Experiment Station
> ATTN: CEWES-HE-P
> 3909 Halls Ferry Road
> Vicksburg, MS 39180-6199

This same information is also available on computer diskettes. The information presented in Tables 3 and 4 are examples of the tabulated format for the water levels (depth of sensor below water surface), salinities, and temperatures which are available for each data recording location. Time is given in hours and minutes, Eastern Standard Time (EST), for each reading of depth, conductivity, temperature, and salinity. Note that the sampling interval has been set for 10 min.

24. Tables 5-7 are examples of the tabulated format for the suspended sediment concentrations which are also available for each data recording location.

25. As with any long term measurement effort, there are periods when the equipment malfunctions for various reasons. The information presented in Tables 8 and 9 list the status of each water level-salinity-temperature recorder and water sampler during the 12 month data collection period (1-1-89 through 12-31-89).

26. Typical examples of the graphical format for the water levels, salinities, temperatures, and suspended sediment concentrations are presented in Plates 1-36. These plots are presented to illustrate the changes that typically occur during various seasons of the year. Plates 1-9 illustrate the changes in the water levels, salinities, and temperatures during the spring period (April-June). Plates 10-18 illustrate the changes that occur during the summer period (August-October). Plates 19-27 display the changes that occur during the winter period (December). The changes in the suspended sediment concentrations for the period August-November are illustrated in Plates 28-36. The locations used for the representative samples were chosen to show the changing conditions with the seasons in the St. Marys entrance

area (TLR-7 and WS7KB; high salinity), in the Navy Submarine base (TLR-4 and WS4KB; limited freshwater inflow), and in the Crooked River area (TLR-5 and WS5KB; small watershed freshwater inflow).

27. Datum planes for the tide data at the locations are adjusted to mean low water (mlw), from established tidal bench marks that were established in August 1989. Analyses have been used to determine the mean water level reading for each 30-day period and the monthly mlw has been used as the reference datum plane in each plot.

PART V: SUMMARY

28. The information presented herein represents a portion of the data collected during the second year of the study. This report is the second in a series of four annual interim data reports.* All information from each period of the study will be used to determine if changes to the estuarine processes have occurred due to physical changes of the navigation channel. This determination will be made through comparisons of the data from this 5-year study to data collected prior to the changed channel conditions.

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* T. L. Fagerburg, H. A. Benson, J. W. Parman, and G. M. Fisackerly. 1991 (Feb). "Cumberland Sound Monitoring; Report 1, 1988 Data Collection Report," Technical Report HL-91-4, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Table 1

Mean Values of Gate Height for St. Marys River Near Gross, FL

October 1988-September 1989

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - ORLANDO 09/14/90

STATION NUMBER 02231253 ST. MARYS RIVER NEAR GROSS, FLA. STREAM SOURCE AGENCY USGS
LATITUDE 304429 LONGITUDE 0814117 DRAINAGE AREA 1360.00 DATUM STATE 12 COUNTY 089

GAGE HEIGHT, FEET, WATER YEAR OCTOBER 1988 TO SEPTEMBER 1989
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	12.03	11.92	10.75	10.80	10.31	10.75	10.37	11.02	10.91	12.03	10.56	11.51
2	11.66	11.29	10.54	10.92	10.19	11.50	10.77	10.64	10.62	11.79	10.78	11.34
3	11.65	11.26	10.43	10.79	10.23	11.60	10.86	10.89	10.56	11.43	11.30	11.24
4	11.61	11.52	10.31	10.63	10.34	11.21	10.77	11.31	10.63	11.16	11.48	11.77
5	12.02	11.15	11.41	11.07	11.08	11.10	10.72	11.37	10.54	11.20	11.06	11.57
6	12.24	10.48	11.17	10.97	11.27	11.03	10.46	11.06	10.46	10.79	10.72	11.60
7	12.57	10.24	10.84	10.65	11.17	11.08	10.26	10.97	10.59	10.33	10.86	11.95
8	12.66	10.45	10.84	10.89	10.93	12.02	10.30	11.17	10.45	10.10	11.09	12.29
9	12.45	10.64	10.82	11.03	11.10	12.28	10.48	10.95	10.14	10.29	11.73	12.07
10	12.33	10.92	11.28	11.72	10.98	12.67	11.04	10.31	9.92	10.58	11.77	11.95
11	11.94	10.85	11.50	11.79	10.77	12.41	11.42	10.53	10.30	10.49	11.44	11.80
12	11.47	11.63	12.23	11.57	10.42	11.69	11.66	10.83	10.66	10.46	11.31	11.80
13	11.82	11.48	11.76	10.72	10.55	11.38	11.47	10.74	10.47	10.27	11.36	12.02
14	11.82	11.10	11.13	11.35	10.26	11.10	11.15	10.83	10.13	10.03	11.33	12.04
15	11.62	11.10	10.80	10.90	10.19	10.60	10.98	10.94	10.12	10.47	11.39	11.76
16	11.49	11.34	11.04	10.34	10.24	10.39	10.94	10.77	10.23	10.64	11.25	11.65
17	11.38	11.06	11.13	10.82	11.19	10.87	11.80	10.81	10.28	10.44	11.25	11.49
18	11.39	11.32	11.04	10.82	11.07	10.83	11.50	10.86	10.37	10.56	11.43	11.80
19	11.29	11.80	10.83	10.47	11.74	10.82	10.14	11.00	10.62	10.90	11.46	12.13
20	12.08	11.46	10.80	10.41	11.65	11.43	10.73	11.08	10.83	11.02	11.61	11.85
21	12.24	10.85	10.79	11.29	11.32	10.92	11.65	10.94	10.77	11.30	11.62	11.95
22	11.84	11.48	10.83	12.21	10.90	10.94	11.33	10.82	10.73	11.30	11.30	11.20
23	11.87	11.95	11.21	12.22	9.94	12.19	10.92	10.52	10.78	11.33	10.91	11.01
24	11.87	11.79	11.05	11.85	9.67	11.65	10.73	10.38	10.89	11.26	10.66	11.79
25	11.74	11.68	10.75	11.27	10.54	11.06	10.60	10.57	10.89	11.13	10.95	12.68
26	11.71	11.40	11.09	10.83	10.45	10.95	10.31	10.68	11.26	11.37	11.41	11.95
27	11.75	10.97	11.35	10.46	10.16	10.81	10.53	10.62	11.14	11.16	11.62	12.03
28	11.69	10.15	10.66	10.94	10.07	10.56	10.87	11.25	11.02	10.56	11.54	13.15
29	11.40	10.66	10.40	10.82	---	10.50	11.13	12.07	10.99	10.55	11.49	12.83
30	11.88	10.96	10.83	10.42	---	10.30	11.05	11.62	11.40	10.74	11.48	12.25
31	12.23	---	10.88	10.19	---	10.14	---	11.20	---	10.80	11.38	---
MEAN	11.86	11.16	10.98	11.01	10.70	11.19	10.91	10.93	10.63	10.85	11.28	11.88
MAX	12.66	11.95	12.23	12.22	11.87	12.67	11.80	12.09	11.48	12.03	11.77	13.15
MIN	11.29	10.15	10.31	10.19	9.67	10.14	10.14	10.31	9.92	10.03	10.56	11.01

CAL YR 1988 MEAN 11.11 MAX 12.67 MIN 9.61
WTR YR 1989 MEAN 11.12 MAX 13.15 MIN 9.67

Note: From provisional tables to the USGS Annual Gage Height and Discharge Report for Water Year 1988.

Table 2

Mean Values of Discharge, cubic feet per second, for St. Marys River Near Gross, FL

October 1988-September 1989

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - ORLANDO 09/14/90

STATION NUMBER 02231253 ST. MARYS RIVER NEAR GROSS, FLA. STREAM SOURCE AGENCY USGS
LATITUDE 304429 LONGITUDE 0814117 DRAINAGE AREA 1360.00 DATUM STATE 12 COUNTY 089

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1988 TO SEPTEMBER 1989
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4090	3240	2670	2830	e1300	2070	1430	1310	2240	2750	1890	-3560
2	3800	3260	1970	1940	e1500	2200	1100	1470	2780	3500	1230	783
3	4330	1490	2060	2580	e2000	2030	958	881	2960	3840	1440	483
4	5340	1810	1250	1510	e2500	1680	953	2150	3170	3900	1530	555
5	3030	3220	1260	1350	e3200	1330	1340	3030	3560	3380	1600	2140
6	3050	2580	2540	2340	e2300	1190	1660	3120	3220	2300	885	-1780
7	3510	1620	3080	1240	e3000	1560	1640	2790	3320	2420	1180	-3360
8	3890	1730	1630	1870	e3500	2000	1320	2660	3450	2710	1230	-3500
9	3940	2050	1830	2310	e2800	2440	1540	3130	3680	2050	1050	-4240
10	3830	2370	1940	2490	e3200	2490	1760	3030	2780	1980	2090	-6120
11	3960	2580	2810	3100	e2700	2780	2230	2250	2360	2170	1720	-5610
12	3410	2320	2880	3420	e2400	2800	1990	2070	2440	1750	1200	-6230
13	2850	3510	4640	3390	e2200	2240	2150	2090	3170	1890	1290	-3150
14	3630	3050	3440	2510	e1900	2220	1850	1540	2720	1760	425	-5730
15	3370	2450	3370	3100	1720	2110	1940	1950	2610	1160	1280	-786
16	3200	2180	2320	2110	1610	1750	1370	1840	2600	2360	1640	-558
17	2810	2550	2880	1400	1220	1320	e1200	1550	2830	2310	2340	-1140
18	2270	1130	2000	1960	1960	1680	e1000	1890	3460	2320	2540	447
19	2310	1280	1970	1800	2240	1240	e1300	2410	3710	2570	2170	1690
20	-138	3160	1680	1550	2120	1690	1620	2680	4160	2610	2630	1320
21	3260	1790	1680	338	2190	2060	2430	2970	4650	2580	2770	-789
22	2570	1680	1370	2820	2380	1520	3080	2630	4650	2720	2260	-496
23	2320	3580	2080	2900	2710	2140	3350	3140	4520	2910	1390	-2970
24	3160	2970	2770	e2500	1940	2800	2320	2570	4440	2680	-793	-5060
25	2790	3570	2610	e2100	2160	2410	2600	2700	4030	1840	-3330	-5890
26	3160	3250	2190	e2500	2450	2110	2450	2770	2820	1520	-2010	-3690
27	2870	3150	3000	e3000	2250	2020	2130	2600	2250	1150	1760	-1540
28	3240	3640	3210	e3300	2340	2080	2030	972	2020	522	664	700
29	2950	2050	2130	e2500	---	2040	1080	1710	2090	141	17	-2300
30	2420	2710	2460	e2600	---	1880	1570	2570	1430	-55	307	-1090
31	2760	---	2180	e2800	---	1970	---	2320	---	1490	-1560	---
TOTAL	97982	75970	73900	72158	63790	61850	54191	70793	94120	67528	32835	-61391
MEAN	3161	2532	2384	2328	2278	1995	1806	2284	3137	2178	1059	-2046
MAX	5340	3640	4640	3420	3500	2800	3350	3140	4650	3900	2770	2140
MIN	-138	1130	1250	338	1220	1190	953	881	1430	-55	-3330	-6230
AC-FT	194300	150700	146600	143100	126500	122700	107500	140400	186700	133900	65130	-121800

WTR YR 1989 TOTAL 703726 MEAN 1926 MAX 5340 MIN -6230 AC-FT 1396000

e Estimated

Note: From provisional tables to the USGS Annual Gage Height and Discharge Report for Water Year 1988.

Table 3

Sample Printout of Water Level Recorder Data for Station TLR-4

Kings Bay - Station TLR-3 - 1 December 1989

ENDECO TYPE 1152 DENSITY COMPENSATING WATER LEVEL RECORDER
DATUM OFFSET APPLIED: -2.120 (FEET)
SERIAL NUMBER: 11520279

DATE (MM/DD/YY)	TIME (HH:MM)	TEMPERATURE (CELSIUS)	CONDUCTIVITY (MMHO/CM)	SALINITY (PPT)	DEPTH (FEET)
12/01/89	05:00	15.53	35.03	27.5	1.160
12/01/89	05:10	15.51	35.07	27.6	1.349
12/01/89	05:20	15.47	35.08	27.6	1.552
12/01/89	05:30	15.46	35.04	27.6	1.759
12/01/89	05:40	15.55	35.11	27.6	1.973
12/01/89	05:50	15.51	34.61	27.2	2.242
12/01/89	06:00	15.50	34.50	27.1	2.478
12/01/89	06:10	15.54	35.74	28.2	2.694
12/01/89	06:20	15.53	35.61	28.1	2.920
12/01/89	06:30	15.69	35.67	28.0	3.164
12/01/89	06:40	15.54	35.51	28.0	3.391
12/01/89	06:50	15.69	35.65	28.0	3.612
12/01/89	07:00	15.65	35.54	27.9	3.852
12/01/89	07:10	15.65	34.66	27.1	4.080
12/01/89	07:20	15.58	34.55	27.1	4.316
12/01/89	07:30	15.89	35.80	28.0	4.518
12/01/89	07:40	16.25	36.21	28.1	4.767
12/01/89	07:50	16.36	36.15	27.9	5.005
12/01/89	08:00	16.37	36.02	27.8	5.214
12/01/89	08:10	16.41	36.39	28.1	5.434
12/01/89	08:20	16.40	36.38	28.1	5.640
12/01/89	08:30	16.41	36.34	28.1	5.818
12/01/89	08:40	16.42	36.43	28.1	5.982
12/01/89	08:50	16.43	36.50	28.2	6.122
12/01/89	09:00	16.45	36.46	28.1	6.235
12/01/89	09:10	16.46	36.64	28.3	6.344
12/01/89	09:20	16.42	37.74	29.3	6.415
12/01/89	09:30	16.41	37.74	29.3	6.495
12/01/89	09:40	16.39	37.78	29.3	6.559
12/01/89	09:50	16.38	37.80	29.3	6.626
12/01/89	10:00	16.36	38.15	29.7	6.649
12/01/89	10:10	16.34	37.38	29.0	6.691
12/01/89	10:20	16.34	37.99	29.5	6.695
12/01/89	10:30	16.33	37.90	29.5	6.679
12/01/89	10:40	16.39	37.37	29.0	6.670
12/01/89	10:50	16.43	38.08	29.5	6.640
12/01/89	11:00	16.45	37.85	29.3	6.599

Table 4

Sample Printout of Water Level Recorder Data for Station TLR-1

Kings Bay - Station TLR-5 - 1 December 1989

ENDECO TYPE 1152 DENSITY COMPENSATING WATER LEVEL RECORDER
DATUM OFFSET APPLIED: -3.270 (FEET)
SERIAL NUMBER: 11520273

DATE (MM/DD/YY)	TIME (HH:MM)	TEMPERATURE (CELSIUS)	CONDUCTIVITY (MMHO/CM)	SALINITY (PPT)	DEPTH (FEET)
12/01/89	05:00	15.91	34.22	26.6	-1.592
12/01/89	05:10	15.90	34.31	26.7	-1.439
12/01/89	05:20	15.90	27.40	20.8	-1.254
12/01/89	05:30	15.88	34.23	26.6	-1.073
12/01/89	05:40	15.87	33.91	26.3	-.867
12/01/89	05:50	15.87	33.79	26.2	-.656
12/01/89	06:00	15.87	34.11	26.5	-.443
12/01/89	06:10	15.87	34.05	26.5	-.217
12/01/89	06:20	15.88	34.15	26.5	.008
12/01/89	06:30	15.90	34.17	26.6	.257
12/01/89	06:40	15.89	33.59	26.1	.518
12/01/89	06:50	15.86	34.76	27.1	.778
12/01/89	07:00	15.85	34.80	27.1	1.050
12/01/89	07:10	15.86	34.87	27.2	1.310
12/01/89	07:20	15.86	35.09	27.4	1.568
12/01/89	07:30	15.80	35.40	27.7	1.809
12/01/89	07:40	15.77	35.58	27.9	2.047
12/01/89	07:50	15.76	35.76	28.0	2.282
12/01/89	08:00	15.75	35.84	28.1	2.505
12/01/89	08:10	15.73	35.87	28.1	2.737
12/01/89	08:20	15.70	36.22	28.5	2.971
12/01/89	08:30	15.67	36.25	28.5	3.161
12/01/89	08:40	15.64	36.29	28.6	3.356
12/01/89	08:50	15.62	36.34	28.6	3.549
12/01/89	09:00	15.62	36.42	28.7	3.718
12/01/89	09:10	15.63	36.50	28.8	3.871
12/01/89	09:20	15.62	36.58	28.8	4.021
12/01/89	09:30	15.60	36.30	28.6	4.158
12/01/89	09:40	15.56	36.60	28.9	4.280
12/01/89	09:50	15.54	36.70	29.0	4.392
12/01/89	10:00	15.52	36.86	29.2	4.493
12/01/89	10:10	15.51	36.96	29.3	4.582
12/01/89	10:20	15.47	37.00	29.3	4.653
12/01/89	10:30	15.46	36.98	29.3	4.727
12/01/89	10:40	15.47	37.02	29.3	4.785
12/01/89	10:50	15.51	37.15	29.4	4.841
12/01/89	11:00	15.49	37.14	29.4	4.879

Table 5

Daily Average of Suspended Sediment Concentrations, MG/L

for the Automatic Water Samplers

August 1989

Date	Sampler No.					
Aug 89	ws2KB	ws3KB	ws4KB	ws5KB	ws6KB	ws7KB
4	27	53	6	24	21	6
5	24	28	5	10	31	2
6	22	50	11	13	35	2
7	12	49	11	38	28	13
8	22	43	11	37	36	4
9	27	29	11	26	49	9
10		41	12	19	42	20
11		36	15	22	33	
12		43	11	31	50	26
13		37	13	34	29	18
14		40	15	39	26	49
15		47	18	37	44	36
16		55		37	47	31
17		78	7	42	57	30
18		49	25	40	61	48
19		47		54	73	31
20		48	21	35	73	35
21		52	23	40	67	41
22		49	17	24	56	19
23		57	13	38	43	18
24		55	15	33	58	22
25		47	13	7	49	25
26		36	11	44	28	30
27		29	11	32	20	29

Table 6

Daily Average of Suspended Sediment Concentrations, MG/L

for the Automatic Water Samplers

September 1989

Date	Sampler No.					
Sep 89	ws2KB	ws3KB	ws4KB	ws5KB	ws6KB	ws7KB
4	20	64	12	27	34	32
5	21	50	12	34	32	26
6	26	42	9	30	48	20
7	29	59	14	29	48	42
8	20	70	12	31	54	33
9	22	76	9	32	50	10
10	19	35	11	24	32	37
11	22	35	19	32	34	41
12	17	41	13	23	23	36
13	19	42	16	28	18	34
14	22	46	16	31	39	41
15	26	55	14	40	42	32
16	108	83	25	45	63	42
17		69	13	55	71	25
18		76	16	97	52	22
19		76	15	71	103	38
20		112	15	48	142	22
21		79	17	40	102	26
22		53	10	42	82	33
23		44	8	50	68	28
24		44	13	41	42	33
25		63	7	45	48	33
26		36	10	38	86	112
27		43	5		66	69

Table 7

Daily Average of Suspended Sediment Concentrations, MG/L

for the Automatic Water Samplers

November 1989

Date	Sampler No.					
Nov 89	ws2KB	ws3KB	ws4KB	ws5KB	ws6KB	ws7KB
1	51	137	8	64	86	77
2	48	136	22	56	99	72
3	53	182	24	50	87	61
4	45	173	27	51	70	78
5	32	206	13	46	63	44
6	34	82	30	50	54	45
7	64	82	58	62	54	45
8	53	46	30	50	66	46
9	48	32	25	57	53	
10	57	31	27	40	43	48
11	58	37	24	39	47	80
12	54	31	23	39	56	83
13	53	53	12	41	48	126
14	56	92	32	47	64	111
15	55	100	27	51	64	126
16	50	79	28	36	67	103
17	39	68	22	48	77	170
18	31	48	21	53	55	134
19	32	47	23	44	47	97
20	43	56	17	41	29	116
21	42	32	23	40	47	94
22	42	36	15	37	25	100
23	55	40	21	50	35	140
24	33	EMPTY	24	EMPTY	EMPTY	EMPTY

Table 8

Status of Water Level, Salinity and Temperature Recording Gages

Station No.	Data Periods Beginning Date	Ending Date	Comments
TLR-7	1/ 1/89	2/ 5/89	Meter removed for repairs
	2/ 5/89	3/ 6/89	Meter removed for repairs
	3/ 6/89	4/19/89	Meter removed for repairs
	4/19/89	6/ 1/89	Meter reinstalled
	6/ 1/89	6/27/89	
	6/27/89	8/ 2/89	
	8/ 2/89	8/31/89	
	8/31/89	10/12/89	
	10/12/89	11/ 6/89	
	11/ 6/89	11/30/89	
	11/30/89	12/31/89	
TLR-2	1/ 1/89	2/ 5/89	
	2/ 5/89	3/ 6/89	
	3/ 6/89	4/19/89	
	4/19/89	6/ 1/89	
	6/ 1/89	6/27/89	Meter removed for repairs
	6/27/89	8/ 2/89	
	8/ 2/89	8/31/89	Meter reinstalled
	8/31/89	10/12/89	
	10/12/89	11/ 6/89	
	11/ 6/89	11/30/89	
	11/30/89	12/31/89	
TLR-3	1/ 1/89	2/ 5/89	
	2/ 5/89	3/ 6/89	
	3/ 6/89	4/19/89	
	4/19/89	6/ 1/89	
	6/ 1/89	6/27/89	
	6/27/89	8/ 2/89	Meter removed for repairs
	8/ 2/89	8/31/89	Meter reinstalled
	8/31/89	10/12/89	
	10/12/89	11/ 6/89	
	11/ 6/89	11/30/89	
	11/30/89	12/31/89	
TLR-4	1/ 1/89	2/ 5/89	
	2/ 5/89	3/ 6/89	
	3/ 6/89	4/19/89	
	4/19/89	6/ 1/89	
	6/ 1/89	6/27/89	
	6/27/89	8/ 2/89	
	8/ 2/89	8/31/89	
	8/31/89	10/12/89	
	10/12/89	11/ 6/89	

(Continued)

Table 8 (Concluded)

Station No.	Data Periods: Beginning Date	Ending Date	Comments
TLR-4	11/ 6/89	11/30/89	
(Cont'd)	11/30/89	12/31/89	
TLR-5	1/ 1/89	2/ 5/89	
	2/ 5/89	3/ 6/89	
	3/ 6/89	4/19/89	
	4/19/89	6/ 1/89	
	6/ 1/89	6/27/89	
	6/27/89	8/ 2/89	Meter removed for repairs
	8/ 2/89	8/31/89	Meter removed for repairs
	8/31/89	10/12/89	Meter reinstalled
	10/12/89	11/ 6/89	
	11/ 6/89	11/30/89	
	11/30/89	12/31/89	
TLR-6	1/ 1/89	2/ 5/89	Meter lost; replacement ordered
	2/ 5/89	3/ 6/89	Meter lost; replacement ordered
	3/ 6/89	4/19/89	Meter lost; replacement ordered
	4/19/89	6/ 1/89	Meter lost; replacement ordered
	6/ 1/89	6/27/89	Meter reinstalled
	6/27/89	8/ 2/89	
	8/ 2/89	8/31/89	
	8/31/89	10/12/89	
	10/12/89	11/ 6/89	
	11/ 6/89	11/30/89	
	11/30/89	12/31/89	

Table 9

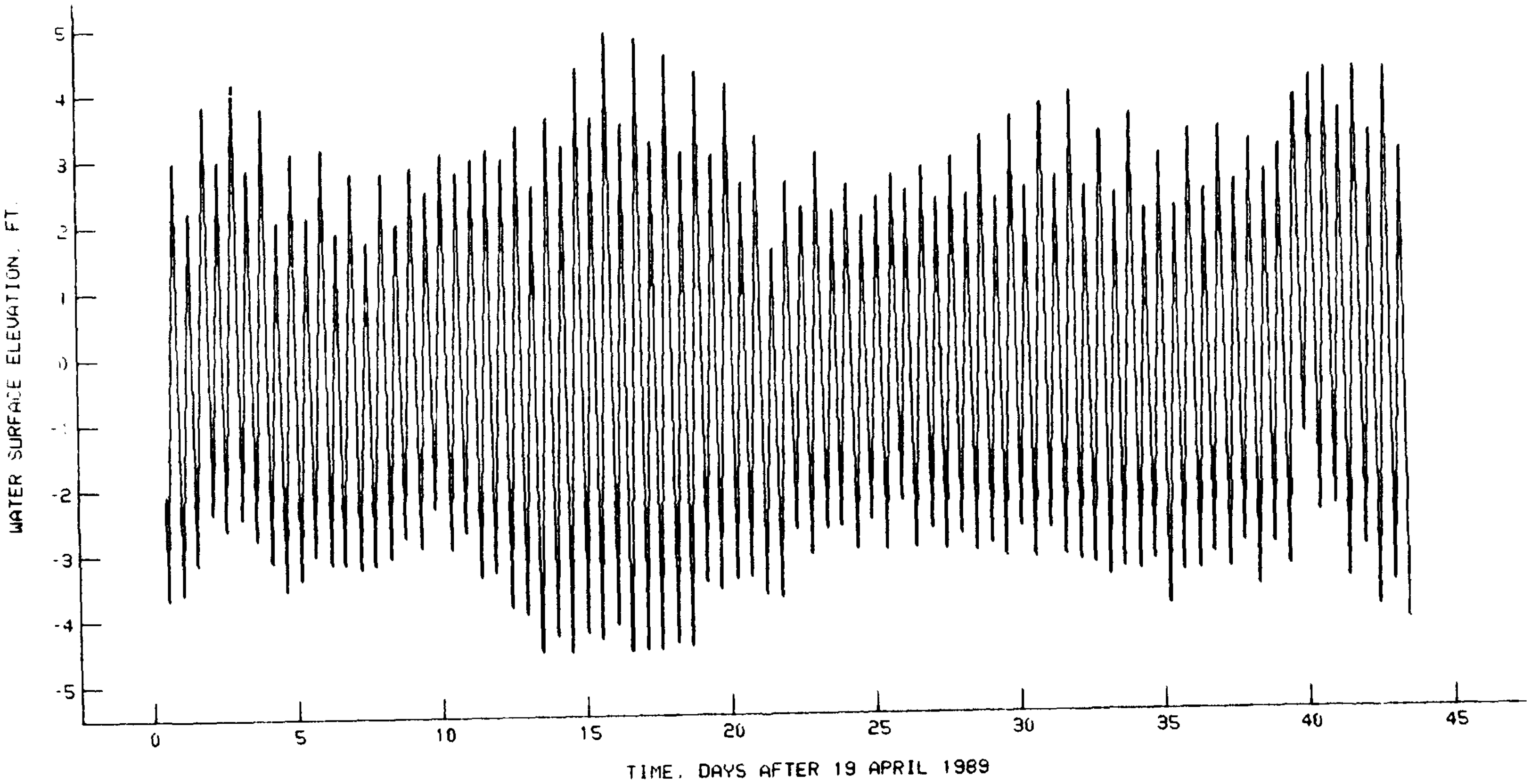
Status of Automatic Water Samplers

Sampler No.	Sample Periods Start Date	End Date	Comments
WS7KB	6/27/89		Sampler installed; middepth sample (9 ft above bottom LW)
	6/27/89	8/ 2/89	No samples; program error
	8/ 2/89	8/31/89	
	8/31/89	10/12/89	
	10/13/89	11/ 6/89	
	11/ 7/89	12/31/89	Samples contaminated; no data
WS2KB	6/28/89		Sampler installed; middepth sample (5 ft above bottom LW)
	6/27/89	8/ 2/89	
	8/ 2/89	8/31/89	Partial samples; program error
	8/31/89	10/12/89	
	10/13/89	11/ 6/89	
	11/ 7/89	12/31/89	Samples contaminated; no data
WS3KB	6/27/89		Sampler installed; middepth sample (4 ft above bottom LW)
	6/27/89	8/ 2/89	No samples; program error
	8/ 2/89	8/31/89	
	8/31/89	10/12/89	
	10/13/89	11/ 6/89	
	11/ 7/89	12/31/89	Samples contaminated; no data
WS4KB	6/27/89		Sampler installed; middepth sample (14 ft above bottom LW)
	6/27/89	8/ 2/89	No samples; program error
	8/ 2/89	8/31/89	
	8/31/89	10/12/89	
	10/13/89	11/ 6/89	
	11/ 7/89	12/31/89	Samples contaminated; no data
WS5KB	6/28/89		Sampler installed; middepth sample (6 ft above bottom LW)
	6/27/89	8/ 2/89	No samples; program error
	8/ 2/89	8/31/89	
	8/31/89	10/12/89	
	10/13/89	11/ 6/89	
	11/ 7/89	12/31/89	Samples contaminated; no data

(Continued)

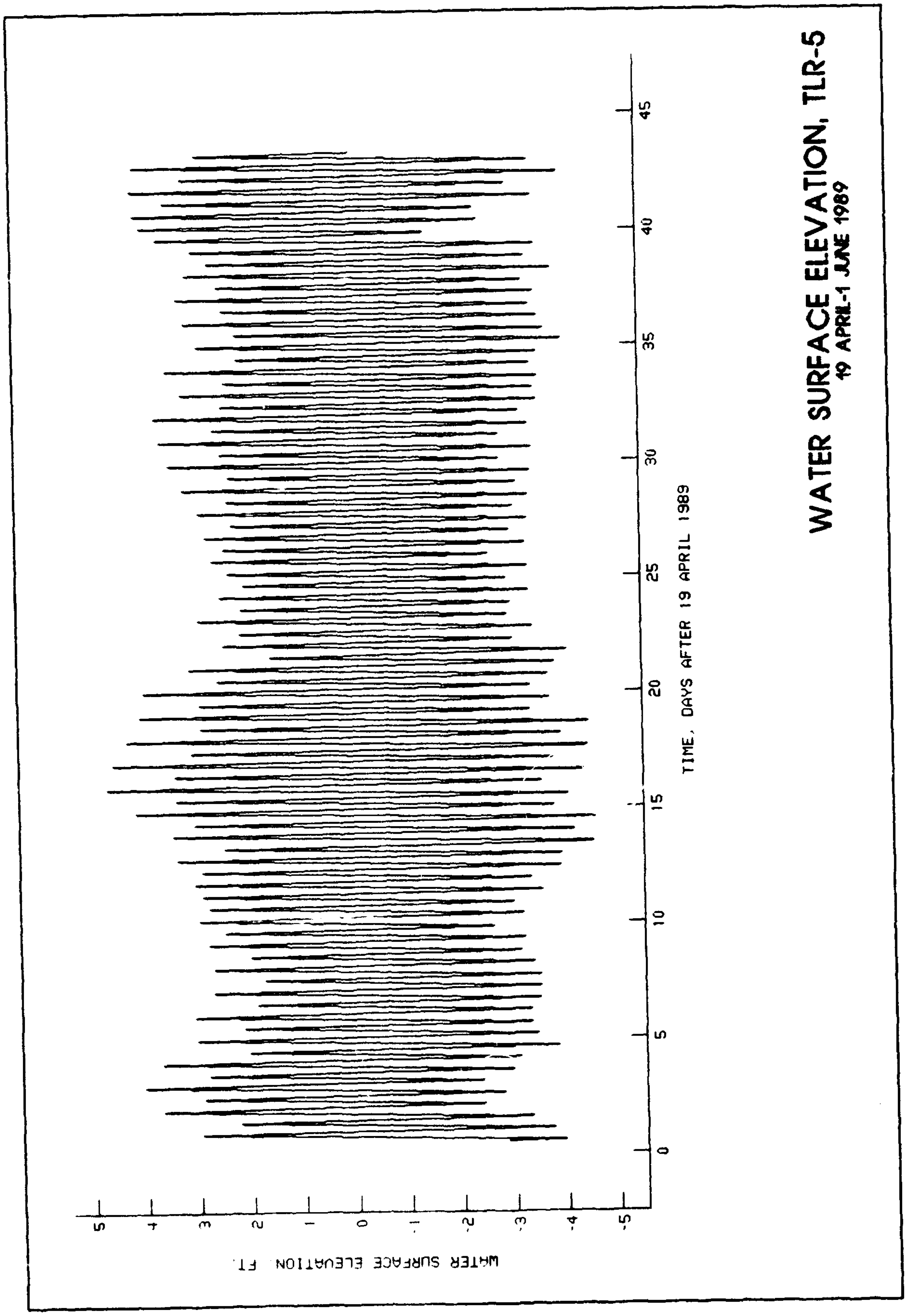
Table 9 (Concluded)

Sampler No.	Sample Periods Start Date	End Date	Comments
WS6KB	6/27/89		Sampler installed; middepth sample (5 ft above bottom LW)
	6/27/89	8/ 2/89	No samples; program error
	8/ 2/89	8/31/89	
	8/31/89	10/12/89	
	10/13/89	11/ 6/89	
	11/ 7/89	12/31/89	Samples contaminated; no data



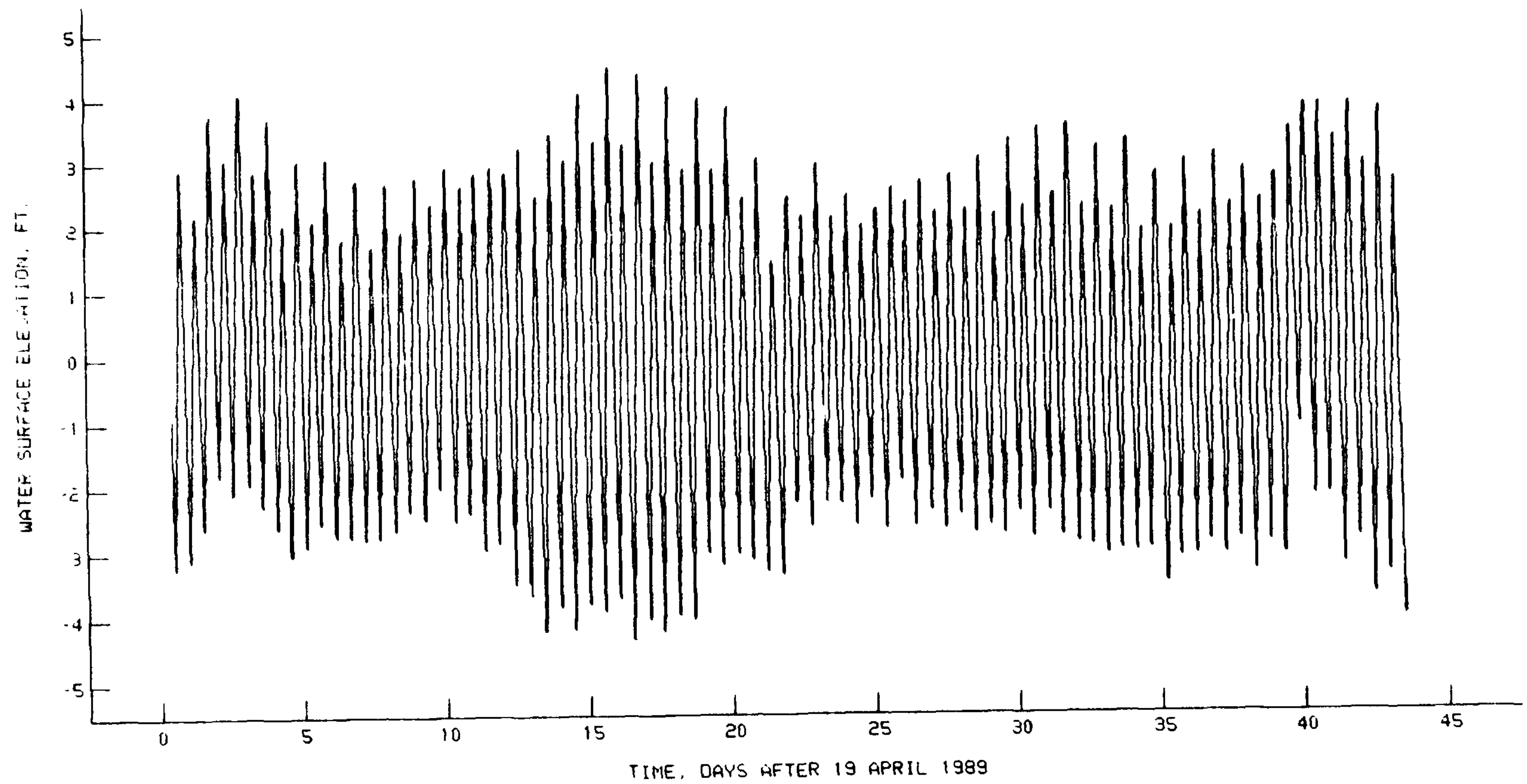
WATER SURFACE ELEVATION, TLR-4
19 APRIL-1 JUNE 1989

PLATE 1



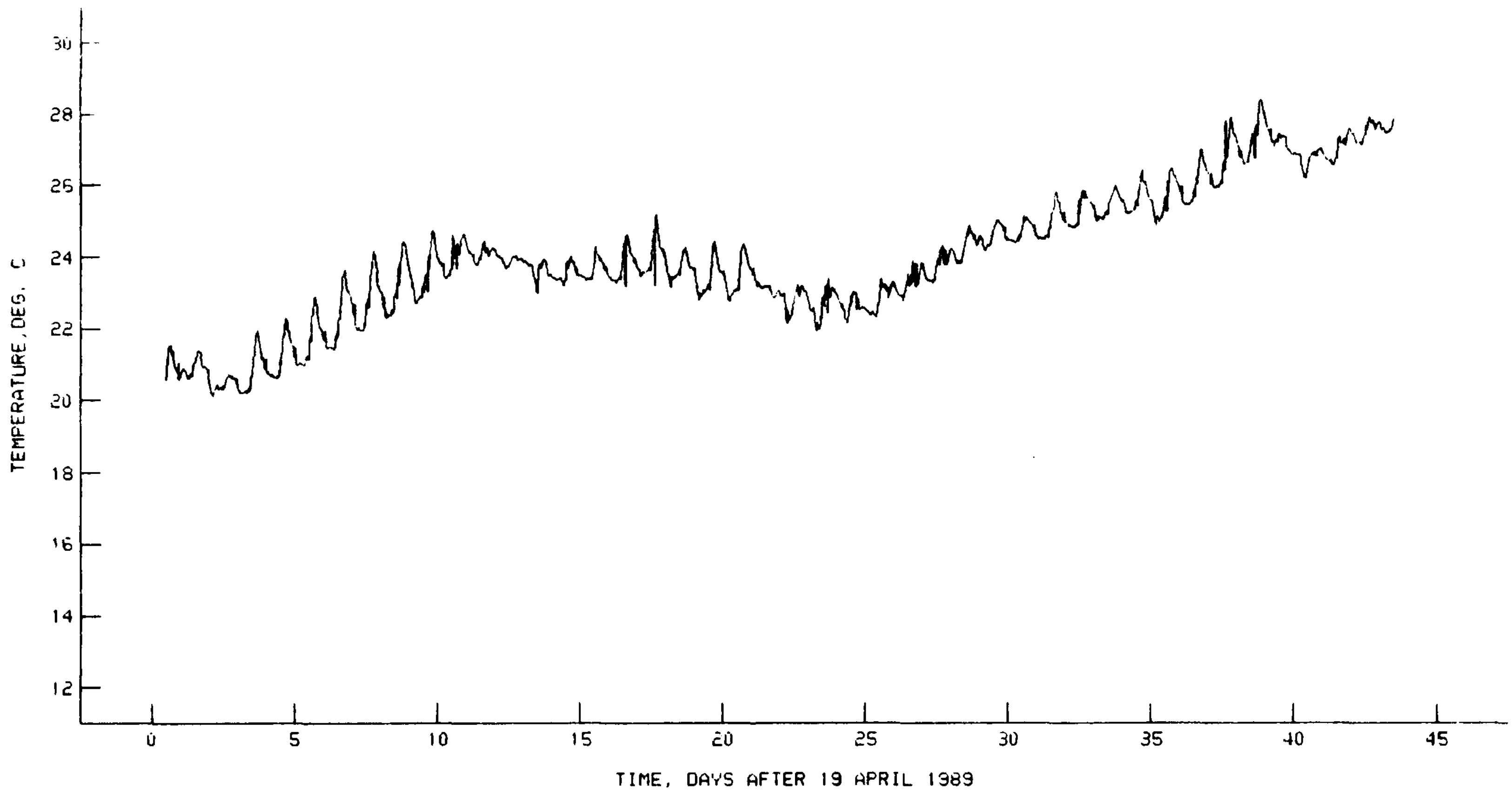
WATER SURFACE ELEVATION, TLR-5
19 APRIL-1 JUNE 1989
TIME, DAYS AFTER 19 APRIL 1989
WATER SURFACE ELEVATION FT.
.5
.4
.3
.2
.1
0
-.1
-.2
-.3
-.4
-.5
0
5
10
15
20
25
30
35
40
45

PLATE 2



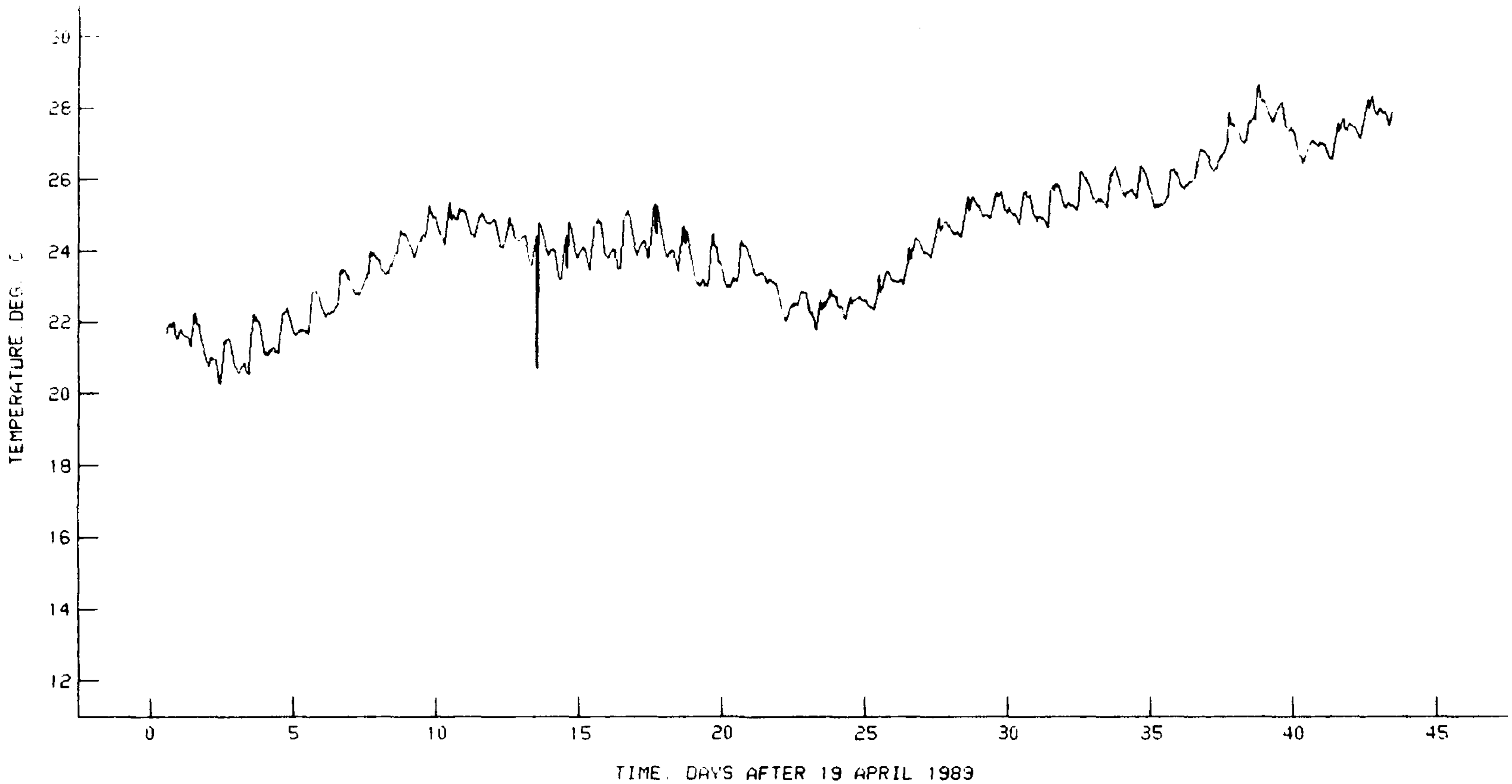
WATER SURFACE ELEVATION, TLR-7
19 APRIL-1 JUNE 1989

PLATE 3



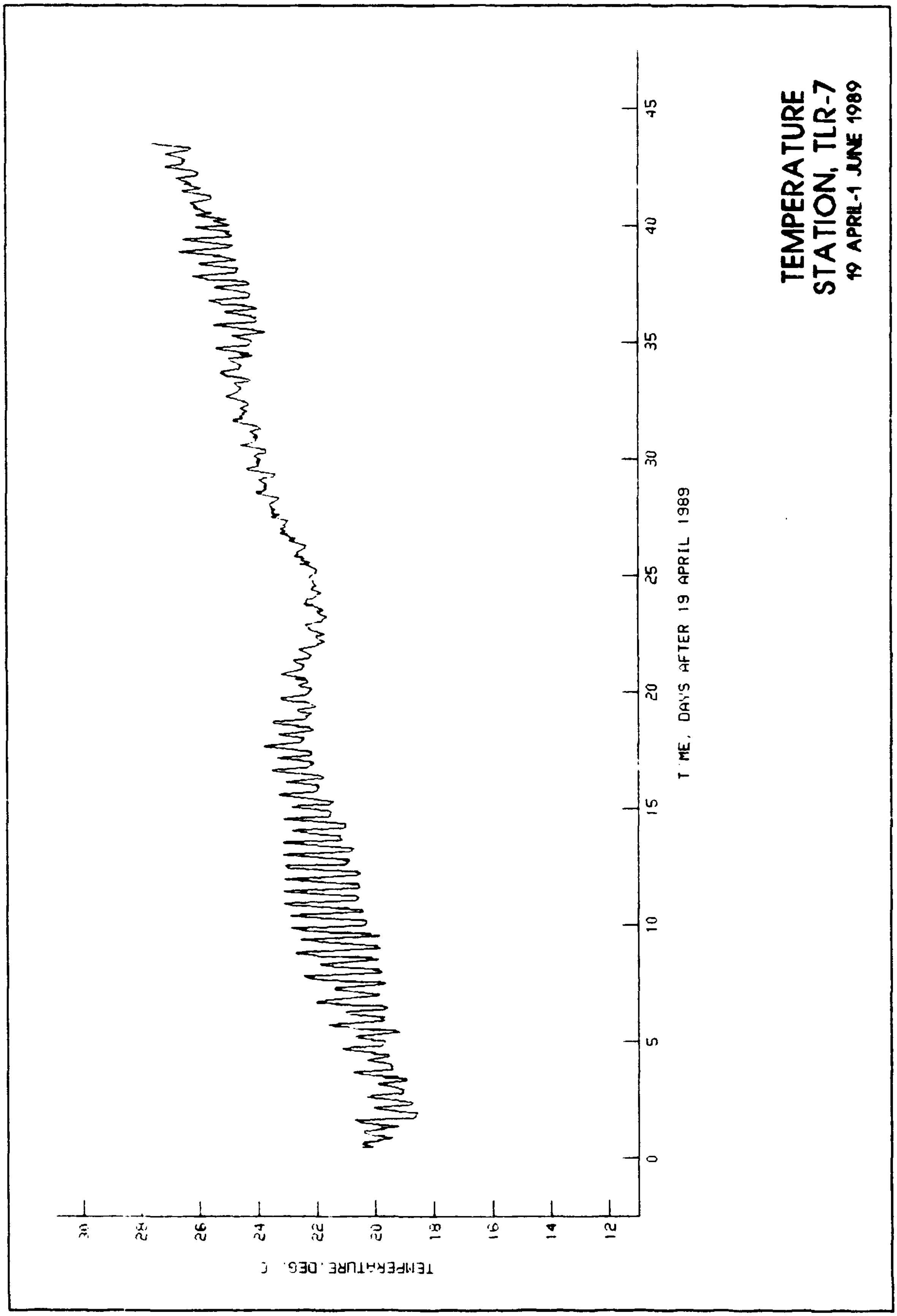
TEMPERATURE
STATION, TLR-4
19 APRIL-1 JUNE 1989

PLATE 4



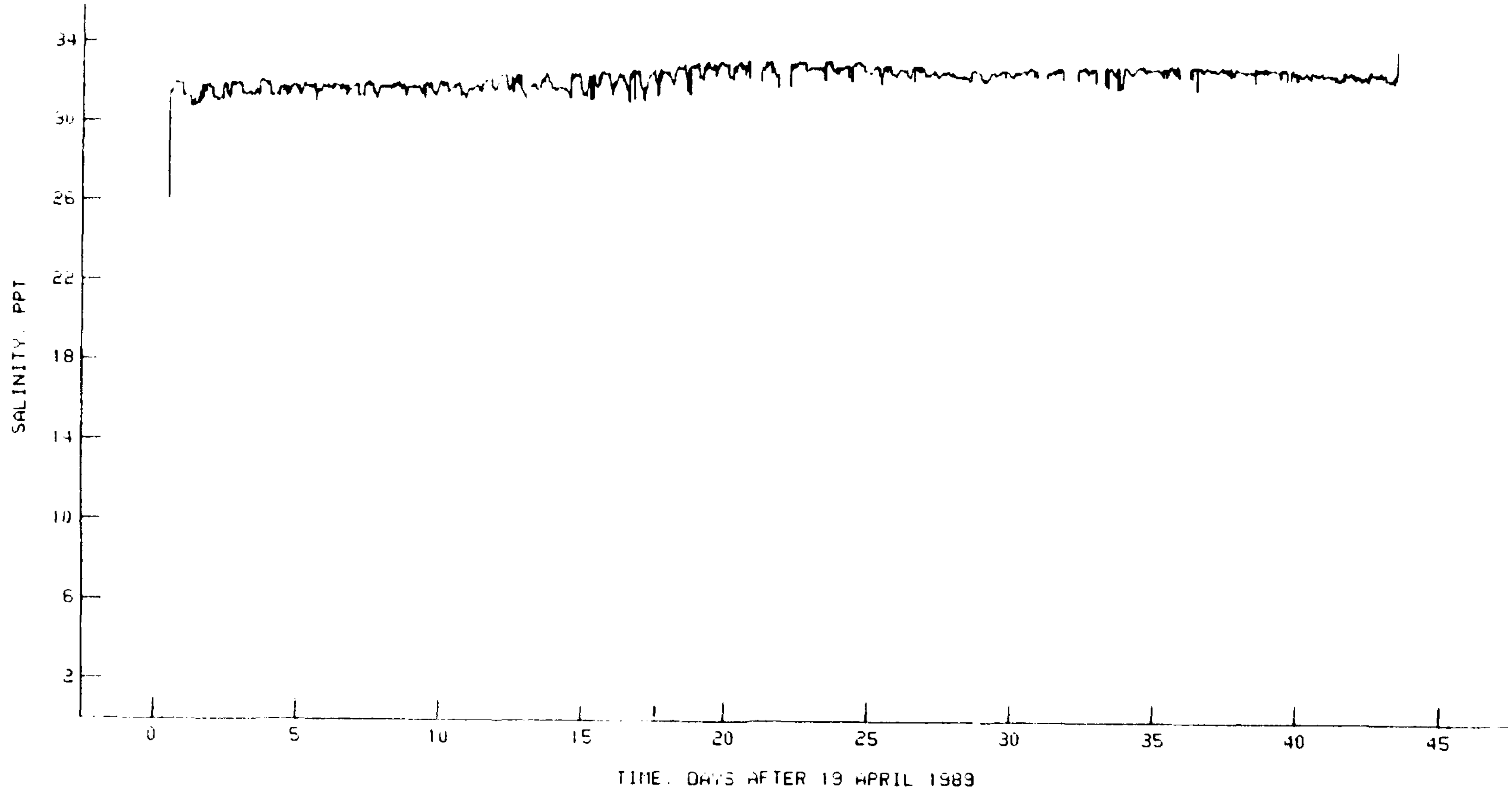
TEMPERATURE
STATION, TLR-5
19 APRIL-1 JUNE 1989

PLATE 5



TEMPERATURE
STATION, TLR-7
19 APRIL-1 JUNE 1989
TIME, DAYS AFTER 19 APRIL 1989
TEMPERATURE, DEG. C
0
5
10
15
20
25
30
35
40
45
12
14
16
18
20
22
24
26
28
30

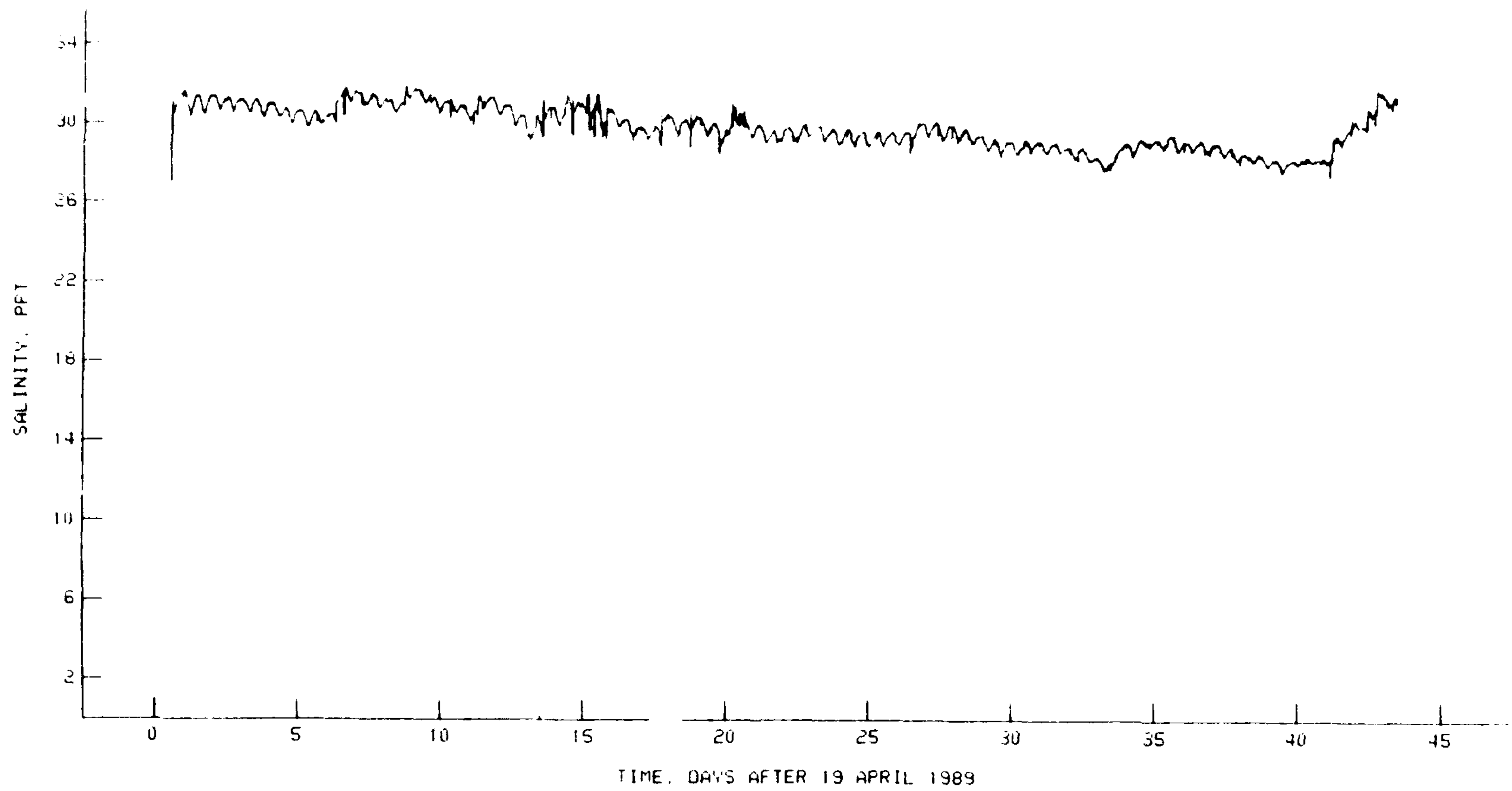
PLATE 6



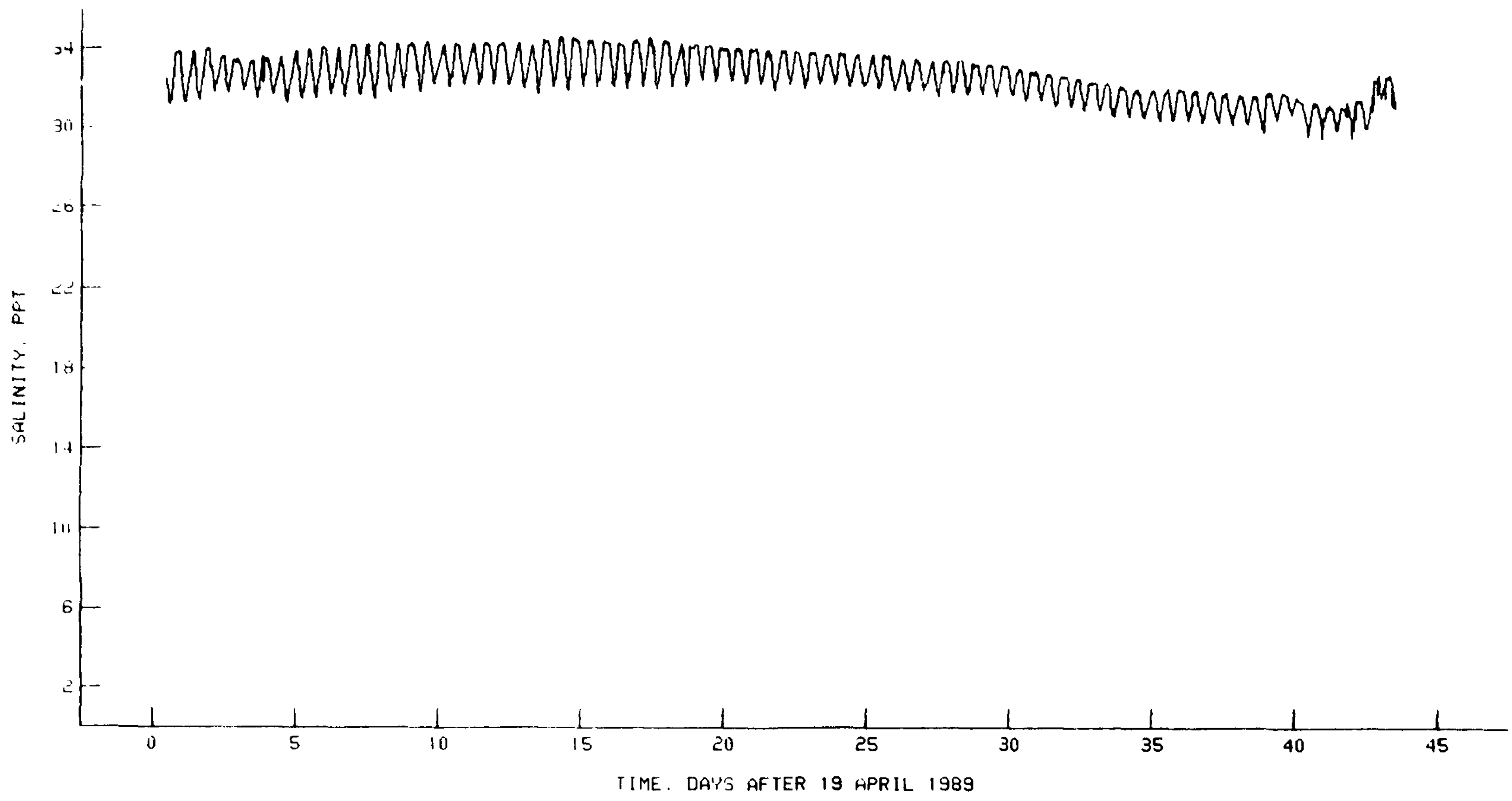
SALINITY
STATION, TLR-4
19 APRIL-1 JUNE 1989

PLATE 7

PLATE 8



SALINITY
STATION, TLR-5
19 APRIL-1 JUNE 1989



SALINITY
STATION, TLR-7
19 APRIL-1 JUNE 1989

PLATE 9

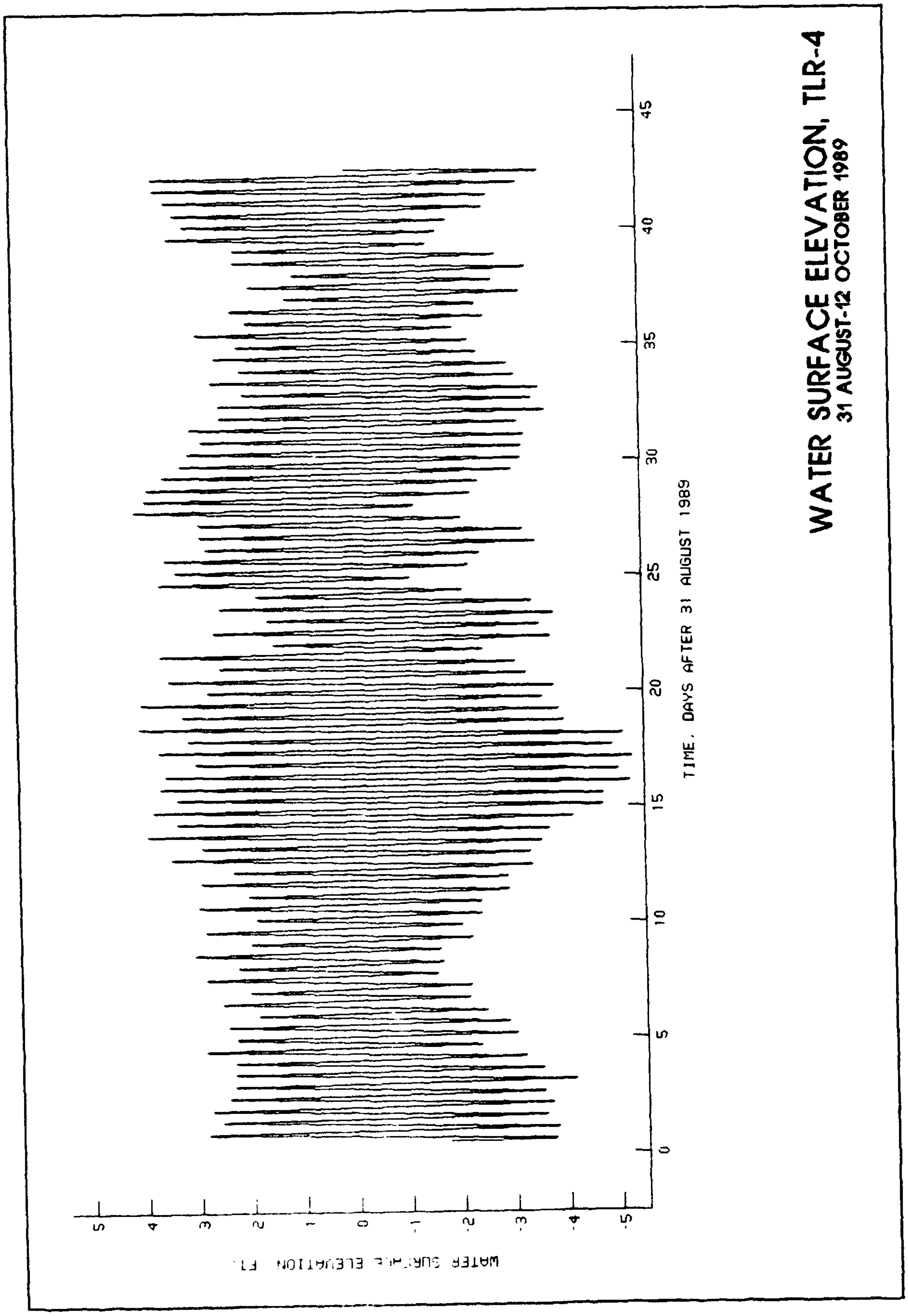
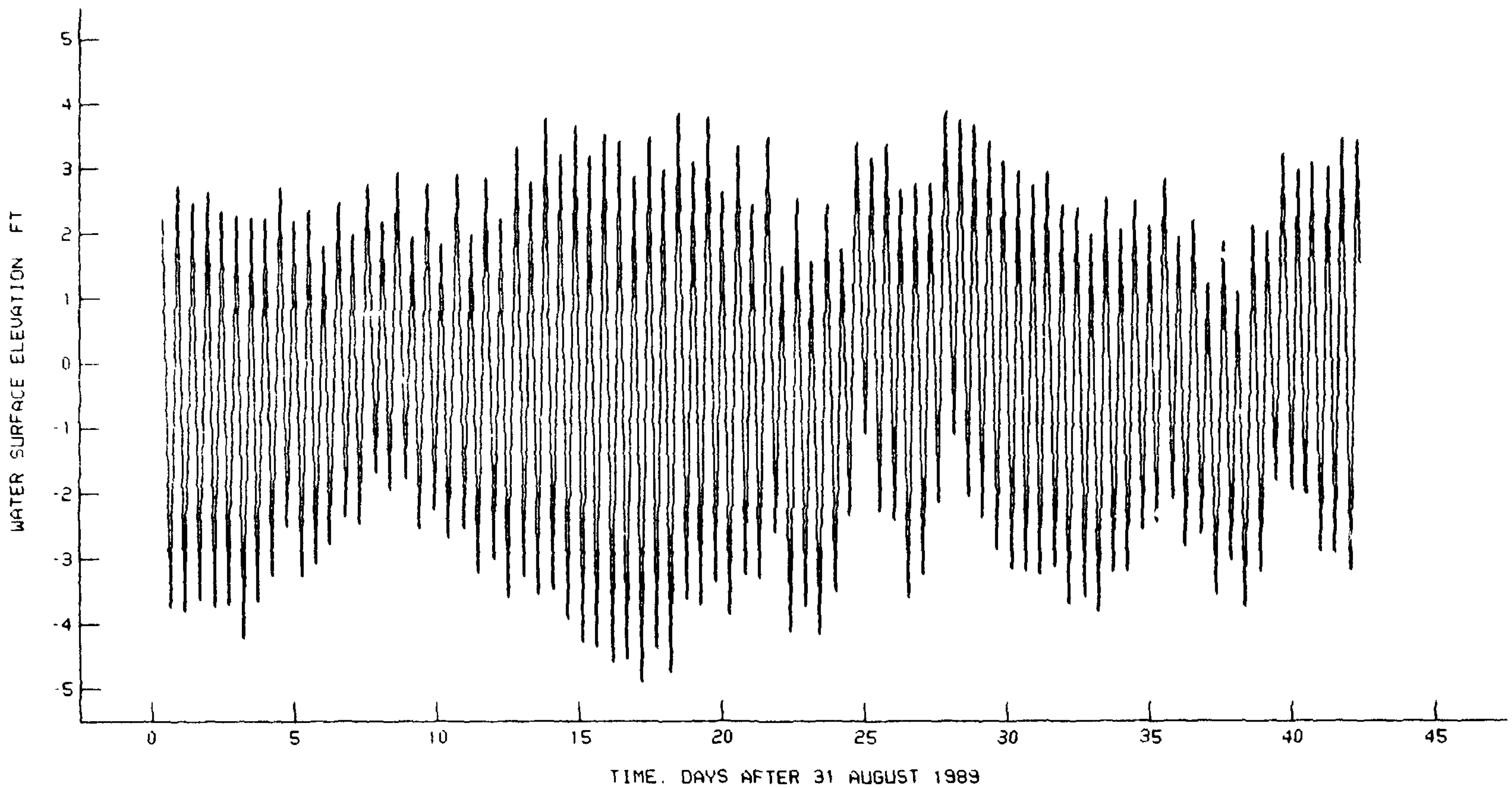

WATER SURFACE ELEVATION, TLR-4
31 AUGUST-12 OCTOBER 1989
TIME, DAYS AFTER 31 AUGUST 1989
0
5
10
15
20
25
30
35
40
45
.5
.4
.3
.2
.1
0
-.1
-.2
-.3
-.4
-.5

PLATE 10



WATER SURFACE ELEVATION, TLP-5
31 AUGUST-12 OCTOBER 1989

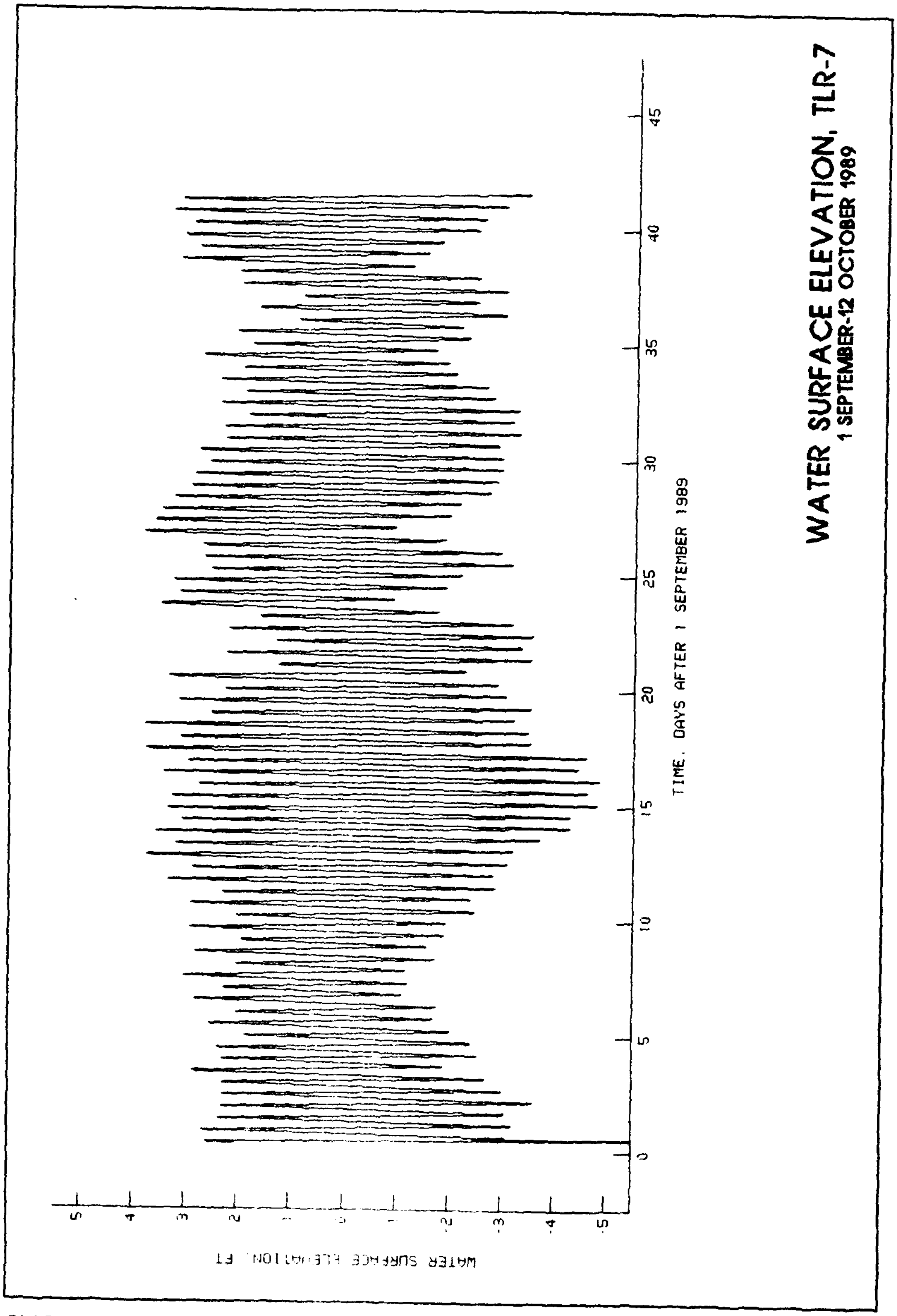
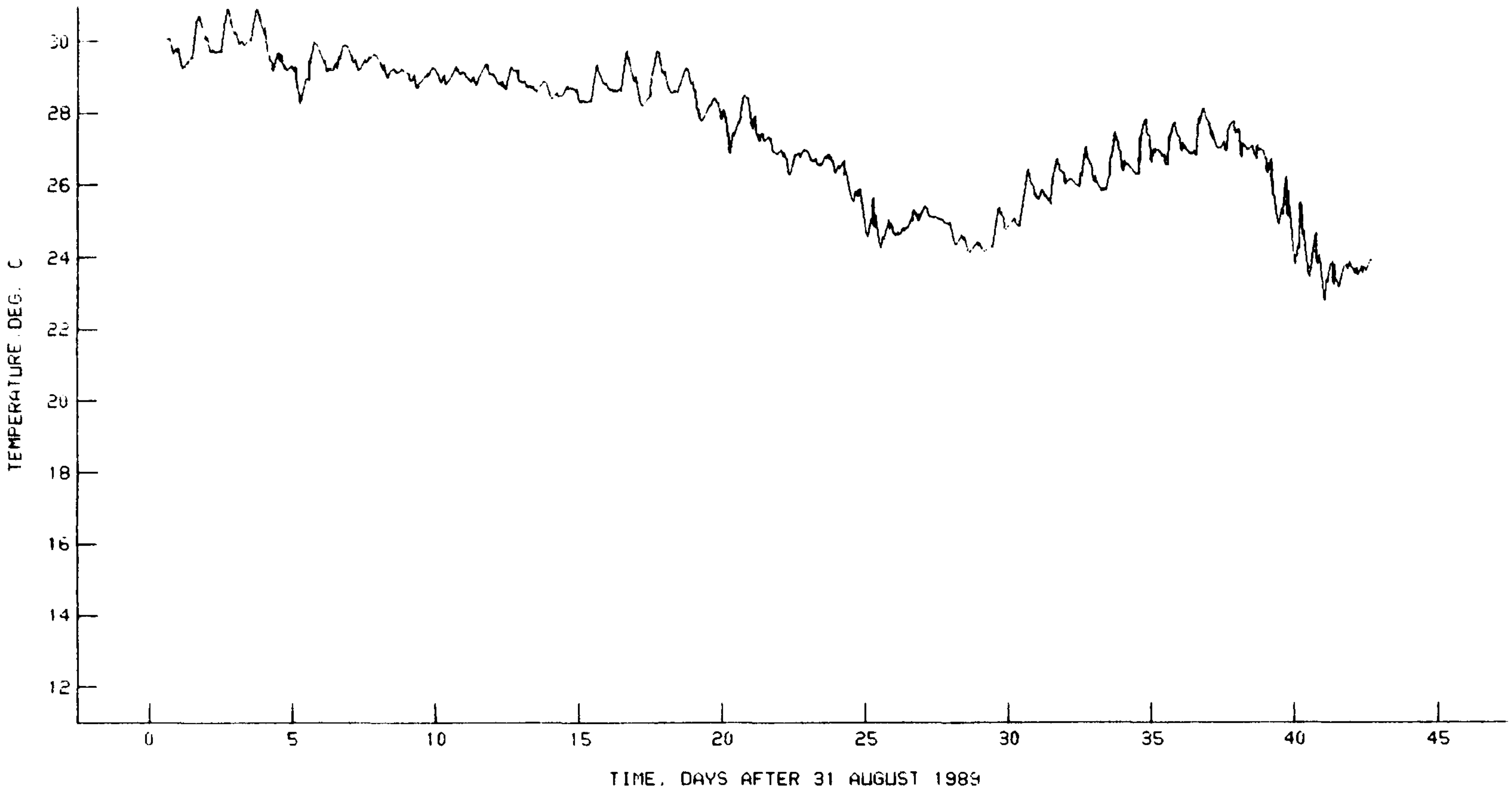
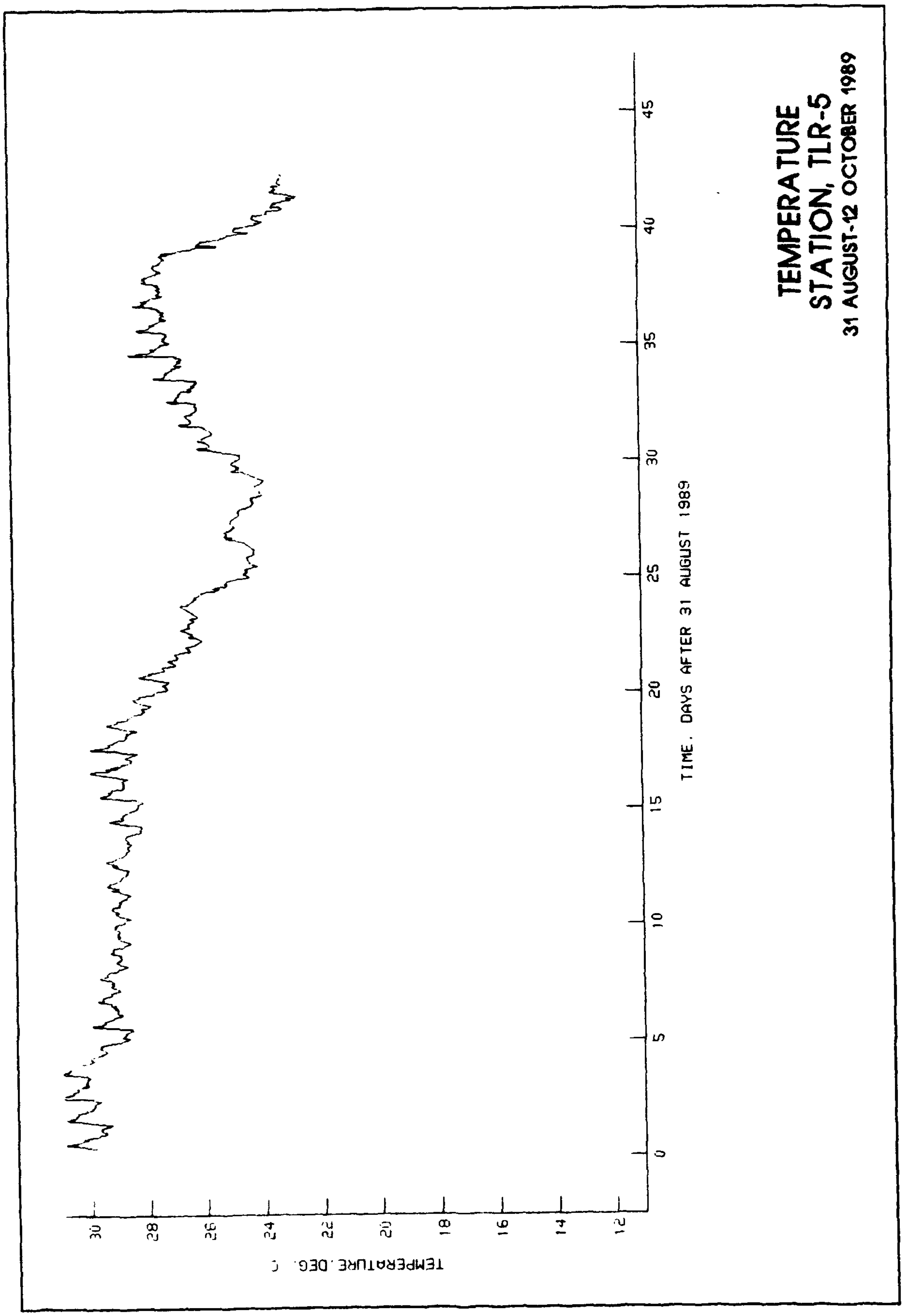

WATER SURFACE ELEVATION, TLR-7
1 SEPTEMBER-12 OCTOBER 1989
TIME, DAYS AFTER 1 SEPTEMBER 1989
WATER SURFACE ELEVATION, FT
0
5
10
15
20
25
30
35
40
45
.5
.4
.3
.2
.1
0
-.1
-.2
-.3
-.4
-.5

PLATE 12

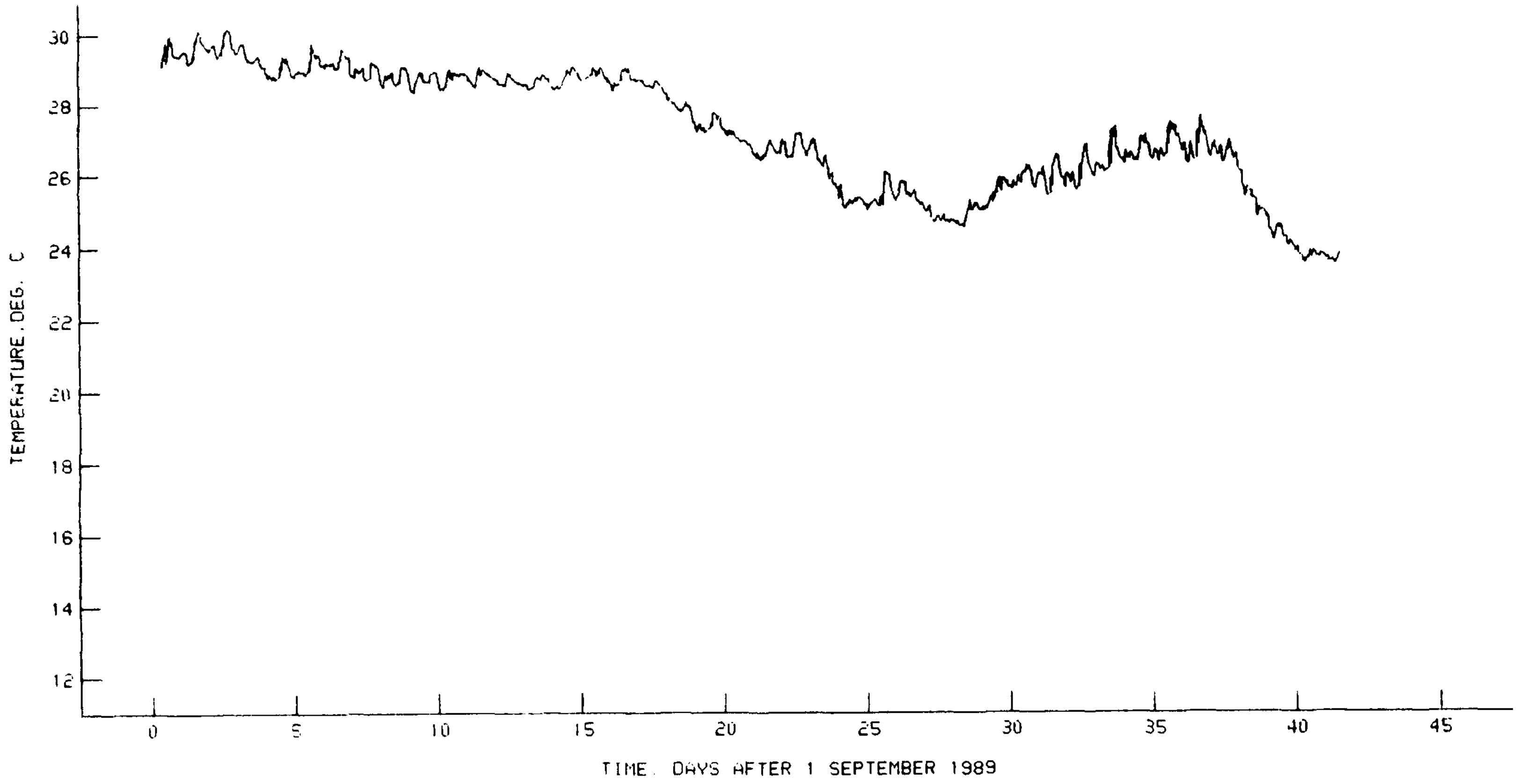


TEMPERATURE
STATION, TLR-4
31 AUGUST-12 OCTOBER 1989



TEMPERATURE
STATION, TLR-5
31 AUGUST-12 OCTOBER 1989

PLATE 14



TEMPERATURE
STATION, TLR-7
1 SEPTEMBER-12 OCTOBER 1989

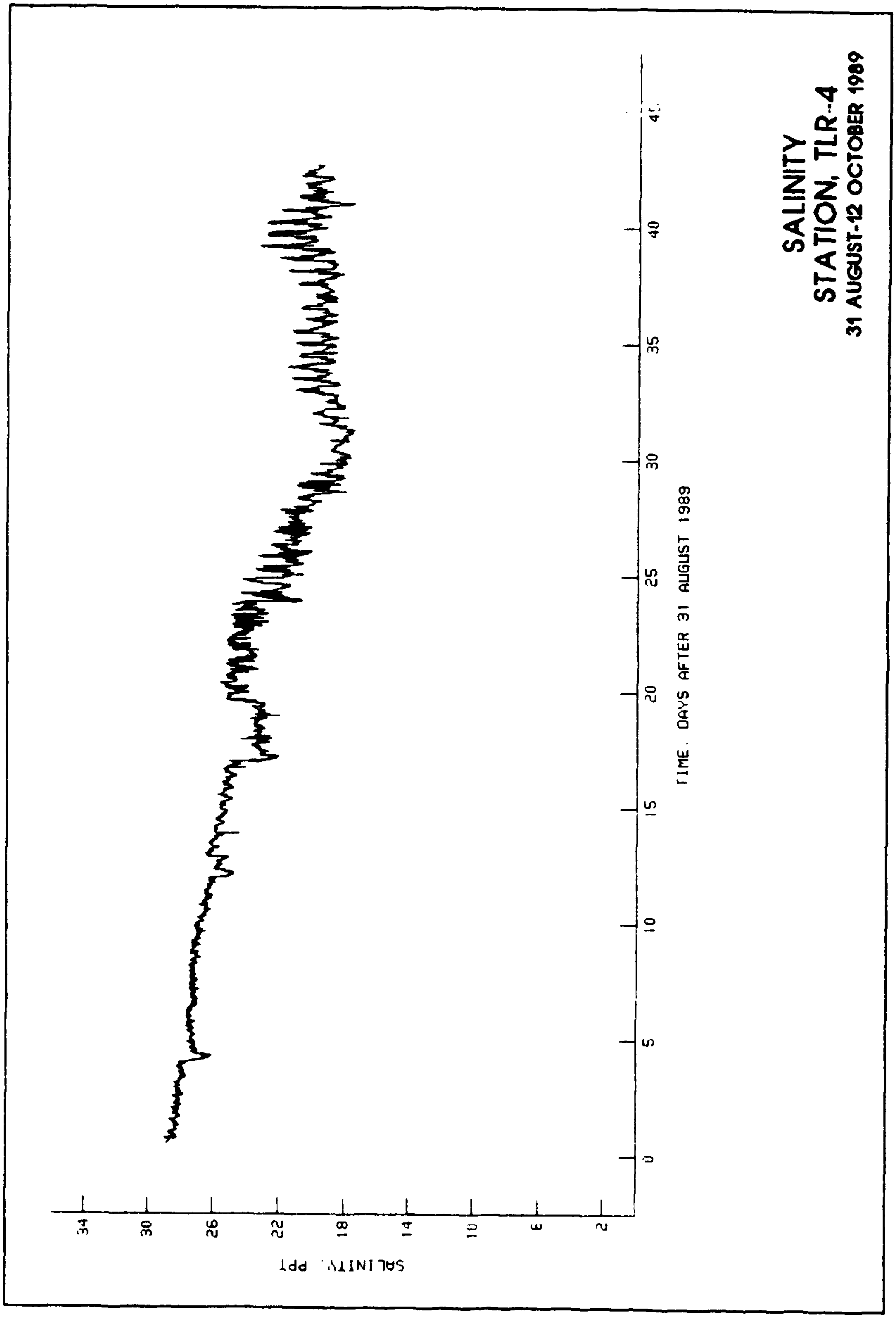
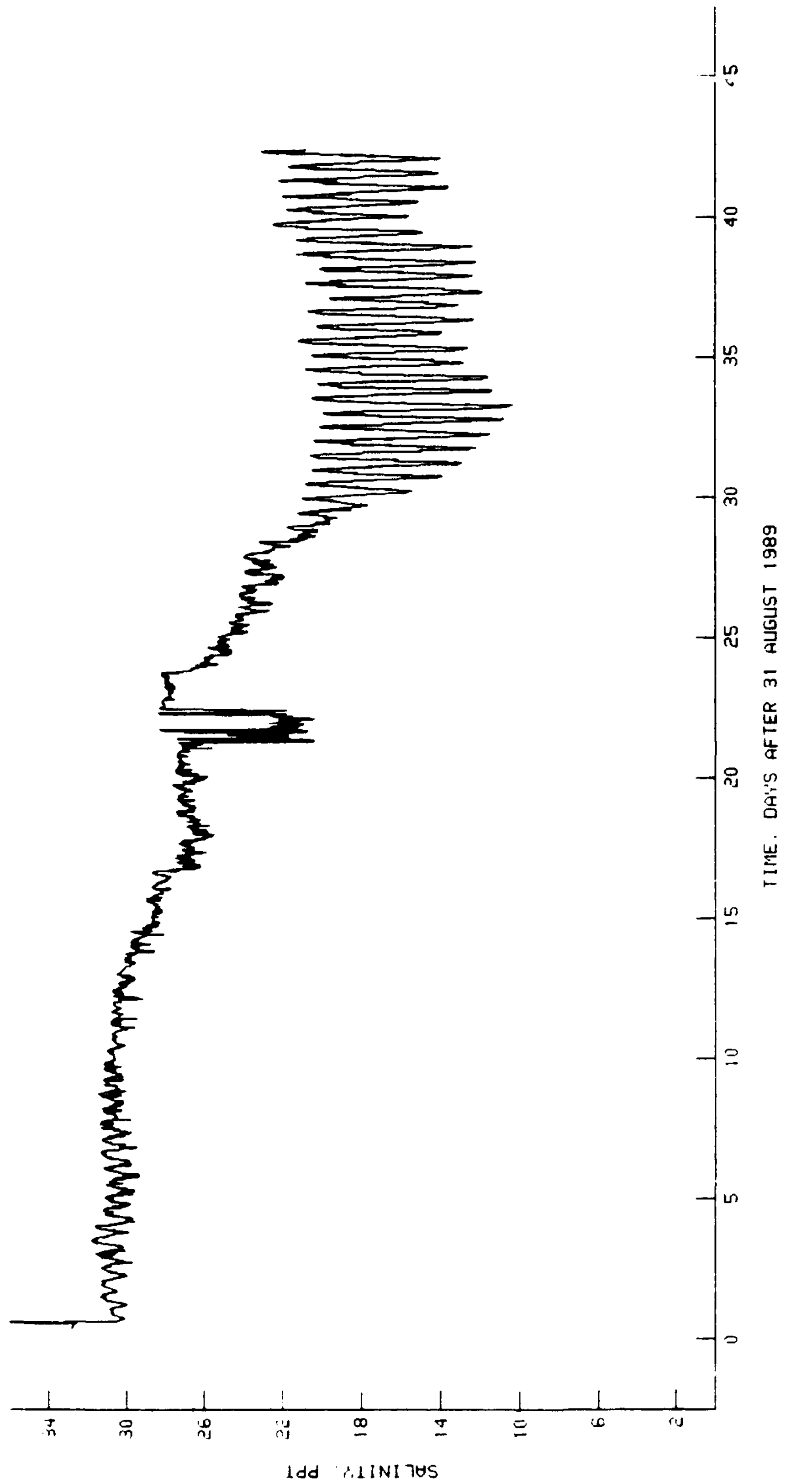

SALINITY
STATION, TLR-4
31 AUGUST-12 OCTOBER 1989
TIME. DAYS AFTER 31 AUGUST 1989
SALINITY, PPT
0
5
10
15
20
25
30
35
40
2
6
10
14
18
22
26
30
34

PLATE 16



SALINITY
STATION, TLR-5
31 AUGUST-12 OCTOBER 1989

PLATE 17

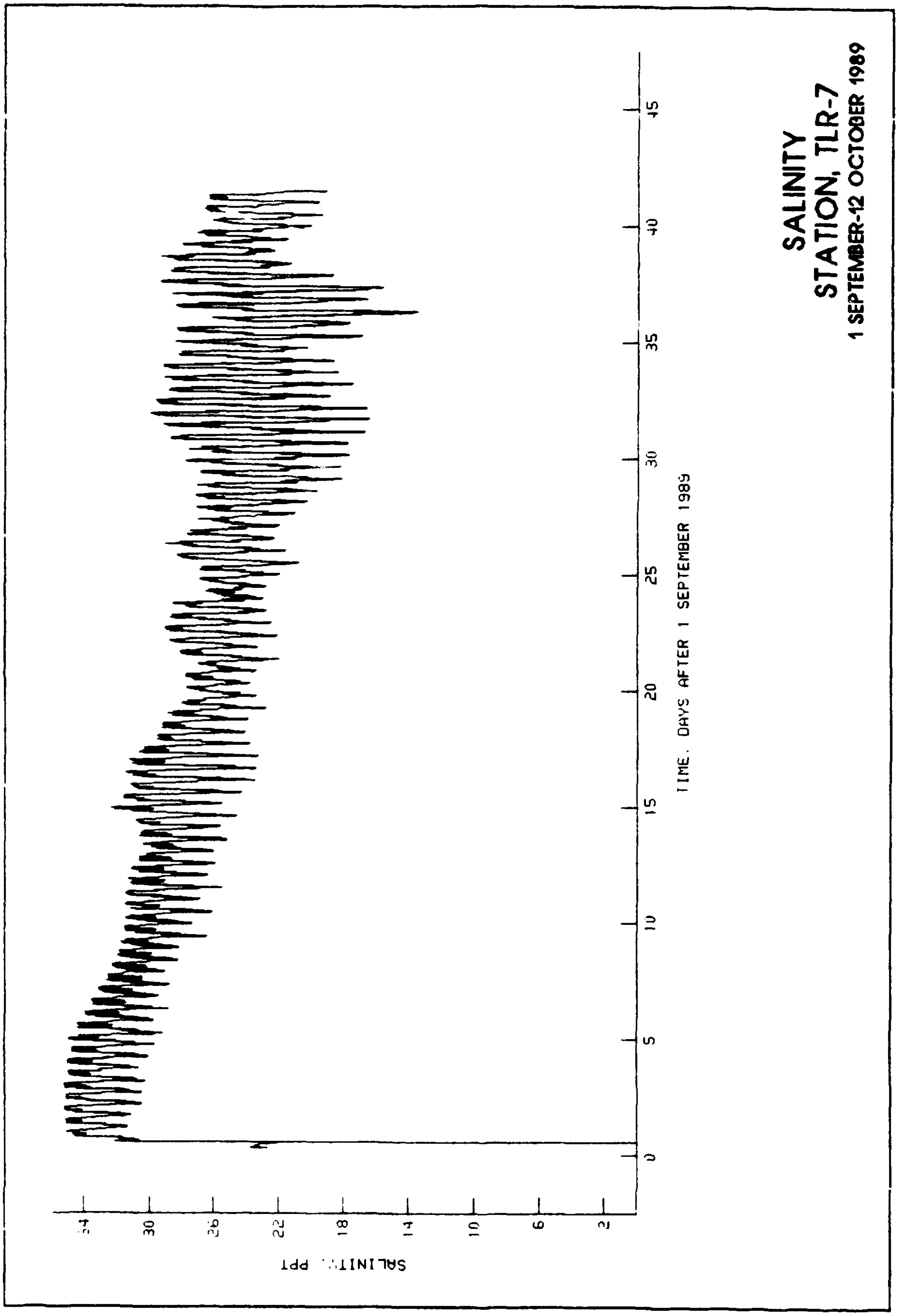

SALINITY
STATION, TLR-7
1 SEPTEMBER-12 OCTOBER 1989
TIME, DAYS AFTER 1 SEPTEMBER 1989
SALINIT PPT
0
5
10
15
20
25
30
35
40
45
2
6
10
14
18
22
26
30
34

PLATE 18

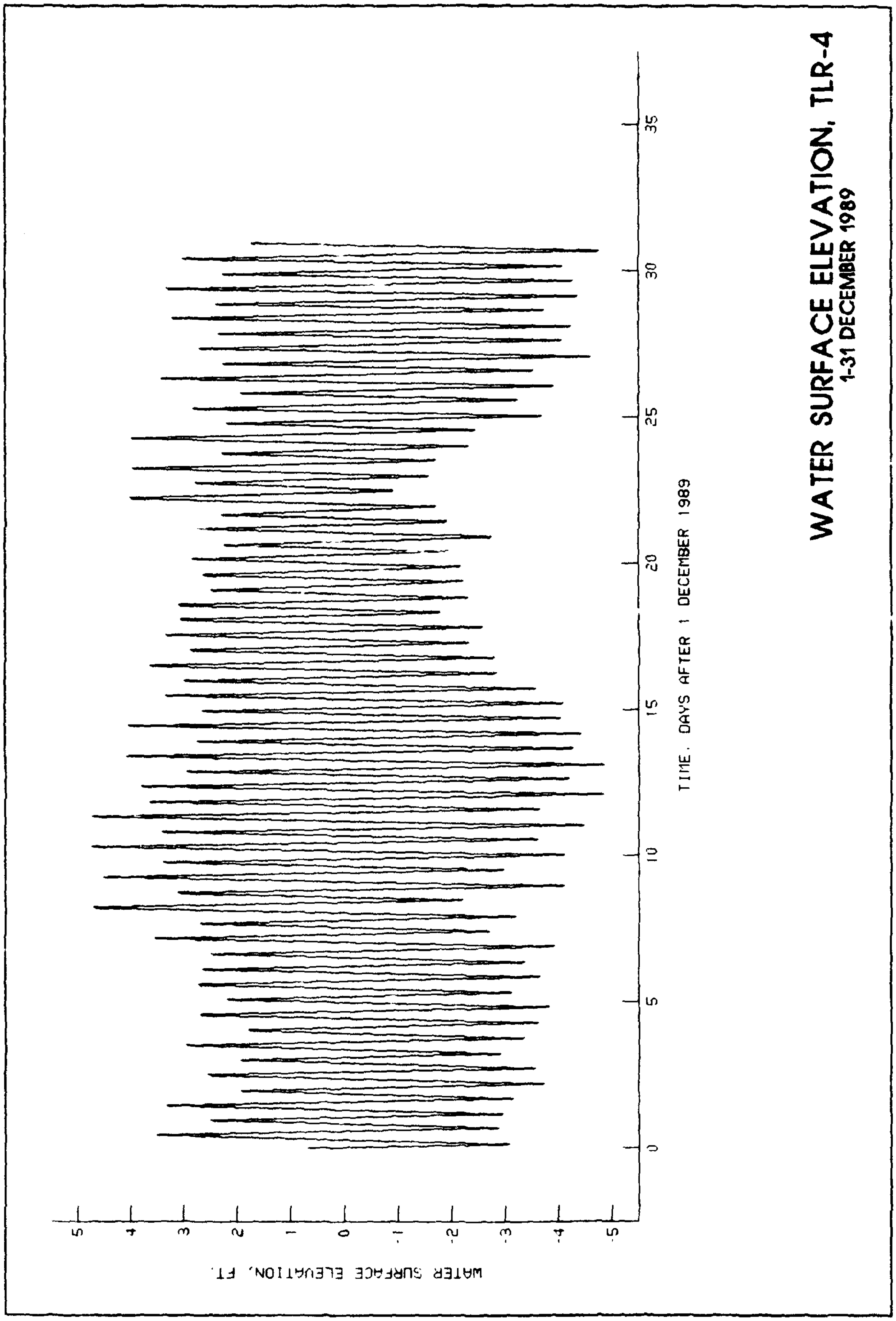

WATER SURFACE ELEVATION, TLR-4
1-31 DECEMBER 1989
TIME, DAYS AFTER 1 DECEMBER 1989
0
5
10
15
20
25
30
35
WATER SURFACE ELEVATION, FT.
5
4
3
2
1
0
-1
-2
-3
-4
-5

PLATE 19

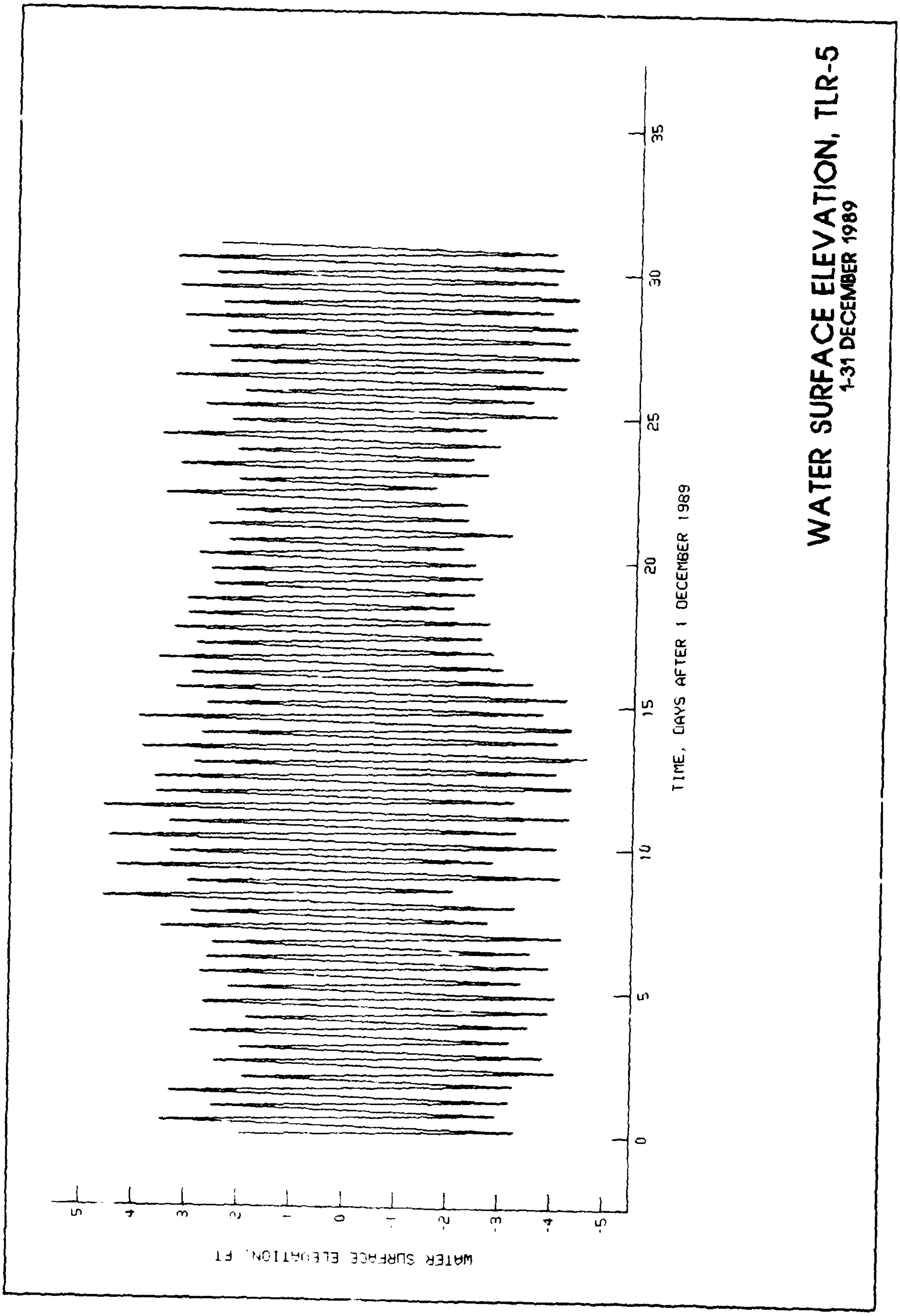
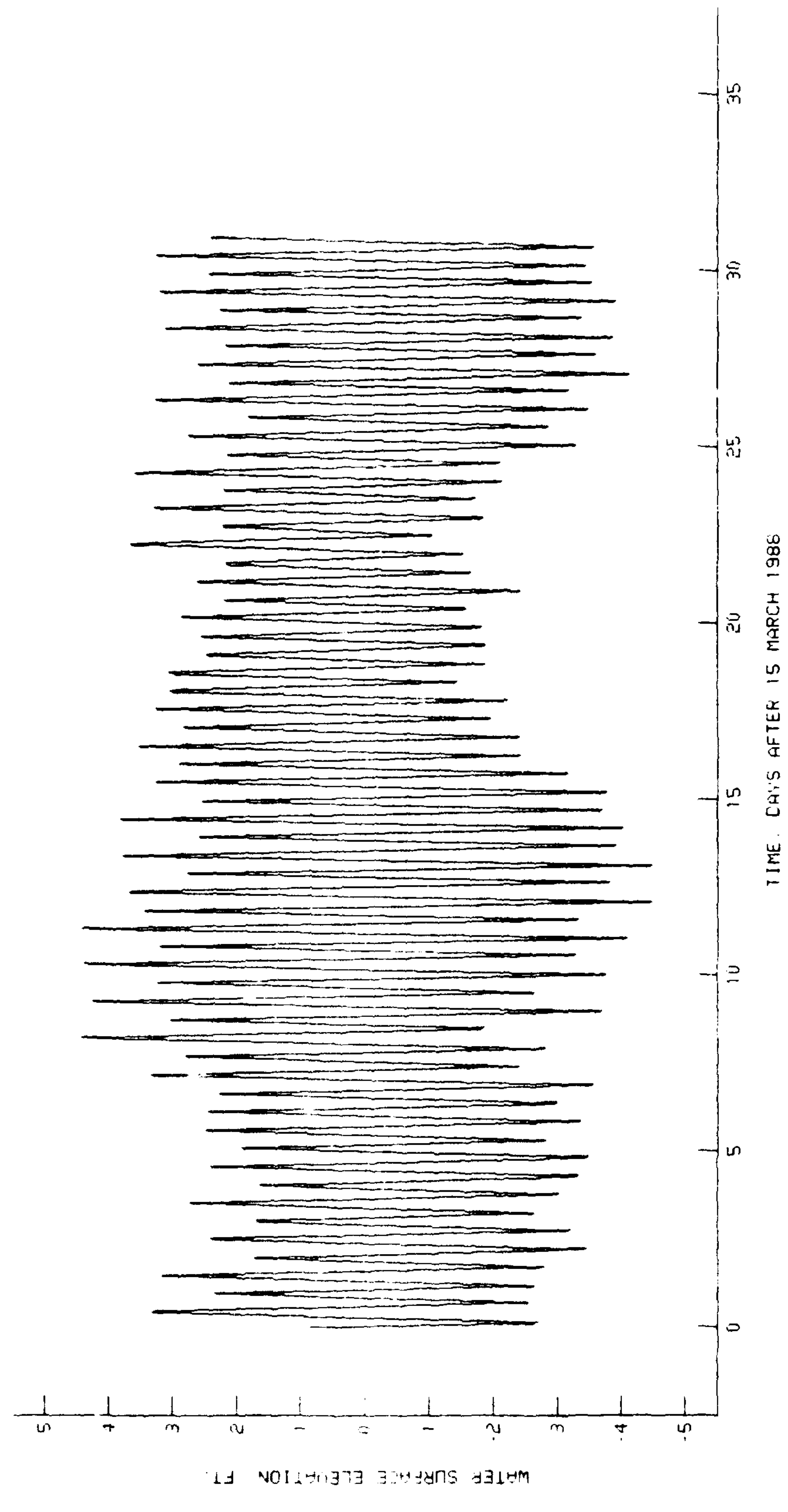

WATER SURFACE ELEVATION, TLR-5
1-31 DECEMBER 1989
TIME, DAYS AFTER 1 DECEMBER 1989
WATER SURFACE ELEVATION, FT
0
5
10
15
20
25
30
35
5
4
3
2
1
0
-1
-2
-3
-4
-5

PLATE 20



WATER SURFACE ELEVATION, TLR-7
1-31 DECEMBER 1989

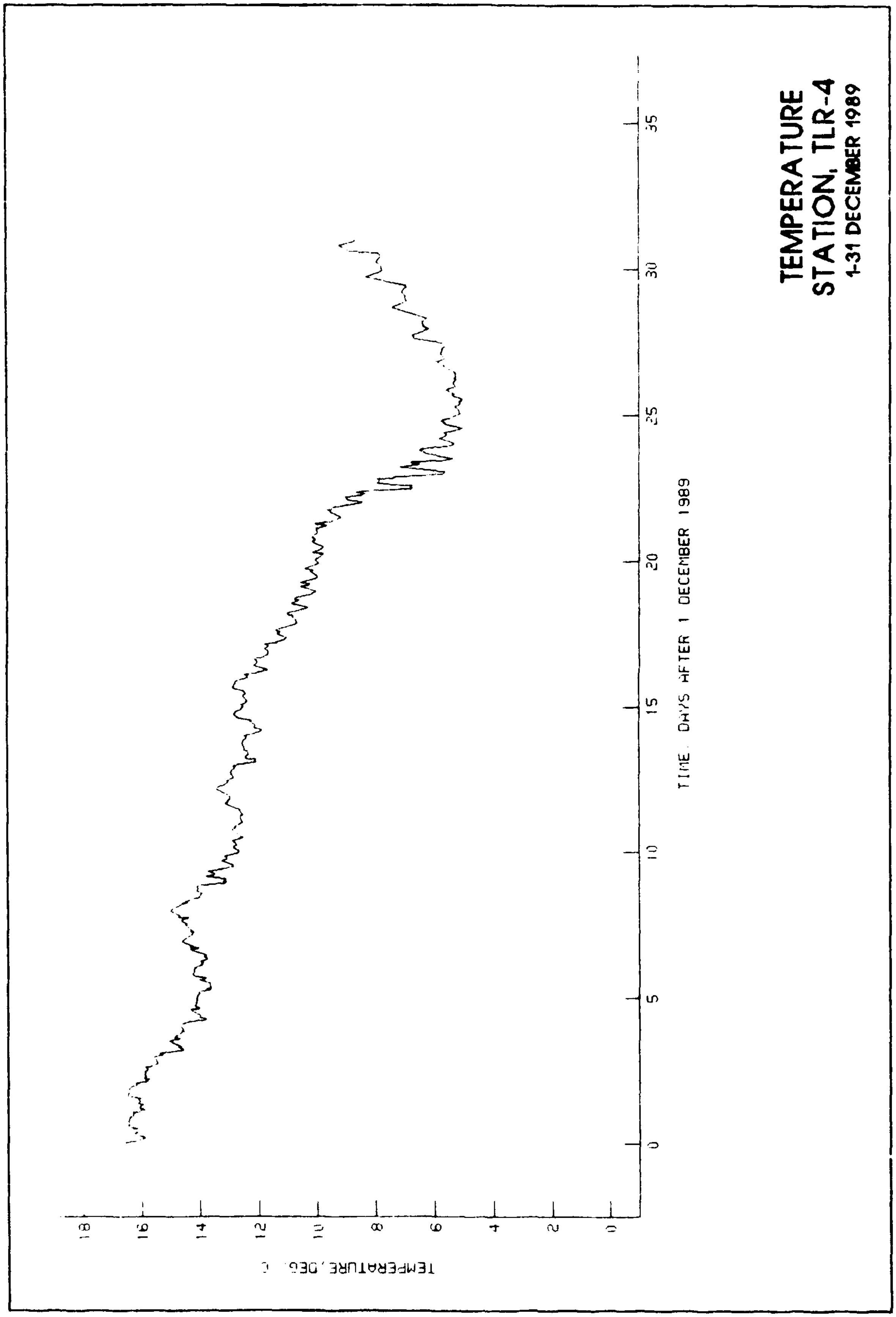
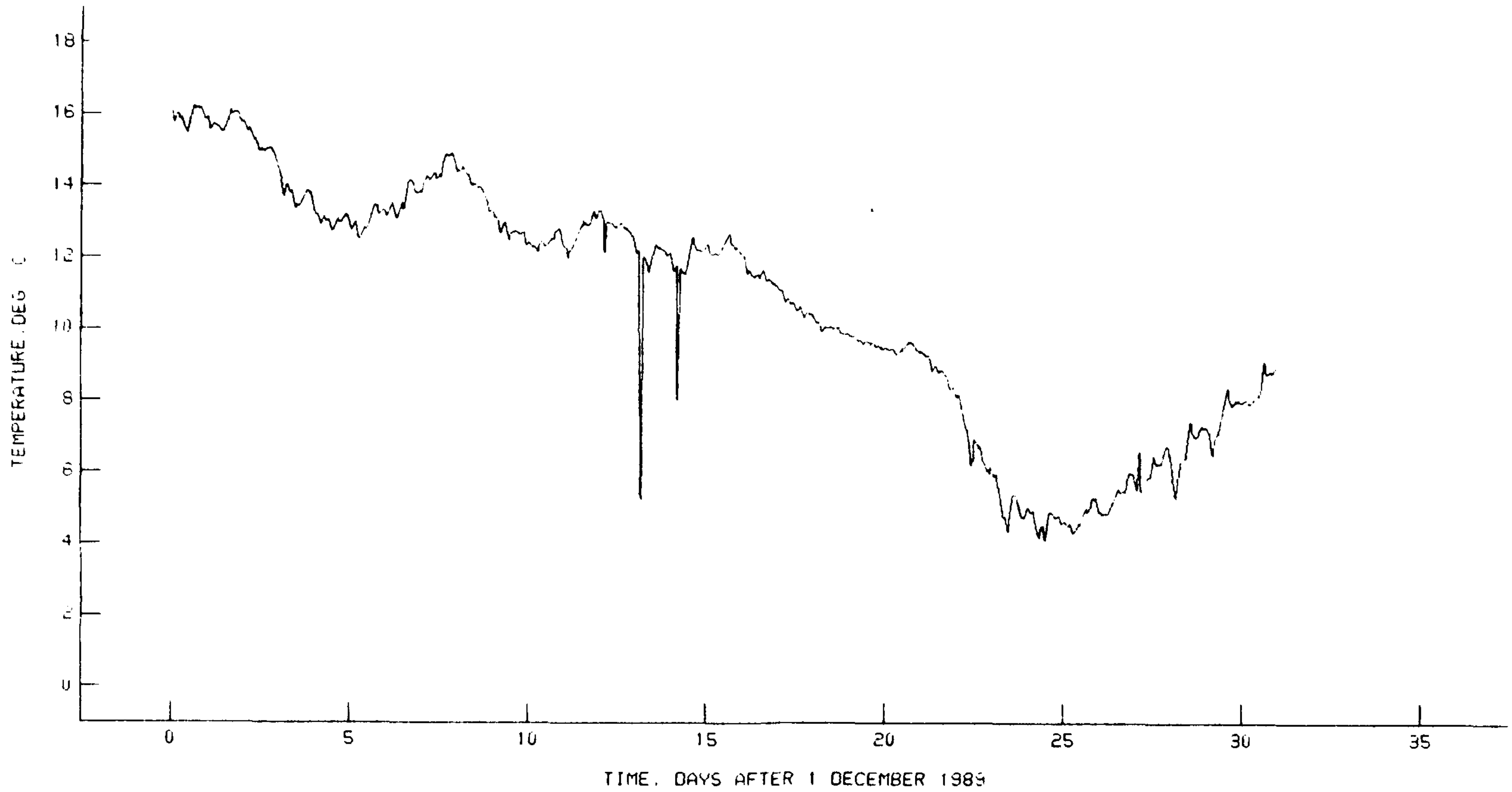
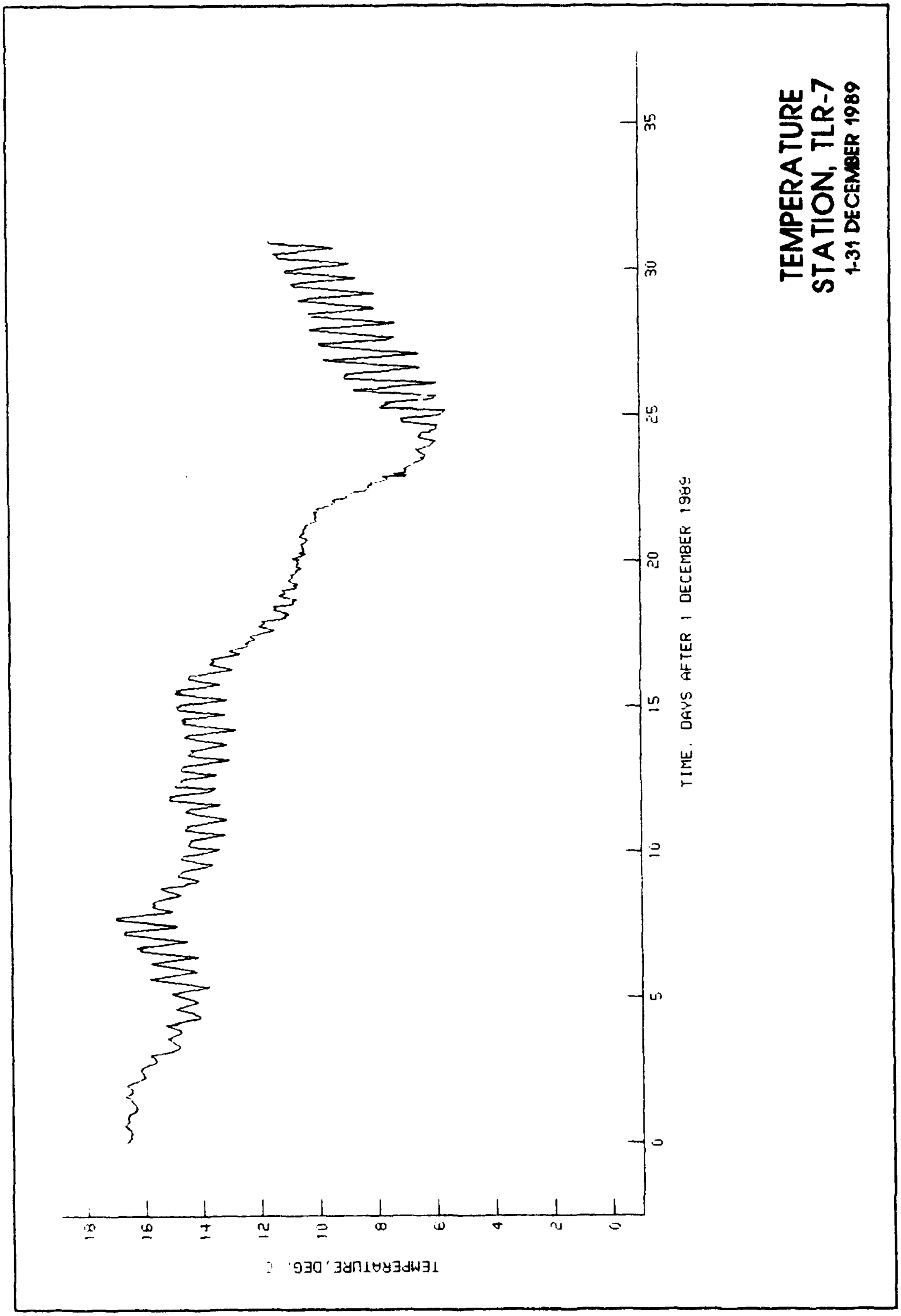

TEMPERATURE
STATION, TLR-4
1-31 DECEMBER 1989
TIME, DAYS AFTER 1 DECEMBER 1989
TEMPERATURE, DEG C
0
5
10
15
20
25
30
35
0
2
4
6
8
10
12
14
16
18

PLATE 22

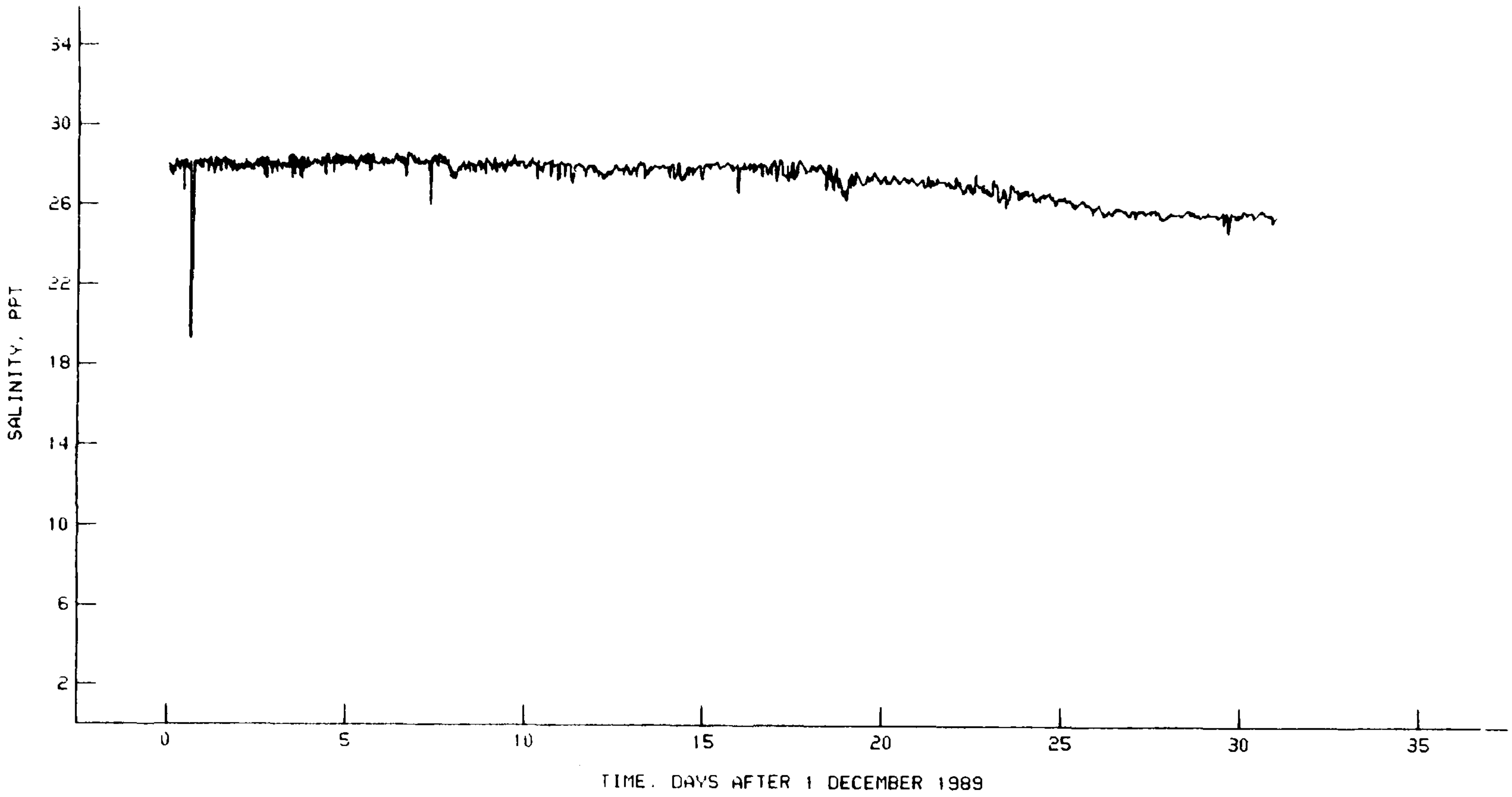


TEMPERATURE
STATION, TLR-5
1-31 DECEMBER 1989



TEMPERATURE
STATION, TLR-7
1-31 DECEMBER 1989

PLATE 24



SALINITY
STATION, TLR-4
1-31 DECEMBER 1989

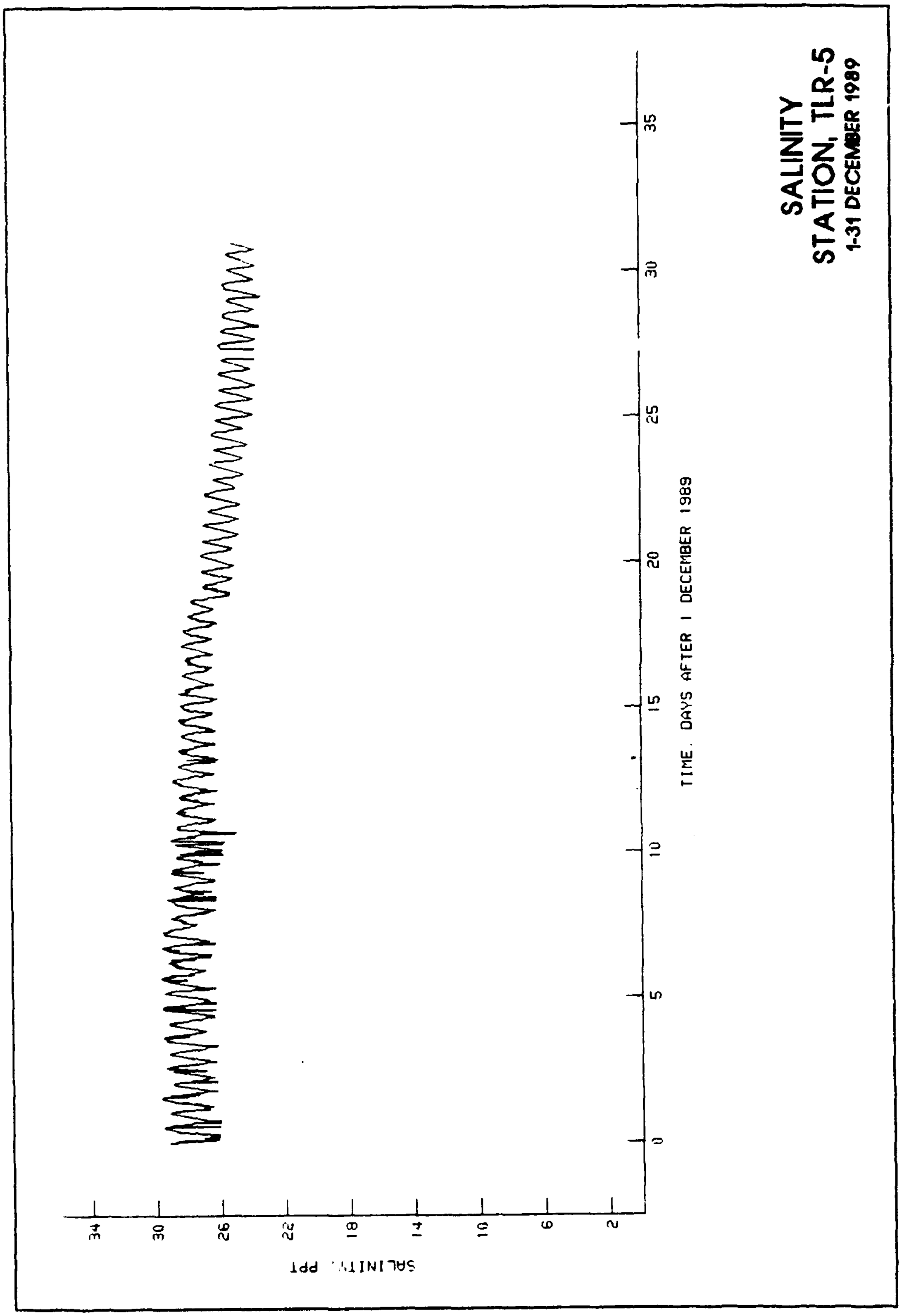
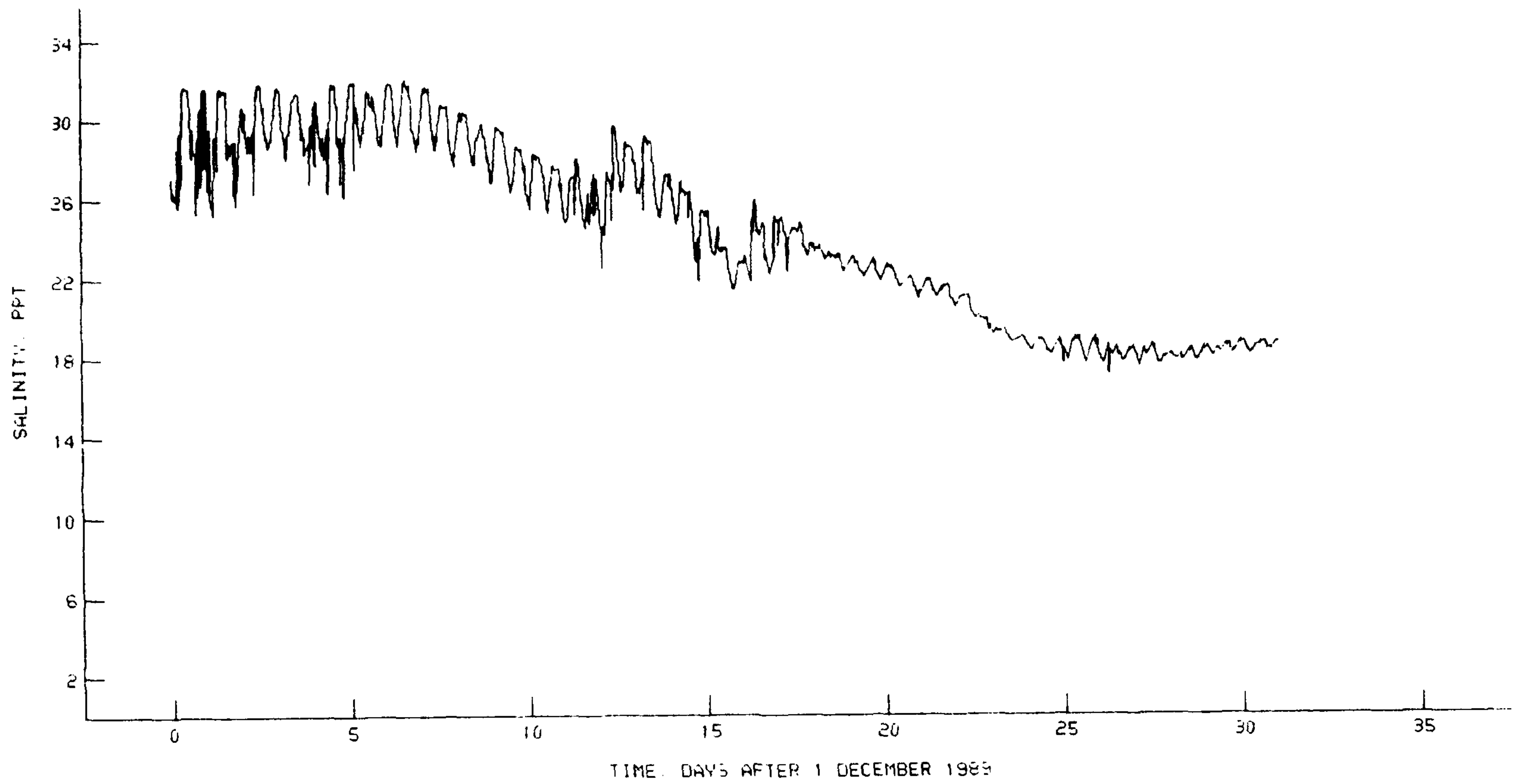
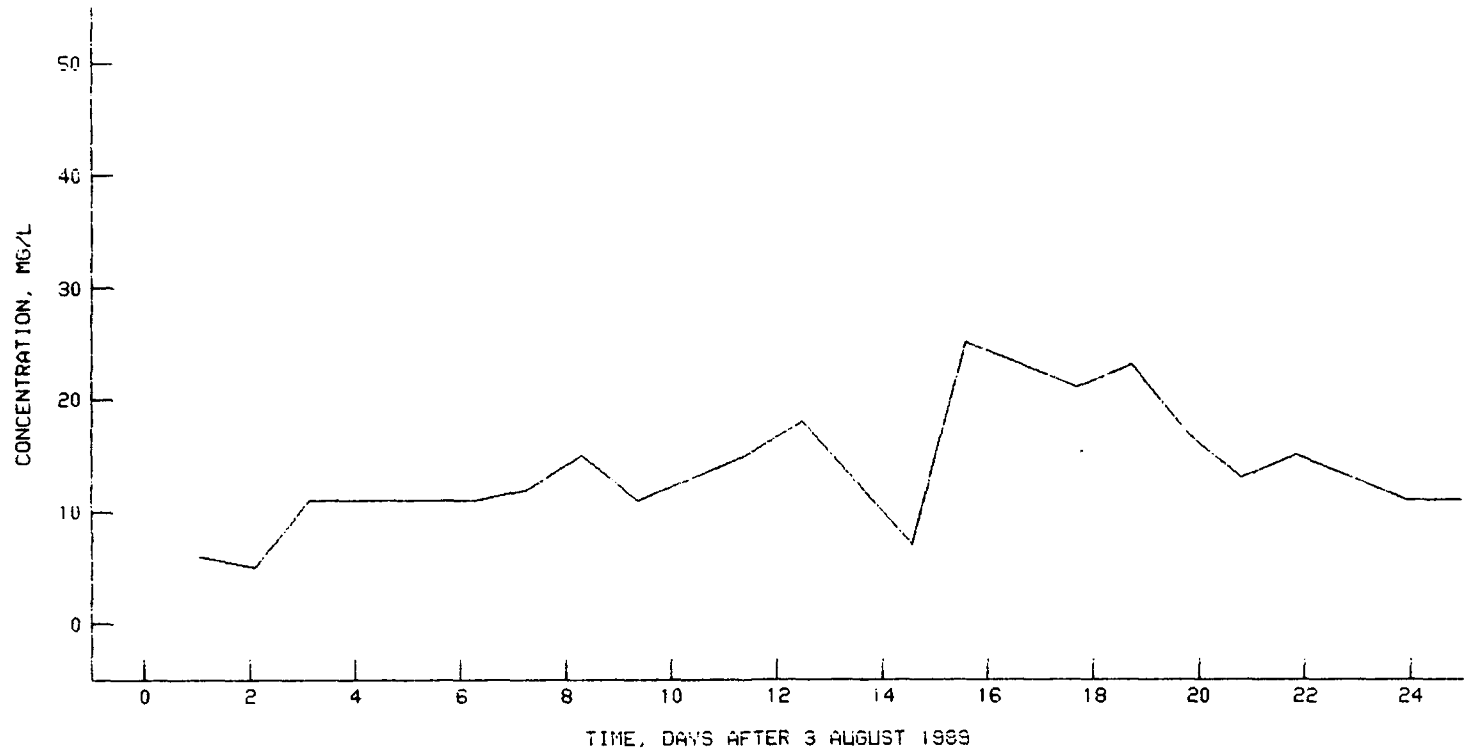

SALINITY
STATION, TLR-5
1-31 DECEMBER 1989
TIME, DAYS AFTER 1 DECEMBER 1989
SALINITY, PPT
0
5
10
15
20
25
30
35
2
6
10
14
18
22
26
30
34

PLATE 26



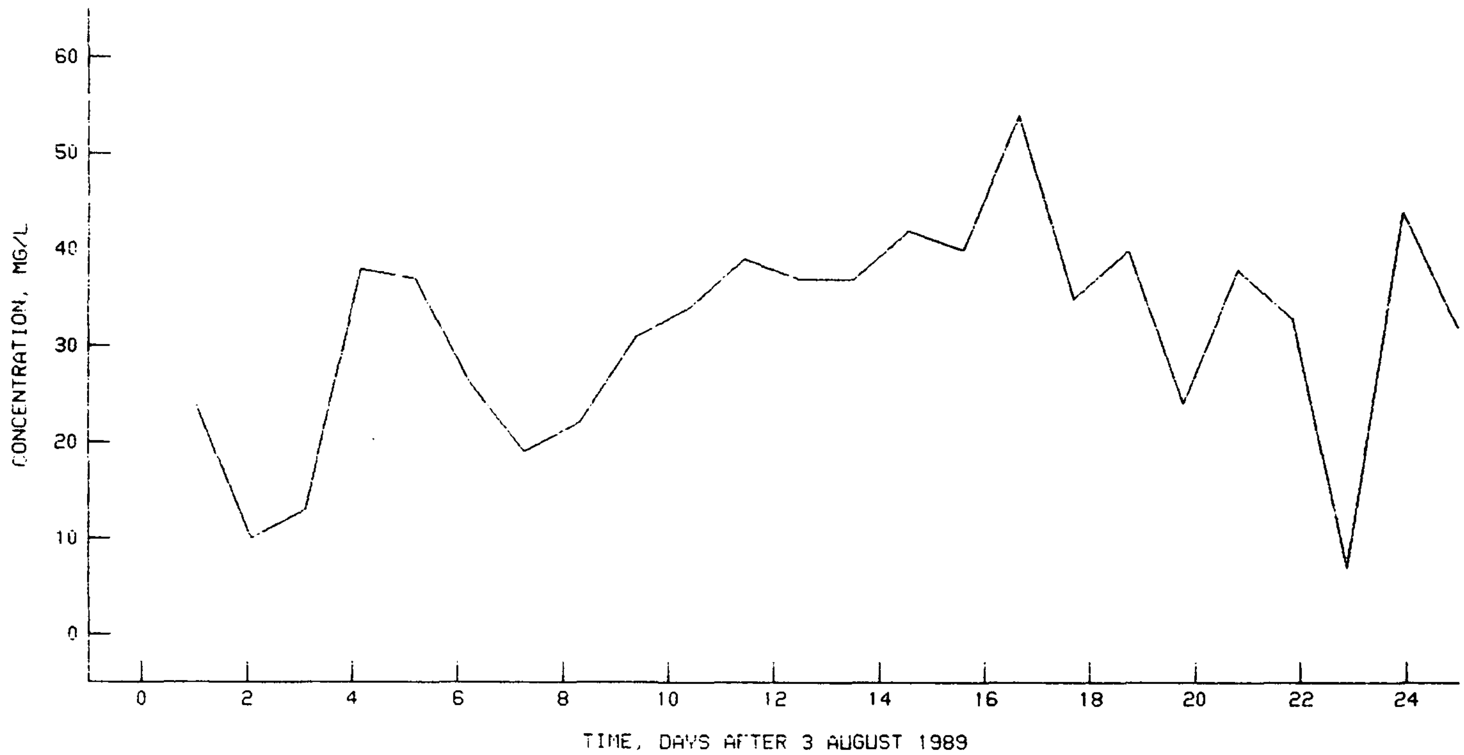
SALINITY
STATION, TLR-7
1-31 DECEMBER 1989



SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLERS, WS4KB

AUGUST, 1989

PLATE 28



SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLERS, WS5KB

AUGUST, 1989

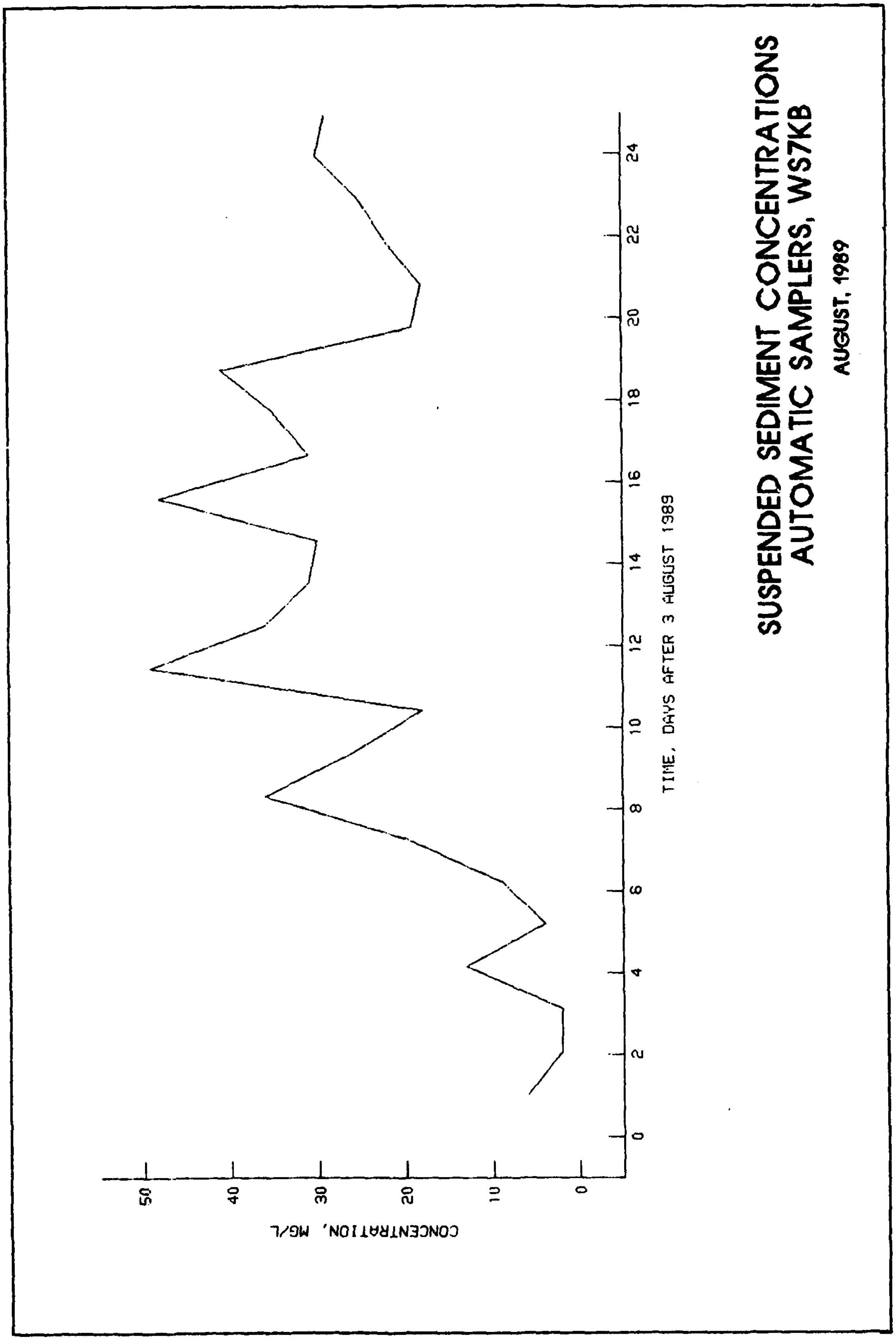
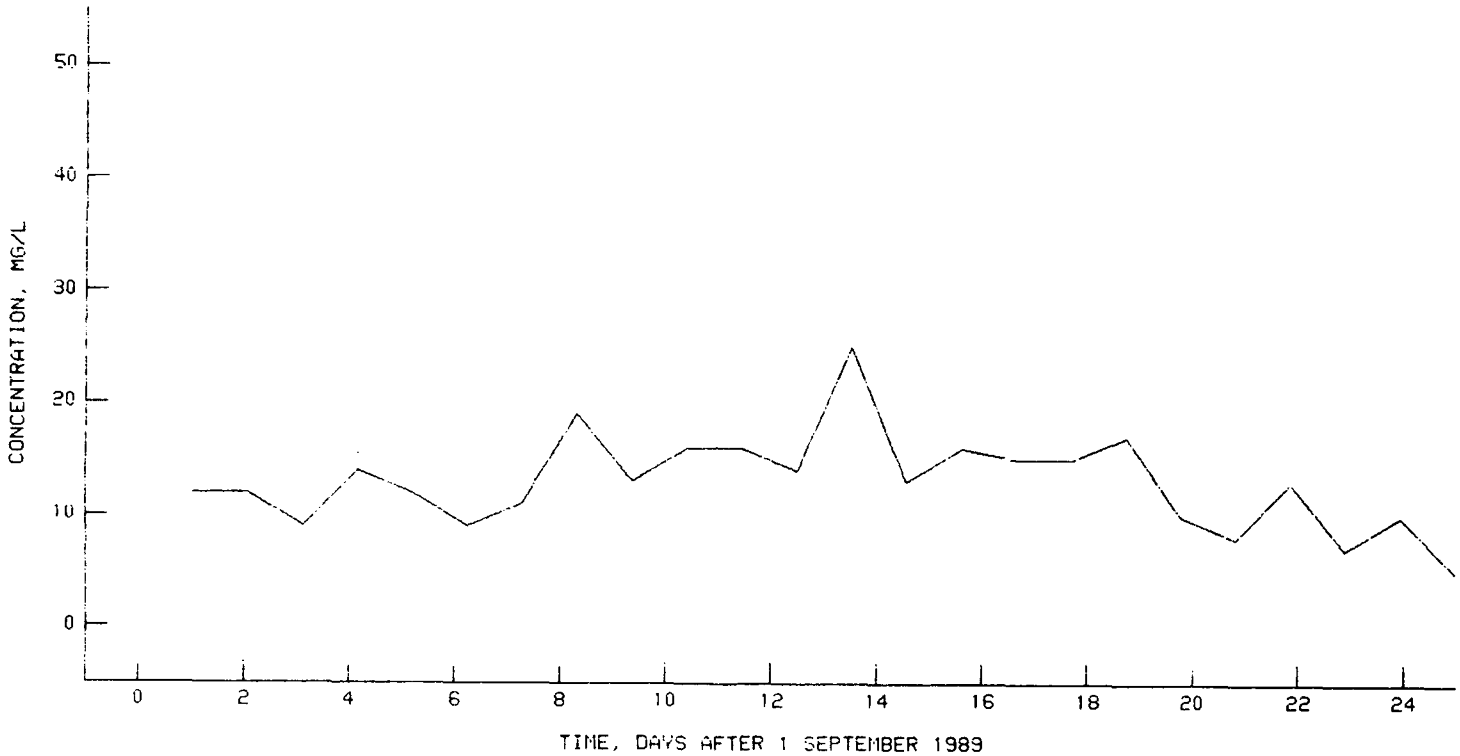
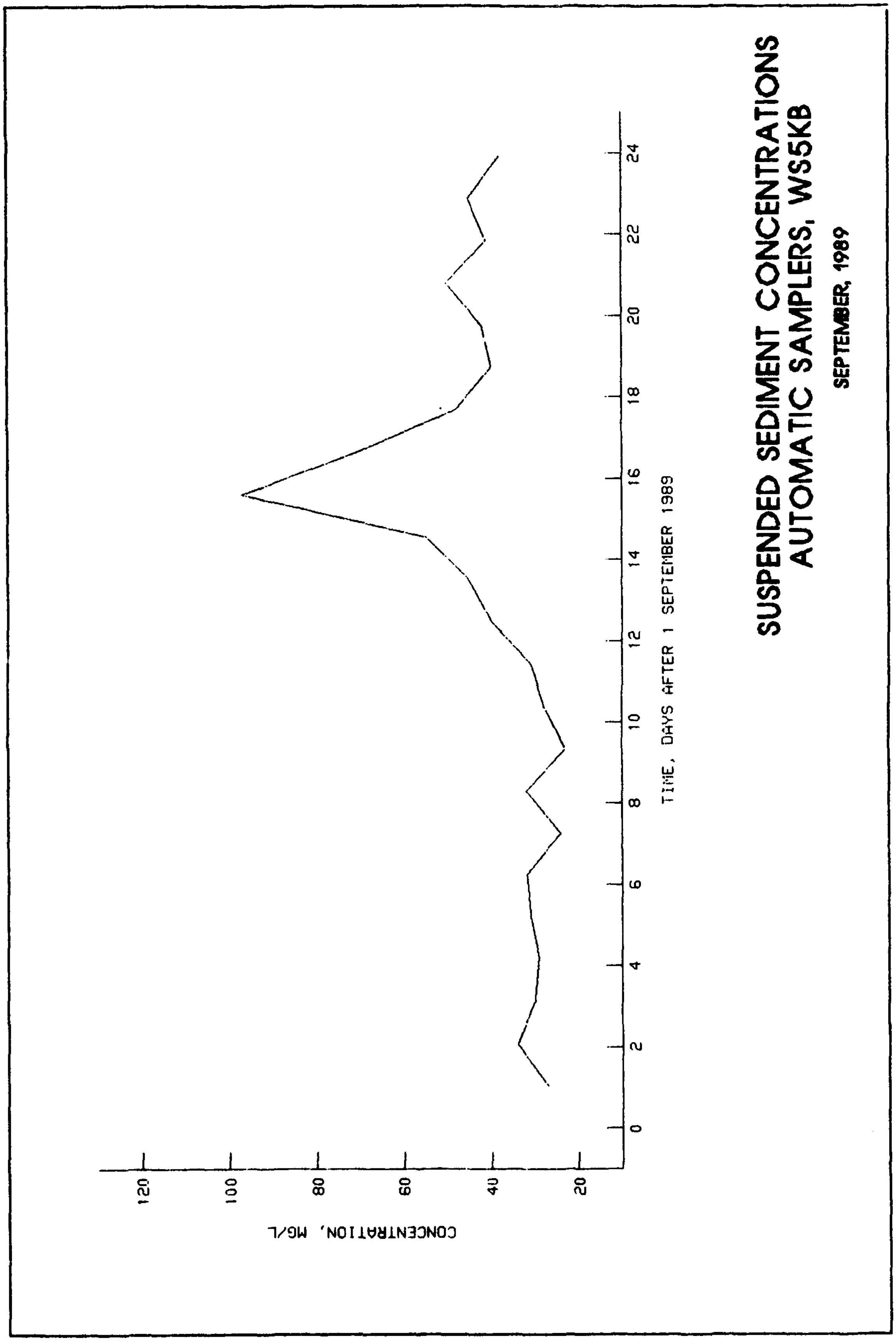

SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLERS, WS7KB
AUGUST, 1989
TIME, DAYS AFTER 3 AUGUST 1989
CONCENTRATION, MG/L
0
2
4
6
8
10
12
14
16
18
20
22
24
0
10
20
30
40
50

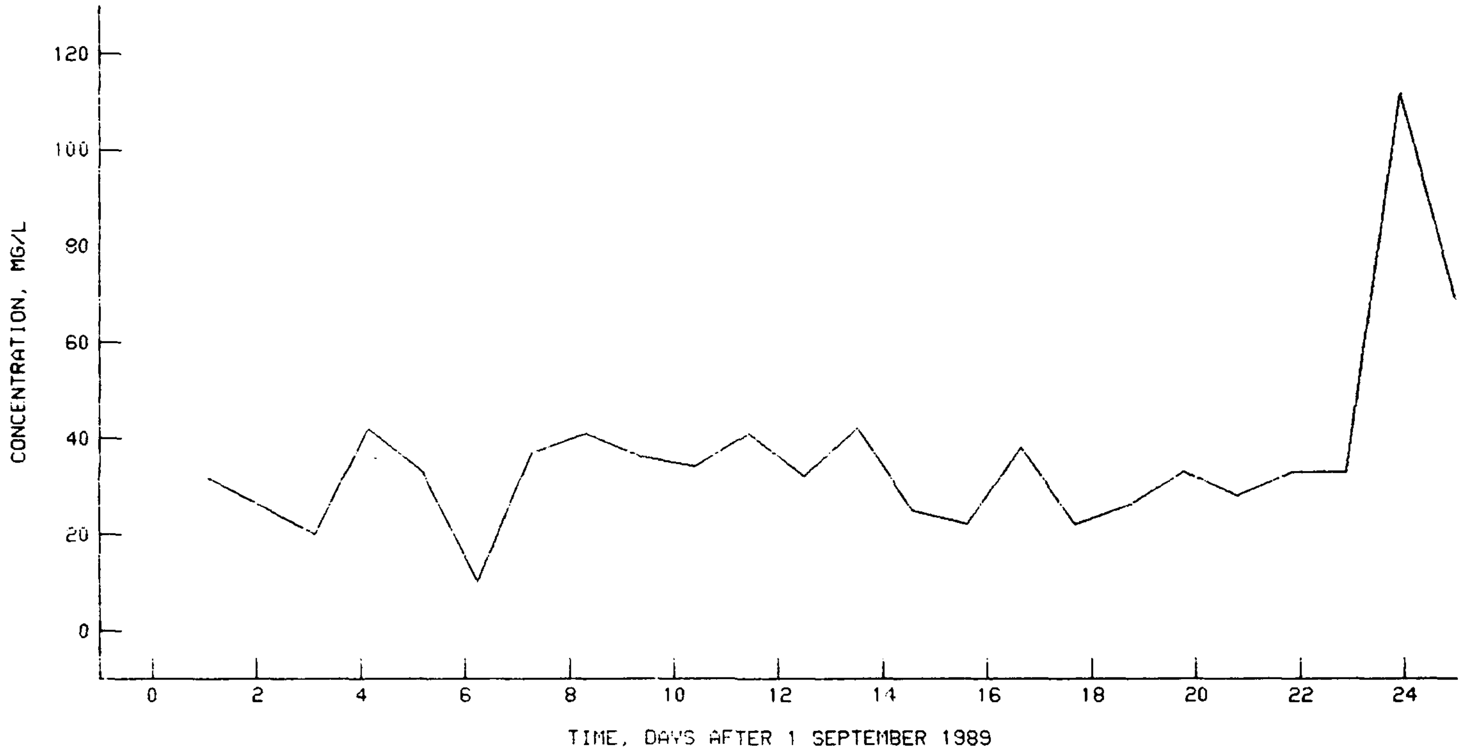
PLATE 30



SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLERS, WS4KB

SEPTEMBER, 1989


SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLERS, WS5KB
SEPTEMBER, 1989
CONCENTRATION, MG/L
120
100
80
60
40
20
TIME, DAYS AFTER 1 SEPTEMBER 1989
0
2
4
6
8
10
12
14
16
18
20
22
24



SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLERS, WS7KB

SEPTEMBER, 1989

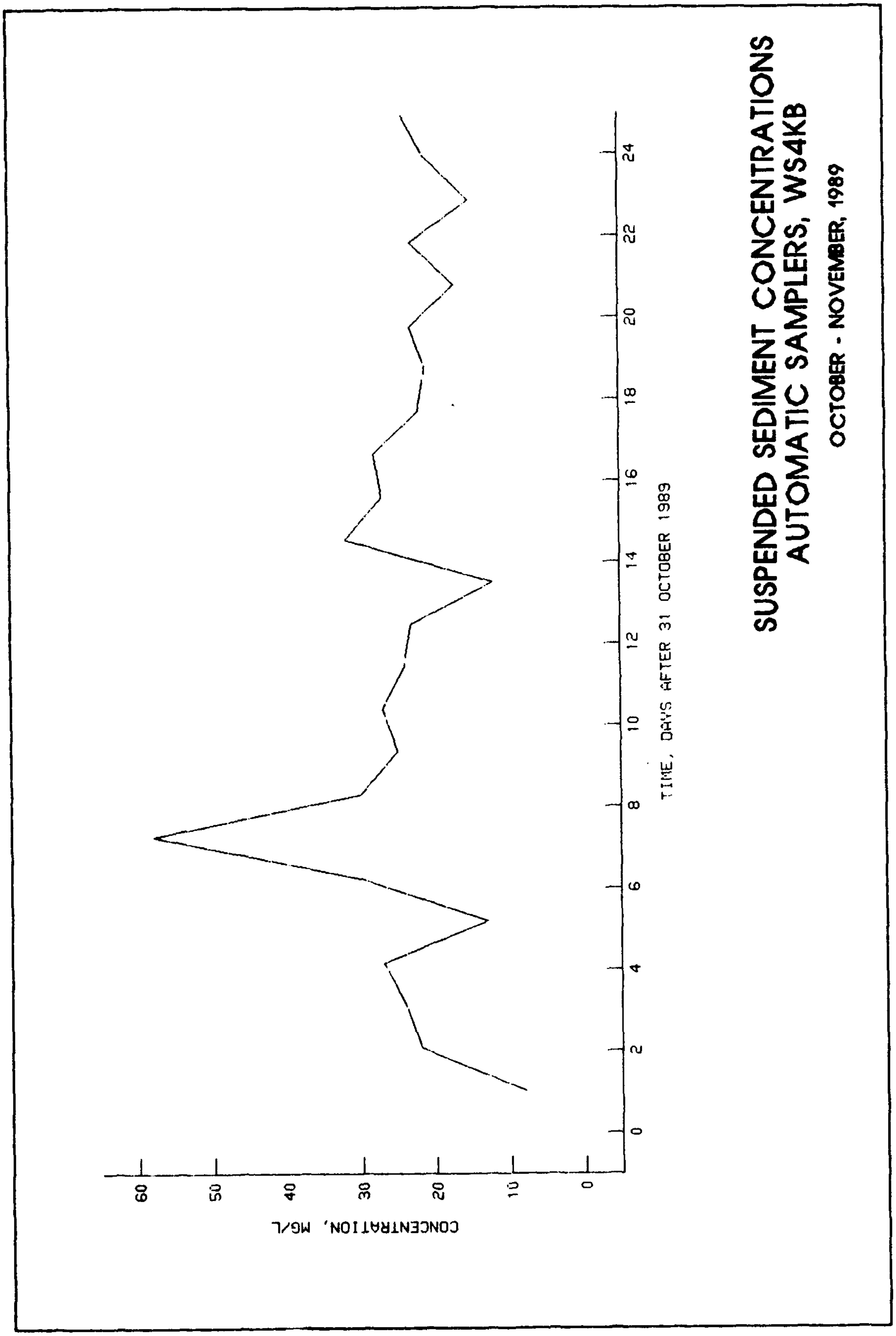
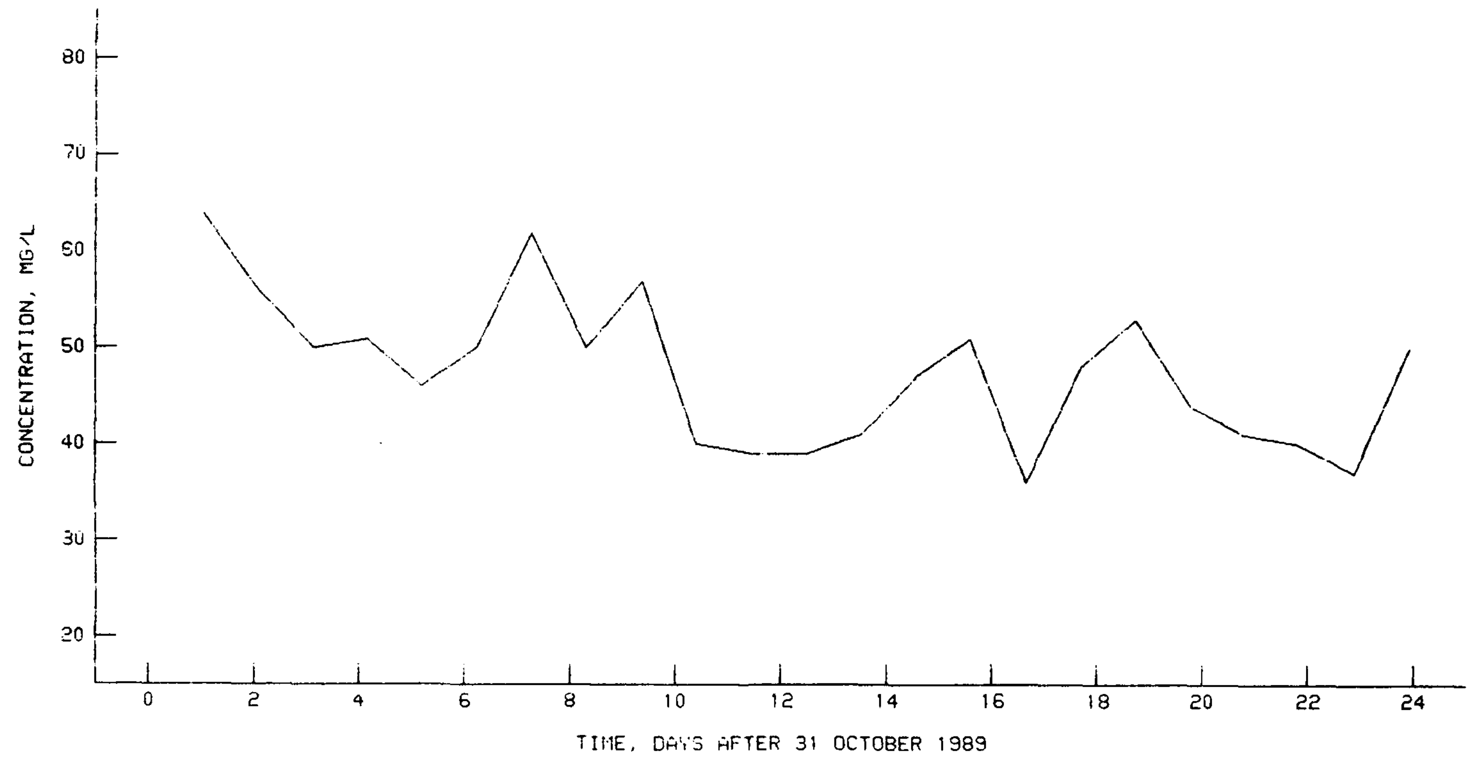
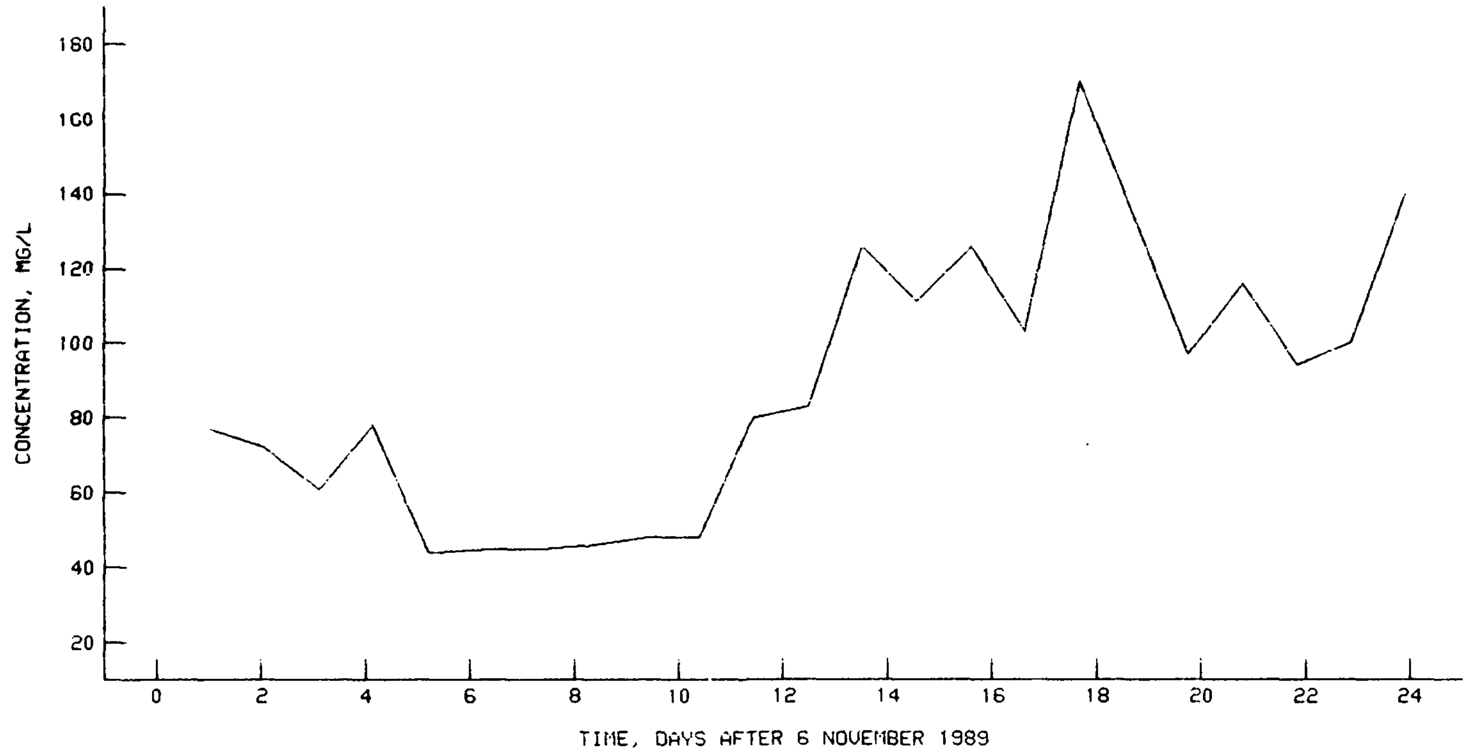

SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLERS, WS4KB
OCTOBER - NOVEMBER, 1989
CONCENTRATION, MG/L
0
10
20
30
40
50
60
TIME, DAYS AFTER 31 OCTOBER 1989
0
2
4
6
8
10
12
14
16
18
20
22
24

PLATE 34



SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLERS, WS5KB

OCTOBER - NOVEMBER, 1989



SUSPENDED SEDIMENT CONCENTRATIONS AUTOMATIC SAMPLERS, WS7KB

NOVEMBER, 1989